JTG

Industry Standards of
the People's Republic of China
中华人民共和国行业标准

JTG F80/1—2017(EN)

Standards for Quality Inspection and Verification of Highways
Part 1: Civil Engineering Works

公路工程质量检验评定标准
第一册　土建工程

(英文版)

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Issued by Ministry of Transport of the People's Republic of China

中华人民共和国交通运输部

公　　告

第10号

交通运输部关于发布《公路工程质量检验评定标准 第一册　土建工程》英、法文版等4项公路工程行业标准外文版的公告

为促进公路工程行业标准的对外交流，现发布《公路工程质量检验评定标准 第一册 土建工程》英文版［JTG F80/1—2017(EN)］［代替标准号JTG F80/1—2004(E)］及其法文版［JTG F80/1—2017(FR)］、《公路路基路面现场测试规程》英文版［JTG 3450—2019(EN)］［代替标准号JTG E60—2008(E)］、《公路技术状况评定标准》［JTG 5210—2018(EN)］。

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特此公告。

中华人民共和国交通运输部

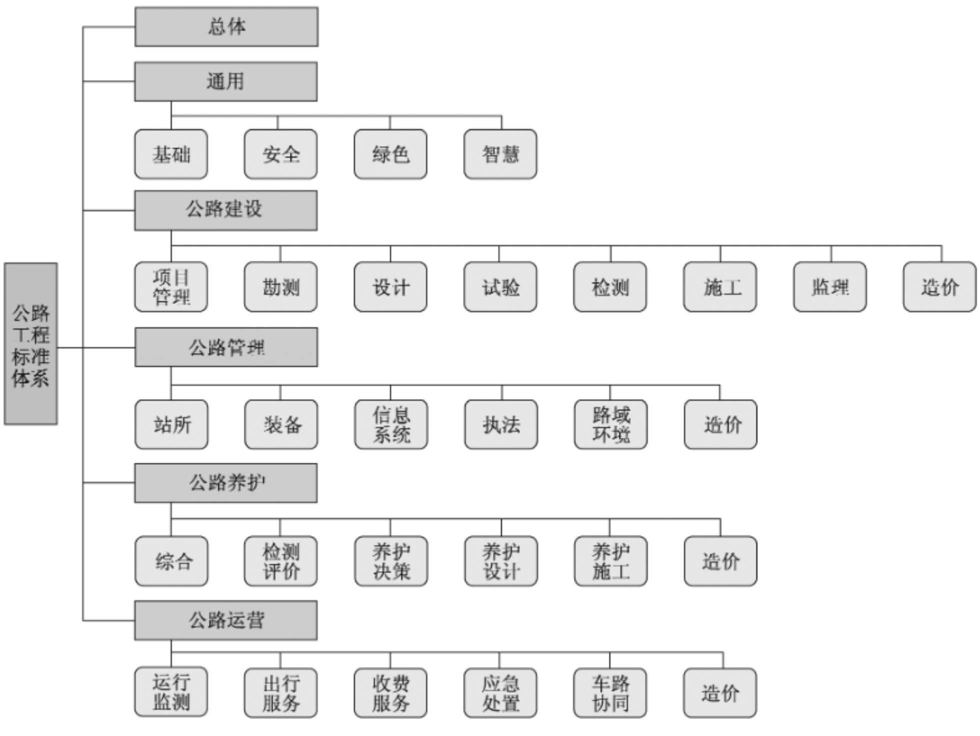
2022年1月18日

交通运输部办公厅　　2022年1月19日印发

英文版编译出版说明

标准是人类文明进步的成果，是世界通用的技术语言，促进世界的互联互通。近年来，中国政府大力开展标准化工作，通过标准驱动创新、合作、绿色、开放的共同发展。在“丝绸之路经济带”与“21 世纪海上丝绸之路”，即“一带一路”倡议的指引下，为适应日益增长的全球交通运输发展的需求，增进世界连接，促进知识传播与经验分享，中华人民共和国交通运输部组织编译并发布了一系列中国公路行业标准外文版。

中华人民共和国交通运输部发布的公路工程行业标准代号为 JTG，体系范围包括公路工程从规划建设到养护管理全过程所需要制定的技术、管理与服务标准，也包括相关的安全、环保和经济方面的评价等标准。



中国政府历来高度重视交通基础设施建设，不断完善公路基础设施设计相关的标准规范。二十世纪八十年代，中国在原《公路工程技术标准》（JTJ01-81）基础上，开始制订公路路线、路基、路面、桥梁、涵洞等专业技术规范，并在 1985 年颁布实施了第一部《公路工程质量检验评定标准》（JTJ 071-85），用于施工过程质量控制以及工程验收。尔后，经历了 1994 年的第一次修订（JTJ 071-94）和 1998 年的第二次修订（JTJ 071-98），从 2004 年的第三次修订开始，分为了“第一册 土建工程（JTG F80/1-2004）”和“第二册 机电工程（JTG F80/2-2004）”，并且在 2017 年对土建工程册进行了第四次修订（JTG F80/1-2017）。经过近四十年的技术发展，建立了内容较为完整的公路工程质量检验评定体系。本次编译的《公路工程质量检验评定标准 第一册 土建工程》（JTG F80/1-2017）中文版于 2017 年 12 月修订发布，并于 2018 年 5 月 1 日实施。

到 2020 年底，中国公路通车总里程接近 520 万公里，高速公路通车总里程超过 16 万公里。《公路工程质量检验评定标准》（以下简称《标准》）一直是我国公路工程施工质量验收方面的强制性技术标准，对中国公路工程建设质量提供了重要保障。《标准》以分项工程为基本单元，根据分项工程-分部工程-单位工程的顺序进行逐级评定，参与公路工程的建设项目的施工单位、监理单位、建设项目法人单位、检测单位和质量监督管理部门均应根据《标准》对公路工程质量进行自检、质量评定和验收。

在中国公路建设过程中，随着新材料的投入、设计理念的转变、高污染高成本工艺的淘汰，公路工程质量控制的标准也在不断进步和完善，这些经验与成果在《公路工程质量检验评定标准 第一册 土建工程》（JTG F80/1-2017）中得到了充分的体现。本英文版的编译发布便是希望将中国的工程经验和技术成果与各国同行进行交流分享，为其他国家的公路建设提供参考借鉴。

本英文版的编译工作由中华人民共和国交通运输部委托中国路桥工程有限责任公司主持完成，并由中华人民共和国交通运输部公路局组织审定。

本英文版标准的内容与现行中文版一致，如出现异议时，以中文版为准。

感谢中文版主编孟书涛先生、田克平先生在本英文版编译与审定期间给予的指导与支持。

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The People's Republic of China
Ministry of Transport
Public Notice

No. 10

Public Notice for Issuing the English version of the *Standards for Quality Inspection and Verification of Highways, Part 1: Civil Engineering Works*, and three other international versions of the Highway Transportation Industry Standards

For international cooperation and standardization of the highway transportation industry, four international versions of the Highway Transportation Industry Standards (JTG) are issued hereby:

(1) the English version of the *Standards for Quality Inspection and Verification of Highways, Part 1: Civil Engineering Works* [JTG F80/1—2017 (EN)], to replace its former edition [JTG F80/1—2004 (E)];

(2) the French version of *Standards for Quality Inspection and Verification of Highways, Part 1: Civil Engineering Works* [JTG F80/1—2017 (FR)];

(3) the English version of *Field Test Methods of Highway Subgrade and Pavement* [JTG 3450—2019 (EN)], to replace its former edition JTG E60—2008 (E); and

(4) the English version of *Highway Performance Assessment Standards* [JTG 5210—2018 (EN)].

The general administration and final interpretation of the Highway Performance Assessment Standards belong to Ministry of Transport of the People's Republic of China, while particular interpretation for application and routine administration of the international version of these Standards shall be provided by the China Road and Bridge Corporation.

Comments, suggestions and inquiries are welcome and should be addressed to the China Road and Bridge Corporation (Address: C88, Andingmenwai Dajie, Beijing, Postal Code: 100011, email: kjb@crbc.com). The feedback will be considered for future revisions.

It is hereby announced.

Ministry of Transport of the People's Republic of China

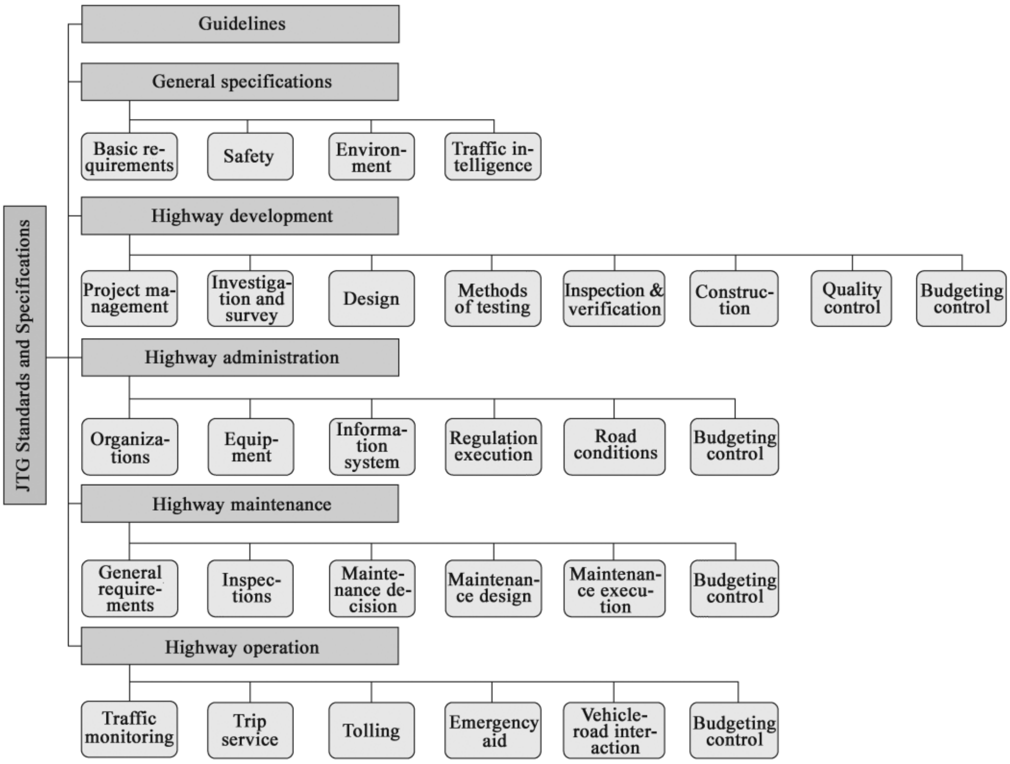
January 18, 2022

General Office of Ministry of Transport Printed on January 19, 2022

Introduction to English Version

Standards reflect the achievement of civilization, provide common language for technical communications, and improve global connectivity. In recent years, the Chinese government has been proactively implementing a strategy on standardization to stimulate innovation, coordination, greening, opening up and sharing for reciprocal development in China and worldwide. In the light of mutual development along the Silk Road Economic Belt and the 21st-Century Maritime Silk Road (so called 'the Belt and Road Initiative'), the Ministry of Transport of the People's Republic of China organized translation and published an international version of the Chinese transportation industry standards and specifications to cater for the increasing demands for international cooperation in world transportation, achieve interconnected development and promote knowledge dispersion and sharing experience.

JTG is the designation referring to the standards and specifications of the highway transportation industry, issued by the Ministry of Transport of the People's Republic of China. It covers the standards and specification in terms of technology, administration and service for the process from highway planning through to highway maintenance. The criteria for safety, environment and economic assessment are also included.



The Chinese government has always emphasized the development of the transportation infrastructure as a priority, and continuously improved and updated the standards for highway transportation. In the 1980s, following the publication of the principal standard, JTJ 01-81: Technical Standards for Highway Engineering, a series of professional and vocational specifications were drafted and developed. These specifications involve in highway geometry, subgrade, pavement, bridges and culverts. The first edition of the Standards for quality inspection and verification of Highways (JTJ 071-85) was issued and implemented in 1985, followed by a first revision and second revision in 1994 and 1998 respectively, providing guidance for the quality control during construction and the inspection and verification for acceptance. In the third revision in 2004, these Standards were divided into two parts, namely part 1 for civil works (denoted as F80/1-2004) and part 2 for electric and mechanical works (F80/2-2004) under the same title of Standards for quality inspection and verification of Highways, as was the fourth revision in 2017. For nearly four decades of technical development and continuous improvement, these Standards have effectively and successively served as guidelines for the inspection and verification of highway construction. The English version is JTG

F80/1-2017: Part 2: Civil Works of the Standards for Quality Inspection and Verification of Highways. The original Chinese version was issued in December 2017 and has been implemented since May 1, 2018.

By the end of 2020, the total length of highways being operated in China reached 5.2 million kilometers, of which 160 thousand kilometers were motorways. The Standards for Quality Inspection and Verification of Highways plays an important role in quality assurance of highway construction, and thus shall be regarded and implemented as mandatory requirements. As required by these Standards, the inspection and verification shall be executed in an increasing sequence one layer after another from the subdivisions of work, through the divisions of work, to the types of work. The self-inspections, quality assessment and verification for acceptance shall be carried out by various stakeholders of the project, including the contractors, supervisors, client, quality supervisors and relevant government agents.

During the process of highway development in China, many new materials have been introduced and adopted, innovative ideas absorbed into design concepts, some high polluting or low efficient workmanship were eliminated, and consequently the quality control standards have been continuously updated and improved. All these experiences and achievements have been incorporated and summarized in the JTG F80/1-2017: Standards for Quality Inspection and Verification of Highways, Part 1: Civil Works, and also in the English version of these Standards, which may be taken as a reference for engineers, project managers, and other practitioners of highway transportation in other countries.

The English translation of these specifications was conducted by China Road and Bridge Corporation under the authorization of the Ministry of Transport and approved by the Highway Administration of the Ministry of Transport.

The contents and numbering of the chapters, sections, clauses and sub-clauses in the English version are exactly the same as those in the Chinese version. In case of any ambiguity or discrepancies, the Chinese version should prevail.

Acknowledgement is given to Senior Eng. Meng Shutao and Senior Eng. Tian Keping, the Editors of the Chinese version, for the valuable assistance and suggestions during editing and reviewing of the English version.

Comments, suggestions and inquiries are welcome and shall be addressed to the organization responsible for the English version: China Road & Bridge Corporation (Address: 88C Andingmenwai Dajie, Postal Code: 100011, E-mail: kjb@crbc.com). The feedback shall be taken into account in future editions.

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Foreword to Chinese Version

Authorized by Ministry of Transport of China, the Research Institute of Highways (RIOH) MOT is in charge of updating the former JTG F80/1—2004 *Standards for Inspection and Verification of Quality of Highway Works*.

The former edition, JTG F80/1—2004, has been fully reviewed and updated. This edition was issued and put into effect as JTG F80/1—2017: *Standards for Quality Inspection and Verification of Highways*, *Part 1 Civil Engineering Works*.

In principle, the updating is guided by objectives and is focused on problem solving. As the technical basis for quality inspection and verification of highway construction, this edition highlights the rules for implementation, as well as limiting values and mandatory requirements. Adhering to the existing frameworks of quality inspection and verification, this edition simplifies the verification procedures, advocates rational determination of indicators and emphasizes the importance and leading role of inspection and verification of quality.

Major updates and revisions made in this edition are as follows:

1. The method of verification by rating used in the previous edition is replaced by a method based on 'percentage of conformity', thus the items and criteria of quality inspections on deliverables and activities are completely revised.

2. The scope of application, the procedures and activities of quality inspection and verification have been modified to enhance applicability, adaptability and practicability of the standard.

3. Chapters have been restructured; Chapter 3 is amended to include 'Basic elements', Chapter 12 of the previous edition is split into two, namely, Chapter 12 for 'Vegetation' and Chapter 13 for 'Noise Barriers'.

4. Some of the quality criterion for measurement items have been adjusted or revised, and the minimum requirements of percentage passing for general items are added.

5. Inspection frequencies of some measurement items have been adjusted. Based on the standard methodology, accurate and efficient inspection methods are encouraged.

6. Criteria of limiting defects in appearance quality and the requirements of joints of W-shaped guardrails have been added.

7. Holistic revisions have been made to work classification, for which the type of work, division of work and items of work have been redefined and categorized.

8. In order to keep consistence with the other relevant standards, corresponding verification indicators, inspection methods and relevant scope of works have been adjusted accordingly.

The background to provisions in these standards provides explanations on the purpose, rationale and the issue to which attention shall be paid during implementation. However, these expressions do not have a legal binding as the provisions in clauses, and thus shall be taken as references for comprehension.

For this edition of the standards, Meng Shutao and Zhou Xuli are responsible for drafting Chapters 1, 2 and 3, Zhang Tao, Xu Quanliang and Wei Xiaodan for drafting Chapters 4, 5 and 7, Wang Guoliang, Tian Keping, Xie Jun and Zheng Xiaohua for drafting Chapters 6, 8 and 9, Chen Jianxun and Ren Shangqiang for drafting Chapter 10, Zhou Zhiwei and Tang Hengheng for drafting Chapter 11, Shao Shegang for drafting Chapter 12 and Shang Xiaodong for drafting Chapter 13.

Comments, suggestions and inquiries are welcome and should be addressed to the Editing Organization (Contact person: Mr. Meng Shutao, Address: Floor 12 of Kuang-yi Plaza, No. 15, Huayuan Road East, Haidian District, Beijing, postal code: 100191, Tel: 010-62028502; fax: 010-62370155; email: st.meng@rioh.cn).

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Contents

1 General Provisions

1.0.1 These standards are formulated to regulate the process of quality inspection and verification of highway works, to unify the criteria of quality inspection and verification so as to insure the quality of highways.

1.0.2 These standards are applicable for inspection and verification of construction quality of new construction, upgrading and reconstruction of classified highways.

1.0.3 These standards set the minimum criteria for construction quality of highway works, and shall be confirmed by the inspection and verification of construction quality of highway works.

1.0.4 If there are no suitable criteria available in these standards because the construction project is located in an extraordinary area or adopts newly introduced materials, designs or technologies, the criteria may be developed by referring to relevant technical specifications or in accordance with actual conditions, and used for quality inspection and verification subject to the approval of the controlling authorities.

1.0.5 Besides these standards, quality inspection and verification shall conform to relevant provisions in current national and industry standards.

2 Terms and Definitions

2.0.1 Inspection

Activities to evaluate and judge the acceptance of a project by examining, measuring and testing its characteristics and properties.

2.0.2 Verification

Activities to determine the level of quality by inspecting the sub-divisions of work, divisions of work, types of work and packages of contract of a project.

2.0.3 Dominant item

The inspection item that performs critical and determinant roles in structural safety, durability and major service function are denoted by ‘△’ in these standards.

2.0.4 General item

The inspection item rather than a dominant one.

2.0.5 Quality of appearance

The external quality and functional status, recognized by direct observation and possibly measurement, of a construction work.

3 Basic Elements

3.1 General

3.1.1 Quality inspection and verification of highway construction shall be executed hierarchically from subdivisions of work, divisions of work to types of work and shall conform to the provisions as follows:

1 In a contract package, the works that are independent in terms of construction conditions and structural functions are defined as types of work.

2 A type of work may be divided into divisions of work by road section length, structure position or construction characteristics.

3 A division of work may be further divided into sub-divisions of work in terms of construction sequence, workmanship or materials.

3.1.2 The work classification to identify types of work, division ofwork and sub-divisions of work shall be conducted at the start-up stage of construction and shall conform to Appendix A of these standards.

3.1.3 Quality inspection and verification of highway works shall conform to the provisions as follows:

1 After completion, each subdivision of work shall be inspected and verified in accordance with these standards. Any concealed work shall be inspected for acceptance before being covered.

2 When a division of work or a type of work is completed, the quality verification data of the

relevant sub-divisions of work or the relevant divisions of work shall be collected, reviewed and assessed. The appearance shall also be inspected and the overall work quality shall be verified.

3.2 Quality Inspection

3.2.1 An subdivision of work shall be inspected and verified in terms of basic requirements, measurement items, quality of appearance and quality assurance data respectively.

3.2.2 The quality inspection and verification of a subdivision of work shall be performed only if that the basic requirements, in terms of raw materials, semi-finished or finished products and construction control points, are conformed, that no limited defect exists on appearance, and that the quality assurance data are correct and adequate

3.2.3 Inspection for basic requirements shall conform to the following provisions:

1 All of the listed basic requirements for sub-divisions of work shall be examined one by one. No quality inspection and verification shall be executed if there is any non-conformity.

2 The types, sizes and quality of raw materials, the mix design and the semi-finished or finished products shall conform to the corresponding technical standards and satisfy the design requirements.

3.2.4 Inspectionand verification of measurement items shall conform to the provisions as follows:

1 Inspection items shall be inspected by the methods at the frequency as specified for random sampling, testing and calculating the percentage conformity.

2 Methods of inspection specified in these standards are standard ones. Calibration and verification are required if a different testing method is to be adopted.

3 The inspection frequency in terms of length of a road segment specified in these standards is the lowest frequency for inspecting a two-lane road segment. The frequency of inspection shall be increased in proportion to the number of multiplelanes to two lanes.

4 Percentage passing of an inspection item shall be calculated by the following equation:

$$\text{Percentage passing of an inspection item}(\%) = \frac{\text{number of points(sets) passed}}{\text{total number of points(sets) inspected}} \times 100\%$$

3.2.5 The conformity of an inspection item shall verified in accordance with the criteria as follows:

1 Percentage passing of a dominant item shall not be less than 95% (100% for mechanical & electrical works), otherwise the inspected item is disqualified.

2 Percentage passing for a general item shall not be less than 80%, otherwise the inspected item is disqualified.

3 For an inspection item with a specified limiting value, any single testing value shall not exceed the specified limiting value, otherwise the inspection item is disqualified.

4 If any inspection item, which is inspected and verified by the methods stated in Appendices B to S, does not conform to the requirements, it shall be disqualified.

3.2.6 Appearance shall be fully inspected and conform to specified requirements, otherwise the inspection-verification portfolio shall be verified as disqualified.

3.2.7 Quality assurance data on construction works, including site logs, test records and quality inspection results, shall be correct, accurate, adequate and complete, and shall include but not be limited to the following:

1 Quality inspection results on the raw materials, semi-finished or finished products used in the works;

2 Inspection and test data on mix design and mixing processing;

3 Construction logbooks on ground foundation treatment, concealed works, and construction monitoring records on bridge and tunnel construction;

4 Test records on quality control indicators and master chart of quality inspection;

5 Records on abnormal situations during construction and relevant analytical evaluation reports on their impacts on construction quality;

6 Documents with evidence that can prove the conformity achieved by remediation of any quality mishap that occurred.

3.2.8 Any inspection-verification portfolio that is verified as disqualified shall be rectified or reworked until it passes inspection.

3.3 ConstructionQuality Verification

3.3.1 Construction quality is divided into two categories, qualified and disqualified.

3.3.2 Data as specified in Appendix K of these standards shall be provided for quality verification of sub-divisions of work, divisions of work and types of work.

3.3.3 Quality verification of sub-divisions of work shall conform to the following requirements:

1 Test records shall be complete;

2 Measured items shall be qualified;

3 Quality of appearance shall conform to specified requirements.

3.3.4 Quality verification on divided work shall conform to the following requirements:

1 Data and files for verification shall be complete;

2 Sub-divisions of work including their associated measurement items shall be verified as qualified;

3 Quality of appearance shall conform to specified requirements.

3.3.5 A qualified type of work shall conform to the following requirements:

1 Data and files for verification shall be complete;

2 Divisions of work contained in the type of work shall be verified as qualified;

3 Quality of appearance shall conform to specified requirements.

3.3.6 Disqualified work, either a sub-division or a division of work, may be re-inspected and re-verified, after reworking, remediation, strengthening or rechecking of the conformity to design requirements.

3.3.7 If all types of work of a contract package have been verified as qualified, the contract package shall be verified as qualified; similarly, if all contract packages of a construction project have been verified as qualified, the construction project shall be verified as qualified.

4 Earthworks

4.1 General

4.1.1 The specified values or tolerances of measurement items forearthworksare given in two groups: one group is Motorwaysand Class-1 highways, and another group refers to the other highway including Class-2, -3 and -4 highways. However the compaction of earthworks shall be classified into three groups: (1) earthworks of Motorways and Class-1 highways, (2) earthworks of Class-2 highways, and (3) earthworks of Class-3 and -4 highways.

4.1.2 The density of earthworks after compaction shall be tested in layers, and the density of the upper roadbed shall be verified according to the provisions of Appendix B. Other inspection items of road subgrade shall be inspected and measured on the upper layer in the roadbed.

4.1.3 Earth shoulder works can be inspected and verified as one sub-divisions of work of road pavement.

4.1.4 The compaction of earthwork in a toll plaza or the roads and parking lot at a service area, can be inspected and verified according to the requirements for earthworks in soil.

4.2 Earthworks in soil

4.2.1 Earthworks in soil shall conform to the basic requirements as follows:

1 All ground vegetations, mixed materials and standing water shall be cleared, silt and topsoil shall be removed, and water ponds shall be treated in the footprint areas of earthworks and borrow pits. The cleared area shall be properly compacted according to the

construction specifications and design requirements. Topsoil should be re-utilized as far as possible.

2 Soil embankment fill shall be placed and compacted in layers with an even layer surface, appropriate cross-slopes for good drainage, no obvious roller racks, and no uncompacted slope edges.

3 A temporary drainage system shall be provided to avoid erosion of the slope. The upper surface of the roadbed must not allow ponding water.

4 Borrow materials shall be properly excavated in assigned borrow areas. Excessive exploitation and random excavation are forbidden. The borrow-pits and areas of spoil shall be restored as required after work completion.

4.2.2 The measurement items forearthwork in soil shall conform to the criteria in Table 4.2.2

Table 4.2.2 Measurement items forearthworks in soil

<table>
<tr><th rowspan="3">No.</th><th rowspan="3" colspan="4">Inspection items</th><th colspan="3">Specified value or tolerance</th><th rowspan="3">Methods and frequency of inspection</th></tr>
<tr><th rowspan="2">Motorway and Class-1 highway</th><th colspan="2">Other classified highway</th></tr>
<tr><th>Class-2 highway</th><th>Class-3 and -4 highway</th></tr>
<tr><td rowspan="7">1△</td><td rowspan="7">Density (%)</td><td colspan="2">Upperroadbed</td><td>0 ~ 0.3m</td><td>≥96%</td><td>≥95%</td><td>≥94%</td><td rowspan="7">Appendix B by densitytest: 2 points in every 200m in each compacted layer</td></tr>
<tr><td rowspan="2">Lower road bed</td><td>Light, medium and heavy traffic load class</td><td>0.3m ~ 0.8m</td><td>≥96</td><td>≥95</td><td>≥94</td></tr>
<tr><td>Very-heavy and extra-heavy traffic load class</td><td>0.3m ~ 1.2m</td><td>≥96</td><td>≥95</td><td>—</td></tr>
<tr><td rowspan="2">Upper embankment</td><td>Light, medium and heavy traffic load class</td><td>0.8m ~ 1.5m</td><td>≥94</td><td>≥94</td><td>≥93</td></tr>
<tr><td>Very heavy and Extra heavy traffic load class</td><td>1.2m ~ 1.9m</td><td>≥94</td><td>≥94</td><td>—</td></tr>
<tr><td rowspan="2">Lower embankment</td><td>Light, medium and heavy traffic load class</td><td>> 1.5m</td><td rowspan="2">≥93</td><td rowspan="2">≥92</td><td rowspan="2">≥90%</td></tr>
<tr><td>Very-heavy and extra-heavy traffic load class</td><td>> 1.9m</td></tr>
</table>

continued

No.	Inspection items	Specified value or tolerance			Methods and frequency of inspection
		Motorway and Class-1 highway	Other classified highway		
			Class-2 highway	Class-3 and -4 highway	
2△	Deflection(0.01mm)	Not greater thandesigned value of deflection for acceptance			Appendix J
3	Profile levels(mm)	+10, -15	+10,-20		By level:2 pointsin every 200m at centerline
4	Theoffset from centerline(mm)	50	100		By total station: 2 pointsin every 200m, and additional two points, HY and YH, on curves
5	Width(mm)	Conform to the design requirement			By tape measure: 2 pointsin every 200m
6	Roughness(mm)	≤15	≤20		By 3-meter straight-edge: 2 pointsin every 200m and 5 times at every point
7	Cross slope(%)	± 0.3	±0.5		By level:2 cross-sections in every 200 m
8	Side slope	Conform to the design requirement			By tape measure:2 pointsin every 200 m

Note:1. The density figures listed in the table above are the relative field density to the maximum dry density (MDD) by the heavy compaction test as stipulated in JTG E40: *Test Methods of Soils for Highway Engineering*. The minimum confidence limit of the average densities in a road segment shall not be less than the specified values, and the single measuring value shall not be less than the limiting value (the tabulated value minus 5 percent). The percentage passing shall be calculated by the number of qualified points (each measured value is not less than tabulated specified value minus 2 percent divided by total number of measured points.

2. Forsevere drought regions, severe humid regions or over wet soil subgrade, the compaction of earthworks may be inspected and verified according to the design and construction specifications.

3. The compaction criteria for earthwork of Class-2 highways shall be adopted for the inspection and verification on earthworks of Class-3 and -4 highways with cement concrete pavement or asphalt concrete pavement.

4.2.3 The appearance of earthworks in soil shall conform to the following requirements:

1 Any change in slope appearing along the edge lines and side slopes of an embankment fill

shall not be longer than 50m over a one-way cumulative length.

2 No landslide, collapse or gully erosions deeper than 100mm shall be allowed on side slopes, embankment berms and slope berms in cuttings.

4.3 Earthworks in rock

1 A rock fill embankment shall be placed and rolled in layers. Each layer of fill shall be flat and even on the surface with appropriate cross slopes, good drainage, free from obvious roller tracks on the upper roadbed and no uncompacted slope edges.

2 Site clearance and top soil stripping on the original ground shall be executed before construction of rock fill embankment. The thickness of each layer of fill shall conform to the relevant construction specifications and design requirements and the stone voids shall be properly filled with fine stone and chips.

3 The criteria for deflection control of a rock fill embankment shall be determined by trial sections.

4.3.2 The measurement items for a rock fill embankment shall conform to table 4.3.2

Table 4.3.2 Measurement items forstone-filled embankment

No.	Inspection items	Specified value or tolerance		Methods and frequency of inspection
		Motorway andClass-1 highway	Other highway	
1△	Compaction①	Voids Conform to the design requirements.		By density test: 2 places in every 200m segmentof a compacted layer
		Deflection ≤ deflection criteria determined from trial sections		Bylevel: 1 cross-section every 50m, 5 points in each cross-section
2△	Deflection(0.01mm)	Notmore than the deflection value of the accepted design		Inspectin compliance with Appendix J
3	Profilelevels(mm)	+10, −20	+10, −30	By level: 2 points in every 200m along centerline
4	Offset of centerlin (mm)	≤50	≤100	By total station: 2 points in every 200m, and additional 2 pointsat HY and YH on curves
5	Width(mm)	Conform to the design requirements		By tape measure: 4 pointsin every 200m
6	Roughness(mm)	≤20	≤30	By 3-meter straight edge: 2 pointsin every 200m and 5 times at each point

continued

No.	Inspection items		Specified value or tolerance		Methods and frequency of inspection
			Motorway andClass-1 highway	Other highway	
7	Cross slope (%)		±0.3	±0.5	By level:2cross-sections in every 200m segment
8	Side slope	Slope	Conform to the design requirements		By tape measure:4 pointsin every 200m
		Smoothness	Conform to the design requirements		

Note:①For soil upper roadbed and lower roadbed, the criteria for compaction are the same as those of earthworks in soil.

4.3.3 The appearance of a rock fill subgradeshallconform to the following requirements.

1 Any folding appearing along the edge lines and side slopesof embankment fill shall not be greater than 50m in one-way cumulative length.

2 No loose rocks shall exist on the upper part of a side slope.

4.4 Soft GroundImprovement

4.4.1 Soft ground improvement shall conform to the basic requirements as follows:

1 The requirements for backfilling and compaction of ground soil replacement shall be the same as those for the earthworks in soil as stated in section 4.2 of these standards.

2 Sand mat shall be backfilled and compacted in layers; the width of sand mat shall be 0.5-1.0m wider than the slope toes on each edge, and the two edges shall be constrained with rubble masonry; the thickness of sand mat and its filter blanket above shall conform to the design requirements.

3 Stability berms: the height and width of the berms shall conform to the design requirements, and the compaction shall not be less than 90%.

4 For fabric-packed sand drains and wick drains:no tangling or fracture should occur during sinking of filter sleeves or prefabricated vertical drain (PVD) strips; the bottom elevation of sand wells (or PVD strips) shall conform to the design requirements. The top of the PVD strip above the ground surface shall be inserted into the sand blanket for a distance of at least 500mm.

5 Gravel columns:gravel columns shall be constructed and tested for compaction before the

subsequent layers; column shafts shallbe structurally continuous and well compacted.

6 Soil-cement columns: columns shall be constructed and tested for workmanship and pile strengths before subsequent layers are constructed; auto-logging devices for cement (or grout) jetting must be mounted on the construction machine; the construction methods and procedures shall conform to the requirements of the construction specifications.

7 Cement Fly-ash Gravel (CFG) piles: Piling procedures shall be evaluated on a trial section and the trial pile strength shall be tested before the piling construction starts. The mixture shall be mixed evenly, and a reasonable driving order should be selected for pile construction. Displacement monitoring shall be carried out on the pile top in the process of piling.

8 Rigid piles: Pile test shall be carried out before construction. The piling procedures shall conform to the requirements of construction specifications.

9 Embankment on soft ground shall conform to the design requirements for settlement criteria and stability.

4.4.2 Measurement items forsoft ground improvement shall conform to Tables 4.4.2-1 to4.4.2-6.

Table 4.4.2-1 Measurement items for sand mat

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Thickness of sandmat	≥design value	Bytape measure: 2 points in every 200m and not less than 5 points in total
2	Width of sandmat	≥Design value	Bytape measure: 2 points in every 200m and not less than 5 points in total
3	Filter position	Conform to the design requirement	By tape measure: 2 points in every 200m and not less than 5 points in total
4	Compaction (%)	≥90 ≥90	By density method: 2 points in every 200m and not less than 5 points in total

Table 4.4.2-2 Measurement itemsfor fabric-packed sand drains and prefabricated vertical drains(PVD)

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Spacing of wells (wicks) (mm)	±150	By tape measure: Spot check 2% and not less than 5 points in total
2△	Depth of well (wick)	> Design value	Check construction logbook
3	Well diameter (mm)	+10, -0	Excavate and check 2% and not less than 5 points in total
4	Ratio of sand-fill(%)	−5	Check construction logbook

Table4. 4. 2-3 Measurement items forgravel columns

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Column spacing (mm)	± 150	Spot check 2% and not less than 5 points in total
2	Column diameter (mm)	≥Design value	Spot check 2% and not less than 5 points in total
3△	Column length (m)	≥Design value	Check construction logbook
4	Ratio of gravel penetration	≥Design value	Check construction logbook
5	Ground bearing capacity	Conform to the design requirements	Spot check 0. 1% of the piles and not less than 3 points in total

Table 4. 4. 2-4 Measurementitems of soil-cementcolumns

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Column spacing (mm)	±100	By tape measure: Spot check 2% and not less than 5 points in total
2	Column diameter(mm)	≥Design value	Spot check 2% and not less than 5 points in total
3△	Column length(m)	≥Design value	Check construction logbook and combine with pile coring inspection: 0. 2% of the total and not less than 3 piles
4	Quantity of Cement (grout) jetted per meter in each column	≥Design value	Check construction logbook
5△	Strength (MPa)	Conform to the design requirement	By coring: spot check 0. 5% of the piles, and not less than 3 groups
6	Ground bearing capacity	Conform to the design requirement	Spot check 0. 1% of the piles and not less than 3 points

Table 4. 4. 2-5 Measurement items forCement Fly-ash Gravel (CFG) pile

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Pile spacing(mm)	± 100	Bytape measure: Spot check 2% and not less than 5 points in total
2	Pile diameter(mm)	≥Design value	Spot check 2% and not less than 5 points in total
3△	Pile length(m)	≥Design value	Check construction logbook and combine with pile coring inspection: 0. 2% of the total and not less than 3 groups
4△	Strength (MPa)	Conform to the design requirement	Measured by core method: Spot check 0. 5% of the piles, and not less than 3 groups
5	Ground bearing capacity	Conform to the design requirement	Spot check 0. 1% of the piles and not less than 3 points

Table 4.4.2-6 Measurement items forrigid piles

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Pile spacing(mm)	±100	Bytape measure:spot check 2% and not less than 5 points in total
3	Pile diameter(mm)	≥Design value	Spot check 2% and not less than 5 points in total
4△	Pile length(m)	≥Design value	Check construction logbook
5	Bearing capacity of a single pile	Conform to the design requirement	Spot check 0.1% of the piles and not less than 3 piles in total

4.5 Geosynthetic treated Layers

4.5.1 The geosynthetic treated layers shall conform to the basic requirements as follows:

1 Geosynthetics shall be free from signs of aging, damage or contamination.

2 Geosynthetics shall adhere to the lower bearing course. They shall be placed, stretched and fixed well in compliance with design and construction requirements.

3 The overlapping joints, seams, cohesion strength and length of geosynthetics shall conform to the design requirements. The overlapping joints or seams in upper and lower layers shall be staggered from one another.

4.5.2 Measurement items for geosynthetic treated layers shall conform to the requirements of Tables 4.5.2-1 to 4.5.2-4.

Table 4.5.2.1 Measurement items for geosynthetic treated layers for material reinforcement

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Formation of thesupporting layer	Conform to the design requirement	Inspect 4points in every 200m
2	Width ofoverlap(mm)	+50,0	By tape measure:spot check of 2%
3	Staggerspacing of overlap jointsor seams on adjacent layers (mm)	Conform to the design requirements	By tape measure:spot check of 2%
4	Anchorage length (mm)	Conform to the design requirement	By tape measure:spot check of 2%

Table 4.5.2-2 Measurement items ofgeosynthetic treated layersformaterial isolation

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Evenness and camber of supporting layer	Conform to the design requirement	Check 4 places in every 200m
2	Overlap width(mm)	+ 50,0	尺 By tape measure tape:spot check 2%
3	Stagger spacing of overlaps or seams of adjacent layer (mm)	Conform to the design requirement	Spot check of 2%
4	Waterinfiltration at overlap joints	No more than 1 point	Check eachjoint

Table 4.5.2-3 Measurement items forgeosynthetic treated layers for filtration in drainage works

No.	Inspection items	Specified value or tolerance	Methods and frequency of inspection
1	Formation of the supporting layer	Conform to the design requirements	Check 4 placesin every 200m
2	Overlap width(mm)	+ 50,0	By tape measure:spot check of 2%
3	Staggerspacing of overlaps or seams on adjacent layers (mm)	Conform to the design requirements	By tape measure:Spot check of 2%

Table 4.5.2-4 Measurement items forgeosynthetic treated layers for cracking control

No.	Inspectionitems	Specified value or tolerance	Methods and frequency of inspection
1	Evenness and camber of supporting layer	Conform to the design requirement	Check 4points in every 200m
2	Overlap width(mm)	+50,0	By tape measure:Spot check of 2%
3	Cohesion(N)	≥20	Spot check of 2% of the total area

4.5.3 The appearance of geosynthetic treated layers shall conform to the following requirements.

1 Geosynthetics shall have no folds or wrinkles.

2 Geosynthetics shall be fastened firmly.

5 Drainage Works

5.1 General

5.1.1 The construction of drainage works shall conform to the design requirements and construction specifications. Drainage works shall be positioned properly in accordance with local terrain to remove surface water and ground water out of the road reserve.

5.1.2 Draines, interception drains, discharge drains and other drainage elements shallbe inspected in accordance with the requirements in Clauses 5.5 and 5.6 of these standards.

5.1.3 Drainage works such as hydraulic drops, water chutes and water cushions shall be inspected for compliance with the requirements in Clause 5.6 of these standards.

5.1.4 Water curbs on pavement shall be included in items of work 'Curbs'. Subsurface drainage in a pavement base course shall be inspected in compliance with the requirements in Chapter 7 of these standards.

5.1.5 Backfilling of ditches and trenches shall conform to construction specifications and design requirements.

5.1.6 The open excavation for the foundations of sump pumps shall be inspected in compliance with the requirements in Chapter 8 of these standards.

5.1.7 The reinforced concrete members shall include the sub-divisions of work of steel reinforcing bar preparation and installation, and pre-stressed concrete members shall include the sub-divisions of work of preparation and tensioning of pre-stressing tendons.

5.2 Prefabrication of culvert segments

5.1.2 Prefabrication of culvert segments shall conform to the following requirements:

1 Concreteshall conform to the design requirements of durability (such as anti-frost, impermeability, anti-erosion.)

2 Neither exposed reinforcing bars nor honeycombing is allowed.

5.2.2 The measurement items for prefabrication of culvert segments shall conform to the requirements in Table 5.2.2.

Table 5.2.2 Measurement items for prefabrication of culvert segments

No.	Inspection items	Specified value ortolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Inner diameter (mm)	≥design value	By tape measure: random check 10% of the segments, at 2 cross-sectionsfor each segment and not less than 5 cross-sections in total.
3	Wall thickness (mm)	−3	By tape measure: random check 10% segment units, at 2 cross-sections for each segment and at least 5 cross-sections in total.
4	Straightness	Misalignmentshallbe no more than 0.2% ofpipelength	Random check 10% segment units. Measuring the greatest difference by using a stringline along the pipe.
5	Length (mm)	+5, 0	By tape measure: random check 10% of the segments, 1 place for each unit, at least 5 places in total.

5.2.3 Quality of appearance ofculvert segments shall conform to the following requirement:

1 No limited defects as listed in Appendix P, shall beevident onmedium or small pre-fabricated members.

5.3 Installation of precast concrete culverts

5.3.1 The installation of precast concrete culvertsshall conform to the basic requirements as follows:

1 The footings of precast culverts shallConform to the design requirements.

2 Each precast culvert segmentshallbe checked individually to ensurethat no cracks or other damage exists.

3 Segmentsshallbe placed in anevenand stable mannerto prevent the bottom of the culvert havinga converseslope. The elevation difference at segment jointsshall not be more than 5mmwhere drainage water flows. No mud, hard lumps, mortar orother debris is permitted inside theculvert.

4 For a pipe culvertwith inner diameter greater than 750mm, the segment joints shall be fully sealed all round from inside the culvert.

5 Before the externalsealing is constructed the connecting surfaces of segments shall be thoroughly washed. The surfaces shall be smooth, solid and free of cracks. The segment joints shallbe covered while the external sealing curingis taking place.

6 Culverts shall be tested forleaking if so required by the design. The leakage shall conform to the design requirements.

5.3.2 The measurement items forinstallationof prefabricated concrete culverts are specified in Table 5.3.2:

Table 5.3.2 Measurement items for installation of precast concrete drainage pipe

No.	Inspectionitems		Specified value or tolerance	Inspectionmethods and frequency
1△	Compressive strength of concrete or mortar strength (MPa)		Within the required range	According to AppendixD&F
2	Deviationof culvert axis (mm)		15	Total station or By tape measure:3 points between 2 adjacent manholes.
3	Elevation of the surfacefor water flow(mm)		± 10	Level or straight edge: Between two adjacent manholes, 1 point each atinlet and outlet, 1 or 2 points in between.
4	Thickness of culvert footing (mm)		≥design value	By tape measure:3 points between 2adjacent manholes
5	Pipe footing	肩宽 shoulder width (mm)	+10, -5	Bytape measure:2 positions between two adjacent manholes
		Shoulder height (mm)	±10	
6	Sealing	Width	≥design value	Byruler:random check 10% of external seals
		Thickness	≥design value	

5.3.3 The appearance of precast concrete culverts after installation is specified as follows:

1 No limited defects as listed in Appendix Pshallexist or appear on the culvert footing.

2 The culvertsegment jointsshallnot have cracks or spalling. The mortar on theinside of the joints shallnot have any bulges.

3 The surface of external sealing belts at segment jointsshall not be interrupted, nor bulging.

5.4 Masonry of manholes (gully pots)

5.4.1 The brickwork, blockwork and masonryof manholes (or gully pots) shall conform to the following requirements:

1 Thestrengths of masonrymaterials and concreteof manhole footings shall conform to the design requirements.

2 The quality of manhole covers shall conform to the design requirements.

3 The mortarmix shallbe correct. The mortar applied in manhole chamber walls shall fill the joints with good finishing. The internal surfaces of a chamber wall shallbe smooth. The lining shall be dense, smooth and free of cracks. Steps shallbe firmly fixed.

5.4.2 Measurement items forthemasonry of manholes (or gully pots) are specified in Table 5.4.2.

Table5.4.2 Measurement items formanholes or installationof rain-collection wells

No.	InspectionItems		Specified value or tolerance	Method and frequency
1△	Mortar strength (MPa)		Within the required range	According to Appendix F
2	Position of center point (mm)		50	Total station: Inspect every manhole.
3	Diameter (round) or length andwidth (rectangular) (mm)		± 20	Bytape measure: Inspect every manhole, 2 points for each manhole
4	Wallthickness (mm)		-10,0	By tape measure: Inspect every manhole, 2 points for each manhole
5	Bottom elevation (mm)		±20	By level: Inspect every manhole
6	Level difference manhole lid from surrounding road surface (mm)	Gully pot	0, -4	By level, carpenter level: every manhole
		Manhole	+4, 0	

5.4.3 The appearance of manholes or gully pots shall conform to the followingrequirements:

1 The manhole lids and lid framesshallbe firmly fixed. No ponding water is allowed around a manhole lid.

5.5 Earthditch

5.5.1 Earth ditches shall conform to the following requirements:

1 The slope of anearth ditch shallbe even, well compacted and stable.

5.5.2 Measurement items for earthditches are specified in Table 5.5.2:

Table 5.5.2 Measurement items for earth ditches

No.	Measuringitems	Specified value andtolerance	Method and frequency
1	Levels of ditch bottom(mm)	0, −30	By level: 4 points in every 200m and at least 5 points in total
2	Sectional dimensions (mm)	≥design value	By tape measure: 2 points in every 200m and at least 5 points in total.
3	Slope gradient	≥design value	By tape measure: 2 points in every 200m and at least 5 points in total.
4	Edge straightness (mm)	50	By tape measure: 2 points in every 200m by 20m stringline and at least 5 points in total.

5.5.3 The appearance ofan earth ditch shall conform to the following requirements:

1 No debrisor impediment to water flow shall be inside the ditch.

5.6 Stone pitcheddrainage ditches

5.6.1 Stone pitched ditches shall conform tothe following requirements:

1 The quality and sizes of stones (either rubble or blocks) or precast concrete blocksshallconform to the requirements of relevant national andindustry mandatorystandards, and anyother standards stated in contract documents and design requirements.

2 The mix of mortarshallbe correct. The spaces between pitching stonesshallbe uniformly and fully filled with mortar, and the surface of joints shall be fully sealed.

3 The contraction joints in the stone pitchingshall be aligned with those in the wall.

5.6.2 Measurement items for mortar set and stone pitched drainage ditchesshall conform to the requirements shown in Table 5.6.2.

Table 5.6.2 Inspection items for mortar rubble paved ditch

No.	Inspectionitems	Specified value or tolerance	Method and frequency
1△	Mortarstrength (MPa)	Within the required range	According to Appendix F
2	Axis offset (mm)	50	By total station ortape measure: 5 points in every 200m
3	Level at ditch bottom (mm)	±15	By level:5 points inevery 200m
4	Straightness of wall (mm)	30	By 20m stringline:2 points in every 200m
5	Slope gradient	Conform tothe design requirements	By slopegauge:2 points inevery 200m
6	Sectional dimensions (mm)	±30	By tape measure: 2 cross-sections inevery 200m and at least 5 cross-sections in total.
7	Thicknessof pitching(mm)	≥design value	By tape measure:Measure 2 points in every 200m
8	The width and thickness of footing (mm)	≥design value	By tape measure:2 points in every 200m

5.6.3 The appearance of a mortar pitching ditch shall satisfy the following requirements:

1 The finishing of pitched stone joints shall not have depressions or bulges.

2 There shall be no debris insidethe ditches, and no impediment to water flow.

5.7 Blind drains

5.7.1 Blind drains shall conform to the following requirements:

1 The placement, and the size and quality of filling materials of blind drains shall conform to construction specifications and design requirements.

5.7.2 Measurement items for blind drains shall conform to the requirements shown in Table 5.7.2.

Table 5.7.2 Measurement items for blind drain

No.	Inspectionitems	Specified value and tolerance	Method and frequency
1	Level on trench bottom(mm)	± 15	By level: measure 1 point in every 200m
2	Sectional dimensions(mm)	No less than the design value	By tape measure: 1 point in every 200m

5.7.3 The appearance of a blind ditch shall conform to the following requirements:

1 Water flow should not be blocked at the inlets and outlets of blind drains.

5.8 Sump pump well

5.8.1 Sump pump wells shall conform tothe following requirements:

1 The groundfoundation for a well should have an adequate bearing capacity.

2 The concrete of well walls shall be dense. The well sinking operation shall start only after the well concrete reaches full strength and conforms to the required strength.

3 During sinking operation, attention shall be paid to keeping the well in the correct position. If any deviation or inclination occurs, it shall be rectified immediately.

4 The bottom of a well shall be dense and free of leakage.

5 Pumps, pipes and their fittingsshall be fixed firmly in the correct position.

5.8.2 Measurement items for wells of sump pumps are shown in Table 5.8.2.

Table 5.8.2 Inspection items for sump pump well

Item	Inspection items	Specified value or tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Horizontal offset from axis (mm)	50	By total station: 2 points each in longitudinal and transverse directions
3	Verticality(mm)	1% H	By plumbing: 2 points each in longitudinal and transverse directions
4	Dimensions (mm)	±50	By tape measure: 2 points each on length, width and height respectively.
5	Wall thickness(mm)	−5,0	By tape measure: 5 points for every well
6	Levels onwell top(mm)	±50	By level: 4 points

Note: H represents depth of a well, and the specified value and tolerance shall be calculated in mm.

5.8.3 The appearance of the well of a sump pump shall conform to the following requirements:

1 The limited defects, as those listed in Appendix P, shall not exist in a well.

5.9 Desilter

5.9.1 Desilters shall conform to the basic requirements as follows:

1 The position and elevations ofa inlet or outlet shall onform to design requirements.

2 If the desilter is designedto be impermeable, leakage tests hallbe conducted to ensure leakage is below the specified limits.

5.9.2 Measurement tems for desilters shall conform to the requirements in Table 5.9.2.

Table 5.9.2 Measurement items for desilter

No.	Inspectionitems	Specified value or tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the requiredrange	According to Appendix D
2	Offset of horizontal axis	±50	By total station:2 points each on longitudinal and transverse directions.
3	Dimensions (mm)	±50	By tape measure:2 points each on length, width, height and wall-thickness respectively.
4	Bottom elevation (mm)	±50	By level:2 points

5.9.3 The appearance of a desilter shall conform to the following requirements:

1 The limited defects, as listed in Appendix P, shall not exist in a desilter.

6 Protective and Retaining Works

6.1 General

6.1.1 A retaining wall, either stone pitched or a rubble-concrete, which average height is greater than or equal to 6m, and the total area of the front-face is greater or equalto 1,200m^2, is defined as a large-scale retaining wall. Every large-scale retaining wall shall be regarded as an independent division of work for quality inspection and verification.

6.1.2 For composite retaining walls, such as soldier pile walls, tieback walls or anchored walls, each of them at a site shall be regarded as one of the independent division of work for quality inspection and verification.

6.1.3 For soldier pile walls, the piles shall be inspected according to relevant specifications given in Section 8.5 of these standards. Prefabrication and installation of the laggings shall be inspected according to the relevant specifications in Section 6.4 of these standards.

6.1.4 The soldier piles may be inspected according to piling workmanship by referring to the relevant specifications given in Section 8.5 of these standards.

6.1.5 Spur dikes and river revetments may be inspected by referring to the related specifications for retaining walls.

6.1.6 The minor masonry works which are not included in Clause 6 or Clause 8 may be inspected with reference to Clause 6.10.

6.1.7 Reinforced concrete structures or structural members shall comply with the sub-divisions of work of processing and installation of reinforcing steel, and shall be inspected according to Section 8.3 of these standards.

6.2 Stone-pitched and rubble-concrete retaining walls

6.2.1 Retaining walls, either stone-pitched or rubble-concrete ones, shall conform to the following requirements:

1 The strength of the mortar for pointingshall not be lower than that of the mortar for masonry.

2 The bearing capacity of ground and the embedded depth of footing shall conform to the design requirements.

3 Stones or rubble shall be laid in layers, and the inter-stone joints shall be staggered from one layer to the next. For wet masonry, sufficient mortar shall be placed and compacted to fully fill the joints with no voids. For dry masonry, pitched stones or rubbles shall not be loose; putting two smaller pieces together as a solid one or just plugging small pieces into an overlarge joint are not allowed.

4 The concrete shall be poured in layers. The placement of construction joints and rubbles shall conform to the construction specifications.

5 The positions, sizes and number of settlement joints, expansion joints and weepholes shall conform to the design requirements. Settlement joints and expansion joints shall be vertically straight, continuous through the wall from bottom to top, and filled with resilient water-stop material to a depth in compliance with the design requirements.

6.2.2 Measurement items forstone pitched or rubble-concrete retaining walls shall conform to Table 6.2.2-1 to Table 6.2.2-3

Table 6.2.2-1 Measurement items for mortar pitched retaining walls

No.	Inspection Items	Specified value and tolerance	Method and frequency
1△	Mortar strength (MPa)	Within the required range	According to Appendix F
2	Horizontal position (mm)	≤50	By total station: for outer edge line along wall top: 5 points for a wall length upto 30m, and 1 additional point for every 10 m increase.
3	Slope of wall (%)	≤0.5	By plumbing: 5 points for a wall length upto 30 m, and 1 additional point for every 10 m increase.

continued

No.	Inspection Items		Specified value and tolerance	Method and frequency
4△	Sectional dimensions (mm)		≥design value	By tape measure: 10 cross-sections for a wall length upto 50m, and 1 additional cross-section for every 10m increase.
5	Elevation of wall top (mm)		±20	By level: 5 points for a wall length upto 30 m, and 1 additional point for every 10 m increase.
6	Surface evenness (mm)	Stone-pitched concrete	≤20	By2m straight edge: 3 points in every 20m, in both vertical and longitudinal directions at each point.
		Rubble	≤30	
		precast concrete block ordressed stone	≤10	

Table 6.2.2-2　Measurement items for dry-laid masonry retaining wall

No.	Inspection Items	Specified value and tolerance	Method and frequency
1	Horizontal position (mm)	≤50	By total station: for outer edge line along wall top, 5 points for a wall length upto 30 m, and 1 additional point for every 10 m increase.
2	Slope of wall (%)	≤0.5	By plumbing: 5 pointsfor the wall length upto 30 m, and 1 additional point for every 10 m increase.
3△	Sectional dimensions (mm)	≥design value	By tape measure: 10 cross-sections for a wall length upto 50 m, and 1 additional cross-section for every 10 m increase.
4	Elevation at wall top (mm)	±50	By level: 5 points for the wall length upto 30 m, and 1 additional point for every 10 m increase.
5	Surface evenness (mm)	≤50	By2m straight edge: 3 points in every 20m, in both vertical and longitudinal directions at each point.

Table 6.2.2-3　Measurement items for rubble concrete retaining wall

No.	Inspection Items	Specified value and tolerance	Method and frequency
1△	Strength ofconcrete (MPa)	Within the required range	According toAppendix D
2	Horizontal position (mm)	≤50	By total station: for outer edge line along wall top, 5 points for a wall length upto 30 m, and 1 additional point for every 10 m increase.
3	Slope of wall (%)	≤0.3	By plumbing: 5 pointsfor the wall length upto 30 m, and 1 additional point for every 10 m increase.

continued

No.	Inspection Items	Specified value and tolerance	Method and frequency
4△	Sectional dimensions (mm)	≥design value	By tape measure: 10 cross-sections for a wall lengthupto 50 m, and 1 additional cross-section for every 10 m increase.
5	Elevation of wall top (mm)	±20	By level:5 points for the wall length up to 30 m, and 1 additional point for every 10 m increase.
6	Surface evenness(mm)	≤8	By 2mstraight edge:3 points in every 20m, in both vertical and longitudinal directions at each point.

6.2.3 The appearance of a retaining wall, either stone pitched or rubble-concrete, shall conform to the following requirements:

1 The cumulative equivalent-area of defects, such as cracking, loose filling, peeling, shall not be more than 1.5% of the total area of mortar filled openings, and any single equivalent area of defects shall not be greater than 0.08m^2. The equivalent area is computed by the length of defective openings multiplied by 0.1m.

2 The limited defects, as listed in Appendix P, shall not exist on the concrete surfaces.

3 The body of a wallshall not be deformed with outward bulging.

4 Weepholesshall not be blocked, nor have reversed slopes.

6.3 Cantilever and buttressed walls

6.3.1 Cantilever and buttressed retaining walls shall conform to the basic requirements as follows:

1 Ground bearing capacityshall conform to the design requirements.

2 The positions, sizes and number of settlement joints, expansion joints and weepholes shall conform to the design requirements; the settlement joints and expansion joints shall be straight vertically and continuous from bottom to top, filled with elastomeric waterproof material to a depth in compliance with the design requirements.

6.3.2 Measurement items for cantilever and buttressed retaining walls shall conform to the requirements in Table 6.3.2

Table 6.3.2 Measurement items for cantilever and buttressed retaining walls

No.	Inspection Items	Specified value and tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According toAppendix D
2	Horizontal position(mm)	≤30	By total station:5 points for a wall length upto 30 m, and 1 additional point for every 10 m increase.
3	Slope of wall (%)	≤0.3	By plumbing:5 pointsfor a wall length upto 30 m, and 1 additional point for every 10 m increase.
4△	Sectional dimensions (mm)	≥design value	By tape measure: 10 cross-sections and 10 buttresses for a wall length upto 50 m, and 1 cross-section and 1 buttress additional for every 10 m increase.
5	Elevation of wall top (mm)	±20	By level:5 points for a wall length upto 30 m, and 1 additional point for every 10 m increase.
6	Surface evenness(mm)	≤8	By 2m straight edge:3 points for every 20m, each in vertical and longitudinal directions respectively.

6.3.3 The appearance of cantilever and buttressed retaining walls shall conform to the following requirements:

1 The limited defects, as listed in Appendix P,shall not exist on the concrete surface and those defectsre the are stricted in Appendix P shall not exist.

2 The body ofa wall shall not be deformed with outward bulging.

3 Weepholesshall not be blocked, nor have reversed slopes.

6.4 Tieback walls, anchored walls and reinforcedearth-wall

6.4.1 Tieback walls, anchored walls and reinforced earth-walls shall conform to the basic requirements as follows:

1 The number of tiebacks, anchored rods, or soil reinforcementstrips shall not be less than that required by the design.

2 The ground bearing capacityshall conform to the design requirements.

3 Reinforcementstrips shall be disentangled, straightened and laid flat. The connections between strips and face panels or those between strips shall be firm.

4 The length of a tieback shall be greater than or equal to its designed length. The length of a tieback, which is to be inserted into a pre-drilled hole, shall not be less than 98% of its designed length.

5 The grouting around tiebacks shall conform to the relevant construction specifications. The grout in anchor holes shall be dense. The grouting pressure shall conform to the design requirements.

6 The positions, sizes and numberof contraction joints, expansion joints and weepholes shall conform to the design requirements. The settlement joints and expansion joints shall be vertically straight, continuous from bottom to top, and densely filled with elastomeric waterproof material to a depth incompliance with the design requirements.

7 The protection of tie rods and anchor rods shall conform to the design requirements.

6.4.2 Measurement items for grouted-tieback walls, end-anchored walls and reinforced earthwalls shall conform to the following requirements:

1 Pre-fabrication of footings andrib-columns shall be inspected according to relevant specifications in Section 8.5 and Section 8.12. The other measurement items shall follow the criteria in Table 6.4.2-1 to Table 6.4.2-6.

Table 6.4.2-1 Measurement items for tieback walls

No.	Inspection items	Specified value and tolerance	Method and frequency
1	Length of tie-strip	≥design values	By tape measure: 5strips in every 20m
2	Connection of tie-strip to face-panel	Conform to the design requirements	Visual inspection: all connections
3	Connection of tie-strip to strip	Conform to the design requirements	Visual inspection: all connections
4	Tie-strip laying	Conform to the design requirements	Visual inspection: all tie-strips

Table 6.4.2-2 Measurement items foranchor-rod walls

No.	Inspection items	Specified value and tolerance	Methodand frequency
1△	Length (mm)	≥design value	By tape measure: measure 5 anchor-rods over every 20m
2	Spacing between anchor-rods (mm)	±100	By tape measure: measure 5 anchor-rods over every 20m
3	Connectionof anchor-rods to facepanels or deadmen (anchors)	Conform tothe design requirements	Visual inspection: all connections

Table 6.4.2-3 Measurement items for tieback walls

No.	Inspection items	Specified value and tolerance	Method and frequency
1△	Strength of grout (MPa)	Within the required range	According to Appendix For Appendix M
2	Depth of drilled hole(mm)	≥design value	Bytape measure: check 20% randomly
3	Diameter of drilled hole (mm)	Conform tothe design requirements	By ruler: 20% randomly
4	Axial offset of drilled hole (%)	2	Inclinometer: 20% randomly
5	Hole spacing(mm)	±100	By tape measure: 20% randomly
6△	Pull- resistance of tieback(kN)	Conform to design. If no specific requirements given in the design, then average pullout-resistance ≥ design value; pullout-resistance of 80% of tiebacks≥design value; Minimum pullout-resistance ≥ 0.9 of design value	Pullout test: the number inspected as specified in the design, 5% but not less than 3 tiebacks if no specific requirement in the design.
7	Connectionof tieback to facepanel	Conform to the design requirements	Visual inspection: all connections

Table 6.4.2-4 Measurement itemsforprefabrication of face panels

No.	Inspection items		Specified value tolerance	Method and frequency
1△	Strength of concrete(MPa)		Within the required range	According to Appendix D
2	Edge length (mm)	Side length < 1m	±5	By tape measure: spot check 10%, measure the height and width of each plate once
		others	±0.5% of side length	
3	Difference between two diagonals (mm)	Side length < 1m	≤10	Bytape measure: spot check 10%, measure 2 diagonals ofeach plate.
		others	≤0.7% of the larger diagonal length	
4△	Thickness (mm)		+5, −3	By tape measure: spot check10%, measure 2 points ofeach plate.
5	Surface evenness(mm)		≤5	By2m straight edge: spot check 10%, 1 point in length direction.
6	Positions of built-in fitting (mm)		≤5	By tape measure: spot check 10%

Table 6.4.2-5 Measurement itemsfor installation of face panels

No.	Inspection items	Specified value and tolerance	Method and frequency
1	Level of top edge of face panel in row(mm)	±10	By level: 5 groups in a length upto 30 m, and 1 additional for every 10m increase.
2	Axis offset(mm)	≤10	By stringline and ruler: 5 points in a length upto 30m, and 1 additional every 10m increase.
3	Slope of face panel (%)	+0, -0.5	By plumbing: 5 points in a length upto 30 m, and 1 additional in every 10 m increase.
4	Faulting of face panels	≤5	By ruler: 5 joints at the maximum faulting gap of each, and 1 additional for every 10 m increase.
5	Width of inter-panel joints (mm)	≤10	Ruler: 5 joints in a length upto 30m, and 1 additional joint for every 10 m increase

Note: During installation, one group of panels consists of two panels next to each other in the same horizontal row.

Table 6.4.2-6 Measurement itemsfor tieback walls, anchored walls and reinforced earth wallsin general

<table>
<tr><th>No.</th><th colspan="2">Inspection items</th><th>Specified value and tolerance</th><th>Method and frequency</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Horizontal position of top of wall and rib column(mm)</td><td>Revetment type</td><td>+50, -100</td><td rowspan="2">By total station: where the length is not more than 30 m, 5 points shall be measured, and 1 additional point for every 10 m increase.</td></tr>
<tr><td>Shoulder type</td><td>±50</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Levels of top of the wall andrib columns (mm)</td><td>Revetment type</td><td>±50</td><td rowspan="2">By total station: where the length is not more than 20 m, 3 points shall be measured, and 1 additional point for every 10 m increase.</td></tr>
<tr><td>Shoulder type</td><td>±30</td></tr>
<tr><td>3</td><td colspan="2">Spacing of rib columns(mm)</td><td>±15</td><td>Ruler: check every spacing</td></tr>
<tr><td>4</td><td colspan="2">Evenness of wall surface (mm)</td><td>≤15</td><td>2m straight edge: measure 3 points for every 20m, checking along vertical and longitudinal directions at each point.</td></tr>
</table>

6.4.3 The appearance of tieback walls, anchored walls or reinforced earth walls shall conform to the following requirements:

1 The limited defects, as listedin Appendix P, shall not exist in the concrete members.

2 Anchor headshall not be exposed. Sealing concrete or mortar at anchor heads shall have no cracking or spalling.

3 The body ofa wall shall not be deformed with outward bulging.

4 Weep holesshall not be blocked, nor in reversed slopes.

6.5 Backfill behind wall

6.5.1 Backfill behind retaining walls shallconform to the basic requirements as follows:

1 Selected materials in compliance with design requirementsshall be used for backfilling behind retaining walls. Such materials should be free from organics, iced blocks, grass or plants, roots, and other debris or domestic waste. The chemical or electro-chemical performance of backfill materials shall satisfy the needs for rust-resistance and durability of tiebacks, anchor rods and reinforcing strips. Any materials with high swelling potential or high liquid limit, such as humus soil, salty soil, mud or frozen soil are strictly prohibited to be used for backfilling.

2 Backfill behind retaining wallsshall overlap the earthworks in cutting or embankment fill, and Conform to the design requirements.

3 Backfillshall be compacted in layers. The surface of each layer shall be smooth, and shaped to the cross slopes of the surface layer.

4 The materials and the position ofa filter layer shall conform to the design requirements.

5 Backfilling shall start only after the strength of the main body of the retaining wall reaches 75% of the design strength.

6.5.2 Measurement items for backfill behind retaining walls shall conform to the following requirements:

1 For tieback walls, anchored walls and reinforced earth walls, the measurement items used for the zones within 1 m from the backface of a retaining wall are listed in Table 6.5.2. For other types of retaining walls, the requirements for the compaction of backfill are the same as the earthwork in soil.

Table 6.5.2 Measurement items for the backfill behind a tieback wall, anchored wall or reinforced-earth retaining wall

No.	Inspection items	Specified value and tolerance	Method and frequency
1△	Compaction within the 1m zone from backface of a wall(%)	≥90	According to Appendix B. 1 point in every 50m long compacted layer, and not less than one point in total

续上表

No.	Inspection items	Specified value and tolerance	Method and frequency
2	Thickness of filter layer (mm)	≥design thickness	Bytape measure: 5 points in a length upto 50 m, and 1 additional point for every 10 m increase.

6.5.3 The appearance of backfill behind a wall shall satisfy the following requirements:

1 The accumulated length ofan uneven surface of backfill shall not be greater than 10% of the total wall length.

2 No uncompacted slope edge is allowed.

6.6 Slope protection with anchors

6.6.1 Slope protection with anchors shall satisfy the basic requirements as follows:

1 The slope gradients and surfaces shall conform to the design requirements. There shall be no weathered materials or loose rocks on the slope surface. The slope surface shall be washed by jetting water before shotcreting.

2 The number of anchor rods or tieback cables shall not be less than that specified in the design.

3 The reinforcing bars or Steel fabrics of the grid beams shall be fixed firmly to anchor rods or other anchoring devices, and stay rigid during shotcreting.

4 The performance of grout shall conform to relevant construction specifications. Grouting pressure shall satisfy the design requirements and the grout in anchor holes shall be dense.

5 Water seepage and flow on the slope surface shall be properly treated before shotcreting.

6 The basic requirements of pre-stressed anchor rods or tieback cables shall conform to the provisions in Clause 8.3.2 of these standards. The tensioning shall be executed in compliance with the procedures defined in the design.

7 The lengths ofan anchor rod or a tieback cable shall be greater than or equal to the designed length. For a prestressed rod or tieback cable, the length inserted into the anchor hole shall not be less than 97% of designed length, and for other types of anchors shall notbe less than 98%. The duct for the non-anchored part of a tieback shall be fixed in the position in

compliance with design requirements.

8 The pre-stressed anchor rods or tieback cables shallbe cut by machine. The anchor strength shall conform to the design requirements.

9 The position and width of a settlement joint or an expansion joint shall conform to the design requirements. The joints shall be densely filled with elastomeric materials to a depth in compliance with design requirements.

10 The rods and tie cables shall be protected as required by the design.

6.6.2 Measurement items for slope protection by anchors are shown in Table 6.6.2-1 and Table 6.6.2-2.

Table 6.6.2-1 Measurement items for anchor rods or tieback cables

<table>
<tr><th>No.</th><th colspan="2">Inspection items</th><th>Specified value andtolerance</th><th>Inspection methodsand frequency</th></tr>
<tr><td>1△</td><td colspan="2">Strength of grout (MPa)</td><td>Within the required range</td><td>Mortar shall be inspected by Appendix F. Other items shall be inspectedby Appendix M</td></tr>
<tr><td>2</td><td colspan="2">Depth of anchor hole(mm)</td><td>≥design value</td><td>By ruler: spot check20%</td></tr>
<tr><td>3</td><td colspan="2">Diameterof anchor hole(mm)</td><td>As specified in design</td><td>By ruler: spot check 20%</td></tr>
<tr><td>4</td><td colspan="2">Angle of anchor hole (%)</td><td>2</td><td>By inclinometer: spot check 20%</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Position ofanchor hole(mm)</td><td>Grid beam</td><td>±50</td><td rowspan="2">By ruler: spot check 20%</td></tr>
<tr><td>others</td><td>±100</td></tr>
<tr><td>6△</td><td colspan="2">Pullout resistance of anchor rod or tieback cable(kN)</td><td>Conform to the design requirements. If no special requirements from design, then average pullout-resistance≥design value; the pullout-resistance of 80% of rods≥design value; the minimum pullout resistance ≥0.9 of design value</td><td>Pullout test: Inspection number shall follow the design requirements. If it is not specified in the design, 5% of the rods and not less than 3 rods shall be inspected.</td></tr>
<tr><td>7△</td><td colspan="2">Jacking force(kN)</td><td>As specified in design</td><td>Check oil pressure gauge for every rod or cable</td></tr>
<tr><td>8</td><td colspan="2">Elongation fromtensioning (%)</td><td>Conform to the design requirements. If not specified in design, it shall be taken as ±6.</td><td>Ruler: every rod or cable</td></tr>
<tr><td>9</td><td colspan="2">Number of wires broken or slipped</td><td>One wire for each cable, and less than 1% of total wires in any cable section.</td><td>Visual inspection: every rod or cable</td></tr>
</table>

Note: No need to inspect the items which are not involved in an actual project.

Table 6.6.2-2 Measurement items for protection of slope surface

No.	Inspection items	Specified value and tolerance	Method and frequency
1△	Strength of concrete(MPa)	Within the required range	Shotcrete according to Appendix E, others according to Appendix D
2	The thickness of shotcrete (mm)	Average thickness ≥ design value; thickness of 80% of measured points ≥ design thickness; minimum thickness ≥ 0.6 of design value, and not less than minimum value specified by the design.	By coring, or geo-radar method: 1 point for every $50m^2$, not less than 5 points in total.
3	Dimensions of anchor seat (mm)	+10, −5	By ruler: spot check 20%, the side length at top and bottom and the height
4	Geometry of grid beam, bottom beam, and peripheral beam(mm)	≥ design value	By tape measure: spot check20%, two cross-sections for each beam
5	Horizontal positions of grid beam, bottom beam, and peripheral beam(mm)	±150	By tape measure: spot check 10%

Note: No need to inspect the items which are not involved in an actual project.

6.6.3 The appearance for slope protection by anchors shall satisfy the following requirements:

1 Shotcrete shall be free of abrupt changes and missed spraying. Accumulated area of peeling, gouging or cracking shall not be more than 1.5% of total shotcreted area. Any single defective area, which is calculated as the length of crack multiplied by 0.1m, shall not be greater than $0.02m^2$.

2 The limited defects, as listed in Appendix P, shall not be exist in anchor seats, grid beams, bottom beams, peripheral beams and seals of anchor heads.

3 No exposure ofany part of reinforcing meshes, geogrids, anchor rods or tieback cables is allowed.

4 Grid beams shall not be separate from the underlying slope.

6.7 Slope protection with soil nails

6.7.1 Slope protection by soil nailing shall conform to the basic requirements as follows:

1 The slope shall be excavated in accordance with the procedures and in the depth of each layer as specified by design. The slope surface shall be even with a gradient in compliance with the design. Neither overbreak nor underbreak is allowed.

2 The number of nails and their connections shall conform to the design requirements.

3 Soil nails shall be firmly connected to reinforcing steel or mesh of the grid beams. Steel fabric shall be fixed in position firmly and remain stable during shotcreting.

4 The lengthof a soil nail inserted into the anchor hole shall not be less than 95% of its design length.

5 The performance of grout shall satisfy the relevant construction specifications. The grout fill in the anchor holes shall be dense and full.

6 A drainage systemfor use during construction shall be provided as required by the design.

6.7.2 Measurement items for slope protection with soil nails are shown in Table 6.7.2. The slope surface protection shall conform to the provisions given in Clause 6.6.2.

Table 6.7.2 Measurement items for soil nailing

No.	Inspection items	Specified value and tolerance	Method and frequency
1△	Strength of grout(MPa)	Within the required range	Mortar according to Appendix F, and others according to Appendix M
2	Depth of drill hole(mm)	+200, −50	Bytape measure: spot check 10%
3	Angleof drill hole (°)	2	Byinclinometer: spot check 10%
4	Spacing of drill holes (mm)	±100	Bytape measure: spot check 10%
5	Diameter of drill hole(mm)	+20,-5	By ruler: spot check 10%
6△	Pullout resistance of nail (kN)	Average pullout resistance≥ design value; 80% of the pullout resistance≥ design value; the minimum pullout resistance ≥0.9 of design value	By pullout test: 1% of the total number, but not less than 3 nails in total

6.7.3 The appearance of the slope protection with soil nails shall satisfy the following requirements:

1 Steel fabric and soil nails shall not be exposed.

2 Shotcrete, grid beams, anchor beams and peripheral beams shall conform to the provisions of Clause 6.6.3 of these standards.

6.8 Slope protection with masonry

6.8.1 Slope surface protection with masonry shall conform to the basic requirements as follows:

1 The strength of mortar for pointing shall not be lower than that for laying masonry.

2 The embedded depth ofthe foundation at the bottom of the slope surface and the ground bearing resistance shall conform to the design requirements.

3 The density of the backfill material beneath the protecting surface shall conform to the design requirements. Stone pitching shall start only after the slope surface has been properly trimmed.

4 Stone pitching shall be laid in a staggered pattern and interlocked tightly with the joints being fully filled.

5 Settlement joints, expansion joints, weepholes and drainage facilitieson slope shall be provided as required by the design.

6.8.2 Measurement items for slope surface protection with masonry shall conform to the criteria in Table 6.8.2

Table 6.8.2 Measurement items for Slope surface protection with masonry

No.	Inspection items		Specified value and tolerance	Method and frequency
1△	Mortar strength (MPa)		Within the required range	According to Appendix F
2	Top elevation (mm)	Dressed stone, cut stone	±30	By level: 5 points over a length upto 30 m, and 1 additional point for every 10 m increase.
		Rubble	±50	
3	Surface evenness (mm)	Dressed stone, cut stone	≤25	By 2m straight edge: 3 points in every 50m long segment, 1 measurement in longitudinal and transverse directions at each point except on a conical slope where 3 measurements are taken in the slope direction.
		Rubble	≤35	
4	Slope gradient		≤design value	By slopegauge: 5 points in a length upto 30m, and 1 additional point for every 10 m increase.
5△	Thickness and sectional dimensions (mm)		≥design value	Bytape measure: 10 cross-sections over a length upto 50m, and 1 additional cross-section for every 10 m increase.
6①	Spacing of grid beams (mm)		±150	Ruler: spot check 10%

Note: ①only applicable to slope protection with grid beams.

6.8.3 The appearance of slope surface protection with masonry shall conform to the following requirements:

1 The cumulative area of equivalent cracks in joints, spalling or stripped pointing shall not exceed 1.5% of the slope area protected. Any individual area of equivalence shall not be more than 0.08m^2. The equivalent area is computed by the length of defective joints multiplied by 0.1m.

2 Grid beams shall not be separated from the underlying slope surface.

3 There must beneiter depressions nor upheavals on slope surface.

6.9 Slope protection with gabions

6.9.1 Slope protection with gabions shall conform to the basic requirements as follows:

1 The types, sizes and quality of gabion cages, tie-wires and fill materials shall conform to the design requirements.

2 The ground footing shall be treated and the ground bearing capacity shall conform to the design requirements.

3 Gabions shall be fully and densely filled with filling stones.

4 Gabions shall be laid staggered (both for stack-laid or flat-laid), and shall be firmly fixed with tie wires with no loose or missing tie wires.

6.9.2 Measurement items for gabion protection are as shown in Table 6.9.2

Table 6.9.2 Measurement items forgabion protection

No.	Inspection items	Specified value and tolerance	Method and frequency
1	Offsets from horizontal position (mm)	≤300	By total station: according to the control coordinate given in the design
2	Length (mm)	≥design value-300	By tape measure: everysegment
3	Width (mm)	≥design value-200	Bytape measure: 5 points in every segment
4	Height (mm)	≥design value	By level or tape measure: 5 points in every segment

6.9.3 The appearance of slope protection by gabions shall conform to the following requirements:

1 Stack-laid gabion shall not have any through joints.

2 No outward bulging is allowed.

6.10 Other masonrystructures

6.10.1 Other masonry structures shall conform to the basic requirements as follows:

1 The strength of mortar for pointing shall not be lower than that for stone pitching.

2 Pitching stones shall be laid with joints staggered in subsequent layers and shall be tightly interlocked. For wet-masonry, stones shall be seated on a layer of mortar and pressed tightly. For dry-masonry, stone pitching shall be free of over-lapping or gap filling.

6.10.2 The measurement items for other masonry structures are shown inTable 6.10.2-1 and Table 6.10.2-2.

Table 6.10.2-1 Measurement items for wet masonry

No.	Inspection items		Specified value and tolerance	Method and frequency
1△	Strength of mortar(MPa)		Within the required range	According to Appendix F
2	Level at top surface(mm)	Dressed stone, cut stone	±15	By level: 5 points over a length upto 30m, and 1 additional point for every 10m increase.
		Rubble	±20	
3	gradient(%)	Dressed stone or cut stone	≤0.3	By plumbing: 5 points over a length upto 30 m, and 1 additional point for every 10 m increase.
		Rubble	≤0.5	
4△	Sectional dimensions (mm)	Dressed stone	±20	By tape measure: 10 cross-sections over a length upto 50m, and 1 additional cross-section for every 10m increase.
		Cut stone	±30	
		Rubble	±50	
5	Surface evenness (mm)	Dressed stone	≤15	2mstraight edge: check 3 points for every 20m, 1 measurement in each direction (longitudinal or transverse).
		Cut stone	≤25	
		Rubble	≤35	

Table 6.10.2-2 Measurement items for dry-laid masonry

No.	Inspection items		Specified value and tolerance	Method and frequency
1	Top elevation (mm)		±30	lBy level;5 points over a length up to 30 m, and 1 additional point for every 10 m increase.
2	Sectional dimensions (mm)	Height	±100	By tape measure;5cross-sections over a length upto 30m, and 1 additional cross-section for every 10m increase.
		Thickness	±50	
3	Surface evenness(mm)		≤50	By2m straight edge:check 3 points for every 20m, 1 measurement in each direction (longitudinal or transverse).

6.10.3 The appearance of other types of masonry structures shall conform to the following requirements:

1 The cumulative area of equivalent cracks in joints, spalling or stripped pointing shall not exceed 1.5% of the slope protected. Any individual area of equivalence shall not be more than 0.08m^2. The equivalent area is computed by the length of defective joints multiplied by 0.1m.

2 There must beneither depressions nor bulges in a masonry structure.

6.11 Water flow regulation works

6.11.1 Works for regulating water flow shall conform to the basic requirements as follows:

1 The ground bearing capacity and the embedded foundation depth of a diversion dike or dam shall conform to the design requirements.

2 Fill materials shall be compacted in layers.

3 The joints in a diversion dike or dam shall be constructed in accordance with the design requirements. The connections to the side slopes of river banks or berms shall be properly treated to ensure stability and durability.

6.11.2 Measurement items for water flow regulation works are shown in Table 6.11.2

Table 6.11.2 Measurement items for water flow regulation works

No.	Inspection items	Specified value and tolerance	Method and frequency
1△	Strength of mortar or concrete (MPa)	Within the required range	For concrete: according to Appendix D; for mortar according to Appendix F
2△	Compaction of dike (dam) (%)	Conform to the design requirements	Dry density: 3 points for each compacted layer
3	Offset from horizontal position (mm)	30	By total station: according to control coordinates given in the design
4	Length (mm)	≥design length-100	By tape measure: every unit
5	Sectional dimensions (mm)	≥design value	By tape measure: 5 cross-sections
6	Slope gradient	≤design value	By slopegauge: 5 points
7	Levels of top surface (mm)	±30	By level: 5 points

6.11.3 The appearance of awater flow regulation work shall satisfy the following requirements:

1 No uncompacted slope edges exist on diversion dike or dam body.

2 Thecumulative length of irregular surface or poor alignment shall not exceed 10% of the total length.

7 Pavement Works

7.1 General

7.1.1 The specified value or tolerance of The measurement items forpavement works shall be determined in two groups: the Motorways and Class-1 highways and the Class-2, 3 and -4 highways. The inspection criterion for structural layer thickness of pavement is an tolerance.

7.1.2 A bedding layer shall be inspected in accordancewith the requirements for the subbase course of the same material. The basic requirements for prime coat, tack coat and seal coat shall be the same as those for asphalt surface treatment layer specified in 7.5.1. The subdivisions of work for processing and installing steel bars in a cement concrete surface course shall be inspected according to the criteria in Chapter 8.

7.1.3 For a composite pavement with an asphalt surface layer overlaying on a cement concrete layer, both structural layers shall be inspected and verified. For the cement concrete layer, the texture depth for skid resistance need not be inspected, but the evenness shall conform to the criteria for that type of classified highway. For the asphalt surface , the deflection need not be inspected.

7.1.4 Stabilized soil base and subbase courses include cement-treated soil, lime-treated soil, lime-flyash-treated soil. Stabilized granular base and subbase courses include cement stabilized material, lime stabilized material, and lime- flyash stabilized material, cement-flyash stabilized material, etc.

7.1.5 Priming bitumen shall be sprayed and seal coat shall be paved after the completion of granular material base. The bitumen penetration depth of prime coat shall not be less than 5 mm; the penetration depth of prime coat in the stabilized soil base course should not be less than 3 mm.

7.2 Cement concretesurface course

7.2.1 The cement concrete surface course shall conform to the basic requirements as follows:

1 The quality of a base course shall conform to the specifications and the design requirements. The surface of a base course shall be clean and free of loose soil.

2 Joint fillers shall conform to the specifications and to the design requirements.

3 The position, specification and size of a joint, the placement of dowel bars and tie bars shall conform to the design requirements.

4 After paving, the concrete pavement shall be cured in compliance with the requirements of the construction specifications.

5 Cracks caused by drying shrinkage and temperature shrinkage shall be treated.

7.2.2 Measurement items forcement concrete surface course shall conform to the requirements specified in Table 7.2.2.

Table 7.2.2 Measurement items forcement concrete surface layer

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Inspection item</th><th colspan="2">Specified value or tolerance</th><th rowspan="2">Method and frequency</th></tr>
<tr><th>Motorways & Class-1 highways</th><th>Other highway</th></tr>
<tr><td>1△</td><td colspan="2">Flexural tensile strength(MPa)</td><td colspan="2">Within the required range</td><td>According to Appendix C</td></tr>
<tr><td rowspan="3">2△</td><td rowspan="3">Slab thickness (mm)</td><td>Representative value</td><td colspan="2">-5</td><td rowspan="3">According to Appendix H
2 pointsin every 200m.</td></tr>
<tr><td>Acceptance value</td><td colspan="2">-10</td></tr>
<tr><td>Limiting value</td><td colspan="2">-15</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Roughness[①]</td><td>σ(mm)</td><td>≤1.32</td><td>≤2.0</td><td rowspan="2">By roughness meter: continuous inspection for the whole length on each lane, and calculate σ and IRI in every 100m</td></tr>
<tr><td>IRI(m/km)</td><td>≤2.2</td><td>≤3.3</td></tr>
<tr><td>Maximum clearance (mm)</td><td>3</td><td>5</td><td>By 3m straight edge: 2 places, 5 times at each place on each half traveled-way in every 200m.</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Depth of anti-skid texture depth (mm)</td><td>General road section</td><td>0.7~1.1</td><td>0.5~1.0</td><td rowspan="2">By sand patch method: measure 1 place in every 200m</td></tr>
<tr><td>Special road section[②]</td><td>0.8~1.2</td><td>0.6~1.1</td></tr>
</table>

continued

No.	Inspection item		Specified value or tolerance		Method and frequency
			Motorways & Class-1 highways	Other highway	
5	Sideways Force Coefficient (SFC)	General road section	≥50	—	According to Appendix L: 1 measurement for every 20m
		Special road section	≥55	≥50	
6	Height difference between adjacent slabs (mm)		≤2	≤3	By ruler: 2 points at every expansion joint; spot chek 2 points each of any 2 longitudinal and transverse joints in every 200m
7	Longitudinal and transverse joint straightness (mm)		≤10		By20m-string: for longitudinal joint, 4 locations in every 200m; for transversal joints: 4 joints in slab width direction in every 200m.
8	Horizontal offset at center line (mm)		20		By total station: 2 points in every 200m.
9	Width of pavement (mm)		± 20		By tape measure: 4 points in every 200m
10	Profile elevation (mm)		± 10	± 15	By level: 2cross-sections in every 200m
11	Cross slope (%)		± 0.15	± 0.25	By level: 2 cross-sections in every 200m
12	Ratio ofbroken slab[3] (%)		≤0.2	≤0.4	By visual inspection: inspect all slabs and count the number of broken slabs and the number of total slabs.

Notes: ①σ is the standard deviation measured by roughness meter; IRI represents the International Roughness Index; h is the maximum clearance between a 3m straight edge and the surface of the road pavement.

②Special road sections on a Motorway or Class-1 highway include interchange ramps, at-grade junctions, curves, speed-change lanes, grades with resultant radient equal to or steeper than 3%, bridges, tunnels, toll plazas, etc. On Other highway, the special road sections include superelevated sections, grades with combined gradients greater than or equal to 4%, intersection sections, bridges, upgrades and downgrades, tunnels and sections near or through towns or villages, etc.

③The ratio of broken slabs includes broken corners. The slabs of through lanes and overtaking lanes shall be counted, but the slabs of the hard shoulder and slabs repaired shall not be included.

7.2.3 The appearance of cement concrete surface course shall conform to the following requirements:

1 There shall be no limited defects defined in Appendix P exist on the slabs.

2 There shall be no holes, upheavals or broken corners on the slabs.

3 Joint filling must be complete with no loose material or excess material on the road pavement surface.

4 The road surface shall be free of ponding water after rainfall.

7.3 Asphalt concrete surface course and asphalt macadam (either crushed stone or gravel) surface course

7.3.1 Asphalt concrete surface course and asphalt macadam (either crushedstones or gravel) surface course shall conform to the basic requirements as follows:

1 The quality of the base course shall conform to the construction specifications and the design requirements. The surface of a base course shall be dry, clean and free of dust.

2 The heating temperature of the asphalt mix shall be strictly controlled. The asphalt mix shall be uniform and free of uncoated stones, segregation or agglomeration (caking).

3 Rolling compaction shall follow specified procedures, and the paving and rolling temperature shall be strictly controlled.

7.3.2 The measurement items forasphalt concrete surface course and asphalt macadam (either crushedstone or gravel) surface course are shown in Table 7.3.2.

Table 7.3.2 Measurement items for asphalt concrete surface course or asphalt macadam(crushed stone or gravel)**surface course**

No.	Inspection item		Specified value or tolerance		Method and frequency
			Motorways & Class-1 highways	Other highway	
1△	Compaction[①] (%)		≥96% of laboratory standard density (*98%) ≥92% of maximum theoretical density (*94%) ≥98% density of trial section (*99%)		According to Appendix B, 1point in every 200m. Bynuclear (non-nuclear) density instrument: 5 times at one location in every 200m.
2	Roughness	σ(mm)	≤1.2	≤2.5	By roughness meter: continuously inspect over whole length, and IRI or σ to be calculated in every 100m
		IRI(m/km)	≤2.0	≤4.2	
		Maximum clearance h(mm)	—	≤5	By3m straight edge: 2 places and 5 times at each placein every 200m
3	Deflection (0.01mm)		Not greater than the design acceptance value		According to Appendix J

continued

No.	Inspection item		Specified value or tolerance: Motorways & Class-1 highways	Specified value or tolerance: Other highway	Method and frequency
4	Permeability coefficient(ml/min)	SMA pavement	≤120	—	Bypermeameter:1 place in every 200m.
		OtherAC pavement	≤200		
5	Friction coefficient		Conform to the design requirements	—	By pendulum tester: 1 place in every 200m. SFC measuring vehicle: continuous survey over whole length and evaluation according to Appendix L
6	Texture depth		Conform to the design requirements	—	By sand patch method: 1 place in every 200m.
7△	Thickness[2] (mm)	Representative value	Total thickness: −5% H Upper layer: −10% h	−8% H	According to AppendixH, 1 point in every 200m
		Acceptance value	Total thickness: −10% H Upper layer: −20% h	−15% H	
8	Horizontal offset of centerline (mm)		20	30	By total station:2 points in every 200m.
9	Level of profile(mm)		±15	±20	By level:2 cross-sections in every 200m
10	Width (mm)	Withcurbs	±20	± 30	By tape measure: 4 cross-sections in every 200m.
		Without curbs	≥ design value		
11	Cross-slope (%)		± 0.3	± 0.5	By level:2 cross-sections in every 200m
12△	Mineral aggregate gradation		Conform tothe mix for production		T 0725:once in every shift
13△	Asphalt content		Conform tothe mix for production		T 0722,T0721,T0735:oncein every shift
14	Marshall stability		Conform tothe mix for production		T 0709:oncein every shift

Notes: [1] For the compaction in the table above, two criteria shall be applied for Motorways and Class-1 highways, and the lower required rate shall be taken as the evaluation result. One criterion shall be applied for the inspection on other class highways. Those with * simbol represent SMA pavement.

[2] Only negative tolerance is specified for the thickness of the asphalt layer listed in the table. H is the total thickness of the asphalt layers, and h is the thickness of upper asphalt layer. The tolerance of thickness representative values and required values for Other highway is calculated according to the total thickness. Where H ≤ 60mm, the tolerance is −5mm and −10mm respectively. Where H > 60mm, the tolerance is −8% H and −15% H.

7.3.3 The appearance of asphalt concrete surface course and asphalt macadam surface course (either crushed stone orgravel) shall conform to the following requirements:

1 The cumulative length of surface cracking, deterioration, shoving, rolling marks, oil stains, bleeding asphalt and segregation shall not exceed 50m.

2 The hot joints shall be free from burnt asphalt.

3 The road surface shall be free of ponding water after rainfall.

7.4 Asphalt penetration surface course (or surface course of penetration macadam with hot-mix overlay)

7.4.1 Asphalt penetration surface course (or surface course of penetration macadam with hot-mix overlay) shall conform to the basic requirements as follows:

1 Asphalt content, mineral aggregate gradation and Marshall stability test shall be conducted daily for the hot-mix overlay mixture.

2 Drainage for pavement structure layers and shoulders shall be provided before the construction of asphalt penetration surface course.

3 The crushed stones shall be trimmed smooth and interlocked firmly stable. Asphalt shall be sprayed uniformly, fully and deeply penetrated, and shall not contaminate the surfaces of other structures.

4 The filling material shall be hot-laid, uniformly spread and with no overlapping.

5 Where hot-mix overlay is adopted, the mixture shall be uniformly mixed with no uncoated aggregate, segregation, or agglomeration, and paved evenly with smooth overlap joint, and then rolled and compacted as soon as possible.

7.4.2 The measurement items forthe surface course of asphalt penetration macadam (or penetration macadam with hot-mix overlay) shall conform to the criteria in Table 7.4.2.

Table 7.4.2 Measurement items forasphalt penetration surface course

(or surface course of penetration macadam with hot-mix overlay)

No.	Inspection item		Specified value or tolerance	Method and frequency
1	Roughness	σ(mm)	≤≤3.5	By roughness meter: inspection over whole length of each lane, and IRI or $\sigma$to be calculated in every 100m
		IRI(m/km)	≤5.8	
		Maximumclearance h(mm)	≤8	By 3m straight edge: 2 places, and 5 times at each place in every 200m.
2	Deflection (0.01mm)		Not greater than design acceptance deflection value	According to Appendix J

continued

No.	Inspection item		Specified value or tolerance	Method and frequency
3△	Thickness[1] (mm)	Representative value	−8% H or −5	According to Appendix H 2 pointsin every 200m.
		Acceptance value	−15% H or −10	
4	Totalquantity of bitumen sprayed (litres)		±0.5%	Spray checking: once for each layer during every shift.
5	Horizontal offset of centerline (mm)		30	By total station: 2 points in every 200m.
6	Profile elevation (mm)		±20	By level: 2 cross-sections in every 200m
7	Width (mm)	Withcurbs	±30	Bytape measure: 4 points in every 200m
		Without curbs	Not less than design value	
8	Cross slope (%)		±0.5	By level: 2 cross-sections in every 200m
9△	Mineral aggregate gradation		Conform to mix for proportion	T 0725: oncein every shift
10△	Asphalt content		Conform to mix for proportion	T 0722, T 0721, T 0735: oncein every shift

Note: [1] H is the design thickness. The thickness is calculated according to the thickness percentage where H ≥ 60mm; or uses a fixed value where H < 60mm.

7.4.3 The appearance of asphalt penetration surface course (or the surface course of penetration macadam with hot-mix overlay) shall conform to the following requirements:

1 No loose or unsprayed areas and no surface waves or oil stains are allowed in a surface course.

2 The road surface shall be free of ponding water after rainfall.

7.5 Asphalt surfacetreatment

7.5.1 Asphalt surface treatment shall conform to the basic requirements as follows:

1 The surface of the underlying layer shall be solid, stable, even, clean and dry.

2 Asphalt shall be evenly sprayed, without uncoated aggregate, and shall not contaminate other structure structures.

3 Aggregates shall be hot and evenly spread with no overlapping, and compacted evenly.

7.5.2 The measurement items forasphalt surface treatment shall conform to the requirements in Table 7.5.2.

Table 7.5.2 Measurement items for asphalt surface treatment

No.	Inspection item		Specified value or tolerance	Method and frequency
1	Roughness	σ(mm)	≤4.5	By roughness meter: continually inspect over whole length of each lane, and calculate IRI or σin every 100m
		IRI(m/km)	≤7.5	
		Maximum clearance h(mm)	≤10	By 3m straight edge: 2 places, 5 times at each place in every 200m.
2	Deflection value (0.01mm)		Not greater than design acceptance deflection value	According to Appendix J
3△	Thickness (mm)	Representative value	-5	According to Appendix H: 1 point inevery 200m of each lane
		Acceptance value	-10	
4	Total asphalt usage volume		±0.5%	Inspect spraying on each layer once and in every shift.
5	Horizontal offset from centerline(mm)		30	By total station: 2 points in every 200m.
6	Profile elevation(mm)		±20	By level: 2 cross-sections in every 200m
7	Width (mm)	With curbs	±30	Bytape measure: 4 places in every 200m
		Without curbs	≥ design value	
8	Cross slope (%)		±0.5	By level: 2 cross-sections in every 200m

7.5.3 The appearance of asphalt surface treatment layer shall conform to the following requirements:

1 The surface shall be free of drag traces. The cumulative length of loose material, shoving, oil stains, bleeding and segregation shall not exceed 50m over one kilometer paved surface.

2 The pavement surface shall be free of ponding water after rainfall.

7.6 Stabilized soil base and subbase

7.6.1 A stabilized soil base and subbase shall conform to the basic requirements as follows:

1 Lime shall be fully hydrated and the depth of road mixing shall reach the bottom of the layer.

2 Lime treated materials shall be compacted at the optimum moisture content. The finishing

time of rolling the cement treated material shall not be later than final setting time of the cement.

3 Soon after confirmation of compaction, the chemically treated layer shall be covered or water-sprayed for curing. The curing period shall conform to the requirements of the specifications.

7.6.2 The measurement items forstabilized soil base or subbase shall conform to the requirements in Table 7.6.2.

Table 7.6.2 Measurement items forstabilized soil base or subbase

<table>
<tr><th rowspan="3">No.</th><th rowspan="3" colspan="2">Inspection item</th><th colspan="4">Specified value or tolerance</th><th rowspan="3">Inspection method and frequency</th></tr>
<tr><th colspan="2">Base</th><th colspan="2">Subbase</th></tr>
<tr><th>Motorway & Class-1 highway</th><th>Other classified highway</th><th>Motorway& Class-1 highway</th><th>Other classified Highway</th></tr>
<tr><td rowspan="2">1△</td><td rowspan="2">Compaction (%)</td><td>Rep. value</td><td>—</td><td>≥95</td><td>≥95</td><td>≥93</td><td rowspan="2">According to Appendix B Measure 2 points in every 200m.</td></tr>
<tr><td>Limiting value</td><td>—</td><td>≥91</td><td>≥91</td><td>≥89</td></tr>
<tr><td>2</td><td colspan="2">Evenness (mm)</td><td>—</td><td>≤12</td><td>≤12</td><td>≤15</td><td>3m straight edge: inspect 2 sections and measure 5 consecutive times at each section in every 200m.</td></tr>
<tr><td>3</td><td colspan="2">Profile elevation (mm)</td><td>—</td><td>+5, −15</td><td>+5 , −15</td><td>+5, −20</td><td>Level: Measure 2 sections every 200m</td></tr>
<tr><td>4</td><td colspan="2">Width (mm)</td><td colspan="2">Conform to the design requirements</td><td colspan="2">Conform to the design requirements</td><td>Tape measure: Measure 4 sections every 200m.</td></tr>
<tr><td rowspan="2">5△</td><td rowspan="2">Thickness (mm)</td><td>Rep. value</td><td>—</td><td>−10</td><td>−10</td><td>−12</td><td rowspan="2">According to Appendix H Measure 2 points in every 200m.</td></tr>
<tr><td>Acceptance value</td><td>—</td><td>−20</td><td>−25</td><td>−30</td></tr>
<tr><td>6</td><td colspan="2">Cross slope (%)</td><td>—</td><td>±0.5</td><td>±0.3</td><td>±0.5</td><td>Level: Measure 2 sections every 200m</td></tr>
<tr><td>7△</td><td colspan="2">Strength (MPa)</td><td colspan="2">Conform to the design requirements</td><td colspan="2">Conform to the design requirements</td><td>According to Appendix G</td></tr>
</table>

7.6.3 The appearance of a stabilized soil base or subbase shall conform to the following requirements:

1 The surface shall be free of loose material, potholes and rolling marks.

7.7 Stabilizedgranular base and subbase

7.7.1 Stabilized granular base and subbase shall conform to the basic requirements as follows:

1 Granular material shall be clean and sound. Lime shall be fully hydrated. Slag shall be fully reacted and chemically stable. Large slumps shall be removed.

2 Site-mixing shall be thorough over the full depth of the layer.

3 Lime treated materials shall be rolled at optimum moisture content. The finishing time of rolling cement materials shall not exceed the final setting time of cement.

4 Immediately after the confirmation of compaction, the stabilized granular layers shall be covered or water-sprayed for curing, and the curing period shall conform to the requirements of specifications.

7.7.2 The measurement items forstabilized granular base and subbase shall conform to the requirementsin Table 7.7.2.

Table 7.7.2 Measurement items forstabilized granular base and subbase

No.	Inspection item		Specified value or tolerance				Inspection methodand frequency
			Base		Subbase		
			Motorway& Class-1 highway	Other highway	Motorway& Class-1 highway	Other classified highway	
1△	Compaction (%)	Rep. value	≥98	≥97	≥96	≥95	According to Appendix B: 2 points in every 200m.
		Limiting value	≥94	≥93	≥92	≥91	
2	Evenness (mm)		≤8	≤12	≤12	≤15	By3m straight edge: 2 places, and 5 times at each place in every 200m.
3	Profile elevation (mm)		+5, -10	+5, -15	+5, -15	+5, -20	By level: 2 cross-sections in every 200m
4	Width (mm)		Conform to the design requirements		Conform to the design requirements		Bytape measure: 4points in every 200m
5△	Thickness (mm)	Rep. value	-8	-10	-10	-12	According to Appendix H: 2 points in every 200m.
		Acceptance value	-10	-20	-25	-30	
6	Cross slope (%)		±0.3	±0.5	±0.3	±0.5	By level: Measure 2 sections every 200m
7△	Strength (MPa)		Conform to the design requirements		Conform to the design requirements		According to Appendix G

7.7.3 Appearance of a stabilized granular base or subbase shall conform to the basic requirements as follows:

1 The surface shall be free from loose material, potholes and rolling marks.

2 Continuous segregation on surface shall not exceed 10m and cumulative length of segregation shall not exceed 50m.

7.8 Graded crushed stone (gravel) base and subbase

7.8.1 Graded crushed stone (gravel) base and subbase shall conform to the basic requirements as follows:

1 Batching shall be accurate.

2 Plasticity index shall conform to the design requirements.

7.8.2 The measurement items forgraded crushed stone (gravel) base and subbase shall conform to the criteria in Table 7.8.2.

Table 7.8.2 Measurement items forgraded crushed stone(gravel) **base and subbase**

No.	Inspection item		Specified value or tolerance				Method and frequency
			Base		Subbase		
			Motorway & Class-1 highway	Other Highway	Motorway Class-1 highway	Other highway	
1△	Compaction (%)	Rep. value	≥98		≥96		According to Appendix B, 2 points in every 200m
		Limiting value	≥94		≥92		
2	Deflection (0.01mm)		Conform to the design requirements		Conform to the design requirements		According to Appendix J
3	Evenness (mm)		≤8	≤12	≤12	≤15	By3m straight edge: inspect 2 places and measure 5 consecutive times at each place in devery 200m.
4	Transverse profile elevation (mm)		+5, −10	+5, −15	+5, −15	+5, −20	By level: 2 cross-sections in every 200m
5	Width (mm)		Conform to the design requirements		Conform to the design requirements		Bytape measure: 4 points in every 200m
6△	Thickness (mm)	Rep. value	−8	−10	−10	−12	According to Appendix H, 2 points in every 200m
		Acceptance value	−10	−20	−25	−30	
7	Cross slope (%)		±0.3	±0.5	±0.3	±0.5	By level: 2 sections in every 200m

7.8.3 The appearance of a graded crushed stone (gravel) base or subbase shall conform to the following requirements:

1 The surface shall be free from loose material, potholes and rolling marks.

2 Continuous segregation on surface shall not exceed 10m; and cumulative length of segregation shall not exceed 50m.

7.9 Gap-filled crushed stone (slag) base and subbase

7.9.1 The gap-filled crushed stone (slag) base and subbase shall conform to the basic requirements as follows:

1 The sizes and quality of the materials used shall conform to the design requirements.

2 The material shall be compacted by vibro-rollers until the gap is fully filled and compacted.

7.9.2 The measurement items forgap-filled crushed stone (slag) base and subbase shall conform to the requirements given in Table 7.9.2.

Table 7.9.2 Measurement items forgap-filled crushed stone (slag) base and subbase

No.	Inspection item		Specified value or tolerance				Inspection method and frequency
			Base		Subbase		
			Motorway& Class-1 highway	Other highway	Motorway& Class-1 highway	Other highway	
1△	Solid volume ratio(%)	Rep. value	—	≥90	≥88		Density method: 2 points in every 200m.
		Limiting value	—	≥82	≥80		
2	Deflection value (0.01mm)		Conform to the design requirements		Conform to the design requirements		According to Appendix J
3	Evenness (mm)		—	≤12	≤12	≤15	By3m straight edge: 2 places, and 5 times at each place in every 200m.
4	Profile elevation (mm)		—	+5, −15	+5, −15	+5, −20	By level: 2 cross-sections in every 200m
5	Width (mm)		Conform to the design requirements		Conform to the design requirements		Bytape measure: 4 points in every 200m

continued

No.	Inspection item		Specified value or tolerance				Inspection method and frequency
			Base		Subbase		
			Motorway& Class-1 highway	Other highway	Motorway& Class-1 highway	Other highway	
6△	Thickness (mm)	Rep. value	—	-10	-10	-12	According to Appendix H, 2 points in every 200m.
		Acceptance value	—	-20	-25	-30	
7	Cross slope (%)		—	±0.5	±0.3	±0.5	By level: 2 cross-sections every 200m

7.9.3 The appearanceof a gap-filled crushed stone (slag) base or subbase shall conform to the following requirements:

1 The surface shall be free from loose material, potholes and rolling marks.

2 Continuous segregation on the surface shall not exceed 10m; and cumulative length of segregation shall not exceed 50m.

7.10 Laying curbs

7.10.1 Laying curbs shall conform to the basic requirements as follows:

1 The strength of cement concrete shall conform to the design requirements.

2 The placement shall be firm, the top surface shall be flat, the width of inter-curb joint shall be uniform and the same, the pointing shall be dense, and the alignments shall be smooth.

3 The ground beneath the curb and any backfilling material shall be tamped and well-compacted.

7.10.2 The measurement items forlaying curbs shall conform to the criteria in Table 7.10.2.

Table 7.10.2 Measurement items forlaying curbs

Item no.	Inspection item	Specified value or tolerance	Method and frequency
1	Straightness (mm)	15	By 20m-string and tape measure: 4 places in every 200m

continued

Item no.	Inspection item		Specified value or tolerance	Method and frequency
2	Laying precast curbs	Height difference between two adjacent curbs (mm)	3	By carpenter level: 4 points in every 200m
		Joint width between two adjacent curbs (mm)	±3	By ruler: 4 points in every 200m
	Cast-in-place	Width (mm)	±5	By ruler: 4 points in every 200m
3	Top elevation (mm)		±10	Level: 4 points in every 200m

7.10.3 The appearance of curb installation shall conform to the following requirements:

1 Curbs shall not be damaged.

2 Flush curbs shall permit water flow.

7.11 Shoulders

7.11.1 Shoulders shall conform to the basic requirements as follows:

1 The surface of a shoulder shall be even, well compacted, and free of ponding water.

2 A shoulder line shall be straight on tengent and smooth on curve.

7.11.2 The measurement items forshoulders shall conform to the criteria in Table 7.11.2.

Table 7.11.2 Measurement items forshoulders

No.	Inspection item		Specified value or tolerance	Method and frequency
1	Compaction (%)		Not less than design value, or not less than 90% if no specific value specified in design	According to Appendix B, measure 1 point every 200m
2	Evenness (mm)	Earth shoulder	≤20	By 3m straight edge: inspect 2 places and measure 5 consecutive times at each place in every 200m.
		Hard shoulder	≤10	
3	Cross slope (%)		±1.0	By level: measure 2 sections every 200m
4	Width (mm)		Conform to the design requirements	By tape measure: measure 2 points in every 200m.

7.11.3 The appearance of shoulders shall conform to the following requirements:

1 Shoulders shall not block water from flowing over and shall be free of debris.

8 Bridges

8.1 General

8.1.1 Unless otherwise stated, every structure and component member of a bridge shall be inspected.

8.1.2 The masonry works of foundations, piers, abutments, arch rings, and spandrel walls of a masonry bridge shall be inspected in accordance with the criteria in relevant sections of this Chapter. Other masonry works shall be inspected in accordance with the criteria in Chapter 6.

8.1.3 Reinforced concrete members and pre-stressed concrete members shall include not only the sub-divisions of work for fabrication and installation of the members, but also those for processing and installing the reinforcing steel, and processing and tensioning the prestressing tendons. Internally pre-stressed members shall also include the subdivision of work for grouting the prestressing conduits.

8.1.4 Where one of the bridge erection methods, such as incremental launching girders, balanced cantilever, or erection by rotation or swing, is adopted, the segments of beams or arch rings shall be inspected and verified, in addition to the inspection items stated in Clauses 8.7.3 to 8.7.5 and Clause 8.8.4 hereinafter.

8.1.5 The spandrel structures of an arch bridge shall be inspected in terms of types of the structural member. For arch bridges, the over-all performance of composite abutments shall be inspected in accordance with Clause 8.6.3 hereinafter, and other members shall be inspected in accordance with the criteria for corresponding sub-divisions of work stated in this Chapter.

8.1.6 The cable-stayed bridges, of which main spans and side spans are made of different materials, shall be classified into different subdivisions of work, and then inspected and verified in accordance with relevant provisions for various types of components of cable-stayed bridges given in Section 8.10. The anchor blocks of a ground-anchored cable-stayed bridge may be inspected in accordance with Section 8.11.

8.1.7 The main beam of a batter post rigid-frame bridge shall be inspected and verified in terms of construction method and in accordance with subdivisions of work stated in Section 8.7 hereinafter.

8.1.8 For ground-anchored suspension bridges, the excavation and lining for ground anchors shall be inspected in accordance with the provisions in Chapter 10 herein. Hybrid suspension and cable-stayed bridges shall be inspected and verified in accordance with Sections 8.10 and 8.11 hereinafter.

8.1.9 For self-anchored suspension bridges, the manufacturing and installation of anchorage system, the tensioning of suspenders and the system transformation shall be inspected and verified in accordance with Clauses 8.11.16 to 8.11.18, and other subdivisions of work shall be inspected in accordance with the provisions for ordinary suspension bridges and beam bridges.

8.1.10 The steel protection for the steel anchor boxes, saddle and cable clamps of a cable-stayed bridge or suspension bridge, and the steel casing of a concrete filled steel arch (CFSA) bridge shall be inspected and verified in accordance with the provisions in Clause 8.9.3.

8.1.11 The ratio and length of welds in a steel structure to be inspected and verified shall primarily conform to the design requirements. If there is no such a specific requirement given in the design, the ratios specified in these standards shall be adopted for calculating the number of welds, which are of the same type and under the same conditions, to be inspected. In the case of radiographic inspection, a length of 250 ~ 300mm at each end of a weld shall be inspected, and an additional length of 250 ~ 300 mm in middle shall also be inspected if the total length of a weld exceeds 1,200mm. In the case of ultrasonic inspection, the welds shall be inspected in whole length.

8.2 Bridge in general

8.2.1 A bridge in general shall conform to the basic requirements as follows.

1 Bridge works shall be fully completed in accordance with the design.

2 The clearance under a bridge shall not be less than design requirement.

3 Loading tests shall be implemented for the bridges with super-large spans or complicated structures, or those of which the load-carrying capacity need to be verified. The test results shall conform to the design requirements and relevant technical specifications.

8.2.2 The measurement items fora bridge in general shall conform to the criteria listed in Table 8.2.2.

Table 8.2.2 Measurement items for Bridge in General

No.	Inspection Item		Specified Value or Tolerance	Method and frequency
1	Offset from bridge axis (mm)		≤20	By total station: one point on every 50m in length and no less than 5 points in total
2	Width of bridge deck (mm)	Traveled-way	±10	By tape measure, one cross-section every 50m in length, and no less than 5 cross- sections
		Sidewalk	±10	
3	Bridge Length (mm)		+300, −100	By tape measure or total station: along centerline
4	Level on bridge deck (mm)	$L<50$m	±30	By level: one point every 50m, and no less than 3 points in total; check points shall be arranged at mid-span, above piers and abutments.
		$L \geq 50$m	$\pm(L/5{,}000+20)$	

Note: L refers to the length of a bridge span, taking mm as the unit for calculating specified value or tolerance.

8.2.3 The appearance of a bridge in general shall conform to the following requirements:

1 The outline alignment shall be free of abnormal and abrupt changes.

2 There shall not be any residues or debris existing in or on bridge structures including bearings and expansion joints.

3 No bump is allowed at bridge ends.

8.3 Reinforcing Steel, Prestressing Tendon and Conduit for grouting

8.3.1 Processing and installation of reinforcing steels

1 The processing and installation of reinforcing steels shall conform to the basic requirements as follows:

1) The installation of reinforcing steels shall ensure the number of steel bars in compliance with design.

2) The types of steel bar connection and the connected area within the same connecting zone shall conform to the design requirements. The steel bars shall be connected in the zones with low stress; and any single bar must not have two joints within one connecting zone.

3) The length of overlapping, and the quality of welds and mechanical joints shall conform to the requirements of the construction specifications.

4) No crack or other damages shall exist on the surface of a load-bearing reinforcing bar.

5) Concrete spacers shall be tied and evenly distributed on reinforcement cages. The number and material properties of concrete spacers shall satisfy the design requirements and relevant construction specifications.

6) Reinforcing steel bars shall be installed firmly, and Steel fabrics shall be supported by adequate steel bars. The reinforcing steel shall not be displaced during concrete pouring.

2 The measurement items for processing and installation of reinforcing steel bars shall conform to the requirements listed in Tables 8.3.1-1 to -4. The thickness of concrete cover for reinforcing steel bars at any point shall not exceed 1.5 times of the tolerance listed in the tables. The thickness deviation of concrete cover for reinforcement in seawater or other corrosive environment shall not be in a negative value. The thickness of concrete cover shall be inspected after the completion of shuttering but before the starting of concrete pouring.

3 The appearance of processing and installation of reinforcing steels shall conform to the following requirements:

1) No crack, oil, granular or flake corrosion, welding slag, and burn damage shall exist and the wire-fixed or welded reinforcement meshes and cages must not be loose or contain weld breaks.

2) No crack shall exist in welded joints or steel-bar couplers.

Table 8.3.1-1 Measurement items for Reinforcement Installation

No.	Inspection Item			Specified Value or Tolerance	Method and frequency
1△	Spacing of load-bearing steel bars (mm)	Spacing of two or more rows		±5	By tape measure: 2 cross-sections for every unit if the length ≤20m, or 3 cross-sections for every unit if the length >20m.
		In same row	Beam, slab, arch rib and spandrel	±10(±5)	
			Foundation, anchorage, abutment, and pier	±20	

continued

No.	Inspection Item		Specified Value or Tolerance	Method and frequency
2	Spacing of stirrups, non-structural bars, and deformed steel bars (mm)		±10	By tape measure: 10 spacings for every unit
3	Size of reinforcing steel cap(mm)	Length	±10	By tape measure: spot check (30% of the total skeleton)
		Width, height or diameter	±5	
4	Position of bar bend (mm)		±20	By tape measure: spot check (30% of each skeleton)
5△	Thickness of concrete cover (mm)	Beams, slabs, arch ribs and spandrels	±5	By tape measure: one point for each $3m^2$ of shuttering surface and no less than five spots for every side surface.
		Foundation, anchor-blocks, abutments, and piers	±10	

Note: 1. For installation of reinforcing steels of small-scale members, 30% of total shall be inspected by random.

2. The foundation in the above table does not include concrete piles and underground diaphragm walls.

3. The value in brackets under No. 1 in the above table is applicable to the prefabrication of steel-concrete composite bridge deck.

Table 8.3.1-2 Measurement items for Installation of Steel fabrics

No.	Inspection Item		Specified Value or Tolerance	Method and frequency
1	Length and width of Steel fabric(mm)		±10	By tape measure: every side
2	Size of Steel fabric eye(mm)		±10	By tape measure: 5 mesh eyes
3	Difference of diagonal lengths mesh eye(mm)		±15	By tape measure: 5 mesh eyes
4	Position of mesh	In-plane	±20	By tape measure: at mid-points of every side of a Steel fabric
		Out-plane	±5	

Table 8.3.1-3 Measurement items for Installation of Reinforcing Steel Cages of Precast Piles

No.	Inspection Item	Specified Value or Tolerance	Method and frequency
1	Spacing of main reinforcing bars(mm)	±5	By tape measure: 3 cross-sections
2	Spacing of stirrups and deformed reinforcing bars (mm)	±10	By tape measure: 10 spacings
3△	Thickness of concrete cover (mm)	±5	By tape measure: 5cross-sections, and 4points on each cross-section.
4	Position of Steel fabric on top of pile(mm)	±5	By tape measure: at mid-point of each edge line of every mesh
5	Position of vertical reinforcing steels at pile tip	±5	By tape measure: in 2 perpendicular directions

Table 8.3.1-4 Measurement items for Installation of Reinforcing Steels of Bored (Excavated) Piles and Underground Diaphragm Walls

No.	Inspection Item	Specified Value or Tolerance	Method and frequency
1	Spacing of main reinforcing steels (mm)	±10	By tape measure;2cross-sections for each segment
2	Spacing of stirrups and deformed steel bars (mm)	±20	By tape measure: 10spacings for each segment
3	Outer diameter or thickness, and width of reinforcing steel cage (mm)	±10	By tape measure: 2 cross-sections for each segment
4	Length of reinforcing steel cage (mm)	±100	By level;2points for every steel cage
5	Bottom level of reinforcement cage (mm)	±50	By tape measure;take level at top and calculated by the length of reinforcement cage.
6△	Protective layer thickness (mm)	+20,-10	By measure: the spacer location at outer side of each reinforcement cage

8.3.2 Processing and tensioning of prestressing tendons

1 The processing and tensioning of prestressing tendons shall conform to the basic requirements as follows:

1) The steel wires or strands in a prestressing tendon shall be smooth and straight with no twists, knots and free from surface damages.

2) No wire fracture shall exist in a single strand. Any single reinforcing steel bar shall not be fractured or slipped.

3) The area of prestressing tendon joints within a cross-section shall not exceed 25% of the whole area, and quality of the joints shall conform to the criteria of construction specifications.

4) The concrete strength and age for tensioning or relaxing shall conform to the design requirement. The tensioning process shall follow the specific design.

5) The heads shall be regularly round with no incline or broken where heading anchors are applied for prestressing wires.

6) A tendon conduit shall be installed in position firmly with tightly-fit joints and smooth

curvature. The plane of an anchor bearing plate shall be in right angle to the axis of the duct.

7) The tensioning equipment shall be calibrated and shall not be used beyond the calibration period.

8) Prestressing tendons shall be mechanically cut after anchoring and the exposed length shall conform to the design requirement.

2 The measurement items for processing and tensioning of pre-stressed steel shall conform to Tables 8.3.2-1 and -2.

Table 8.3.2-1 Measurement items for Pre-tensioning Steel Wires and Strands

No.	Inspection Item		Specified Value or Tolerance	Method and frequency
1	Relative difference in length of headed wires in one strand (mm)	$L>20m$	$\leq L/5000$ and 5	By tape measure: 2 strands for every processing lot
		$6m \leq L \leq 20m$	$\leq L/3000$ and 5	
		$L<6m$	≤ 2	
2△	Stress value of tensioning		Conform to the design requirements	Check the oil pressure gauge for each tendon
3△	Elongations during tensioning		Conform to the design requirements, or ±6% if no requirement given in the design	By tape measure: every tendon
4	The percentage of broken wires in total number of wires of one member		≤1%	Visual inspection: every strand
5	Coordinates of tensioned tendon on cross- sections (mm)		±5	By tape measure: 2 cross- sections
6	Length of non-bond section (mm)		±10	By tape measure: every tendon

Note: L refers to the length of a prestressing tendon, taking unit in mm for calculating specified value & tolerence.

Table 8.3.2-2 Measurement items for Post-tensioning

No.	Inspection Item		Specified Value or Tolerance	Method and frequency
1	Coordinates of duct (mm)	In direction of beam length	±30	By tape measure: 30% of the ducts in every unit, 3 points on every curve, 1 point on every 10m tangent, and all anchors and joints.
		In direction of beam width	±10	
		In direction of beam height	±10	
2	Spacing of ducts (mm)	In the same row	±10	By tape measure: 30% of the ducts in every unit, 2 cross-sections
		Between two adjacent rows	±10	

continued

No.	Inspection Item	Specified Value or Tolerance	Method and frequency
3△	Tensioning stress value	Conform to the design requirements	Check oil pressure gauge for each tendon
4△	Elongation of tensioning	Conform to the design requirements, or ±6% if no requirement given in the design	By tape measure: for each tendon
5	Number of broken or slipped wires (mm)	1 wire in every strand, and total number shall not exceed 1% of all of the wires in a cross- section. For steel bars, not allowed.	Visual inspection: for each strand or bar

3 The appearance of processing and installation of prestressing tendon shall conform to the following requirements:

1) Prestressing steel bars shall not have oil contamination, and the rusted area shall not exceed 20% of the total surface area. Anchors or connecting devices shall not have cracks, oil contamination or rust. The outer casings shall be free from cracks and mechanical damages.

2) The prestressing tendons and ducts shall not be folded.

3) Neither damages nor loose connections shall exist in a prestressing conduit.

8.3.3 Grouting of Prestressing Conduits and Sealing of Anchors

1 The grouting of prestressing conduit and sealing of prestressing anchors shall conform to the basic requirement as follows:

1) The technical properties of grout shall conform to construction specifications and the design requirements.

2) Debris and water standing in a prestressing conduit shall be removed completely before grouting. Where vacuum-aid grouting is applied, the air-tightness shall conform to relevant technical specifications.

3) Vent holes shall be provided at the highest position of a prestressing conduit. All vent holes and inspection holes shall be filled fully with grout.

4) The grouting work shall be conducted in time as required by design. Any single conduit shall be grouted continuously and completed once for all. Every conduit must be grouted. No one-grouted conduit is allowed.

5) Effective countermeasures for freeze isolation or warm reservation shall be provided if the atmosphere temperature is below 5°C during grouting and for 48 hours after grouting.

6) Concrete for anchor sealing shall be cast according to design requirements.

2 The measurement items for conduit grouting and anchor sealing shall conform to the criteria in Table 8.3.3.

Table 8.3.3 Measurement items for Conduit Grouting and Anchor Sealing

No.	Inspection Item	Specified Value or Tolerance	Method and frequency
1△	Strength of grout (MPa)	Within the required range	According to Appendix M
2△	Grouting pressure (MPa)	Conformity to construction specifications	Check the oil pressure gauge for each conduit
3	Standup Pressure Period (s)	Conformity to construction specifications	Measure by timers for each conduit

3 The appearance of conduit grouting and anchor sealing shall conform to the following requirements:

1) The joint fault between the anchor concrete and the concrete surrounded shall be not greater than 5mm.

2) No limited defects as listed in Appendix P shall exit in anchor concrete.

8.4 Masonry works

8.4.1 Masonry works shall conform to the basic requirements as follows.

1 The ground bearing capacity shall conform to the design requirement. Any over-break must not be backfilled with loose materials.

2 Blocks shall be staggered in layers and firmly placed against each other on mortar. The

widths of joints shall be uniform. The inter-block joints shall be fully and firmly filled with calking material and mortar.

3 The radiating joints of an arch-ring shall be perpendicular to the arch axis and the staggered space between adjacent layers of arch stones shall not be less than 100mm.

4 The arch scaffolding shall be firm and stable. The pitching of arch-ring and the dismantling of scaffolding must strictly follow the procedures specified in the design.

5 The strength of pointing mortar shall not be lower than that of masonry mortar.

8.4.2 The measurement items for masonry works shall conform to the criteria in Tables 8.4.2-1 to Table 8.4.2-4.

Table 8.4.2-1 Measurement items for Foundation Masonry

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of mortar (MPa)		Within the required range	According to Appendix F
2	Offset from axis (mm)		≤25	By total station: 2 points each in longitudinal and transversal directions
3	Size in plane (mm)		±50	By tape measure: 3 points each for length and width
4	Level at top surface (mm)		±30	By level: 5points
5	Level of ground foundation	in soil	±50	By level: 5 points
		In rock	+50, −200	

Table 8.4.2-2 Measurement items for Masonry of Piers and Abutments

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of mortar (MPa)		Within the required range	According to Appendix F
2	Offset from axis (mm)		≤20	By total station: measure two points in longitudinal and transversal directions
3	Length and width (mm)	Dressed stone	+20, −10	By tape measure: 3 cross-sections
		Cut stone	+30, −10	
		rubble	+40, −10	
4	Verticality or slope (mm)	Dressed stone and cut stone	≤0.3	By plumbing: 4 points in two axes
		rubble	≤0.5	
5△	Elevation of top surfaces of piers and abutments (mm)		±10	By level: 5 points

continued

<table>
<tr><th>No.</th><th colspan="2">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Evenness of side-face(mm)</td><td>Dressed stone</td><td>≤10</td><td rowspan="3">By 2-m straight edge: 1 place in every $20m^2$, but not less than 3 places in total, in both vertical and horizontal directions at each point.</td></tr>
<tr><td>Cut stone</td><td>≤20</td></tr>
<tr><td>Rubble</td><td>≤30</td></tr>
</table>

Table 8.4.2-3 Measurement items for Arch Masonry

<table>
<tr><th>No.</th><th colspan="3">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of mortar (MPa)</td><td>Within the required range</td><td>According to Appendix F</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Deviation of outer-surface of masonry (mm)</td><td rowspan="2">Without facing</td><td>Outward</td><td>≤30</td><td rowspan="4">By total station: both sides at arch spring, arch crown, 1/4 point and 3/4 point of span</td></tr>
<tr><td>inward</td><td>≤10</td></tr>
<tr><td rowspan="2">With stone facing</td><td>outward</td><td>≤20</td></tr>
<tr><td>inward</td><td>≤10</td></tr>
<tr><td>3△</td><td colspan="3">Depth of arch ring (mm)</td><td>+30,0</td><td>By tape measure: both sides at arch spring, arch crown, 1/4 point and 3/4 point of span</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Faulting between two adjacent facing stones (mm)</td><td colspan="2">Dressed stone, precast concrete block</td><td>≤3</td><td rowspan="2">By drawstring and measure tape: 5points</td></tr>
<tr><td colspan="2">Cut stone</td><td>≤5</td></tr>
<tr><td rowspan="3">5△</td><td rowspan="3">Offset of intrados from the design line(mm)</td><td colspan="2">$L \leq 30m$</td><td>±20</td><td rowspan="3">By level: levels on both sides at arch spring, arch crown, 1/4 point and 3/4 point of span</td></tr>
<tr><td colspan="2">$L > 30m$</td><td>$\pm L/1500$</td></tr>
<tr><td colspan="2">Maximum values at 1/4 and 3/4 spans</td><td>Two times of thetolerance in opposite directions</td></tr>
</table>

Note: L refers to bridge span, in mm for both specified value and tolerance.

Table 8.4.2-4 Measurement items for Sidewall Masonry

<table>
<tr><th>No.</th><th colspan="3">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of mortar(MPa)</td><td>Within the required range</td><td>According to Appendix F</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Deviation of outer face of masonry (mm)</td><td rowspan="2">Without facing</td><td>outward</td><td>≤30</td><td rowspan="4">By total station: 5points</td></tr>
<tr><td>inward</td><td>≤10</td></tr>
<tr><td rowspan="2">With veneering</td><td>outward</td><td>≤20</td></tr>
<tr><td>inward</td><td>≤10</td></tr>
<tr><td>3△</td><td colspan="3">Width (mm)</td><td>+40, −10</td><td>By tape measure: 5 places</td></tr>
<tr><td>4</td><td colspan="3">Elevation of top surface(mm)</td><td>±10</td><td>By level: 5places</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Verticality or slope (mm)</td><td colspan="2">Pitching rubble</td><td>≤0.5</td><td rowspan="2">By plumbing: five points</td></tr>
<tr><td colspan="2">Stone facing with dressed stone, cut stone or concrete panel</td><td>≤0.3</td></tr>
</table>

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
6	Evenness(mm)	Dressed stone	≤10	By 2-m straight edge: 1 point in every 20m2, but not less than 3 points in total, and check in both vertical and horizontal directions at each point
		Cut stone	≤20	
		rubble	≤30	

8.4.3 The appearance of masonry works shall conform to the following requirements:

1 The equivalent cumulative area of the cracked joints, and loose or peer-off pointing shall not exceed 1.5% of the total area of the masonry face, and the equivalent area of each defect shall not be larger than $0.04m^2$. The masonry joint crack wider than 0.5mm and longer than the length of a block is not permitted. The equivalent area shall be calculated by the length of a masonry crack multiplied by 0.1m.

2 No hollow, wide crack, massive mortar pocket or dummy joint shall exist within masonry joints.

8.5 Foundation

8.5.1 Concrete Spread footing

1 The concrete spread footings shall conformed to the basic requirements as follows:

1) The ground treatment and ground bearing capacity shall conform to the design requirements.

2) Overbreak must not be backfilled with loose materials.

2 The measurement items for concrete spread footings shall conform to the criteria in Table 8.5.1.

Table 8.5.1 Measurement items for Concrete Spread footings

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Size of plane (mm)		±50	By tape measure: 3 points and each for both length and width
3	Level of bottom surface of foundation (mm)	In soil	±50	By level: 5 points
		In rock	+50, −200	

continued

No.	Inspection item	Specified value & Tolerance	Method and frequency
4	Elevation of top surface of foundation (mm)	±30	By level: 5 points
5	Offset from axis (mm)	≤25	By total station: 2 points, each in both longitudinal and transversal directions

3 The appearance of concrete spread footing shall conform to the following requirements:

1) No rubbish, debris and temporary embedded parts shall exist on the surface.

2) No limited defects as listed in Appendix P shall exist.

8.5.2 Bored Piles

1 The bored piles shall conform to the basic requirements as follows:

1) After boring completion, the borehole shall be cleaned, and the diameter, depth, location and sediment thickness shall be measured and confirmed in conformity to construction specifications before underwater concreting activities begin.

2) Underground concreting shall be conducted continuously, during which the reinforcement cage shall not float upward.

3) The length of an anchor bar inserted into the pile cap must not be less than that required by design.

2 The measurement items for bored piles shall conform to the criteria in Table 8.5.2.

Table 8.5.2 Measurement items for Bored Piles

No.	Inspection item			Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)			Within the required range	According to Appendix D
2	Pile Location (mm)	Group piles		≤100	By total station: the coordinates of center point of each pile
		Bent piles	allowable value	≤50	
			Limiting value	≤100	
3△	Depth of borehole (m)			≥design value	By drawstring: every pile
4	Diameter of borehole (mm)			≥design value	By hole detector or ultrasonic detector for hole formation: every pile

continued

No.	Inspection item	Specified value & Tolerance	Method and frequency
5	Inclination of borehole (mm)	≤1%S and ≤500	By plumbing at drilling shaft, or ultrasonic detector for hole formation: every pile
6	Sediment thickness (mm)	Conform to the design requirement	By sedimentation box or slag meter; every pile
7△	Integrity of pile	Each pile shall conform to the design requirements or not less than that for type II if no requirements specified in the design	Conform to the design requirements, or by the method of low strain reflection wave or sonic wave method if no specific requirements given in design

Note: S refers to the length of a pile, in mm for both specified values and allowable deviations

3 The appearance of a bored pile shall conform to the following requirements:

1) No residual loose concrete shall remain on the pile top after breaking down to its cut-off.

2) No limited defects, as listed in Appendix P, shall exist on the exposed concrete surfaces.

8.5.3 Excavated piles

1 Excavated piles shall conform to the basic requirements as follows:

1) As soon as the excavation reaches the depth as designed, the bottom of the excavated hole shall be processed to such a status that no disturbed soft soils such as loose slag or mud. The geological conditions at the bottom of an excavated hole shall conform to the design requirements.

2) The reinforcement cage shall not float up during concrete casting. The underwater concreting shall be conducted continuously; and vibrating compaction shall be conducted during normal concreting.

3) The lengths of reinforcing steel bars inserted into a pile cap must not be less than those required by the design.

2 The measurement items fora excavated pile shall conform to the criteria in Table 8.5.3.

Table 8.5.3 Measurement items for Excavated piles

<table>
<tr><th>No.</th><th colspan="3">Inspection items</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Pile Location (mm)</td><td colspan="2">Group piles</td><td>≤100</td><td rowspan="3">By total station: the coordinates of center point of each pile</td></tr>
<tr><td rowspan="2">Bent piles</td><td>Allowable value</td><td>≤50</td></tr>
<tr><td>Limiting value</td><td>≤100</td></tr>
<tr><td>3△</td><td colspan="3">Hole depth (m)</td><td>≥design value</td><td>By drawstring: every pile</td></tr>
<tr><td>4</td><td colspan="3">Hole diameter or side length (mm)</td><td>≥design value</td><td>By well-diameter detector: every pile</td></tr>
<tr><td>5</td><td colspan="3">Inclination of a hole (mm)</td><td>≤0.5%S and ≤200</td><td>By plumbing: every pile</td></tr>
<tr><td>6△</td><td colspan="3">Integrity of a pile</td><td>Each pile shall conform to the design requirement or not less than that for type-II if no specific requirements in the design</td><td>Conform to the design requirements, or by either low-strain reflection wave or sonic wave method if no specific requirements given in design</td></tr>
</table>

Note: S refers to the length of a pile, in mm for both Specified value & tolerance.

3 The appearance quality of excavated pile shall conform to the following requirements:

1) No residual loose concrete shall remain on the pile top after breaking down to its cut-off.

2) No limiting defects, as listed in Appendix P, shall exist on the exposed concrete surfaces.

8.5.4 Driven Piles

1 The driven piles shall conform to the basic requirements as follows:

1) The process of pile driving shall conform to the construction specifications.

2) The quality of pile joints shall conform to the design requirements.

2 The measurement items for driven piles shall conform to the criteria in Tables 8.5.4-1 to -3. The pile location of any pile bent shall not exceed two times of the value listed in the tables.

Table 8.5.4-1 Measurement items for Pre-fabrication of Precast Concrete Piles

<table>
<tr><th>No.</th><th colspan="2">Inspection items</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="2">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td>2</td><td colspan="2">Length (mm)</td><td>±50</td><td>By tape measure: every pile</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Cross-section (mm)</td><td>Diameter or side length</td><td>±5</td><td rowspan="2">By tape measure: 10% of piles by random, 3 cross-sections on each pile</td></tr>
<tr><td>Deviation of hollow center from pile center</td><td>≤5</td></tr>
</table>

continued

No.	Inspection items	Specified value & Tolerance	Method and frequency
4	Offset of pile toe from longitudinal axis(mm)	≤10	By tape measure:10% of piles by random
5	Max. offset from pile longitudinal axis (mm)	≤0.1%S, and ≤20	By a drawstring:stretched at both ends of pile, take the 'rise', for10% of piles by random
6	Offset of top surface from the plane perpendicular to longitudinal axis of pile (mm)	≤1%D, and ≤3	By angle square: 10% of piles by random, check two perpendicular directions
7	Perpendicularity of pile joint surface to axis of pile	≤0.5	By angle square: 20% of piles by random, check two perpendicular directions

Note:S refers to the length of a pile and D is the diameter or side length of a pile, both in mm for specified values and allowable deviations.

Table 8.5.4-2 Measurement items for Steel Pipe Manufacturing

<table>
<tr><th>No.</th><th colspan="3">Inspection items</th><th>Specified Value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1</td><td colspan="3">Length (mm)</td><td>+300,0</td><td>By tape measure:every pile</td></tr>
<tr><td>2</td><td colspan="3">Max. displacement from pile longitudinal axis (mm)</td><td>≤0.1%S and ≤30</td><td>By a drawstring stretched at both ends of pile, take the 'rise', for 10% of piles by random</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Outline dimension of pipe segment</td><td colspan="2">Ovality of tube end(mm)</td><td>±0.5%D and ≤ ±5</td><td rowspan="2">By tape measure: 10% of piles by random, 3 cross-sections on each pile</td></tr>
<tr><td colspan="2">Perimeter (mm)</td><td>±0.5% L and ≤ ±10</td></tr>
<tr><td rowspan="5">4△</td><td rowspan="5">Dimension of Joint</td><td rowspan="2">Diameter difference (mm)</td><td>≤700</td><td>≤2</td><td rowspan="5">By tape measure: 10% of piles by random,on every joint</td></tr>
<tr><td>>700</td><td>≤3</td></tr>
<tr><td rowspan="3">Height difference of joint plate (mm)</td><td>δ≤10</td><td>≤1</td></tr>
<tr><td>10<δ≤20</td><td>≤2</td></tr>
<tr><td>δ>20</td><td>≤δ/10 and ≤3</td></tr>
<tr><td>5</td><td colspan="3">Size of welding line (mm)</td><td rowspan="2">Conform to the design requirement</td><td>By measure gauge: 10% of piles, all welds on each pile, and 3 points on each weld line.</td></tr>
<tr><td>6△</td><td colspan="3">Welding inspection</td><td>By ultrasonic method: Conform to the design requirement, and 10% of piles, 20% of welding lines on a pile, and no less than 3 welding lines on each pile
By X-ray method:Conform to the design requirement, and 10% of piles, 2% of welding lines on a pile, and no less than 1 welding line.</td></tr>
</table>

Note:D refers to the diameter, S is the length, and L is the perimeter of a pile, and δ is the thickness of a wall; all in mm for both specified values and allowable deviations.

Table 8.5.4-3 Measurement items for Driven piles[1]

No.	Inspection item			Specified value & Tolerance	Method and frequency
1	Pile location	Pile group	Pile in middle	≤D/2 and≤250	By total station: 20% of piles, check the coordinates of center point of a pile
			Pile at edge	≤D/4 and≤150	
		Pile bent	Longitudinal	≤40	
			Transversal	≤50	
2△	Level of pile toe (mm)			≤design value	By level: measure top level then back-calculate the bottom level for every pile.
3△	Penetration(mm)[4]			≤design value	Compare with penetration values for each pile
4	inclination		Vertical pile	≤1%	By plumbing: every pile
			Raked pile	≤15% tgθ	

Note: 1. The allowable deviation shall conform to the design requirements where a floating piling rig is used for driven piles in deep water.
2. D refers to the diameter or the short-side length of a pile, in mm for calculating specified value & tolerance.
3. θ refers to the intersection angle between the axis of a raked pile and perpendicular vertical line.
4. If the penetration value conforms to the design requirement before the pile bottom reaches to design level, the inspection shall be conducted as required in the construction specifications and the pile bottom level can be deemed as qualified if it accepted by the designers.

3 The appearance of driven piles shall conform to the following requirements:

1) No limited defects, as listed in Appendix P, shall exist on exposed concrete surfaces of prefabricated piles.

2) All splitting, cracking or breaking in a pile head shall be properly processed.

3) The shaft of a steel pipe shall be free of concave and convex, or any scratches with a depth exceeding 0.5mm or half of the allowable negative deviation in terms of the steel thickness. Welding lines shall be free of cracks, beadings, lack of penetration, arc scratching, unfilled arc pits and any appearance defects that are not allowable by the design.

8.5.5 Underground Diaphragm Walls

1 The underground diaphragm walls shall conform to the basic requirements as follows.

1) Immediately after a section of trench is formed, the trench bottom shall be cleaned, and the depth, width and inclination of the trench shall be measured and inspected for conformity to construction specifications, after which the underwater concreting may start.

2) The underwater concrete shall be cast continuously during which the reinforcement cage shall not float up.

3) The number and results of non-destructive tests and coring tests shall conform to the design requirements.

4) The types and quality of inter-section joints shall conform to the design requirements. No slag or loosing material shall exist in the wall joints; and no water or mortar leaking shall appear in the joints when concrete is cast in interval.

5) The deviation of centerlines of the diaphragm wall in two adjacent trenches shall not exceed 1/10 of wall thickness in any depths.

2 The measurement items for underground diaphragm walls shall conform to the criteria in Table 8.5.3.

Table 8.5.5 Measurement items for Underground Diaphragm Walls

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Position of axis (mm)	≤30	By total station: 2 points each in both longitudinal and transversal directions in every trench section
3△	Inclination (mm)	≤0.5% H	By ultrasonic wave groove meter or by monitoring system on trenching machine: every trench section
4	Sediment thickness (mm)	Conform to the design requirements	Sedimentation box or slag meter: every trench section
5	Trench depth (mm)	≥design value	By drawstring or ultrasonic groove meter for every trench section
6△	Trench width (mm)	≥design value	By rectangular gauge or ultrasonic wave groove meter: every trench section

Note: L refers to wall height, the unit is mm.

3 The appearance of underground diaphragm walls shall conform to the following requirements:

1) No loose concrete shall exist on wall top.

2) No abrupt folds shall exist on exposed parts of the wall in any trench section.

3) After and during foundation excavation, neither water nor sand shall leak through the

diaphragm walls.

8.5.6 Open Caissons

1 The open caissons shall conform to the basic requirements as follows:

1) The sinking of an open caisson should start only after the concrete of its walls reaches the specified strength. Water tightness tests shall be conducted for floating transportation of the open caissons before launching and floating.

2) The vertical axis lines of every section of a caisson shall be coincided with that of the first bottom section. The inclination shall be rectified before extension.

3) As soon as the open caisson sinks down and reaches the design level, the ground foundation shall be carefully inspected. Only upon the confirmation of conformity to design requirements, could the bottom of the open caisson be sealed.

4) In case there are cracks appear on the caisson walls during sinking, the sinking process shall be suspended for problem investigation. Only after effective countermeasures have been taken and the problem successfully solved, may the sinking continue.

2 The measurement items for open caissons shall conform to the criteria in Table 8.5.6.

Table 8.5.6 Measurement items for Open Caissons

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Plan size (mm)	Length and width	±0.5% B if B≤ 24m ±120 if B>24m	By tape measure: top surface of each segment
		Radius	±0.5% R if R≤24m ±60 if R>12m	
		Difference of two diagonal lengths due to egg shape	1% of diagonal length, max. ±180mm	
3	Thickness of caisson wall (mm)	concrete	+40, −30	By tape measure: 8 points along edge line of every segment
		Steel walls and reinforced concrete	±15	
4	Elevation of top surface (mm)		±30	By level: 5 points
5	Level of bottom edge (mm)		Conform to the design requirements	By tape measure: 5 places on caisson height, and then calculate in accordance with the Elevation of top surface

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
6△	Offset at center (Longitudinal and transversal direction) (mm)	Normal caisson	≤H/100	By total station: intersection points of edge lines and axis lines of each segment
		Floating caisson	≤H/100 + 250	
7	Perpendicularity (mm)		≤H/100	By plumbing: the positions of the two axis lines, 4 points

Note: B refers to the side length, R refers to the radius, and H refers to caisson height, all in mm for both Specified value & tolerance.

3 The appearance of a caisson shall conform to the following requirements.

1) No leaking shall appear on caisson walls, and no bulging shall appear on the outer face of the caisson wall.

2) No limited defects, as listed in Appendix P, shall exist on concrete surfaces.

8.5.7 Float-in double-wall steel cofferdams

1 The float-in double-wall steel cofferdams shall conform to the basic requirements as follows:

1) The manufacturing dimensions and assembling precision of steel hull components in a float-in double-wall steel cofferdam shall conform to the design requirements and relevant technical specifications.

2) After welding fabrication, the steel cofferdam shall be tested for water-tightness. Only confirmed for the conformity to design requirements, can the sinking operation of the cofferdam be commenced and executed in accordance with the requirements same as those for open caissons.

3) The sequence of filling concrete into the hatches of a steel cofferdam shall conform to the design requirements.

2 The measurement items for float-in double-wall steel cofferdams shall conform to the criteria in Table 8.5.7.

Table 8.5.7　Measurement items for Float-in double-wall steel cofferdams

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Offset from axis of top surface (mm)		≤ 80	By total station: 2 points on each axis and 4 points in total
2	Plane size(mm)	radius	± D/500, the difference of diameters in crossing from each other < 20	By tape measure: top surface of each segment
		Length and width	± 30, the difference of diagonal lengths from each other < 20	
3	Height(mm)		± 10	By tape measure: 5 points on each segment
4	Faulting at interface joint(mm)		≤2	By steel ruler: every interface joint
5	Size of welding line(mm)		Conform to the design requirements	By measure gauge: 20% welding lines but not less than 3 in total, and 3 points on each welding lines
6△	Welding inspection			By ultrasonic method: Conform to the design requirement, or 20% of welding lines but not less than 3 in total
7	Elevation of top surface (mm)		± 30	By level: 5 points
8	Verticality (mm)		≤h/100	By plumbing: 2 points on each axis and thus 4 in total

Note: D refers to the diameter and h refers to height of a cofferdam, in mm for both specified value & tolerance.

3　The appearance of a float-in double-wall steel cofferdam shall conform to the following requirements.

1) No cracks, welding lumps, slags, lack of penetration, arc scratches, unfilled arc pits or any other appearance defects that not allowed by the design shall exit.

2) Any scratches with a depth deeper than 0.5mm or 1/2 of the negative deviation from the thickness allowed for the steel shall not appear on steel surfaces.

8.5.8　Concrete bottom seal for open caissons and steel cofferdams

1　The concrete bottom seal for open caissons and steel cofferdams shall conform to the basic requirements as follows:

1) The cleaning of ground foundation shall conform to the design requirements. The

underwater concreting for bottom sealing may start only after the conformity is confirmed by inspection.

2) The underwater concreting shall be conducted continuously and completed once for all. Hollows or water leaking shall not exist at the interfaces to the wall enclosure.

2 The measurement items for concrete bottom seal for open caissons and steel cofferdams shall conform to the criteria in Table 8.5.8.

Table 8.5.8 Measurement items for Concrete bottom seal for Caissons and Cofferdams

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Level of bottom surface (mm)	0 - 200	By drawstring and level:5 points
3	Elevation of top surface (mm)	±50	By level:5 points

3 The appearance of open caissons and steel cofferdams shall conform to the following requirements:

1) No heaving or breaking shall happen to concrete bottom seal.

2) No cracks or gaps shall exist in the joints at the interfaces of concrete seal and steel walls.

8.5.9 Pile caps and mass concrete structures

1 The pile caps and mass concrete structures shall conform to the basic requirements as follows.

1) The highest temperature in concrete and the internal - external temperature differences of concrete due to hydration heat shall be controlled within an acceptable range.

2) The arrangement and treatment of construction joints shall conform to the design requirements and the criteria of construction specifications.

2 The measurement items for pile caps and mass concrete structures shall conform to the criteria in Table 8.5.9.

Table 8.5.9 Measurement items for Mass Concrete Structures

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
2	Size of plane(mm)	B<30;	±30;	By tape measure:2 cross-sections
		B≥1000	±B/1000	
3	Height of (mm)		±30	By tape measure:5points
4	Top level (mm)		±20	By level:5points
5	Offset from axis (mm)		≤15	By total station: 2 points and each in both longitudinal and transversal directions
6	Evenness (mm)		≤8	By 2-m straight edge: 1 point in every $20m^2$ on each side face, and at each point measures in both vertical and horizontal directions

Note:B refers to the diameter or side length, in mm for specified value & tolerance.

3 The pile caps and other mass concrete structures shall conform to the following requirements.

1) No limited defects, as listed in Appendix P, shall exist.

2) No construction rubbish, debris or temporary embedded parts shall exist on the surfaces.

8.5.10 Base grouting of cast in-place concrete piles

1 Base grouting of a bored cast in-place concrete pile shall conform to the basic requirements as follows.

1) The relevant grouting parameters and construction method shall be determined by tests.

2) Grouting equipment, grouting pipes and tubes, relevant joints and valves shall be inspected and checked for their pressure bearing capacity. The inspection results shall conform to the requirements in grouting method.

3) The grouting valves shall be open in time before hardening of the concrete at pile base and the grouting work shall be conducted in accordance with design requirements and relevant provisions of construction specifications.

2 The measurement items for base grouting of a cast in-place pile shall conform to the criteria in Table 8.5.10.

Table 8.5.10 Measurement items for the Grouting the bottom of a bored pile

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of grout (MPa)	Within the required range	According to Appendix M
2	Final pressure of grouting (MPa)	conform to the requirements of grouting method	Check readings on pressure gage: all pipes
3△	Volume grouted (l)	conform to requirements of grouting method	By calibration vessel method or flow meter: every pile
4	Period of maintaining pressure (min)	≥5	By stop watch: all pipes

8.6 Concrete Piers and Abutments

8.6.1 Concrete piers and abutments

1 Concrete piers and abutments shall conformed to the basic requirements as follows:

1) The strength, stiffness and stability of formworks and scaffolds shall satisfy the criteria of construction specifications.

2) The placement and treatment of construction joints shall satisfy the criteria of construction specifications.

2 The measurement items fora concrete piers or abutments shall conform to the criteria in Tables 8.6.1-1 to -3.

Table 8.6.1-1 Measurement items for Cast-in-place Piers/Abutments

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Cross-sectional size (mm)		±20	By tape measure: 1 cross-section in every construction segment, or 2 cross-sections if no segmentation.
3	Verticality over whole height (mm)	H≤5m	≤5	By total station: 2 points each in longitudinal and transversal directions
		5m < H≤60m	≤H/1000 and ≤20	
		H > 60m	≤H/3000 and ≤30	
4	Elevation of top surface (mm)		±10	By level: 3 points
5△	Offset from axis (mm)	H≤60m	≤10 and≤8 comparing to the previous segment	By total station: the intersection points of side lines and two axis on top surface of each construction segment

continued

No.	Inspection Items		Specified value & Tolerance	Method and frequency
5△	Offset from axis (mm)	H > 60m	≤115 and ≤8 comparing to the previous segment	By total station: the intersection points of side lines and two axis on top surface of each construction segment
6	Inter-segmental faulting (mm)		≤5	By tape measure: each side-face of every segment
7	Evenness (mm)		≤8	By 2-m straight edge: 1 point in every $20m^2$ and each in both vertical and horizontal directions
8	Location of embedded part (mm)		Conform to the design requirement, or ≤ 5mm if no specific requirements given in design	By tape measure: every member

Note: H refers to the height of a pier or abutment, in mm for both specified value and tolerance.

Table 8.6.1-2 Measurement items for Cast-in-place Pier/Abutment Caps or Capping Beams

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Size of cross-section (mm)	±20	By tape measure: 3 cross-sections
3	Offset from axis (mm)	≤10	By total station: 2points each in both longitudinal and transversal directions
4	Elevation of top surface (mm)	±10	By level: 5 points
5	Position reserved for bearing plinth (mm)	≤10	By tape measure: for every bearing
6	Evenness (mm)	≤8	By 2-m straight edge: 3 points in longitudinal directions each on every side face

Table 8.6.1-3 Measurement items for Precast Pier Segments

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Size of Cross-section (mm)	Outline	±15	By tape measure: 2 cross-sections
		Wall thickness	±10	
3	Height (mm)		≤10	By tape measure: at centerline
4	Evenness (mm)		±10	By 2-m straight edge: 1 point on every side face and each in vertical and horizontal directions
5	Position of anchor hole reserved for bearing plinth (mm)		≤10	By tape measure: every hole
6	Position of embedded part (mm)		≤8	By tape measure: every member

Note: Inspection is not required for the item not involved in a real project.

3 The appearance of a concrete pier or abutment shall conform to the following requirements.

1) No limited defects, as listed in Appendix P, shall exist.

2) No construction waste, debris and temporary embedded units shall be left on the surfaces.

8.6.2 Installation of Precast Segments of Piers and Abutments

1 The installation of precast segments of a pier or abutment shall conform to the basic requirements as follows:

1) The precast segments of a pier body or abutment body can only be installed when they have been inspected as qualified.

2) The types and technical performance of cementing material of the precast segments shall conform to the design requirement. The inter-segment joints shall be tightly filled.

3) The depth of which a pier or abut is inserted into the built-in socket of a foundation shall conform to the design requirement.

2 The measurement items for the installation of piers and abutments shall conform to the criteria in Table 8.6.2.

Table 8.6.2 Measurement items for Installation of Piers and Abutments

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Offset from axis (mm)	H≤60m	≤10 and ≤8 compared to the previous segment	By total station: intersection points of side lines and two axis lines on top surface of each segment
		H>60m	≤15 and ≤8 compared to the previous segment	
2	Elevation of top surface (mm)		±10	By level: 5 points
3	Verticality over whole length (mm)	H≤5m	≤5	By total station: 2 points each in both longitudinal and transversal directions
		5m<H≤60m	≤H/1000 and ≤20	
		H>60m	≤H/3000 and ≤30	
4	Inter-segment faulting (mm)		≤3	By taper gauge: each side face of every segment
5	Strength of concrete in wet joint (MPa)		Within the required range	According to Appendix D

Note: *H* refers to the height of a pier or abutment, in mm for both specified value & tolerance.

3 The appearance of installed concrete piers and abutments shall conform to the following requirements:

1) No limited defects, as those listed in Appendix P, shall exist on wet jointed concrete surface.

2) No peeling or cracking shall occur to the filling materials in joints.

8.6.3 Composite abutments of an arch bridge

1 The composite abutments of an arch bridge shall follow the basic requirements as follows.

1) Ground bearing capacity shall conform to the design requirement.

2) Slip-resistance plate must not be broken.

3) The displacement, settlement and rotation of a composite abutment, as well as the attachments of its component parts shall be monitored. Any of those beyond allowable tolerance shall be analyzed and processed wherever necessary.

4) The backfilling behind an abutment shall be completed before the horizontal pushing forces acting on the abutment. The progress of backfilling shall be properly controlled so that the displacement of the abutment shall never exceed the allowable range as the design specified

2 The measurement items for composite abutments of an arch bridge shall conform to the criteria in Table 8.6.3.

Table 8.6.3 Measurement items for Composite Abutments of Arch Bridge

No	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Settlement of abutment back before erection of arch-ring (mm)	≥85% of designed value	By level: each abutment at both sides of upstream and downstream from the start of backfilling until start of the arch-ring erection
2	Abutment backward inclination	≤1/250	By plumbing: each abutment, computed based on the separation values of settlement joints on both sides of upstream and downstream
3	Backfill completed before erection of arch-ring (m^3)	≥90%	By estimate: each abutment, based on actual situation of backfill

continued

No	Inspection Items	Specified value & Tolerance	Method and frequency
4	Horizontal displacement after arch erection (mm)	≤the value allowed by design	By total station: each abutment, on monitoring points pre-established on both sides

3 The appearance of composite abutments of an arch bridge shall conform to the following requirements.

1) The faulting of the top surfaces of adjacent component parts shall not exceed 8mm.

2) No separation shall appear at the interfaces of different component of parts in a composite abutment.

8.6.4 Backfilling behind abutment

1 The backfilling behind abutments of an arch bridge shall conform to the basic requirements as follows.

1) Permeable materials or the materials required by the design shall be used for backfilling. Unsuitable materials such as humus, salty soil, sludge, chalk soil, kieselguhr or frozen soil are strictly prohibited. Organics, ice blocks, turfs, tree roots or household wastes shall not be contained in the materials for backfilling.

2) The backfilled materials shall be compacted in layers. The top surface of each layer smoothly leveled with an appropriate cross-slopes.

3) The backfilling shall only commence after the abutment concrete reaches 85% of the design strength.

4) Backfilling behind the abutments of an arch bridge shall be completed before the abutment carries horizontal thrusts from the arch ring.

5) The backfill behind abutments shall connect to road embankment in such a manner as specified by design.

6) The waterproofing and drainage shall conform to the design requirements.

2 The measurement items for backfilling behind abutment shall conform to the criteria in Table 8.6.4, and be inspected for other items as required for road earthworks.

Table 8.6.4 Measurement items for Backfilling behind abutment

No.	Inspection Items	Specified value & Tolerance			Method and frequency
		Motorway & Class-1 highway	Class-2 highway	Class-3 and -4 highway	
1△	Compaction (mm)	≥96	≥95	≥94	According to appendix B: 2 points on every compacted layer
2	Length of backfill (mm)	≥design value			By tape measure: on two sides of top and bottom surfaces of each abutment

3 The appearance of backfilling behind an abutment shall be conform to the following requirements:

1) Accumulated length of the uneven surface of backfilling and the kink of edge lines shall not exceed 10% of the total length.

2) No uncompacted slope edges shall exist.

8.7 Concrete beam bridges

8.7.1 Cast-in-place beam and slab

1 The cast-in-place beams and slabs shall conform to the basic requirements as follows.

1) The strength, stiffness and stability of formworks and scaffolds shall satisfy the requirements of construction specifications.

2) Estimated scaffolding deformation and the settlement of ground foundation shall satisfy the designed level of the beams after construction. Uneven settlement in ground foundation shall be eliminated. Non-elastic deformation of scaffolding shall be minimized by preloading.

3) The setting out and placement of pre-embedded units shall conform to the design requirements and satisfy the criteria of construction specifications.

2 The measurement items for cast-in-place beams and slabs shall conform to the criteria in

Table 8.7.1.

Table 8.7.1 Measurement items for Cast-in-place Girder and Slab

No.	Inspection Items		Specified Values or Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Offset from axis (mm)		≤10	By total station:5 points on every span
3	Elevation of top surface (mm)		±10	By level:5 points on every span, especially at midspan, above piers and abutments
4△	Size of cross-section(mm)	Height	+5, -10	By tape measure: 3 cross-sections on each span
		Top width	±30	
		Bottom width of box beam	±20	
		thickness of top and bottom flanges, webs or diaphragms	+10, 0	
5	Length(mm)		+5, 10	By tape measure: centerline of the top surface for every beam.
6	Inter-segment faulting (mm)		≤5	By tape measure or ruler: bottom and side surfaces
7	Cross slope (mm)		±0.15	By level:3 places on every span
8	Evenness (mm)		≤8 沿梁长方向每侧面每 10m 梁长测 1 处×2 尺	By 2-m straight edge:1 place, two measures in every 10m length of beam on both side faces

3 The appearance of concrete-in-place beams and slabs shall conform to the following requirements.

1) No limited defects, as listed in Appendix P, shall exist on the concrete surfaces.

2) No construction waste, debris and temporarily pre-embedded parts shall remain.

8.7.2 Precast beams and slabs

1 The precast concrete beams and slabs shall conform to the basic requirements as follows.

1) The quality of roughened faces, and the quantity and quality of key grooves for segmental splicing shall conform to the design requirements.

2) When a precast segment is hoisted up to move away from its shuttering base, its concrete shall have reached the strength not lower than that specified in design and shall be free of

damages. At the time when it is to be installed, the bearing structures, such as piers, abutments, capping beams and bearing plinths, shall reach the strength not lower than those specified in design.

3) Before installation, the beams or slabs to be erected shall be inspected and confirmed for conformity, and the bearing structures such as piers, abutment and bearing plinths shall be stable and firmly fixed. After erection, the beams or slabs shall be placed in right position on the bearings. The interface between the bottom of a beam and the top surface of a bearing, as well as that between the bottom of a bearing and the bearing pad shall contact against each other tightly, and the temporary supports shall be stable.

4) The types, scales, and performance of joint filling materials shall conform to the design requirements. The joints shall be filled fully and densely.

2 The measurement items for precast beams and slabs shall conform to the criteria in Tables 8.7.2-1 to -3.

Table 8.7.2-1 Measurement items for Precast Beams and Slabs

<table>
<tr><th>No</th><th colspan="4">Inspection Items</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="4">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="2">2</td><td colspan="3" rowspan="2">Length of beam(mm)</td><td>Total length</td><td>+5, −10</td><td rowspan="2">By tape measure: centerline of top surface and both edge-lines of bottom surface for every beam</td></tr>
<tr><td>Segment length</td><td>0, −2</td></tr>
<tr><td rowspan="7">3△</td><td rowspan="7">Size of cross-section (mm)</td><td rowspan="4">Width</td><td rowspan="2">Box beam</td><td>Top width</td><td>±20(±5)①</td><td rowspan="6">By tape measure: 3 cross-sections on every beam, or 2 cross-sections on every slab or every beam segment</td></tr>
<tr><td>Bottom width</td><td>±10(+5,0)①</td></tr>
<tr><td rowspan="2">Other beams & slabs</td><td>Dry joint (beam flanges, slabs)</td><td>±10(±3)②</td></tr>
<tr><td>wet joint (beam flanges, slabs)</td><td>±20</td></tr>
<tr><td rowspan="2">Height</td><td colspan="2">Box beams</td><td>0, −5</td></tr>
<tr><td colspan="2">Other beams and slabs</td><td>±5</td></tr>
<tr><td colspan="3">Thickness of top and bottom flanges, webs and diaphragms</td><td>+5,0</td><td></td></tr>
<tr><td>4</td><td colspan="4">Evenness (mm)</td><td>≤5</td><td>By 2-m straight edge: 1 place, 2 measures in every 10m length of beam on both side surfaces</td></tr>
<tr><td>5</td><td colspan="4">Position of cross beams and pre-embedded units (mm)</td><td>≤5</td><td>By tape measure: for every member</td></tr>
</table>

continued

No	Inspection Items		Specified value & Tolerance	Method and frequency
6	Cross slopes (%)		±0.15	By level: 3 cross- sections for every beam, or 2 cross-sections for every slab or beam segment
7	Anchor plane of stay cables③	Coordinates of anchor points (mm)	±5	By total station and measure tape: every anchor bearing plate, check levels and coordinates of the points of two crossing centerlines of an anchor hole intersecting with two side lines of the anchor bearing plate
		Angle of anchor plane (°)	0.5	By angle gauge: intersection angle of every anchor bearing plate to horizontal and vertical plane. Three points at every plate.

Note: 1. The figures in brackets of item No. 3 for width of box beams in above table apply to segment assembled beams.

2. The figures in brackets for dry joint in other beams and slabs of item No. 3 apply to the deck slab of a composite beam.

3. Item No. 7 applies to the prefabricated beam segments of a cable-stayed bridge only.

Table 8.7.2-2 Measurement items for Installation of Precast Beams and Slabs

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1	Offset from center point of bearing unit (mm)	Beams	≤5	By tape measure: 6 bearing places in every span, or all if less than 6
		Slabs	≤10	
2	Elevation of top surface (mm)		±10	By level: 5 points in each span, including at midspans and above piers or abutments especially
3	Elevation difference of adjacent beams/slabs (mm)	$L \leq 40$	≤10	Taper gauge: at the points with maximum elevation difference of adjacent beams or slabs
		$L > 40$	≤15	

Table 8.7.2-3 Measurement items for Span-by-span Installation of Beams

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)		≤5	By total station: 3point in every span
2	Inter-segment faulting (mm)	Top surface	≤5	Taper gauge: maximum faulting at every joint on top, bottom, and side surfaces
		Bottom &side surfaces	≤3	
3	Width of vertical joint between segments (mm)		≤3	By ruler: 3points on every joint
4	Length of beam (mm)		+20, −40	By tape measure: lengths of centerline and both edge lines of every span
5	Offset from center point of bearing unit (mm)		≤5	By ruler: center point of bearing unit

3 The appearance of a precast concrete beam or slab shall conform to the following requirements.

1) No limited defects, as listed in Appendix P, shall exist on the concrete surfaces.

2) No construction waste, debris or temporary pre-embedded units shall remain on surfaces.

3) No peeling or cracking shall exist in filling materials of the joints of adjacent beam segments.

8.7.3 Incrementally launched beams

1 The beams erected by incremental launching shall conform to the basic requirements as follows:

1) The centerline of launching platform and sliding tracks shall coincide with the bridge axis.

2) A trial assembling of the launching nose shall be conducted before being installed on the launching platform. The launching nose and the first beam shall be firmly connected.

3) Jacks and other pushing equipment shall be calibrated prior to construction. All launching points shall be acting synchronously if multi-point pushing is adopted.

4) The settlement and displacement of piers and abutments, the offset of the beams, and the deflection of the launching nose shall be monitored during launching.

5) The procedures of incremental launching and beam positioning shall conform to the design requirements. If cracks appear on beams, investigation shall be conducted and effective countermeasures be implemented before the beam launching may continue.

2 The measurement items for beam erection by incremental launching method shall conform to the criteria in Table 8.7.3.

Table 8.7.3 Measurement items for Beam Erection by Incremental Launching

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)	≤10	By total station: 2 points on every segment
2△	Counterforce during beam positioning	Conform to the design requirement, or ≤1.1 times of design counterforce if no specific requirements in design	By checking the readings of all oil pressure gauges

continued

No.	Inspection Items		Specified value & Tolerance	Method and frequency
3△	Level difference of supporting points (mm)	Adjacent longitudinal supports	Conform to the design requirement and ≤ 5 if no specific requirements in design	Inspect all supporting points with levels
		Two side supports on a pier	Conform to the design requirement, or ≤ 2 if no specific requirements in design	

8.7.4 Balanced cantilever beams

1 The beams constructed by balanced cantilever method shall conform to the basic requirements as follows.

1) Detailed rechecking on the levels of each anchor block on a pier (or pier segment) and the axis of the bridge shall be conducted for conformity to design requirements before the commencement of segment casting or assembling by balanced cantilever.

2) The construction by balanced cantilever shall progress in a symmetrical and balanced way, during which the axis and levels shall be monitored and controlled.

3) Any stress cracks wider than the allowable limits as specified in the design or relevant specifications shall not appear on the beams during construction.

4) Inter-faces of segments, either casted or assembled in-place, shall be properly treated in accordance with the design requirements. The types, scales, and quality of cementing materials for joint filling shall conform to the design requirements. The inter-segment joints shall be fully and densely filled.

5) The level difference of the head segments shall be within the allowable ranges as specified in design before the closure of two cantilever arms of a span. The procedures of beam closing and mechanical system transforming shall conform to the design requirements.

2 The measurement items fora beams constructed by balanced cantilever shall conform to the criteria in Tables 8.7.4-1 and -2.

Table 8.7.4-1 Measurement items for Cast-in-place Balanced Cantilever Beams

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Offset from axis(mm)	$L \leq 100$m	≤10	By total station: 2 points on every segment
		$L > 100$m	$\leq L/10000$	

continued

No.	Inspection Items		Specified value & Tolerance	Method and frequency
3	Elevation of top surface (mm)	L≤100m	±20	By level:2 points on every segment
		L>100m	±L/5000	
4△	Size of cross-section (mm)	Height	+5, −10	By tape measure:1 cross- section in every segment
		Top width	±30	
		Bottom width	±20	
		Thickness of top and bottom flanges and webs	+10,0	
5	Post-closure level difference of two symmetrical points in one span (mm)	L≤100m	≤20	By level: 6 symmetrical points on bottom of beam for every span
		L>100m	≤L/5000	
6	Cross slope of top surface (%)		±0.15	By level:2 places on every segment
7	Evenness (mm)		≤8	By 2-m straight edge: 1 point in both vertical and horizontal directions on each side surface of every segment,
8	Faulting of adjacent segments (mm)		≤5	Taper gauge: check bottom and side surfaces

Note: *L* refers to the length of a span, in mm for both specified value and tolerance.

Table 8.7.4-2 Measurement items for Precast Balanced Cantilever Beams

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of concrete of closure Segment (MPa)		Within the required range	According to Appendix D
2	Offset from axis(mm)	*L*≤100m	≤10	By total station:2 points on every segment
		L>100m	≤*L*/10000	
3	Elevation of top surface (mm)	L≤100m	±20	By level:2 points on every segment
		L>100m	±L/5000	
4	Level difference of symmetrical points of one span after closure(mm)	L≤100m	≤20	By level: By level: 6 symmetrical points on bottom of beam for every span
		L>100m	≤L/5000	
5	Faulting of adjacent segments (mm)		≤3	Taper gauge: check bottom and side surfaces

Note: 1. *L* refers to the length of a span, in mm for both specified values and allowable deviations.

2. Item No. 1 is not applicable to non-closure segments.

3 The appearance of a beams constructed by balanced cantilever shall conform to the criteria in Item No. 3 of Clause 8.7.2. The alignment of a beam shall be smooth and free of kinks.

8.7.5 Beams Constructed by Swing

1 The beams constructed by swing shall conform to the basic requirements as follows.

1) The swing operation shall commence only after the swing equipment and anchorage systems are inspected and qualified.

2) A position control system shall be provided and the two sides shall work synchronously if such a swing method is adopted.

3) If cracks appear in superstructure during swing operation, investigation shall be conducted to identify the causes and implement effective countermeasures.

4) The level difference of the ends of cantilever arms before closure in midspan shall conform to the design requirements.

2 The measurement items for the beams constructed by swing method shall conform to the criteria in Table 8.7.5.

Table 8.7.5 Measurement items for Swing constructed Girders

No.	Inspection Items	Specified Value & Tolerance	Method and frequency
1△	Strength of the concrete for beam closing and for sealing of the swing gears (MPa)	Within the required range	According to Appendix D
2△	Offset from axis (mm)	≤L/10000	By total station: 5 points
3	Elevation of top surface (mm)	±20	By level: 3 points each at cross-sections at midspan and both of beam ends
4	Level difference from each other of adjacent components or that of two edges of one cross-section (mm)	≤10	By level: 5 cross- sections

Note: L refers to the length of a span, in mm for both specified values and allowable deviations.

3 The appearance of the beams constructed by swing method shall conform to the criteria as follows:

1) No limited defects, as listed in Appendix P, shall exist.

2) No construction waste, debris and temporary pre-embedded units shall remain on the surfaces.

8.8 Arch Bridge

8.8.1 Cast-in-place Arch Rings

1 The cast-in-place arch rings shall conform to the basic requirements as follows.

1) The formwork scaffolding shall be erected firmly and stable in accordance with the construction specifications.

2) Arch ring concrete shall be poured in accordance with the procedures as specified in the design.

3) The arch scaffoldings shall be dismantled in accordance with the sequences specified in the design.

2 The measurement items for cast-in-place arch rings shall conform to the criteria in Table 8.8.1.

Table 8.8.1 Measurement items for Cast-in-place Arch Rings

<table>
<tr><th>No.</th><th colspan="3">Inspection Items</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Offset from axis(mm)</td><td colspan="2">Slab arch</td><td>≤10</td><td rowspan="2">By total station: 5 points for every arch rib or arch slab</td></tr>
<tr><td colspan="2">Rib arch</td><td>≤5</td></tr>
<tr><td rowspan="2">3△</td><td rowspan="2">Deviation of intrados apart from the design arc line (mm)</td><td colspan="2">L≤30m</td><td>±20</td><td rowspan="2">By level: 1 point each on both sides at arch crown, at 1/4 span and 3/4 span</td></tr>
<tr><td colspan="2">L>30m</td><td>±L/1500 and≤ ±40</td></tr>
<tr><td rowspan="4">4△</td><td rowspan="4">Size of cross-section(mm)</td><td colspan="2">Height</td><td>±5</td><td rowspan="4">By tape measure: 5 cross-sections at arch springing, arch crown, 1/4 span and 3/4 span</td></tr>
<tr><td colspan="2">Thickness of top, bottom flanges and webs</td><td>+10, 0</td></tr>
<tr><td rowspan="2">Width</td><td>±20</td><td>±20</td></tr>
<tr><td>±10</td><td>±10</td></tr>
</table>

Note: L refers to the length of a span, in mm for both specified value & tolerance.

3 The appearance of a cast-in-place arch ring shall conform to the criteria in Item No. 3 of

Clause 8.7.1. No kinks shall appear on the arch alignment.

8.8.2 Precast arch ring segments

1 The segment prefabrication of an arch ring shall conform to the basic requirements in Item No. 1 of Clause 8.7.2 herein above.

2 The measurement items for the segment prefabrication of an arch ring shall conform to the criteria in Tables 8.8.2-1 and -2.

Table 8.8.2-1 Measurement items for Precast Arch Ring Sections

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Length of intrados of each arch box segment (mm)		0, −10	By tape measure: intrados of both sides of each segment
3△	Offset from designed intrados line (mm)		±5	By templet: 3 points on bottom surface of every segment
4△	Size of cross-section (mm)	Thickness of top and bottom flanges, and webs	+10, 0	By tape measure: check both end cross-sections
		width, height	+10, −5	
5	Evenness (mm)	Rib arch	≤5	By drawstring and measure tape: both side surfaces of every segment
		Box arch	≤10	
6	Arch box joint inclination (mm)		±5	By straight edge: 2 points on every joint
7	Position of pre-embedded units (mm)		≤5	By tape measure: every unit

Table 8.8.2-2 Measurement items for Precast Members of a Truss arch

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2△	Size of cross-section (mm)	±5	By tape measure: 2 cross-sections
3	Length of truss member (mm)	±10	By tape measure: along centerline of top and bottom surfaces
4	Side curving of truss member (mm)	≤5	By drawstring and measure tape: every truss member
5	Position of pre-embedded unit (mm)	≤5	By tape measure: every unit

Note: inspection by sampling 25% of truss members in each batch in the case of batch production

3 The appearance of prefabricated segments for arch rings shall conform to the criteria in Item No. 3 of Clause 8.7.2 hereinabove

8.8.3 Installation of Arches

1 The arch installation shall conform to the basic requirements as follows:

1) The installation of an arch bridge shall conform to the procedure as specified in design.

2) The steel plates wedged in joints shall be uniformly arranged and must not be placed concentrated in a few places or along one side only.

3) The cast-in-place concrete for the joints of prefabricated segments shall be fully and densely filled. The spandrel works may be constructed only after the concrete of the joints reaches the design strength.

4) During installation, any cracks appearing on the structural members or joint rods shall not be wider than the allowable values specified in the design and specifications.

5) The difference of levels at two ends of the closure segment shall not exceed the allowable values specified in design.

2 The measurement items for installation of an arch shall conform to the criteria in Tables 8.8.3-1 to-3.

Table 8.8.3-1 Measurement items for Installation of Main Arch Rings

<table>
<tr><th>No.</th><th colspan="3">Inspection Items</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of the concrete of joints (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Offset from axis (mm)</td><td colspan="2">L≤60m</td><td>≤10</td><td rowspan="2">By total station: 5 points on every arch rib in every span</td></tr>
<tr><td colspan="2">L>60m</td><td>≤L/6000 and ≤40</td></tr>
<tr><td rowspan="2">3△</td><td rowspan="2">Level of arch ring (mm)</td><td colspan="2">L≤60m</td><td>±20</td><td rowspan="2">By level: 5 points on every arch rib in every span</td></tr>
<tr><td colspan="2">L>60m</td><td>±L/3000 and≤ ±50</td></tr>
<tr><td rowspan="3">4△</td><td rowspan="3">Relative level difference of the joints at symmetrical points of an arch (mm)</td><td rowspan="2">Allowable</td><td>L≤60m</td><td>≤10</td><td rowspan="3">By level: check every pair of symmetrical joints on every arch rib in every span</td></tr>
<tr><td>L>60m</td><td>≤L/3000 and ≤40</td></tr>
<tr><td colspan="2">maximum</td><td>Twice the tolerance and in opposite direction</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Relative level difference of arch ribs in a span (mm)</td><td colspan="2">L≤60m</td><td>≤20</td><td rowspan="2">By level: 5 points</td></tr>
<tr><td colspan="2">L>60m</td><td>≤L/3000 and ≤30</td></tr>
</table>

Note: *L* refers to the length of a span, in mm for both specified value and tolerance.

Table 8.8.3-2 Measurement items for Cantilevering Assembly of Truss Arch

No.	Inspection Items			Specified value & Tolerance	Method and frequency
1△	Strength of the concrete of joints (MPa)			Within the required range	According to Appendix D
2△	Offset from axis (mm)	L≤60m		≤10	By total station: 5 points on every arch rib of every span
		L>60m		≤L/6000 and ≤40	
3	Arch ring levels (mm)	L≤60m		±20	By level: 5 points on every arch rib of every span
		L>60m		±L/3000 and≤ ±50	
4	Level difference of the joints at symmetrical points of an arch (mm)			≤20	By level: 5 point in every span
5△	Relative level difference of symmetrical points (mm)	Allowable	L≤60m	≤20	By level: 5places at symmetrical joints on every arch rib of every span
			L>60m	≤L/3000 and ≤40	
		maximum		Two times of the tolerance and in opposite direction	
6	Verticality of an arch (mm)			≤h/300 and≤20	By plumbing: three points at1/4 span, 3/4 span and arch crown

Note: L refers to the length of a span and h refers to the rise of an arch, in mm for both specified value and tolerance.

Table 8.8.3-3 Measurement items for Installation of Arch Spandrels

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)	≤10	By total station: 3 points at arch crown and both springings
2	Level of spring line (mm)	±20	By level: 2 points on each spring line
3	Level difference of adjacent members (mm)	≤5	By tape measure: 2 points on every adjacent members

3 The appearance of an installed arch shall conform to the following requirements.

1) No abnormal kink or deformation shall appear on main arch rings, upper chords or lower chords.

2) No limited defects, as listed in Appendix P, shall exist in concrete surface of joints.

8.8.4 Arches erected by swing method

1 The arches erected by swing method shall conform to the basic requirements as specified in Item No. 1 of Clause 8.7.5 herein above

2 The measurement items for arches erected by swing method shall conform to the criteria in Table 8.8.4.

Table 8.8.4 Measurement items for Arches Erected by Swing Method

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Strength of the concrete for sealing swing gears and for beam closure (MPa)	Within the required range	According to Appendix D
2	Offset from axis (mm)	≤L/6000 and ≤30	By total station: 5points
3△	Level of arch crown at midspan (mm)	±20	By level: at centerline and both side lines
4	Level difference of two sides of a cross-section, or adjacent upper components (mm)	≤10	By level: 5 points

Note: L refers to the length of a span, in mm for both specified value and tolerance.

3 The appearance of the arches erected by swing method shall conform to the criteria in Item No. 3 of Clause 8.7.5.

8.8.5 Melan arches

1 Melan arches shall conform to the basic requirements as follows.

1) The framework of a Melan arch shall be made of the steels and welding materials in compliance with the design requirements, fabricated into the alignment as designed, and put into trial assembly before being erected on site.

2) Neither cracking in any component members nor partial instability of the framework shall occur during construction.

3) The framework shall be hoisted in such a way that it can be stably lowered into position with minimal deformation. Calibration and necessary adjustment shall be made to the framework before concreting.

4) Concrete shall be poured symmetrically in layers following the sequences in compliance with the design requirements.

5) During concrete pouring, arch axis shall be monitored to make sure the stability of the framework and the accumulated errors are well controlled within an allowable range.

2 The measurement items for Melan arches shall conform to the criteria in Tables 8.8.5-1 to-3.

Table 8.8.5-1 Measurement items for Fabrication of Stiff Skeletons

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1	Size of cross-section of member (mm)	Not less than design values	By tape measure: both ends for every truss member
2	Height and width of framework (mm)	±10	By tape measure: 3 cross-sections on every segment
3△	Offset from designed intrados line (mm)	±10	By templet: 3 points on every segment
4	Arc length of each segment (mm)	+10, −10	By tape measure: intrados lines on both sides for every segment
5△	Welding inspection	Conform to the design requirement	By ultrasonic method: every and all truss members

Table 8.8.5-2 Measurement items for Installation of Stiff Skeletons

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)		≤ L/6000 and ≤40	By total station: 5 points on every framework
2	Elevation (mm)		±L/3000	By level: points at arch crown, arch springing and all joints
3△	Relative level difference of symmetrical points (mm)	Allowable	≤L/3000 and ≤40	By level: every and all joints
		Maximum	Two times of the tolerance and in opposite direction	
4△	Welding inspection		Conform to the design requirement	By ultrasonic method: every and all welding joints

Note: L refers to the length of a span, in mm for both specified value and tolerance.

Table 8.8.5-3 Measurement items for Concreting of Melan arches

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Offset from axis (mm)	L≤60m	≤10	By total station: 5 points on every skeleton
		L>60m	≤L/6000 and ≤40	
3△	Level of arch ring (mm)		±L/3000 and≤ ±50	By level: 5 points at both springing, arch crown, 1/4 span and 3/4 span
4	Relative level difference of symmetrical points(mm)	Allowable	≤L/3000 and ≤40	By level: 8 symmetrical points
		Maximum	Two times of the tolerance and in opposite direction	
5	Size of cross-section (mm)		±10	By tape measure: 10 cross-sections

Note: L refers to the length of a span, in mm for both specified value and tolerance.

3 The appearance of a Melan arch shall conform to the following requirements.

1) Neither abnormal alignment kink nor deformation shall appear on the framework.

2) Welding lines shall be intact without cracks, beadings, lack of penetration, arc scratch, unfilled arc pits or other appearance defects that are not allowed by design.

3) No limited defects, as listed in Appendix P, shall exist on concrete surfaces.

4) No construction waste, debris and temporary pre – embedded units shall remain inside and outside the arch rings.

8.8.6 Concrete Filled Steel Tubular (CFST) Arches

1 Concrete filled steel tubular arches shall conform to the basic requirements as follows.

1) The concrete shall have such properties as low – foaming, high fluidity, retarded initial setting and little expansion.

2) Assessment shall be conducted on the welding workmanship for tubular arch ribs and the results shall conform to the relevant technical specifications. A detailed method of welding operation shall be developed.

3) The welding operation shall not start until all of component members of a rib segment are inspected and qualified. The rib segments of a steel tubular arch shall be installed only after the conformity is confirmed.

4) A disqualified welding line at the same part of a work may be repaired but shall not be repaired for more than twice. The repaired welding line shall be re – inspected in accordance with the same criteria and shall be used only if the conformity is confirmed.

5) The transversal stabilizing measures, and the rigging and lifting slings for installation of steel tubular arches shall conform to the design requirements.

6) The tube filling concrete shall be injected by pumping, pushed up from both arch springing to the arch crown in a simultaneously and symmetrically equalized way, and implemented once for all.

2 The measurement items for concrete-filled steel tubular arches shall conform to the criteria

in Tables 8.8.6-1 to 8.8.6-3.

Table 8.8.6-1　Measurement items for Segmental Fabrication of Steel Tubular Arch Ribs

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Diameter of steel tube (mm)	±D/500 and≤ ±5	By tape measure: 3 points on every segment of every tube
2	Tube ovalness (%)	≤0.2	By tape measure: 3 points on every segment of every tube
3	Length c/c of a tube (mm)	±4	By tape measure: 2 points on every segment
4	Difference of two diagonal lengths (mm)	≤4	
5	Flatness of segment (mm)	≤3	By drawstring and measure tape: both end cross-sections of every segment
6△	Offset from designed intrados line (mm)	±8	By template: 3points on every segment
7	Faulting at joint (mm)	≤0.1 time of plate thicknessand≤2	By tape measure: every joint
8	Length of intrados arc (mm)	0, -10	By tape measure: 2 places on every segment
9	Size of welding line	Conform to the design requirements	By measure gauge: 3 point on every welding line of all segments
10△	Welding inspection		By ultrasonic method: all welding lines, or by X-ray method: conform to design, or 5% of total and not less than two welding lines if no specific requirements given in design

Note: *D* refers to the diameter of a steel tube, in mm for both specified value and tolerance.

Table 8.8.6-2　Measurement items for Installation of Steel Tubular Arch Ribs

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)		≤L/6000 and ≤40	By total station: 5 points
2	Level of arch rib (mm)		±L/3000	By level: 5 points at arch crown, both arch springing, 1/4 span and 3/4 span
3△	Relative level difference of symmetrical points (mm)	Allowable	≤L/3000 and ≤40	By level: every joint
		Limiting	Twice of the allowable value and in opposite direction	
4△	Faulting at arch rib joint (mm)		≤0.2t and ≤2	By tape measure: max. gap at every joint
5	Size of welding line (mm)		Conform to the design requirement	By measure gauge: 3 points on every welding line
6△	Welding inspection			Ultrasonic method: every welding lines; or ray method: Conform to the design requirements, or 2% but at least 1 welding line by random if no specific requirements given in design

continued

No.	Inspection Items	Specified value & Tolerance	Method and frequency
7△	Torque on high strength bolt	±10%	By torque wrench: 5% but at least 2 bolts

Note: L refers to the length of a span and t refers to the thickness of a plate, in mm for both specified value and tolerance.

Table 8.8.6-3 Measurement items for Concreting the Steel Tubular Arch Ribs

No.	Inspection Items		Specified Value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Offset from axis (mm)	L≤60m	≤10	By total station: 5 points
		L>60m	≤L/6000 and ≤50	
3	Level of arch ring (mm)		±L/3000 and ≤ ±50	By level: 5 points at both springing, arch crown, 1/4 span and 3/4 span
4△	Void ratio of concrete (%)		≤1.2	By knocking or ultrasonic method: whole rib
5△	Relative level difference of symmetrical points (mm)	Allowable	≤L/3000 and ≤40	By level: every joint
		Limiting	Twice the tolerance and in opposite direction	

Note: L refers to the length of a span, in mm for both specified value and tolerance.

3 The appearance of concrete - filled steel tubular arches shall conform to the following requirements.

1) No abnormal alignment kink or deformation shall appear on the arches.

2) Welding lines shall be intact without cracking, beadings, lack of penetration, arc scratching, unfilled arc pits or the appearance defects that are not allowable in the design.

3) After the final tightening, only 2 or 3 threads of a high - strength bolt may be exposed and the number of non-conformity shall not be more than 10%, unless otherwise specified in the design.

8.9 Steel Bridges

8.9.1 Fabrication of steel girder

1 The fabrication of steel girders shall conform to the basic requirements as follows.

1) For the members and component parts of a steel girder or a segment of girder, including

temporary lifting points and the hoisting points for maintenance facility tracks, processing dimensions and assembly accuracy, shall conform to the design requirements and conform to relevant technical specifications. Quality inspection shall be carried out in stages and only those qualified by the stage inspection shall be released to enter into the next stage of processing.

2) Assessment shall be conducted on the welding workmanship for manufacturing steel girders or girder segments, and the results shall conform to the relevant technical specifications. A detailed method of welding operation shall be developed.

3) A disqualified welding line at the same part of a work may be repaired but shall not be repaired for more than twice. The repaired welding line shall be re-inspected in accordance with the same criteria and shall be used only if the conformity is confirmed.

4) Slip-resistance coefficient of the friction surfaces contacting to the connecting plate of a high strength bolt shall be inspected, and the inspection results shall conform to the design requirements. The friction surface shall be kept dry and clear, and the treatment of gap appeared during installation shall conform to relevant technical specifications.

5) A trial for assembly of steel girders or a girder segments shall be implemented and inspected for approval in accordance with design requirements and relevant technical specifications.

6) The disallowed deformation, damage by collision or damage to the coating shall not appear to the steel girders, girder segments, or their component parts during the moving and storing. Deformed components must not be used.

7) The installation of drainage facilities, lamp post bases, barriers, curbs, pre-embedded members of handrail posts and shear studs shall be installed in accordance with the design documents precisely without omission.

2 The measurement items for the fabrication of steel girders shall conform to the criteria in Tables 8.9.1-1 to 8.9.1-6.

Table 8.9.1-1 Measurement items for Fabrication of Steel Plate Girders

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1	Height (mm)	Main girder ≤ 2m	±2	By tape measure: measure the height of webs at both ends of a beam
		Main girder > 2m	±4	
		Cross beam	±1.5	
		Stringer	±1.0	

continued

<table>
<tr><th>No.</th><th colspan="3">Inspection Items</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>2</td><td colspan="3">Span(mm)</td><td>±8</td><td>By tape measure: the distance between centerlines of bearings</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Length (mm)</td><td colspan="2">Total length</td><td>±15</td><td rowspan="3">By tape measure: along centerline</td></tr>
<tr><td colspan="2">Stringer</td><td>+0.5, −1.5</td></tr>
<tr><td colspan="2">Cross beam</td><td>±1.5</td></tr>
<tr><td>4</td><td colspan="3">Side curving of stringer and cross beam (mm)</td><td>≤3</td><td>By dipping: 3 points at midspan, 1/4 span and 3/4 span on the web side with a drawstring stretched at 100mm away from the main welding lines when the beam in up-right position.</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Camber (mm)</td><td rowspan="2">Main girder</td><td>uncambered</td><td>+3,0</td><td rowspan="2">By dipping: 3 points at midspan, 1/4 span and 3/4 span with a drawstring stretched at outside of lower cover plate when the beam in side-down position</td></tr>
<tr><td>Cambered</td><td>+10, −3</td></tr>
<tr><td colspan="2">Difference of cambers</td><td>≤4</td><td>By dipping: measure the cambers of two girders and calculate the difference</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">Flatness (mm)</td><td colspan="2">Web of main girder</td><td>≤h/350,且≤8</td><td rowspan="2">By straight edge and feeler gauge: 3 points</td></tr>
<tr><td colspan="2">Webs of stringer & cross beam</td><td>≤h/500,且≤5</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Perpendicularity of beam to webs</td><td colspan="2">with holes</td><td>≤0.5 if cover slab width≤60mm, otherwise≤1.0</td><td rowspan="2">By angle square and feeler gauge: 5 points</td></tr>
<tr><td colspan="2">Other parts</td><td>≤1.5</td></tr>
<tr><td>8</td><td colspan="3">Size of welding line</td><td rowspan="2">Conform to the design requirements</td><td>By measure gauge: 3 points on each of all welding lines</td></tr>
<tr><td>9△</td><td colspan="3">Welding inspection</td><td>By ultrasonic method: every and all welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 lines</td></tr>
<tr><td>10△</td><td colspan="3">Torque of high strength bolt</td><td>±10%</td><td>By torque wrench: 5% by random but not less than 2 bolts</td></tr>
</table>

Note: h refers to the height of web, in mm for both specified values and allowable deviations.

Table 8.9.1-2 Measurement items for Fabrication of Steel Truss Segments

No.	Inspection Item	Specified Value or Allowable Deviation	Method and frequency
1	Length of segment (mm)	±2	By tape measure: along centerline of every segment
2	Height of segment (mm)	±2	By tape measure: 2 points on every segment

continued

No.	Inspection Item	Specified Value or Allowable Deviation	Method and frequency
3	Width of segment (mm)	±3	By tape measure: 2 points on every segment
4	Difference of diagonal lengths (mm)	±3.5	By tape measure: at both ends of every segment
5	Flatness of truss panel (mm)	≤3	By dipping: every truss panel
6	Camber	±3	By dipping: at middle part of truss panel
7	Size of welding line	Conform to the design requirement	By measure gauge: every and all welding lines
8△	Welding inspection		By ultrasonic method: every welding line, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements given in design
9△	Torque of high strength bolt	±10%	By torque wrench: 5% by random but not less than 2 bolts

Table 8.9.1-3 Measurement items for Fabrication of Steel Box Girders

No.	Inspection Item		Specified value & Tolerance	Method and frequency
1△	Height (mm)	h≤2m	±2	By tape measure: webs at both ends
		h>2m	±4	
2	Span (mm)		±8	By tape measure: distance between centerlines of two bearings
3	Total length (mm)		±15	By tape measure: alongcenterline
4△	Nominal spacing of webs (mm)		±3	By tape measure: c/c spacing between two webs at both ends
5	Difference of diagonal lengths of cross-section (mm)		≤4	By tape measure: on cross-sections at both ends of a girder
6	side curving (mm)		3 + L/10000	By dipping: 3 points atmidspan, 1/4 span and 3/4 span
7	Camber (mm)		+10, −5	By dipping: 3 points atmidspan, 1/4 span and 3/4 span
8	Flatness of Web (mm)		≤h/350 and ≤8	By straight edge and feeler gauge: 3 points on every web
9	Warping (mm)		≤1per meter and≤10 for each section	On a flat platform: measure the gap at fourth corner when the other three are directly contact to surface of platform

continued

<table>
<tr><th>No.</th><th>Inspection Item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>10</td><td>Faulting at joint (mm)</td><td>≤2</td><td>Taper gauge: interface atevery joint</td></tr>
<tr><td>11</td><td>Size of welding line(mm)</td><td rowspan="2">Conform to the design requirement</td><td>By measure gauge: 3 points on every welding line</td></tr>
<tr><td>12△</td><td>Welding inspection</td><td>By ultrasonic method: every welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements given in design</td></tr>
<tr><td>13△</td><td>Torque of high strength bolt (Nm)</td><td>±10%</td><td>By torque wrench: 5% by random but not less than 2 bolts</td></tr>
</table>

Note: *L refers to the length of a span* and h refers to the girder height, in mm for both specified value and tolerance.

Table 8.9.1-4 Measurement itemsfor Segmental Fabrication of Steel box girder of Cable-Stayed Bridge

<table>
<tr><th>No.</th><th colspan="2">Inspection Item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1</td><td colspan="2">Length of girder segment(mm)</td><td>±2</td><td>By tape measure: alongcenterline and two side lines</td></tr>
<tr><td>2</td><td colspan="2">Level difference of four corners of the deck slab of a girder segment (mm)</td><td>≤4</td><td>By level: 4 corners</td></tr>
<tr><td>3</td><td colspan="2">Straightness deviation of wind fairings (mm)</td><td>≤L/2000 and ≤ 5</td><td>By dipping: both edge ofwind fairing of every segment</td></tr>
<tr><td rowspan="4">4△</td><td rowspan="4">Size of cross-section at segmental ends</td><td>Width (mm)</td><td>±4</td><td rowspan="4">By tape measure: both ends of every segment</td></tr>
<tr><td>Center height (mm)</td><td>±2</td></tr>
<tr><td>Side height (mm)</td><td>±2</td></tr>
<tr><td>Difference of cross-sectional diagonal lengths (mm)</td><td>≤6</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Anchor box</td><td>Coordinates of anchor points (mm)</td><td>±2</td><td>By total station and measure tape: every anchor pad plate, measure 4 intersection points of the anchor hole centerlines in crossing and the side lines of anchor pad plate, and then to work out the coordinates</td></tr>
<tr><td>Angles of anchor plane (°)</td><td>≤0.5</td><td>By angle gauge: 3 points on every anchor pad plate to check intersection angle of the plate to horizontal and vertical planes.</td></tr>
<tr><td rowspan="2">6△</td><td rowspan="2">Compatibility of girder segments</td><td>Offset from longitudinal centerline of bridge (mm)</td><td>≤1</td><td>By tape measure: every segment</td></tr>
<tr><td>Gap of joint at top, bottom and web slabs (mm)</td><td>+3, −1</td><td>By tape measure: every inter-segmentjoint</td></tr>
</table>

continued

No.	Inspection Item		Specified value & Tolerance	Method and frequency
6△	Compatibility of girder segments	Faulting of joint attop, bottom and web slabs (mm)	≤2	By tape measure: every inter-segmentjoint
7	Size of welding line		Conform to the design requirement	By measure gauge: 3 points on every welding line
8△	Welding inspection			By ultrasonic method: every welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements given in design
9△	Torque of high strength bolt (Nm)		±10%	By torque wrench: 5% by random but not less than 2 bolts

Note: L refers to the length of a girder segment, in mm for both specified value and tolerance.

Table 8.9.1-5 Measurement itemsfor Fabrication of I-Beam Segments of Composite Girder Cable-Stayed Bridge

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Height (mm)	Main girder	±2	By tape measure: both ends of every segment
		Cross beam	±1.5	
2	Length (mm)	Main girder	±2	By tape measure: alongcenterline
		Cross beam	±1.5	
3	Width (mm)	Main girder	±1.5	By tape measure: both ends of every segment
		Cross beam	±1.5	
4	Web flatness	Main girder	≤h/350, and ≤8	By straight edge and feeler gauge: 3 points
		Cross beam	≤h/500, and ≤5	
5	Anchor box	Coordinates of anchor point (mm)	±2	By total station and measure tape: every anchor pad plate, measure 4 intersection points of the anchor hole centerlines in crossing and the side lines of anchor pad plate, and then to work out the coordinates
		Axial angles of stay cable (°)	≤0.5	By angle gauge: 3 points on every anchor pad plate to check intersection angle of the plate to horizontal and vertical planes
6△	Faultingat joints of cover plates and webs (mm)		≤2	By tape measure: every inter-segmentjoint
7	Size of welding line		Conform to the design requirements	By measure gauge: 3 points on every welding line
8△	Welding inspection			By ultrasonic method: every welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements given in design

continued

No.	Inspection Items	Specified value & Tolerance	Method and frequency
9△	Torque of high strength bolt (Nm)	±10%	By torque wrench: 5% by random but not less than 2 bolts

Note: h refers to the height of a beam, in mm for both specified value and tolerance.

Table 8.9.1-6 Measurement itemsfor Segmental Fabrication of Steel stiffening box girder of Suspension Bridge

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1	Length of girder segment (mm)		±2	By tape measure: alongcenterline and two side lines
2	Level difference of four corners of deck slab of a girder segment (mm)		≤4	By level: 4 corners
3	Straightness deviation of wind fairings (mm)		≤L/2000 and ≤ 5	By dipping: both edges of wind fairing of every segment
4△	Size of cross-section at segmental ends	Width (mm)	±4	By tape measure: both ends of every segment
		Height in middle (mm)	±2	
		Height at edge (mm)	±2	
		Difference between diagonal lengths of a cross-section (mm)	≤6	
5	Positions of hanging points	Distancefrom center point of to bridge centerline and to the baseline at the girder ends (mm)	±2	By measure ruler: cross-section of hanging point
		Level difference of two sides hoist points within one girder segment(mm)	±5	By level: measure in pairs

continued

No.	Inspection Items		Specified value & Tolerance	Method and frequency
6△	Compatibility of girder segments	Longitudinal Offset from centerline (mm)	≤1	By tape measure: every segment
		Joint gap of top and bottom slabs, webs (mm)	+3, −1	By tape measure: every inter-segmentjoint
		Joint misalignment of top and bottom slabs, webs (mm)	≤2	Measure each joint section with steel rulers
7	Size of welding line		Conform to the design requirement	By measure gauge: 3 points on every welding line
8△	Welding inspection			By ultrasonic method: every welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements given in design
9△	Torque of high strength bolt (Nm)		±10%	By torque wrench: 5% by random but not less than 2 bolts

Note: L refers to the length of a box girder segment, in mm for both specified value and tolerance.

8.9.2 Installation of Steel Girders

1 The installation of steel girders shall conform to the basic requirements as follows:

1) Assessment shall be conducted on the welding workmanship and the results shall conform to the relevant technical specifications. A detailed method of welding operation shall be developed.

2) The installation work shall be conducted following the procedures required in design.

3) A disqualified welding line at the same part of a work may be repaired but shall not be repaired for more than twice. The repaired welding line sh be re-inspected in accordance with the same criteria and shall be used only after the conformity is confirmed.

4) The slip-resistance coefficient of friction surfaces contacting to high strength bolts shall be inspected, and the inspection results shall conform to the design requirements. The friction surface shall be kept dry and clear, and the treatment of gap appeared during installation shall conform to relevant technical specifications.

5) Any deformations, damages by collision or damages to coatings that are not allowed by the design shall be avoided during the transportation and hoisting of steel girders. Deformed components are not allowed to be installed on site.

2 The measurement items for the installation of steel girders shall conform to Table 8.9.2.

Table 8.9.2 Measurement items for Installation of Steel Girders

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)	Longitudinal axis	≤10	By total station: 3 points on every span
		Relative deviationof centerlines of cross beams at adjacent spans	≤5	By tape measure: every cross beam at adjacent ends of steel girders
2	Level (mm)	Pier and abutment	±10	By level: 3 points on every pier or abutment
		Level difference of cross beamsat the adjacent spans	≤5	By level and ruler: every cross beam at adjacent ends of steel girders
3	Offset of support center of fixed bearing (mm)	Simply supported beam	≤10	By tape measure: every fixed bearing
		Continuousbeam	≤20	
4	Size of welding line		Conform to the design requirement	By measure gauge: 3 points on every welding line
5△	Welding inspection			By ultrasonic method: every welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements are given in the design
6△	Torque of high strength bolt		±10%	By torque wrench: 5% by random but not less than 2 bolts

3 The appearance of steel girder installation shall conform to the following requirements.

1) No gap shall appear between the girder bottom and a bearing, and between the bearing bottom and the pad beneath.

2) No abnormal kink or deformation shall appear on the alignment of a girder.

3) Welding lines and high strength bolts shall conform to the criteria in Item No. 3 of

Clause 8.9.1 hereinabove.

4) The damaged protective layers of a steel girder shall be properly remedied.

8.9.3 Protection of Steel Girders

1 Protection for steel girders shall conform to the basic requirements as follows:

1) Coating system shall conform to the design requirements. Proposed coating system shall be verified by trials in workshop or on site for conformity prior to the installation.

2) The surfaces of a girder shall be treated in accordance with the design requirements. The surfaces of a steel girder before being coated shall be dry, clear and free of dust, grease, scale cinder, rust or other dirt. Retreatment shall be done if any rust or contamination appears on the surface.

3) The environment, time interval of each layer of coating, and the tools and equipped shall conform to the requirements of coating workmanship and coating materials.

4) After a layer of coating finishes, the dry film thickness shall be inspected and upon confirmation of conformity, permission shall be given to proceeding next coating.

5) The damaged coating layer shall be properly remedied.

2 The measurement items for the protection of steel girders shall conform to the requirements in Table 8.9.3.

Table 8.9.3 Measurement itemsfor Protection Coating of Steel Girders

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Descaling grade	Conform to the design requirements. If no specific requirements in design, Sa3.0 for coating with thermal spraying of zinc or aluminum and Sa2.5 (St3) for coating with inorganic zinc-rich primer or others	Inspect all by prototype comparison
2△	Surface roughness Rz (μm)	Conform to the design requirements. If no specific requirements in design, 60 ~ 100 for coating with thermal spraying of zinc or aluminum and 50 ~ 80 for coating with inorganic zinc-rich primer and 30 ~ 75 for coating with others	Inspect as required by the design requirement. If no specific requirements in design, inspect all by prototype comparison

continued

No.	Inspection Items	Specified value & Tolerance	Method and frequency
3	Total thickness of dry film (μm)	Conform to the design requirements. If no specific requirements in design, the measure points with dry film thickness less than the design value shall ≤ 10% and the thickness of any measure point shall ≥ 90% of the design value	Inspect as required by the design requirements. If no specific requirements in design, sampling inspect by thickness gauge (20% but not less than 5 members, measure 10 points for every $10m^2$ but not be less than 10 in total)
4	Adhesive (MPa)	Conform to the design requirements	Inspect as required by the design requirements. If no specific requirements in design, adopt pull-off test for adhesion: inspect by sampling 5% but not less than five samples, and 1 point for each sample.

3 The appearance of steel girder protection shall conform to the following requirements.

1) The maximum area of drooping, wrinkling, and water printing of the coating shall not be more than $900mm^2$ and no more than 2 pieces within any $1m^2$ area.

2) No bubbling, cracking, peeling, large droplets, loose particles, falling blocks and re-rusting shall occur. All the surface areas shall be coated.

8.10 Cable-stayed bridges

8.10.1 Concretepylons of cable-stayed bridge

1 The concrete pylons of a cable-stayed bridge shall conform to the basic requirements as follows.

1) Positions of cable holes and anchor boxes, and intersection angles between anchor planes and horizontal plane shall be controlled precisely. An anchor bearing plate shall be perpendicular to the cable holes.

2) The placement and treatment of construction joints shall conform to the design requirements and construction specifications.

3) The deformation of temporary props for cross beam construction shall conform to the relevant construction specifications. Cross beams and pylons shall be firmly integrated as a whole.

2 The measurement items for the concrete pylons of a cable-stayed bridge shall conform to the criteria in Tables 8.10.1-1 and -2.

Table 8.10.1-1 Measurement items for Pylons of a Cable-stayed Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2△	Offset of pylon axis(mm)	≤15 and ≤8 compared to the preceding segment	By total station: measure the intersection points of side lines and two axis lines on the top surface of every segment
3	Verticality of whole height of pylon (mm)	≤H/3000 and ≤30	By total station: 2 points eachin longitudinal and transversal directions
4	Outline dimensions(mm)	±20	By tape measure: 1cross-section for every segment
5	Thickness of pylon wall (mm)	±10	By tape measure: 5 points on top surface of every segment
6	Level of anchor points (mm)	±10	By total station: everyanchor point
7△	Position of cable hole (mm)	≤10and two ends in the same direction	By tape measure: every hole
8	Position of built-in fittings (mm)	≤5	By tape measure: every unit
9	Inter-segment faulting (mm)	≤3	By feeler gauge: maximum value at joint on every side surface of every segment
10	Evenness (mm)	≤8	By 2-m straight edge: 2 points on every side surface of every segment, each in vertical and horizontal directions

Note: 1. H refers to the heightof a pylon, in mm for both specified value and tolerance.
2. Item No. 6shall not be inspected if anchor boxes or anchor beams are placed.

Table 8.10.1-2 Measurement items for Cross Beams between Pylons of a Cable-stayed Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Offset from axis(mm)	≤10	By total station: 5 points
3	Outline dimensions (mm)	±15	By tape measure: 2 cross-sections
4	Thickness of pylon wall (mm)	±10	By tape measure: 2 cross-sections, and 5 points on each
5	Elevation of top surface (mm)	±20	By total station: 5 points
6	Evenness(mm)	≤8	By 2-m straight edge: 2 points on every side surface of every segment, each in vertical and horizontal directions

3 The appearance of concrete pylons of a cable-stayed bridge shall conform to the criteria in

Item No. 3 of Clause 8. 7. 1.

8. 10. 2 Segment fabrication of on-pylon steel anchor beam and steel anchor box

1 Segmental fabrication of on-pylon steel anchor beams and steel anchor boxes shall conform to the basic requirements specified under Item No. 1 of Clause 8. 9. 1 hereinabove; while the quality and quantity of stud pins shall conform to the design requirements.

2 The measurement items for the segment fabrication of pylon steel anchor beams and anchor boxes shall conform to the criteria in Tables 8. 10. 2-1 and -2.

Table 8. 10. 2-1 Measurement items forSegment Fabrication for On-pylon Steel Anchor Beams

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Length of anchor beam (mm)	±2	By tape measure: distance between two ends atweb
2△	Nominal spacing of webs (mm)	±2	By tape measure: distance between the center lines of two webs
3	Difference of diagonal lengths of cross-section(mm)	≤m	By tape measure: 2 end cross-sections
4	Side curving (mm)	3	By dipping: 3 points at midspan, 1/4 span and 3/4 span
5	Warping (mm)	≤2	On a flat platform: measure the gap at fourth corner when the other three are directly contact to the surface of platform
6	Coordinates of anchor point (mm)	±2	By total station and measure tape: every anchor pad plate, measure 4 intersection points of the anchor hole centerlines in crossing and the side lines of anchor pad plate, and then to work out the coordinates
7	Angles of anchor plane (°)	≤0.5	By angle gauge: 3 points on every anchor pad plate to check intersection angle of the plate to horizontal and vertical planes.
8	Size of welding line	Conform to the design requirement	By measure gauge: 3 points on every welding line
9△	Welding inspection		By ultrasonic method: every welding lines, or By X-ray method: Conform to the design requirement, or 10% by random but not less than 3 welding lines if no specific requirements given in design
10△	Torque of high strength bolt	±10%	By torque wrench: 5% by random but not less than 2 bolts

Table 8.10.2-2 Measurement items for Fabrication of Pylon Steel Anchor Box Segments

<table>
<tr><th>No.</th><th colspan="2">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1</td><td colspan="2">Height of segment (mm)</td><td>±1</td><td>By tape measure: along centerline of every segment</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Size of cross-section(mm)</td><td>Side length</td><td>±2</td><td rowspan="2">By tape measure: top and bottom surfaces of every segment</td></tr>
<tr><td>Difference ofdiagonal lengths</td><td>≤3</td></tr>
<tr><td>3</td><td colspan="2">Parallelity of upper and lower end surfaces (mm)</td><td>≤0.8</td><td>Byparallelity measuring instrument: measure six points on every segment</td></tr>
<tr><td>4</td><td colspan="2">Flatness of end surface (mm)</td><td>≤0.2</td><td>Byflatness measuring instrument: measure six points on end surfaces of every segment instrument</td></tr>
<tr><td>5</td><td colspan="2">Coordinates of anchor points (mm)</td><td>±2</td><td>By total station and measure tape: every anchor bearing plate, check levels and coordinates of the points of two crossing centerlines of an anchor hole intersecting with two side lines of the anchor bearing plate</td></tr>
<tr><td>6</td><td colspan="2">Angle of anchor plane (°)</td><td>≤0.5</td><td>By angle gauge: intersection angle of every anchor bearing plate to horizontal and vertical plane. Three points at every plate.</td></tr>
<tr><td>7</td><td colspan="2">Size of welding line</td><td rowspan="2">Conform to the design requirement</td><td>By measure gauge: 3 points on every welding line</td></tr>
<tr><td>8△</td><td colspan="2">Welding inspection</td><td>By ultrasonic method: every welding lines, or
By X-ray method: Conform to the design requirements, or 10% by random but not less than 3 welding lines if no specific requirements given in design</td></tr>
<tr><td>9△</td><td colspan="2">Flexural crack ofwelded studs</td><td>No crack shall appear</td><td>By visual observation: the welding lines and the heat affected area after bending to 30°. Inspect 1% for every stud group but not less than 1</td></tr>
</table>

3 The appearance of the segments of an on-pylon steel anchor beam or box shall conform to the following requirements:

1) There shall have no depressions, scratches, or welding scars on either inner or outer surfaces of a steel anchor beam or box. All edges shall be smooth with no burrs.

2) Welding lines shall be free of surface cracks, overlaps, slag inclusion, arc scratch,

incomplete penetration, under filling, and any other welding defects that are not allowable in design. Neither welding slags nor spatters shall appear on the surfaces of a member.

3) No missing or gaping shall exist in the welding line around a stud.

8.10.3 Segmental installation of on-pylon steel anchor beams and anchor boxes

1 The installation of segmented on-pylon steel anchor beams and anchor boxes shall conform to the basic requirements as indicated in Item No. 1 of Clause 8.9.2. A trial assembly for installation of pylon steel anchor beams and anchor boxes shall be conducted, and site installation can only commence subject to the confirmation of conformity.

2 The measurement items for the installation of segmented on-pylon steel anchor beams and anchor boxes shall conform to the criteria in Tables 8.10.3-1 and -2.

Table 8.10.3-1 Measurement items for Installation of Steel Anchor Beam

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Offset from centerline (mm)	≤5	By total station: 2 points each in longitudinal and transversal directions on every segment
2	Elevation of top surface (mm)	±2nand ≤ ±10	By total station: at four corners
3△	ratio of contact between steel anchor beam and supporting plat	Conform to the design requirements	By feeler gauges: every supporting pat
4	Size of welding line	Conform to the design requirements	By measure gauge: 3 points on every welding line
5△	Welding inspection		By ultrasonic method: every welding line, or By X-ray method: as design required

Table 8.10.3-2 Measurement items for Installation of On-pylon Steel Anchor Box

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Offset from centerline (mm)	≤5	By total station: 2 points each in longitudinal and transversal directions on every segment
2	Elevation of top surface (mm)	±2and ≤ ±10	By total station: at four corners
3△	Ratio of contact between steel anchor box cross-sections and the supporting plate	Conform to the design requirement	By feeler gauges: every supporting plat
4△	Torque of high strength bolt	±10%	By torque wrench: 5% by random but not less than 2 bolts

Note: n is number of segments

3 The appearance of an on-pylon steel anchor beam or anchor box shall conform to the following requirements:

1) There shall be no damage to the protection of steel anchor beams and anchor boxes.

2) The welding lines and high strength bolts shall conform to the criteria in Item No. 3 of Clause 8.9.1 hereinabove.

8.10.4 Concrete pouring for girder segments on main piers of a concrete cable-stayed bridge.

1 The concrete pouring for the girder segments on main piers of a concrete cable-stayed bridge shall be conformed to the basic requirements as follows:

1) The strength, stiffness and stability of formwork and scaffolding shall satisfy the requirements of construction specifications.

2) The stress cracks wider than the allowable values specified in design requirements and relevant specifications shall not appear on the girder segments during construction.

2 The measurement items for concrete pouring for girder segments on main piers of a concrete cable-stayed bridge shall conform to the criteria in Table 8.10.4.

Table 8.10.4 Measurement items of Concrete Pouring of Girder Segments

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Offset from axis (mm)		≤L/10000	By total station: at both ends and midspan
3	Elevation of top surface (mm)		±10	By level: 5 points
4△	Size of cross-section (mm)	Height	+5, −10	By tape measure: 2 cross-sections
		Top width	±30	
		Bottom width orwidth between ribs	±20	
		Thickness of topflange, bottom flange, web, or width of rib	+10,0	
5	Cross slope (%)		±0.15	By level: 3 points
6	Position of built-in fitting		≤5	By tape measure: every unit
7	Evenness (mm)		≤8	By 2-m straight edge: 1 point in every 10m length, each in both long and wide directions

Note: L refers to the length of a span, in mm for both specified value and tolerance.

3 The appearance of concrete pouring for girder segments on main piers of a concrete cable-stayed bridge shall conform to the criteria stated in Item No. 3 of Clause 8.7.1.

8.10.5 Cantilever construction of concrete girders of a cable-stayed bridge

1 The cantilever construction of concrete girders of a cable-stayed bridge shall conform to the basic requirements as follows:

1) Stay cables, anchors and their accessories shall be installed on site subject to the conformity is confirmed by quality inspection.

2) The equipment for tensioning stay cables, such as jacks, oil pressure gauges shall be calibrated on site before use and shall not be used beyond the calibration period.

3) The anchor holes shall be free of burrs before and during cables are being placed through.

4) Cable forces, levels, pylon deformations and environmental temperatures shall be monitored during construction.

5) The level of on-pier block (pier segment) and bridge axis shall be rechecked in details. Only the conformity to design requirements is confirmed, may the construction of cantilevered segments start.

6) The cantilever construction shall be executed in a symmetrical way. The number of times, the values and sequence of tensioning on stay cables shall conform to the design and the requirements for construction control.

7) The level difference of the ends of two cantilever arms before closure shall be within the range specified in design.

8) No stress cracks wider than allowable values specified in design and relevant specifications shall appear in any part of the girder.

9) Adjustment shall be made according to the requirements for construction control in case the force or level of any cable during construction exceeds the design tolerance.

10) The types, positions, treatment of jointing surfaces, performance and quality of adhesive materials of the inter-segment joints shall conform to the design

requirements. The joint gap shall be fully and densely filled.

2 The measurement items for cantilever construction of concrete girders of a cable-stayed bridge shall conform to the criteria in Tables 8.10.5-1 and -2.

Table 8.10.5-1 Measurement items forConcrete Pouring of the Segment in Cantilever

<table>
<tr><th>No.</th><th colspan="3">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Offset from axis (mm)</td><td colspan="2">$L \leqslant 100$m</td><td>$\leqslant 10$</td><td rowspan="2">By total station: 2 points on every segment</td></tr>
<tr><td colspan="2">$L > 100$m</td><td>$\leqslant L/10000$</td></tr>
<tr><td rowspan="4">3△</td><td rowspan="4">Size of cross-section(mm)</td><td colspan="2">height</td><td>+5,-10</td><td rowspan="4">By tape measure: 1cross-section on every segment</td></tr>
<tr><td colspan="2">Top width</td><td>±30</td></tr>
<tr><td colspan="2">Bottom width or width between webs</td><td>±20</td></tr>
<tr><td colspan="2">Thickness of topflange, bottom flange, web, or width of rib</td><td>+10, −0</td></tr>
<tr><td rowspan="2">4△</td><td rowspan="2">Cable force (kN)</td><td colspan="2">Allowable</td><td>Conform to the design and the requirements for construction control</td><td rowspan="2">By load cell: every cable</td></tr>
<tr><td colspan="2">Limiting</td><td>Conform to the design and the requirements for construction control, or max. deviation $\leqslant 10\%$ of design value if no specific requirements given in design</td></tr>
<tr><td rowspan="3">5△</td><td rowspan="3">Level of girder topor anchor points on girder</td><td colspan="2">Girder segment</td><td>Conform to the requirements for construction control</td><td rowspan="3">By total station or level: everyanchor point or 2 points on top surface of every segment</td></tr>
<tr><td rowspan="2">After c losure</td><td>$L \leqslant 100$m</td><td>±20</td></tr>
<tr><td>$L > 100$m</td><td>$\pm L/5000$</td></tr>
<tr><td>6</td><td colspan="3">Offset of pylon top (mm)</td><td>Conform to the design and the requirements for construction control</td><td>By total station: center point of every side edge of the surface of every pylon</td></tr>
<tr><td>7</td><td colspan="3">Cross slope (%)</td><td>±0.15</td><td>By level: 2 points on every segment</td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Plane of stay cable Anchor</td><td colspan="2">Coordinates of anchor points (mm)</td><td>±2</td><td>By total station or ruler: Inspect each anchor bearing plate, deduct the coordinates by measuring the intersection of anchor hole centerline and side line of anchor bearing plates</td></tr>
<tr><td colspan="2">Angles of anchor plane (°)</td><td>$\leqslant 0.5$</td><td>By angle gauge: measure intersection angle between each anchor bearing plate and horizontal/vertical plane. Three points for each intersection angle.</td></tr>
</table>

continued

No.	Inspection item	Specified value & Tolerance	Method and frequency
9	Position of built-in fitting	≤5	By tape measure: every unit
10	Evenness (mm)	≤8	By 2-m straight edge: 1 point in every 10m long in bothvertical and horizontal directions
11	Inter-segment faulting	≤5	Taper gauge: max. value of faulting on bottom and side surfaces of every joint

Note: 1. L refers to the length of a span, in mm for both specified value and tolerance.
2. Items 4 and 8 above are applicable to the inspections on segments with stay cables.
3. Item No. 6 above applicable to the inspection of the closure segment between two girder arms in cantilever.

Table 8.10.5-2 Measurement items forSegmental Assembly in Cantilever

<table>
<tr><th>No.</th><th colspan="3">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="3">Strength of concrete of closure segment (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Offset from axis (mm)</td><td colspan="2">L≤100m</td><td>≤10</td><td rowspan="2">By total station: 2 points on every segment</td></tr>
<tr><td colspan="2">L>100m</td><td>≤L/10000</td></tr>
<tr><td rowspan="2">3△</td><td rowspan="2">Cable force (kN)</td><td colspan="2">Allowable</td><td>Conform to the design and the requirements for constructin control</td><td rowspan="2">By load cell: every cable</td></tr>
<tr><td colspan="2">Limiting</td><td>Conform to design and the requirements for construction control; or max. deviation ≤10% of design value if no specific requirements given in design</td></tr>
<tr><td rowspan="3">4△</td><td rowspan="3">Level ofanchor points on girder or girder top</td><td colspan="2">Girder segment</td><td>Conform to the requirements for construction control</td><td rowspan="3">By level or total station: 2 point on every anchor fixing point or top surface of every segment</td></tr>
<tr><td rowspan="2">After closure</td><td>L≤100m</td><td>±20</td></tr>
<tr><td>L>100m</td><td>±L/5000</td></tr>
<tr><td>5</td><td colspan="3">Offset of pylon top (mm)</td><td>Conform to the design and the requirements for construction cont-rol</td><td>By total station: central point of top surface of every pylon</td></tr>
<tr><td>6</td><td colspan="3">Inter-segment faulting (mm)</td><td>≤3</td><td>Taper gauge: max. value offaulting on bottom and side surfaces of every joint</td></tr>
</table>

Note: 1. L refers to thelength of a span, in mm for both specified values& tolerances.
2. Item No. 3 above is applicable to the inspection on beam segment with stay cables.
3. Item No. 5 above is applicable to the inspection on the closure segment between two girder arms in cantilever.

3 The appearance for cantilever construction of a concrete cable-stayed bridge shall conform to the following requirements.

1) Wires and strands of a stay cable shall not be intertwined or tangled. Neither cracking nor breaking shall appear on stay cables or anchors.

2) Appearance of the girders by cantilever construction shall conform to the criteria in Item No. 3 of Clause 8.7.2 hereinabove. The alignment of a girder shall be smooth with no abnormal bends and folds.

8.10.6 Segment assembly for steel box girders of a steel girder cable stay bridge

1 The assembly of steel box girder segments shall conform to the basic requirements as follows.

1) Steel box girder segments, stay cables, anchors and accessories can be installed on site only after the conformity is confirmed by inspection.

2) Assessment shall be conducted on the welding workmanship on site and the results shall conform to the relevant technical specifications. A detailed method of welding operation shall be developed.

3) Repair of a disqualified welding line at the same part of a work may be repaired but shall not be repaired more than twice. The repaired welding line shall be re-inspected in accordance with the same criteria and shall be used only if the conformity is confirmed.

4) Slip-resistance coefficient of the friction surfaces that contact high strength bolts shall be inspected, and the inspection results shall conform to the design requirements. The friction surface shall be kept dry and clear, and the treatment of gap appeared during installation shall conform to relevant technical specifications.

5) The equipment for tensioning stay cables, such as jacks, oil pressure gauges, shall be calibrated in set before use and shall not be used beyond the calibration period.

6) Cable forces, levels, pylon deformations and environmental temperatures shall be monitored during construction. Adjustment shall be made according to the requirements for construction control in case the force or level of any cable during construction exceeds the tolerance specified in the design.

7) Cantilever construction shall be conducted in a symmetrically way as specified in design requirements.

2 The measurement items for assembling steel box girder segments for a steel girder cable stay bridge shall conform to the criteria in Tables 8.10.6-1 and -2.

Table 8.10.6-1 Measurement items for Assembling Steel Box Girder Segments

No.	Inspection item			Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)	$L \leqslant 200$m		≤10	By total station: 2 points on every segment
		$L > 200$m		≤L/20000	
2△	Cable force (kN)	Allowable		Conform to the design and the requirements for construction control	By load cell: every cable
		Limiting		Conform to the design and the requirements for construction control, or max. deviation ≤10% of design value if not specifically specified	
3△	Level of girder anchor points or girder top	Girder segment		Conform to the requirements for construction control	By level: every anchor point or 2 points on the top surface of every segment
		After closure	$L \leqslant 200$m	±20	
			$L > 200$m	$\pm L/10000$	
4	Offset of pylon top (mm)			Conform to the design and the requirements for construction control	By total station: center point of every side edge of top surface of every pylon
5	Level difference of four corners of girder top (mm)			≤20	By level: at four corners
6	Inter-segment faulting			≤2	Taper gauge: max. value at the joint of every segment
7	Size of welding line			Conform to the design requirement	By measure gauge: 3 points on every welding line
8△	Welding inspection				By ultrasonic method: every welding line, or by X-ray method: as specified in design, or 10% but not less than 3 welding lines if no specific requirements given in design
9△	Torque of high strength bolt			±10%	By torque wrench: 5% by random but not less than 2 bolts

Note: 1. L refers to the length of a span, in mm for both specified value and tolerance.
2. Item No.4 above applicable to the inspection the closure segment of a span.

Table 8.10.6-2 Measurement items for Assembling Steel Box Girder Segments on Temporary Props

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Offset from axis (mm)	≤10	By total station: 2 points on every segment
2	Inter-segment faulting	≤2	Taper gauge: max. value of misalignment at every joint
3	Longitudinal position of girdersegment (mm)	≤10	By total station: coordinates of the center point of every segment
4△	Level of girder top (mm)	±10	By level: at midpoint of both ends of segment
5	Level difference of four corners of girder top (mm)	≤10	By level: at four corners
6	Size of welding line	Conform to the design requirement	By measure gauge: 3 points on every welding line
7△	Welding inspection		By ultrasonic method: every welding line, or By X-ray method: as design required and sampling inspection (10%) and not less than three welds if not specified in design
8△	Torque of high strength bolt	±10%	By torque wrench: 5% by random but not less than 2 bolts

3 The appearance quality of the assembled steel box girders of a steel girder cable stay bridge shall conform to the following criteria:

1) Wires and strands of a stay cable shall not be intertwined or tangled. Neither cracking nor breaking shall appear on stay cables or anchors.

2) The alignment of a steel box girder shall be smooth without abnormal bends and folds.

3) Welding lines and high strength bolts shall conform to the criteria in Item No. 3 of Clause 8.9.1 hereinabove.

8.10.7 Cantilever assembly of steel segments of a composite girder for a cable-stayed bridge

1 The cantilever assembly of steel segments of a composite girder for a cable-stayed bridge shall conform to the basic requirements as indicated in Item No. 1 of Clause 8.10.6.

2 The measurement items for the cantilever assembly of steel segments of a composite girder for a cable-stayed bridge shall conform to the criteria in Table 8.10.7.

Table 8.10.7 Measurement items for Cantilever Assembly ofSteel Segments of a Composite Girder for a Cable-stayed Bridge

<table>
<tr><th>No.</th><th colspan="2">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Offset from axis (mm)</td><td>$L \leqslant 200$m</td><td>$\leqslant 10$</td><td rowspan="2">By total station: 2 points on every segment</td></tr>
<tr><td>$L > 200$m</td><td>$\leqslant L/20000$</td></tr>
<tr><td>2</td><td colspan="2">Inter-segment faulting</td><td>$\leqslant 2$</td><td>Taper gauge: max. value of misalignment at every joint</td></tr>
<tr><td>3</td><td colspan="2">Cable force (kN)</td><td>Conform to the design and the requirements for construction control</td><td>By load cell: every cable</td></tr>
<tr><td rowspan="2">4△</td><td rowspan="2">Level of anchor points on girder or level of girder top (mm)</td><td>Girder segment</td><td>Conform to the requirements for construction control</td><td rowspan="2">By level: every anchor point or 2 points on the top surface of every segment</td></tr>
<tr><td>Level difference ofmain girders</td><td>$\leqslant 10$</td></tr>
<tr><td>5</td><td colspan="2">Offset of pylon top (mm)</td><td>Conform to the design and the requirements for construction control</td><td>By total station: center point of every side edge of top surface of every pylon</td></tr>
<tr><td>6</td><td colspan="2">Size of welding line</td><td rowspan="2">Conform to the design requirement</td><td>By measure gauge: 3 points on every welding line</td></tr>
<tr><td>7△</td><td colspan="2">Welding inspection</td><td>By ultrasonic method: every welding line, or
By X-ray method: as design required and sampling inspection (10%) and not less than three welds if not specified in design</td></tr>
<tr><td>8△</td><td colspan="2">Torque of high strength bolt</td><td>±10%</td><td>By torque wrench: 5% by random but not less than 2 bolts</td></tr>
</table>

Note: 1. L refers to the length of a span, in mm for both specified value and tolerance.
2. Item No. 5 above is applicable only to the closure segment of a span.

3 The appearance of cantilever assembled steel segments of a composite girder of a cable-stayed bridge shall conform to the criteria stated in Item No. 3 of Clause 8.10.6 hereinabove.

8.10.8 Concrete slabs of a composite girder in a cable-stayed bridge

1 The concrete slabs of a composite girder in a cable-stayed bridge shall conform to the basic

requirements as follows.

1) The procedures of casting or installing the concrete slabs shall satisfy the design requirements

2) Adjustment shall be made during construction according to the requirements for construction control if offsets of the forces or levels of stay cables exceed the tolerance values expressed in the design.

3) The rust and dirt on connecting members and steel plates shall be removed, and the surfaces shall be clean before concrete is poured on.

2 The measurement items for the concrete slabs of a composite girder in a cable stay bridge shall conform to the criteria in Table 8.10.8.

Table 8.10.8 Measurement items for Concrete deck slabs of a composite girder in a cable-stayed bridge

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2△	Size ofprecast concrete slab (mm)	thickness	+10, 0	By tape measure: 2 points on every cross-section
		width	±30	
3	Installationoffset of precast concrete slab (mm)		±5	By tape measure: 30% of deck slabs
4△	Cable force (kN)	Allowable	Conform to the design and the requirements for construction control	By load cell: every cable
		Limiting	Conform to the design and the requirements for construction control; or ≤10% of design value if not specified	
5△	Level (mm)	$L \leqslant 200$m	±20	By level: 1 point in every 30m, but not less than 3 points in total
		$L > 200$m	$\pm L/10000$	
6	Cross slope (%)		±0.15	By level: 1 point in every 40m, but not less than 3 cross-sections

Note: 1. L refers to the length of a span, in mm for both specified value and tolerance.
2. Inspection is not required for the item not involved in a real project.

3 The appearance of concrete slabs of a composite girder in a cable-stayed bridge shall conform to the criteria stated in Item No. 3 of Clause 8.7.1 hereinabove.

8.11 Suspension Bridges

8.11.1 Concrete Pylons of Suspension Bridge

1 The concrete pylons of a suspension bridge shall conform to the basic requirements as stated in Item No. 1 of Clause 8.10.1. The concrete in the steel lattice shall be dense, and bonded with steel lattices together as a whole, of which the shrinkage and strength shall conform to the design requirements.

2 Measurement items for the concrete pylons of a suspension bridge shall conform to the criteria in Table 8.11.1.

Table 8.11.1 Measurement items forConcrete Pylon Columns of a Suspension Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2△	Offset of pylon column axis (mm)	≤15, and ≤8 compared to the previous section	By total station: intersection points of edge lines and axis lines of each segment
3	Verticality of whole height (mm)	≤H/3000 and ≤30	By total station: 2 points eachin longitudinal and transversal directions
4	Outline dimensions (mm)	±20	By tape measure: 1 cross-section of every segment
5	Wall thickness(mm)	±10	By tape measure: 5 points on top surface of every segment
6	Top surface level of steel lattice-at pylon top (mm)	15,0	By total station: center and four corners of every steel lattice
7△	Difference of top surface level of steel lattice at pylon top (mm)	≤2	
8	Position of built-in fitting	≤5	By tape measure: every unit
9	Inter-segment faulting (mm)	≤3	Taper gauge: max. value of faulting at every segmental joint
10	Evenness (mm)	≤8	By 2-m straight edge: 2 points each in vertical and horizontal directions on every side faces of every segment

Note: H refers to theheight of a pylon, in mm for both specified values& tolerances.

3 The appearance of concrete pylons of a suspension bridge shall conform to the criteria in Item No. 3 of Clause 8.10.1.

8.11.2 Fabrication of Anchor blocks and anchorage systems

1 The fabrication of anchor blocks and anchorage systems shall conform to the basic requirements as follows.

1) Assessment shall be conducted on the welding workmanship for fabrication of component members and the results shall conform to the relevant technical specifications. A detailed method of welding operation shall be developed.

2) The treatment of oxidation and thermal-refining of tie rods, connecting plates, coupling sleeves and nuts shall conform to the design requirements.

3) The manufacturing sizes of the component members including anchor beams and anchor rods of a rigid frame, and the installation precision of trial-assembly of a rigid-frame anchorage system shall conform to the design requirements and the provisions of relevant technical specifications. Only those qualified shall proceed into next operation.

4) Before normal production, strength and fatigue tests shall be conducted on the tie rods and connecting devices by the method and frequency of sampling as required by design. The test results shall conform to the design requirements.

5) The coating protection of component members shall conform to Clause 8.9.3 hereinabove.

2 The measurement items for fabrication of block anchorage systems shall conform to the criteria in Tables 8.11.2-1 and -2.

Table 8.11.2-1 Measurement items for Fabrication of Prestressed Anchorage systems

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Connecting-plate	Spacing c/c of tie rod hole and anchor hole (mm)	±0.5	By electronic ruler: randomly 50% of plates, every hole of every tie rod for each plate
		Diameter of major hole (mm)	1.0,0.0	ByVernier caliper: randomly 50% of plates, and every hole in each plate
3		Perpendicularity of hole axisto top and bottom surfaces(°)	≤0.3	Bypositioning method: randomly 50% of plates, 3 places in every hole of each plate
4		Parallelity of top and bottom surfaces (mm)	≤0.4	Bymicrometers: randomly 50% of plates, and 3 holes in each plate
5		Thickness of plate (mm)	1.0,0.0	By Vernier caliper: randomly 50% of plates, 5 points on each plate

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
6	Coupling sleeve	Perpendicularity of axisto top and bottom surfaces (°)	≤0.3	By pulsation detector: randomly 50% of couplers, and 3 points on each plate
7		Parallelity of top and bottom surfaces (mm)	≤0.25	By end circular run-out method: randomly 50% of couplers, ad 3 points on each
8		Wall thickness (mm)	1.0,0.0	ByVernier caliper: 50% of couplers, and 5 points on each
9	Concentricity of tie rod (mm)		≤0.1	Byradial circular run-out method: randomly 50% of tie rods, and 3 points on each
10△	Flaw detection of tie rods, connecting plates, coupling sleeves and bolts		Conform to the design requirements	By the method andfrequency specified by design, or by ultrasonic method for 100%; or by X-ray method for 10% of the total member if no specific requirements in design

Table8.11.2-2 Measurement items for Fabrication of Rigid-Frame Anchorage system

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Size of cross-section of anchor rod or anchor beam (mm)	±1.5	By tape measure: 2 points on each
2	Length ofanchor rod/beam (mm)	Conform to the design requirement, or ±3 if no specific requirements in design	By tape measure: alongcenterline of each unit
3	Flatness of wing plates in the connectingposition of an anchor rod/beams (mm)	≤0.5	By tape measure and feeler gauge: every connecting surface
4	Bending of anchor rod/anchor beam (mm)	≤3	By dipping: every unit
5	Warping of anchor rod/beam (mm)	Conform to the design requirement; or ≤3 if no specific requirements in design	On a flat platform: measure the gap at the fourth corner when the other three directly contact to the surface of platform
6	Size of welding line (mm)	Conform to the design requirement	Bymeasure gauge: every welding lines, and 2 points on each
7△	Welding inspection		By ultrasonic method: every welding line, or By X-ray method: as design required and; or sampling inspection (10%) and not less than three welds if not specified in the design

3 The appearance of a block anchorage system shall conform to the following requirements:

1) The surfaces of tie rods, connecting plates, coupling sleeves and anchor rods shall not be depressed, scratched or remained with spatters and burrs.

2) Welding lines and high strength bolts shall conform to the criteria stated in Item No. 3 of Clause 8.9.1 hereinabove.

8.11.3 Installation of block anchorage system

1 The installation of a block anchorage system shall conform to the basic requirements as follows.

1) The anchorage system shall be issued with quality certificates, and be inspected and confirmed with acceptance before the installation.

2) A rigid-frame anchorage system shall be installed firmly and no disturbance or displacement shall exist during concrete pouring.

3) The bearing plates of a prestressed anchorage system shall be perpendicular to the axis of holes. The tensioning work can commence only after the concrete reaches the strength and age as specified in the design.

4) Protecting work shall be provided as specified in design.

5) Welding lines and high strength bolts shall conform to relevant criteria stated in Clause 8.9.2 hereinabove.

2 The measurement items for installation of block anchorage system shall conform to the criteria in Tables 8.11.3-1 and-2.

Table8.11.3-1 Measurement items for Installation of Prestressing Anchorage system

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Offset of center point of hole on anchor surface (mm)	±10	By total station: every hole
2△	Angle of hole on front anchor surface (°)	±0.2	By total station: every hole
3	Offset from axis of connecting plate (mm)	≤5	By total station and ruler: the intersection point of centerline and side lines of every connecting plate

Table8.11.3-2 Measurement items for Installation of Rigid-framed Anchorage systems

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Offset of center line ofrigid frame (mm)		≤20	By total station;front and rear ends
2	Level difference of horizontal connections of installed anchor rods (mm)		+5, -2	By level: every anchor rod
3△	Coordinatesof anchor rods(mm)	Longitudinal	±10	By total station: both ends of every rod
		Transversal	±5	
		Vertical	±5	
4	Size of welding line		Conform to the design requirements	By measure gauge: 2 points on every welding line
5△	Welding inspection			By ultrasonic method: every welding line, or By X-ray method: as design required; or sampling inspection (10%) and not less than three welds if no specific requirements in design
6△	Torque of high strength bolt		±10%	By torque wrench: 5% by random but not less than 2 bolts

3 The appearance of installation of a block anchorage system shall conform to the following requirements:

1) No damage shall appear on the surface of component members including connecting devices and anchor rods.

2) No kink shall exist in the alignment of an anchor rod.

3) Welding lines and high strength bolts shall conform to the criteria stated in Item No. 3 of Clause 8.9.1.

8.11.4 Concrete anchor blocks

1 The concrete anchor blocks shall conform to the basic requirements as follows.

1) The ground bearing capacity shall conform to the design requirements.

2) The scales, lengths, quantities, and spacing, as well as the surface treatment of the steel bars that pre-embedded in each layer of sequentially poured concrete shall conform

to the design requirements and the criteria of construction specifications.

3) The maximum temperature inside of concrete and the temperature difference of inside and on surface of concrete caused by hydration heat shall be properly controlled in the allowable range.

2 The measurement items for the concrete anchor blocks shall conform to the criteria in Table 8.11.4.

Table 8.11.4 Measurement items for Installation of Concrete anchor blocks

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Offset from axis (mm)	foundation	≤20	By total station: every one
		notch	≤10	
3△	Size in plane (mm)		±30	By tape measure: 3 points
4	Level of ground foundation (mm)	Soil	±50	By level: 10 points
		rock	+50, -200	
5	Elevation of top surface (mm)		±20	By level: 10 points
6	Position of built-in fitting (mm)		Conform to the design requirement; or shall be not more than 5mm if no specific requirements in design	By tape measure: every unit
7	Evenness (mm)		≤8	By 2-m straight edge: 1 point in every $10m^2$, and each point in both vertical and horizontal directions

3 The appearance of aconcrete anchor block shall conform to the criteria in Item No. 3 of Clause 8.5.9. Neither ponding nor leaking of water shall appear on anchor rooms.

8.11.5 Tensioning and grouting of prestressing anchor cables

1 The tensioning of prestressing anchor cables shall conform to the criteria stated in Clause 8.3.2. However, the measurement items on the position of prestressing tendons are not required.

2 The grouting of prestressing anchor cables shall conform to the criteria stated in Clause 8.3.3. A trial tensioning shall be conducted in accordance with the design requirements and the tensioning activities may commence only after conformity is confirmed based on

results of the trial.

8.11.6 Concrete plug in a tunnel anchorage

1 The concrete plug in a tunnel anchorage shall conform to the basic requirements as follows.

1) The properties of concrete regarding impermeability and micro-expansion shall be tested and the results shall conform to the design requirements.

2) The maximum temperature in concrete and the temperature difference of inside and on surface of the concrete due to hydration heat shall be controlled in the allowable range.

3) The concrete shall be filled or plugged into the tunnel fully and densely, and bonded with the surrounding rock mass of the tunnel tightly and seamlessly. The gaps, if there is any, shall be properly treated in accordance with the instruction stated in design documents and the results shall satisfy the requirements.

2 The measurement items for the concrete plug in a tunnel anchorage shall conform to the criteria in Table 8.11.6.

Table8.11.6 Measurement items for ConcretePlug in Tunnel Anchorage

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Coordinates in longitudinal direction of the center points of front and rear surfaces of an anchorage (mm)	±50	By total station and steel ruler: onfront and rear surfaces of anchorage
3	Incline angle of front and rear surfaces of an anchorage (°)	±0.5	Byinclinometer: 3 points on both front and rear surfaces of anchorage
4	Position of built-in fitting (mm)	As required by design; or ≤5mm if no specific requirements in design	By tape measure: every unit

3 The appearance of the concrete plug in a tunnel anchorage shall conform to the criteria in Item No. 3 of Clause 8.11.4 hereinabove.

8.11.7 Fabrication of cable saddles

1 The fabrication of cable saddles shall conform to the basic requirements as follows.

1) The castings of a bridge cable saddle shall be delivered with ex-factory certificates and

be qualified by non-destructive tests to confirm their material properties in conformity to design requirements.

2) Flaw detection by ultrasonic method shall be conducted on every steel plate of saddle base in accordance with relevant technical standards. The steel plates produced in batch shall be sampled and tested for chemical composition and mechanical performance in the frequency and by the methods specified in design and relevant specifications. The plates shall be put into production only after the conformity is confirmed by flaw detection and other tests.

3) Assessment on welding workmanship in terms of parent metal, welding rods, welding types and welding quality shall be conducted in accordance with the design requirements and relevant technical specifications. Only qualified welding rods, welding wires and welding soldering flux shall be adopted.

4) Flaw detection shall apply to the welding lines of cable saddle in accordance with design requirements. The test results shall be qualified.

5) Trial assembly shall be conducted before delivery. Every component part shall be labeled with identification codes and position marks shall be presented on each member. Neither damaging nor missing shall happen to the component parts and their coatings during moving, transporting and storage.

2 The measurement items for the fabrication of cable saddles shall conform to the criteria in Tables 8.11.7-1 and-2.

Table 8.11.7-1 Measurement items for Fabrication of Main Cable Saddles

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Main plane	flatness	≤0.08mm/1000mm and ≤0.5mm/the whole plane	By flatness gauges or machine tool: 12 points on main lane in a cross-over way
2△		Parallelity of two planes (mm/whole plane)	≤0.5	By flatness gauges or machine tool: 6 points
3△		Perpendicularity ofthe plane beneath saddle to the vertical plane of central cable (mm/the whole length)	≤2	By pulsation detector or machine tool: 6 points
4		Perpendicularity of joint vertical plane compared to the lower plane of saddle body (mm/the whole length)	≤3	By pulsation detector or machine tool: 6 points

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
5	height	Height between saddle bottom plane and the bottom of central cable groove (mm)	±2	By pulsation detector or machine tool: 6 points
6△	Arc radius	Outline arc radius of groove (mm)	±2	By pulsation detector or machine tool: 6 points
7△	Size in the groove	Width and depth of each groove (mm)	±1 and the accumulated error is ±2	By template: 3 cross-sections
8		the symmetry of each groove and central cable groove (mm)	≤0.5	By pulsation detector or machine tool: 3points
9△		Thickness of manufactured saddle bottom and sidewalls (mm)	±10	Bymachine tool or by established bench mark: 3 cross-sections
10		Vertical and horizontal angles of each groove curve (°)	±0.2	Bymachine tool or angle sensor: every curve
11		Surface roughness of saddle groove, Ra (μm)	Conform to the design requirements	Byroughness meter: 5 points on every saddle surface

Note: The main planes include the bottom plane of main saddle block, the vertical planes jointing to it, the top and bottom planes of upper and lower bearing plates, and the vertical (base) plane of central cable groove.

Table 8.11.7-2 Measurement items for Fabrication of Cable splay saddles

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Main plane	flatness	≤0.08mm/1000mm and ≤0.5mm/whole plane	By flatness gauges or machine tool: 9 points on main lane in a cross-over way
2△		Parallelity of two planes (mm/whole plane)	≤0.5	By flatness gauges or machine tool: 6 points
3△		Perpendicularity ofthe centerline of pendulum shaft to the central plane of cable groove (mm/the whole length)	≤3	By pulsation detector or machine tool: 6 points
4	Height	Height between pendulum shaft joint plane and cable groove bottom (mm)	±2	By pulsation detector or machine tool: 3 points
5△	Radius of saddle arc	Outline arc radius of groove (mm)	±2	By pulsation detector or machine tool: 3 points

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
6△	Size insaddle groove	Width and depth of each groove (mm)	±1 and accumulated error is ±2	By template: 3 cross-sections
7△		Symmetry of each pair of grooves to central cable groove (mm)	≤0.5	By pulsation detector or machine tool: 3 points
8△		Post-processing thickness of manufactured saddle bottom and sidewalls (mm)	±10	Bymachine tool or by established bench mark: 3 cross-sections
9		Vertical and horizontal angles of each groove curve (°)	±0.2	Bymachine tool or angle sensor: every curve
10		Surface roughness of saddle groove, Ra (μm)	Conform to the design requirements	Byroughness meter: 3 points on every saddle surface

Note: The main planes include the plane of pendulum shaft, the bottom plane of base plate and vertical plane of central cable grooves.

3 The appearance of a manufactured cable saddle shall conform to the following requirements:

1) Pores, holes, or shrinkage loose must not appear on the surfaces of steel castings.

2) The welding lines shall conform to the criteria state din Item No. 3 of Clause 8.9.1.

3) Anti-corrosive grease must be applied on the processed surfaces of various holes and planes.

8.11.8 Installation of cable saddles

1 The installation of cable saddles shall conform to the basic requirements as follows.

1) The finished cable saddles shall be inspected in accordance with design requirements and relevant technical specifications, and shall be installed only after conformity is confirmed.

2) A base plate shall be installed in accordance with design requirements. Its surface shall be smooth and shall stick to the bearing plate tightly and seamlessly.

3) A cable saddle shall be inspected thoroughly to ensure no damage occurs before installation. A cable groove shall be clean with no grease or painting materials on its

surfaces.

4) A cable saddle shall be fixed and locked tightly once it is positioned.

2 The measurement items for the installation of a cable saddle shall conform to the criteria in Tables 8.11.8-1 and -2.

Table8.11.8-1 Measurement items for Installation of Main Cable Saddles

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Finaloffset (mm)	Longitudinal direction	Conform to the design requirement	By total station and measure ruler: 2 points each onlongitudinal and transversal centerlines of every cable saddle
		Transversal direction	≤10	
2△	Level ofbase plate (mm)		+20,0	By total station: 4corners of every cable saddle
3	Level difference of4 corners of base plate (mm)		≤2	
4	Torque on high strength bolts (Nm)		±10%	By torque wrench: 5% by random but not less than 2 bolts

Table8.11.8-2 Measurement items for Installation of Cable splay saddles

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Longitudinal and transversal offsets of the axis of base plate (mm)	≤5	By total station: 2 points onlongitudinal and transversal centerlines of every cable saddle
2	Levelat center of base plate (mm)	±5	By level: every saddle
3	Level difference of base plate (mm)	≤2	By level: 4 corners of base plate in every cable saddle
4△	Vertical incline angle of cable splay saddle	Conform to the design requirements	By total station: every cable saddle

3 The appearance of an installed cable saddle shall conform to the following requirements:

1) No dirt shall remain in saddle grooves.

2) Any damage to surface protection shall be repaired or remedied.

8.11.9 Fabrication of strands and associated anchor heads of main cable

1 The fabrication of the strands and associated anchor heads of a main cable shall conform to the basic requirements as follows.

1) Every anchor socket or anchor plate shall be inspected by non-destructive flaw detection and shall be put in use only after the conformity is confirmed.

2) Before batch production, a tensile-to -failure test shall be conducted in accordance with design requirements, followed by a check on the cut section of the anchor head after the test. The production shall start subject to the conformity is confirmed.

3) Labels on the main cable strands shall be complete and accurate. The coating protection for anchor heads shall conform to the criteria in Clause 8.9.3 hereinabove.

4) No damage, contamination or corrosion shall occur to main cable strands and anchor heads during transportation and storage.

2 The measurement items for fabrication of main cable strands and associated anchor heads shall conform to the criteria in Table 8.11.9.

Table8.11.9 Measurement items for Fabrication ofMain Cable Strands and Associated Anchor Heads

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Nominal length of wire (mm)	±Lz/15000	By specialist measuring platform: every wire
2△	Length ofproduct strand (mm)	±Ls/10000	By specialist measuring platform: every wire
3△	Casting ratio ofalloy in hot cast anchor (%)	>92	By calculation: base on the volume measured at every anchor
4	Expansion length of pressed strand in anchor head end (based on the specified pressure continuing for 5min) (mm)	Conform to the design requirement	By dial gauge: every anchor
5△	Perpendicularityof the axis of strand to the end plane of anchor (°)	±0.5	By angle square: every anchor

Notes: 1. L_Z refers to the nominal length of a wire; and L_S refers to the length of a stand; in mm for both specified value and tolerance.

2. The tolerance of expansion length in Item No. 4 shall be measured after the deduction of initial expansion.

3 The appearance of the main cable strands and associated anchor heads shall conform to the following requirements:

1) No intertwining and extruding shall occur to wires, and no kinks in cable strands.

2) The wrapping on cable stands shall not be loose and the protection of wires and anchor heads shall not be damaged.

8.11.10 Erectionof main cables

1 The main cable erection shall conform to the basic requirements as follows.

1) The product cable strands shall be delivered with quality certificates and inspected in accordance with the design requirements and relevant technical specifications. Then the cable may be erected after conformity is confirmed by the inspection.

2) The position ofcable strands in saddles and anchor grooves shall conform to the design requirements. The cable stands shall not be bent, twisted or loose during erection.

3) The cable strands shall be anchored at a right angle to the anchor plate. The anchor heads shall be fixed and locked firmly.

2 The measurement items for erecting main cables shall conform to the criteria in Table 8.11.10.

Table8.11.10 Measurement items for Main Cable Erection

No.	Inspection item			Specified value & Tolerance	Method and frequency
1△	Level of cable stand (mm)	Base-line	Main span	± L/20000	By total station: atmidspan of every strand
			Side span	± L/10000	
			Level difference between up- and down-streams	≤10	
		Ordinary	Compared tobase-line strand	+10, −5	By total station or specialist calipers: every stand
2	Cable force deviation in anchor span			As specified in design, or ± 3% if no specific requirements in design	By load cell: measure each strand with dynamometer
3	Void ratio of main cable (%)			±2	By calculation based on perimeter measured: 50% by random, at and between clamps
4	Ovalness in diameter of main cable(%)			≤2	Bycaliper: 30% by random, at and between clamps after cable tightened

Notes: L refers to the length of a main span, in mm for both specified values and tolerances.

3 The appearance of an erected main cable shall conform to the following requirements:

1) No extrusion and overlapping shall appear along strand wires.

2) Neither interwinding nor twisting shall appear along strands.

3) No contamination shall exist on the surface of a cable stand. The damages to the protection of anchor heads and galvanized surfaces, if there is any, shall be remedied.

8.11.11 Fabrication ofcable clamps

1 Fabrication of cable clamps shall conform to the basic requirements as follows.

1) The steel castings processed by heat treatment in batches and the structural alloy steel shall be inspected for acceptance based on conformity to design requirements and the criteria of relevant technical specifications.

2) Everyfinished product (either cable clamp or screw stem) shall be inspected by non-destructive flaw detection for the conformity to design requirements and the provisions of relevant technical specifications. The test results shall be positive for conformity. The two parts in pair of a clamp shall be labeled with identification codes and put into trial assembly for conformity before being used.

3) A disqualified clamp may be repaired, however the repaired spots in any half piece of a clamp shall not be more than two and any spots shall not be repaired twice. Repairing records shall be properly filed for tracing.

4) The inter-surfaces of a cable clamp, the nut and washer shall be in a right angle to the axis of the screw stem. The manufacture precision shall conform to the design requirements.

2 The measurement items for fabrication of cable clamps shall conform to the criteria in Table 8.11.11.

Table8.11.11 Measurement items for Fabrication of Cable Clamps

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Inner diameter and length of a clamp (mm)	±2	By tape measure: measure the inner diameter twice in two directions at cross; and measure the length twice
2△	Wall thickness (mm)	+5,0	ByVernier caliper: 10 points

continued

No.	Inspection item		Specified value & Tolerance	Method and frequency
3	Roundness (mm)		≤2	Byelectric profilometer or machine tool: 5 points on every set
4	Straightness (mm)		≤1	Bystraightness measuring instrument or laser collimators: 5 points on every set
5△	Roughness of inner side of a clamp, R_a (μm)		Conform to the design requirement and between 12. 5 ~ 25if no specific requirements in design	By roughness meter: 10 points on every set
6	Ear plate	Offsetof pinhole center point (mm)	±1	ByVernier caliper: 50% by random, and 2 points on every set
		Inner diameter of a pin hole (mm)	+1,0	
7	Screw hole	Offset of screw hole center (mm)	±1.5	ByVernier caliper: 50% by random, and 2 points on every set
		Inner diameter of a screw hole (mm)	±2	
		Straightness(mm)	≤L/500	By straightness measuring instrument or fiber optic sensors: 50% by random, and 3 points on every set

Notes: L refers to the depth of a screw hole, in mm for both Specified value & tolerance.

3 The appearance of a fabricated cable clamp shall conform to the following requirements:

1) Surface defects, such as depressed spots, bubble holes and blisters, shall not beyond the limits specified in the design. The surfaces of a clamp shall free of any rough edges or burrs.

2) The screws, nuts and washers shall be properly protected by adequate grease on surfaces and shall be free of rust, dirt or any damages to the screw threads.

8.11.12 Fabrication ofsuspenders and associated anchor heads

1 The fabrication of suspenders and associated anchor heads shall conform to the basic requirements as follows.

1) Non-destructive flaw detection shall be conducted to inspect the anchor sockets, ear plates and pin rolls one by one in accordance with design requirements. All test results

shall be positive.

2) Tensile-to -failure tests shall be conducted for suspenders and fittings of anchor heads in accordance with the design requirements. The test results shall confirm the conformity to requirements.

3) The length of a suspender shall be measured and cut under the tension as specified by design. The length and direction position shall be marked at a point near anchor head.

4) The coasting protection of an anchor head shall conform to the criteria of Clause 8.9.3, and the protection of a suspender shall conform to the design requirements.

5) No accessories shall be missing, and neither suspenders nor anchor heads shall be damaged during transportation and storage.

2 The measurement items for fabrication of suspenders and associated anchor heads shall conform to the criteria in Table 8.11.12.

Table 8.11.12 Measurement items for Fabrication of Suspenders and Anchor Heads

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Length (between pin rolls) of an adjusted suspender (mm)	≤5m	±1	By tape measure or on the specialist measure platform: every cable
		>5m	± L/5000and not more than ±30	
2	Diameter of pin roll (mm)		0,-0.15	ByVernier caliper: measure the diameters twice but in two directions at cross on every end cross-section
3	Offsetof centerline of the pin roll of a fork-shaped ear plate (mm)		±2	By steel ruler: check both sides of every ear plate. Calculate based on intersection points of the horizontal centerline and two side-lines of the hole
4△	Alloy casting ratio of a hot-cast anchor (%)		>92	Measure the volume and calculate: every anchor
5	Outward displacement of a suspender at anchor head end (under a specified pressure for 5 minutes) (mm)		Conform to the design requirement	By dial gauge: every anchor
6△	Perpendicularityof the axis of suspender strand to the end plane of anchor (°)		≤0.5	By angle square: 3 points on every anchor, each in two perpendicular directions

Notes: 1. The tolerance of outward displacement inItem No. 5 shall be measured after deduction of initial displacement.
2. L refers to the length of a suspender, in mm for both specified value and tolerance.

3 The appearance of manufactured suspenders and their associated anchor heads shall conform to the following requirements:

1) No rust shall spear on the surface of a suspender, and no damage to the protection coatings.

2) No kinks shall exist in a suspender. The sheath of a suspender shall be in a proper shape and free of bubbles, scratches, cracks or deformations.

8.11.13 Installation of Clamps and Suspenders

1 The installation of clamps and suspenders shall conform to the basic requirements as follows.

1) The devices for fastening screws shall be calibrated by which the tensile forces in screws shall be inspected and measured in phases as specified in the design and required by relevant technical specifications.

2) The inner surface of a clamp and the contact surface on the main cable shall be properly treated and kept clean and dry during installation.

3) The anchor head shall be fixed and locked firmly.

2 The measurement items for installation of suspenders and clamps shall conform to the criteria in Table 8.11.13.

Table8.11.13 Measurement items for Installation of Cable Clamps and Suspenders

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Clamp deviation	Along the cable (mm)	≤10	By total station and steel ruler: everyclamp
		deflection angle (°)	≤0.5	By anglegauge: every clamp
2△	Fastening force on screw (kN)		Conform to the design requirement	By tensioning pressure meter: every one

3 The appearance of installed clamps and suspenders shall conform to the following requirements:

1) No twisting shall appear in suspenders.

2) No scratches, cracks or raptures shall exist on the protections of clamps and suspenders.

8.11.14 Protection of main cables

1 The protection of main cables shall conform to the basic requirements as follows.

1) Before and during the protection work, the surfaces of cable wires shall be kept dry and clean, free of any dust, grease or water standing. The seams between cable wires and the wrapping wires shall be evenly filled with sealant.

2) Themachines for wire wrapping shall be calibrated before they are put into use.

3) A wrapping wire shall be inserted into the groove reserved on the end of a cable clamp for at least three rounds or as the design required. The end of a wrapping wire shall be inserted into the groove on the cable clamp and fixed by welding with no looseness.

4) The seams of clamps, holes of screw stems and ends of cables clamps shall be fully and seamlessly sealed with sealants in compliance with the design requirements.

5) The surfaces of protecting coats or membranes shall be smooth.

6) Air tightness of main cable sheaths shall conform to the design requirements.

2 The measurement items for main cable protection shall conform to the criteria in Table 8.11.14.

Table8.11.14 Measurement items for Main Cable Protection

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Spacing of wrapping wires (mm)	≤1	By feeler gauge: measure the max. spacing in a length of 1m by random between two clamps
2△	Tensile strength of wrapping wire (kN)	±0.3	By calibrating inspection: once on every bundle
3△	Thickness of protection coat or membrane (μm)	Conform to the design requirements	Patch methodfor coating and slicing method for sealant: once in every 100m length, but not less than 3 points in total for every bundle or every span

3 The appearance of main cable protection shall conform to the following requirements:

1) The wire seams shall be fully filled with wrapping putty, but no wrapping putty shall not be remained on the wrapping layer.

2) Neither overlapping nor crossing-over shall appear on wire wrapping.

3) No needle holes, cracks or peeling or missed coating shall appear on protective coatings or membranes.

4) No cracking, bubbling or gaps shall appear in the seals of cable clamps.

5) Main cables must be free of water inside.

8.11.15 Installation of steel stiffening girders of a suspension bridge

1 The installation of steel stiffening girders of a suspension bridge shall conform to the basic requirements as stated in Item No. 1 of Clause 8.9.2. The main cable saddles shall be jack-pushed to right location in the construction phase as specified in design.

2 The measurement items for the installation of steel stiffening girders of a suspension bridge shall conform to the criteria in Table 8.11.15.

Table 8.11.15 Measurement items for Installation of steel stiffening girders

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Offset of hanging points (mm)	≤30	By total station: every hanging point
2	Level difference of hanging points symmetrically positioned at both ends of a girder segment (mm)	≤20	By level: every hanging point
3△	Inter-segment faulting	2	By tape measure: max. value of misalignment at every joint
4	Size of welding line	Conform to the design requirements	By measure gauge: every welding line, 2 points each welds
5△	Welding inspection		By ultrasonic method: every welding line, or By X-ray method: as design required; or by sampling inspection for 10% but not less than three welds if not specified in the design
6△	Torque on high-strength bolt	±10%	By torque wrench: 5% by random but not less than 2 bolts

3 The appearance of installation of steel stiffening girders shall conform to the following

requirements.

1) No abnormal bends and folds shall appear on the alignment of a steel stiffening girder.

2) Welding lines and high strength bolts shall conform to the criteria in Item No. 3 of Clause 8.9.1 hereinabove.

8.11.16 Fabrication of main cableanchorage system of a self-anchored suspension bridge

1 Fabrication of main cable anchorage system of a self-anchored suspension bridge shall conform to the basic requirements as follows.

1) Manufactured sizes of anchor bearing plates, conduits and other component members of an anchorage system shall conform to the design requirements and qualified for conformity.

2) The connection and protection of a conduit and an anchor bearing plate shall conform to the design requirements.

2 The measurement items for fabrication of the main cable anchorage system of a self-anchored suspension bridge shall conform to the criteria in Table 8.11.16.

Table 8.11.16 Measurement itemsfor the Fabrication of Main Cable Anchorage system of a Self-Anchored Suspension Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency	
1	Length of conduit (mm)	±5	By tape measure: 1 point on every conduit	50% by random
2	Angleof anchor bearing plate to conduit (°)	≤0.5	By anglegauge: 1 point in each axis directions on every anchor bearing plate	

3 The appearance of fabricated main cable anchorage system of a self-anchored suspension bridge shall conform to following criteria.

1) Burrs and any raised objects that might damage the cable strands, or any abrasion or scratches deeper than 50% of negative deviation of the plate thickness, must not exist on the surfaces of a conduit or an anchor bearing plate.

2) No depressions shall appear on the surface of a conduit.

8.11.17 Installation of main cable anchorage system of a self-anchored suspension bridge

1 Installing the anchorage system of main cables for a self-anchored suspension bridge shall conform to the basic requirements as follows.

1) The anchorage system could be installed only after being inspected and qualified.

2) The anchorage system shall be installed firmly so that no disturbance or displacement shall occur during concrete casting.

2 The measurement items for installing the main cable anchorage system for a self-anchored suspension bridge shall conform to the criteria in Table 8.11.17.

Table 8.11.17 Measurement items for Installation of Main Cable Anchorage system for a Self-Anchored Suspension Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Coordinates ofcenter point of front-end hole of pre-embedded conduit (mm)	±5	By total station: every hole
2	Coordinates ofcenter point of rear-end hole of pre-embedded conduits (mm)	In same direction to front end, ±5	By total station: every hole

3 The appearance of the installed anchorage system of main cables for a self-anchored suspension bridge shall conform to the following criteria.

1) No damage shall appear on the surface of an anchorage system.

2) No construction wastes and debris shall remain inside and outside of an anchorage system.

8.11.18 Tensioningof suspenders and system transformation of a self-anchored suspension bridge

1 The tensioning of suspenders and system transformation of a self-anchored suspension bridge shall conform to the basic requirements as follows.

1) The equipment for tensioning such as jacks and oil pressure gauges shall be calibrated and must not be used beyond the calibration period.

2) The force in suspenders, the displacement of pylon columns, the offsets from position of main saddles, and the alignment, the stresses and strains on upper and lower edges of steel stiffening girders shall be monitored and recorded during the process of system transformation.

3) The system transformation should be carried out in accordance with the requirements for construction control. Cable forces, application sequence, pre-offset of cable saddles, time and duration of jacking force shall conform to the requirements for construction control.

4) The suspender forces shall be adjusted if the offset of pylons, the level of steel box girder or the forces in suspenders exceed the allowable ranges of the design.

2 The measurement items for tensioning of suspenders and the system transformation of a self-anchored suspension bridge shall conform to the criteria in Table 8.11.18.

Table 8.11.18 Measurement items for the Suspender Tensioning and System transformation of Self-Anchored Suspension Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Level of steel stiffening girder (mm)	±30	By level: 5 points on main spans, and 3 points on side spans
2	Level difference in lateral direction of steel stiffening girder (mm)	≤20	
3△	Force on suspender (kN)	Conform tothe requirements of design and for construction control, or ±10 if no specific requirements given in design	By load cell: every suspender

3 The appearance of suspender tensioning and system transformation of a self-anchored suspension bridge shall conformed the following requirements.

1) No abnormal folds or bends shall appear on the alignments of main cables or stiffen girders.

2) No twisting shall appear in suspenders.

3) No damages or cracks shall appear on the protection of suspenders.

8.12 Bridge Deck system and auxiliary works

8.12.1 Waterproofing for concrete bridge deck

1 The waterproofing for concrete bridge deck shall conform to the basic requirements as follows.

1) The waterproofing materials shall be compatible to each other and their service lives shall not be shorter than that of the concrete pavement. In addition, these materials shall have the properties adapting to dynamic loads and the capacity of keeping undamaged even if the concrete cracks.

2) The interface between deck concrete and waterproofing shall be sound, smooth, clean, dry and free of contaminations such as dust, debris, grease, or laitance. The surface treatment shall conform to the design requirements.

3) Construction of waterproofing should be carried out in accordance with the working process specified in design. The waterproof materials should be placed in favorable environmental conditions. Construction work shall not be carried out if it is expected that the painting surface will not be dried before raining. During construction, it is forbidden to step on undried waterproof coatings. After the maintenance of waterproofing and before the completion of bridge deck pavement, vehicles may travel on waterproof coating, but sharp turning or sudden braking shall be avoided.

4) The waterproofing treatment at the connections to weepholes, barriers or curbs shall conform to the design requirements.

5) The overlapping, either in length or in width direction, of coiled sheets or the core material of laminated sheets shall conform to the design requirements. Any laterally all-through seam is not allowed.

2 The measurement items for the waterproofing for concrete bridge deck shall conform to the criteria in Table 8.12.1.

Table 8.12.1 Measurement items for the Waterproofing

No.	Inspection item		Specified Values or Deviation Permits	Method and frequency
1△	Waterproof coating	Thickness (mm)	Conform to design requirements. If no specific requirements in design, average thickness ⩾ design thickness, the thickness of 85% checkpoints ⩾ design thickness, and min. thickness ⩾80% design thickness	By thicknessdetector: 10 locations and 3 points in each location on every construction segment
		Qty. (kg/m^2)	Conform to the design requirements	By calculation: base on the area applied
2△	Strength of bonding (MPa)		Within the required range	Refer to Annex N
3	Moisture content of the concrete surface		Conform to the design requirements	By moisture instrument: 5 places and take average of 3 points in each on a construction segment not larger than $1000m^2$; and additional 1 place with 3 points for every $1000m^2$ increment

Notes: For waterproof coating, only one item, either thickness or quantity, needs to be inspected; for permeable waterproof coating, only quantity is to be inspected.

3 The appearance of waterproofing for concrete bridge deck shall conform to the following criteria.

1) The waterproof coating shall be applied to cover all areas with no bubbling, peeling and exposal of core materials.

2) The water proofing sheets shall have no uncovered spaces, warped edges or wrinkles and folds.

3) The connections of waterproofing to weep holes, expansion joints, barriers and curbs shall have no leaking.

8.12.2 Pavement onconcrete bridge deck

1 The pavement on a concrete bridge deck shall conform to the basic requirements as follows.

1) The cement concrete pavement on bridge shall conform to the criteria in Clause 7.2.1 and the asphalt pavement on bridge shall conform to the criteria in Clause 7.3.1.

2) The pavement at and around the inlet of a weep hole shall be conducive to removing the standing water or infiltrated water. The number of weep holes shall not be less than that design required.

2 The measurement items for paving on a concrete bridge deck shall conform to the criteria in Tables 8.12.1-1 to -3.

Table 8.12.2-1 Measurement items forCement Concrete Pavement on Bridge Deck

No.	Inspection item		Specified value & Tolerance: Motorway & Class-1 highway	Specified value & Tolerance: Other classified highway	Method and frequency
1△	Strength of concrete (MPa)		Within the required range		According to Appendix D
2	Thickness (mm)		+10, −5		By level: take the point where deflection is the same as that of bridge deck as a bench mark, survey the relative level difference of bridge deck before and after paving: on every lane, 3 points in 100m segment, and 2 additional points for every 100m increment
3	Roughness	σ (mm)	≤1.32	≤2.0	By roughness instrument: continuously measure along every lane for whole length of the bridge, calculate σ and IRI for every 100m
		IRI (m/km)	≤2.2	≤3.3	
		Max. gap h(mm)	≤3	≤5	By 3-m straight edge: for half of roadway, 2 places, 5 measures each in every 200m length
4	Cross slope (%)		±0.15	±0.25	By level: 5 cross-sections in first 200m length and 1 additional point for every 100m increment
5	Surface texturefor skid resistance (mm)		0.7~1.1	0.5~1.0	By sand patch method: 5 points in first 200m, and 1 additional point in every 100m increment

Notes: 1. σrefers to the standard deviation of roughness; IRI refers to international roughness index; and h is the maximum gap beneath a 3-m straight edge on pavement surface.

2. For small bridges, these inspections above may be executed as part of the inspections of road pavement, while for medium bridges may depend upon real situation.

Table 8.12.2-2 Measurement items for AsphaltConcrete Pavement on Bridge Deck

No.	Inspection item	Specified value & Tolerance: Motorway & Class-1Highway	Specified value & Tolerance: Other classified highway	Method and frequency
1△	Compaction	≥96% (*98%) of standard density in laboratory; ≥92% (*94%) of the max. theoretical density; ≥98% (*99%) of density oftrial section		Accordingto Annex B: 5 points in first 200m length and 2 additional points for every 100m increment

continued

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Inspection item</th><th colspan="2">Specified value & Tolerance</th><th rowspan="2">Method and frequency</th></tr>
<tr><th>Motorway & Class-1 Highway</th><th>Other classified highway</th></tr>
<tr><td>2</td><td colspan="2">Thickness (mm)</td><td colspan="2">+10, -5</td><td>By level: take the point where deflection is the same as that of bridge deck as a bench mark, survey the relative level difference of bridge deck before and after paving: along every lane, 3 points in fist 100m segment, and 2 additional points for every 100m increment</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Roughness</td><td>σ (mm)</td><td>≤1.32</td><td>≤2.0</td><td rowspan="2">By roughness instrument: continuously measure every lane for whole length of the bridge, calculate σ and IRI for every 100m</td></tr>
<tr><td>IRI (m/km)</td><td>≤2.2</td><td>≤3.3</td></tr>
<tr><td>Max. gap h (mm)</td><td>≤3</td><td>≤5</td><td>By 3-m straight edge: for half of roadway, 2 places, 5 continuously measures each in every 200m length</td></tr>
<tr><td>4</td><td colspan="2">Water permeability coefficient (ml/min)</td><td colspan="2">Conform to the design requirement, and ≤120 for SMA and ≤200 for others if no specific requirements in the design</td><td>By filtration testing instrument: 5 points in first 200m length and 1 additionl point for every 100m increment</td></tr>
<tr><td>5</td><td colspan="2">Cross slope (%)</td><td>±0.15</td><td>±0.25</td><td>By level: 5 cross-sections in first 200m length and 1 additional point for every 100m increment</td></tr>
<tr><td>6</td><td colspan="2">Depth of surface texture for skid-resistance (mm)</td><td>Conform to the design requirements</td><td>-</td><td>By sand patch method: 5 points in first 200m, and 1 additional point in every 100m increment</td></tr>
</table>

Notes: 1. For Motorways and Class-1 highways, the compaction shall be evaluated by two criteria, and take the lower passing rate as evaluation result. For other classified highways, only one criterion is needed for evaluation. The * refers to SMA pavement.

2. σ refers to the standard deviation of roughness; IRI refers to international roughness index; and h is the maximum gap beneath a 3-m straight edge on pavement surface.

3. For small bridges, these inspections may be included that for road pavement while for medium bridges, inspections may be conducted either independently or included according to site conditions.

4. For asphalt mixtures, which pavement type and construction workmanship are the same to that of the road pavement, the compaction and permeability coefficient can be inspected as part of the inspection for road pavement while the coring for compaction can be sampled on road pavement.

Table 8.12.2-3 Measurement items for Concrete Pavement on Composite Bridge Deck

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Thickness (mm)	+10, −5	By level: take the point where deflection is the same as that of bridge deck as a bench mark, survey the relative level difference of bridge deck before and after paving: on every lane, 3 points in fist 100m segment, and 2 additional points for every 100m increment
3	Roughness (mm)	≤5	By 3-m straight edge: for half of roadway, 2 places, 5 continuously measures each place in every 200m length
4	Cross slope (%)	±0.15	By level: 5 cross-sections in first 200m length and 1 additional cross-section for every 100m long increment

Notes: The asphalt surface course in a composite bridge deck shall be inspected in accordance with Table8.12.2-2.

3 The appearance of a concrete bridge deck shall conform to the following criteria:

1) In the connections to curbs or barriers, the cement concrete deck payment shall be free of any cracks wider than 0.3mm; the asphalt concrete deck pavement shall be free of cracking and loosening.

2) Other quality items shall conform to the criteria in Clauses 7.2.3 and 7.3.3.

8.12.3 Waterproof bonding coat on steel bridge deck

1 The waterproof bonding coat on a steel bridge deck shall conform to the basic requirements as follows.

1) Rust, dust, grease or other contaminants shall be removed. No welding overlaps, spatters and burrs shall remain on the surface of steel deck plates. The deck surface shall be clean and dry, on which waterproof bonding coats shall be applied within the period of time as specified in design.

2) The bonding coat shall be applied in suitable environment temperature and humidity as required.

3) The waterproofing treatment at the connections to weep holes, barriers or curbs shall

conform to the design requirements.

4) The heating temperature and spray temperature of waterproof bonding material shall conform to the design requirements.

2 The measurement items for the waterproof bonding coat on steel bridge deck shall conform to the criteria in Table 8.12.3.

Table 8.12.3 Measurement items for the Waterproof Bonding Layer on Steel Bridge Deck

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Cleanlinessof steel deck (mm)		Conform to the design requirements.	By comparing to template: all
2	Roughness Rz (μm)		Conform to the design requirements, or 60 ~ 100μm if no specific requirements in design	As design required, or comparing to template if no specific requirement in design: all
3△	Waterproof bonding layer	Thickness (mm)	Conform to design requirements. If no specific requirements in design, average thickness ⩾ design thickness, the thickness of 85% checkpoints ⩾ design thickness, and min. thickness ⩾80% design thickness	By thicknessdetector: 10 places in every segment sprayed and 3 points in each place
		Qty. (kg/m^2)	Conform to the design requirements	By calculation: based on the area sprayed according to the coating area of construction segment
4△	Strength of bonding between the bonding coat and the prime paint on steel deck (MPa)		⩾design value	According to design requirements, or by pull-off gauge: 6 points for every of sprayed section

Notes: On one item, either thickness or quantity, shall be inspected; or only quantity to be inspected where is difficult to use a thickness detector.

3 The appearance of waterproof bonding coat on steel bridge deck shall conform to the following requirements.

1) The bridge deck shall be fully covered with waterproof bonding coats without missing or gapping.

2) The waterproof bonding coats shall be free of accumulation, bubbling or wrinkling. The surface must not be contaminated by grease or other dirt.

8.12.4 Asphalt concrete pavement on steel bridge deck

1 The asphalt concrete paved on steel bridge deck shall conform to the basic requirements as follows.

1) The amounts of various aggregate materials and asphalt, the heating temperature and rolling temperature of various materials and asphalt mixture shall conform to the requirements of design and the provisions of construction specifications.

2) The asphalt mixture shall be uniformly mixed with no color difference. The aggregates shall be well coated with no segregation or agglomeration.

3) The pavement at and around the inlet of a weep hole shall be conducive to removing the standing water or infiltrated water. The number of weep holes shall not be less than that design required.

4) After being applied, the bonding coat shall be kept clean and dry. The asphalt concrete on bridge deck shall be paved and completed within the period of time as specified by design.

2 The measurement items for asphalt concrete pavement on steel bridge deck shall conform to the criteria in Table 8.12.4.

Table 8.12.4 Measurement items for Asphalt Concrete Pavement on Steel Bridge Deck

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Compaction	Conform to the design requirement	By tonnage and passes of rolling
2△	Thickness (mm)	+5, −3	By level: take the point where deflection is the same as that of bridge deck as a bench mark, survey the relative level difference of bridge deck before and after paving: on every lane, 3 points in fist 100m segment, and 2 additional points for every 100m increment; or By engineering radar: on every lane, 3 points in fist 100m segment, and 2 additional points for every 100m increment

continued

No.	Inspection item			Specified value & Tolerance	Method and frequency
3	Roughness	Motorway& Class-1 Highway	IRI(m/km)	≤2.0	By roughness instrument: continuously measure on every lane all over the bridge, calculate σ and IRI for every 100m
			Σ(mm)	≤1.2	
		Other classified highway	IRI(m/km)	≤4.2	
			σ(mm)	≤2.5	
			Maximum gap h(mm)	≤5	By 3-m straight edge: 2 places, 5 continuously measures each in every 200m length
4	Cross slope (%)			±0.3	By level: 5 cross-sections in first 200m length and 1 additional point for every 100m increment
5	Water permeability coefficient (ml/min)			≤80	By filtration testing instrument: 5 points in first 200m length and 1 additional point for every 100m increment
6	Friction coefficient			Conform to the design requirement	ByBritish pendulum number (BPN) pendulum tester: 5 points in first 200m and 1 additional point for every 100m increment
7	Depth ofsurface texture for skid-resistance (mm)			Conform to the design requirement	By sand patch method: 5 points in first 200m, and 1 additional point in every 100m increment

Notes: 1. σ refers to the standard deviation of roughness; IRI refers to international roughness index; and h is the maximum gap beneath a 3-m straight edge on pavement surface.

2. Item No. 5 is not applicable to epoxy asphalt concrete pavement.

3. Bore holes shall be drilled for verification if the ground penetrating radar is used for quality inspection.

3 The appearance of asphalt concrete pavement on steel bridge deck shall conform to the provisions of Clause 7.3.3. The connections to curbs and barriers shall be free of cracking or loosening.

8.12.5 Bearing plinths and restraint blocks

1 The bearing plinths and restraint blocks shall conform to the basic requirements as follows.

1) Treatment of construction joints shall conform to construction specifications.

2) The concrete in the connections of bearing plinths and restraint blocks to the abutments, piers or capping beams shall be dense and free of cracks.

2 The measurement items for bearing plinths and restraint blocks shall conform to the criteria in Tables 8.12.5-1 and -2.

Table 8.12.5-1 Measurement items for Bearing plinths

<table>
<tr><th>No.</th><th colspan="2">Inspection item</th><th>Specified value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="2">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td>2</td><td colspan="2">Offset from axis (mm)</td><td>≤20</td><td>By total station and measure tape: 50% ofbearing plinths, each in both longitudinal and transversal directions</td></tr>
<tr><td>3</td><td colspan="2">Size of cross-section (mm)</td><td>±5</td><td>By tape measure: 50% of bearing plinths, 1 cross-section for each</td></tr>
<tr><td rowspan="3">4△</td><td colspan="2">Elevation of top surface (mm)</td><td>±2</td><td rowspan="3">By level: center points and four corners</td></tr>
<tr><td rowspan="2">Level difference of top surface (mm)</td><td>Side length≤ 500mm</td><td>≤1</td></tr>
<tr><td>others</td><td>≤2</td></tr>
<tr><td>5</td><td colspan="2">Position of pre-embedded units (mm)</td><td>≤5</td><td>By tape measure: every unit</td></tr>
</table>

Note: The tolerance for the level difference of top surface in the table above is only applicable to the bearing plinths on which a bearing is directly placed.

Table 8.12.5-2 Measurement items for Restraint blocks

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Position in plane(mm)	≤5	By total station: 30% of the blocks, at both ends of centerline
3	Size of cross-section and height (mm)	±10	By tape measure: 30% of the blocks, 1 cross-section and 2 points for height
4	Gapunder girder bottom (mm)	±5	By tape measure: 30% of the blocks, each at both sides

3 The appearance of bearing plinths and restraint blocks shall conform to the following requirements.

1) No limited defects as listed in Appendix P shall exist on the concrete surface.

2) The connecting faulting of restraint blocks shall not exceed 3mm.

8.12.6 Installation of bearings

1 The installation of bridge bearings shall conform to the basic requirements as follows.

1) The bridge bearings shall conform to the design requirements and relevant construction specifications in terms of types, scales and technical performance. Bearings shall be

delivered with product certificates, and then be accepted by inspection on site prior to the installation.

2) For the bearings to be grouted after installation, the properties of grouting material shall conform to the design requirements. The grout in bearings shall be dense with no hollows or gaps.

3) Longitudinal axes of the upper and lower parts in a bearing shall be kept in the same alignment. A longitudinal offset shall be set out in advance based on the calculations if the temperature during installation is different from that expected by the design.

4) The bearing shall not be inclined, unevenly loaded or vacated. Teflon board and stainless steel plate on a sliding surface shall be free of any scratches or cuts. The position shall be accurate, and the silicone grease shall be applied before installation.

5) The connections of bearings to the superstructure and substructure of a bridge shall conform to the design requirements and the provisions of relevant construction specifications.

6) The surfaces of the steel parts in a bearing and the surfaces of attachments shall be applied with protective treatment as required by the design.

2 The measurement items for installation of bridge bearings shall conform to the criteria in Tables 8.12.6-1 and-2.

Table 8.12.6-1 Measurement items for Bearing Installation

No.	Inspection item		Specified value & Tolerance	Method and frequency
1△	Lateral offset at center of bearing (mm)		≤2	By tape measure: every bearing
2	Longitudinaloffset at center of bearing (mm)		≤5	By tape measure: every bearing
3△	Elevation of bearing (mm)		Conform to the design requirements, or ±5 if no specific requirement in the design	By level: at centerline of every bearing
4	Level difference of four corners of a bearing (mm)	Bearing force ≤5000 kN	≤1	By level: every bearing
		Bearing force >5000 kN	≤2	

Note: Item No. 4 is not required for the bearings directly placed on bearing plinths.

Table 8.12.6-2 Measurement items for Bearing Installation for a Cable-stay Bridge or Suspension Bridge

No.	Inspection item	Specified value & Tolerance	Method and frequency
1△	Transversal and longitudinaloffset of vertical bearings (mm)	≤5	By total station and steel ruler: 2 points each in both longitudinal and transversal direction for every bearing
2△	Offset of bearing (mm)	±10	By level: 5 pointsfor every bearing
3	Flatness of steel plate on bearing plinth (mm)	≤2	By level and steel ruler: 5 points for every bearing
4	Parallelity of the centerline of sliding plate in bearing to the bridge axis (mm)	1/1000S	By total station and steel ruler: ateach end of centerline of sliding plate in every bearing
5	Verticality of bearing and restraint block for lateral wind resistance (mm)	≤1	By angle square: 5 pointsfor every bearing
6	Parallelity the surface of bearing against lateral wind to the surface of restraint block (mm)	≤1	Bycaliper: 5 points for every bearing
7	Spacing betweenthe surfaces of restraint block and that of bearing against lateral wind (mm)	±2	Bycaliper: 5 points for every bearing

Note: S refers to the length of a sliding plate, in mm for both specified value and tolerance.

3 The appearance of installed bearings shall conform to the following requirements.

1) Bearing surfaces shall be free of contaminants and dust. No construction waste or other debris shall exist nearby bearings.

2) No scratch or peeling shall appear on the protective layer of bearings.

3) Neither missing nor damaging shall happen to dust covers.

8.12.7 Installation of expansion joints

1 The installation of expansion joints shall conform to the basic requirements as follows.

1) The products of expansion joints shall conform to the design requirements and the provisions of relevant technical specifications in terms of types, scales and technical performance, be delivered with product certificates and then shall pass the inspection for acceptance on site before installation.

2) The types and strengths of concrete filled in both sides of an expansion joints shall conform to the design requirements

3) No standing water shall be at expansion joints.

2 The measurement items for expansion joints shall conform to the criteria in Table 8.12.7.

Table 8.12.7 Measurement items for Installation of Expansion joint

No.	Inspection item		Specified value & Tolerance	Method and frequency
1	Length (mm)		Conform to the design requirements	By tape measure: every joint
2△	Width of gap (mm)		Conform to the design requirements	By tape measure: 1point in every 2m length of every joint
3	Level difference of the joint to bridge deck (mm)		≤2	By tape measure: 5 points at both sides of a joint
4	Grade(%)	ordinary	±0.5	By level: 5 points on a joint
		large	±0.2	
5	Transversal evenness (mm)		≤3	By 3-m straight edge: 2 points each along the joint and at abutting concrete
6	Size of welding line		Conform to the design requirements, or conform to the standard quality requirements for Execution Class 2 if no specific requirements in design	By measure gauge: 2 points on every welding line
7△	Welding inspection			By ultrasonic method: every welding line

Note: 1. Item No.2 shall be deduced in accordance with the temperature at installation.
2. Items No.6 and No.7 shall be for the welding lines on site.

3 The appearance of an installed expansion joint shall conform to the following requirements.

1) No leakage, deformation or cracking shall appear on an expansion joint.

2) No obstacles to joint movement shall remain in the gap of an expansion joint.

3) Welding lines shall be intact without cracks, overlaps, welding slugs, under filling, or arc strikes.

4) No limited defects as listed in Appendix P shall exist on the surfaces of abutting concrete.

8.12.8 Prefabrication of small concrete members

1 The prefabrication of small concrete members shall conform to the basic requirements as follows.

1) Quality of the rough surface for connecting, and the quantity and quality of key grooves shall conform to the design requirements.

2) The scales, position and quantities of pre-embedded fittings or pre-drilled holes in a component member shall conform to design requirements.

2 The measurement items for the prefabrication of small concrete members shall conform to the criteria in Table 8.12.8.

Table 8.12.8 Measurement items of Prefabrication of Small concrete members

<table>
<tr><th>No.</th><th>Inspection item</th><th>Specified value & Tolerance</th><th colspan="2">Method and frequency</th></tr>
<tr><td>1△</td><td>Strength of concrete (MPa)</td><td>Within the required range</td><td colspan="2">According to Appendix D</td></tr>
<tr><td>2</td><td>Size of cross-section (mm)</td><td>±5</td><td>By tape measure: 2 cross-sections</td><td rowspan="2">Random check 30% of total members</td></tr>
<tr><td>3</td><td>Length (mm)</td><td>+5,-10</td><td>By tape measure: at centerline</td></tr>
</table>

3 The appearance of prefabricated small concrete members shall conform to the criteria in Item No. 3 of Clause 8.7.2.

8.12.9 Paving of pedestrian sidewalks

1 Paving sidewalks shall conform to the basic requirements as follows.

1) Various components on sidewalks shall be firmly fixed and connected.

2) The sidewalk slabs shall be placed and firmly grouted only after the sidewalk beams are anchored and fixed.

3) Floor tiles shall be bonded firmly with no hollows or cracks.

2 The measurement items for paved sidewalks shall conform to the criteria in Table 8.12.9.

Table 8.12.9 Measurement items for Paving Sidewalks

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Offset in plane at edges of sidewalks (mm)	≤5	By total station and steel ruler: 5 points in every 200m length of sidewalk
2	Longitudinal elevation (mm)	+10,0	By level: 5 points in every 200m
3	Level difference between two sides of a joint (mm)	≤2	By tape measure: 10% of joints, measure the max. level difference
4	Cross slope (%)	±0.3	By level: 5 points in every200m length
5	Flatness (mm)	≤5	By 3-m straight edge: 5 points in every 200m

Note: If the length of a bridge is less than 200m, it will be treated as a 200m long bridge.

3 The appearance of paved sidewalks shall conform to the following requirements:

1) The components must not be ruptured.

2) Any missing corner shall not be longer than 20mm or more than 10mm in depth.

3) The floor tiles shall be free of cracks. The tile joints shall have no hollows or unfilled gaps.

8.12.10 Installationof handrails

1 The installation of handrails shall conform to the basic requirements as follows.

1) Only qualified product and components of handrails can be used.

2) Handrails shall be installed after the completion of paving sidewalks.

3) The handrails shall be installed firmly. The filling material in joints of component members shall be full and smooth with a strength in compliance with the design requirements.

2 The measurement items for installation of handrails shall conform to the criteria in Table 8.12.10.

Table 8.12.10 Measurement items for Installation of Handrails

No.	Inspection item	Specified value & Tolerance	Method and frequency
1	Offset in plane of handrail (mm)	≤4	By total stations and tape measure: measure five places in every 200m
2	Level oftop rail (mm)	±10	By levels and tape measure: Sample inspection (20%)
	Level difference of column tops (mm)	≤4	
3	Level difference at joints of top rail (mm)	≤3	By feeler gauge: sample inspection (20%)
4	Verticalityof posts or columns in bridge length and width directions (mm)	≤4	By plumbing: sample inspection (20%): measure each in transversal and longitudinal directions

3 The appearance of installed handrails shall conform to the following requirements:

1) No cracking shall exist at the joints of posts and rails.

2) No abnormal bends or folds shall appear on the alignment of handrails.

8.12.11 Concrete Barriers

1 The concrete barriers shall conform to the basic requirements as following:

1) The steel members on a barrier should be solidly welded and protected according to the design requirements.

2) The arrangement of separation joints and dummy joints shall conform to the design requirements.

3) The barriers should be installed in specific construction phases specified by the design.

2 The measurement items for concrete barriers shall conform to the criteria in Table 8.12.11.

Table 8.12.11 Measurement items for Casting Concrete Barriers

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Offset in Offset in plane (mm)	≤4	By total stations and steel rulers: 5 points in every 200m of every barrier
3△	Size of cross-section (mm)	±5	By tape measure: 5 points in every 200m of every barrier
4	Verticality (mm)	≤4	By plumbing: 5 points in every 200m of every barrier
5	Position of pre-embedded fittings (mm)	≤5	By tape measure: every unit

Note: If the length ofa barrier is less than 200m, it will be treated as a 200m long barrier.

3 The appearance of concrete barriers shall conform to the following requirements:

1) Abnormal bends, folds or abrupt changes shall not appear on the alignment of barriers.

2) Limited defects listed in Appendix P shall not exist in the concrete.

3) Welding surface should be free of welding cracks, overlaps or slag inclusions.

8.12.12 Installation of steel barriers on a steel bridge

1 The installation of steel barriers on a steel bridge shall conform to the basic requirements as follows:

1) Members and accessories shall be installed only after being inspected and qualified for conformity.

2) The barriers shall be installed in the specific construction phase as specified in the design.

3) The protection of barriers including the treatment of barrier ends and joints shall conform to the design requirements.

2 The measurement items for installing steel barriers on a steel bridge shall conform to the criteria in Table 8.12.12.

Table 8.12.12 Measurement items for installation of Steel Barriers

No.	InspectionItems	Specified value & Tolerance	Method and frequency
1	Offset in plane (mm)	≤4	By total station and tape measure: 5 points in every 200m length of every barrier
2	Spacing c/c of posts (mm)	±10	By tape measure: 10% of posts
3	Verticality of posts in directions of bridge length and width (mm)	≤2	By plumbing: 10% of posts
4	Height of cross beam (mm)	±5	By tape measure: 10% of beams
5△	Flaw detection on welding lines at base plate	Conform to the design requirements	According to the design requirements, or By ultrasonic method: 20% but not less than 3 welding lines

Note: Anysteel barrier shorter than 200min length will be inspection as a 200m long bridge.

3 The appearance of the installation of steel barriers on a steel bridge shall conform to the following requirements:

1) Welding lines shall be intact without cracks, overlaps, slag inclusion, arc strikes or other appearance defects not allowable by the design.

2) Any damage to the protective layers should be remedied.

8.12.13 Approach slabs at bridge ends

1 Approach slabs shall conform to the basic requirements as follows:

1) The strength and compaction of ground foundation, bedding layer or base course beneath an approach slab shall conform to the design requirements.

2) The connection of an approach slab to the bridge abutment shall conform to the design requirements.

2 The measurement items for approach slabs at bridge ends shall conform to the criteria in Table 8.12.13.

Table 8.12.13 Measurement items for Approach Slabs at Bridge Ends

No.	InspectionItems		Specified value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Size of sleeper beam beneath approach slab (mm)	Width and height	±20	By tape measure: 2 cross-sections for each sleeper beam
		length	±30	By tape measure: alongthe centerline of a sleeper beam
3	Sizeof approach slab (mm)	Length and width	±30	By tape measure: 2 points each on length and width
		Thickness	±10	By tape measure: 4 points
4	Elevation of top surface (mm)		±5	By level: 5 points at center point and 4 corners

3 The appearance of an approach slab shall conform to the following requirements:

1) Limited defects as listed in Appendix P shall not exist.

2) Filling to the joints of an approach slab shall be free of hollows or fake fillings.

8.12.14 Surface protection of concrete members

1 The surface protection of concrete members shall conform to the basic requirements as follows.

1) The protective coating shall be compatible with the mold release agent used for concreting. The construction of surface protection shall start after the concrete aches are 28 days old or another age specified in the design and subject to the approval of quality inspection.

2) The surface of a concrete member shall be firm, clean, and free of contaminants such as dusts, oil stains, mildew spots or salt precipitates. And the water content shall conform to the requirements for coating materials.

3) The environmental conditions of construction shall conform to the requirements of coating materials. The number of coats and thickness of a coating film shall be in compliance with the requirements of the design. The protective coating may proceed to the next coat only after and subject to the inspection and acceptance of the precedent coats.

2 The measurement items for the protection of concrete members shall conform to the criteria in Table 8.12.14.

Table 8.12.14 Measurement items for Protection of Concrete members

No.	InspectionItems	Specified Value & Tolerance	Method and frequency
1	Thickness of dry film (μm)	Mean thickness ≥ design thickness; thickness of 80% measured points ≥ design thickness; and Min. thickness ≥ 80% design thickness	By thickness gauge: 1 point for every $50m^2$, but not less than 30 points in total, to be checked after 7 days
2△	Adhesive strength of coating (MPa)	Conform to the design requirements; or ≥1.5 if no specific requirements given in the design	By adhesion gauge: 3 places in every $1000m^2$, and 3 points in each place to take the average

3 The appearance of the surface protection of a concrete member shall conform to the following requirements:

1) The surface of a member should be free of missing coating, spalling, bubbling or cracking.

2) Any area of coating pinholes, runs, orange peels or wrinkles shall not be larger than $2500mm^2$, and no more than 2 pieces of defected areas shall appear in any 1 square meter of coated area.

9 Culvert Works

9.1 Basic requirements

9.1.1 The number of culvert members to be inspected shall conform to Clause 8.1.1 hereinabove.

9.1.2 The prefabrication of segments of a concrete pipe culvert shall be inspected according to the provisions in section 5.2 hereinabove.

9.1.3 The backfill to culvert trenches should be inspected according to the provision 8.6.4. The protection for the embankment surfaces at the ends of a culvert (usually stone pitched retaining walls in a conical shape) shall be inspected in accordance with the provisions in section 6.10 hereinabove.

9.1.4 For reinforced concrete culverts, inspection shall be executed not only on the subdivisions of work mentioned in this chapter, but also on those of steel processing and installation.

9.2 Culvert in General

9.2.1 A culverts in general shall conform to the basic requirements as follows:

1 All construction activities shall have been executed and fully completed in accordance with the requirements of design documents.

2 Abnormal deformation shall not exist in any structural members.

3 All of the inter-segment joints and settlement joint shall be in correct position. The joint sealant shall be free of hollows, cracks, or water leakage. For precast members, the inter-segment joints and settlement joints should be in the same plane.

9.2.2 The measurement items for culverts in general shall conform to the criteria listed in Table 9.2.2.

Table 9.2.2 Measurement items for Culvert Structures in General

No.	Inspection Item		Specified Value or Tolerance	Method and frequency
1	Offset from axis (mm)	OpenCulvert	≤20	By total Station: 5 points on centerline
		Buried Culvert	≤50	
2	Levels of water flow (mm)		±20	By level: 5 points, at midpoint, 1/4 and 3/4 points and both inlet and outlet of a culvert
3	Thickness of bedding (mm)		+40, −10	By tape measure: 5 points
4	Length (mm)		+100, −50	By tape measure: along centerline
5	Span orInner Diameter (mm)	Corrugated Steel Pipe Culvert	±2%D	By tape measure: 1 point in every 5m but not less than 3 points in total, each in both vertical and horizontal directions
		Others	±30	By tape measure: 5 points
6	Height clearance (mm)	Open Culvert	≥Design Value-20	By tape measure: 3 pointsrespectively at inlet, midpoint and outlet
		Buried Culvert	≥ Design Value -50	

Note: 1. D refers to the diameter of a pipe culvert, in mm for both specified values and tolerances.
2. Inspection is not required for the item not involved in a real project.
3. Open culvert originally refer to a road-crossing ditch or trench with or without cover slabs on top; nowadays it refers to the culvert that pavement is placed directly on top of them without earthwork backfill in between, which is usually used in low embankment or cutting sections. A buried culvert is the culvert with earthwork backfill and pavement on top it, which is popularly seen in a high embankment section.

9.2.3 The appearance of a culvert in general shall conform to the following requirements:

1 Construction wastes or debris shall not remain in a culvert. No impediment to water flow shall exit at the inlet and outlet of a culvert, inside culvert and at the connections to drainage ditches or trenches.

2 No depressions or slope insufficiency shall exist in the slope protection of cone-shaped embankment at culvert ends.

9.3 Culvert Abutment

9.3.1 A culvert abutment shall conform to the basic requirements as follows:

1 The ground bearing capacity and the embedded depth of a foundation shall conform to the design requirements.

2 A settlement joint shall be in a vertical alignment all through the abutment, and shall be filled densely and seamlessly.

3 Masonry blocks shall be placed in stagger and tightly on and against each other. The inter-block joints shall be fully filled with mortar and calking materials.

4 The strength of mortar for joint pointing shall be not lower than the strength of mortar for pitching.

9.3.2 The measurement items for a culvert abutment shall conform to the criteria in Table 9.3.2.

Table 9.3.2 Measurement items for Culvert Abutment

No.	Inspection Items		Specified value & Tolerance	Method and frequency
1△	Strength of Concrete orMortar (MPa)		Within the required range	According to Appendix D or F
2	Size of Cross-section (mm)	Rubble Masonry	±20	By tape measure: 3 cross-sections
		Concrete	±15	
3	Verticality (mm)		≤0.3%H	By plumbing: 3cross-sections
4	Elevation of top surface (mm)		±10	By level: 5 points

Notes: H refers to the height of an abutment, in mm for both specified value and tolerance.

9.3.3 Appearance of a culvert abutment shall conform to the following requirements:

1 The limited defects as listed in Appendix P shall not exist on the surfaces of concrete.

2 Accumulative converted-area of masonry cracking, loose pointing, and peeling off shall not exceed 1.5% of the whole surface area, and any single converted-area of defects shall not be larger than $0.04m^2$. Any non-stress crack in a masonry joint, which is longer than the width of a block or wider than 0.5mm, shall not exist. The conversion area shall be calculated by multiplying the length of a crack by 0.1m.

3 Hollows, wide cracks, gaps filling with large amount of mortar or dummy joints should not exist in masonry joints.

9.4 Installation of Concrete Culvert Pipes

9.4.1 The installation of concrete culvert pipes shall conform to the basic requirements as follows.

1 The ground bearing capacity shall conform to the design requirements. The culvert pipes should be placed firmly and stably on the base slab, pipe bed or foundation.

2 The filling of an inter-segment junction or a settlement joint shall be sufficient with smooth surface.

3 Cracked or damaged culvert pipes must not be installed.

4 A settlement joint in culvert base shall be positioned at the same plane of an inter-segment joint with no stagger.

5 Any culvert pipe segment must not have a reversed bottom slope.

6 Leakage tests shall be conducted to the inverted siphon culverts with requirement for leak proofing. The amount of leakage shall satisfy the criteria in relevant technical specifications.

9.4.2 The measurement items for installation of concrete culvert pipes shall conform to the criteria in Table 9.4.2.

Table 9.4.2 Measurement items for Installation of Concrete Culvert Pipes

<table>
<tr><th>No.</th><th colspan="2">InspectionItems</th><th>Specified Value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="2">Strength of concrete ofculvert base or bedding(MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td>2</td><td colspan="2">Width anddepth of culvert base or bedding (mm)</td><td>≥Design Values</td><td>By tape measure: 5 cross-sections</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Faulting at bottoms of adjacent segments (mm)</td><td>Diameter≤1m</td><td>≤3</td><td rowspan="2">By steel ruler: takemax. value at five joints</td></tr>
<tr><td>Diameter >1m</td><td>≤5</td></tr>
</table>

9.4.3 The appearance of installed concrete culvert pipes shall conform to the following requirements:

1 Repetitive bends or folds shall not exist in the alignment of a pipe culvert.

2 Peeling-off, gaping, bulging, or cracks wider than 0.5mm shall not exist in any joint.

9.5 Fabrication ofcover slabs

9.5.1 The fabrication of cover slabs shall conform to the basic requirements as follows:

1 A slab joint shall be placed in the same plane of a settlement joint.

2 The Strength of concrete of a cover slab shall not be lower than the required strength for hoisting when it is moved out from prefabrication base.

9.5.2 The measurement items for fabrication of cover slabs shall conform to the criteria in Table 9.5.2.

Table 9.5.2 Measurement items for Fabrication of Cover Slabs

<table>
<tr><th>No.</th><th colspan="2">Inspection Items</th><th>Specified Value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1△</td><td colspan="2">Strength of concrete (MPa)</td><td>Within the required range</td><td>According to Appendix D</td></tr>
<tr><td rowspan="2">2△</td><td rowspan="2">Height (mm)</td><td>OpenCulvert</td><td>+10,0</td><td rowspan="4">By tape measure: 30%, but not less than 3 slabs, check 2 cross-sections on each slab.</td></tr>
<tr><td>Buried Culvert</td><td>≥Design Value</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Width (mm)</td><td>Cast-in-place</td><td>±20</td></tr>
<tr><td>Precast</td><td>±10</td></tr>
<tr><td>4</td><td>Length (mm)</td><td colspan="2">+10, −20</td><td>By tape measure: 30%, but not less than 3 slabs, two sides on each slab.</td></tr>
</table>

9.5.3 Appearance of fabricated cover slabs shall conform to the following requirements:

1 The defects as listed in Appendix P shall not exist on the surface of concrete.

2 Construction wastes, debris or temporarily pre-embedded parts shall not exist.

9.6 Installation ofcover slabs

9.6.1 The installation of cover slabs shall conform to the basic requirements as follows.

1 The cover slabs, culvert walls and supporting plats should be qualified by inspection.

2 The cover slabs should fully and seamlessly touch their supporting plats.

3 The type and performance of the materials for filling the joints between cover slabs shall conform to the design requirements. The joint filling should be dense and sufficient.

4 A settlement joint shall be matched by one of the inter-segment joints in the same plane.

9.6.2 The measurement items for the pre-fabrication of cover slabs shall conform to the criteria in Table 9.6.2.

Table 9.6.2 Measurement items for Installation of Cover Slabs

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1	Offset of center of supporting plat (mm)	≤10	By tape measure: 3 slabs for every culvert.
2	Max. leveldifference between the adjacent cover slabs (mm)	≤10	By tape measure: 20%, but not less than 6 slabs, measure the max. value of faulting at inter-segment joint

9.6.3 Appearance of installed cover slabsshall conform to the following requirements:

1 Shedding or cracks wider than 0.5mm shall not exist in the filling of joints.

2 Hoist holes forshall be filled sufficiently.

9.7 Installation of Corrugated Steel Pipe Culvert

9.7.1 The installation of a corrugated steel pipe culvertshall conform to the basic requirements as follows:

1 Any deformed pipe segments or plate components shall not be used in installation.

2 Ground treatment and ground bearing capacity shall conform to the design requirements. The pipe segments shall connect to ground foundation tightly and stably.

3 The inter-segment joints shall be filled sufficiently in a depth in compliance with design requirements and shall be free of water leaking.

4 Damaged coatings for the pipe sections or plates, and connection components should be remedied.

5 Every culvert pipe segment must not in reversed bottom slope.

9.7.2 The measurement items for installed corrugated steel pipe culverts shall conform to the criteria in Table 9.7.2.

Table 9.7.2 Measurement items for Installation of Corrugated Steel Pipe Culverts

No.	Inspection Items	Specified value & Tolerance	Method and frequency
1	Compaction ofground foundation	Conform to the design requirements	According to appendix B. One point in every 5m, but not less than 3 points.
2	Inner diameter of pipe(mm)	±1%D	By tape measure: 1 point in every 5m but not less than 3 points, each point in two directions at cross.
3	BottomElevation (mm)	±10	By level: 5 points: at inlet, outlet, midpoint, 1/4 and 3/4 points
4△	Torque onhigh-strength bolts	±10%	Bytorque wrench: 5% but at least 2 bolts
5	Field applied anti-corrosive coating	Conform to the design requirements	Every coat and whole coating surface

9.7.3 The appearance of an installed corrugated steel pipe culvert shall conform to the following requirements:

1 Repetitive bends or folds shall not exist in the alignment of a pipe culvert.

2 Coat missing, bubbling, or peeling off must not exist on field applied anti-corrosive coating.

9.8 Casting concrete box culverts

9.8.1 The concrete casting of box culverts shall conform to the basic requirements as listed in Item No. 1 of Clause 8.7.1 hereinabove and the ground capacity and embedding depth of foundation shall conform to the design requirements.

9.8.2 The measurement items for concrete casting for a box culvert shall conform to the criteria in Table 9.8.2.

Table 9.8.2 Measurement items for Cast in-place box Culverts

No.	Inspection Items		Specified Value & Tolerance	Method and frequency
1△	Strength of concrete (MPa)		Within the required range	According to Appendix D
2	Netheight and width (mm)	Height	+5, -10	By tape measure: 3 cross-sections
		Width	±30	
3△	Thickness oftop plate (mm)	Open Culvert	+10, 0	By tape measure: 5 points
		Buried Culvert	≥Design Values	
4	Thickness ofsidewall and base slab (mm)		≥Design Values	By tape measure: 5 points on every wall or slab
5	Flatness (mm)		≤8	2-m straight edge: 2 points on every side face in every 10m length, each in both vertical and horizontal directions

9.8.3 The appearance of a cast in-place box culvert shall satisfy the criteria in the Item No. 3 of Clause 8.7.1 hereinabove.

9.9 Concrete casting (or stone pitching) of Arch Culvert

9.9.1 The concrete casting or stone pitching of an arch culvert shall conform to the basic requirements stated in Clause 9.3.1.

9.9.2 The measurement items for concrete casting or stone pitching of an arch culvert shall conform to the criteria in Table 9.9.2.

Table 9.9.2 Measurement items forConcrete Casting or Masonry Arch Culverts

No.	Inspection Items		Specified Value & Tolerance	Method and frequency
1△	Strength ofconcrete or mortar (MPa)		Within the required range	According to Appendix D or F
2△	Thickness of arch ring (mm)	Masonry	+50, −20	By tape measure: 5 pointson sides at both arch springings, arch crown, 1/4 span and 3/4 span
		Concrete	+30, −15	
3	Deviation of intrados from designed arc (mm)		±20	By template: 3 points, at arch crown, 1/4 span and 3/4 span, measures both sides of each point

9.9.3 The appearance of concrete casting or stone pitching of an arch culvert shall conform to the criteria of Clause 9.3.3.

9.10 Masonry of Inverted Siphon Shafts and Catch Pits

9.10.1 Themasonry of shafts and catch pits of an inverted siphon shall conform to the basic requirements as follows:

1 The requirements for the masonry are the same as those in Clause 9.3.1.

2 Surface finishing shall be smooth and attached to the shaft walls tightly.

3 The shaft walls and joint fillings shall be smooth, sufficient and watertight.

4 Water filling tests should be conducted, and the testing results shall conform to the criteria of the relevant technical specifications.

Table 9.10.2 The Measurement items for Inverted Siphon Shafts andCatch pits

No.	Inspection Item		Specified Value & Tolerance	Method and frequency
1△	Strength of Mortar(MPa)		Within the required range	According to Appendix F
2△	Elevation (mm)	Bottomof shaft	±15	By level: 3 points on top and bottom each.
		Topof shaft	±20	
3	Diameter ofpipe shaft or side length of box shaft (mm)		±20	By tape measure: 2 cross-sections, or diameter in two directions at cross.
4	Thicknessof shaft wall and bottom slab (mm)		+20, −5	By tape measure: 8 points on walls, and 3 points at bottom of shaft

9.10.2 The measurement itemsfor inverted siphon shafts and catch pits shall conform to the criteria in Table 9.10.2.

9.10.3 The appearance of inverted siphon shafts and catch pits shall conform to the criteria as follows:

1 Construction wastes or debris must not exist inside of a shaft.

2 No peeling-off or bulging shall not exist on the surface finishing of shaft walls.

9.11 Straight-end walls andwing walls

9.11.1 The straight-end walls and wing wallsshall conform to the basic requirements as follows.

9.11.2 The measurement items for straight-end walls and wing wallsshall conformed to the criteria in Table 9.11.2.

Table 9.11.2 Measurement items for the Straight-end walls and Wing Walls

Item	Inspection Item	Specified value & Tolerance	Method and frequency
1△	Strength of Concrete or Mortar (MPa)	Within the required range	According to Appendix D or F
2	Plane Locations (mm)	≤50	By total station: 3 points on internal edges of top surface
3	Elevationof top surface (mm)	±20	By level: 3 points
4	Gradient (%)	≤0.5	By plumbing: 3 points along length
5△	Sizes of cross-section (mm)	≥Design Values	By tape measure: 2 cross-sections

9.11.3 The appearance of a straight end wall or a wing wall shall conform to the criteria in Clause 9.3.3.

9.12 Pipe-jacking culverts

9.12.1 Thepipe-jacking culverts shall conform to the basic requirements as follows.

1 The pipe-jacking can be carried out only after the strength of overall structures of a culvert conforms to design requirements.

2 The ground foundation should be well compacted and the bearing capacity shall conform to the design requirements.

3 The thrust wall of a thrust pit shall be able to provide adequate restraint for pipe-jacking. The axis of thrusts shall be in consistence with centerline of the culvert.

4 The watertight treatment shall be applied to inter-segment joints as required by the design.

5 Grouting of culvert walls shall conform to the design requirements.

9.12.2 The measurement items forpipe-jacking culverts shall conform to the criteria in Table 9.11.2.

Table 9.11.2 The Measurement items for Pipe-jacking Culvert

<table>
<tr><th>Items</th><th colspan="3">Inspection Items</th><th>Specified Value & Tolerance</th><th>Method and frequency</th></tr>
<tr><td rowspan="6">1</td><td rowspan="6">Offset from axis (mm)</td><td rowspan="2">Culvert length <15m</td><td>Box Culvert</td><td>≤100</td><td rowspan="6">By total station: at both endsof every segment</td></tr>
<tr><td>Pipe Culvert</td><td>≤50</td></tr>
<tr><td rowspan="2">Culvert length 15 ~ 30m</td><td>Box Culvert</td><td>≤150</td></tr>
<tr><td>Pipe Culvert</td><td>≤100</td></tr>
<tr><td rowspan="2">Culvert length >30m</td><td>Box Culvert</td><td>≤300</td></tr>
<tr><td>Pipe Culvert</td><td>≤200</td></tr>
<tr><td rowspan="6">2△</td><td rowspan="6">Level (mm)</td><td rowspan="2">Culvert length <15m</td><td>Box Culvert</td><td>+30, −100</td><td rowspan="6">By level: 5 points at bottom of every segment</td></tr>
<tr><td>Pipe Culvert</td><td>±20</td></tr>
<tr><td rowspan="2">Culvert length 15 ~ 30m</td><td>Box Culvert</td><td>+40, −150</td></tr>
<tr><td>Pipe Culvert</td><td>±40</td></tr>
<tr><td rowspan="2">Culvert length >30m</td><td>Box Culvert</td><td>+50, −200</td></tr>
<tr><td>Pipe Culvert</td><td>+50, −100</td></tr>
<tr><td rowspan="2">3</td><td colspan="2" rowspan="2">Level difference of adjacent culvert segments (mm)</td><td>Box Culvert</td><td>≤30</td><td rowspan="2">By ruler: taking max. value at every inter-segment joint</td></tr>
<tr><td>Pipe Culvert</td><td>≤20</td></tr>
</table>

Note: The fabrication and installation of a culvert shall be inspected according to the relevant criteria in these standards.

9.12.3 Appearance of apipe-jacking culvert shall conform to the following requirements:

1 Neither water flow nor traffic flow shall be hindered by the culvert pipes, the culvert inlet and outlet, or the ditches, trenches or any other waterways connecting to or from the culvert.

2 The limited defects of concrete as listed in Appendix P should not exist.

10 Tunnel works

10.1 General requirements

10.1.1 These standards are applicable tothe tunneling by drill-and-blast method.

10.1.2 Forthe tunnels using anchor-shotcrete lining or composite lining, the contractor shall keep complete data and charts derived by systematic monitoring and measurement.

10.1.3 The excavation ofa tunnel portal shall conform to the technical requirements for construction. The inspection tunnel portals, wing walls and portal-top slope protections shall be carried out in accordance with the relevant provisions in Chapter 6 herein above.

10.1.4 The inspection of the basecourse and surface course of pavement in a tunnel shall be carried out in accordance with the relevant provisions of Chapter 7 hereinabove.

10.1.5 The tunnelfitting-out and facilities shall conform to *GB*50210: *Standard for Construction Quality Acceptance of Building Decoration*.

10.2 Tunnel in general

10.2.1 A tunnel in general shall conform to the basic requirements as follows:

1 The intrados of tunnel lining and all operating facilities shall not intrude into the clearance profile of a tunnel.

2 The layout of a tunnel portal shall conform to the design requirements.

3 The drainage system inside and outside a tunnel shall conform to the design requirements.

4 The roof-arch, sidewalls, pavement and equipment cabinet adits in a tunnel on a Motorway, Class-1 highway or Class-2 highway shall be watertight without leaking. For the tunnel in a seasonally freezing area, there shall be no stagnant water behind the tunnel lining, no freezing in drainage ditches, no dipping in adits either for vehicle traffic or pedestrian, and no running water on sidewalls.

5 For the tunnels on a Class-3 or -4 highway, there shall be no dipping from roof-arch, no running water on sidewalls, no water ingress in equipment cabinet adits, and no ponding water on pavement surface. For those in a seasonally freezing area, there shall be no stagnant water behind tunnel lining and no freezing in drainage ditches.

10.2.2 The measurement items for tunnelin general shall conform to the criteria in Table 10.2.2.

Table 10.2.2 The measurement items for a tunnel in general

No.	Inspection items	Specified value or Tolerance	Methods and frequencies
1	Width oftraveled-way (mm)	±10	According to Appendix Qor by tape measure: one cross-section for every 20m on curve, or 40m on tangent
2	Width of intrados (mm)	Not less than design value	
3△	Height of intrados (mm)	Not less than design value	According to Appendix Q or by laser rangefinder: one cross-section in every 20m on curve, or every 40m on tangent, each measures 3 points at arch crown and both quarter points
4	Offset of tunnel(mm)	20	By total station: 1 point in every 20 m length on curve, or 40m on tangent
5	Gradient of side slope or portal-top slope	Not greater than the design value	By tape measure: check 10 places at each portal

10.2.3 The appearance ofa tunnel in general shall conform to the following requirements:

1 There shall be no potential falling rocks on the sloped besides and above a tunnel portal.

2 The drainage system shall not be silted up or clogged.

10.3 Concrete casting for cut-and-cover tunnels

10.3.1 Concrete casting for a cut-and fill tunnel shall conform to the basic requirements as follows:

1 The ground bearing capacity shall conform to the design requirements and construction specifications. Any overbreak must not be backfilled with loose materials.

2 The processing and installation of steel bars shall conform to the design requirements.

3 The interface between the cut-and-cover section and underground section of a tunnel shall conform to the design requirements.

4 The settlement joint between the cut-and-cover tunnel section and underground tunnel section shall conform to the design requirements.

10.3.2 The measurement items for acut-and-cover tunnel shall conform to the criteria in Table 10.3.2.

Table 10.3.2 The measurement items for cut-and-cover tunnel

No.	Inspection item	Specified value or Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2△	Thickness of concrete (mm)	Not less than design value	According to Appendix Ror by tape measure: one cross-section in every 10m, and 5 points of each at arch crown, both springings and on both sidewalls.
3	Wall flatness(mm)	20 at construction joints or deformation joints	By2-m straight edge: 2 successive measures in every 10m length of sidewall, taking the max. value of gap
		5 for other parts	

10.3.3 Appearance of a cut-and-cover tunnel shall conform to the following requirements:

1 The area of honeycomb and bugholes must not exceed 0.5% of total area of concrete surface, and the depth must not exceed 10mm.

2 The cracks in reinforced concrete structures of tunnel lining must not be wider than

0.2mm.

10.4 The waterproofing layer on cut-and-cover tunnel

10.4.1 A water proofing layer on a cut-and-cover tunnel shall conform to the basic requirements as follows:

1 Before laying a water proofing layer, the exterior concrete surfaces of a cut-and-cover tunnel shall be smooth, rounded, and free of extruding steel bars or any other sharp objects.

10.4.2 The measurement items for water proofing layer on a cut-and-cover tunnel shall conform to the criteria in Table 10.4.2.

Table 10.4.2 The measurement items for water proofing layer on cut-and-cover tunnels

Item	Inspection items		Specified value or Tolerance	Methods and frequencies
1△	Length of overlap (mm)		≥100	By tape measure: 3 pointson every ring of overlapping joint
2	The lengthof water proofing layer extended into underground section of tunnel (mm)		≥500	By tape measure: 3 points
3	Thelength of water proofing layer extended laterally into ground foundation (mm)		≥500	By tape measure: 3 points
4△	Width of joint (mm)	Hot melting	Weld width≥10	By tape measure: test 1 ring for each lining platform car, and 5 points for each ring of overlapping joint
		Glue bonding	The width of a bonded seam ≥50	
5△	Water tightness of hot melting		Conform to the design requirements	According to Appendix S: one point in every 10m of hot melt seam

10.4.3 The appearance of water proofing layer on a cut-and-cover tunnel shall conform to the following requirements:

1 The waterproof material shall be free of damages, folds and wrinkles.

2 Hot melting shall be free of loose melting, melting gaps, false melting, burnt-off, or burnt holes. The glue-bonding shall be free of loose bonding and bonding gaps.

10.5 Backfillto cut-and-cover tunnel

10.5.1 Backfillto a cut-and-cover tunnel shall conform to the basic requirements as follows.

1 The concrete strength of a roof-arch shall not be less than 75% of designed strength during manual backfilling. The backfilling by machines shall be carried out after not only the strength of concrete of roof arch rings reaches the design strength, but also the backfill at both sides the arch ring, which is labor tamped, is not less than 1.0m high above the arch springings.

2 Backfilling behind sidewalls shall be carried out symmetrically and simultaneously on both sides.

3 A water proofing layer of clay material for a cut-and-cover tunnel shall be well connected to side slopes and portal top slope with sufficient overlaps and tight seals.

10.5.2 The measurement items for backfill to a cut-and-cover tunnel shall conform to the criteria in Table 10.5.2.

Table 10.5.2 The measurement items for backfill to cut-and-cover tunnel

Item	Inspection item	Specified value or Tolerance	Method and frequency
1	Compaction of backfill	Conform to the design requirements	By tape measure: thickness and number of rolling passes
2	Thickness of each backfill layer (mm)	≤300	By tape measure: 5 points on every layer at each side
3	Height difference of backfilling at both sides (mm)	≤500	By level: 3 points on every layer at each side
4	Slope	Conform to the design requirements	By tape measure: 3 points
5	Backfilling thickness (mm)	Not less than design value	By level: 5 points ontop surface of backfill above the arch

10.5.3 The appearance of backfillto a cut-and-cover tunnel shall conform to the following provision:

1 There shall be no stagnant water on backfill slopes.

10.6 Excavation for tunnel tube

10.6.1 The excavationfor a tunnel tube shall conform to the basic requirements as follows:

1 Pre-reinforcement and pre-supporting shall be provided before excavation in the case of poor self-stabilization of the surrounding rock mass.

2 In the area around tunnel location where geology varies or approaches to a dividing line of different rock masses, the tunnel excavation shall not proceed before the geologic and hydrogeological conditions are explored and confirmed by geologic radar, advance trial pits, advance drilling or other effective methods.

3 The profile of excavation shall allow for the amount of expected deformation, which shall be adjusted from time to time according to the feedback of survey and measurement.

4 Controlled blasting technology shall be adopted in order to minimize the disturbance of excavation to surrounding rock mass.

5 Underbreak shall be strictly limited. No underbreak is allowed within the range of 1m above arch springings and wall toes. Where the rock quality is hard, solid and integral, and the compressive strength of the rock is greater than 30MPa with no negative impact on the stability and strength of lining structures, an individual part of rock may be allowed as long as the intrusion is less than 0.1m^2 in every 1 m^2 of cross-section of lining structure. The depth of an underbreak must not be more than 30mm for shotcrete lining, or 50mm for ordinary lining.

6 During the excavation of a tunnel, initial shotcreting support shall be timely applied after loose rocks are removed.

10.6.2 The measurement items for tunneling shall conform to the criteria in Table 10.6.2.

Table 10.6.2 The measurement items for tunnel excavation

<table>
<tr><th>No.</th><th colspan="2">Inspection item</th><th>Specified value or Tolerance</th><th>Method and Frequency</th></tr>
<tr><td rowspan="3">1△</td><td rowspan="3">Overbreak at roof-arch (mm)</td><td>Rock mass Grade-I (Hard rock)</td><td>Ave. 100, max. 200</td><td rowspan="5">According to appendix Q or by total station: 1 cross-section in every 20m length; and each cross-section to check 1 point in every 2m from arch crown.</td></tr>
<tr><td>Rock mass Grade-II, -III and-IV (Medium hard rock and soft rock)</td><td>Ave. 150, max. 250</td></tr>
<tr><td>Rock mass Grade-V and -VI (fractured rock, soil)</td><td>Ave. 100, max. 150</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Overbreak at sidewall (mm)</td><td>Each side</td><td>+100,0</td></tr>
<tr><td>Full width</td><td>+200,0</td></tr>
<tr><td>3</td><td colspan="2">Overbreak at arch invert and the bottom of tunnel (mm)</td><td>Ave. 100, max. 250</td><td>By level:3 points in every 20m</td></tr>
</table>

10.6.3 The appearance of tunnel excavation shall conform to the following requirements:

1 No loose rocks shall exist on the roof of a tunnel.

10.7 Shotcreting

10.7.1 Shotcreting shall conform to the basic requirements as follows:

1 The quality of the excavated cross-sections, the treatment of overbreaks and underbreaks and the treatment of water ingress and infiltration on rock mass surface shall conform to construction specifications, and the receiving rock surface shall be clean.

2 Shotcrete shall be closely bonded to the surface of rock mass and free of voids or pockets. There shall be no other materials such as rubbles or wood planks in shotcrete layer. Shotcreting with formwork is strictly forbidden.

3 The spacing between steel frames and rock mass shall be fully and densely filled with shotcrete.

4 The surface flatness of shotcrete shall conform to the technical specifications for construction.

10.7.2 The measurement items for shotcrete shall conform to the criteria in Table 10.7.2.

Table10.7.2 The measurement items for shotcrete

No.	Inspection item	Specified value or Tolerance	Method and Frequency
1△	Strength of shotcrete (MPa)	Within the required range	According to Appendix E
2	Thickness of shotcrete lining (mm)	Average thickness ≥ Design thickness; The thickness of 60% of inspected points ≥ design thickness; Min. thickness ≥ 0.6 Design thickness	By drilling method: 1 cross-section in every 10m, each cross-section is measured 1 point in every 3m from centerline of arch crown, or According to Appendix R: along 5 longitudinal lines at arch crown, both quarter points of the arch, and both sidewalls in every 10m, and 5 points on each cross-section.
3△	Bonding between shotcrete and rock mass	No holes, no sundries.	

10.7.3 The appearance of shotcrete shall conform to the following provision:

1 Noleak spray, segregation, bulging, or steel exposure shall exist on surface of shotcrete.

10.8 Rock bolts

10.8.1 Rock bolts shall conform to the basic requirements as follows:

1 The length of a rock bolt shall not be less than the designed length. The length inserted into anchor hole of a rock bolt shall not be less than 95% of the designed length.

2 The strength of mortar or grout injected in a rock bolt shall not be less than the value as designed and required by specifications. The grout in a rock bolt hole shall be dense and full.

3 The number, length and entry angles of tieback bolts (pipes) shall conform to the design requirements.

10.8.2 The measurement items for rock bolts shall conform to the criteria in Table 10.8.2.

Table10.8.2 The measurement items for the anchor bolt

No.	Inspection items	Specified value or Tolerance	Method and Frequency
1△	Quantity (Nos.)	Not less than designed quantity	By visual: count in-place one by one
2△	Pull-off resistance of rock bolt (kN)	Average pull-off force at 28d ≥ designed value, and Min. pull-off force ≥ 0.9 design value	By pull-off gauge: 1%, but not less than 3 bolts.

continued

No.	Inspection items	Specified value or Tolerance	Method and Frequency
3	Hole position (mm)	±150	By tape measure: 10%
4	Hole depth (mm)	±50	By tape measure: 10%
5	Hole diameter(mm)	⩾Diameter of anchorbolt +15	By tape measure: 10%

10.8.3 The appearance of rock bolts shall conform to the following provision:

1 There shall be no gap between the cushion plate of a rock bolt and the surface of rock mass.

10.9 Steel fabric

10.9.1 Steel fabrics shall conform to the basic requirement as follows:

1 The Steel fabrics shall be placed after initial lining of shotcrete.

10.9.2 The measurement items for steel fabrics shall conform to the criteria in Table 10.9.2.

Table10.9.2 The measurement items for Steel fabrics

No.	Inspection item	Specified value or Tolerance	Method and Frequency
1	Thickness of shotcrete cover on steel mesh (mm)	⩾20	By drilling method: 5 points in every 10m
2△	Grid size (mm)	±10	By tape measure: 3 mesheyes in every $100m^2$ of Steel fabrics
3	Length of overlap (mm)	⩾50	By tape measure:3 points in every 20m

10.9.3 The appearance of steel fabrics shall conform to the following provisions:

1 No loose connections of steel fabrics to rock bolts or other fixed members shall exist.

10.10 Steel frame

10.10.1 Steel frames shall conform to the basic requirements as follows:

1 Steel frames shall be connected by longitudinal reinforcing steel bars and installed firmly on

stable bases.

2 Where an installation base is not high enough for the steel frame, stone pieces or crushed stones are not allowed to use. Steel plates shall be provided or concrete cushions with a strength level not less than C20 shall be applied.

3 The steel frames shall be installed closely against the surfaces for initial lining by shotcrete.

4 The connecting steel plates shall be firmly welded onto the steel frames. The steel plates for connecting the steel frame segments shall be bolted tightly or welded firmly.

10.10.2 The measurement items for steel frames shall conform to the criteria in Table 10.10.2.

Table10.10.2 Measurement items for steel frames

<table>
<tr><th>No.</th><th colspan="2">Inspection items</th><th>Specified value or Tolerance</th><th>Method and Frequency</th></tr>
<tr><td>1△</td><td colspan="2">Number offrames</td><td>Not less than the design value</td><td>By visual inspection or inspection according to appendix R: one-by-one inspection</td></tr>
<tr><td>2△</td><td colspan="2">Spacing (mm)</td><td>±50</td><td>According to Appendix R or by tape measure: every frame</td></tr>
<tr><td>3</td><td colspan="2">Thickness of shotcrete protective cover (mm)</td><td>Outside protective layer ⩾ 40.
Inner protective layer ⩾ 20</td><td>By drilling method: 5 points in every 20m</td></tr>
<tr><td>4</td><td colspan="2">Inclination (°)</td><td>±2</td><td>By plumbing: every fame</td></tr>
<tr><td>5</td><td colspan="2">Assemblyoffset (mm)</td><td>±3</td><td>By tape measure: every frame</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">Installationerror (mm)</td><td>Lateral</td><td>±50</td><td rowspan="2">By ruler andlevel: every frame</td></tr>
<tr><td>Vertical</td><td>Not lower than the designvalue</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Connecting steel bar</td><td>Quantity</td><td>Not less than the design value</td><td>By visual inspection: every frame</td></tr>
<tr><td>Spacing (mm)</td><td>±50</td><td>By tape measure: 3 points on every frame</td></tr>
</table>

Note: 'inside' refers to the side of a steel frame facing the opening of a tunnel, 'outside' facing to tunnel wall.

10.10.3 The appearance of a steel frame shall conform to the following provisions:

1 No false welding or welding gaps shall exist. The base shall be free of slags or sundries.

10.11 Arch invert

10.11.1 The arch invert shall conform to the basic requirements as follows:

1 The ground bearing capacity of an arch invert shall conform to the design requirements.

2 No loose soil or slags is allowed to backfill the overbreak beneath an arch invert.

3 Any stagnant water, sundries and rubble shall be removed before the concrete casting of an arch invert.

4 The curvature of an arch invert and the connections of an arch invert to the sidewalls shall conform to design requirements and construction specifications.

10.11.2 The measurement items for an arch invert shall conform to the criteria in Table 10.11.2.

Table10.11.2 The measurement items for arch invert

No.	Inspection items	Specified value or Tolerance	Method and Frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2△	Thickness (mm)	Not less than design value	By tape measure: 1 cross-section in every 20m, 5 points on each cross-section
3	Cover thickness of steel bar (mm)	+10, −5	By tape measure: 5 points in every 20m
4	Elevation of bottom (mm)	±15	By level:5 points in every 20m

10.11.3 The appearance of an arch invert shall conform to the following requirement:

1 No reinforcing steels shall be exposed on the surface of concrete.

10.12 Concrete backfill to arch invert

10.12.1 The concrete backfill to an arch invert shall conform to the basic requirements as follows:

1 There shall be no ponding water or sundries on the surface of an arch invert before concrete backfilling.

2 The concrete backfilling shall not be carried out before the concrete strength of an arch invert reaches 70% of designed strength.

10.12.2 The measurement items for concrete backfilling to an arch invert shall conform to the criteria in Table 10.12.2.

Table10. 12. 2　The measurement items for backfilling to arch invert

No.	Inspection items	Specified value or Tolerance	Method and Frequency
1△	Strength of concrete(MPa)	Within the required range	According to Appendix D
2	Elevation on top surface (mm)	±10	By level: 5 points per 20m

10. 12. 3　The appearance of concrete backfill to an arch invert shall conform to the following requirement:

1　There shall be no cracking on the surface of concrete backfill to an arch invert.

10. 13　Reinforcingsteel in lining

10. 13. 1　The reinforcing steels in tunnel lining shall conform to the basic requirements as follows:

1　The splicing methods and the splicing area in a specific connection zone shall conform to the design requirements. A steel bar splice shall be placed in a position where the stresses are comparatively small.

2　The length of a lap splice, and the quality of a welded or mechanical splice shall conform to the requirements of construction specifications.

3　The quantities of reinforcing steels as specified by design shall be ensured during the installation of.

4　Load-bearing steel bars shall be straight with no cracks and other damages on their surface.

5　The concrete spacers shall be evenly distributed. The quantity and material properties shall conform to the requirements of design and relevant specifications.

6　Multi-layer steel fabrics shall be supported by sufficient stirrups in order to provide the steel cages with sufficient stiffness and to prevent from displacement during concreting.

10. 13. 2　The measurement items for steel bars in tunnel lining shall conform to the criteria in Table 10. 13. 2.

Table10.13.2 The measurement items for steel bars in lining

No.	Inspection item	Specified value or Tolerance	Method and Frequency
1△	Spacing of main rebars (mm)	±10	According to Appendix Ror by tape measure: 3 points on every segment of shuttering
2	Spacingbetween adjacent rebar layers (mm)	±5	By tape measure: 3 points for every segment of shuttering
3	Spacingbetween adjacent stirrups (mm)	±20	By tape measure: 3 points for every segment of shuttering
4	Length of rebar(mm)	Conform to the design requirements	By tape measure: Check 2 barsfor every segment of shuttering
5	Thickness ofconcrete cover (mm)	+10, −5	By tape measure: 3 points for every segment of shuttering

10.13.3 The appearance of steel bars in lining shall conform to the following provisions:

1 No rust particles or scales, and no welding slag or burns shall exist on the surface of steel bars. Steel fabrics or reinforcing cages, either wire-tied or welded, shall not be loose or disconnected.

2 No crack is allowed in welded splices or coupling sleeves.

10.14 Concrete lining

10.14.1 Concrete lining shall conform to the basic requirements as follows:

1 Anyvoids behind the initial support shall be remedied and any intrusion into the clearance profile shall be corrected before the construction of lining.

2 Any empty pockets behindthe lining shall be filled by grouting.

10.14.2 The measurement items for concrete lining shall conform to the criteria in Table 10.14.2.

Table10.14.2 Measurement items for concrete lining

No.	Inspection item	Specified value or Tolerance	Method and frequency
1△	Strength of concrete(MPa)	Within the required range	According to Appendix D
2	Thickness of lining (mm)	Thickness at 90% of check points ≥ design thickness, and min. thickness ≥ 0.5 design thickness	By tape measure: 1 cross-section in every 20 m, and 5 points on each cross-section; or according to Appendix R: along 5 longitudinal lines at arch crown, both quarter points of the arch and both sidewalls, 1 cross-section in every 20 m and 5 points in each
3	Flatness of wall surface (mm)	At construction joint or deformation joint ≤ 20	By2-m straight edge: successive 5 measures on each side in every 20m, taking max. gap in each measure
		At other position ≤5	
4△	Compaction condition on the back of lining	No holes, no sundries.	According to Appendix R: along 5 longitudinal lines at arch crown, both springings and both sidewalls.

10.14.3 The appearance of concrete lining shall conform to the following provisions:

1 The area of surface defects such as honeycombs and bugholes shall not exceed 0.5% of the total surface area. The depth of any surface defect shall not exceed 10mm.

2 The width of any crack in tunnel lining shall not exceed 0.2mm for reinforced concrete structure, or 0.4mm for concrete structure.

10.15 Water proofing layer

10.15.1 Water proofing layer shall conform to the basic requirements as follows:

1 The shotcrete surfaces, before being laid with waterproof materials, shall be free of sharp protrusions such as exposed steel bars or pipe fittings.

2 The inner corner at a tunnel cross-section transition or at a turning shall be rounded to a curved surface in a radius not less than 50mm.

3 There shall be no surface water on the surface to be laid with water proofing layer during construction of waterproofing.

10.15.2 The measurement items for a water proofing layer shall conform to the criteria in

Table 10.15.2.

Table10.15.2 The measurement items for water proofing layer

No.	Inspection item		Specified value or Tolerance	Method and frequency
1△	Overlap length (mm)		≥100	By tape measure: 3 in every 5 rings of overlapped joints.
2△	Seam width (mm)	Hot-melting	Weld width≥10	By tape measure: 3 in every 5 rings of overlapped joints
		Glue-bonding	Adhesive seam width≥50	
3	Spacing of fixed points (m)		Conform to the design requirements	By tape measure: 3 placesin every 20m
4	Density ofhot-melting		Conform to the design requirements	According to Appendix S: 1 hot-melting seam in every 20m

10.15.3 The appearance of a water proofing layer shall conform to the following provisions:

1 The surface of a water proofing layer shall be free of wrinkling, bubbling, damaging and tight stretching.

2 Welding shall be free of de-welding, gaped welding, false welding, welding burnt and welding penetration. The bonding connections shall be free of de-connecting or gapped connection.

10.16 Waterstop

10.16.1 Waterstops shall conform to the basic requirement as follows:

1 A waterstop shall be placed at right angle to the shuttering of lining ends.

10.16.2 The measurement items for waterstops shall conform to the criteria in Table 10.16.2.

Table10.16.2 Measurement items for the waterstop

Item	Inspection items	Specified value or Tolerance	Method and frequency
1	Longitudinaloffset (mm)	±50	By tape measure: 1 ring of waterstop for every lining platform vehicle, test 3 points on each ring
2	Offset fromcenterline of lining (mm)	≤30	By tape measure: 1 ring of waterstop for every lining platform vehicle, test 3 points on each ring
3△	Spacing of fixed points (mm)	±50	By tape measure:3 points of waterstop on every ring by every lining platform vehicle

10.16.3 The appearance of waterstops shall conform to the following requirements:

1 A waterstop shall not be loose or twisted.

2 The joints of a waterstop shall be free of cracking and disconnecting.

10.17 Drainage

10.17.1 Drainage shall conform to the basic requirements as follows:

1 The material and specifications of longitudinal drainage pipe, transverse drainage pipe and circumferential drainage pipe of a tunnel shall conform to the design requirements.

2 The spacing between transverse drains and circumferential drains shall conform to the design requirements.

3 The slope of the longitudinal drainage pipes and the base of a central trench (or pipe) shall conform to the design requirements.

4 The overall alignment of drainpipes shall be smooth, and the joints must not be loose.

5 Upon the completion of waterproofing and drainage works, all construction wastes shall be removed from the drainage system, the drainage pipelines shall be cleaned in time, and water flushing and discharging tests shall be conducted.

10.17.2 The measurement items for drainage ditches (pipes) shall conform to the criteria in Table 10.17.2

Table10.17.2 Measurement items for drainage ditches (pipes)

No.	Inspection item	Specified value or Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Offset from axis (mm)	15	By total station: 1 point in every 10m
3	Size of cross-section or pipe diameter (mm)	±10	By tape measure: 1 point in every 10m
4△	Thickness of pipe wall (mm)	Not less than design value	By tape measure: 1 point in every 10m
5	Level at trench bottom (mm)	±20	By level: 1 point in every 10m
6△	Longitudinalgradient	Conform to the design requirements	By level: 1 point in every 10m
7	Thickness of base (mm)	Not less than design value	By tape measure: 1 point in every 10m

10.17.3 The appearance of drainage works shall conform to the following provision:

1 The cover slabs shall be neither loose nor damaged.

10.18 Advance rock bolts

10.18.1 The advance rock bolts shall conform to the basic requirements as follows:

1 The entry angle of advance a rock bolt shall conform to the design requirements and the construction specifications.

2 The horizontal lap length of the two longitudinal rows of advance rock bolts shall not be less than 1m.

3 The grouting mortar shall be fully and densely filled into rock bolt holes.

10.18.2 The measurement items for advance anchor bolts shall conform to the criteria in Table 10.18.2.

Table10.18.2 Measurement items for advance rock bolt

No.	Inspection item	Specified value or Tolerance	Method and frequency
1	Length (mm)	Not less than design value	By tape measure;every bolt
2	Quantity (unit)	Not less than design value	By visual: count every bolt
3	Position of hole (mm)	±50	By tape measure: 5holes in every 5 rings
4	Depth of hole (mm)	±50	By tape measure: 5holes in every 5 rings
5	Diameter of hole(mm)	⩾40	By tape measure: 5holes in every 5 rings

10.18.3 The appearance of an advance rock bolt shall conform to the following provision:

1 There shall be no false welding or welding gaps in the connections of the end of rock bolts to steel frames.

10.19 Acvance tremie

10.19.1 The acvance tremies shall conform to the basic requirements as follows:

1 The strength and mix of grout, the grouting pressure and grouted amount of acvance tremies shall conform to the design requirements. The steel pipes and the surrounding voids shall be full filled with grout slurry.

2 The entry angle of an acvance tremie shall conform to the requirements of design and construction specifications.

3 The horizontal lap lengths of two groups of longitudinal steel pipes shall not be less than 1m.

10.19.2 The measurement items for acvance tremies shall conform to the criteria in Table 10.19.2.

Table10.19.2 Measurement items for acvance tremie

No.	Inspection items	Specified value or Tolerance	Method and frequency
1	Length(mm)	Not less than design value	By tape measure: every pipe
2	Quantity (unit)	Not less than design value	By visual: count on site
3	Position of hole site(mm)	±50	By tape measure: 5 pipes in every 5 rings of tremies
4	Depth of hole (mm)	Greater than designlength of steel pipe	By tape measure: 5 pipes in every 5 rings of tremies

10.19.3 The appearance of an acvance tremie shall conform to the following requirements:

1 There shall be no false welding or gaped welding in the end connections of a steel pipes to the steel frame.

10.20 Pipe roofing

10.20.1 Pipe roofing shall conform to the basic requirements as follows:

1 The strength and mix of grout, the grouting pressure and grouted amount of a pipe roofing shall conform to the design requirements.

2 The ground bearing capacity of a pipe roofing shall conform to the design requirements and relevant construction specifications.

3 The entry angle of the advance steel pipes shall conform to the design requirements and

relevant construction specifications.

4 The length of horizontal overlaps in longitudinal direction between two groups of pipe roofing shall not be less than 3m.

10.20.2 The measurement items for pipe roofing shall conform to the criteria in Table 10.20.2.

Table10.20.2 Measurement items for pipe roofing

No.	Inspection items	Specified value or Tolerance	Method and frequency
1	Length (mm)	Not less than the design value	By tape measure: every pipe
2	Quantity (piece)	Not less than the design value	By visual: count on site
3	Position of hole (mm)	±50	By tape measure: 10 pipes in every ring of pipe roofing
4	Depth of hole (mm)	Greater than the design value of steel pipe length	By tape measure: 10 pipes in every ring of pipe roofing

10.20.3 The appearance of pipe roofing shall conform to the following requirements:

1 There shall be no false welding or gaped welding in the connection of the steel pipes to the steel frames.

11 Traffic Control Devices

11.1 General

11.1.1 Traffic control devices shall be qualified by product verification, and may be put into operation after conformity to design is confirmed by on-site inspection and verification.

11.1.2 Where steel materials are used in traffic control devices, anticorrosion treatment shall be processed. An anticorrosive layer shall conform to the design requirements.

11.1.3 The inspection andverification of bridge barriers shall be performed in accordance with the relevant provisions of Chapter 8 hereinabove.

11.1.4 Other traffic control devices, which are not included in this Chapter, may be inspected and verified in accordance with the standards specifically developed by referring the design documents and relevant specifications.

11.2 Traffic Signs

11.2.1 Traffic signs shall conform to the basic requirements asfollows:

1 The processing and manufacture of traffic signs shall conform to the provisions of the current *GB*5768: *Road Traffic Signs and Markings*, and *GB/T*23827: *Road Traffic Sign Boards and Support*

2 The front face of a signboard and the coating of metal components shall not be damaged

during transportation.

3 The placement and installation of traffic signs shall conform to the design requirements and the provisions of construction specifications.

4 Traffic signs and supporting parts shall be installed firmly. The strength of the concrete footing shall conform to the design requirements.

11.2.2 The measurement items for traffic signs shall conform to the criteria in Table 11.2.2.

Table 11.2.2 Measurement items for traffic signs

No.	Inspection items	Specified value or Tolerance	Inspection method and frequency
1△	Coefficient of retro-reflection of front face of sign board ($cd \cdot lx^{-1} \cdot m^{-2}$)	Conform to the design requirements	By retro-reflecting coefficient tester: 3 points for each color of every signboard.
2	The clearance height between the lower edge of the sign board and road surface (mm)	+100,0	By theodolite, total station or tape measure: 2 points for each board
3	Distance from the most-right edge of a sign structure to the edge line of right earth shoulder (mm)	Conform to the design requirements	By tape measure: 1 point at each location
4	Sign post verticality (mm/m)	3	By plumbing: 2points for every post
5	Evennessof top surface of foundation	4	Byruler: Maximum gap in diagonal directions, 2points for each foundation
6	Size of signboard foundation	+100, −50	By tape measure:2 pointseach for length and width of every foundation

11.2.3 The appearance of a traffic sign shall conform to the following requirements:

1 There shall be no damage to the coating of a traffic sign or its metal components.

11.3 Road Marking

11.3.1 Road marking shall conform to the basic requirements as follows:

1 Road surface shall be clean, dry and free of dust before the road marking is applied.

2 The coating materials for road marking shall conform to the provisions in the current *JT/*

*T*280: *Pavement Marking Paint* and *GB/T* 24722: *Glass Beads for Road Markings*. Skid-resistant coating products shall conform to the provisions of the current *JT/T* 712: *Pavement Antiskid Paint*.

3 The colors, shapes and position of road markings shall conform to the provisions of the current *GB*5768: *Road Traffic Signs and Markings* and conform to the design requirements.

4 Glass beads of a reflective marking shall be spread uniformly with no blistering or peeling off after applying.

11.3.2 Measurement items for road markings shall conform to the criteria in Table 11.3.2:

Table11.3.2 Measurement items for road marking

No.	Inspection Items			Specified value or Tolerance	Method and frequency
1	Length of a marking segment (mm)	6000		±30	By tape measure: 3 placesin every 1 kilometer, and 3 marks at each place
		4000		±20	
		3000		±15	
		2000		±10	
		1000		±10	
2	Width of a marking segment (mm)			+5,0	By tape measure: 3 placesin every 1 kilometer, and 3 points at each place
3△	Thickness of a marking segment (Dry Film, mm)	Solvent type		Not less than the design value	By marking thickness gauge or caliper: 3 places in every kilometer and 6 points in every place
		Thermoplastic type		+0.50,-0.10	
		Water soluble paint		Not less than the design value	
		Two component paint		Not less than the design value	
		Preformed marking stripe		Not less than the design value	
		Raised	Height raised	Not less than the design value	
			Baseline thickness	Not less than the design value	
4	Transverse offset of road marking (mm)			≤30	Bytape measure: 3 places in every kilometer and 3 points at each place
5	Longitudinal spacing ofroad markings(mm)	9000		±45	By tape measure: 3 places in every kilometer and 3 marks at each place
		6000		±30	
		4000		±20	
		3000		±15	

continued

No.	Inspection Items			Specified value or Tolerance		Method and frequency
6△	R_L Retro reflection luminance coefficient R_L (mcd·m^{-2}·lx^{-1})	Markings unreflectable on rainy night	Grade Ⅰ	White	≥150	By retro reflectometer: 3 places in every kilometer and 9 points at each place
				Yellow	≥100	
			Grade Ⅱ	White	≥250	
				Yellow	≥125	
			Grade Ⅲ	White	≥350	
				Yellow	≥150	
			Grade Ⅳ	White	≥450	
				Yellow	≥175	
		Markings reflectable on rainy night	Dry	White	≥350	By retro reflectometer: 3 places in every kilometer, and 9 points at each place
				Yellow	≥200	
			Moist	White	≥175	
				Yellow	≥100	
			Continuous Rainfall	White	≥75	
				Yellow	≥75	
		Façade reflective marker	Dry	White	≥400	
				Yellow	≥350	
			Moist	White	≥200	
				Yellow	≥175	
			Continuous Rainfall	White	≥100	
				Yellow	≥100	
7①	Skid-resistance value (BPN)	Slid-resistant marking		≥45		By British Pendulum Tester: 3 places every kilometer
		Colored skid-resistant marking		Conform to the design requirements		

Note: ① Skid-resistance value shall be measured for skid-resistant marking (either colored or white).

11.3.3 The appearance of road markings shall conform to the following requirements:

1 The alignment of road markings shall not bend or ford that are required by the design.

11.4 Corrugated beam barriers

11.4.1 Corrugated beam barriers shall conform to the basic requirements as follows:

1 Product corrugated steel barrier shall conform to the provisions of the current *GBT/*

T31439: Corrugated Sheet Steel Beams for Road Guardrail.

2 The compaction of earthworks beneath road shoulders and the median strip shall not be less than the design values.

3 The embedded depth of barrier posts and foundation treatment in rock cutting or on top of a retaining wall shall conform to the design requirements.

4 Installation of the components for a corrugated beam barrier shall conform to the design requirements and construction specifications. Corrugated beams, posts and buffer blocks shall not be welded, cut or drilled on site. The direction of overlapping joints shall be correct.

5 Treatment of the beginning, ending and transition segments shall conform to the design requirements.

11.4.2 Measurement items for corrugated steel barriers shall conform to the criteria in Table 11.4.2.

Table 11.4.2 Measurement items for corrugated steel barrier

No.	Inspection items	Specified value or Tolerance	Method and frequency
1△	Metal thickness of corrugated beam (mm)	Conform to current GB/T31439	By micrometer for plate thickness, and by coating thickness gauge: random 5% of the number of beam plates, and at least 10 in total.
2△	Thickness of metal post base (mm)	Conform to current GB/T31439	By micrometer or ultrasonic thickness gauge for plate thickness, and by coating thickness gauge: 2% by random, but not less than 10 in total.
3△	Height at midpoint of cross beam (mm)	±20	By tape measure: 5 placesin every kilometer on each side
4	Spacing between centerlines ofposts (mm)	±20	By tape measure: 5 placesin every kilometer on each side
5	Verticality of post (mm/m)	±10	By plumbing: 5 places in every kilometer on each side
6	Spacingbetween outer edge of post and the edge of earth shoulder	≥ 250; or not less than the design requirements	By tape measure: 5 placesin every 1 kilometer on each side
7	Embedded depth of a post (mm)	Not less than the design requirements	By tape measure orburied depth detector: 5 places in every 1 kilometer on each side
8	Final torque on bolt	±10%	By torque wrench: 5 placesin every 1km length on each side

11.4.3 The appearance of corrugated steel barriers shall conform to the requirements as follows:

1 The surface of any component parts of a barrier shall be free from mis-plating, metal exposure and scratching.

2 There shall be no bumps or waves in the alignment of a barrier.

11.5 Concrete barrier

11.5.1 Concrete barriers shall conform to the basic requirements as follows:

1 Ground bearing capacity of a concrete barrier shall conform to the design requirements.

2 The dimensions of a standardized segment, and the starting or ending segment of a concrete barrier shall conform to the design requirements.

3 Precast concrete members shall not be broken during handling, transportation and installation.

4 The segmental connections of a concrete barrier and connections of a barrier to its footings shall conform to the design requirements.

5 Embedded depth, reinforcing steel schedule and number of a concrete barrier shall conform to the design requirements.

6 The treatment of both ends and transition segments of a concrete barrier shall conform to the design requirements.

11.5.2 Measurement items for concrete barriers shall conform to therequirements in Table 11.5.2.

Table11.5.2 Measurement items for concrete barriers

No.	Inspection Items		Specified value or Tolerance	Method and frequency
1	Cross-sectional dimensions (mm)	Height	±10	By tape measure: 5 placesin every 1km length on each side
		Top width	±5	
		Bottom width	±5	
2	Dimensions of reinforcing steel cage(mm)		Conform to the design requirements	Process inspection, by tape measure: 5 places in every 1km length on each side

continued

No.	Inspection Items	Specified value or Tolerance	Method and frequency
3	Lateral offset(mm)	±20 or conform to the design requirements	By tape measure: 5 placesin every 1km length on each side
4①	Footing thickness(mm)	±10% H	Process inspection, by tape measure : 5 placesin every 1km length on each side
5△	Strength of concretebarriers (MPa)	Conform to the design requirements	According to Appendix D
6	Inter-segment faulting(mm)	≤5	By tape measure: 5 places in every 1km length on each side

Note: H is the design thickness of footing, in mm.

11.5.3 The appearance of concrete barriers shall conform to the following requirements:

1) The accumulated area of honeycombing, scaling, cracking, spalling and other defects shall not exceed 0.5% of total area of the concrete surface, while the depth of any defect shall not exceed 10mm.

2) The length of any damaged edge or corner in a concrete barrier shall not exceed 20mm.

3) There shall be no bumps or waves in the alignment of a barrier.

11.6 Cable barrier

11.6.1 Cable barriers shall conform to the basic requirements as follows:

1 Product cable barrier shall conform to the provisions of the current JT/T895: *Cable Barrier.*

2 The end posts shall be firmly installed. The strength of footing concrete shall conform to the design requirements.

3 Treatment of barrier ends and transition sections shall conform to the design requirements.

11.6.2 Measurement items for cable barriers shall conform to the requirements in Table 11.6.2

Table 11.6.2 Measurement items for cable barrier

No.	Inspection items	Specified value or Tolerance	Method and frequency
1△	Initial tensile force	±5%	By tensiometer: each cable
2	Height of the lowest cable (mm)	±20	By tape measure: 5 placesin every 1km length on each side
3	Nominal spacing of posts (mm)	±20	By tape measure: 5 placesin every 1km on each side
4	Verticality of post (mm/m)	±10	By plumbing: 5 places in every 1km length on each side
5	Embedded depth of post (mm)	Not less than the design requirements	By tape measure or embedded depthdetector: 5 places in every 1km on each side
6	Dimensions ofconcrete footing	Conform to the design requirements	By tape measure: 2 pointseach for length and width of every concrete footing

11.6.3 The appearance ofa cable barrier shall conform to the following requirements:

1) The surface of any barrier components shall be free from mis-plating, metal exposure and scratches.

2) There shall be no bumps or waves in the alignment of a barrier

11.7 Raised Pavement Markers (RPM)

11.7.1 Raised pavement markers shall conform to the basic requirements as follows:

1 Product raised pavement markers shall conform to the current *GB/T* 24725: *Raised Pavement Markers*, and *GB /T* 19813: *Solar Energy Raised Pavement Markers*.

2 The layout and color of a raised pavement marker shall conform to the provisions of the current *GB* 5768: *Road Traffic Signs and Markings* and Conform to the design requirements.

3 The road surface shall be clean and dry before placing raised pavement markers. The setting out of the RPMs shall be accurate.

4 The raised pavement markers shall be firmly adhered to the road surface.

11.7.2 Measurement items for raised pavement markers shall conform to thecriteria in Table 11.7.2

Table 11.7.2 Measurement items for raised pavement markers

No.	Inspection Items	Specified value or Tolerance	Method and frequency
1	Angle ofinstallation (°)	±5	By angle square: spot check 10%
2	Longitudinal spacing (mm)	±50	By tape measure: spot check 10%
3	Lateral offset (mm)	±30	By tape measure: spot check 10%

11.7.3 The appearance of raised pavement markers shall conform to the following requirements:

1 The surface of a raised pavement marker shall be free from staining and damage.

11.8 Delineator

11.8.1 Delineators shall conform to the basic requirements as follows:

1 Product delineators shall conform to the current GB/T 24970: *Delineator*.

2 Strength and dimensions of the concrete footing of delineator posts shall conform to the design requirements.

3 Layout of delineators shall conform to the design requirements and the construction specifications.

4 Delineators shall be installed firmly. The chroma performance and luminosity performance shall conform to the design requirements.

11.8.2 Measurement items for a delineator shall conform to thecriteria in Table 11.8.2

Table 11.8.2 Measurement items for delineator

No.	Inspection items	Specified value or Tolerance	Method and frequency
1	Angle of installation (°)	0~5	By range pole, cross plate, tape measure, universal angle square: spot check 5%
2	Height ofcenter point of reflector (mm)	±20	By tape measure: spot check 5%
3	Verticality of delineator post	±10	By plumbing: spot check 5%

11.8.3 The appearance of a delineator shall conform to therequirements as follows:

1 The surface of a delineator shall be free of stain or damage.

11.9 Glare devices

11.9.1 Glare devices shall conform to the basic requirements as follows:

1 Product glare screens shall conform to the current GB/T 24718: *Anti-Glare Board*, the other glare devices shall conform to the design requirements and the construction specifications.

2 Dimensions and shielding angle of a glare device shall conform to the design requirements.

3 Glare devices should be installed firmly.

11.9.2 Measurement items for glare devices shall conform to the criteria in Table 11.9.2

Table11.9.2 Measurement items for glare devices

No.	Inspection items	Specified value or Tolerance	Method and frequency
1△	Height of installation (mm)	±10	By tape measure: 10 places in every 1km
2	Spacingof screens (mm)	±10	By tape measure: 10 places in every 1km
3	Verticality (mm/m)	±5	By plumbing:5 places in every 1km length
4	Size of mesh eye in an glare net	Conform to the design requirements	By tape measure: 5 placesin every 1km, and 3 mesh eyes in every place

11.10 Fence andfalling-object net

11.10.1 Highway fences and falling-object net shall conform to the basic requirements as follows:

1 Product fence shall conform to the current GB/T 26941: *Fences*. Shrub fencing and falling-object netting shall conform to the design requirements.

2 Concrete footing of a post shall conform to the design requirements.

3 The installation of various component parts shall conform to the design requirements and construction specifications.

4 Mesh-eyes of a falling-object net shall be of equal in size, strong in structure and tightly enclosed.

5 The end enclosure at the beginning or ending point of a highway fence shall conform to the design requirements.

11.10.2 The measurement items for highway fencing and falling-object netting shall conform to the criteria in Table 11.10.2

Table11.10.2 Measurement items for fence and falling-object net

<table>
<tr><th>NO.</th><th colspan="2">Inspection items</th><th>Specified value or Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1</td><td colspan="2">Height(mm)</td><td>±15</td><td>By tape measure: 5 placesin every 1km length</td></tr>
<tr><td>2</td><td colspan="2">Sag at midpoint of barbed wire (mm)</td><td>≤15</td><td>By tape measure: 5 placesin every 1km length</td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">Interval of posts (mm)</td><td>Welded</td><td>±30</td><td rowspan="4">By tape measure: 5 placesin every 1km length</td></tr>
<tr><td>Metal plate</td><td>±30</td></tr>
<tr><td>Barbed wire</td><td>±60</td></tr>
<tr><td>Woven</td><td>±60</td></tr>
<tr><td>4</td><td colspan="2">Verticality of post (mm/m)</td><td>±10</td><td>By plumbing: 5 places in every 1km</td></tr>
<tr><td>5</td><td colspan="2">Buried depth of post (mm)</td><td>Not less than the design requirements</td><td>Process inspection, by tape measure: spot check 2%</td></tr>
</table>

11.10.3 The appearance ofhighway fences and falling-object nets shall conform to the following requirements:

1 Surface of a concrete post shall be free of cracks or honeycombs.

11.11 Movable barrier at median-opening

11.11.1 Movable barriers at median-openings shall conform to the basic requirements as follows:

1 The protection level of a movable barrier at median-opening shall conform to the design requirements, and the safety performance shall conform to the provisions of JTG B05-01: *Standard for Safety Performance Evaluation of Highway Barriers.*

2 The installation of a median barrier at median-opening and the treatment of transition sections of median barrier shall conform to the design requirements and the construction specifications.

3 Movable barriers at median-opening shall be easy to open and close, and convenient for moving and relocating during operations.

11.11.2 The measurement items for a movable barrier at median opening shall conform to the criteria in Table 11.11.2.

Table11.11.2 Measurement items for movable barrier at median-opening

No.	Inspection items	Specified value or Tolerance	Method and frequency
1	Height(mm)	±20	By tape measure: 5 pointsat every place
2△	Thickness of coating (μm)	Conform to the design requirements	By gauge for coating thickness: 5 points in every place

11.12 Kilometer-marker and hectometer-stake

11.12.1 Kilometer-markers and hectometer-stakes shall conform to the basic requirements as follows:

1 The style and size of a kilometer-marker and the character colors and fonts on it shall conform to the current GB 5768: *Road traffic signs and markings*.

2 There shall be no broken edges or damage to the kilometer-markers and hectometer-stakes from handling, transportation and installation.

3 The locality of a kilometer-marker or hectometer-stake shall be set out accurately. The installation shall be firm and sound.

11.12.2 Measurement items for kilometer-markers and hectometer-stakes shall conform to the criteria in Table 11.12.2

Table11.12.2 Measurement items for kilometer-marker and hectometer-stake

No.	Inspection items		Specified value or Tolerance	Method and frequency
1	Dimensions (mm)	Height	±10	By tape measure: spot check 10%
		Width	±5	
		Thickness	±5	
2	Character font and size (mm)		Conform to the design requirements	By tape measure: spot check 10%
3	Verticality of kilometer-marker (mm/m)		±10	By plumbing: spot check 10%

11.12.3 The appearance of a kilometer-marker or a hectometer-stake shall conform to the following requirement:

1 There shall be no cracking, honeycombing or other damaging on the surface of a kilometer-marker or hectometer-stake.

11.13 Emergency escape ramp

11.13.1 Emergency escape ramps shall conform to the basic requirements as follows:

1 Foundation bed and drainage of an emergency escape ramp shall conform to the provisions in Chapter 4 and Chapter 5 of these standards.

2 The fill materials and grading of an arrestor bed shall conform to the design requirements.

11.13.2 The measurement items for emergency escape ramp shall conform to the criteria in Table 11.13.2.

Table11.13.2 Measurement items for emergency escape ramp

No.	Inspection items	Specified value or Tolerance	Method and frequency
1	Width of emergency escape ramp (m)	Conform to the design requirements	By tape measure: 5cross-sections on every ramp, at the exit to escape ramp.
2△	Length of arrester bed (m)	Conform to the design requirements	By tape measure: 3 placeson every ramp
3	Thickness of aggregates in arrestor bed (m)	Conform to the design requirements	By tape measure: 5 placeson every ramp
4	Gradient (%)	Conform to the design requirements	By level: 5 places on every ramp

12 Revegetation Works

12.1 General

12.1.1 Plant seeds shall have a quality inspection report issued by the national statutory agency for seed quality inspection. The seedlings and seeds to be transplanted from other provinces or metropolitans shall have a phytosanitary certificate.

12.1.2 Plant survival rate, coverage, and vegetation coverage shall be inspected after a full year of growth.

12.2 Land preparation for revegetation

12.2.1 Land preparation for revegetation shall conform to the basic requirements as follows:

1 There shall be no abandoned structures, construction debris and waste, or any pollutants remaining in the revegetation areas. In the areas with special landscaping requirements, such as those around interchanges, roundabouts, maintenance facilities and service facilities, shall be free of perennial weeds and remaining roots.

2 The scope of landscaping and backfilling, in terms of thickness, elevation, shape and slope, shall conform to the design requirements. Before vegetation the topsoil shall reach full natural settlement, and there shall be no obvious depressions where water ponding may occur.

12.2.2 The measurement items for land preparation for revegetation shall conform to the requirements in Table 12.2.2.

Table 12.2.2 Measurement Items for Land Preparation for Revegetation

<table>
<tr><th>No.</th><th colspan="2">Inspection Items</th><th>Specified value or Tolerance</th><th>Method and Frequency</th></tr>
<tr><td>1</td><td colspan="2">Effectivethickness of topsoil (mm)</td><td>Conform to the design requirements</td><td>By cutting ring method or by trial pits and tape measure:
forlandstrip ①, 5 points in every 1km;
for land spot②, 2 points in every 1000 m^2 area but not less than 3 points in total for every continuous planting zone.</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Relativeelevation of terrain ③ (mm)</td><td>$H \leqslant 1000$</td><td>±50</td><td rowspan="4">By level or tape measure: for median or separation strips, 5 points in every 1km; for interchanges, roundabouts, maintenance facilities and service facilities, 2 points in every $1000m^2$ area but not less than 3 points in total for every continuous planting zone.</td></tr>
<tr><td>$1000 < H \leqslant 2000$</td><td>±100</td></tr>
<tr><td>$2000 < H \leqslant 3000$</td><td>±150</td></tr>
<tr><td>$3000 < H \leqslant 5000$</td><td>±200</td></tr>
</table>

Note: ① 'land strip' refers to the revegetation area along a road, such as median and outer separation, side slope, stability berm, cutting berm, and embankment berm, etc.

② 'land spot' refers to the centralized revegetation area scattered along a road, such as around interchange, roundabout, maintenance facility zone, service facility zone, borrow pit and spoiling yard, etc.

③ H is the height difference between design elevation and the original ground. There is no such a requirement for the revegetation areas of side slopes, various berms, borrow pits and spoiling yards, etc.

12.3 Tree Planting

12.3.1 Tree planting shall conform to the basic requirements as follows:

1 It is strictly forbidden to use seedlings with serious pests or disease. Signs of the pests and disease that do not require quarantining shall not exceed 10% of the body of a tree seedling.

2 The setting out and locality of a planting pit or trough shall be accurately marked and conform to the design requirements.

3 The non-degradable packaging materials shall be removed from the root and soil clod of a seedling before being planted.

4 Tree planting shall not interfere with the sight distance for traffic safety at the time of planting or after the tree is fully grown. Shaped vegetation such as hedges and spherical plants shall be neatly trimmed. No gaps shall exist in continuous shrub fencing.

5 Existing solitary trees, trees of precious species, and large trees (trunk diameter greater than 200 mm for deciduous trees and evergreen broad leaved trees; and over 6 m high or with a diameter above 180 mm at ground level of evergreen coniferous trees) shall be protected.

12.3.2 The measurement items for tree planting shall conform to the requirementsin Table 12.3.2.

Table 12.3.2 Measurement items for tree planting

<table>
<tr><th>No.</th><th colspan="3">Inspection items</th><th colspan="2">Specified Value or Tolerance</th><th>Methods and Frequency</th></tr>
<tr><td rowspan="2">1</td><td colspan="3">Diameter (mm) of planting pit (trough) (mm)</td><td colspan="2">d + 400 ~ d + 600①</td><td rowspan="2">Bytape measure: spot check 5% of all planting pits, and not less than 10 pits in total.</td></tr>
<tr><td colspan="3">Depth (mm) of planting pit (trough) (mm)</td><td colspan="2">3/4 ~ 4/5 of pit diameter</td></tr>
<tr><td>2</td><td colspan="3">Number of seedlings</td><td colspan="2">Conform to the design requirements</td><td rowspan="2">By visual inspection or unmanned aerial vehicle (UAV):
For land strip: seedlings in a 100m segment in every 1km length;
For land spot, 10% of every continuous planting zone, but not less than 10 seedlings. All shall be checked if seedlings in total are less than 10.</td></tr>
<tr><td>3△</td><td colspan="3">Seedling survival rate (%)</td><td colspan="2">≥95</td></tr>
<tr><td rowspan="17">4</td><td rowspan="17">Seedling-data</td><td rowspan="7">Tree</td><td rowspan="5">DBH Diameter at Breast Height (mm)</td><td>≤50</td><td>-2</td><td rowspan="17">By tape measure: for land strip, seedlings in a 100m segment in every 1km length; for land spot, 10% of every continuous planting zone, but not less than 10 seedlings. All shall be checked if seedlings in total are less than 10.</td></tr>
<tr><td>50 ~ 90</td><td>-5</td></tr>
<tr><td>90 ~ 150</td><td>-8</td></tr>
<tr><td>150 ~ 200</td><td>-10</td></tr>
<tr><td>>200</td><td>-20</td></tr>
<tr><td colspan="2">Height (mm)</td><td>-200</td></tr>
<tr><td colspan="2">Crown diameter (mm)</td><td>-200</td></tr>
<tr><td rowspan="4">Shrub</td><td rowspan="2">Height (mm)</td><td>≥1000</td><td>-100</td></tr>
<tr><td><1000</td><td>-50</td></tr>
<tr><td rowspan="2">Crown diameter (mm)</td><td>≥1000</td><td>-100</td></tr>
<tr><td><1000</td><td>-50</td></tr>
<tr><td rowspan="8">Spherical plant</td><td rowspan="4">Crown diameter (mm)</td><td><500</td><td>0</td></tr>
<tr><td>500 ~ 1000</td><td>-50</td></tr>
<tr><td>1000 ~ 2000</td><td>-100</td></tr>
<tr><td>>2000</td><td>-200</td></tr>
<tr><td rowspan="4">Height (mm)</td><td><500</td><td>0</td></tr>
<tr><td>500 ~ 1000</td><td>-50</td></tr>
<tr><td>1000 ~ 2000</td><td>-100</td></tr>
<tr><td>>2000</td><td>-200</td></tr>
</table>

continued

No.	Inspection items			Specified Value or Tolerance		Methods and Frequency
4	Seedling-data	Liana	Length of main stem (mm)	≥1500	-100	By tape measure: for land strip, seedlings in a 100m segment in every 1km length; for land spot, 10% of every continuous planting zone, but not less than 10 seedlings. All shall be checked if seedlings in total are less than 10.
			Diameter of main stem (mm)	≥10	0	
			Plant height (mm)	≤1000	0	
				1000 ~ 2500	-100	
				2500 ~ 4000	-200	
				>4000	-300	
		Palm plant	Ground diameter (mm)	≤100	-10	
				100 ~ 400	-20	

Note: ① d is the diameter of a root and soil clod of a seedling or the length of outspread roots of bare-rooted seedling, in mm.

12.3.3 The appearance of tree planting shall conform to the following requirements:

1 The seedlings of trees, shrubs and spherical plants shall not have evidence of burn marks on the stem. There shall be no seedling with an inclined crown that may negatively affect driving safety.

2 Tree branches shall not be broken, dead or have serious pests or disease.

12.4 Turfing, herbaceous ground cover and flower planting

12.4.1 Turfing, herbaceous ground covering and flower planting shall conform to the following requirements:

1 The grass rolls or grass blocks for turfing shall have a uniform thickness, and the percentage of weeds shall not exceed 5%.

2 The planting technology, varieties, proportions or plant spacing of turfing, herbaceous ground covering and flower planting shall conform to the design requirements. Where spray planting is adopted, the quality inspection shall be carried out in accordance with the relevant provisions in Section 12.5.

3 The laying off, density and pattern of planting flower seedlings shall conform to the design

requirements.

12.4.2 The measurement items for turfing, herbaceous ground covering and flower planting shall conform to the requirements of Table 12.4.2.

Table 12.4.2 Measurement items for Turfing, Herbaceous Ground Cover and Flower Planting

<table>
<tr><th>No.</th><th colspan="2">Inspection items</th><th>Specified value or Tolerance</th><th>Method and frequency</th></tr>
<tr><td>1</td><td colspan="2">Area of turfing and herbaceous ground covering</td><td>Conform to the design requirements</td><td>By tape measureor by unmanned aerial vehicle (UAV):
For land strip, 100m in every 1km;
For land spot, all plants in every continuous planting zone.</td></tr>
<tr><td rowspan="2">2△</td><td rowspan="2">Covering ratio of turfing and herbaceous ground covering (%)</td><td>Greening area of borrow pit and spoil ground</td><td>≥90%</td><td rowspan="2">Byvisual inspection or by UAV
For land strip, 100m in every 1km;
For land spot, all plants in every continuous planting zone.</td></tr>
<tr><td>Other greening area</td><td>≥95%</td></tr>
<tr><td>3</td><td colspan="2">Flower quantity</td><td>Conform to the design requirements</td><td rowspan="2">By visual inspection or UAV:
For land strip, number of flowers in a 100m length in every 1km;
Forland spot, 5% of total number of flowers in every continuous planting zone, but not less than 10 flowers in total.</td></tr>
<tr><td>4△</td><td colspan="2">Survival ratio of flower(%)</td><td>≥95%</td></tr>
</table>

12.4.3 The appearance of turfing, herbaceous ground covering and flower planting shall conform to the following requirement:

1 No continuously unvegetated spots shall exist in turf, herbaceous cover and flowers on revegetated areas such as around interchanges, roundabouts, management or maintenance facility areas, and the service facilities.

12.5 Revegetation by hydroseeding

12.5.1 Revegetation by hydroseeding shall conform to the basic requirements as follows:

1 The quality of grass-seeds shall not be lower than Grade-2 as specified in GB 6142: *Quality Grading of the Grass Seeds*. The quality of tree-seeds shall not be lower than Grade-2 as specified in GB 7908: *Classification of Forest Tree Seed Quality*. For the

seeds not mentioned in either GB 6142 or GB 7908, the tests for germination rates and trials for seed mix shall be conducted to determine the appropriate seed dosage for large-scale construction.

2 The plant varieties and seed mix used in hydroseeding shall conform to the design requirements.

12.5.2 The measurement items forrevegetation by hydroseeding shall conform to the requirements in Table12.5.2.

Table 12.5.2 Measurement Items for Hydroseeding

No.	Inspection Items	Specified value or Tolerance	Method and frequency
1△	Thickness of mulch sprayed (mm)	Design thickness ±10	By cutting ring method or by trial pits and tape measure: For land strip: 10 points in every 1km; Forland spot: 2 points in every 1000m^2 area of each continuous planting zone, but not less than 5 points in total.
2	Plant species composition of hydroseeding	Conform to the design requirements	By quadrant sampling: For land strip, 3 sampling squares (2m in length and 2m or equivalent in width of revegetation area) but not less than 3; for land spots, 3 sample squares (2m by 2m) for every continuous planting unit but not less than 3.
3	Area of Planting	Conform to the design requirements	By tape measureor UAV: For land strip, 100m in every 1km; For land spot, all plants in every continuous planting unit.
4△	Vegetation coverage(%)	⩾95	By visual inspectionor UAV: For land strip, 100m in every 1km; For land spot, all plants in every continuous planting unit.

12.5.3 The appearance of hydroseeding shall conform to the following requirements:

1 There must be no continuous barren or gully erosion in the revegetation area.

13 Noise Barrier

13.1 General

13.1.1 Insertion loss ofa noise barrier shall conform to the design requirements.

13.1.2 The drainage at a noise barrier shall conform to the design requirements.

13.2 Stone pitching noise barrier

13.2.1 Stone pitching noise barriers shall conform to the basic requirements as follows:

1 Types, properties and quality of the cement, sand, water and admixture used in mortar shall conform to the design requirements.

2 The ground bearing capacity shall conform to the design requirements.

3 Before footing construction, the dimensions of the excavation for footings shall be inspected for conformity to the design requirements.

4 The pitching stones shall be layered with staggered joints over the full width. For wet mortar pitching, all joints shall be fully and firmly filled with mortar. No voids shall exist.

5 The reinforcing steel used in stone pitching shall conform to the requirements of design for anti-corrosion treatment.

13.2.2 The measurement items for stone pitching noise barriers shall conform to the criteria in Table 11.13.2

Table 13.2.2 Measurement items for stone pitching noise barrier

No.	Inspection items	Specified value or Tolerance	Method and frequency
1△	Strength of mortar (MPa)	Within the required range	According to Appendix F
2△	Elevation on top surface (mm)	±20	By level: spot check 30% of total number of standard segments, 1 point on every segment
3△	Wall thickness (mm)	Conform to the design requirements	By tape measure: spot check 30% of total number of standard segments, 1 point on every segment
4	Exposed width of footing (mm)	±20	By tape measure: spot check 30% ofstandard segments, 1 point on each segment
5	Verticality of wall (mm/m)	≤3	By tape measure and theodolite: spot check 30% of standard segments, 1 point on every segment
6	Vertical straightness (mm/10m)	≤10	By 10-m stringline: 2 places in every 100m, but not less than 5 places.
7	Surface flatness	≤8	By 2-meter straight edge: 10 measurements in every 100m

13.2.3 The appearance of stone pitching noise barriers shall conform to the following requirements:

1 The wall shall be free of damage.

13.3 Metallic noise barrier

13.3.1 Metallic noise barriers shall conform to the basic requirements as follows:

1 Buried depth of a footing shall conform to the design requirements.

2 Acoustic performance of a metallic screen shall conform to the design requirements. A test report of acoustic performance is required.

3 Before the installation of metal posts, connectors and metal screens, no deformation shall

occur to the component parts, and no damage to the anti-corrosion coatings.

4 Bolts shall be fully tightened. The positions shall be correct, and the number shall conform to the design requirements.

5 The joints between screen panels and between the screen panels and the footings shall be tight.

13.3.2 Measurement items for metallic noise barriers shall conform to the criteria in Table 13.3.2

Table 13.3.2 Measurement items for metallic noise barrier

No	Inspection items	Specified value or Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix F
2△	Elevation on top surface (mm)	±20	By level: spot check 30% of the number of standard segments, and 1 point on every segment
3	Exposed toe of footing (mm)	±20	By tape measure: spot check 30% of thenumber of standard segments, and 1 point on every segment
4	Position offset from the shoulder border	±20	By tape measure: spot check 30% of thenumber of standard segments, and 1 point on every segment
5	Spacing of posts	≤10	By tape measure: spot check 30% of thenumber of standard segments, and 1 point on every segment.
6	Verticality of post (mm/m)	≤3	By plumbing: spot check 30% of the number of standard segments, and 1 point in each segment
7	Coating thickness of post (μm)	Not less than specified value	Bythickness gauge: spot check 20% of the number of standard segments, and 1 point in each segment.
8	Coating thickness on screen surface (μm)	Not less than specified value	Bythickness gauge: spot check 20% of the number of standard segments, and 1 point in each segment.
9△	Thickness ofscreen back panel (mm)	±0.1	ByVernier caliper: spot check 5% of total number of screen back panels
10	Surface flatness (mm)	≤8	By2-m straight edge: 10 measurements in every 100m

13.3.3 The appearance of metallic noise barriers shall conform to the provisions as follows:

1 There shall be no peeling, bubbling, misplating, nicking or scratching on the coated or plated surfaces of a post.

2 There shall be no cracking or scratching on a barrier screen panel.

13.4 Composite noise barrier

13.4.1 Compositenoise barriers shall conform to the basic requirements as follows:

1 The buried depth of a footing shall conform to the design requirements.

2 The acoustic performance of a non-metallic noise barrier shall conform to the design requirements. The inspection and verification report on acoustic performance shall be required.

3 Installation of fasteners shall conform to the design requirements and relevant specifications.

4 The posts, connectors or screen panels of noise barriers shall be inspected before installation to make sure no deformation to the components and no damage to anti-corrosive coating occurred.

5 The fixing bolts shall be fully tightened. The positions shall be correct, and the quantity shall conform to the design requirements.

6 The joints of screen panels to posts, and post to footings shall be fully and tightly fixed.

13.4.2 The measurement items of a composite noise barrier shall conform to the criteria in Table 13.4.2

Table13.4.2 Measurement items for noise barrier

No.	Inspection item	Specified value or Tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2△	Elevation of top surface (mm)	±20	By level: spot check 30% of the standard segments, and 1 point on every segment
3△	Thickness of barrier panel (mm)	±3	By tape measure: spot check 30% of the standard segments, and 1 pointon every segment
4△	Thickness ofsee-through screen (mm)	±0.2	By Vernier caliper: spot check 30% of the standard segments, 1 point on every segment

continued

No.	Inspection item	Specified value or Tolerance	Method and frequency
5	Exposed width of footing toe (mm)	±20	By tape measure: spot check 30% of the standard segments, and 1 pointon every segment
6	Position offset from the shoulder edge line (mm)	±20	By tape measure: spot check 30% of the standard segments, and 1 point on every segment
7	Spacing of posts (mm)	≤10	By tape measure: spot check 30% of the standard segments, and 1 point on every segment
8	Verticality of post (mm/m)	≤3	By plumbing: 30% of the number of standard segments, and 1 point on every segment
9	Coating or plating thickness of metal post (μm)	Not less than specified value	By thickness gauge: 20% of the number of standard segments, and 1 point on every segment
10	Surface flatness (mm)	≤8	By2-m straight edge: 10 measurements in every 100m

13.4.3 The appearanceof a composite noise barrier shall conform to the provisions as follows:

1 There shall be no peeling, bubbling, misplating, nicking or scratching on the coated or plated surfaces of a post.

2 There shall be no cracking or scratching on a barrier screen panel.

Appendix A: Work Classification

Table A-1 WorkClassification of a Construction Project (General)

Type of Work	Division of Work	Subdivision of work
Earthworks (10km segment each, or whole length of a contract package)	Earthmoving and ground treatment (1 ~ 3km segment each)	Earthworks in soil, earthworks in rock, soft ground treatment, geosynthetic treatment.
	Drainage (1 ~ 3km segment each)①	Prefabrication and installation of culvert segments, masonry manholes (gullies), earth ditches, masonry ditches, blind drains, waterdrops, chutes, water cushions, caisson and sedimentation pits in a pumping station.
	Small bridge or any passage similar to small bridge, footbridge, aqueduct (each unit)	Processing and installation of reinforcing steels, masonry works, concrete spread footings, bored piles, concrete piers and abutments, placement of piers and abutments, backfilling to abutments, in-situ concreting for beams and slabs, prefabrication and erection of beams and slabs, in-situ concreting for arches, concreting of bridge decks, waterproofing on bridge decks, installation of bearing plinths and constraint blocks, installation of bearings, installation of expansion joints, installation of handrails, concrete barriers, approach slabs, masonry works for slope protection, concrete surface protection, bridge in general.
	Culvert, underpass (1 ~ 3km segment each)①	Processing and installation of reinforcing steels, construction of inlets and outlets of culverts, prefabrication of culvert segments, installation of culvert base slab and culvert pipes, installation of corrugated steel pipe culverts, precast and placing cover slabs, concreting for box culverts, concreting (or stone pitching) for arch culverts, masonry of siphon culvert shafts and catch pits, construction of straight wingwalls and flare wingwalls, backfilling to culverts, culvert pipe jacking, masonry for slope protection, culvert in general.

continue

Type of Work	Division of Work	Subdivision of work
Earthworks (10km segment each, or whole length of a contract package)	Slope protection (1 ~ 3km segment each)[1]	Stone pitching retaining walls, backfill behind retaining wall, slope anchors, soil nails, masonry of slope protection, stone gabions, stream diversion.
	Large retaining wall, combined retaining wall (each place)	Processing and installation of reinforcing steels, stone pitching retaining walls, cantilever walls, buttress walls, tieback walls, anchored walls, reinforced-earth-walls, backfilling behind walls.
Pavement works (10km segment each, or whole length of a contract package)	Pavement (1 ~ 3km segment each)[1]	Bedding layers, sub-base coarse, base course, surfacing course, curbs, shoulders.
Bridge works[2] (eachbridge or each package of contract)	Foundation and substructure (1 to 3 piers and abutments)[3]	Processing and installation of reinforcing steels, processing and tensioning of prestressing tendons, grouting of prestressing conduits, concrete spread footings, bored piles, excavated concrete piles, sinking piles, grouting the bottom of piles, diaphragm walls, open caissons, concrete bottom sealing for caissons and steel cofferdams, mass concrete for pile caps, masonry works, concrete piers/abutments, installation of piers and abutments, bearing plinths and constraint block, composite abutments in arch bridges and backfilling behind abutments.
	Superstructure-prefabrication and installation (1 ~ 3 spans)[3]	Processing and installation of reinforcing steels, processing and tensioning of prestressing tendons, grouting of prestressing conduits, prefabrication and installation of beams and slabs, girder construction in balanced cantilever, girder construction by incremental launching, girder construction by swaying method, prefabrication of arch-ring in segments, erection of arches, arch construction by swaying method, suspenders and flexible tie rods of half-through arch bridges, stiff suspenders, fabrication of steel girders, erection of steel girders, steel girder protection.
	Superstructure-in-situconcrete casting (1 ~ 3 spans)[3]	Processing and installation of reinforcing steels, processing and tensioning of prestressing tendons, grouting of prestressing conduits, in-situ concrete girders and slabs, girder constructed by cantilever method, in-situ concrete arch-rings, Melan arches, arches of steel tubes filled with concrete, suspenders and flexible tie rods, stiff suspenders for through or half-through arch bridges, stiff tie rods.

continue

Type of Work	Division of Work	Subdivision of work
Bridge works② (eachbridge or each package of contract)	Bridge deck system, auxiliary works, and bridge-work in general	Processing and installation of reinforcing steels, water-proofing on concrete deck, water-proofing/ bonding layer on steel bridge deck, concrete deck pavement, asphalt concrete pavement on steel bridge deck, installation of bearings, installation of expansion joints, walkway paving, installation of handrails, concrete guardrails, installation of steel barriers on steel bridge, construction of approach slabs, prefabrication of small sized concrete elements, masonry works for slope protection, surface protection of concrete elements, bridge works in general.
	Protection work	Masonryworks for slope protection, bank revetment④, river diversion works.
	Approaches to bridge	Refer tothe types of work for earthworks and pavement works.
Tunnel works (in unit or every package of contract)⑤	Tunnel work in general and fitting-out (in unit or every contract package)	Tunnel work in general, tunnel fitting-out
	Tunnel portal (in every portal)	Protection of uphill and side slopes at tunnel portals, portal wall and wingwalls, interception trenches, drainage around tunnel portal, concrete casting for cut-and-cover tunnels, waterproofing for cut-and-cover tunnels, backfilling to cut-and-cover tunnels
	Excavation of tunnel(200 lm)	Tunnel excavation
	Lining in tunnel (in every 200 lm)	Shotcrete, rock bolts, steel mesh, steel frames, inverted arch, back filling to inverted arch, steel reinforcing for tunnel lining, concrete lining, advanced rock bolts, advanced pipe tremie, pipe roofing
	Drainage and water-proofing (in every 200 lm)	Waterproofing, water-stop, drainage
	Pavement (in each 1-3km segment)①	Base course,surfacing course
	Shafts, adits and other auxiliary works⑥ (200 linear meters)	Excavation, shotcrete, bolts, steel meshes, steel frames, inverted arches, back filling to inverted arch, steel reinforcing for lining, concrete lining, advance anchor bolts, advanced pipe tremie, pipe roofing, waterproofing, water-stopping and drainage

continue

Type of Work	Division of Work	Subdivision of work
Revegetation works (for every contract package)	Revegetation on land strips (such as in median and outer separations), on slopes, on various berms and terraces (in every 2km); Revegetation inland zones: such as those in interchanges or roundabouts, at maintenance facilities, at service facility areas, at borrow pits or spoil grounds (each place)	Site preparation, seeding and planting, turfing, herbaceous ground cover and flower planting, revegetation by hydroseeding
Noise barrier (every package of contract)	Noise barrier (eachplace)	Stone pitching noise barrier, metal noise barrier, composite noise barrier
Traffic safety facility (every 20km or every package of contract)	Traffic signs, road markings, raised road markers, delineators (in every 5 ~ 10km segment)	Traffic signs, road markings, raised road markers, delineators
	Barriers (5 ~ 10km segment each)①	Corrugatedsteel barriers, cable barriers, concrete barriers, movable barriers at median opening
	Anti-glare facilities, isolation fences, falling-object nets (5 ~ 10km segment each)①	Glare boards, glare meshes, isolation fences, falling-object nets
	Kilometer-markers, hectometer stakes (5km segment each)	Kilometer-markers, hectometer-stakes
	Emergency escape ramp(every place)	Emergency escape ramp
Traffic electrical and mechanical work	The related workdivisions and work subdivisions refer to Volume II: Electrical and Mechanical works of these criteria.	
Subsidiary facilities	Control center, service zone, building works, toll stations, maintenance work zones and other facilities	Inspection andverification in accordance with the quality criteria for relevant specialist works concerned.

Note: 1 For the divisions of work in terms of road segments in length, low values should be used for Motorways and Class-1 highways, and high values may be used for Class-2,-3 and-4 highways.

2 In the case of bridges with separated roadways, each roadway shall be classified as an independent unit. A super-large cable-stay bridge or suspension bridge should be classified by referring to Table A-2. For other kinds of cable-stayed or suspension bridges, each may be taken as an independent unit and further classified by referring to Table A-2.

3 A super-large bridge in terms of a single span should be taken as one division of works. Other kinds of super-large bridges should be taken as 2 or 3 divisions of works depending on the number of super-large spans.

4 Bank revetments should be classified by comparing with retaining walls.

5 Each tunnel of twin tunnels should be taken as an independent type of work.

6 Shafts, adits and other auxiliary works include vertical shafts, inclined shafts, parallel heading, adits, ventilation passages, underground ventilator rooms and so on.

Table A-2 Work Classification of Super-large Cable-stay Bridges and Suspension bridges

Type of Work	Division of Work	Subdivision of work
Pylon, anchor pier, and transitional pier (every unit)	Foundation for pylon/tower	Processing and placing of reinforcing steels, construction of concrete spread footings, construction of bored piles, grouting the bottom of bored piles, construction of open caissons, concrete bottom sealing for caissons or steel cofferdams
	Pile cap for pylon/tower	Processing and placing of reinforcing steels, construction of double wall steel cofferdams, concrete bottom sealing for caissons and cofferdams, construction of pile caps and other mass concrete structures
	Pylon/tower	Processing and placing of reinforcing steels, processing and tensioning of prestressing tendons, grouting of prestressing conduits, construction of concrete pylons, segmental prefabrication of steel anchor boxes on pylons, installation of segmental steel anchor boxes, placing of bearing plinths and constraint block
	Anchor pier Transitional pier	Processing and placing reinforcing steels, processing and tensioning of prestressing tendons, grouting for conduits, bored piles, grouting the bottom of piles, pile caps and other mass concrete structures, bottom sealing for caissons or cofferdams, concrete piers and abutments, installation of piers and abutments, bearing plinths and constraint blocks.
Anchor block (each)	Foundationfor anchor block	Processing and placingof reinforcing steels, concrete spread footing, bored piles, grouting the bottom of bored pile, diaphragm walls, caissons, concrete bottom sealing for caissons or cofferdams
	Anchor block	Processing and placingof steel bars, fabrication of anchor system, installation of anchor system, construction of concrete anchor blocks, tensioning and grouting of prestressing cables, excavation for tunnel-typed anchor blocks, and construction of anchor plugs for tunnel-typed anchors.
Fabrication and protection of Steel superstructure	Main cable	Preparation and protection of cable strands and anchor heads, protection of main cables
	Cable saddle	Fabrication of cable saddles, protection of cable saddles

continue

Type of Work	Division of Work	Subdivision of work
Fabrication and protection of Steel superstructure	Cable clamp	Fabrication of cable clamps, protection of cable clamps
	Suspender	Fabrication and protection of suspenders and anchor heads
	Stiffening girder	Fabrication of steel girders, protection of steel girders, fabrication of anchor assembly of main cable strands for self-anchoring suspension bridge
Superstructure- casting and installation	Casting of stiffening girder	Casting the girder segments on main piers of a cable-stay bridge, construction in balanced cantilever of a concrete cable-stay bridge, concrete upper layer on composite girders of a cable-stay bridge
	Installation	Installation of cable saddles, erection of main cables, installation of suspenders and clamps, erection of steel stiffening girders, installation of anchor assemblies of main cables of a self-anchoring suspension bridge, tensioning of suspenders and system conversion of a self-anchoring suspension bridge, erecting the segments of steel box girders of a steel cable-stay bridge , or erecting segments of I-girders by balanced cantilever of a composite girder cable-stay bridge, construction in balanced cantilever of a concrete cable-stay bridge
Deck system, auxiliary works and bridgework in general	Deck system	Processing and installation of reinforcing steels, water-proofing layer on concrete deck or waterproofing/bonding layer on steel deck, pavement on concrete deck or asphalt pavement on steel deck
	Auxiliary works and bridge overall	Installation of bearings, installation of expansion joints, installation of walkways, installation of handrails, installation of concrete barriers, installation of steel barriers on a steel bridge, surface protection of concrete elements, construction of approach slabs, bridge-work in general

Appendix B: Determination of Compaction

B.0.1 The compaction of earthworks, especially subgrade, and pavement subbase course and base course shall bedetermined in accordance with the compaction test under heavy compaction criteria

B.0.2 Parallel tests shall be conducted for standard densities in order tocalculate an average value to be used as the standard value for site inspection. In the case of poor uniformity in earthwork soil or pavement materials, additional standard density tests shall be conducted wherever necessary in order to obtain the standard values.

B.0.3 An inspection unit for compaction of earthworks or pavement shall be a road section in a length of 1 to 3 km long, inspected by sampling at the frequency as specified in the relevant Clauses of these criteria to calculate K_i that is the actual compaction at each point sampled and tested. Sand replacement method or core cutting method may be used for fine-grain soil; sand replacement method, water-bag method or coring and wax-envelope method may be used for coarse-grained soil and pavement materials. Where the nuclear method is used, the nuclear densometer must be inspected and calibrated by comparative tests to confirm their reliability.

The representative value of compaction, K, for the road segment under inspection (which is the minimum confidence threshold of the arithmetic mean) is as follows:

$$K = \bar{k} - t_\alpha S/\sqrt{n} \geqslant K_0$$

where $\bar{k}$——average of densities of the points that are sampled and tested in the segment under inspection

t_α——Coefficient varying with number of points tested and reliability (or confidence threshold α) in the t-distribution table; $t_\alpha$in Table B.0.3. The reliability adopted: 99% for subbase and base courses and 95% for earthworks and surfacing course on Motorways and Class-1 highways; and 95% for subbase and base courses, and 90% for earthworks and surfacing course on Class-2,-3 and-4 highways.

S——standard deviation of the values tested

N——Number of points tested

K_0——Standard density of compaction

Earthwork, subbase and base courses:

The road segment under inspection maybe verified as complying 100% where $K \geqslant K_0$, and all the compaction values at a single point K_i are greater than or equal to the specified value minus 2 percent;

Thecompliance shall be calculated based on the number of points which had a tested value greater than or equal to the specified value minus2 percent, where $K \geqslant K_0$ and all of the compaction values at a single point K_i are greater than or equal to the specified limiting values.

The road segment shall be verified as failed where $K < K_0$ or any one of the compaction values at a single point Ki is less than the specified limiting value; and thus the whole item of work has failed.

For a short segment of earthworks, the compaction of every layer shall comply with the requirements, and the number of samples must not be less than 6.

For asphalt surfacing course:

The compaction of the road segment shall be verified ascomplying 100% where $K \geqslant K_0$ and all the compaction values at a single point K_i are greater than or equal to the specified value minus 1 percent;

Thecompliance shall be calculated based on the number of points which had a tested value greater than or equal to the specified value minus1 percent, where $K \geqslant K_0$ and all the compaction values at a single point K_i are greater than or equal to the specified limiting values.

The road segment shall be verified as failed where $K < K_0$ or any one of the compaction values at a single point K_i is less than specified limiting value; and thus the whole item of work has failed.

Table B.0.3 Values oft $\alpha/\sqrt{m}$

n	Reliability			*n*	Reliability		
	99%	95%	90%		99%	95%	90%
2	22.501	4.465	2.176	11	0.833	0.546	0.414
3	4.021	1.686	1.089	12	0.785	0.518	0.393
4	2.270	1.177	0.819	13	0.744	0.494	0.376
5	1.676	0.953	0.686	14	0.708	0.473	0.361
6	1.374	0.823	0.603	15	0.678	0.455	0.347
7	1.188	0.734	0.544	16	0.651	0.438	0.335
8	1.060	0.670	0.500	17	0.626	0.423	0.324
9	0.966	0.620	0.466	18	0.605	0.410	0.314
10	0.892	0.580	0.437	19	0.586	0.398	0.305

continue

n	Reliability			n	Reliability		
	99%	95%	90%		99%	95%	90%
20	0.568	0.387	0.297	70	0.285	0.199	0.155
30	0.449	0.310	0.239	80	0.266	0.186	0.145
40	0.383	0.266	0.206	90	0.249	0.175	0.136
50	0.340	0.237	0.184	100	0.236	0.166	0.129
60	0.308	0.216	0.167	>100	$\frac{2.3265}{\sqrt{n}}$	$\frac{1.6449}{\sqrt{n}}$	$\frac{1.2815}{\sqrt{n}}$

Appendix C: Determination of Flexural-Tensile Strength of Concrete

C.0.1 Concrete flexural-tensile strength shall be determined by Standard Little Beam method or core splitting method. Test specimens shall be prepared in accordance with standardized methods with a standard curing period of 28 days. The time when a pavement core is split shall be controlled within a period between 28 days and 56 days. Usually, 28 days is used for concrete without flyash mixture, and a period of 28 to 56 days is for flyash mixed concrete.

C.0.2 For Motorways and Class-1 highways, every working crew or shift shall prepare 2 to 4 groups of specimens respectively: 2 groups if daily progress is less than 500m, 3 groups if daily progress is not greater than or equal to 500m but less than 1000m, and 4 groups for daily progress is greater than and equal to 1000m. For other classified highways, every working crew or shift shall prepare 1 to 3 groups of specimens respectively: 1 group of specimens if the daily progress is less than 500m; 2 groups for daily progress is greater than or equal to 500m but less than 1000m; and 3 groups for daily progress is greater than or equal to 1000m. The average value of three specimens in a group shall be taken as one statistical datum.

C.0.3 The qualification of concrete flexural-tensile strength shall conform to the following criteria:

1 In the case of more than 10 groups of specimens, the judgment formula of the average flexural-tensile strength is as follows:

$$f_{cs} \geqslant f_r + K_{\sigma} = C_v \bar{f}_c$$

where: f_{cs}——The average flexural-tensile strength for qualification judgment of concrete (MPa);

f_r——standard value of design flexural-tensile strength (MPa);

K——Qualification judgment coefficient (refer to Table C0.3.1);

σ——statistical mean square deviation of concrete flexural-tensile strength;

C_v——Measured statistical variation coefficient of concrete flexural-tensile strength;

$\bar{f}_c$——Measured statistical average concrete flexural-tensile strength value (MPa).

When there are 11 ~ 19 groups of specimens in total, only one of them is allowed to have a minimum flexural-tensile strength less than 0. 85fr, but never less than 0. 80fr. When there are more than 20 groups, the minimum flexural strength (f_{min}) shall not be less than 0. 85fr for Motorways and Class-1 highways; for other classified highways, only one group is allowed to have minimum flexural strength (f_{min}) less than 0. 85fr, but never less than 0. 80fr.

2 When the specimen group quantity is equal to or less than 10 groups, the average strength shall not be less than 1. 15fr, among which the strength of any group shall not be less than 0. 85fr.

3 The statistical variation coefficient of measured flexural-tensile strength (C_v) shall conform to design requirements.

C. 0. 4 In case any data, namely the average flexural strength at acceptance (f_{cs}) of standard small beams, the minimum flexural strength f_{min}, or statistical variation coefficient, is not in compliance with the above requirements, 3 or more samples in ϕ150mm shall be cored in every 1 km length along every traffic lane on the unqualified road section in order to measure the splitting strength. The flexural-tensile strength can be deducted in accordance with the empirical statistic formula. The acceptance-judgment average flexural strength f_{cs} and minimum value f_{min} must be qualified. Otherwise, re-work shall be required.

C. 0. 5 If the flexural-tensile strength of concrete of the section under evaluation is verified as unqualified, then the corresponding subdivision of work shall be determined as "disqualified".

Appendix D: Determination of Compressive Strength of Cement Concrete

D.0.1 The determination of compressive strength for cement concrete shall be based on the limiting strengths tested on cubic specimens with 150mm side lengths after a 28-day standard curing period. Such determination for large mass of concrete shall follow the specific requirements for standard curing period, if there is any. Three test specimens shall be used as one group, and the number of groups for testing shall conform to the requirements as follows.

1 The concrete of different strength grades and design mixes shall be sampled randomly at pouring places, and the test specimens shall be prepared separately.

2 When pouring concrete for the structures of normal volumes (such as a foundation, a pier or abutment), two groups of test specimens should be prepared for each unit of such structures.

3 When a massive volume of concrete is continuously poured, two groups of specimens shall be prepared for each 80 ~ 200m^3 or every shift.

4 For major components of a superstructure, one group of specimens shall be made for a unit with a length up to 16m; 2 groups for a 16 ~ 30m long unit, 3 groups for a 31 ~ 50m long unit, and at least 5 groups for a unit with a length over 50m. For small components, at least two groups should be made for each batch or every shift.

5 At least two groups should be prepared for each bored pile. No less than three groups should be made for the pile with a length greater than 20m. At least four groups shall be made for the pile with a large diameter or with long casting period. If working in shifts, two groups should be made in every shift.

6 For structures, like small bridges or culverts, retaining walls or sound barriers, two groups of specimens should be made for each structure, at each location or in every shift. Two

groups may be made for several structures or at several locations if the concrete is made of the same raw materials, with the same mix and in the same mixing plant.

7 In order to satisfy the needs for construction, extra groups of specimens shall be prepared and cured in the same conditions as that of the structures, which shall be tested and used as the concrete strength in construction phases such as formworks removal, hoisting, prestressing and loading.

D. 0. 2 The following criteria shall be conformed when evaluating the compressive strength of the cement concrete:

1 In the case of more than 10 groups of specimens, the evaluation shall be conducted by means of mathematical statistics methods and conform to the following requirements:

$$m_{fcu} \geqslant f_{cu,k} + \lambda_1 S_n \quad (D.0.2\text{-}1)$$

$$f_{cu,min} \geqslant \lambda_2 f_{cu,k} \quad (D.0.2\text{-}1)$$

Where, n——number of concrete specimen groups for each inspection lot;

m_{fcu}——average strength value of n groups of test specimens, with accuracy up to 0. 1 MPa;

S_n——standard deviationof strength of n groups of test specimens, with accuracy to 0. 1 MPa. Take $S_n = 2.5$ MPa if the calculated value is less than 2. 5 MPa;

$f_{cu,k}$——designed strength class of concrete (MPa);

$f_{cu,min}$——value of the group which concrete strength is the lowest (MPa), with accuracy up to 0. 1 MPa;

λ_1 and λ_2——coefficient of conformity, refer to Table D. 0. 2-1 hereinafter.

Tab. D. 0. 2-1 Valuesof λ_1 and λ_2

n	10-14	15-19	≥5-
λ_1	1. 15	1. 05	0. 95
λ_2	0. 9	0. 85	

2 Where the number of specimen groups in each inspection lot is less than ten, the evaluation may be conducted by mean of non-mathematical statistics methods and shall conform to the following requirements:

$$m_{fcu} \geqslant \lambda_3 f_{cu,k} \quad (D.0.2\text{-}3)$$

$$f_{cu,min} \geqslant \lambda_4 f_{cu,k} \quad (D.0.2\text{-}4)$$

where: λ_3 and λ_4—— Coefficients of conformity, refer to Table D. 0. 2-2.

Tab. D. 0. 2-2 Valuesλ_3 and λ_4

Grade ofConcrete Strength	< C60	≥600
λ_3	1. 15	1. 10
λ_4	0. 95	

D. 0. 3 In inspection items, if the compressive strength of concrete is evaluated as unqualified, the corresponding subdivision of work shall be verified as disqualified.

Appendix E: Determination of Compressive Strength of Shotcrete

E.0.1 The compressive strength of shotcrete is the result of the limiting compressive strength times a factor of 0.95. Such a limiting compressive strength shall be determined by standard testing method on the cubic specimens (100mm × 100mm × 100mm in size) taking from shotcrete plates and cured under standard conditions for 28 days.

E.0.2 For a 2- or 3-lane tunnel, at least one group (with 3 specimens) shall be sampled from the roof arch and both sidewalls respectively in every 10 linear meters length. For other kinds of tunnels, at least one group of specimens shall be prepared for every $50m^3 \sim 100m^3$ of shotcrete mixtures or any individual work of which shotcrete mixture is less than $50m^3$. New specimens shall be sampled and prepared wherever either material or mix is changed.

E.0.3 Qualification of the strength of shotcrete shall conform to the following criteria.

1) In the case of the number of specimen groups in an inspection lot, $n \geqslant 10$, the average value of the compressive strength of specimens shall not be lower than design value, and the compressive strength of any one group of specimens shall not be lower than 85% of the design value.

2) In the case of the quantity of specimen groups in an inspection lot, $n < 10$, the average value of compressive strengths of specimens shall not be less than 1.05 times of the design value, and the compressive strength of any one group specimens shall not be less than 90% of the design value.

E.0.4 For measuring items, the compressive strength of shotcrete in the section under evaluation fails, then the corresponding itemized-work shall be verified as disqualified.

Appendix F: Determination of Cement Mortar Strength

F. 0. 1 The inspection of cement mortar strength shall be based on the strengths tested on the cubes with 70. 7mm side lengths after a 28-day standard curing period. Three test specimens shall be used as one group, and the number of groups for testing shall conform to the requirements as follows.

1 The test specimens shall be sampled randomly and separately in terms of different strengths and various mixes of cement mortar;

2 For important and main masonry structures, two groups shall be prepared in every working shift;

3 For ordinary and minor masonry structures, one group may be prepared in every working shift;

4 The number of groups of test specimens shall not be less than three;

5 In order to satisfy the needs for construction, extra groups of specimens shall be prepared and cured in the same conditions as that for the parent structures in order to check the strength in each construction stage.

F. 0. 2 Testing and calculation methods shall conform to the criteria of current *JGJ/T* 70 *Basic Testing Methods for Construction Mortar.*

F. 0. 3 The strength of cement mortar shall conform to the following criteria:

1 The average strength of specimens in the same strength grade shall not be lower than 1. 1 times of the designed strength in that grade;

2 The strength of any group of specimens shall not be lower than 85% of designed strength.

F.0.4 If in the measuring items, the strength of cement mortar is judged as disqualified, then corresponding subdivision of works shall be deemed to be unqualified.

Appendix G: Determination of Strength of Chemically Stabilized Materials

G.0.1 The strength of chemically stabilized materials shall be the unconfined compressive strength at 7-days during which the specimens are cured in a certain moisture environment for 6 days and in water immersion for 1day at the specified temperature.

G.0.2 The samples shall be taken on site at a frequency as specified, and the specimens shall be prepared according to the expected field compaction. One group of specimens shall be prepared for every 2 000m^2 of the material constructed or in a working shift. Regardless of particle sizes, 6 specimens shall be prepared where the coefficient of variation of compressive strength, $C_v \leqslant 10\%$; 9 specimens where $C_v = 10\% \sim 15\%$; and 13 specimens where $C_v > 15\%$.

G.0.3 The average strength of a specimen, $\overline{R}$, shall satisfy the formula (G.0.3):

$$\overline{R} \geqslant R_d / (1 - Z_\alpha C_V) \tag{G.0.3}$$

Where: R_d——Design compressive strength (MPa);

C_V——The coefficient of variation of the test results (expressed as decimal);

Z_α——Coefficient varies with the reliability in the standard normal distribution table.

Expressway and Class I highway: reliability is 95%, $Z_a = 1.645$;

Other highways: reliability is 90%, $Z_a = 1.282$.

G.0.4 If the strength of the chemically stabilized material in an evaluation segment is rejected by verification, the item of work is rejected.

Appendix H: Determination of Thickness of Pavement layers

H.0.1 The thickness of the pavement structural layers in a segment under inspection shall be determined according to the representative value and allowable deviation of individual compliance value.

H.0.2 The thickness shall be inspected by digging a pit or core drilling at a frequency as specified.

H.0.3 The representative value of thickness is the minimum confidence threshold of arithmetic mean of thickness as follows:

$$X_{\mathrm{L}} = \overline{X} - t_{\alpha} \frac{S}{\sqrt{n}}$$

Where: X_{L}——Representative value of thickness (which is the confidence threshold of the arithmetic mean);

$\overline{X}$——Average value of thickness;

S——Standard deviation;

N——Number of points inspected;

t_{α}——Coefficient varying with number of points tested and reliability (or confidence threshold α) in the t-distribution table; t_{α} refers to Table B.0.3.

Thereliability adopted: 99% for subbase and base courses and 95% for earthworks and surfacing course on Motorways and Class-1 highways; and 95% for subbase and base courses, and 90% for earthworks and surfacing course on other classified highways.

H.0.4 Where the representative value of thickness is larger than or equal to the value of the design thickness minus the allowable deviation of the representative values, the compliance shall be calculated based on the single inspection value not exceeding single-point acceptance value. If not, the corresponding item of work shall be verified as rejected.

The representative value and the allowable deviation of a single-point acceptance value refer to the table of measurement items in the relevant sections of Chapter 7.

H.0.5 The asphalt surfacing course should be determined according to the overall thickness of paved asphalt materials. Where the surfacing course on a Motorway or Class-1 highway is paved in 2 or 3 layers, the upper surfacing layer shall be inspected and verified individually.

Appendix J: Determination of Deflection on Road Subgrade, Granular Subbase and Basecourse, and Asphalt Surfacing Course

I. 0. 1 The deflection value shall be measured by using a falling weight deflectometer (FWD), auto-deflectometer or Benkelman beam. The number of inspection points for every inspection segment (not longer than 1 km) on a two-lane highway shall conform to the requirements in Table J. 0. 1. The inspection points shall be increased correspondingly in the case of a multi-lane highway.

TableJ. 0. 1 Number of Points for Deflection Measurements

Equipment	Falling Weight Deflectometer (FWD)	Auto-deflectometer or Benkelman beam
Number of points (nos.)	40	80

I. 0. 2 The representative value of deflection on subgrade or asphalt pavement layers is the upper tail of the measured deflection values, which can be calculated by the following formula:

$$l_r = (\bar{l} + \beta \cdot S) K_1 K_3$$

where l_r——The deflection representative value (0. 01mm);

$\bar{l}$——Average value of measured deflections (0. 01mm);

S——Standard deviation;

β——Target reliability indicator, refer to Table J. 0. 2;

K_1——Moisture correction factor

K_3——Temperature correction factor, which is 1 for measuring the deflection on the surface of the subgrade, or should be determined by using the following formula for the deflection on the surface of pavement layers

T——Temperature (℃) measured or predicted at the mid-depth of the asphalt layer during measuring deflection;

H_a——Thickness of asphalt bound materials (mm)

E_0——Modulus of resilience of the subgrade under condition of moisture equilibrium (MPa)

Table J.0.2 Value of Target Reliability Indicator, β

Highway Classification	Motorway	Class-1	Class-2	Class-3	Class-4
Targetreliability(%)	95	90	85	80	70
Targetreliability indicator β	1.65	1.28	1.04	0.84	0.52

J.0.3 The representative value of deflection onthe surface of a chemically stabilized subbase or base course shall be calculated by the following formula:

$$l_r = \bar{l} + Z_\alpha S$$

where l_r—— representative value (0.01mm)

$\bar{l}$——average of measured deflections (0.01mm)

S——standard deviation;

Z_α——coefficient related to the reliability: $Z_\alpha = 2.0$ for Motorways and Class-1 highways; $Z_\alpha = 1.645$ for Class-2 highways; and $Z_\alpha = 1.5$ for Class-3 and-4 highways.

J.0.4 On Class-2 and lower class highways where the representative values of deflections on subgrade or granular subbase and base course do not conform to the requirements, individual values beyond $\bar{l} + (2 \sim 3)$S may be deleted. The boundary of these deleted points shall be identified and treated individually, and then the deflections may be re-measured, the means and standard deviations may be re-calculated. However, the deletion of individual values is not allowed for Motorways and Class-1 highways.

J.0.5 The corresponding items of work shall be verified as disqualified where the representative value of deflection is greater than the design deflection.

AppendixK: Forms for Inspection and Verification of Quality of Construction Works

TableK-1: Inspection and Verification of Quality of Subdivisions of Work

Subdivision of work: Position of work (Chainage, Code of pier/abutment/span): Project (package of contract):

Division ofwork: Type ofwork: Contractor: Code of subdivision of work:

Basic requirement		1. 2. ….														
Measurement Item	No.	Inspection item	Specified value or allowable deviation	Value or offset measured										Qualityverification		
				1	2	3	4	5	6	7	8	9	10	Average value& rep. value	Rate of conformity (%)	Verification
Appearance										QA Data						
Grade of quality																

Inspector in charge Inspected by: Recorded by: Checked by: Date:

TableK-2: Inspection and Verification of Quality of Division of Work

Division of work:　　　　　　　　　　Position of work: (Chainage, Code of Pier/Abutment/Span)

Type of work:

Project (Package of Contract):

Contractor　　　　　　　　　　Code of division of work:

Subdivision of work			Remarks
Code	Name	Grade of Quality	

Inspector in charge:　　　Recorded by:　　　Checked by:　　　Date:

Table K-3Inspection and Verification of Quality of Type of Work

Name of type of work： Location or chainage：

Project (Package of contract)：

Contractor： Code of type of work：

Division of work			Remarks
Code	Name	Quality grade	
Appearance			
Verification file：			
Grade of quality			
Conclusion			

Inspector in charge： Recorded by： Checked by： Date：

Appendix L: Determination of the Sideways Force Coefficient of a Pavement Surfacing

L. 0. 1　Pavement side-ways force coefficient (SFC) shall be determined in accordance with design value or the acceptance value of SFC.

L. 0. 2　The representative value of SFC refers to the minimum confidence threshold of the arithmetic mean, which is

$$\mathrm{SFC_r} = \overline{SFC} - t\alpha \frac{S}{\sqrt{n}}$$

Where: $\mathrm{SFC_r}$——Representative value of SFC

$\overline{SFC}$——mean of SFC

S——Standard deviation

n——sample size for data collection

t_α——coefficient varies as number of points surveyed and reliability with the t distribution in Table B. 0. 3. Reliability adopted: 95% for Motorways and Class-1 highways; or 90% for other classified highways.

L. 0. 3　Compliance shall be calculated from all the individual values of SFC where the representative value of SFC is not less than the criterion specified in the design or that for acceptance.

Appendix M: Determination of Compressive Strength of Cement Grout

M. 0. 1 The compressive strength of cement grout shall be evaluated by using cuboid specimens (40mm × 40mm × 160mm in size) with a standard curing period of 28 days. Every group of specimens shall comprise 3 specimens, and the number of groups shall be determined in accordance with the criteria as follows.

1 The test specimens shall be sampled in random and prepared separately in terms of grades of strength and specific mix;

2 Every work crew or shift shall sample and prepare one group of specimens, or one group of specimens for every $10m^3$, if the volume consumed is more than $10m^3$.

3 For grouting pile foundation, at least one group of specimens shall be sampled and prepared for every pile.

4 For groutingprestressing conduits, at least one group of specimens shall be sampled and prepared for every grouting operation or every 25 conduits under grouting.

5 For grouting anchor rods, at least on group of specimens shall be sampled and prepared for every grouting operation or every 50 anchor rods under grouting.

M. 0. 2 The testing procedures and calculation methods shall conform to the current GB/T17671: *Method of testing cements-Determination of Strength*. Every group of specimens shall be tested for six values of compressive strength.

M. 0. 3 The strength of cement grout shall conform to the criteria as follows.

1 The average of compressive strengths derived from the specimens in the same strength grade shall not be less than designed value;

2 The compressive strength of any group of the specimens shall not be less than 85% of the design value.

M.0.4 In measuring items, if the compressive strength of cement grout under evaluation is verified unqualified, then the corresponding subdivision of work shall be failed.

Appendix N: Determination of Normal Bonding Strength Between Waterproofing layer and Concrete Surface

N.0.1 This Appendix applies to the testing and determination of normal bonding strength of the waterproofing layer in a concrete bridge deck.

N.0.2 The technical performance of an on-field detector (pull-off tester) for identifying of bonding strength shall not be lower than the criteria in JG 3056: Digital Sticking Strength Tester.

N.0.3 The number of measuring points and their distribution shall conform to the following requirements:

1 Measure 5 points if the area of a construction section is not more than $500m^2$, add 2 measuring points for each area increment of $500m^2$. One construction section is defined as each waterproof bridge deck length constructed continuously.

2 The measuring points shall be arranged randomly and their spacing are not less than 5.0m.

N.0.4 The measured surface shall be clear and dry. A pre-cut slot shall be in a 50mm circle along which cut from a clean surface into concrete about 3 to 5mm deep and 1 to 2mm wide. The surface shall be cleaned again after the slot is cut.

N.0.5 Using high strength and fast bonding glue to stick a standard steel unit, during which attention shall be paid to avoid the glue enter into the precut slot. The steel standard block must not be disturbed before fully fixed.

N.0.6 A standard block shall be made of Grade 45 steel, 50mm in diameter and as least 20mm in thickness, on which an attached load transmission screw shall be assured to satisfy the requirements for inspection instruments.

N.0.7 The steel standard unit shall be stick to the solidification of waterproofing layer after it fully dried. The loading shall be applied at a uniformly increment speed equal to or slower than 0.2MPa/s; the loading value and the temperature of waterproofing layer at failure shall be recorded, and the failure mode shall be observed. The waterproofing layer damaged by the test shall be patched and repaired after the testing.

N.0.8 Normal bonding strength shall be calculated by equation (N.0.8):

$$f_i = \frac{P_i}{A} \tag{N.0.8}$$

where f_i——normal bonding strength of point i(MPa);

P_i——breaking load of point i(N);

A——bonding area of standard steel unit (mm^2)

N.0.9 No breaking off shall happen at the interface between the standard steel unit and the bonding glue. Otherwise, the test shall be re-processed.

N.0.10 The measured bonding strength shall be adjusted according to the actual temperature at the spot inspected where the temperature at inspected spot is not in consistent with the temperature corresponding to design strength.

N.0.11 The bonding strength of a waterproofing layer shall conform to the following criteria:

1 The average of measured strength shall be greater than or equal to designed strength value;

2 The number of measuring spots with measured strength less than the design value shall not exceed 5%;

3 The minimum strength measured shall not be less than 85% of designed value.

N.0.12 In measuring items, if the bonding strength of waterproofing layer is verified as unqualified, the corresponding subdivision of work shall be judged as unqualified.

Appendix P: Limited defects of Appearance Quality of Structural Concrete

P. 0. 1 The appearance quality of structural concrete shall be inspected thoroughly.

P. 0. 2 Coating work shall not be conducted on the surface of structural concrete before the appearance is inspected.

P. 0. 3 The limited defects of appearance quality of structural concrete shall be identified and determined in accordance with Table P. 0. 3 hereinafter.

Tab. P.0.3 Limited defects for Appearance Quality of Structural Concrete

	Description	Limited defects		
		Partially compressed units or parts: underpass, concrete under anchor, cushion of anchor cables	Beam, slab, arch, piers and abutment, capping beam, pylon column, barriers, curbs, expansion joints, anchor, sealing concrete, and. precast small units, etc.	Retaining wall, pile cap, anchorage block, filling body of tunnel anchor, caisson, foundation, approach slab, slope beams, etc.
Crack	Cracks extended from surface to the internal areas	Non-stressed cracks, and stressed crack whose width exceed the value specified by design ①	Non-stressed cracks, whose widths exceed specified values in design, exist. ①(If no specific values in design, 0.3mm for barriers, slope beams, and embedded structures or units; and 0.2mm for other structures or units); Non-stressed cracks existin full prestressed concrete or Type-A prestressed concrete units; Unstressed cracks, whose width exceed specified value in design or relevant specifications, exist on Type-B prestressed concrete or reinforced concrete units.	
Hole	Holes whose depth exceed the concrete-cover.	Holes Exist.		
Exposed re-bar	Exposureof reinforcement steel uncovered by concrete.	Exposed reinforcement steel exists.		
Honeycomb	Exposedcoarse aggregate due to insufficient cement paste at the concrete surface, looks like honeycombs.	Concrete honeycombing Exists.	Honeycombing exist in main stressed zones②; Otherzones: honeycombing area of a single spot exceeds 0.02m^2, or cumulated honeycombing area exceeds 1%, or any honeycomb with a depth greater than either 10mm or half of the concrete cover.	Honeycombing area of a single spot exceeds 0.04m^2, or cumulative honeycombing area exceeds 2% of the total concrete surface area, or any honeycomb with a depth greater than either 10mm or half of the concrete cover.

continue

	Description	Limited defects		
		Partially compressed units or parts: underpass, concrete under anchor, cushion of anchor cables	Beam, slab, arch, piers and abutment, capping beam, pylon column, barriers, curbs, expansion joints, anchor, sealing concrete, and. precast small units, etc.	Retaining wall, pile cap, anchorage block, filling body of tunnel anchor, caisson, foundation, approach slab, slope beams, etc.
Concrete Loosing	Partial concrete loosing resulted from segregation or lack of vibration.	Concreteloosing exists.	Main stressed zones[②]: Concrete loosing exists Otherzones: cumulated loosing area exceeds 1% of total area of the surface, or the loosing area of a single spot exceeds 0.02m^2, while the loosing depth exceeds 10mm or 1/2 of the concrete cover.	Cumulated loosen area exceeds 2% of total area of the surface, or the loosing area of a single spot exceeds 0.04 m^2, while the loosing depth exceeds 10mm or 1/2 of the concrete cover.
Slag Inclusion	Slags arecontained in concrete.	Slag inclusion exists.	Metallic slags such as steel bars or steel plates may be regarded as exposed reinforcing steel; Non-metallic slags such as soil lumps, wooden pieces, concrete fragments, etc. may be regarded as honeycombs.	——
Pitted Surface	Rough surface with small dense pits in small areas due to lack of cement grout.	For precast units: cumulated area of pitted surfaces exceeds 2% of total area of the concrete surface; For other structures or units: cumulated area of pitted surface exceeds 3% of the total concrete surface area.		For exposed structures or units: cumulated area of pitted surfaces exceeds4% of total area of the concrete surface; For concealed structures or units: cumulated area of pitted surfaces exceeds 3% of the total concrete surface area.

continue

	Description	Limited defects		
		Partially compressed units or parts: underpass, concrete under anchor, cushion of anchor cables	Beam, slab, arch, piers and abutment, capping beam, pylon column, barriers, curbs, expansion joints, anchor, sealing concrete, and. precast small units, etc.	Retaining wall, pile cap, anchorage block, filling body of tunnel anchor, caisson, foundation, approach slab, slope beams, etc.
Outline Defects	Unsquared edge, surface warping, convex ribs of overflow edges, edge failure and corner failure	Anyoutline defects affecting the structural functions or unit installation, the edge failures or corner failures with a depth greater than 1/2 of the concrete cover.		
Other defects on concrete surface	Peeling off, surface roughing and contamination	For precastunits, cumulated area of the defects exceeds 2% of total area of the whole surface; For cast-in-situ units, cumulated area of the defects exceeds 3% of total area of the whole surface	For exposed structures or units: cumulated area of the defects exceeds4% of total area of the structure or unit; For concealed structures or units: cumulated area of the defects exceeds6% of total area of the structure or unit.	

Note: 1. Non-stressed cracks are the defects caused by the actions other than loads, and stressed cracks are caused by the action of loads.

2. The main stressing zones include the midspan and bearing segments of a beam, slab, capping beam, the segments of arch springing, arch vault, and the bottom segments and connection segments of a pylon or column bottom area, connection area, etc.

Appendix Q: Method of Surveying Tunnel Cross-Section by Laser Profiler

Q.0.1 scope of application

The method for inspecting and surveying tunnel cross-section with laser profiler (or simplified refer to as laser profiler method) is suitable for determining cross-sections in terms of tunnel excavation, initial lining and secondary lining section so as to evaluate the quality of tunnel excavation and identify whether the cross-section of support (lining) intrudes into the tunnel clearance profile.

Q.0.2 The tunnel laser profiler is mainly composed of three parts: a detectionhost, a PDA, and data processing software.

The main technical parameters:

1 Detecting radius: 1m to 45m.

2 Detecting points: automatic detecting, usually 35 points on each cross-section.

3 Ranging accuracy: better than ±1 mm.

4 Angle measurement accuracy: better than 0.01°.

5 Azimuth range: 30° ~ 330° (the instrument's probe head is 0° vertically downwards), continuous measurement is 60° ~ 300°.

6 The rotation range of azimuth of manual probe: 0° ~ 350°.

7 Positioning and measuring method: providing a mark for vertically downward centering by laser and the function of distance measuring.

Q.0.3 Preparation operations shall proceed prior to the cross-section surveying by tunnel laser-profiler. Firstly, a total station is used to set out the centerline of the tunnel in a certain interval according to the frequency specified for inspection, usually 20m for excavation, 10m for initial support lining, and 20m for secondary lining. Secondly, a level is used to measure the ground elevations (H) of every point along the centerline, and then to set out and mark the corresponding points for cross-sections on both side walls of the tunnel. The steps of inspecting and surveying cross-sections by laser-profiler are as follows:

1 Place the tunnel laser-profiler at one of the center line points where the tunnel cross-sections are to be surveyed, install the instrument and make it be centered.

2 After the instrument is installed and centered to zero, measure the instrument height Z_1 and record (the instrument height is the height of the instrument relative to the ground).

3 Select [X-section] in the main menu on thePDA.

4 Then select [New Measure], input the chainage (stake number) of the cross-section, and setup the parameters such as the starting and ending measurement angles of the cross-section and the number of points to be detected.

5 Finally, select [Measure], the tunnel laser profiler probe will automatically complete the detection of the section and save the parameters such as angle and slope distance in the file. The contour of the detected section can be seen in the field.

6 Exit the program after the screen shows [complete] in prompt bar. All detection data will be automatically saved in PDA and the next cross-section survey may start. In order to minimize the disturbances to site activities, all survey data shall be brought back office for further processing.

Q.0.4 After site survey, the data in PDA shall be transmitted to a computer for further processing by the specific software.

1 The designed contour (or typical cross-section) of the tunnel shall be edited and plottedby computer. The surveyed cross-section data shall be uploaded to the computer for processing and editing. Note that the instrument is set at a point on centerline at bottom of the tunnel, which means the X coordinate value of the point is zero, and the Z value is defined as the instrument height relative to the design elevation of the pavement surface in the tunnel and shall be calculated according to the following formula:

$$Z = Z_1 - (H_2 - H_1)$$

Where: Z_1——The height of the instrument measured on site (m)

H_2——The design elevation of the stake number of the detection section of the tunnel (m)
H_1——Ground elevation during on-site detection of tunnel (m)

2 Z values are input, andfollowed by keying in other relevant data about the measurement (such as the time of survey, the undertaker of survey and the surveyor in charge, etc.) to complete the editing of the current cross-sections. Then the computer shall automatically produce related charts and tables.

3 Finally, the typical cross-section profiles and the measured cross-section profiles in the charts shall be compared andanalyzed to identify if there is any over-break or under-break of tunnel excavation, and then the positions, the maximum values and areas if there is any. Meanwhile, the computerized program may further identify whether and where there is any intrusion into the clearance profiles at support lining or secondary lining and their positions, and also give the information about the maximum values in relation to the intrusion into clearance profiles, the areas intruded, and so forth.

Appendix R: Method for Detecting Quality of Tunnel Support (lining) by Geological Radar

R.0.1 The method of detecting the quality of tunnel support (lining) by geological radar (hereinafter refer to as geo-radar method) is applicable to detect the thickness of tunnel support (lining), the compaction of backfill behind, and the position and distribution of embedded steel frames and steel bars.

R.0.2 Technical indicators of the mainframe of a geological radar shall include the following characters:

1 Thetransmission gain of a system shall not be less than 150dB.

2 The signal-to-noise shall not be less than 60dB.

3 A/D conversion shall not be less than 16 bits.

4 Sampling intervals shall usually not be greater than 0.2ns.

5 Signal superposition timesshall be added optionally by manual or automatic.

6 Data shall be triggered and acquired by distance/time/manual modes.

7 Point measurement and continuous measurement functions shall be provided.

8 Manual or automatic functions for position marking shall be provided.

9 On-site data processing function shall be provided.

R.0.3 A geological radar antenna shall conform to the following requirements:

1 The antennashall have shielding function;

2 The vertical resolution shall be higher than 2cm;

3 For detecting the density of backfill behind tunnel supporting (primary lining), the maximum detection depth shall be greater than 2m, (thus a 500MHz antenna is preferred).

R.0.4 On-site detection shall conform to the following requirements:

1 When detecting work is conducted during tunnel construction, the survey lines shall be set out mainly in a vertical arrangement, and supplemented with horizontal arrangement. For a two-lane single tube tunnel, five survey lines shall be set out: one survey line along the arch crown, two survey lines along both left and right arch haunches, and the other two along both left and right sidewalls. For a three-lane single tube tunnel, two additional survey lines are required to add along the arch haunches. An additional survey lines shall be added wherever defects exist in tunnel support (lining).

2 During the inspection of taking-over stage, the setting-out of survey lines should be mainly in vertical arrangement and supplemented by horizontal arrangement. A total of three survey lines shall be set out for a two-lane single tube tunnel, which are one along the arch crown, and two along both left and right arch haunches. Two survey additional survey lines shall be added along the arch haunches for a three-lane single tube tunnel. An additional survey line shall be added wherever defects exist in tunnel support (lining).

3 There shall be a chainage mark at every 5-10 m of a survey line.

R.0.5 The parameters of medium shall be calibrated in accordance with the following requirements:

1 Before the detection, the dielectric constant orthe electromagnetic wave velocity of support (lining) concrete shall be calibrated on site at least 3 times in at least one point in every tunnel, and taking the average value as the dielectric constant or electromagnetic wave velocity in the tunnel. Additional calibration points shall be required for an extra-long tunnel.

2 The calibration may be conducted by one of the following methods, such as the on-site measurement by drilling, the measurement on other embedded parts of the known thickness or the same material as that of the tunnel, or the measurement of direct waves by using

dual-antenna at a portal or in a refugee adit.

3 Conditions for obtaining parameters shall be that the thickness of a calibration target is known and generally not less than 15cm; the reflection signal at interface during the calibration recording shall be clear and accurate.

4 The resultsof calibration shall be calculated according to formula (R.0.5-1) or (R.0.5-2)

$$\varepsilon_r = \left(\frac{0.3t}{2d}\right)^2 \quad (R.0.5\text{-}1)$$

$$v = \frac{2d}{t} \times 10^9 \quad (R.0.5\text{-}2)$$

where: ε_r——Relative dielectric constant

v——Electromagnetic wave speed (m/s)

t——Two-way traveling time (ns)

d——Thickness of target object for calibration (m)

R.0.6 Instrument operation shall conform to the following requirements:

1 The inspection personnel shall be trained in advance and before operating instrument to understand the performance and working principle of the instrument, and have certain experience in image recognition;

2 Before a detection begins, the connection of a radar system shall be inspected to ensure the connection in normal state, and a trial operation shall be conducted to ensure that the mainframe, antenna and input/output equipment are operating normally;

3 The chainage shall be accurately marked on the surface of tunnel support (lining) before a detection;

4 For detecting (when radar images are being collected), the antenna (except for air-coupled antennas) and the surface of support (lining) shall contact to each other properly and seamlessly;

5 For detecting (when radar images are being collected), the moving of antenna shall be stable and uniform. The moving speed should be 3 ~ 5km/h;

6 Detection records shall include the data on the position and identification number of survey lines, the moving direction, marking interval and type of antenna;

7 In the case detection in section is required, the overlapping length of adjacent detection

sections shall not be less than 1m;

8 The objects that may have electromagneticinterference to detection, such as seeping water, cables, iron frames and embedded pipe fittings, and their positions shall be recorded in time;

9 Detection activities shall conform to relevant safety procedures and regulations.

R.0.7 Data processing shall conform to the following requirements:

1 Before data processing, inspection shall be conducted to make sure that the original data is complete, the signal is clear and the chainage record is correct;

2 Only officially certified or qualified software shall be used for data processing and interpretation;

3 The correct filtering method shall be adopted for data processing so that the quality of tunnel lining can be properly analyzed and correctly interpreted based on these data images.

R.0.8 The data interpretation shall conform to the following requirements:

1 The interpretation by radar data shall be based on in-field records to analyze the positions of pre-embedded rigid members, as embedded pipe fittings, with which possibly interference may exist, and accurately distinguish the abnormity of internal defects in tunnel support (lining) from that of embedded pipe fittings;

2 Afterand based on the interpretation by radar data, verification shall be conducted on-site by

R.0.9 The main characteristics for interpreting and determining the compaction of backfill behind tunnel support (lining) shall conform to the following provisions:

1 Dense: the reflection signal isweak; the image is uniform, and the reflection interface is not obvious;

2 Not dense: the reflection signal is strong and the image changes disorderly;

3 Cavity: the reflection signal is strong; the image is arc-shaped, and the reflection interface

is obvious.

R.0.10 The distribution of steel frames, steel bars, and pipe fittings embedded in tunnel support (lining) shall be identified by the main characteristics and rules as follows:

1 Steel frame and pipe fittings: the reflection signal isstrong; the image is in a scattered crescent;

2 Steelbars: the reflection signal is strong, and the image is in a continuous small hyperbola.

Appendix S: Method of Inspection of Construction Quality of Hot-melt Seams of Waterproof Boards

S. 0. 1 The working principles of a hot-melting machine for waterproof board connection are as shown in Figure S. 0. 1 below: the motor via a reduction gear box drives the upper and lower pressing rollers, while a sliding bracket drives the heating wedge and insert it between two films of parent material, and then the pressing arms apply pressure on the pressing rollers which in turn transmit the pressure so that the two hot melted films of parent material be pressed and melted into one.

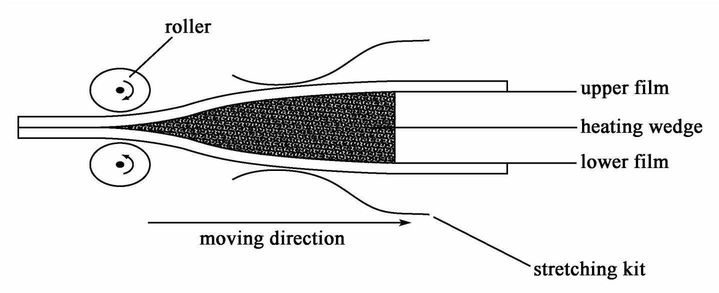


Figure S. 0. 1 Diagram of Hot Melting

S. 0. 2 The quality inspection of the hot melting joints of waterproof boards shall conform to the following requirements:

1 The hot melt seams of waterproof board are usually inspected with the naked eyes. If a seam looks transparent and free of bubbles, itimplies that the two films has been well hot-melted into one, and thus the seam is strong and tight.

2 A hot-melt seam of waterproof boards may be inspected by random sampling and air inflation method, as shown in Figure S. 0. 2. The air pump equipped with a pressure gauge inflates the seam under inspection until the required pressure is reached, e. g. 0. 25Mpa, and keep for 15minutes. If the pressure drops less than 10%, the seam is qualified while there is some poor melts exit in the seam if the pressure drops more than 10%. Such poor melts may be detected by applying soapy water to the welding seam and check the places in bubbling. If the readings of pressure gauge do not drop or drop by less

than 20% without air leakage for 2 minutes, it means that the hot melt seam is qualified; otherwise, the seam shall be further inspected and repaired.

3 The tensile strength of the hot-melt seam shall not be less than 70% of the strength of the waterproof board, and the peel strength of the seam shall not be less than 70 N/cm. Re-melting shall be requiredif there is any missing or false spots in the seam. Any scorches, burnt holes or exposed fixed points shall be patched and hot-melted with the same material as waterproof boards.

Wording Explanation for the *Standards*

This strictness in execution of the*Standards* is expressed by using the wording as follows:

1) Must—A very restrict requirement in any circumstances.

2) Shall—A mandatory requirement in normal circumstances.

3) Should—An advisory requirement.

4) May—A permissive condition. No requirement is intended

Background to Provisions

1 General Provisions

1.0.1 This Clause defines that the objective of these standards is to regulate the activities of quality inspection and verification for highway works so as to insure quality of highway construction. Reference shall be made to Highway Laws of the People's Republic of China, in which:

Article 26 states that "*highway construction must conform to the technical standards for highway engineering. The organizations responsible for highway design, construction or quality supervision shall establish suitableQ/A systems and strictly apply the quality responsibility system in accordance with related regulations of the country and shall undertake to design, construct or supervise the projects in compliance with related laws, regulations, codes and in accordance with the requirements specified in the technical standards for highway engineering and the conditions of contracts in order to ensure the quality of construction.*"; and

Article 33 states that "*a handing-over inspection shall be conducted upon completion of construction; any highway, either newly constructed or rehabilitated, must not be placed in use before a successful handing-over inspection.*"

The inspection for acceptance can be conducted in levels of work, namely type of work, division ofwork and subdivision of work.

1.0.2 The scope and subjects of application have been modified in this Edition.

On the basis of the suggestions of peer expertise and the guiding opinions of the highway administration of MOT, this Edition defines '*these standards are applicable to inspection and verification of construction quality of new construction, upgrading and reconstruction of classified highways*'.

The standards for quality inspection and verification of highway maintenance are given separately in other specifications. Thus these standards are not applicable to highway maintenance.

In this Edition, detailed criteria for environmental protection and electrical/mechanical works are not given separately in specific provisions. As stated in appendix A, building works are categorized as associated works and may be assigned as a type of work, for which quality verification shall be conducted in accordance with relevant specialist criteria.

In this Edition, the subjects of application have been withdrawn. Since the duties and responsibilities of highway administrations, quality supervising authorities and construction participants for quality inspection, verification and acceptance have been stated in relevant regulations, only brief notes are given in clause 3.1.3 of this Edition.

1.0.3 This Edition defines the attributes of these standards in the process of quality inspection and verification of highway construction, that is, the threshold limiting values of criteria for construction quality of highway works. Practitioners shall keep the essence of these standards in mind and apply them strictly.

In practice, the execution of these standards for inspection and verification might be compromised occasionally, which would have a negative impact on highway quality and performance. During the revision period of this Edition, an extensive survey was conducted to collect opinions from transport administrations and quality supervising authorities at both national and provincial levels and also from construction firms. Based on the opinions obtained at a specialist seminar organized by MOT in 2013, the clarification is made that the '*criteria for quality inspection and verification*' are '*the threshold limiting values of the criteria for construction quality of highway works*', *which defines the role and position of* '*these standards in quality inspection and verification of highway construction*', and also emphasizes the normative requirements for conformity.

These standards, as the limiting values of highway construction, take the consistency with relevant design and construction specifications into account. However, some discrepancies may exist, in which case these standards prevail. If the requirements in terms of specified values and tolerances for quality inspection are different from those of newly undated technical specifications, the provisions in the new technical specifications may be also used during the application of these standards.

1.0.4 These standards should be regarded as mandatory technical regulations, and thus must be strictly applied in practice. However, they are the result of popular experience or practice, and therefore may not be able to provide provisions for all situations, such as those in extraordinary regions, or where newly introduced materials, designs or techniques are adopted. In such cases, reference should be made to other relevant standards to develop proposals suitable for quality assurance, which is submitted to the authorities in charge for approval in accordance with required procedures.

This clause gives provisions for unusual situations which may be encountered in practice. Special criteria for quality inspection and verification may be developed based on actual conditions. Firstly it must be ensured that there are no loopholes and secondly that the criteria are submitted for approval by the controlling authorities. This procedure is proposed to resolve the technical disputes or arguments that may occur during the implementation of these standards.

2 Terms and Definitions

With reference to the current GB 50300: *Unified standard for constructionalquality acceptance of building engineering*, this chapter gives definitions and explanations to important technical terms, such as inspection, verification, dominant item, general item, and quality of appearance, used in these standards. This Edition introduces a new method of quality verification and cancels the previous explanation on weighting.

For other technical terms applied to highway engineering, reference may be made to relevant national standards, industry standards, and especially the construction specifications in these standards.

2.0.2 Verification

The requirements for work classification stated in Chapter 3 ofthe previous edition are now expressed as definitions to the terms of type ofwork, division ofwork and subdivision of work in this Edition.

2.0.3 Dominant item

This term is also defined in GB 50300 Unified standard for constructional quality acceptance of building engineering.

2.0.5 Quality of appearance

This term is also defined in GB 50300 Unified standard for constructional quality acceptance of building engineering.

3 Basic Elements

The title of this Chapter has been changed from Engineering Quality Evaluation to Basic Elements. This Chapter comprises three sections as in the previous edition. The titles of these sections have been changed to General, Quality Inspection, and Construction Quality Verification.

Since the verification-by-rating method has been abolished, the hierarchical structure of quality inspection and verification needs to be re-defined, which may be represented as: construction project →contract package→type of work→division ofwork→subdivision of work→inspection-verification portfolio (basic requirements, measurement items, appearance quality and quality assurance data) → measurement items (presented in tabular format) →inspection items (as shown in tables) →measurement criteria (some inspection items may contain multiple indicators, such as pavement surface roughness and friction coefficients.).

3.1.1 A highway construction project is usually in a long line, scattered with many structural works and involves multiple technologies, and thus the elements of quality inspection and verification shall be well defined. Work classification, or work breakdown system (WBS), is one of the fundamental elements for project management. Work classification shall be conducted at the start-up stage of a construction project, at which all types of work, divisions of work and sub-divisions of work are assigned with a unique identification by using a unified coding system.

3.1.2 Since 1985 when these standards of quality inspection and verification of highway works was first implemented, a bottoms-up methodology has been used for quality inspection and verification of highway projects, which is from sub-divisions of work, divisions ofwork and types of workup to packages of contract. Classification of sub-divisions of work, divisions ofworks and types of work is one of the major tools used by project management and is in the core concept of these standards. It involves construction management in terms of quality, safety, progress, cost and other aspects and thus provide a platform for interactive activities performed by various project stake-holders such as contractor, supervisor, and client.

3. 1. 3 According to the legal requirements and regulations, construction contractors are responsible for construction quality. Therefore, the contractors of a project shall execute the inspection and verification of construction quality in accordance with these standards.

Duties and tasks of relevant parties, including the client, supervisors, contractors, governmental agencies for quality supervision and quality measuring and testing, are defined in *Inspection Procedures for Completion and Handing-over of Highway Works*. This part of the provisions is withdrawn from these standards.

JTG G10-2016, *Specifications for Supervision of Highway Construction*, stipulates that the contractor's site office shall inspect and verify the division ofworkon completion without delay. Chief Resident Engineer and his supervisory team shall promptly organize the quality verification on types of work and contract package.

Procedures for quality inspection and verification of highway works are as shownin Fig. 3-1

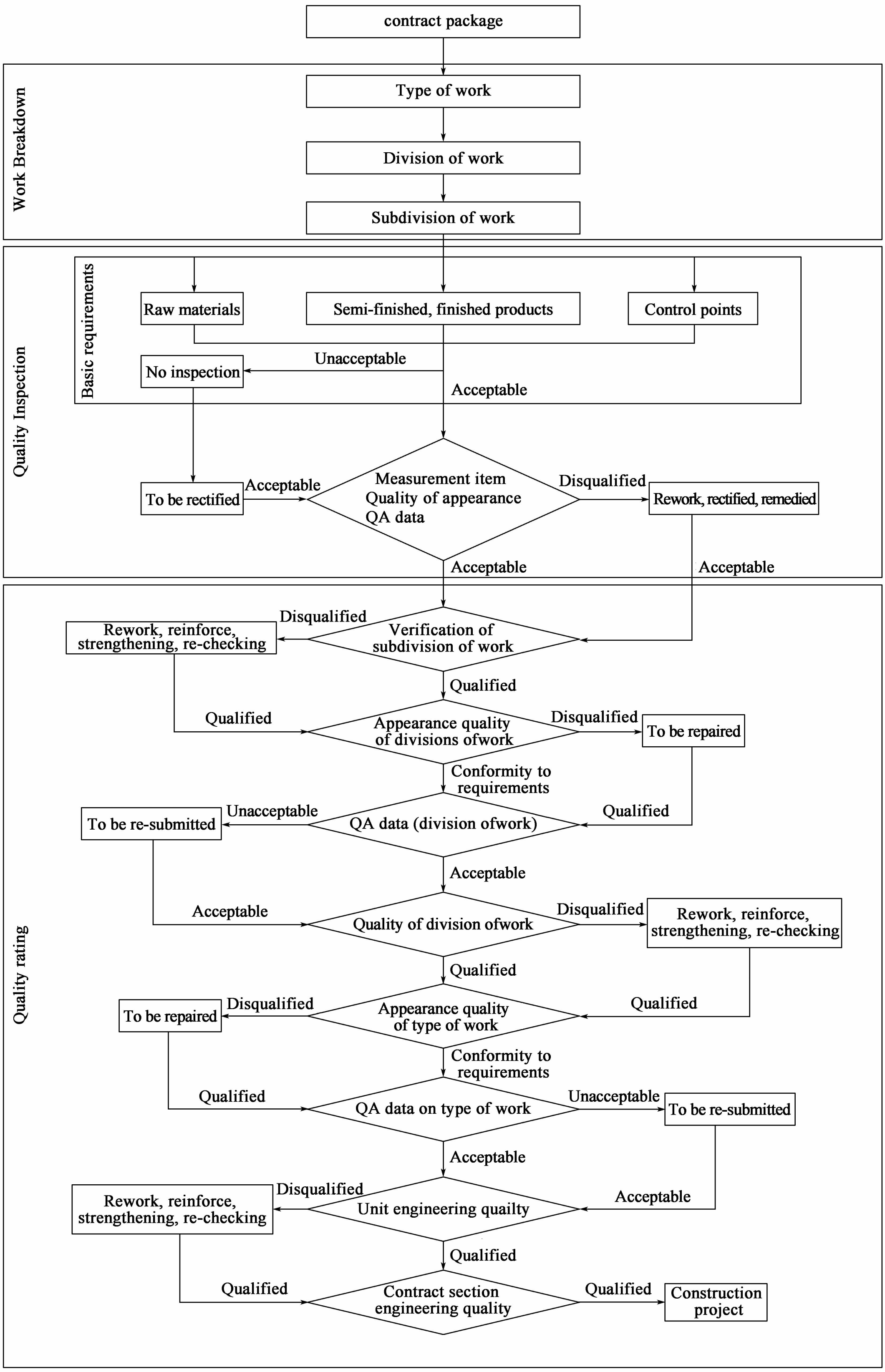


图 3-1　公路工程质量检验评定流程

Table 4-1　Gravity density of soil, internal and external friction angles

<table>
<tr><td colspan="3">合同段　contract package</td></tr>
<tr><td rowspan="3">工程划分
Work Breakdown</td><td>单位工程</td><td>Type of work</td></tr>
<tr><td>分部工程</td><td>Division of work</td></tr>
<tr><td>分项工程</td><td>Subdivision of work</td></tr>
<tr><td rowspan="9">工程质量检验
Quality Inspection</td><td>基本要求</td><td>Basic requirements</td></tr>
<tr><td>原材料</td><td>Raw materials</td></tr>
<tr><td>半成品、成品</td><td>Semi-finished, finished products</td></tr>
<tr><td>施工控制要点</td><td>Control points</td></tr>
<tr><td>不予检验</td><td>No inspection</td></tr>
<tr><td>整改</td><td>To be rectified</td></tr>
<tr><td>实测项目检验外观质量
质量保证资料</td><td>Measurement item Quality of appearance
QA data</td></tr>
<tr><td>返工、整修、整改</td><td>Rework, rectified, remedied</td></tr>
<tr><td>返工、加固、补强、调测</td><td>Rework, reinforce, strengthening, re-checking</td></tr>
<tr><td rowspan="10">工程质量等级评定

Quality rating</td><td>分项工程评定</td><td>Verification of subdivision of work</td></tr>
<tr><td>分部工程外观质量</td><td>Appearance quality of divisions ofwork</td></tr>
<tr><td>返修</td><td>To be repaired</td></tr>
<tr><td>补充</td><td>To be re-submitted</td></tr>
<tr><td>分部工程质量保证资料</td><td>QA data (division ofwork)</td></tr>
<tr><td>分部工程质量</td><td>Quality of division ofwork</td></tr>
<tr><td>单位工程外观质量</td><td>Appearance quality of type of work</td></tr>
<tr><td>单位工程质量保证资料</td><td>QA dataon type of work</td></tr>
<tr><td>单位工程质量合同段质量</td><td>Quality of the type of work</td></tr>
<tr><td>建设项目</td><td>Construction project</td></tr>
<tr><td rowspan="6">(箭线标注)
⟶</td><td>不满足要求</td><td>Unacceptable</td></tr>
<tr><td>满足要求</td><td>Acceptable</td></tr>
<tr><td>合格</td><td>Qualified</td></tr>
<tr><td>不合格</td><td>Disqualified</td></tr>
<tr><td>符合规定</td><td>Conformity to requirements</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="3">Fig. 3-1 Procedures of quality inspection and verification of highway works</td></tr>
</table>

3.2　Quality Inspection

Compared tothe previous edition, significant changes have been made in this section because of the cancellation of verification-by-rating method. This Section gives details of inspection-verification portfolio, fundamental conditions of inspection and verification, the provisions for basic requirements, measurement items, appearance quality, QA data, and the consequential process for disqualified inspection-verification portfolios.

3.2.1 According to the hierarchical work classification and quality verification system developed over many years, there are four aspects in an inspection-verification portfolio, namely, basic requirements, measurement items, quality of appearance and quality assurance data.

3.2.2 This Clause clarifies the pre-requisites for quality inspection of sub-divisions of work, that is, conformity to basic requirements, free from serious defects in appearance, and correct and complete QA data.

3.2.3 These standards provide basic requirements, mainly in terms of raw materials, semi-finished or finished products and construction control elements, for each subdivision of work. These are fundamental conditions for insuring construction quality. Non-conformity of basic requirements of these standards theoretically means that the construction quality is disqualified.

To avoid repetition and to save document length, these standards give general descriptions of the types, sizes, quality of raw materials, the mixture design and semi-finished or finished products in this Section. The requirements for the materials and mixtures mentioned in other chapters and sections, subject to specific requirements, shall be referred to and followed as stated in this Section.

3.2.4 to 3.2.5 These two clauses present the core concept of quality inspection of highway construction works. In this Edition, the formermethod of verification-by-rating is withdrawn and thus quality verification shall be based on whether or not the measured percentage passing for a subdivision of work conforms to the specified requirements.

(1) Two methods, verification-by-rating and verification-by-passing-percentage, were used for quality verification since 1985 when these standardswere first issued. However, the verification-by-rating method had been criticized for many years because of its subjective shortcomings. Apart from administrative grounds, the technical aspects in relation to the rating method were reviewed and re-assessed during the updating of these standards.

Referring to national standards and the practice in other industries, verification by percentage passing is adopted as the standard method of quality inspection and verification of highway construction works.

Verification by percentage passing for highway quality is to inspect the sub-divisions of work, calculate percentage passing for each inspected item, judge the conformity of the subdivision of work in accordance with specified requirements, and then verify the quality of division ofwork, type ofwork and contract packages step by step. The method is comparatively simple, straight forward, and objective, which reduces of subjective influence and improves verification effectiveness.

(2) According to statistics over a 10-year period (2003 to 2014) on the quality of classified highways, the percentage passing in sampling inspection on highway quality has been continuously improving and reached a stable level in 2011. The average of accepted percentages are all above 95% for classified highways.

The statistical data shows that the items adopted for sampling inspection were primarily dominant items, among which:

—inspection items for earthworks includes earthwork compaction; strength of concrete for small bridges, strength of mortar and concrete for retaining structures, cross sectional sizes of retaining structure, bedding thickness and cross-sectional sizes of drainage works, the dimensions of main structures of small bridges;

—inspection items forroad pavement include deflection bowl, rutting, strength, compaction, evenness, thickness, level difference between adjacent concrete slabs, skidding, thickness and strength of bedding layers;

—inspection items for bridges includes steel bar coverage, thestrength of concrete of bridge superstructure, piers and abutments; the width, thickness and cross slopes of the bridge deck, level difference between expansion joints and deck, perpendicularity of substructures, dimensions of main superstructure and substructure works;

—inspection items for tunnels include strength and thickness of tunnel lining, clearance profile;

—inspection items for safety control devices: the central height of barrier beams, the thickness of wall of guardrail post, strength of concrete barrier, the thickness of Wsteel profile of guardrails, clearance of sign boards; and

—raw materials mainly used in highway works: asphalt, steel bars, and cement.

Furthermore, Clause 5.0.1 of GB 50300-2013: *Unified standard for constructional quality* *acceptance of building engineering*, states that the quality of alldominant items shall be measured by sampling inspection, that is, the criteria for verification is the percentage passing of 100%.

Based on the above, and taking the complexity and large variety of highway construction activities into account, it is reasonable and practicable to set qualified rate of dominant items for all categories of engineering as 95%, although it is 5% higher than that in the previous edition.

(3) In these standards, most of the general items for inspection are those in terms of dimensional sizes. In contrast to dominant items involving structural safety and durability, these general items may have lower importance but their level of qualification relates to construction workmanship and managerial capability.

The criteria of percentage passing for general items stipulate 'Percentage passing for general items shall not be less than 80%' and 'for an inspection item with a specified limiting value, any single testing value shall not exceed the specified limiting value, otherwise the inspection item is disqualified.'

During the feedback stage of the draft copy, some comments suggested that different verification percentages be set for different classified highways; for instance, minimum 80% verification percentage for Motorways and Class-1 highways, and minimum 75% for Class-2 and lower classified highways. However, considering that criteria of inspection, indicators of inspection items for the same subdivision of work are different from each other for different class of highways, further relaxation in verification criteria may result in a lower quality standard, thus this Edition uses the same requirements of percentage passing for general items.

During the final review of this Edition, from June 2013 to September 2014, the highway administration of MOT conducted a research project on verification criteria for general items on subdivided works. The editing team of these standards collected data on 40 completed projects (including Motorways, Class-1, Class-2, Class-3 and Class-4 highways) in 10 provinces (including province-level municipality) of China. These data have been recalculated and reanalyzed in terms of the percentage passing of sub-divided works. It was found that using 80% or 60% as a percentage passing, some of the sub-divided works qualified by verification-by-rating method actually failed when verification by-passing-percentage method is used. Taking 80% as percentage passing, 4% of sub-divideded works of Motorways and Class-1 highways would have been disqualified, while for Class-2, Class-3 and Class-4 highways, 7% of subdivided works would have been disqualified; the overall disqualification rate would be 6%. Even if percentage passing-of 60% were taken as qualification criterion, 1% of subdivided works of Motorways and Class-1 highways, and 2% of subdivided works of Class-2, Class-3 and Class- 4 highways would have been disqualified; the overall disqualification rate of subdivided works would be 1%.

The research results above show that disqualification exists in completed construction projects even if the verification criterion of 60% for sub-divisions of work were adopted; if 80% was adopted, the disqualification rate would be less than 5% for Motorways and Class-1 highways, and 7% for Other highway, which confirms the necessity of increasing the quality verification criteria.

According to the original verification results, the method of percentage passing is more strict and easier to apply in practice than the method of rating. The method of percentage passing may effectively minimize data manipulation and confirm the position and role of verification criteria. Considering the technical point of view, the method of verification-by-rating is actually the result of trading off and revising the quality verification of subdivided works at a macro level, which emphasizes whether or not a dominant item is qualified, and thus without variation and dispersion; however, the method of verification-by-percentage passing is a quantitative requirement for individual items to be measured, straight forward and strict, but it does not pay enough attention to the relationship between measurement items forthe subdivided works. It cannot avoid the problematic data variation and dispersion and thus causes disqualification of a complete contract package due to the failure of an individual general item. Therefore, introducing the method of verification by percentage passing may cause a number of disqualified works. Special attention shall however be paid to the compulsory requirements for conformity in this Edition.

In addition, according to the number of verification criteria of engineering specifications in the national standard, GB 50300-2001: *Unified standard for constructional quality acceptance of building engineering*, the verification criteria in various trade specifications are not consistent and harmonized. For instance, seven specifications for ground foundation, masonry works, concrete structure, steel structure, ground improvement, fitting out and decoration, ventilating and air-conditioning works, require that the percentage passing shall not be less than 80% of sampled inspection points, whereas other specifications in the same national standard, such as for wood structure, roofing, underground waterproofing, ground drainage, water supply and sewage, electrical installation and elevator installation, require 100% conformity rather than 80%.

Considering the actual demand of highway construction and the implementation of modern management systems, the editing team of these standards adhered to the policy of strict control, and determined that the percentage passing for general items shall not be less than 80%.

(4) Measurement items are the combination of inspection items and relevant requirements. Chapters 4 to 12 of these standards give detailed requirements, including type of item, name of inspection item, specified values and deviation permitted, methods and frequency of inspection and so on. In these standards, revisions have been made to the methods of calculation for percentage passing and statistical calculations, definitions of dominant items, general items, limiting values and the frequency of inspection for two-lane highways.

In these standards, the degree of compaction of the subgrade and pavement layers, deflection values, the thickness of pavement structural layers, the compressive and bending strengths, the strength of stabilized soil materials are dominant items to be verified by statistical methods.

Considering the actual demands of application, the requirement remains that the percentage passing for a subdivision of mechanical/electrical work shall not be less than 100%, otherwise the item fails.

This Edition introduces new requirements for the minimum percentage passing and tolerance, which further substantiates the requirements for subdivided works on one hand and conforms to the relevant national standards on the other hand.

Specified limiting values of measurement items refer to the limiting values that any individual measured value must not exceed. In the case of non-conformity, the measurement item shall be verified as unacceptable. Clearly defining minimum requirements for the percentage passing and specified limiting values is for the purpose of ensuring structural safety and service function of construction works. Any dominant item, if the percentage passingis less than 90% as required or measured values which exceed the specified limiting values at a single point, must be reworked.

For types of work such as earthworks or pavement layers, the inspection frequency specified in the relevant provisions of these standards are based on the requirement for two-lane highways only, which is the minimum number of inspections. In the case of multiple lane highways, the number of inspections shall be increased proportionally according to the number of lanes.

3.2.6 Most of the requirements for quality of appearance in chapters 4 to 12 are expressed as unacceptable surface defects. The appearance of highway works shall be examined over the full length rather than inspecting at selected spots. Any defects, including appearance defects, that impact quality of the works shall be rectified. Because the method of verification by rating is abolished, the mark-deduction method may no longer be used for inspection of appearance. Thus this Edition defines criteria for verifying quality of appearance, and adds the criteria of limits for the defects of appearance of structural concrete by referring to relevant national standards.

3.2.7 The previous edition of these standards provided the requirements to construction contractors and supervisors for quality assurance data. This Edition simplifies the wording, and requires additional information that remedial site inspection or sampling tests shall be conducted by qualified laboratoriesin case where some minor data are missing, with reference to GB 50300—2013: *Unified standard for constructional quality acceptance of building engineering*.

3.2.8 This Clause is added and gives the rules of procedures in the case where an inspection-verification portfolio is verified as disqualified.

3.3 Construction Quality Verification

The following clauses present quality verification of sub-divisions of work, divisions ofwork, types of work, contract packages and construction projects. Since the verification by rating is withdrawn, the requirements for quality verification have been significantly changed.

The work verification classifies as two results, qualified or disqualified, whichis consistent with *Inspection Procedures for Completion and Handing-over of Highway Works.*

3.3.3 to 3.3.5 The previous edition did not require inspections on divisions of work and types of work but only verification by summarizing and calculation. This Editionspecifies that conformity of a type of work or division of work requires not only complete data and files on the division of work, but also qualified by inspection on quality of appearance. Reference may be made to relevant provisions of these standards relating to sub-divisions of work for executing the inspection on quality of appearance.

3.3.7 Quality verification on a contract package or a construction project shall be executed in accordance with relevant laws and regulations, as well as the standard procedures for handing over highway construction works.

4 Earthworks

4.1 General

4.1.1 The technical criteria, specified values and tolerances, of The measurement items forearthworks in these standards and other specifications are specified in two groups: Motorways and Class-1 highways, and the Other highway (including Class-2, -3 and -4 highways). However, considering that JTG B01-2014: *Technical Standardsfor Highway Engineering* specifies the criteria for compaction of earthworks in three groups, these standards follow the same approach and specify the compaction of earthworks in three groups, i. e. Motorways and Class-1 highways, Class-2 highways, and Class-3 and -4 highways, while other criteria are given for two groups.

4.1.2 The earthwork densities should be inspected and tested in layers to ensure the compaction quality of the layers; the density can be evaluated according to the inspection data of the upper roadbed, lower layers shall be checked and controlled by the supervising engineers in accordance with the compaction requirements for each earthwork layer. The construction inspection and supervision of embankment compaction often face the problemsdue to a limited number of samples. In case where the number of samplesis less than ten, the statistical coefficient for a certain guaranteed rate might be too large. In such an event, the quality control of layer compaction shall require full conformity, i. e. 100%, and the actual number of samples shall not be less than six.

4.1.4 Requirements are given for the earthwork compaction in a toll plaza, or the roads and parking lot in a service area.

4.2 Earthworks in soil

4.2.1

1 This Clause defines the scope and work operations of site clearance and grubbing, gives the requirements for ground compaction, and adds new requirements for topsoil utilization.

2 For effective quality control of layered construction, the surface levels of each layer of embankment fill shall be parallel to the pavement surface and no uncompacted slope edges are allowed.

3 Emphasis is placed on surface drainage, and temporary drainage systems during the construction process as well as the protection of side slopes and roadbed layers.

4 Excavation for fill and disposing of unsuitable materials shall conform to the relevant requirements for safety, environmental protection and landscaping.

4.2.2

1 Specified values of density of earthworks shall be consistent with the current JTG B01: *Technical Standardsfor Highway Engineering*;

2 General feedback across the country reported that frequent inspection of earthworks density was quite difficult in practice. This Edition reduces the frequency of inspection on earthwork compaction after extensive enquiries and investigations.

3 The frequency of inspection on the deviation from the centerline, roughness, profile levels and cross slopes is reduced.

4 Note① stipulates that the specified values (the lower confidence limit) of density shall not be less than the specified value, which can guarantee the overall quality of degree of compaction. In order to prevent the road pavement from being damaged as a result of localized insufficient compaction, the limiting value of a single point shall not be less than the specified value minus 5 percent. The percentage passing shall be calculated as a percentage of the number of inspection points where the measured values are not less than the specified value minus 2 percent to the total number of inspection points. Overall

compaction level shall be controlled during construction, and its representative values shall conform to the specified values.

5 Note ③ stipulates that the criteria for earthwork compaction specified in the subgrade design and construction specifications may be used in extraordinarily dry or extraordinarily wet areas, saturated soil conditions, or for the earthworks of the Class-3 and -4 highways with intermediate-type or low-type pavement.

4.3 Earthworks in rock

4.3.1

1 The methods of stone blasting must ensure safety and stability of earthwork side slopes. Large-scale blasting shall be restricted.

2 This Clause gives the basic methods for constructing a rock fill embankment. These methods of construction are important for construction quality assurance, that is, the embankments shall be filled and rolled layer by layer, stone blocks on the slope shall be placed firmly and tidily; the thickness of each layer shall be properly controlled; stone voids shall be filled with fine stones and stone chippings, and the particle sizes of fillers and stones shall be strictly controlled.

3 This Clause states that the inspection of compaction of a rock fill embankment shall be executed in accordance withthe deflection criteria determined from trial sections. Alternatively, proof-rolling may be adopted in conjunction with close observation and continuous improving, of which the measured settlement should be less than 2 mm after two rolling passes of a 20-t vibratory rolleror 25 kJ impact roller.

4.3.2 Voids is added as a criterion for the compaction of a rock fill embankment and inspection criteria of delection are added for rock fill embankment. The requirements for the profile elevations and roughness listed in the table above are reduced in comparison to those for earthworks in soil. The smoothness of side slopes is often overlooked in the construction of the rock fill subgrade. It is important to take the smoothness as one of the inspection items and check it together with the slope gradients so as to improve the construction quality and management capacity.

4.4 Soft GroundImprovement

4.4.1 The technology for soft soil ground improvement is developing rapidly. This Clause lists commonly used methods, and gives basic requirements for different treatments. Referring to relevant construction specifications, sand drains and stone columns have been combined as 'gravel columns', 'cement jetting piles' has been renamed as 'soil-cement columns', and cement flyash gravel (CFG) piles and rigid piles are newly added.

Speed of embankment settlement is one of the effective and important criteria for monitoring and controlling the earthwork construction on soft ground, and thus shall be extensively used in practice.

InTables 4.4.2-1 to 4.4.2-6:

(1) Measurement items with various technical processes are listed respectively.

(2) No measurement items are assigned to the unsuitable ground soil replacement and the stability berms. The quality inspection and control of these sub-divisions of work are similar to those for embankment fill, and thus may be combined into the sub-divisions of work 'earthworks'.

(3) In order to verify the effect of soft ground improvement, the criteria for inspection and verification of foundation bearing capacity is added in line with the rapid development of quality control technologies.

(4) In this Edition, inspection frequency of the strength of reinforced soil piles has been amended to 0.5% but not less than 3 sets.

4.5 Geosynthetic treated Layers

4.5.1 This Clause gives basic requirements for quality, laying, fixing, stretching, overlapping and seams of geosynthetics.

4.5.2 This Clause lists measurement items in tables in terms of reinforcing, isolation, filtering for drainage, and cracking control of geosynthetic treated layers.

5 Drainage Works

5.1 General

5.1.2 Drainage works may be classified as side draines, interception drains, and discharge drains in terms of functions, or as earth drains, stone pitching drains and concrete drains in terms of material and structure. This Clause states that the requirements given in Sections 5.5 and 5.6 herein are those for drainage works in terms of material and structure in terms of material and structure.

5.1.3 to 5.1.7 To avoid repetitive expressions, the requirements for quality of drainage works are not specifically stated in this Chapter did not specifically. The verification may be conducted in accordance with the criteria listed in relevant parts of these standards.

5.2 Prefabrication of culvert segments

The requirements for appearances shall be inspected and verified in accordance with Appendix P herein regarding limited defects.

5.3 Installation of precast concrete culverts

The title of this Section has be changed from 'installation of footings and segments of pipes' to 'installation of precast concrete culverts'.

5.3.1 Emphasis are drawn to the footings and segmental joints, and installation and external seeling as well.

For the pipe culverts with waterproofing requirements given in the design, a leaking test must be conducted before the trench is backfilled to check whether the segments are tightly jointed, whether there is any broken or damaged segment, to make sure that the leakage for a whole day and night must be less than the specified value.

5.3.2 'Elevation of the surfacefor water flow' is used in this Edition, which was changed from 'invert level of culvert' in former editions.

5.4 Masonry of manholes(gully pots)

A new measurement item, wall thickness, is added; and the 'offset of axis' has been changed into the 'position of center point'.

5.5 Earthditch

The requirements for quality of side drains, interception drains and discharge drains are the same.

5.6 Stone pitcheddrainage ditches

Quality requirements for side drains, interception drains and discharge drains are the same. Quality requirements for wet pitching rubbles, cast in-place concrete, precast concrete are all the same.

5.8 Sump pump well

The requirements for inspection and verification are only given to the concrete construction of sump pump wells. The product pumps and fittings, and relevant construction shall conform to the quality requirements of relevant specifications.

Item	Inspection items	Specified value or tolerance	Method and frequency
1△	Strength of concrete (MPa)	Within the required range	According to Appendix D
2	Horizontal offset from axis (mm)	50	By total station: 2 points each in longitudinal and transverse directions
3	Verticality(mm)	1% H	By plumbing: 2 points each in longitudinal and transverse directions
4	Dimensions (mm)	±50	By tape measure: 2 points each on length, width and height respectively.

continue

Item	Inspection items	Specified value or tolerance	Method and frequency
5	Wall thickness (mm)	−5,0	By tape measure:5 points for every well
6	Levels onwell top (mm)	±50	By level:4 points

Note: H represents depth of a well, and the specified value and tolerance shall be calculated in mm.

5.9 Desilter

Desiters are becoming to be a popular installation in a highway drainage system for the conformity to the requirements for environmental protection, and thus relevant provisions have been added in this Edition. Other similar works such as evaporation pools can be inspected and verified by referring to these provisions.

6 Protective andRetaining Works

6.1 General

6.1.1 This Clause stipulates that a large-scale retaining wall shall be regared as a division of work, and further divided into subdivisions of work such as footings, walls, and so forth.

6.1.2 A composite retaining wall comprises several component parts, usually for tall retaining wall and in large scale. Therefore, it is stipulated herein that every such a retaining wall shall be regarded as a division of work for verification.

6.1.7 This Clause clarifies that a reinforced concrete retaining wall and its components shall include subdivisions of work, the processing and the installation of reinforcing steels.

6.2 Stone-pitched and rubble-concrete retaining walls

6.2.1 Usually the importance of pointing mortar were ignored so that craking and peeling appeared not long after completion. These problems are closely related to the quality of pointing mortar, and thus the requirement that the strength of martar for pointing shall not lower than the strength of mortar for pitching is added. For settlement joints and expension joints, the requirement for density is added to avoi the problems such as water leaking.

6.2.2 The requirement for inspecting the bottom levels has been deleted for reducing workloads of inspection, because that the bottom levels can be well controlled by the level on top surface and the cross-sectional dimensions. Meanwhile, a measurement item for rubble concret retaining wall is added to cope with the needs in practice.

6.4 Tieback walls, anchored walls and reinforcedearth-wall

6.4.2 Full inspection shall be applied to the inspection items by visual. In the measurement items, the inclination of wall and seam widthe of face panel have been moved into installation of face panels, to facilitate process control for quality.

6.5 Backfill behind wall

6.5.1 Backfill behind retaining walls shallconform to the basic requirements as follows:

1 This subdivision of work is for lowerretaining walls. For tieback walls, anchored walls or reinforced earth walls, the chemical and electro-chemical features of backfill materials are importance factors to the corrusion resistance and durability of tie-backs, anchor bolts, and reinforcing strips, for which inspection shall be conducted in accordance with the design requirements.

4 Filter layer is one of the component parts in drainage system of a retaining wall, which function is to allow water flow passing through without soil losing. The materials and scope of placement shall conform to the design requirements.

6.5.2 In order to ensure the compaction of backfill and to avoid the retaining walls from the damage due to rolling activities, this Clause specifies that the compaction shall be 90% within a range of one meter from the back face of a tie-back, anchored or reinforced earth wall.

6.6 Slope protection with anchors

6.6.2 This Section has been revised as 'slope protection with anchors'. The anchor bolts and tie-backs and slope stuctures shall be inspected in two steps. A slope structure includes grid beams, bottom beams, peripheral beams and shotcrete layer. The frequency for inspection of the depth and position of anchor holes was considered a bit too low, and thus modified by increasing 20% in this Edition. The position of a anchor bolt, the length inserted, the depteh, angle, and grouting of a drilled hole shall be inspected during construction.

6.6.3 In order to avoid poor durability due to steel corrosion, reinforcing bars, geogrids and anchor rods must not be exposed. No missed shotcrete covering or peeling off

6.7 Slope protection with soil nails

This Section gives a newly added subdivion of work applicable to the protection of soil slopes, which is developed by referring to the provisions in MOT *Guidelines for Highway Slope Protection by Soil Nailing*.

6.7.1 This Clause gives quality requirements for the materials, cutting side slopes, the connection of steel meshes to soil nails and grouting. The reinforcing steels in grid beams and steel meshes shall be firmly connected to soil nails so that the side pressureof soil can be effectively transmitted to soil nails. The density and fullness of grouting directly affect the pullout resistance of a soil nail. The most suitable method and procedures of grouting shall be selected in construction stage and in accordance with the inclined angles of anchor holes. The coefficient of fullness shall be greater than 1 and the grout filled in anchor holes shall be dense and full.

6.7.2 The pullout resistance of soil nails is a main technical indicator for the purpose of slope protection by soil nailing. Soil nailing is concealed works. The pullout test is indispensable, and could be either destructive for determining the limiting loads for design, or non-destructive for inspection for acceptance. The tests mentioned herein are all for non-destructive inspection unless otherwise as specified.

The inserted length of a soil nail, and the depth and angle of a drilled hole for soil nailing sall be inspected during construction. 6

6.8 Slope protection with masonry

This Section has been revised as slope protection with masonry. In additional to conical slope and slope protection in previous edition, the masonry grid protection and masonry surface protection have been added in this Edition. Though they are quite different from each other in shape and structure, the construction procedures and workmanship are quite similar to each other. , only the strength of mortar, the cross-sectional dimensions and the spacing of grid beams are specifically listed In measurement items, the others are the same as conical slopes and slope protection.

6.11 Water flow regulation works

6.11.1 The joints in a diversion dike (or dam), the interfaces to side slopes of river banks or berms are the places important and difficult to be treated, for which therefore relevant inspections are added.

6.11.2 Compaction is the technical indicator of quality assurance for the strength and stability of a dike, and thus specified as one of the measurement items.

7 Pavement Works

7.1 General

7.1.1 This Clause clarifies and emphasizes that the allowable deviations, or tolerances, shall be taken as the criteria for inspection and verification of the thickness of slab and thickness of pavement structure in measurement items.

7.1.2 According to JTG F40: Technical Specifications for Construction of Highway Asphalt Pavement, the requirements for inspection of binding layer has been withdrawn. According to JTG/T F30: Guidelines for construction of highway cement concrete pavements, the provisions on bedding layer of cement concrete pavement remains. Beding layers are not listed herein as a independent section, for which inspection and verification may be conducted by referring to the requirements for the subbase course with similar material. The provisions on the basic requirements for prime coat, tack coat and seal coat are given in this Chapter.

7.1.4 Stabilized base and subbase were discussed in seven sections in last edition, however have been reorganized into two sections in this Edition.

7.1.5 Differentiated requirements have been given for granular base course and stabilized soil base course.

7.2 Cement concrete surfacecourse

7.2.1 The cement concrete surface course shall conform to the basic requirements as follows:

1 The quality of a base course directly affect the quality and service life of a cement concrete surface course. The purpose of this Clause is taking the quality of base course as one of the critical elements of process control for construction of cement concrete pavement, to prevent the ignorance of base course quality due to the interference of physical factors.

2 The joint fill materials, the position and scale of joints, and the placement of dowel bars are important to the durability of cement concrete pavement. However, negligence occasionally happens during construction. Thus emphasis is given in the basic requirements.

3 Cracking due to dry-shrinkage or thermal shrinkage shall be treated immediately.

7.2.2

1 The flexural tensile strength, thickness and roughness of concrete slab are top three important indicators for quality of cement concrete pavement. Negative errors in flexural tensile strength and thickness of a concrege slab will seriously and negatively affect its service life. Taking the importance of slab thickness into account and to prevent serous damage due insufficient slab thickness, the tolerance for slab thickness shall be controlled within a limit of -5mm in average and -10mm for any single point.

2 The specified values of roughness of pavement are in coordination with the current JTG F30/T: *Guidelines for Construction of Highway Cement Concrete Pavement*

3 A deeper surface texture does not necessarily mean better skid resistance. Therefore ‘not less than 0.7 and not greater than 1.1 for normal segments, and not less than 0.8 and not greater than 1.2 for special segments of a Motorway or Class-1 highway. For other highways, not less than 0.5 and not greater than 0.9 for normal segments, while not less than 0.6 and not greater than 1.1 for special segments.’

4 A measurement item for Side-Friction Coefficient (SFC) is added.

5 Regarding the coordination of longitudinal elevations and tolerances, the inter-relationship of the elevations of each structural courses, the roughness and the deviations in thickness have been taken into account during the revision of these standards, based on which reasonable tolerances are determined.

6 The ratio of broken slabs have been moved from appearance inspection in previos edition to the measurement items in thidEdition. The ratio of broken slabs is assigned with conformity concept, and thus no need to calculate the pacentage passing again.

7.2.3 In addition to the inspections required in Appendix P, attention shall be paid to the surface depressions, upheavals, edge break and broken corners. Any inconformity shall be remedied as soon as possible.

7.3 Asphalt concrete surface course and asphalt macadam (either crushed stone or gravel) surface course

7.3.1

1 Quality of base course is vitally important to asphalt pavement. Conformity of base course shall be ensured before the construction of surface course starts.

2 Emphasis shall be paid to the process control during the material production for surface course and the field construction.

7.3.2

1 Compaction: according to the current JTG F40: *Technical Specifications for Construction of Highway Asphalt Pavement*, for the compaction of an asphalt concrete or asphalt crushed ston (or gravel) macadam, any two of the three indicators, i.e., the standard laboratory density, the maximum theoretical density and the density of a trial section, can be selected and used for quality control during construction, and take whichever is lower one as the result of quality inspection and verification. The nuclear (non-nuclear) methods are added, which reliability shall be confirmed by comparing tests. The compaction by using a nucear density instrument shall be checked at one place in every 200m and 5 points at each place, and then take the average value of the five points.

2 Roughness: Specified values are listed for IRI, σ, and 3-m straight edge (not used for Motorways and Class-1 highways).

3 Deflection: Because of high embankment fill and thick pavement, the seasonal influence to the deflection on a Motorway or Class-1 highway, if the values are measured in a non-unfavorable season, would notbe sensitive as those of a Class-3 highway, and this shall be taken into account in determination of seasonal influence. However, the thicker are the asphalt layers, the more sensitive to temperature influence.

4 The coefficient of friction and the depth of texture, as macro and micro indicators of skid-resistence, play important roles in the safety of driving on road pavement. These two

indicators were both listed in the previous edition, and the application in practice were not consistent in different regions. This Edition lists these two indicators separately and individually, and requires both to be inspected and verified.

5 Permeability coefficient: the indicator shall be tested and determined immediately after the pavement constructed according to the current JTG F40: Specifications for Construction of Highway Asphalt Pavement, and thus thie Edition make the adjustion accordingly.

6 Thickness: the surface course on a Motorway or Class-1 highway usually consists of two or three paved layers. For the lower layer, no specific requirements for inspection for acceptance but need to be strictly controlled during construction. The better is the control of roughness and elevations of base course, the easier the thickness of asphalt layers shall be controlled. The Table stipulates total thickness of asphalt layers and the thickness of upper layer of surface course. The tolerance in thickness for other classified highways shall be calculated in accordance with total thickness of asphalt layers.

7 Marshall stability, gradation of aggregates, bitumen content are important indicators for control. These indicators have been moved from the basic requirements to the measurement items in this Edition in order to further emphasizing the importance of material production and process control.

8 The inpection frequency of the thickness, horizontal offset of centerline, longitudinal elevations and cross-slopes have been adjusted to a lower level.

7.3.3 The uniformity of asphalt pavement surface is one of the hard points in construction, which relates to service quality, service life and overall visual pleasence. Smooth joints are required for interfaces between asphalt surface layers and between the surface layers and road curbs or other installations in order to avoid fluctuated surface, cracking and water ponding.

7.4 Asphalt penetration surface course (or surface course of penetration macadam with hot-mix overlay)

7.4.1

1 Emphasis shall be paid on the specifications and usage of various materials. Restric control on material specifications and amount of usage is one of the key elements for construction quality management, and also a basic requirement for quality inspection and verification.

2 Detailed requirements are given here for the construction of a crushed stone macadam and gap

filling.

3 Where material mixture is used for overlay, the requirements and process control shall be the same as those for asphalt concrete construction.

7.4.2

1 Roughness indicators are represented by the specified values of three indicators, which are IRI, $\sigma$and 3-m straighr edge (not be used for Motorways and Class-1 highways).

2 Deflection is a important indicator representing the overall quality of a pavement, especial for penetration macadams, of which interior quality is usually quite difficult to be quantitively controlled.

3 Thickness: taking the differentiation in design thicknesses into account, 60mm is taken as norminal thickness to be controlled by the percentage of thickness and the amount in mm of insufficiency.

4 Indicators of gradations of mixture for overlay and bitumen content are newly introduced.

5 Indicators for compaction are not listed in inspection items, for the standard values and densities examined in a site laboratory are not easy to determine accurately.

7.4.3

1 To control the appearance defects, uniform and dense surfaces are required.

2 The quality of compaction is emphasized. Roadside defects shall be minimized and avoid.

7.5 Asphalt surfacetreatment

The backgrounds to provisions in this Section shall refer to those in section 7.4.

7.6 to 7.8 Base course and subbase course

During the updating for this Edition, provisions about base course and subbase course have been combined in terms of material types, which mainly include:

Stabilized soil: cement soil base and subbase, lime soil base and subbase, lime flyash soil base and subbase;

Stabilized granular material: cement stabilized granular (crushed stones, grevels or mineral slags) base and subbase, lime stabilized granular (crushed stones, grevels or mineral slags) base and subbase, lime and flyash stabilized granular (crushed stones, grevels or mineral slags) base and subbase, cement and flyash stabilized granular (crushed stones, grevels or mineral slags) base and subbase.

Granular material: graded macadam (crushed stones or gravels) base and subbase, gap-filled macadam (crushed stones or mineral slags) base and subbase.

Apart from the quality requirements in measurement items, the provisions on the base and subbase of the same material are generally the same. For convenient comprehension and avoidance of repeating, the contents in this Chapter are organized in such a material classification and combined pavement structure as mentioned above.

1 Basic requirements: the basic requirements of the base course and subbase course of the same material are given for critical activities from the quality of raw material, control of mix, spreading or paving, compaction rolling, and maintenance curing.

2 Indicators of measurement items:

a) Structural deflection is a popularly used indicator, which can be satisfied if compaction and thickness are well controlled. For chemically stabilized base course, which is controlled by strength indicators and the age is difficlut to determine, the deflection is not required.

b) There is close inter-course and bottom-up relationship interms of three indicators, i. e., elevations, thickness and roughness. Strict control shall start from road subgrade and applied to every structural course so that the quality of surface course can be ensured. In order to ensure structural thickness, the tolerance of elevation is allowed for a comparatively small positive value while a limit for negative value is also specified, which is also use for thickness control. Adjustment has been made to the inspection frequency for these three indicators.

c) Fine soil structures such as cement soil, lime soil and lime-flyash soil are not suitable to use as the base course of a Motorway or Class-1 highway, for their poor resistance against temperature shrinkage, and therefore are not listed in the table of measurement items.

d) Compaction is a important indicator. The frequency of inspection of pavement base course has been reduced, so as done to road earthworks.

e) The representative value of thickness must conform to the requirement. If the limiting value of a single point exceeds the specified value, it shall be counted in the calculation for the percentage to the total number of points inspected for conformity.

f) The compressive strength of a base or subbase with either cement soil or cement stabilized granular material: for a specific road or road segment, the designer shall give a specific value of strength required, and then based on such a specific value the contractor and supervisor shall conduct the mix design, quality supervision and control, and inspection for acceptance.

Attention shall be paid to determining the strength of cement stabilized materials: ensuring the strength without upper limit control may cause serious cracking, even upheaving. Not only the conformity to these standards, but also shall the practitioners work out a criterion for controlling upper limit of strength based on local conditions and experience so as to prevent cement stabilized material from serious cracking.

7.9.2 Solid volume ratio in Table 7.9.2 above is a indicator for controlling the compaction of pavement structural layers, which is determined by calculation based on the analyses of material composition and corresponding densities.

8 Bridges

8.1 General

8.1.1 This Clause explains the ratio of weld inspection. Generally, the construction conditions (such as personnel, equipment and environment) of various bridge components are quite different from each other, and therefore the whole inspection shall be applied. However, some components such as small prefabricated units are made in large quantity with little difference in manufacturing condition and little fluctuation in quality, and thus sampling inspection may be adopted.

Since the bridge components are complicated in structure and vary significantly in size, additional inspection lots or sub-divided works may be added in work classification to facilitate quality inspection and verification. For determining whether full inspection or sample inspection is to be adopted, reference shall be made to the provisions of Clause 8.1.1 for details.

8.1.11 This Clause specifies the number and length of weld inspection for steel structures. There was no provision in the previous edition for the situation that design did not give requirements, which has been clarified in this Edition.

8.2 Bridgein general

8.2.1

1 The fully completed construction shall include the main bridge structures and their protection works, the platforms for maintenance and inspection, the ladders, lighting systems and other associated facilities as well as the installation of expansion joints and the

removal of temporary pre-embedded parts. A completed bridge shall be expected for normal operation.

3 Loading tests are effective methods of checking whether the bridge load behavior and loading capacity satisfy the requirements of design and specifications. Loading test results may reflect the comprehensive construction quality. Therefore, loading tests are mandatory for super-large bridges, and the bridges of complex structures, or the bridges whose capacity needs to be verified.

8.2.2 The levels of bridge deck reflect the state of the bridge in completion and provide important basic data for bridge acceptance, operation and maintenance, and thus shall be inspected. Therefore, this measurement item is added in this Edition. The temperature and time impact during inspection shall also be taken into account.

Because of limited significance to quality controlas well as other items such as offset from centerline and levels of bridge deck, the measurement items for the centerline connection and elevation connection at the interfaces of bridge deck and approaches as stated in the previous edition have been withdrawn from this Edition.

8.3 Reinforcing Steel, Prestressing Tendon and Conduit for grouting

8.3.1

1 The reinforcing steel joints shall be inspected in lots in accordance with the current JTG/T F50: *Technical Specifications of Highway Bridge and Culvert Construction*. The joints in one lot shall be the same in terms of steel type, connection method and processing workmanship. No matter what type of reinforcement connection is adopted, the axis of steel bars shall be on a smooth alignment so as to ensure load transmission effect.

Connecting zone refers to a length near a reinforcement joint, or 35d (d is the larger diameter of the two connecting steel bars) and no less than 500mm for mechanical and welded connections. The length of the connecting zone of a lap splice is 1.3s (s refers to the welded length).

Relevant survey on the thickness of current concrete cover indicates that the qualified ratio is low, either too thin or too thick. Apart from the influence of brackets and formwork, the main causes include inadequacy and uneven distribution of concrete spacers, insufficient stiffness of reinforcement cages, and inadequate mesh supports. Therefore, corresponding sections shall be added to escalate conformity of concrete cover and guarantee the structural durability.

The concrete spacers shall not be less than four pieces per square meter and the spacing shall not be greater than 600mm.

2 The deviation allowance of cover thickness for a beam, slab, arch spandrel or slab shall be the same, since they have similar requirements for minimum thickness of a protective layer and similar process of reinforcing steel bars installation. For easier implementation, reinforcement cages of bored pies and underground diaphragm walls had been combined as one. Meanwhile, inspections after positioning of steel cages had been added in order to ensure the positioning accuracy.

The spacing of reinforcing bars of prefabricated slabs for composite beams shall be strictly controlled with a deviation allowance of ±5mm in order to install connectors.

8.3.2 Processing and tensioning of prestressing tendons

8.3.2

1 The concrete age at tensioning significantly influences long-term deformation of the structure. The early strength of concrete maybe increased by adding admixtures, however, the strength and elastic modulus of concrete would not grow in the same pace. That is the reason to emphasize both the strength and age of concrete at tensioning shall conform to the design requirements.

Grouting prestressing conduits has been assigned asan independent subdivision of work, and thus relevant requirements in previous edition are withdrawn.

2 The elongation of tensioning reflects the elastic modulus of prestressing tendon and the stress distribution along the structure, which shall conform to the design requirements; or shall be controlled in a range of ±6% to that specified in construction specifications if no specific requirement is given in the design.

In order to ensure installation precision, additional inspection items have been added including coordinates of prestressing tendon on the transverse section, the length of unbound section, and the coordinates in width direction of the beams for post-tensioning.

The inspection frequency of prestressing conduits is adjusted and determined by the length and curve sections in order to avoid inadequate inspection on coordinates of long and curved tendons.

8.3.3 Grouting of Prestressing Conduits and Sealing of Anchors

8.3.3

This is a newly-added subdivision of work. The state of grouted prestressing conduits directly influences mechanical performance and durability. However, the construction quality is not easy to ensure, and therefore the work is assigned individually as a specific subdivisions of work to be inspected and verified.

References have been made to *Post-Tensioning Tendon Installation and Grouting Manual* issued by American Federal Highway Authority (FHWA) in 2012, *Durable Bonded PT Concrete Bridges* issued by Concrete Society of UK, and *Duct Grouting Technology Conditions of Railway Post-tensioning Concrete Bridge Beams* (TB/T3192-2008) during writing and editing the inspection-verification portfolios of this subdivision of work. This Clause gives the requirements for inspection and control in terms of raw materials, properties of grout slurry, and grouting procedures. The technical performance (such as bleeding rate, swelling rate, consistency, etc.) of grout slurry plays a critical role in ensuring density of grout and preventing from voids, and thus shall conform to relevant requirements.

The grout slurry freezes at low temperature, which may cause volume expansion, and in turn adversely affect the structure. Therefore, anti-freezing or warm reservation is necessary during grouting and for 48hours after grouting.

Supplementary grouting pipes or inspection holes may be added in appropriate positions (such as the highest point, in middle of a straight section, etc.) to the conduit for the secondary vacuum-grouting after the final setting of the grout if the conduit after first grouting is not fully filled.

8.4 Masonry works

8.4.1

1 All portioned works in terms of masonry in bridges are presented in one section of this Edition.

The widths of masonry joints are different from each other depending on the materials used and shall conform to the relevant requirements in current JTG/T F50: *Technical Specifications for Construction of Highway Bridge and Culverts*. The joints shall be uniform in width. Over-wide or inadequately filled mortar joints are not allowed.

According tothe mechanical characteristics of arch bridges, the radiating joints in an arch ring shall be perpendicular to the axis of the arch. Meanwhile, in order to ensure the safety of structure and construction, the arch scaffolding shall be strong and stable. The masonry pitching sequence and scaffolding dismantling must satisfy the requirements of design.

2 Total station is specified for measuring offsets from the axis of an arch ring: two points in both longitudinal and transverse directions respectively. This means that there are four points to be measured and inspected, two at the intersections of the longitudinal axis with the top edge and bottom edge of a masonry work, and the other two are the transversal axis line with side edges of the masonry work. This is applicable to all the inspections on offsets from axis of bridge works, and this notice shall not be repeated hereinafter.

For the levels of top surface of a structure, the bottom surface of foundation or other inspection items which are to be measured on one plane, the measuring points shall be distributed evenly over such an area. For instance, if the required inspection frequency is 5, the five points shall be arranged in four corners and one at center. This applies to all the similar inspection of structures and components, and this notice is not repeated hereinafter.

8.5 Foundation

8.5.1 Concrete Spread footing

8.5.1

1 Treatment of the ground beneath foundation is one of the necessary processes to facilitate pouring concrete to foundation, avoid the negative influence on foundation and improve structural performance. Ground treatment shall be conducted in accordance with design requirements and thus relevant criteria have been added in the basic requirements.

3 The temporarily pre-embedded parts are those that are placed for construction but would not be used any more after completion, for example, the embedded parts for fixing formworks. To avoid adverse effects on durability and appearance of a structure and its component members, the pre-embedded part, which are not to be used anymore, shall be removed as soon as possible. This rule is applicable to all contents in these specifications without further explanation or repetition hereinafter.

8.5.2 Bored Piles

8.5.2

2 Since bored piles are made by underwater concreting, the defects of pile concrete are not visible, and therefore tests for pile integrity are required. Due to the importance of piling, and taking the simplicity, fastness and economy of the method of low strain reflection wave or sonic wave method into account, the frequency of testing pile integrity has been adjusted to every pile and for all piles regardless of their position, importance, geologic conditions, unless specified in design.

Currently for most of highway bridges and railway bridges, the integrity tests are conducted for every and all of the piles. The stipulation in the previous edition that the integrity test for other bridge piles shall be conducted by sampling inspection of 30% of total piles, but not less than three piles in any circumstances, is considered risky to pile-column integrated piers.

In the case that no specific requirements are given in the design, two methods available for integrity testing as stipulated in these standards, which may be selected based on real needs and situations of pile foundation. Details of the methods could be found in JTG/T F81-01: *Technical Specifications of Dynamic Pile Tests for Highway Engineering*. If there is any uncertainty about the testing results, other methods shall be used for rechecking and confirmation.

The diameter of a pile refers to the measured diameter of formed borehole, and shall not be smaller than the designed pile diameter. The sediment thickness shall conform to the design requirements or follow the requirements in construction specifications if no specific requirements are given in the design.

The inspection of borehole formation by ultrasonic wave method is introduced in this Edition in order to increase the precision and reliability of inspection. This method shall be selected in priority for the bridges, especially large bridges and super-large bridges on Motorways and Class-1 highways. The execution activities shall strictly follow the procedures stated in the user's guide of the instrument and other relevant specifications.

Twomethods are specified for measuring and inspecting the sediment thickness and the inclination of boreholes. If the test results are different, the unfavorable (more conservative) one shall be taken.

8.5.3 Excavated piles

8.5.3

The notice on integrity testing shall refer to the background to Clause 8.5.2

8.5.4 Driven Piles

8.5.4

2 The measurement items for steel-pipe piles are added in this Edition to improve the process inspection during manufacturing. Table8.5.4-2 was drafted by referring to JTG/T F50: *Implementation Manual of Technical Specifications of Highway Bridge and Culvert Construction*. However, the quality requirements for pile driving shall refer to the specifications for driven piles.

Because ofthe great importance for the construction, the bottom level and penetration of the driven piles are listed as dominant items under No.2 item of Table8.5.4-3.

According to the construction specifications, pile tests shall be conducted to determine piling procedures and bearing capacity of piles prior to piling construction except ordinary medium and small sized bridges, of which piling works may rely on sophisticated technology and experience. The construction specifications clearly stipulate the requirements for pile bottom levels and pile penetration. Where the pile bottom levels and penetrations deviate from the design values, countermeasures for rectification shall be implemented taken in accordance with relevant criteria in the construction specifications.

8.5.5 Underground Diaphragm Walls

8.5.5

1 This subdivision of work applies to the underground diaphragm walls that are permanent structures.

Non-destructive tests or coring shall be conducted to inspect the concrete integrity. Taking the function of underground diaphragm walls into account, the inspection shall be conducted by the methods and in the quantity specified in the design.

To facilitate recording and inspection, the depth and width of a formed trench have been adjusted as a measurement item.

2 The concrete at the top of a diaphragm wall usually need to be treated, and thus the level inspection has been was cancelled.

The stipulations about the deviation of centerlines of any two diaphragm wall in adjacent trenches in the previous edition was a bit over-conservative and has nothing to do with wall thickness, which therefore has been revised to 1/10 of the wall thickness.

8.5.6 Open Caissons

8.5.6

1 This Clause was updated in accordance with relevant construction specifications. The difference of diagonal lengths is added under the measurement item No. 2 in Table8.5.6 in order to control the shape deviation of the caissons.

2 This Clause is applied to concrete caissons. For steel caissons, inspection may be conducted by referring to the provisions for steel cofferdams.

8.5.7 Float-in double-wall steel cofferdams

8.5.7

1 The float-in double-wall steel cofferdams mentioned in these standards refer to those designed as permanent structures. The manufacture and installation are assigned as one subdivision of work. This Clause may also apply to the steel suspension box cofferdams that are to be used as permanent protection.

2 A float-in double-wall steel cofferdam is the large structure installed in integrity, for which the precision controlling during construction is quite difficult. Considering the large volume of such a cofferdam and pile cap, a slight relaxation in precision would not significantly impact construction quality of the works above piers. Therefore in this Edition, the allowable limiting offset from the axis of top surface and the tolerance of the level at top surface have been adjusted to 80mm and ±30mm, respectively.

In measurement items, quality of welding is pivotal for the construction quality and safety of steel cofferdams, and thus is assigned as a dominant item. The indicators controlling the shape of a cross-section are the difference of the orthogonal diameters for a round section or of the diagonal lengths for a rectangular section.

8.5.8 Concrete bottom seal for open caissons and steel cofferdams

8.5.8

2 For underwater concreting for bottom sealing, the Elevation of top surface refers to the level of the seal surface after repairing and finishing.

8.5.9 Pile caps and mass concrete structures

8.5.9 For the large foundations, large pile caps and anchor blocks of large span bridges of structures with massive volumes of concrete, countermeasures shall be taken to reduce hydration heat and internal temperature of structural works so as to prevent structures from cracking.

8.5.10 Base grouting of cast in-place concrete piles

8.5.10 This is a newly added subdivision of work. The quality requirements are written in accordance with JTG D63: *Design Specifications for Highway Subgrades and Foundations* and

JTG/T F50: *Technical Specifications for Construction of Highway Bridges and Culverts*.

1 The basic requirements give details about the raw materials, the performance of grout, grouting equipment and workmanship. It is also required that each technical parameter shall be determined by testing to develop viable and effective construction method.

2 Volume grouted is one of the main factors influencing the performance of grout, and therefore is assigned as a dominant item for quality inspection. Volume grouted is effected by various factors including grouting pressure, geological condition, and grout performance, and thus the total volume grouted for each pile shall be guaranteed.

3 The amount of pile heaving during grouting shall be restricted. It is mainly caused by grouting pressure and can be restricted by controlling the pressure. Therefore, specific inspection may not be required.

8.6 Concrete Piers and Abutments

8.6.1 Concrete piers and abutments

Since capping beams and abutment caps are parts of piers and abutments, the title of this Section, 'piers, abutments and capping beams' have been revised as concrete piers and abutments for simplicity.

8.6.1

1 This Clause applies to in-place concrete piers, abutments and precast pier segments. The basic requirements and appearance quality are combined into one, which is presented in conjunction with the measurement items in this Section.

2 In previous edition, the tolerance for pier verticality was a bit low for short piers and relatively high for tall piers. This Edition specifies that the piers taller than 60m shall be inspected in accordance with the requirements for bridge towers. Allowable verticality deviation for the piers lower than 5m is 5mm. For other height of the piers, the tolerance of verticality shall not greater than H/1000 and ≤20mm.

3 The tolerance of surface evenness is adjusted to be 8mm for large-scale in-place concrete. The measurement items for cross beams shall be inspected by referring to Table 8.10.1-2.

4 The places with large faulting values shall be selected for inspection. This applies to all relevant issues and shall not repeat hereinafter.

8.6.2 Installation of Precast Segments of Piers and Abutments

8.6.2

2 Spacing of the adjacent columns in a pier or abutment can be controlled by the offset from axis, and therefore this inspection item was withdrawn during the updating for this Edition.

8.6.4 Backfilling behind abutment

8.6.4 Bumping at bridge heads is a popular defect mainly caused by relatively large amount of settlement of the backfill behind abutments. That is why backfilling behind abutment shall be assigned as one of the subdivisions of work to enhance the quality control.

The thickness of each backfilling layer shall be appropriately less than that of ordinary earthworks in order to assure sufficient compaction.

8.7 Concrete beam bridges

This section has been renamed as concrete beam bridges, which covers the beam bridges and composite beam bridges erected by various construction methods. Relevant subdivisions of work are classified as follows:

1) Simply supported beams are categorized into two subdivisions of work, that is, prefabrication and installation for precast ones, or one subdivision of work only for in-place ones.

2) Simply supported-then-continuous beams are divided into three subdivisions of work, namely, the prefabrication, installation and system transformation respectively.

3) Precast segmental beams are divided into two subdivisions of work: prefabrication and installation.

4) Concrete-in-place beams, either by full-scaffolding or by sliding formworks, are assigned as one subdivision of work only.

5) Beams erected by incremental launching or swing are divided into two subdivisions of work, one is manufacture (either prefabrication or in-place concrete), the other is erection (either by incremental launching or by swing).

6) Cast in-place beams by balanced cantilever method are regarded as one subdivision of work.

7) Precast beams erected by balanced cantilever method are divided into two subdivisions of work: prefabrication and assembly.

8.7.1 Cast-in-place beam and slab

8.7.1

1 The strength, stiffness and stability of formworks and scaffolds are very important in terms of influencing the construction of concrete-in-place beams and slabs, which are therefore listed as basic requirements.

Sliding formwork is one of the methods commonly adopted these days. In order to cover this method, the provisions of basic requirements in previous editions have been appropriately modified.

2 The evenness inspection shall be applied to concrete surfaces formed by shuttering of a beam or slab. The evenness of top surface of a beam or slab shall conform to the design criteria.

8.7.2 Precast beams and slabs

8.7.2

2 For composite beam bridges, the tolerance in width of prefabrication of a concrete deck slab with dry joints shall be determined by referring to JTG D64-01: *Design and Construction Specifications of Highway Steel-Concrete Composite Bridges*.

For box-beam bridges, the tolerance in the top width and bottom width of a precast segment has been adjusted from ±20mm and ±10mm to ±5mm and (+5,-0) mm in order to reduce faulting and improve the precision in installation

Table 8.7.2.2 applies to the simply-supported beams and the simply supported-then-continuous beams that are erected by a span-by-span method.

The beams or slabs with similar concrete ages shall be selected to place in the same span in order to avoid large faulting at joints.

8.7.4 Balanced cantilever beams

8.7.4 The stress cracks in a beam shall be restricted to guarantee the structural durability and mechanical behavior. In case such cracks appear, an investigation shall be conducted, causes identified, and hazards eliminated. Therefore, relevant requirements are included in the basic requirements for this subdivision of work.

Inter-segment joints are relatively vulnerable and thus shall be properly treated in accordance with design requirements in order to ensure the quality of the joints.

8.8 Arch Bridge

8.8.1 Cast-in-place Arch Rings

8.8.1

(1) The dismantling of arch scaffolding and formworks directly influences construction safety and mechanical status of the arch ring. A dismantling sequence reflects the specific structural stress status. Construction accidents may occur during scaffolding dismantlement due to violation of relevant specifications. Therefore, this Clause emphasizes that the dismantling of scaffolding and formworks must follow the sequences specified in the design and the construction specifications.

(2) In the measurement items, maximum value of the offset from designed intrados line is added in order to avoid over-large deviations in a large span arch bridge. Meanwhile, the inspection on the spacings between arch-ribs is cancelled for the compatibility in errors among inspection items.

8.8.3 Installation of Arches

8.8.3

1 To prevent arch rings from excessive loading or the loading eccentrically to one side, the requirement that the steel plates shall be uniformly wedged in joints is added. The cracking

of any chord or joint during installation indicates the stress status exceeding the range specified in design, which may cause damages to structural members. Therefore, investigation shall be conducted to identify the cause, evaluate the impact of cracking, and take necessary countermeasures for safety and ensure the stress status in compliance with design requirements.

2 This Clause details the quality requirement for in-place concrete for joints. The strength of the concrete for joints has been assigned as a measurement item in order to facilitate inspection record tracing. Based on experience, limiting values for the offset from axis and the level difference of arch ring are added to prevent large span arches from excessive deviations.

8.8.4 Arches erected by swing method

8.8.4

2 For the arches erected by swing method, the levels can be adjusted before an arch is fully installed so that a more accurate alignment may be obtained. The tolerance for controlling the levels of arch extrados is specified as ±20mm regardless of the length of a span, which is relatively stricter than that for the arches constructed by other methods.

The backgrounds to the offset from axis are the same as those to Clause 8.8.3.

8.8.5 Melan arches

8.8.5

1 [Note to English version] A Melan arch, or the arch built by the Melan Method, was originally invented by Austrian Engineer Josef Melan at the end of the 19th century. The principle is to build a relatively light steel arch between abutments, serving as centering to support the forms for pouring concrete during construction, and as stiff reinforcement embedded in concrete for permanent service. Such an arch is also called a 'stiff skeleton concrete arch'.

2 According to the investigation on recently built bridges, the offset from axis can be controlled precisely during concrete casting and therefore the precision of L/6000 is appropriate. The backgrounds to the levels of arch rings are the same as those to Clause 8.8.3.

8.8.6 Concrete Filled Steel Tubular (CFST) Arches

8.8.6

1 The protection of a steel tube is vital to its durability. Therefore, it is now assigned as one of the subdivisions of work for inspection and verification and the provisions in previous edition are withdrawn.

2 Referring to JTG D65-06—2015: *Design Specifications of Highway Concrete Filled Steel Tubular Arch Bridges*, and *GB*50923-2013: *Technical Specifications of Concrete Filled Steel Tubular Arch Bridges*, the measurement items have been revised in terms of segmental fabrication: the ovalness of a steel tube and the cross-sectional shape of a truss member have been added as inspection items to facilitate the connection of segments. Meanwhile, the inspection item on the spacing between the joints of vertical truss members has no much significance on the quality inspection of completed structures, and thus was withdrawn from this Edition.

The void ratio of concrete is an important indicator for quality of concrete pouring into steel tubes. The voids between filled concrete and steel tube surface have direct impact on structural performance. Therefore, it is assigned as a measurement item and shall be inspected as a dominant item. The voids must be filled by grouting if the void ratio exceeds the allowable value. In practice, the knocking method may be used to detect positions of voids followed by ultrasonic method for detailed inspection.

The backgrounds to the Offset from axis and the levels of arch rings are the same as those to Clause 8.8.5.

8.9 Steel Bridges

This section provides inspection criteria for subdivisions of work in terms of manufacture, protection and installation of steel girders, in which the manufacture and protection of steel stiffening girders for cable-stayed bridges and suspension bridges are also included.

8.9.1 Fabrication of steel girder

8.9.1

1 The manufacturing precision on steel component parts is the basis of guarantee for ensuring the precision of steel girders and girder segments, and therefore shall be inspected for conformity to design and relevant specifications, though it is not specifically required as an

inspection item in these standards.

Trialassembly of girder segments is an important way of ensuring the installation quality on site and thus must be inspected and qualified. This has been listed in the basic requirements.

2 The tolerance of torque of high strength bolt is obtained by thread retreating method. The inspected number is derived separately based on the bolt group. This rule is applicable to all of these standards and shall not repeat hereinafter.

In order to keep consistencewith current JTG/T F50: *Technical Specifications of Construction of Highway Bridges and Culverts*, the tolerances for steel stiffening box girders and composite girders of cable-stayed bridges and steel stiffening box girders of suspension bridges have been updated including the length and side height of girder segment, the difference of diagonal lengths of a cross-section, and the coordinates of an anchor point. The internodal inspection items have been deleted from the measurement items for steel truss segments while the inspection of the difference of diagonal lengths of a cross-section is added in order to ensure the cross-sectional shape of steel truss beams and the quality of inter-segment installation.

8.9.2 Installation of Steel Girders

8.9.2 This Clause applies to the beam bridges with small or medium span.

1 The installation of steel girders shall follow the procedures specified in design. This is because the process of loading on girders and the stress status of the whole bridge are affected by construction process, and therefore, the procedures of installation shall not be altered by discretion.

2 In order to ensure the stability of the steel girders during installation, and the stressing and deformation status of the bridge in service to be the same to the design, the attachment of the girder bottom to the top surfaces of bearings, and the bearings' bottom to the pads beneath must be tight and firm. The inspection for deviation of support center of a fixed bearing is added in the measurement items.

8.9.3 Protection of Steel Girders

8.9.3

1 The surface treatment has significant influence on the adhesive performance and service life of coating, and thus the requirements for coating processing must be followed. The surface before coating shall be dry and clean with no rust-back or dirt contamination. Therefore, relevant inspection items are added into the basic requirements.

2 The dry film thickness is one of the major factors to ensure the protection effect and duration, and therefore the design requirements must be followed. The number of coating layers shall be increased if the thickness is inadequate. However, the thickness at the measure points shall not exceed three times of the design value.

The measurement items such as the grade of de-rusting, surface roughness, thickness of dry film, and adhesiveness shall be inspected by using the methods specified in the design. If there are no specific requirements in design, the methods listed in the table shall be adopted. The details on these methods shall refer to relevant standards, such as GB/T8923, GB/T13288, GB/T13452, GB/T4956, GB/T9286, GB/T9793 and GB/T5210. For the methods of testing for technical performance of raw materials, reference shall be made to JT/T 722: *Specification of protective coating for highway bridge steel structure*.

The protection of steel girders and girder segments on site must adhere to the same criteria for which the environmental conditions must conform to the requirements for coating workmanship.

8.10 Cable-stayed bridges

In this Edition, the subdivision of work for the manufacture and installation of steel anchor beams and steel anchor boxes on pylon is added, while the fabrication of stay cables has been deleted since most of the cables used in these days are commercial products that have been covered by relevant product standards. However, due to lack of experience, the criteria for quality inspection of steel pylons are not available herewith but shall be added in the future.

8.10.1 Concretepylons of cable-stayed bridge

8.10.1

1 According to investigation and construction experience, to avoid the inter-segment faulting in between cast in-place concrete segments requires very high construction accuracy and high stiffness of formwork scaffolding. Hence the allowable value of faulting between cast in-place concrete segments has been adjusted to that not more than 3mm.

2 To encourage process control, the inspection on offset from axis of every pylon is added to the measurement items since each pylon column section is incorporated in the measurement items; and the inclination deviation of 1/3000 is a general requirement for completed pylons. Taking the facts of large cross-sections, thick pylon walls and difficulty of working at high into account, the tolerance of thickness of a pylon wall is adjusted to be ±10mm. Meanwhile, inspection of the evenness in large areas is added for controlling appearance quality.

The inspection on offset from axis of pylon is included as a measurement item in order to strength process control. The tolerance of 1/3000 in the table is the overall requirement for pylons. Considering that the cross-sectional size of a pylon is large and the wall of a pylon is quite thick, and taking the difficulties of working at high-altitude, the tolerance for the thickness of a pylon wall has been adjusted to ± 10 mm, respectively. Meanwhile the inspection on the evenness of a large and flat area is added for controlling appearance quality.

Similar adjustments have also been made to the measurement items for cross beams.

8.10.2 Segment fabrication of on-pylon steel anchor beam and steel anchor box

8.10.2 Installing steel anchor beams and anchor boxes on cable pylons become more and more popular in large-span cable-stayed bridges, which has been recognized as one of the effective measures to improve structural performance of pylons and also facilitate the construction of pylons. Therefore, two subdivisions of work, the fabrication and the installation of steel anchor beams and steel anchor boxes on pylon, have been added in this Edition, of which relevant requirements were drafted by referring to the practice in Jiashao Bridge and Sutong Yangtze River Bridge.

In order to keep the installation axis in verticality for steel anchor boxes, it is necessary to control the offset in parallelity of upper and lower surfaces. The requirement for inspecting the flatness of end surfaces of a segment is to ensure the ratio of installation contact between segments.

8.10.3 Segmental installation of on-pylon steel anchor beams and anchor boxes

8.10.3 This subdivision of work applies to the installation of the steel anchor beams connected by welding and the steel anchor boxes connected by high strength bolts. The basic requirements and measurement items are based on such considerations that firstly the segments shall be installed in right positions to ensure the accuracy of anchor position for stay cables; secondly, the connections of steel anchor beams to their supporting plats, and the inter-segments connections shall be tight and firm to ensure the loading effectively transmitted to ground foundations.

As an important indicator for installation, the larger is the ratio of contact between faces of anchor beams and their bearing surface, as well as between the cross-sections of steel anchor boxes, the more stable shall be the transmission of pressure forces. Therefore, the relevant inspections are taken as dominant items.

8.10.5 Cantilever construction of concrete girders of a cable-stayed bridge

8.10.5

1 Stay cables are important load-bearing components. The finished cables, anchors and accessories must be inspected in batch for acceptance according to the relevant product standards and shall satisfy the requirements for conformity. The main inspection items include elastic modulus, diameter, length, sheath thickness and flaw detection of anchors. The specific methods of inspection and rules of verification shall be subject to relevant product standards and construction specifications.

2 It is stipulated that the deviation of a cable force from its design value shall not be greater than 10%. In the case of non-conformity to this requirement, adjustment must be made; otherwise, this subdivision of work shall be verified as disqualified.

In cantilever construction of a cable-stayed bridge, it is difficult to avoid the offset of pylon top. The inspection on pylon top offset is added to ensure the target state of a bridge after completion and the safety during construction.

8.1.7 and 8.10.8 For the backgrounds to the offset of pylon top refers to those to Clause 8.10.5.

8.11 Suspension Bridges

Based on the recentdevelopment and past experience in suspension bridges, this section updated the criteria for inspection of ground-anchored and self-anchored suspension bridges, and adjusted the relevant test requirements.

8.11.1 Concrete Pylons of Suspension Bridge

8.11.1 Steel lattice structures are usually installed on the top of a pylon to support cable saddles and are included in this subdivision of work. The steel lattice and concrete should be bonded together to form as a whole structure. Top surface of a steel lattice should be attached with the bearing plate of a cable saddle seamlessly so as to transmit the cable force from the saddle to the concrete structure. Meanwhile the level of a steel lattice should be controlled to ensure the level of a cable saddle and the alignment of a main cable in the state as the design expects. The others are the same as the background to Clause 8.10.1.

8.11.2 Fabrication of Anchor blocks and anchorage systems

8.11.2 The prestressed anchorage system is the anchorage system popularly adopted in the suspension bridges in China, of which the tie rods, connecting devices, nuts and washers are all critical component parts, and thus deserve strict inspection including the flaw detection by ultrasonic and X-ray methods. The storage and transportation also need to be properly managed. Every unit shall be labeled by unified coding system and registered in systematic files, and should be packed properly with plastic before ex-factory delivery, as well as carefully protected against damaging and rusting during transportation and storage.

Inrigid-frame anchorage system, the anchor rods mainly bear tension forces. The anchor rods are anchored on anchor beams while the rigid frame supports both anchor rods and anchor beams. Hence the quality inspection shall focus on structural performance of anchor rods and anchor beams such as mechanical property of materials, welding defects, etc. Meanwhile, in order to guarantee the precision of installation and positioning, the tolerance of warping and the flatness of connecting wing plates have been provided in this Edition. The relevant measurement items for rigid frame members in previous edition were withdrawn.

8.11.3 Installation of block anchorage system

8.11.3

2 For the installation of rigid-frame anchorage system, the position of an anchor beam can be identified once the coordinates of both ends of an anchor rod are determined. Therefore, the relevant inspection items for anchor beams specified in the previous edition have been deleted.

8.11.4 Concrete anchor blocks

8.11.4

1 The concrete anchor block is regarded as a mass concrete structure, of which the most significant problem is the thermal cracking caused by heat of hydration. Hence the maximum temperature in concrete and the temperature difference between inside and the surface shall be controlled. The allowable range shall refer to construction specifications.

3 The metal anchor members are vulnerable to rust in humid environment. Good impermeability is required for the concrete. Water ponding and water leaking shall be avoid.

8.11.6 Concrete plug in a tunnel anchorage

8.11.6

1 The concrete plugged in a tunnel anchorage, which is quite big in terms of volume, shall be inspected as an item for mass concrete. It also requires an effective transferring of the pulling force from a main cable to the surrounding rock mass. Therefore, the basic requirements in this Clause give the criteria for temperature control during concreting and those for tight bonding of the concrete plugs and the surrounding rock mass.

2 The measurement itemsin this Clause give the coordinates of center points and the inclination angles of the front and rear anchor surfaces in order to control the position of front face and rear face of an a concrete plug.

8.11.7 Fabrication of cable saddles

8.11.7

2 This Edition addedthe requirements for controlling the saddle bottom after processing, namely the thickness of sidewalls and the roughness of various surfaces of saddle grooves, so as to ensure the strength of saddle body and the stability of cables in saddle grooves.

If machine tools are used for inspection, calibration shall be conducted before the machine tools are applied for inspection to avoid influence of systematic errors.

8.11.8 Installation of cable saddles

8.11.8

2 A large scale cable saddle is normally manufactured in two or three separated pieces in factory and then assembled on site by using high strength bolts. Therefore, this Edition added an item for inspection of high-tension bolts. However, this inspection is not applicable to integrally manufactured and installed saddles.

8.11.9 Fabrication of strands and associated anchor heads of main cable

8.11.9

1 Rich experience in design and construction of suspension bridges has been accumulated since the completion of Humen Bridge in Guangdong province, and a number of other suspension bridges afterwards, which showed that the construction quality can be guaranteed even without testing for workmanship of strand twining and releasing, and thus these related provisions on such testing stated in previous editions have been withdrawn.

Whether ornot a tensile-failure test should be conducted depends on specific situations. It may not be conducted if the workmanship and materials are not significantly altered and quality could be well guaranteed. This Clause expresses that the decision shall be made based on design requirements.

8.11.10 Erectionof main cables

8.11.10

2 In order to satisfy the alignment required by the design, it is in priority to ensure the lever of midspan in accurate position. The deviation of cable force in an anchor span shall be determined in the design, or depend on actual situation, usually taken 3% in normal circumstances.

The requirement for the level difference between the base-line cable strands in upstream and downstream is provided for the installation of stiffening girder segments. According to current JTG/T F50: *Technical Specifications for Construction of Highway Bridges and Culverts*, the tolerance in level of an ordinary strand to the base-line strand has been adjusted to +10 and -5 in this Edition, while caution shall be taken to avoid the impact on the level of base-line strands during construction.

8.11.11 Fabrication ofcable clamps

8.11.11 The quality control on clamp manufacturing shall focus on the raw materials, their surface flaws and internal flaw defects, of which the relevant criteria are included in the basic requirements. The lateral position of an ear plate has an influence on force transmission, hence relevant inspection has been added. Other requirements were revised and updated by referring to current JTG/T F50: *Technical Specifications for Construction of Highway Bridges and Culverts*.

The protection of clamps has been assigned as another subdivision of work, which may be inspected by referring to Clause 8.9.3 hereinabove, and thus the relevant expression under this clause of previous edition have been deleted accordingly.

8.11.13 Installation of Clamps and Suspenders

8.11.13

1 The cable clamps relies on the frictional resistance generated by the high-strength bolts to ensure their position without sliding downward. Therefore, the inner surface of a clamp and the surface of main cable at the clamp shall be clean and dry.

Filling the seams between clamps and main cables is usually conducted together with the protection work of main cables. Therefore, related inspection is incorporated into the procedure of subdivisions of work for main cable protection.

2 During suspender installation, the level difference between the hanging points at upstream and downstream is mainly controlled by the main cable. Therefore, individual requirements for such an inspection as stated in previous editions are deleted.

8.11.14 Protection of main cables

8.11.14

2 *Detailed inspection method of the measurement item for the thickness of protective coats or membranes shall refer to JT/T* 694: *Specification of anti-corrosive coating for main-cable systems of suspension bridges.*

8.11.16 to 8.11.18 are newly added subdivisions of work. The main differences between self-anchored and ground-anchored suspension bridges lie in the manufacture, installation and system transformation of the anchorage system of main cables. Therefore, only these three aspects are identified as subdivisions of work specifically in relation to self-anchored suspension bridges. The rest aspects may refer to relevant criteria for normal suspension bridges.

The criteria in this Clause are written based on the construction experience of Pingsheng Bridge in Guangdong Province and Ninth Bridge of Qiantang River in Hangzhou, China.

The deviation of suspender forces shall be taken as a dominant item to control the alignments of main cables and the stresses in stiffening girders in expected state. The range of deviation shall be stipulated in the design and for the needs of construction monitoring. According to experiences in completed bridges, it is reasonable to limit the value of this deviation within a range of ±10%.

8.12 Bridge Deck system and auxiliary works

8.12.1 Waterproofing for concrete bridge deck

8.12.1 This Clause applies to the waterproof coating and waterproofing sheeting.

2 According to the investigation on the survey and examination equipment for highway bridges and the development and use of waterproof materials for bridge deck, it is difficult to test the shear strength and peel strength on site. From the construction point of view, construction quality can be ensured if the strength of bonding, interface of waterproofing, and the workmanship of waterproofing can be well controlled. Therefore, the requirements

for testing shear strength and peel strength have been withdrawn from this Edition. Meanwhile, attention should be paid to the fact that the strength of bonding would be lower as the testing temperature rises when the values measured on site are compared with the values specified in the design.

Moisture content is an important factor affecting bonding strength and should be checked and controlled in the range required by the design. The moisture content can be checked at the same points for bonding strength in order to minimize the damage to the waterproofing.

8.12.2 Pavement onconcrete bridge deck

8.12.2 The requirements for roughness have been adjusted in this Edition in order to keep in line with relevant construction specifications. Cement concrete pavement on bridge deck on a Motorway or Class-1 highway shall be constructed by pavers.

8.12.3 Waterproof bonding coat on steel bridge deck

8.12.3

1 To prevent rusting-back, the applying of bonding coat shall be applied within the specified period of time.

ItemNo. 4 of the basic requirements is only applicable to the waterproof bonding materials that need to be heated before spraying.

8.12.4 Asphalt concrete pavement on steel bridge deck

8.12.4

1 The period of time for paving asphalt concrete is stipulated in order to ensure bonding strength. If paving work cannot be conducted in the time as specified, the bonding coat shall be sprinkled again or treated by other measures properly.

2 The pavement on steel bridge deck is usually quite thin. The tolerance of thickness in the previous edition of these standards was (0, −5) mm, which is considerably too large, especially the negative deviation may cause the pavement layer even thinner. Therefore, this Edition revises the negative deviation to −3mm and allows positive deviation.

Thethickness of pavement on steel deck is calculated based on the measured data on level variations, which has no damage to the deck pavement and is prompt in getting results, and thus this method is adopted for inspection. If the self-weight of deck pavement has a significant impact on the deflection of bridge deck, the level variation due to the self-weight of deck pavement shall be taken into account in the calculation based on theoretical thickness. Where the ground penetrating radar is used, the inspection shall be specifically verified by boreholes.

Epoxy asphalt concrete is a highly dense structure and thus the water permeability coefficient is not required.

8.12.5 Bearing plinths and restraint blocks

8.12.5

1 [Note to English version] A bearing plinth is the structural element built on the capping beam of a pier or abutment to provide a smooth surface and accurate elevation for installing bridge bearings. A constraint block is the structural element built on capping beam of a pier or abutment and between or at outer-edge of bridge girders to constrain excessive lateral shifting or moving of bridge girders under seismic forces.

2 According to the feedbacks from the users of these standards, the tolerance for level difference of top surface is adjusted to 2mm for large bearing plinths.

In the case that the cross-section is relatively small, the flatness of bearing plinths may be inspected in two squared directions by using a level ruler rather than checking the height difference of four corners. The conformity shall be confirmed if inspection results show that the top surface of the bearing plinth is in level, unless otherwise specified in design.

Adjustment of the levels ofbearing plinths, if required for system transformation or adjustment of structural stress, shall conform to the design requirements and be strictly controlled.

8.12.6 Installation of bearings

8.12.6

1 The inspection on the protection of steel component parts has been added in the basic requirements in order to improve the durability.

8.12.7 Installation of expansion joints

8.12.7

2 The large expansion joints mentioned in Table 8.12.7 refer to those used in the bridges with very large continuous length, such as cable-stayed bridges and suspension bridges.

For inspection item 'width of gap', inspection shall be conducted after adjustment of the gap if the temperature at installation is different from that assumed in the design. 'Level difference to the bridge deck' refers to the difference in level between an expansion joint and the bridge deck abutting to the joint on both sides.

The 'welding lines' in this subdivision of work refer to the lines welded on site. Based on the results of inspection executed in recent years, the fracture of welding lines, either those for structural steel extension or those welded on site, have become a common problem in expansion joints, of which the main cause is welding defects. Therefore, welding detection is required and assigned as one of the measurement items.

8.12.12 Installation of steel barriers on a steel bridge

8.12.12 This Clause is a newly added subdivision of work. The connections between barriers and main girders are usually welded, which are the key points to installation quality control. Other inspection items should refer to the manual for installation of barriers.

8.12.13 Approach slabs at bridge ends

8.12.13

2 The inspection of longitudinal slope of an approach slab, as required in previous edition, has been cancelled because it can be obtained by taking the levels at the top surface of the slab.

8.12.14 Surface protection of concrete members

8.12.14 This Clause gives requirements for protection by coating, not only the technical performance of the coating materials, but also the criteria for the treatment of concrete surfaces because the surface conditions affect the bonding of coating material to the concrete. The thickness of a dry film of surface coating must conform to two requirements, namely the average thickness ≥

design thickness, and the minimum thickness shall be greater than or equal to 80% of the designed thickness. Meanwhile, the number of points where the thickness is less than the design thickness shall be controlled.

9 Culvert Works

9.1 Basic requirements

9.1.1 Whether whole inspection or sampling inspection shall refer to the backgrounds to Clause 8.1.1

9.2 Culvert in General

This section givesquality requirements for culverts in general. When quality inspection and verification is executed, all construction activities of the culvert should have been completed. No unfinished culvert is allowed to put into service.

9.3 Culvert Abutment

9.3.1 A culvert abutment shall conform to the basic requirements as follows:

9.3.1 Peeling-off of the filling material from settlement joints is one of the common quality problems in culverts, which are mainly caused by the defects in filling materials and poor construction workmanship. Therefore, relevant inspections are added while the requirement for that the strength of mortar for pointing shall be equal to or higher than the mortar for pitching to enhance the quality control of joint pointing.

9.4 Installation of Concrete Culvert Pipes

9.4 Installation of Culvert Pipes and the Base, and

9.6 Installation of Cover Plates

The inspections on inter-segment joints and settlement joints are added with details stated section 9.3.

9.7 Installation of Corrugated Steel Pipe Culvert

9.7.1 This Section is a newly-added subdivision of work for the installation of pipe segments or plate components, which was written based on *JT/T*791-2010: *Corrugated Steel Pipe and Plate for Highway Culvert*, *JTG/T F*50-2011: *Technical Specification for Construction of Highway Bridge and Culvert* and relevant construction experience.

Groundfoundation treatment is necessary in order to accommodate the mechanical characteristics of steel pipe culverts. Suitable methods shall be adopted for specific geological conditions. The ground treatment shall conform to the design requirements. Meanwhile, the compaction of ground foundation shall be well ensured to control the settlement of steel pipe culverts.

9.7.2 In the measurement items, the tolerance of pipe inner diameter is defined as the allowable deviation during the installation. The diameter and shape of a steel pipe might be altered after backfilling due to its flexible pipe walls, for which the allowable deviation is specified in the provision of Culvert in General.

9.8 Casting concrete box culverts

9.8 Castingconcrete box culverts

This section applies to the In-place casting concrete box culverts. The specified value for flatness of concrete is uniformly adjusted to 8 mm.

10 Tunnel works

10.1 Generalrequirements

10.1.1 Most of the tunnels are built in mountainousterrain. These standards are applicable to the tunnels constructed by drill-and-blast method, which may also be used as a reference to develop particular criteria for the tunnels constructed by other tunneling methods, such as shield tunneling method, TBM (Tunnel Boring Machine) method or immersed tube method.

10.1.2 The design and construction of tunnels are guided by the rock bearing theories. The monitoring and measurement during construction lies in core of the rock bearing theory, which provides reliable approaches to evaluate the stability of rock mass and structural safety, and fundamental information for design and construction. In contrast to on-ground engineering works, the monitoring and measurement play outstanding roles in tunneling works. In practice, mechanical analysis or empirical approaches may not be sufficient for reliable solutions. Thus, the contractors shall carry out the construction monitoring and measurement activities in the scope and frequency as specified in the design and relevant construction specifications, and collect and submit systematic, complete and true field records and data.

10.1.3 The inspection of tunnel portals, wingwalls, side slopes and top slopes, which are protection works, shall be conducted in accordance with the provisions in Chapter 6 hereinabove, and thus are not repeated in this Chapter.

10.1.5 The fitting-out and furnishing works of a tunnel shall be conducted based on specific and detailed design and in accordance with *GB*50210: *Code for Construction Quality Acceptance of Building Decoration*

10.2 Tunnel in general

This Section gives criteria fordimensional inspection and verification in order to ensure fundamental functions of tunnel works. Reference shall be made to Table 10.2.2 for measurement items for service passages in general.

10.2.1 Tunnel drainage and leakage prevention are still among the major issues in tunnel construction though relevant technology has been significantly improved in recent years. Special attention shall be drawn to the quality of drainage and waterproofing materials, construction workmanship, site environment and so forth.

10.2.2 The Laser profiler automatically completes the matching between the actual profile and the design profile with the help of computer, and outputs the intrusion limits (distance and area) between each survey point and the corresponding design profile. At the beginning of 1990s, China introduced profilers (including Profiler2000, Profiler3000, Profiler4000) manufactured by Amberg of Switzerland at very high costs for a small number of them. To this end, domestic survey instrument manufacturers made scientific researches, tackled the key and finally developed a new tunnel profile inspection system. Through many years of engineering application, this system proved very mature and is already widely applied in the inspection of tunnel excavation section, initial lining section and secondary lining section.

When used for checking other types of cross-sections such as the width of travelled-way, the width or height of an intrados, or the cross-slope of road pavement, the laser profiler shall be set as manual mode, take the typical points (such as the intersection points of travelled-way and maintenance passage, intersection points of sidewall and maintenance passage, the arch crown, etc.), the inspection on measurement items can be effectively executed.

10.3 Concrete casting for cut-and-cover tunnels

10.3.2 Geologic radar method is an electro-magnetic technology for determining the spectrum distribution (1MHz – 1GHz) of underground mediums. When a geo-radar is in use, one of its antennas transmits high-frequency and broad-band of electro-magnetic waves, while the other receives return waves from underground mediums. Because the route, strength and waveform of an electro-magnetic wave changes when it transmits in different electro-characteristics and forms of mediums, the structure of the mediums could be identified according to the time of wave transmission (or returning time), the range and waveform. Geo-radar has been used in China for inspection of tunnel lining since late 1990s. Through many years of engineering practice, rich experience has been accumulated in the use of instrument, acquisition of signals as well as interpretation of collected information. The geo-radar is very mature for inspection of lining thickness and rebar distribution of a cut-and-cover tunnel. When a geo-radar is used, five lines along the tunnel will be surveyed continuously at arch crown, both quarter points of the arch, and both sidewalls. The data on one cross-section in every 10m in length and 5 points on each cross-section will be taken for thickness verification. Since geo-radar is a non-destructive testing method, the results shall be confirmed by coring in order to assure the accuracy.

At present, the concreting for a cut-and-cover tunnel is conducted by a combined platform machine. The surface evenness of a cut-and-cover tunnel has been improved significantly compared with the method of concreting by small sized platform used before 1990s. According to the analysis on the data collected from 46 tunnels Xi'an-Zuoshui Motorway, Xi'an-Hanzhong Motorway, and Xiaohe-Ankang Motorway in Shaaxi Province (see Table 10-1), the conformity was over 95% even taken 5mm as the criterion for evenness of wall surface. Therefore, the criteria for evenness of wall surfaces are specified as 5mm for wall surfaces and 20mm for the evenness at construction joints and settlement joints.

Table10-1 Inspection Results of Evenness of Tunnel Lining

No.	Highway Route	Evenness measured on large surface (mm)							
		≤20		≤15		≤10		≤5	
		Points measured (no.)	Conformity rate (%)	Points measured (no.)	Conformity rate (%)	Points measured (no.)	Conformity rate (%)	Points measured (no.)	Conformity rate (%)
1	Xi'an-Zuoshui Motorway	2365	100	2363	99.9	2359	99.7	2317	98.0
2	Xi'an-Hanzhong Motorway	4080	100	4069	99.7	4068	99.7	4029	98.8
3	Xiaohe-Ankang Motorway	4070	100	4070	100	4068	99.9	3883	95.4
Total		10515	100	10502	99.9	10495	99.8	3883	97.3

10.4 The waterproofinglayer on cut-and-cover tunnel

The cut-and-cover tunnel sections are vulnerable to water penetration and leaking, for which strict inspectionof construction quality of waterproofing layer is required.

10.5 Backfillto cut-and-cover tunnel

Strict inspection is required for the backfill to cut-and-cover tunnel sections in order to ensure structural safety and prevent leakage.

10.6 Excavation for tunnel tube

10.6.1 Excavation isa key activity to construction time and cost of tunneling. Overbreak will not only increase working loads hence the construction cost, but cause the problems of stress concentration thus poor stability as well. On other side, underbreak will directly cause the insufficiency in the thickness of lining, undermine construction quality and become safety hazards, for which remedy will be difficult, costly and resource waste. Therefore, quality of excavation shall be ensured for stability of rock mass and safety of supporting system.

Tunnels in soft and weathered rock mass are usually constructed by benching tunneling or sequential excavation method. During construction, the springings and sidewall toes play critical roles in structural stability. In order to prevent tunnel springings or sidewall footings from sinking, underbreak is strictly prohibited in a range of 1m above tunnel springing or the toe of a tunnel sidewall.

10.6.2 Overbreak or underbreak shall be inspected by a laser profiler or total station with cross-section survey function, during which one cross-section shall be checked in every 20m length, and one point shall be checked in every 2m from arch crown of each cross-section,

10.7 Shotcreting

10.7.2 The thickness of shotcrete is usually inspected by drill-holes. The inspection by drill-holes should be done by using a short chisel or electric drill within 8 hours after completion of shotcreting when the strength of shotcrete is comparatively low, hole-drilling would be easier, supplemental shotcreting would be possible if the thickness is found insufficient, and resource mobilization would be convenient. In case a jackdrill is used, and the thickness is difficult to identify, phenolphthalein reagent may be applied on the surface of drill-holes and alkaline concrete will become red. One cross-section in every 10m length and one point at every 3m interval from the arch crown shall be checked. Drill-hole method is applicable to check the thickness of shotcrete for all grades of rock mass.

Voids existing in between the lining and rock mass may cause the rock mass loosing and the lining structure in bending. This may further undermine the function and bearing capacity of lining structure and thus produce negative impact on operation safety of the tunnel. This has been proved by accidents that happened to completed tunnels. As a result, detection of the voids of tunnel support (lining) has now attracted much more attention. The voids behind lining layers are concealed hazards that may not be identified by visual inspection. Geo-radar is one of the most popular methods being used for detecting this kind of hidden hazards, in addition to the thickness of lining, the density of backfill behind lining, the distribution of internal steel frames and steel bars. When a geo-radar is used for checking the density of backfill behind lining layers, five lines shall be checked along arch crown, both quarter points of the arch and both midpoints of sidewalls in longitudinal direction of the tunnel, and the inspection results shall be calibrated and confirmed by drill-holes on site.

For Grade IV, V and VI surrounding rock mass, steel framesare installed for initial lining with a relatively thicker shotcrete. In such a case, a geo-radar is capable to identify the interface between lining layer and rock mass and determine the thickness of lining precisely. So the geo-radar should be used for inspection of shotcrete layer thickness. However, for Grade I, II and III surrounding rock mass, the shotcrete layer is quite thin, and thus geo-radar may not be suitable. Instead, the drill-hole method should be used for checking the thickness of lining layer

10.8 Rock bolts

It has beenproved both theoretically and practically that the pull-off resistance may not reflect the actual quality of work while the fullness of surrounding mortar affects the function of a rock bolt significantly. Therefore, the density and fullness of mortar surrounding a rock bolt are listed herewith as one of the basic requirements.

10.10 Steel frame

Steel frames are important measures for supporting the tunnels in soft rock mass and under shallow overburden. The construction quality of steel frames in a tunnel is vital to ensure structural stability. Steel frames are manufactured in segments that are connected together by bolting or welding. The gaps between steel frames and rock mass shall be fully and densely filled with shotcrete.

The spacing between steel frames inthe lining layer may be checked by tape measure during construction or by using geo-radar after shotcreting, together with the checking for thickness density of backfill behind shotcrete lining.

10.11 Arch invert

Arch inverts are vitally important for structural stability and safety of a tunnel. Arch inverts and sidewall footings shall be constructed together as soon as possible after excavation is completed. The thickness of the concrete cover on reinforcing steels shall be inspected before concreting. The inspection and verification shall be conducted in accordance with the criteria in Sections 10.7, 10.9 and 10.10 for initial lining of arch invert, and Section 10.13 for checking the reinforcing steels of arch invert before secondary lining

Arch inverts are concealed works, which are susceptible to defects in tunnels. So far, the destructive methods of inspection after construction, including geo-radar method, are not good enough to satisfactory. Therefore, inspection by coring drill-holes are recommended, especially for the tunnel sections in poor geologic conditions such as mud rock, shale, in fault fracture zones, or those with shallow overburden near tunnel portals.

10.13 Reinforcing steel in lining

The spacing of main reinforcing steel bars shall be inspected by tape measures during construction, or by using geo-radar method after construction of secondary liningis completed, together with the checking on the density of backfill behind lining layer and the thickness of lining.

10.14 Concrete lining

10.14.1 Insufficient thickness of lining and voids existing behind initial lining are common defects of tunnel lining, for which remedial treatments could be difficult. Usually the disqualified lining has to be removed by chiseling, and then re-casting the concrete lining, which may delay the work and increase construction costs. Therefore, pre-inspection on the rock surfaces receiving initial lining before lining construction starts. Any serious intrusion to designed profile shall be remedied immediately to avoid the problem of insufficient thickness of secondary lining. Meanwhile, the density of backfill behind initial lining shall be inspected, and any defects shall be remedied immediately.

10.14.2 The inspection by geo-radar for the density of backfill behind lining, and the thickness of lining shall be conducted along five survey lines, i. e. , one at arch crown, two at quarter points of the arch and other two at sidewalls. One cross-section in every 20m along the longitudinal direction of a tunnel, and 5 points on each cross-section shall be checked, and the data shall be used for quality verification in terms of thickness,

According to the survey and analysis on the thickness of liningin single tube, two-lane tunnels, these standards specifies that the thickness of the 90% measured points shall not be less than the designed thickness, and the minimal thickness measured shall not be less than 50% of the designed thickness. For secondary lining of single tube, three lane or four lane tunnels, minimum thickness should be determined based on specific structural calculation.

The background to the provisions regarding the evenness ofa wall surface in this Clause refers to the background to provisions of Clause 10. 3. 2.

10. 15 Water proofing layer

Although there are very strict requirements in relevant design and construction specifications, and great development has been achieved in both technology and methodology, water leaking and water penetration are common problems in highway tunnels, which are mainly caused by poor quality of materials and uncertainty in construction workmanship. At present, there are many materials and products (such as waterproof sheets, waterstops, drainage pipes) available for waterproof and drainage in highway tunnels, and some of them are not in good quality. Therefore the first is to control the quality of sourcing and procurement, while a quality inspection of construction process shall be established and implemented effectively.

10. 16 Waterstop

Refer to the background toprovisions of Section 10. 15 of these standards.

10. 17 Drainage

Uponthe completion of waterproofing and drainage works, all construction wastes shall be removed from the drainage system, the drainage pipelines shall be cleaned in time, and water flushing and discharging tests shall be conducted.

10. 19 Acvance tremie

Due to the lack of effective inspection methods, the inspectionfor grouting acvance tremies is not listed as a measurement item. However, the grouted amount and grouting pressure shall be inspected in accordance with the design requirements.

10. 20 Pipe roofing

Refer to the background to provisions of Section 10. 19 hereinabove.

11 Traffic Control Devices

11.1 General

11.1.1 Many traffic control devices, such as traffic signs, coating for road markings, corrugated steel barriers, steel cable barriers, raised road-markers, delineators, glare boards, glare meshes, isolation fences, falling object nets and movable barriers at median openings, are factory products. The quality of these products must be ensured before delivery to the site. Firstly ex-factory quality of the products shall be verified by independent and qualified laboratories or specialist organizations; secondly assurance against damages during transportation must be provided, and thirdly after delivery to site, the products must be inspected and verified on site for their conformity to the design before being installed and put into operation.

11.1.2 The steel material used in traffic control devices must beprocessed for anticorrosion. The method and quality of such anticorrosion coating shall conform to the design requirements.

11.1.3 The inspection and verification of bridge concretebarriers shall be performed in accordance with the relevant provisions of Clause 8.12.11 of these standards, and the inspection and verification of steel guardrails on a steel bridge shall be performed in accordance with the relevant provisions of Clause 8.12.12 of these standards.

11.2 Traffic Signs

11.2.1

1 The processing and manufacture of traffic signs shall conform to the provisions of the

current *GB/T* 23827: *Road Traffic Sign Boards and Support*; the characters and graphics of signboards shall conform to the provisions of the current *GB* 5768. 2: *Road Traffic Signs and Markings*, *Part* 2: *Road Traffic Signs*.

11.2.2

1 The coefficient of retro-reflection of a reflective film on the front-face of a signboard is a 'dominant item', which may be measured by a retro-reflectometer in accordance with the method described in GB/T 18833: *Reflective Sheeting for Traffic Control*.

2 The clearance height from the lower edge of a sign board to the road surface shall conform to the design requirements, and the tolerance is positive 100mm and negative 0.

3 Any part of transverse position of any kind of a traffic sign shall not intrude into the highway clearance profile, among which the distance from the edge line of right earth shoulder to the inner edge of a posted signboard, or the inner edge of the post of a cantilever or gantry signboard shall conform to the design requirements.

11.3 Road Marking

11.3.1

2 The coating materials of road markings shall conform to the provisions of the current *JT/T* 280: *Road Marking Paint*. The glass beads for road marking shall conform to the provisions of the current *GB/T* 24722: *Glass Beads for Road Markings*. Anti-skid marking on the road pavement shall conform to the provisions of the current *JT/T* 712: *Pavement Anti-skid Paint*.

3 The planning and design of road marking in terms of color, shape and position shall conform to design requirements and the provisions of the current GB 5768.3: *Road Traffic Signs and Markings*, *Part* 3: *Road Markings*.

11.3.2

1 The length of a marking segment and the longitudinal spacing of road markings mainly refer to the control precision for dotted traffic lines, and the inspection shall be carried out according to different kinds of the line segment. The inspection shall be conducted at 3 places in every 1km, and 3 marking segments at each place.

3 The measurement items for the thickness of a road marking shall be inspected by using a marking thickness gauge or caliper. The height of a raised marker shall be measured according to the method specified in Appendix A of *GB/T* 16311: *Specification and Test Method for Road Markings.*

7 The measurement items for skid resistance value shall be inspected for skid resistant markings and colored skid resistant road pavement. The skid resistant capability of a pavement surface shall be measured by using a pendulum friction coefficient tester according to the method specified in the GB/T 24717: *Preformed Pavement Marking Tape*.

11.4 Corrugated beam barriers

11.4.1

1 The product corrugated steel barriers shall conform to the provisions of the current *GB/T* 31439: *Corrugated Sheet Steel Beams for Road Guardrail.*

4 Quality defects in terms of construction and installation of corrugated steel barriers may include insufficient driven depth of posts, misalignment of connecting bolts and holes, twisted buffer blocks, unfitness of splicing bolts and holes, poor compaction of footing base, which shall be strictly inspected and controlled according to the requirements in the current *JTG D*81: *Design Specifications for Highway Safety Facilities* and *JTG F*71: *Technical Specification for Construction of Highway Traffic Safety Facilities*.

5 The treatment and arrangement of the corrugated beams of steel barriers at the beginning, ending and transition sections at road side, central separation zone, traffic diversion triangle areas and tunnel entrances should conform to the design requirements.

11.4.2

1 and 2 The thickness of a corrugated beam and the metal base of a post shall conform to the current edition of *GB/T* 31439: *Corrugated Sheet Steel Beams for Road Guardrail*

3 The height of a cross beam is the distance from the ground to the mid-point of the beam.

6 The distance from the outer edge of a post to the edge line of road shoulder is to ensure

sufficient lateral earth pressure against the barrier post.

7 The embedded depth of a post shall conform to the design requirements and be measured by a tape measure or depth measuring instrument. After a post is planted, the depth embedded may be detected by a special instrument, a so-called ‘impact elastic wave-based embedding depth measurement apparatus’. This instrument and equipment shall conform to the current *GB/T*24967: *Impact Elastic Wave-based Embedding Depth Measurement Apparatus for Steel Guardrail Post*. In case of any dispute over the test results, the method of ruler measurement shall be taken as the reference for arbitration.

8 The final torque applied on connecting bolts and splicing bolts shall conform to the requirements of construction specifications

11.5 Concrete barrier

11.5.1 Materials such as cement, fine aggregate, coarse aggregate, water for mixing, admixtures and reinforcing steels for concrete barriers shall conform to the current JTG/T F50 : *Technical Specification for Construction of Highway Bridges and Culverts*

11.5.2

1 The diameters and spacing of reinforcing steel bars and the heights and widths of reinforcing steel cages, shall conform to the design requirements.

6 Any inter-segment faulting in a concrete barrier shall not be greater than 5mm.

11.6 Cable barrier

11.6.1

2 The posts at either end of a cable barrier shall be installed firmly. Where an end-post is planted in concrete, the strength of the concrete f of such footing shall conform to the design requirements.

11.6.2

1 The initial tension of a cable is a measurement to ensure the rigidity and flexibility of

barriers.

2 The installation height of the lowest cable mainly depends on the position hit by a colliding vehicle.

5 The embedded depth of a post shall conform to the design requirements and be measured by a tape measure or a depth measuring instrument. After the post is embedded, a special instrument, called impact elastic wave-based embedding depth measurement apparatus for steel barrier post, may be used for measurement, which shall conform to the requirements of the current *GB/T*24967: *Impact Elastic Wave-based Embedding Depth Measurement Apparatus for Steel Guardrail Post*. In case of any dispute over the test results, the ruler method shall be used for arbitration.

11.7 Raised Pavement Markers (RPM)

11.7.1

1 Product raised pavement markers shall conform to the requirements of GB/T 24725: *Raised Pavement Markers*; solar energized RPM shall conform to the requirements of *GB/T* 19813: *Solar Energy Raised Pavement Markers*.

2 The layout and color of raised pavement markers shall conform to the requirements of GB 5768.3: *Road traffic signs and markings*, *Part* 3: *Road markings* or conform to the design requirements.

11.7.2

1 Installation angle refers to the side line of the reflective surface which shall be perpendicular to the driving direction, and the tolerance shall be ±5°.

2 Longitudinal spacing refers to the control accuracy in the longitudinal direction of placing raised markers.

11.8 Delineator

11.8.1

3 For a delineator planted in earth, the post shall be straight and vertical, and the surface shall be flat and smooth. For a delineator attached to a barrier, the retro-reflective surface shall be perpendicular to the direction of traffic flow as much as possible to obtain the best reflective effect.

11.8.2 The surface of retro-reflective material (or the chord of cross-section of a delineator on flexible post) shall be at right angles to the direction of driving vehicles on the road. The tolerance in terms of installation is 0 to 5°.

11.9 Glare devices

11.9.1 The installation and layout of glare devices shall conform to the requirements in JTG D81: *Design Specifications for Highway Safety Facilities* and JTG F71: *Technical Specification for Construction of Highway Traffic control devices*.

11.9.2

1 The installation height of anti-glare devices shall conform to the design requirements.

2 The spacing of glare screens depends on the width of a glare screen and the shielding angle.

11.10 Fence andfalling-object net

11.10.1

1 The product highway fences shall conform to the current GB/T 26941.1: *Fences*, *Part* 1: *General*, GB/T 26941.2: *Fences*, *Part* 2: *Posts*, *Brace Posts and Gates*, GB/T 26941.3: *Fences*, *Part* 3: *Welded Steel Wire Fences*, GB/T 26941.4: Fences, Part 4: *Barbed Steel Wire Fences*, GB/T 26941.5: *Fences*, *Part* 5: *Woven steel wire fences*, and GB/T 26941.6: *Fences Part* 6: *Expanded Steel Fences.*

4 The falling-object nets at an overpass bridge shall be able to prevent people from throwing objects off the bridge, which may hit vehicles travelling on the road beneath. The falling-object nets shall be appropriately selected, the net-eyes shall be of equal and uniform size, and the net-structure shall be strong and fully and tightly enclosed.

5 In order to prevent people and livestock from trespassing, specific enclosures shall be designed and installed for various needs and situations, such as at the beginning and ending of a highway fence, and at bridge or other passage sections where the highway fencing has to be ended.

11.11 Movable barrier at median-opening

11.11.2

1 The height of a movable barrier shall conform to the design requirements. The tolerance is ±20mm.

2 The coating thickness of metal components of a movable barrier shall conform to the design requirements.

11.12 Kilometer-marker and hectometer-stake

11.12.1 Character fonts on a kilometer-marker or a hectometer-stake shall be legible and durable.

11.12.2 Outline dimensions of a kilometer-marker or hectometer-stake and the character fonts and sizes on it shall conform to the design requirements.

11.13 Emergency escape ramp

11.13.1 The arrestor bed of an emergency escape ramp shall be paved with such materials that are clean, not easily compacted and have high rolling resistance. Where aggregates are used, the particles shall be rounded, durable and not crushed easily, in a single size and be able to roll freely. Such materials can maximize aggregate voids, facilitate drainage, and minimize interlocking and compaction possibilities. Freezing of aggregate in an arrester bed in winter shall be prevented.

11.13.2

3 When a vehicle troubled with brake failure enters into an emergency escape ramp, the vehicle wheels will sink into the aggregates of arrestor bed, which will increase the resistance against forward movement of the vehicle. In order to smoothly decelerate the out-of-control vehicle to a stop, the aggregates in an arrestor bed shall be shaped and filled in such a way that it is shallow at the entrance and gradually increases to full depth over a relatively short distance.

12 Revegetation Works

The Chapter 12 in last edition was ‘Revegetation Works and Noise Barrier’, and now splits into two chapters.

12.1 General

12.1.1 According to Article 41 and 52 of *The Seed Law of the P. R. China*, ant Article 16 of The State Forestry Bureau Ordinance No. 21: *The Administrative Regulations for Seeds of Forest Trees*, the producers and practitioners of forestry tree seeds (including woody plants such as arbor, bush and woody climbers, and herbal plants for forest production, land vegetation, or breed materials such as seeds and fruits, as well as roots, stems, seedlings, buds and leaves) shall be responsible for quality inspection and verification, and provide certification for quality assurance in which indicates the percent pure seeds, moisture, Percent germination and other quality indicators. According to Article 7 and 8 of Regulations of Plant Quarantine of P. R. China, All seeds, seedlings and other breed materials must be quarantined before being transported, and only those without quarantine targets shall be issued with the plant quarantine certificates.

12.1.2 Highway revegetation is categorized as a kind of bioengineering works. The rate of survival, percent germination and percent coverage shall be verified after a growth cycle for at least one year.

12.2 Land preparation for revegetation

12.2.1

1 Soil is the base for plant growth. The soil for revegetation, if mixed with abandoned structures, construction debris, and wastes or contaminated by harmful materials, may

impede the root development or even cause the death of plants. Perennial weeds and spread tree roots may have negative impact on the landscape in the areas of interchanges, roundabouts, maintenance administration facilities, service areas.

2 The design may involve land backfilling and appearance reforming in a certain areas in order to improve the landscaping. In such a case, the backfill shall be inspected after natural settlement to prevent the backfill from obvious surface depression and water ponds.

12.2.2

1 the effective thickness of topsoil has quite significant interference with the growing and surviving of plant root systems. The minimum thicknesses of topsoil required for plant growth and survival are quite different from each other kinds of plants.

2 Relevant elevation on a landform is one of the indicators reflecting the quality of backfill for revegetation, land shaping and topsoil preparation, which shall be surveyed on site after natural settlement completes. The areas with comparatively high requirements of landscaping, such as the green lands in median and outer separations, interchanges and roundabouts, maintenance administration facilities and service areas, which usually have specific design for landscaping, are important places for quality control.

12.3 Tree Planting

12.3.1

1 The seedlings with serous pests or disease may spread disease, and thus negatively effects the survival of plants and the results of revegetation.

2 The quality of setting out planting pits or troughs has direct impact on the overall landscaping. The positions of seedling planting shall conform to the design requirements, and marked accurately.

3 Non-degradable packaging materials impede the root development of plants, and thus negatively affect the growth of plants.

4 Tall trees may interfere with the sight distance at interchange ramps, or the triangle areas at a diverging or converging roadway.. Hedges and ball-shaped plants may require regular trimming, scattered bushes may not provide required function and have negative impact on

visual feeling.

5 Solitary trees are those trees planted separately and in single, usually in an outstanding and eye-catching position. Precious trees and large trees (which truck diameter are greater than 200mm as deciduous trees and evergreen broad leaved trees, or over 6m high or with a diameter above 180mm at ground level of evergreen coniferous trees) usually grow slowly and have significant visual effects. Therefore, all of the solitary trees, precious trees and large trees transplanted shall be ensured for 100% survival.

12.3.2

1 The diameter and depth of a planting pit or trough determines the effective thickness of soil after planting, usually depend on the size of root soil ball or root spreads of a seedling, which shall be in favor of the seedling growth and convenient for construction.

2 Rate of survival refers to the percentage of the number of survived seedlings to the total number of seedlings planted, which is the most important and key indicators. Quality of revegetation would be meaningless without ensured survival rate.

3 The scale and quantity of seedlings are important indicators as well, and need to be inspected and verified.

12.3.3

1 the appearance of a seedling is presented in the mode and tend of growth, the shape of crown, the ball of soil, the size of root spreads and pets and diseases. The seedlings of trees, shrubs and spherical plants with black cores or inclined crown may have negatively impact on landscape and traffic safety.

2 The trees with defects such as broken or dead branches, or have serious pests or disease may have negative impact on landscaping.

12.4 Turfing, herbaceous ground cover and flower planting

12.4.1

1 The quality of grass rolls or grass blocks may affect the time and results of turfing. Thepercent weed seeds shall be controlled.

2 Methods and workmanship of turfing, herbaceous ground covering and flower planting in terms of seeding, transplanting and spray planting, are in variety and thus shall be selection in accordance with the specific characteristics of land for revegetation.

3 Designers may adopt gout planting or scatter planting to improve the results of landscaping. The setting out, density and pattern of seedling planting during construction shall conform to the design requirements.

12.4.2

1 the areas of turfing and herbaceous ground covering, and the quantity of flowers are the determinant elements of the quality of revegetation, which shall conform to the requirements in design.

2 Percent coverage of turfing and herbaceous ground covering refer to the percentage of the projected area of plants on ground to the area sampled, which is the key indicator of quality control for turfing and herbaceous ground covering.

3 Percent survival is the key indicator of quality control of flower plantation.

12.4.3 Continuous bald spots in a turf or herbaceous covering area will not only have negative impact on visual pleasance, but may cause soil and water losing as well.

12.5 Revegetation by hydroseeding

12.5.1

1 The quality of seeds determines directly the result of hydroseeding, which shall conform to the standards for Class 2 as specified in GB 6142: Quality Classification of Grass Family Seeds, and GB 7908: Quality Classification of Tree Family Seeds. For the seeds that are not mentioned in above two standards

2 The plant communities proposed by the design is the main objective of hydroseeding construction for revegetation. The type of plants and seed mist shall be well controlled during construction.

12.5.2

1 Hydroseeding is a process of mixing the breed material with water and imported soil, or laying grass seed where you spray a mixture of mulch, seeds, fertilizer, and water over a barren patch of the lawn. You can buy premade hydroseeding mixtures, or you can try your hand at making a DIY hydroseeding mixture (it may be cheaper that way!).

2 The target plant communities proposed by implementation design are the important indicators measuring the results of hydroseeding, which require the types and quantities of plants, especially those of dominant ones.

3 The area of vegetation is the major element determining the quality of revegetation.

4 Plant coverage refer to the ratio of the projected area of plants in a vegetation land to the total area of revegetation, which is the key indicator for hydroseeding.

12.5.3 Continuous bald spots and erosion gullies will not only affects visual pleasure but also cause water and soil loss.

13 Noise Barrier

13.1 General

13.1.1 Insertion loss is the only indicator that measures the effect of noise reduction of a noise barrier. The noise barrier can only be considered acceptable if the design requirements are met.

13.2 Stone pitching noise barrier

13.2.1

(1) The properties and quality of materials used in mortar are emphasized.

(2) The conformity of ground bearing capacity to the design requirements is emphasized.

(3) It is emphasized that there shall be no voids which may result in the passage of noise in a stone pitched noise barrier.

(4) It is emphasized that reinforcing bars in a stone pitching wall shall be protected against corrosion in damp and corrosive environment.

13.2.2

(1) The strength value of mortar is the key indicator of structural safety of a noise barrier.

(2) The elevation of the top surface and the thickness of a noise barrier are key indicators for determining noise reduction effect.

(3) The exposed width of a footing toe is the only quantitative indicator to be inspected for the footing dimensions.

(4) The wall verticality and straightness shall be inspected to ensure smooth alignment of a wall.

(5) The flatness of the wall surfaces shall be inspected to ensure smooth and visual appearance.

13.2.3 Attention should be paid to controlling the damages to the wall surface during construction to ensure a pleasing appearance.

13.3 Metallic noise barrier

13.3.1

(1) This Clause emphasizes the conformity of embedded depth of a footing to the design requirements in order to ensure the stability of footings.

(2) The technical specifications of acoustic performance are emphasized.

(3) Reliable countermeasures shall be taken for noise barrier posts, connectors and barrier panels to prevent them from being deformed, damaged in anti-corrosion coatings during handling and transportation. The use of any deformed components is strictly prohibited.

(4) The fixing bolts shall be tightened properly and the sealing heads shall have no defects. Furthermore, the positions and quantities shall conform to the design requirements

(5) It is emphasized that the joints between the screen panels and their footings shall be tight and conform to the design requirements.

13.3.2

(1) Strength of concrete is one of the key indicators of structural safety.

(2) The elevation on top surface ensures the design height of a noise barrier, which is the key indicator affecting the noise reduction effect of a noise barrier, especially the size of shadow

zone of reducing sound levels.

(3) The exposed width of a footing toe is the only quantitative indicator for the quality inspection on footing size.

(4) To reduce the disturbance to the road landscape, the alignment of a noise barrier shall be consistent with that of the highway, for which the indicator of "offset from the shoulder line" shall be used for quality inspection.

(5) The inspection of 'spacing of post' and 'verticality of post' is to ensure the quality of setting-out and positioning of posts, so as to ensure the tidiness and aesthetics of barrier panels.

(6) The inspection of coating thickness ensures that the anticorrosive treatment of metal posts, barriers and connectors conform to the design requirements and will fulfil the design life.

(7) The back panel of a barrier screen is the most difficult part to inspect, which leads to problems. Because of its key role in limiting noise transmission, the back panel is assigned as one of the dominant items to ensure that the acoustic performance of a screen conforms to the requirements.

(8) The surface flatness is a necessary indicator to control the quality of splicing between barrier panels and the splicing between the barrier panels and posts.

13.3.3

(1) Attention is drawn to protecting the coating or plating on the surface of a post to enhance the aesthetics.

(2) Attention shall be paid to the surface protection of barrier screens.

13.4 Composite noise barrier

13.4.1

(1) This Clause emphasizes that the embedded depth of a footing shall conform to the design requirements so as to ensure the stability of footings.

(2) The acoustic performance of a non-metallic barrier is emphasized.

(3) It is emphasized that the installation of fasteners shall conform to the design requirements.

(4) Reliable countermeasures shall be taken to prevent noise barrier posts, connectors and screen panels from being deformed or damaged during handling and transportation. Installation of deformed components is strictly prohibited.

(5) The fixing bolts shall be fully tightened and sealed with no defects. Furthermore, the positions and quantities shall conform to the design requirements

(6) It is emphasized that the joints of the screen panels and their footings shall be fully tightened and conform to the design requirements.

13.4.2

(1) Strength of concrete is one of the key indicators for structural safety

(2) The elevation on top surface ensures the design height of a noise barrier, which is a key indicator affecting the noise reduction effect of a noise barrier, especially the size of the shadow zone of reducing sound levels.

(3) Because of its key roles in minimizing noise transmission, the thickness of a back panel is considered as one of the dominant items to ensure that the acoustic performance of the screen conforms to the requirements.

(4) The 'see-through screen' refers to PC board, acrylic board and other high-grade materials. Slight differences in thickness may have a significant impact on acoustic performance and cost of the products.

(5) The exposed footing toe is the only quantitative indicator for the quality inspection of footing size.

(6) To reduce the interference with the road landscape, the alignment of a noise barrier shall be consistent with that of road, and the indicator of 'position offset from the shoulder edge line' shall be used for inspection.

(7) The inspection of 'spacing of post' and 'verticality of post' is to ensure the quality of setting-out and the position of posts, so as to ensure the tidiness and the aesthetics of barriers.

(8) The inspection of the thickness of coating or plating ensures that the anticorrosive treatment of a metal post, barrier or connector conform to the design requirements and fulfil the design life.

(9) The surface flatness is a necessary indicator to control the quality of splicing between barrier panels and the splicing between the barrier panels and posts.

13.4.3

(1) Attention is drawn to protecting the coating or plating on the surface of a post to ensure the stylish appearance of posts.

(2) Attention shall be paid to the surface protection and stylish appearance of barrier screens.

Appendix A: Work Classification

1 Earthworks

Each of small bridges and other structures of similar scale such as underpasses, overpasses, aqueducts, large or composite retaining walls, should be classified as one division of works. Culverts and masonry protection works should be classified as divisions of works in terms of the road segments where they are located. Drainage works, as one of the divisions of works, should be further classified in accordance with quantities, work features and construction sequences.

2 Bridge works

Bridges are classified in terms of their spans or total length. A multi-span bridge, either superstructure or substructure, may be divided into several divisions of works, and each division of works may contain one to three spans to ensure that the sizes of divisions of works are similar to one another.

3 Interchanges

Evaluation should be made by referring to the clauses for earthwork or bridge/culvert works as the works would belong to either of the two types. The clause for interchanges in the previous edition is deleted.

4 Tunnel works

The divisions of works have been re-classified because in previous editions the type of work for tunnel works, had been divided into too many divisions of works. Therefore, in this edition, 'tunnel overall' and tunnel fitting-out are merged into one division of works. 'Cut-and-cover tunnels' is included into the division of works of 'tunnel portal works'. 'Tunnel lining' now includes 'tunneling supports (both advance support and initial support)' and 'secondary lining'. As more and more extra-long-tunnels are being built, it is necessary to take 'auxiliary works' as an independent division of works.

5 Traffic control works

The traffic control works are being divided into two independent types of work, traffic safety facilities and traffic electrical/mechanical works. The length of road segment in terms of traffic safety facilities has been re-adjusted.

Division of work for 'sound barrier works' is added. Sound barrier works and revegetation works should be taken as independent types of work and inspected respectively.

Building works are included in this edition of the criteria as one of an independent type of work, and should be inspected in compliance with relevant specialist criteria.

Any work, which is not listed in these criteria nor could be included into other types of work, may be taken as an additional division of work under this type of work.

Appendix B: Determination of Compaction

B. 0. 2 With regard to the typical number of groups of specimens concerned, some of the contractors only conduct one group for optimal moisture content and maximum dry density to determine standard density. However, standard density is the measurement to compare field compaction, which requires adequate accuracy. For uniform soils or materials, the standard value based on only one group of tests is quite difficult to reflect the real situation of specimens because of the differences in parallel tests. Therefore, parallel tests are usually required to obtain the average maximum dry density as the standard value.

B. 0. 3 For the testing methods for determining field compaction, sand-replacement method or water-bag method is usually used for coarse-grained soil or pavement materials, sometimes coring-or-wax-envelope method may also be adopted whenever necessary. According to the standard methods of testing soils, either core cutting method or sand replacement method may be adopted for fine-grain soil, while nuclear densimeters may be used for quick checking but need to be calibrated in contrast to routine methods to ensure reliability.

Compaction quality mainly depends on rolling workmanship and moisture content. However, the property of a soil and uniformity of a material would have significant influence on the indicators of compaction. Non-uniformity is an inevitable in practice, and therefore it is rational to evaluate the compliance of compaction by statistical methods and to include provisions for the limiting value of a single point. Both representative value and limiting value are used as indicators for quality acceptance. In the case where any indicator is lower than the specified value, the item of work shall be verified as failed.

For compaction inspection witha small number of samples, reference may made to the background for Clause 4. 1. 3.

Appendix C: Determination of Flexural-Tensile Strength of Concrete

Thecontents in this Appendix C are primarily in consistence with JTG/T F30: T*echnical Guidelines for Construction of Highway Cement Concrete Pavement*.

Appendix D: Determination of the Compressive Strength of Concrete

According to *GB/T* 50107-2010: *Standard for Evaluation of Concrete Compressive Strength*, the criteria for the conformity of concrete strength are updated in this Appendix.

Mathematical statistics method shall be adopted for the inspection and verification for concrete compressive strengths wherever the strengths, ages, sources of materials, workmanship, and mix are the same in order to reflect the actual situation.

In this Appendix, an inspection lot for bridge beams can comprise only one span, or two and three spans. For medium and small span bridges, several spans of piles and capping beams may be taken as one inspection lot. The number of groups in each inspection lot should be around 80 ~ 100 groups. The time span should not exceed three months and daily average temperature difference should be lower than 15℃.

The standard deviation S_n is an important parameter in statistical inspection. If the difference of concrete sample strengths is large, the value of S_n would be large as well, representing a low value of strength. Therefore, it is necessary to make the concrete with uniform strength as much as possible in order to reduce the value of Sn. The construction company should take this as one of the performance indicators for their managerial capability. Arbitrarily increasing cement quantity during construction shall not be encouraged because it would not help to increase conformity but only waste of resources.

Determiningconcrete strength by drilling cores shall conform to *CECS*03: *Technical Specification for Testing Concrete Strength with Drilled Core*, which is issued by China Association for Engineering Construction Standardization.

Appendix E：Determination of Compressive Strength of Shotcrete

The determination of compressive strength of shotcrete were written on the basis of national standard GB 50086-2015：*Technical Code for Engineering of Ground Anchorages and Shotcrete Support* and the industry standard JTG F60-2009：*Construction Technical Specifications for Construction of Highway Tunnel*.

Appendix F: Determination of Cement Mortar Strength

This appendix has been updated in accordance with GB50203-2011: Code for Acceptance of Constructional Quality of Masonry Structures, mainly regarding the number of specimens in a group and the criteria for conformity.

F. 0. 1 In order to ensure the representativeness of specimens, the specified number of specimens in a group shall not be less than three.

F. 0. 2 Steel bottomed forms shall be used for preparing the test specimens in order to reduce the data discretization. Detailed test procedure shall conform to the requirements in *JGJ* 70: *Testing Method for Basic Performance of Building Mortar*.

F. 0. 3 Because JTG D61: *Code for Design of Masonry Bridge and Culverts* adopts the limit state design method, the inspection and verification of mortar strength shall consider structural reliability to make the probability that the mortar strengths reach or exceed design strength in an appropriate range. Therefore, it is required that the average strength of the specimens should not be lower than 1. 1 times of the designed strength.

Appendix G: Determination of Strength of Chemically Stabilized Materials

The contents of this appendix are consistent to JTG/T F20: *Technical Guidelines for Construction of Highway Roadbases*.

Appendix H: Determination of Thickness of Pavement layers

The main contents in this appendix are abstracted from JTG/T F20: *Technical Guidelines for Construction of Highway Roadbases.*

Verification of thickness: whether the representative value of thickness is less than the design value minus the tolerance; the relevant subdivision of work shall be verified as disqualified if it positive; if negative, the percent conformity shall be calculated by whether the measured value of a single point exceed the value for conformity at a single point.

This criterion may be applicable to the thickness verification by a radar system for pavement condition survey, or other fast, efficient and non-destructive methods.

Appendix J: Determination by Deflection of Road Subgrade, Granular Subbase and Basecourse, and Asphalt Surfacing

Major updatingapplied to this Appendix are:

1 The falling weight deflectometer (FWD) test method has been added. The coefficients for reliability have been specified in accordance with *JTG D*50: *Specifications for Design of Highway Asphalt Pavement*. The formula for calculating deflections on subgrade, granular subbase and base courses, and asphalt surfacing course has been updated.

2 The requirements have been providedfor calculations and countermeasures in the case where the representative value of a subgrade, flexible subbase or base course exceeds the requirements, with suggested treatment at isolated outliers. These outliers shall not be deleted but must be treated in the case of Motorways and Class-1 highways. These requirements are not mandatory to the asphalt surfacing course.

Appendix K: Forms for Inspection and erification of Quality of Construction Works

These forms shall be filled in accordance with work classification, i. e. , subdivisions of work, divisions of work and types of work.

Appendix L: Determination of Side-ways Force Coefficient on a Pavement Surfacing

In the previous edition, Side-ways Force Coefficient (SFC) was based on the arithmetic mean and the reliability, which was not able to identify poor quality segments. Because the SFC is one of the important parameters in relation to traffic safety on a road, a better and more rational statistical method is required to reflect the overall level of quality of the safety on a highway segment.

Following an inspection and analysis of original data collected from representative Motorways in previous years, it was found that the SFC data fits a normal distribution. Taking the sample size of data collection into account, the reliability of one-tailed confidence threshold in t-distribution is suitable for calculating the representative values of SFC for assessment and determination, and this is explained in these criteria.

Appendix M: Determination of Compressive Strength of Cement Grout

The contents in Appendix M were written based on the relevant provisions of GB/T17671: Method of Testing Cements-Determination of Strength, and TB/T 3192-2008: Technical Specification of Cable Grouts on Post-Prestressed Concrete Railway Girder. Meanwhile, reference have also made to BS EN 445:2007: Grout for Prestressing Tendons— Test methods, and BS EN 196-1:2005: Methods of Testing Cement - Part1: Determination of Strength.

Appendix N: Determination of Normal Bonding Strength between Waterproofing layer and Concrete Surface

Themethods for inspection and verification of waterproof bonding strength, which were not included in previous editions, have been provided in this edition.

Appendix N was written based on JG/T507-2016: *Digital Bonding Strength Detector*, and the relevant provisions in Appendix B of CJJ139-2010: *Technical Specification of Urban Bridge Deck Water proofing*. Reference were also made to ASTM D7234-12: *Standard Test Method for Pull-off Adhesion Strength of coatings on Concrete Using Portable Pull-Off Adhesion Testers* (from USA).

N. 0. 8 During testing, no breaking off shall occur at the interface between the standard steel unit and the bonding glue, because the bonding strength to be measured is the strength of interface between the concrete surface of bridge deck and the waterproofing layer. The bonding strength relates to the temperature of waterproofing layer, that is, the strength decreases as the temperature increases. It is therefore necessary to measure the temperature of the waterproofing layer simultaneously. The on-field testing shall be conducted at suitable time during which the temperature is consistent to the designed material parameters for waterproofing, and thus to avoid temperature adjustment.

N. 0. 11 Bonding strength has significant influence on the effect of waterproofing and the performance of deck pavement. Strict control is required, that is, the qualified rate of the testing points shall be not less than 95% and the minimum strength of any tested spot shall be not less than 85% of designed value.

Appendix P: Limited defects of Appearance Quality of Structural Concrete

Limited defects are the quality imperfectness that shall not allowed to exist or must be remedied and repaired according to their impact on structural performance, service function, durability and visual comfort. This appendix specifies limited defects based on the classification of defect features and phenomenon on the appearance of structural concrete.

P. 0. 1 Extensive quality inspections shall be executed all over the appearance of concrete components or structures in order to fully and accurately evaluate appearance quality and identify other potential quality defects.

P. 0. 2 If the structural concrete surface is coated or decorated, the appearance condition would be altered, defects might be covered. This way, the range and degree of defects would be difficult to determine. Therefore, such works should not start prior to the appearance inspection.

P. 0. 3 This provision defines limited defects. The appearance defects of structural concrete are unavoidable, and it could have been uneconomical to prohibit any appearance defects. Meanwhile the appearance defects of various structures and components have different impact on performance, functioning, durability and visual perception. Defects might be compromised if their impact is strictly limited in a reasonable range.

1 Description of defects presented was compiled by referring to the current national standard GB50204: *Acceptance Specification for Construction Quality of Concrete Structure*.

2 The limited defects of non-stress and unstressed cracks in prestressed concrete works are only those within prestressed zones in square to the direction of prestressing. The crack defects in other zones and directions are regarded as the same to those of normal reinforced concrete.

3 The steel exposure shall be limited strictly since it causes not only the corrosion and cross-

sectional deduction to steel bars, but also concrete stripping that exacerbates further and serious corrosion.

4 A honeycomb and concrete loosing, when their depth exceeds 10mm, shall be limited since they usually represent a large defected area and cause more serious damage to concrete covers.

5 The appearance defects such as unsquared edge lines and surface warping may not have much impact on structural performance, but will seriously affect structural functioning, installation and visual perceptions, thus shall be limited.

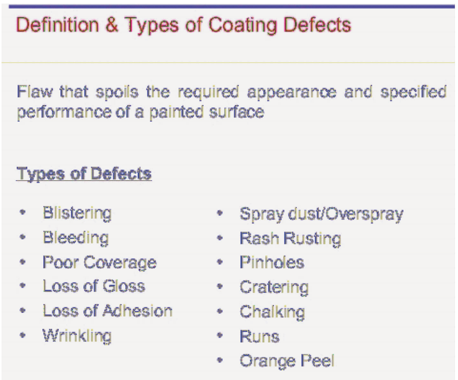
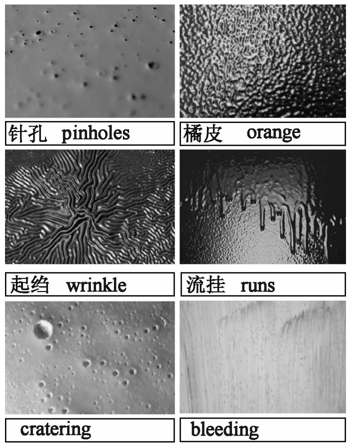
6 The color of concrete is significantly affected by cement used. Different brands of cement, in addition to shuttering surface and curing conditions, will influence the concrete color difference. Meanwhile, concrete color may decay as time elapses, but not necessarily demonstrate changes in concrete performance. Therefore, the provisions on concrete color appearance in previous edition of the standard has been cancelled.

Appendix Q ~ Appendix S

Specific requirements shall be added by referring to the methods of relevant inspection items for tunnel works.

Technical Terms in Chinese and English

序　　号	中 文 词 汇	英 文 词 汇
1	Advancerockbolts	超前锚杆
2	Advanced tremie	超前小导管
3	Angle square	角尺
4	Arch crown	拱顶
5	Arch invert	仰拱
6	Asphalt Surface Defects	沥青面层缺陷
7	Berm	反压护道
8	Bleeding or Flushing asphalt：	泛油
9	Block anchoring system	锚碇锚固系统
10	breaking down（to cut-off level）	破桩头
11	Bridge cable saddle	索鞍（桥梁）
12	British Pendulum Number（BPN）	摆式仪
13	Bugholes	（混凝土）麻面
14	Cable saddle	索夹鞍
15	Camber	预拱
16	Cement-flyash-gravel pile	水泥粉煤灰碎石桩
17	Classification of rock （based on degree of weathering）	岩石风化级别

序　号	中 文 词 汇	英 文 词 汇
18	Coating defect  Definition & Types of Coating Defects Flaw that spoils the required appearance and specified performance of a painted surface Types of Defects • Blistering • Bleeding • Poor Coverage • Loss of Gloss • Loss of Adhesion • Wrinkling • Spray dust/Overspray • Rash Rusting • Pinholes • Cratering • Chalking • Runs • Orange Peel	漆面病害 针孔、流挂、橘皮、起皱 
19	coefficient of retro-reflection	逆反射系数
20	Concrete cover	混凝土保护层
21	Concrete spacer	钢筋的保护层垫块
22	Concrete Surface Defects	混凝土缺陷
23	Construction project	工程项目
24	Controlled blasting	隧道控制爆破
25	Core cutting method	环刀法
26	Corrugated beam barrier/W-beam barrier	波形梁钢护栏
27	Cut stone	块石
28	Cut-and-cover tunnel	隧道明洞
29	Deformed steel bars	变形钢筋
30	Delamination	脱皮(路面)
31	Delineators	轮廓标
32	Deviation permit	允许偏差
33	Division of work	分部工程
34	Dominant item	主控项目
35	Dressed stone	料石
36	Driven pile	沉入桩
37	Dry rubble masonry:	干砌片石
38	Dryfilm thickness (DFT)	干膜厚度
39	Earthmoving and ground treatment	路基土石方工程
40	Earthworks	路基工程
41	Exposed reinforcement steel	露筋

序　　号	中 文 词 汇	英 文 词 汇
42	Fabric-packed sand drain	袋装砂井
43	Feeler gauge	塞尺
44	Flash Rust	斑锈
45	General item	一般项目
46	Glare netting	防眩网
47	Group of piles(pile group)	群桩
48	Arch haunch	拱腰
49	Highway fence	隔离栅
50	Hydroseeding	喷播绿化
51	Inspection and verification portfolio	检验项目
52	Inspection by counting	计数检验
53	Inspection by measurement	计量检验
54	Inspection item	检查项目
55	Intrados (of a tunnel)	内轮廓(隧道)
56	Inverted siphon culvert	倒虹吸涵管
57	Item no.	项次
58	Lap	搭接长度(钢筋)
59	lap splice	搭接(钢筋)
60	lattice	格栅
61	Main bars	主筋
62	Malen arch	劲性骨架拱
63	Manhole lid	井盖(窨井)
64	Movable barrier at median opening	中央分隔带开口护栏
65	Mulch	基材混合物(绿化)
66	Noise barrier, sound barrier	声屏障
67	Sleeper beam (for approach slab)	枕梁(桥头搭板)
68	Open culvert	明涵
69	Overbreak	超挖
70	Package of contract	合同段,标段
71	Pile bent	排架桩
72	Pipe jacking	顶进施工
73	Pipe roofing	超前大管棚
74	Prefabricated Vertical Drains (PVDs)	塑料排水板
75	Quadrant sampling	样方法
76	Quarry stone, quarry rubble	毛石

序　　号	中 文 词 汇	英 文 词 汇
77	Quicksand	流沙
78	Raised pavement marker（RPM）	突起路标
79	Raked pile	斜桩
80	Range pole	花杆
81	Coupling sleeve	（钢筋）连接套筒
82	Reinforced-earth-wall	加劲土挡墙
83	Release of jacking force	放张（预应力）
84	Repair	返修
85	Retroreflector	逆反射系数测试仪，逆反射测量仪
86	Rework	返工
87	Rock bolt	锚杆（隧道）
88	Rock fill	填石路基
89	Rubber balloon（test）method	水袋法（密实
90	Rubble	片石
91	Rubble Masonry	浆砌片石
92	Rust Bloom	泛锈
93	Rust-Back（rerusting）	返锈
94	Spot check	抽样检验
95	Sampling procedure	抽样方案
96	Sand drains and wick drains	砂井
97	Scaling	（砼）起皮
98	Sideways-force coefficient（SFC）	横向力系数 SFC
99	Skew back，impost	拱座
100	Sling	吊索，吊具
101	Slope above portal	隧道仰坡
102	Soft ground improvement	软土地基处治
103	Soil cement column	加固土桩，粉喷桩
104	Spalling	剥落
105	Spandrel	拱上结构
106	Water Cushion	水簸箕
107	Splice	接头（钢筋）
108	Springing line	起拱线，
109	springer	拱脚
110	Springing，Springing point	起拱点
111	Stone column	粒料桩

序　号	中 文 词 汇	英 文 词 汇
112	Stone pitched drain	砌石排水沟(渠)
113	Stress crack	受力裂缝
114	Sub-division of work	分项工程
115	Suspender	吊索
116	Taking-over inspection	交接检验
117	Taper gauge	间隙尺
118	Limited defects	限制缺陷(混凝土表面)
119	Tie Strip	(加劲挡墙)筋带
120	Type of work	单位工程
121	*Ultrasonic Inspection*	超声法(焊缝探伤)
122	Uncompacted slope edges, Insufficient width of embankment	亏坡
123	Underbreak	欠挖(土石方)
124	Underground tunnel	隧道暗洞
125	Undergrounddiaphragm	地下连续墙
126	Uniformity Coefficient	均匀性系数(集料)
127	Visual appearance	观感质量
128	*Visual Inspection (welding)*	目检
129	welded-butt splice	对头焊接(钢筋)
130	Welding defects	焊缝缺陷
131	Welding inspection	焊缝探伤
132	Welding line	焊缝
133	Work breakdown system (WBS)	项目划分(单位工程、分部工程、分项工程等)
134	*X-ray Inspection*	射线探伤(焊缝)