Code for Design of High-speed Railway (Trial)

高速铁路设计规范（试行）

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TB 10621-2009

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Introduction

This version, as one of China’s railway engineering construction standards in English series, which, in compliance with relevant procedures and regulations, is translated by Economic and Planning Research Institute of Ministry of Railways authorized by Construction Management Department of Ministry of Railways.

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The main organizations responsible for translation are the Third Railway Survey and Design Institute Group Co., Ltd, China Railway Siyuan Survey and Design Group Co., Ltd, China Academy of Railway Sciences. Many thanks should go to the staff from relevant standard development organizations and groups like China Railway Eryuan Engineering Group Co., Ltd, Southwest Jiaotong University, Beijing Jiaotong University, Lanzhou Jiaotong University and etc., who have provided great support during the course of translation and examination.

For the sake of improving its quality, any kind of suggestions and comments are welcomed and it would be greatly appreciated if they could be feedback to Construction Management Department of Ministry of Railways and Economic and Planning Research Institute of Ministry of Railways.

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The explanation rights of this Code belongs to Construction Management Department of Ministry of Railways. And the Code is published by Institute of Railway Engineering Technical Standards and China Railway Publishing House.
Foreword

This Code was prepared in accordance with the requirements of Notice on Issuing Preparation Plan for Railway Project Construction Standard of 2008 (Document Tie Jian She Han [2007] No. 1374) issued by Ministry of Railways, based on codes such as Interim Provisions for Design of New Passenger-Dedicated Railway with a Speed of 300～350 km/h (Document Tie Jian She [2007] No. 47), etc., and by learning from the construction and operation experience of high-speed railways (Passenger Dedicated Lines) such as Beijing-Tianjin Railway, Wuhan-Guangzhou Railway, Zhengzhou-Xi’an Railway, Hefei-Nanjing Railway, Hefei-Wuhan Railway, Shijiazhuang-Taiyuan Railway, etc., as well as the work experience in the sixth large-scale speedup campaign on railway lines such as Beijing-Guangzhou Railway, Hangzhou-Zhuzhou Railway, Qingdao-Ji’nan Railway, Zhengzhou-Xuzhou Railway, etc.

Focusing on the overall technical guideline of high-speed railways and following the principle of high starting point and high standard, this Code was prepared on the basis of original innovation, integrated innovation and import-digestion-absorption-based re-innovation, thus forming a design code for high-speed railways of China in conformity to its national conditions and railway conditions and enjoying independent intellectual property rights.


Main technical content of this Code is as follow:

1. It defines the compilation goal, application scope, design vision, design year and design live load. Moreover, it clarifies that this standard is applicable to high-speed lines with design operating speed of passenger train as 250～350 km/h. The maximum design speed is selected according to the matching principle of high-speed trains and cross-line trains.

2. It specifies in principle the selection of technical standard, system integration, comprehensive location design, safety design, arrangement of construction period, investment control, environmental protection and other aspects. Furthermore, it
regulates that the overall design of high-speed railway shall focus on requirements in five aspects, i.e. travel time and operation speed, passenger comfort level, energy saving & environmental protection, monitoring of safety and disaster prevention, operation plan of passenger train and transport organization, so as to achieve the goal of high speed, high comfort, high density, and high safety.

3. The transport organization content contains general principles of passenger train operation, the drawing method of train working scheduling, carrying capacity, transport capacity, etc. According to the realities of China and conditions of China Railways, it specifies the mode of trains with different speed levels running on one line or the mode of trains at the same speed level running on one line, provides basic preparation parameter of train operation diagram, and proposes the capacity calculation method adaptable to China’s high-speed railway.

4. Based on the matching principle of high-speed trains and cross-line trains, it specifies main design standards of plane and profiles, including the plane curve radius of alignment, length of transition curve, maximum gradient of track profile, length of grade section, vertical curve radius, etc.

5. It clarifies the demand of 100 years designed service life for earth structure; optimizes formation construction, filler and compaction standard, embankment filler and compaction standard, subgrade stabilization and settlement control standard; specifies requirements concerning design method of approach embankment, arrangement of drainage facilities for subgrade surface water and underground water, side slope protection, settlement observation and evaluation of embankment and cutting.

6. It specifies the standard limits of bridge structural deformation, displacement, rotation angle of beam end, natural frequency, stiffness and settlement of pier and abutment, perfects the value selection standard of braking force and traction force of bridge in station area, calculation formula of dynamic coefficient, and defines design standard of bridge rescue & evacuation passage.

7. It clarifies the outline design method in tunnel cross-section and the measures of reducing aerodynamic effect. Moreover, it also defines the method, scale and main calculation parameters (e.g. critical wind velocity) concerned in disaster prevention & rescue in tunnel, and adds relevant standards of interface design in tunnel.

8. It defines the regularity & laying precision standards of ballast track, ballastless track and turnout, clarifies design service life of main ballastless track structure no less than 60 years, and regulates requirements on interface design of different track structures with under-track engineering and E/M works.

9. It defines requirements on station layout, determination of the number of arrival-departure tracks in station, setting of safety siding, arrangement of station throat area, selection of turnout type and turnout layout. Besides, it describes the design standard of
plane and profiles of arrival-departure tracks and relevant sidings in station, and adds the requirements on numbering of tracks in large and extra large passenger stations and the name of stations.

10. It defines contents including technical index of power supply voltage and power supply method of catenary, the single line plan of traction substation, the secondary protection demand, power supply dispatching system and catenary, etc. In addition, it clarifies regulations on over-zone feeding capacity, design of special 27.5kV cable and interface design.

11. It clarifies the structure of power supply and distribution system for high-speed railways, defines the requirements on power supply reliability, fire alarm system (FAS), power supply in extra large station building, box-type substation and interface design, details and completes the content about power supply line design.

12. It clarifies the requirements on technology system, function, structure, arrangement and interface of communication subsystems, such as communication channel, transmission and access, data network, GSM-R, integrated video monitoring and video conference, etc.

13. It defines the requirements on integration of transport dispatching and command, train operation control, computer interlocking, centralized signal monitoring and relevant subsystems. Meanwhile, it clarifies design standards of CTCS application level under different speed conditions, turnout snowmelt, station signal, track circuit, balise, RBC, power supply, signal cable and protection.

14. It regulates application information systems, such as operation dispatching, EMU operation control, comprehensive maintenance management, ticket service, passenger service, marketing, public security administration, office automation and call center. In addition, it clarifies the requirements on interconnection and information sharing among different systems, and on the function, hierarchy structure and arrangement of each system.

15. It clarifies setting principles of wind, rain, snow and earthquake monitoring devices in disaster prevention and safety monitoring system for high-speed railway. Moreover, it defines the requirements on interconnection of disaster prevention and safety monitoring system with operation dispatching system, CTC system, power supply dispatching system and integrated video monitoring system.

16. It defines the requirements on working scope, setting principle, general layout, and allocation of operation servicing & maintenance facilities of EMU depot and workshop (or depot, yard), and regulates equipment allocation of maintenance workshop according to 3rd, 4th and 5th maintenance levels.

17. It defines the working contents of inspection and maintenance and the requirements on working scope, structure, design principle, equipment allocation and
interface in infrastructure maintenance base, comprehensive maintenance workshop and comprehensive maintenance work area.

18. Combining with the train transport organization characteristics of high-speed railway, it clarifies setting standard of water supply station and water supply and sewage discharging for passenger train. Furthermore, it adds regulations on sanitary protection of self-constructed water source and protection measures for water supply and sewerage pipe crossing track.

19. According to the “Five Principles” of station design, it clarifies that station size of high-speed railway shall be determined jointly by maximum gathering passenger numbers and delivery volume in rush hour. It also clarifies the streamline mode for high-speed railway station, and raises the requirements on reasonably setting station building and arranging internal and external streamline.

20. It clarifies the composition of integrated earthing system, determines the requirements on scope of integrated earthing system and value of earthing resistance. Meanwhile, it proposes the design principle that using steel bar inside the structure as natural earthing body, and regulates contents of earthing terminal, earthing connection and burying method of through earthing wire.

21. It clarifies basic principles for design of environment-friendly alignment selection, ecological protection, soil and water conservation, noise and vibration pollution treatment, sewage and waste gas treatment, solid waste disposal, and electromagnetic interference prevention. Besides, it defines the design content of sound barrier for high-speed railway, transferring facilities for waste, construction for greening and green channel.

The provisions in boldface in this Code are mandatory, which must be strictly implemented.

All relevant organizations are kindly requested to sum up and accumulate your experiences in actual practices during the process of implementing this Code. In case of some contents needing modification and supplement, the relevant opinions and documents, whenever necessary, can be posted or passed on to the Third Railway Survey and Design Institute Group Co., Ltd. (No. 10, Zhongshan Road, Hebei District, Tianjin, 300142), China Railway Siyuan Survey and Design Group Co., Ltd. (No. 745, Heping Avenue, Wuhan, 430063) and China Academy of Railway Sciences (No. 2, Daliushu Road, Xizhimenwai Avenue, Beijing, 100081) and meanwhile a copy to Economic and Planning Research Institute of Ministry of Railways (No. 29, Beifengwo Road, Haidian District, Beijing, 100038) is also expected, for reference in further revising.

The explanation right of this Code belongs to Construction Management Department of Ministry of Railways.
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1 General Provision

1.0.1 This Code is formulated with a view to unify the technical standards on design for the high-speed railway, and to make the design of high-speed railway meet the requirements of safety and function, latest technology and cost effectiveness.

1.0.2 The code is applicable to high-speed railways of passenger trains with designed speed of 250～350 km/h, and high-speed railways currently carrying both passenger and freight shall also implement relevant provisions.

1.0.3 High-speed railway design should be based on the following principles:

1. The construction concept of “human-centered, serving for transport, emphasizing priorities and simplifying procedures, system optimization and development-oriented”;

2. Adopting advanced, proven, economic benefit, and reliable technologies;

3. Reflecting the technical requirement of higher speed, higher density, higher safety and higher riding comfort;

4. Meeting the requirement of digitalized railways.

1.0.4 The designed speed of high-speed railways should be selected based on the matching principle of high-speed trains and crossing-line trains, and should consider the compatibility of mixed operation of different speeds on the same track.

1.0.5 Design period of high-speed railways shall be divided into short-term and long-term. Short-term shall be ten years since the line was put into operation, long-term shall be twenty years.

For railway infrastructure as well as the buildings and equipments that could not be easily rebuilt and expanded, shall be designed according to long-term traffic volume and traffic characteristics, and shall adapt to the requirement of further development.

For the buildings and equipments that could be easily rebuilt and expanded, shall be designed according to short-term traffic volume and traffic features, and reserve conditions for further development.

The quantity of operational equipment following the change of traffic demand could be designed according to the traffic volume of the fifth year after operation.

1.0.6 The construction and basic clearance of high-speed railway shall be in conformity with Figure 1.0.6, and the clearance widening in curve section shall be determined according to calculation.

1.0.7 ZK live load shall be applied for the designed live load of high-speed railway trains.

ZK live load is train vertical static live load. Figure 1.0.7-1 shows the ZK standard live load, and Figure 1.0.7-2 shows the ZK special live load.
1.0.6 The construction clearance and basic profile of high-speed railway (unit: mm)
1—Rail level; 2—Clearance for sections and main track inside station (without platform); 3—Clearance of station with platform; 4—Maximum height above the top of rail; 5—Distance between the center of track and platform edge (not applicable to main track)

Figure 1.0.7—1 ZK standard live load

Figure 1.0.7—2 ZK special live load

1.0.8 High-speed railways shall be designed as fully fenced and fully separated.

1.0.9 High-speed railway shall be designed in accordance with national relevant laws and codes on energy saving, less water use, less material use and less land use, as well as environmental protection.

1.0.10 The aseismic design for high-speed railway structures shall follow the standards and provision in National Standard of Aseismic Design in Railway Engineering GB 50111 and relevant existing national standards.

1.0.11 Besides this Code, high-speed railway design shall also comply with the valid national relevant standard (code).
2 Glossaries and Symbols

2.1 Glossaries

2.1.1 High-speed railway
Newly-constructed railways for passenger trains with maximum designed operational speed of 250 km/h and above.

2.1.2 General design
General design means the design process of technical solutions for completed general objectives and realization of objectives of railway engineering, which includes selecting key technical standards, track alignment and construction plan, determining system configuration and system integration solutions, confirming the construction period, investment and other control objective, as well as the work contents of system reliability and internal control design.

2.1.3 System Integration
System integration means under the guidance of system engineering scientific method, optimizing the configuration of various technologies and products based on the demand of project, and integrating all the separated subsystem into a complete, reliable, and cost-effective system, which could assort with each other to exert integrated benefits and achieve integrative performance optimization.

2.1.4 Comprehensive maintenance window
In the train working diagram, the comprehensive maintenance window means the time of stopping train operation and cutting power in certain section and in certain period, of which time used for maintenance of track, catenary, etc.

2.1.5 Passing capacity
The passing capacity means, under certain operation organization condition, the maximum passing, arrival or departure of trains (or pair of trains) could be handled by all the available fixed equipment in the section in 24 hours.

2.1.6 Traffic capacity
Traffic capacity means, under certain technical equipment and operation organization condition, the total number of passengers could be carried by one train in 24 hours.

2.1.7 Settlement after civil works
It means the total settlement of infrastructure after rail laying engineering works.

2.1.8 ZK-live load
The designed live load for high-speed railway trains in China.

2.1.9 Designed service life
It means the goal for service life which could be used as a design basis of structure durability by the designing personnel and was provided with sufficient safety or availability. The designed service life shall be determined by owner or by user and designing personnel together, and shall satisfy the requirements of related rules.

2.1.10 The buffer structure of tunnel portal

When there is a building or special surrounding requirement at the two portals of the tunnel, the structure could reduce the air dynamic effect and the sound vibration harm.

2.1.11 Electrical multiple unit (EMU)

A set of trains with distributed power, fixed formation and need not un-coupling during the daily maintenance.

2.1.12 Running line for EMU

Dedicated EMU running line used for in and out EMU depot (workshop).

2.1.13 Running track for maintenance and repair machinery train

Dedicated line used for running of maintenance and repair machinery trains.

2.1.14 Integrated earthing system

The earthing system integrated with equipments along the railway line, like traction power supply, electric power supply, communication, signal and other electric information system, buildings, track, station, bridge, tunnel and sound barrier which need earthing through public grounding wire.

2.1.15 Chinese train control system level 2

The train control system with track-based transmitting information, which delivering train control information by track circuit combined with balise.

2.1.16 CTCS level 3

Train control system used to examine the track occupation condition by using track circuit method and based on radio transmission information.

2.1.17 Radio Block Center (RBC)

The trackside equipment controlling train interval by using radio communication. The system receives all the train location information, sends movement authority to all the trains and provides control function for train intervals.

2.1.18 Train Control Center (TCC)

General appellation of devices like train control, routing command and speed information used on CTCS-2 train control system.

2.1.19 Temporary speed restriction

Speed restriction under temporary condition.

2.1.20 Balise

High-speed data transmission device used to store and send message.

2.1.21 Fixed balise

The transmission device used to send format message.

2.1.22 Switchable balise
The transmission device used to send real-time alterable message through connecting with LEU (line side electric unit) by dedicated cable.

2. 1. 23  Line-side Electric Unit (LEU)

The data acquisition and disposal unit, which means the electric equipment used to periodical receive real-time alterable message sent by train control center and continuously send message to active balise, through connecting with train control center by serial communication interface or other interface.

2. 1. 24  Average power failure interruption to customer

The average power failure interruption to each customer in per unit time. The interruption includes failure interruption times and number of planned black outs.

2. 1. 25  Average outage duration for customer

The average outage duration time of each customer in per unit time, which includes failure outage time and planned maintenance outage time.

2. 1. 26  Power supply reliability ratio

The ratio of total un-interruption hours experienced by customer to the total power supply hours required by customer in one year.

2. 2  Abbreviation

AN  Access Network
AS  Autonomous System
BAS  Building Automation System
BITS  Building Integrated Timing Supply
BSC  Base Station Controller
BTM  Balise Transmission Module
C/A  Carry/Adjacent
C/I  Carry/Interfere
CIR  Cab Integrated Radio communication equipment
CRTS  China Railway Track System
CTC  Centralized Traffic Control
CTCS  Chinese Train Control System
DDF  Digital Distribution Frame
DDN  Digital Data Network
FAS  Fire Alarm System
FE  Fast Ethernet
GE  Gigabit Ethernet
GK  Gate Keeper
GW  Gate Way
ISDN  Integrated Services Digital Network
JRU  Juridical Recorder Unit
LAN    Local Area Network
LEU    Line-side Electric Unit
MCU    Multi-point Control Unit
MPLS   Multi-protocol Label Switching
MSC    Mobile Switching Center
MSTP   Multi-Service Transfer Platform
NTP    Network Time Protocol
ODF    Optical Distribution Frame
POS    Packet Over SDH
POTS   Plain Old Telephone Service
QOS    Quality of Service
RAMS   Reliability, Availability, Maintainability, Safety
RBC    Radio Block Center
SAN    Storage Area Network
SCADA  Supervisory Control and Data Acquisition
SDH    Synchronous Digital Hierarchy
SDU    Speed Distance Unit
TCC    Train Control Center
TCP/IP Transmission Control Protocol /IP Internet Protocol
TCR    Track circuit receiver
TRAU   Transcoder and Rate Adapter Unit
TSR    Temporary Speed Restriction
TSRS   Temporary Speed Restriction Server
TSRT   Temporary Speed Restriction Terminal
VC     Vital Computer
VDF    Voice Distribution Frame
VPN    Virtual Private Network
WAN    Wide Area Network
WLAN   Wireless Local Area Network

2.3 Symbols

\[ V \] -- designed operation speed (km/h)
\[ V_0 \] -- designed maximum speed (km/h)
\[ R \] -- plane curve radius (m)
\[ R_{th} \] -- vertical curve radius (m)
\[ K_{s0} \] -- foundation coefficient (MPa/m)
\[ E_{v4} \] -- dynamic deformation modulus (MPa)
\[ E_{v2} \] -- second deformation modulus (MPa)
\[ K \] -- compacting factor
$L_e$ — effective loading length of bridge structure (m)
$n_0$ — vertical self-excited vibration frequency of simple supported girder ($H_r$)
$F$ — centrifugal force (kN)
$N$ — concentrated load in the diagram of ZK standard live load (kN)
$f$ — centrifugal force compensation coefficient
3 Overall Design

3.1 General Requirements

3.1.1 Design of high-speed railways shall follow philosophy of integrated planning, overall conceiving, gradually deepening, specialty design obeying overall design to realize original goal with scientific approaches.

3.1.2 For the overall design of high-speed railways, requirements of the project and all relevant factors shall be fully studied as the base; main technical standards, strike of alignment and construction plan shall be reasonably selected; system configuration and system integration plan shall be determined; construction period, investment and other control objectives should also be determined.

3.1.3 The overall design of high-speed railways shall meet the objects and requirements such as travel time and maximum operation speed, ride comfortability, energy saving, environmental protection, safety and disaster prevention, and schedule rules and schedules of passenger trains.

3.2 Main Technical Standards

3.2.1 The main technical standards of high-speed railway shall be selected according to design principle of system optimization based on consideration of the role that the railway plays in the railway network, topography along the railway, geological condition, traffic capacity and transport demand. The design of high-speed railways shall include main technical standards as followings;

- designed speed;
- distance between centers of main line tracks;
- minimum plane curve radius;
- maximum gradient;
- available length of arrival and departure line;
- EMU type;
- train operation control mode;
- train operation command mode;
- minimum headway.

3.2.2 The designed speed shall be determined after technical and economic comparisons in terms of the project role in rapid railway passenger transport network, transport demand, engineering specifications to meet the demand of travel time target.

3.2.3 The high-speed railways shall be designed as one time constructed double-track
3.2.4 Distance between centers of main line tracks, minimum plane curve radius and maximum gradient shall be determined according to designed operation speed, traffic organization mode, safety and ride comfort, etc.

3.2.5 The available length of arrival and departure tracks shall be 650m.

3.2.6 EMU type shall comply with passenger train operation speed.

3.2.7 The operation control mode of high-speed trains shall employ CTCS-2 train control system based on track circuit or CTCS-3 train control system based on GSM-R wireless communication transmission. CTCS-2 train control system serves as backup when CTCS-3 System is employed.

The operation control mode of 250km/h high-speed trains uses CTCS-2 train control system.

3.2.8 Train control and command system shall employ centralized traffic control system.

3.2.9 The minimum headway should be 3~4min according to transport demand.

3.2.10 Standards of designed speed, distance between centers of lines, plane and profile of lines shall be systematically designed and coordinated.

3.3 Design of System Integration

3.3.1 High-speed railway system shall be composed of 6 sub-systems, namely, civil works, traction and power supply, train operation control, high-speed train, operation and dispatching and passenger transport service.

3.3.2 High-speed railway system integration shall focus on matching and coordination among different system standards, different interfaces as well as fixed and mobile equipments, so as to realize system optimization.

3.3.3 The interface design of high-speed railways shall comply with following principles:

1. Pay attentions to coordination of various civil works. Deformation compatibility of structures shall be taken into consideration in the design of earth structure, bridge and tunnel. Frequent transition of different structures shall be avoided. Uniformity of track stiffness and stiffness transition of different track structures shall be emphasized.

2. Attentions should be paid to the coordination between design of civil works and other specialties. The auxiliary engineering works of earth structure, bridge and tunnel shall comply with installation requirements of equipments including cable trench, catenary, sound barrier, integrated grounding, track sign, trans-track pipeline in station area, traction and power supply, electricity, communication, trans-track of signal cable, etc.

3. Attentions should be paid to interface coordination in different design stages of the project, different phases of step-by-step designed project, the project and outside related engineering as well as adjacent railways.
3.4 Synthetical Location

3.4.1 The location of high-speed railway shall adhere to following principles:
1 Meet the overall plan of railway networks.
2 Enhance construction quality and transport efficiency and reduce maintenance cost.
3 Cover major cities for passengers’ convenience and trip attraction.
4 Coordinate with overall plan of urban, local traffic, farmland and water conservancy and other relevant engineering constructions to make proper arrangements.
5 The location and overall design shall consider side slope protection, waterproofing and drainage in a system-engineering way, in order to optimize the plane and profile of the track and determine the best engineering scheme after comparison.
6 Detour all kinds of unfavorable geologic body. As for unfavorable geologic body which is difficult to detour, engineering improvement measures shall be taken based on geological exploration in order to ensure operation safety.
7 The subgrade construction shall avoid high filling, deep or long cutting. As for special ground and bad geologic areas, the cutting and filling height of subgrade shall be strictly limited.
8 As for deep gully sections located in complex terrain and unfavorable geologic areas, the design of plane and profile shall be compatible with design requirements of bridges or culverts.
9 The design shall be in accordance with environmental protection, water and soil conservation, land saving and protection of historic relics.

3.4.2 The design of railway terminal and large passenger stations of big cities shall comply with following principles:
1 According to the overall plan of urban and railway terminal, it shall be realized gradually that of “separated tracks for passenger and freight traffic, passenger traffic inside city while freight traffic outside city”.
2 Determine number of passenger stations based on comprehensive study.
3 Select locations of passenger stations based on approach directions and urban master plan to develop urban traffic hub.
4 Make the allocation of EMU depot and workshop (or depot) concentrated and upsized with space for further development.
5 The connecting line for running cross-line train shall be set up according to the traffic demand and the principle of connecting for primary lines and passenger transfer for secondary lines.

3.4.3 The location of high-speed railway lines shall take into consideration of natural and engineering conditions and abide by principles as followings:
1 The alignment of space curve shall be designed according to the running speed and speed difference of train.
2 Distribution of station shall meet the needs of distribution of passenger flow, travel convenience for urban dwellers, train operation optimization, design capacity and maintenance. Distribution of station should also be convenient for travelling at traffic hubs and tourist resorts.

3 The arrangement of earth structure, bridge, culvert and tunnel shall be determined after technical and economic comparison.

4 Track structure type shall be determined according to engineering works under the track and environmental conditions after technical and economic comparison.

5 Alignment design shall consider relations between rail expansion joint and span and structure of bridges.

6 Facilities like EMU depot and workshop (or depot) and comprehensive maintenance depot shall be arranged in an appropriate way.

3.5 Others

3.5.1 The design of high-speed railways shall focus on systematic optimization with consideration of factors including quality, safety, construction schedule, investment, environmental protection and technical innovation.

3.5.2 A precision survey network of high speed railways with integration of design survey, construction survey and operation and maintenance survey shall be built up.

3.5.3 Survey and design of high-speed railway shall strengthen geologic survey and exploration and test works. The geologic survey shall meet the requirements of major structure settlement of earth structure, bridge, tunnel and building. If necessary, study on the influence of regional ground settlement to high-speed railway engineering as well as on counter measures shall be conducted.

3.5.4 The design of high-speed railway shall focus on safety. Safety design and safety assessment shall be considered throughout the whole process of design.

3.5.5 The dynamic simulation of train operation, track and bridge (or earth structure, tunnel) shall be conducted in the design of high-speed railway to make the coupling dynamic responses of vehicle, track and bridge (or earth structure, tunnel) comply with running safety and ride comfortability.

3.5.6 The designed service life of major structures of high-speed railway, such as earth structure, bridge and tunnel is 100 years, while the designed service life of ballastless track shall not be less than 60 years.

3.5.7 The design of high-speed railway shall emphasize protecting ecological environment, natural landscape and cultural spots. Emphasis shall also be laid on water and soil conservation, ecologically sensitive area, wet land protection, disaster preventing and mitigation as well as contamination prevention.

3.5.8 Construction schedule of high-speed railway shall follow principles below:

1 Special consideration should be taken with respect to the systematic complexity and
high technical standards in precision survey, alignment control, settlement monitoring, ballastless track, system integration, operation testing, pilot operation and other key factor that may intervene construction schedule.

2 Based on current technological levels and availability of construction equipments, new technology, new process, new material and new equipment should be utilized to represent average advanced level of the society as a whole.

3 Special attention should be taken in key engineering stages that may influence construction schedule, including construction preparation, subgrade, bridges and tunnels, box girder erection, track engineering, large stations, supporting engineering of E&I works, joint commissioning and trial operation to meet technique and interface requirements of different engineering schedules.

4 Principles of optimizing construction resources, including labor force, heavy-duty special equipments and circulating materials should be implemented. The optimization shall comply with dynamic design process and reduce influence of unstable factors.

3.5.9 Engineering measures should be taken to control vibration and to reduce noise, including noise from wheel/rail system, pantograph/catenary system, electromechanical noise and aerodynamic noise.

3.5.10 Investment control should be determined after comparison and analysis of technical standards, construction plans and engineering measures. Principles of “scientific tendering, moderately tight, emphasizing the fundamental and simplifying the incidental and cost effective” should be well implemented to control investment.
4 Transport Organization

4.1 General Requirements

4.1.1 The transport organization can employ the mode of trains with different speeds running on one line or the mode of trains with the same speed running on one line.

4.1.2 Operation of passenger train shall comply with the following principles:
   1 Train operation scheme shall be made according to origin-destination estimation of passenger flow between large stations, and be designed according to principles of balancing passenger flow and train operation; The service frequency of stations along the railway shall be improved, especially for the large and medium stations, the train departure interval in peak hours shall be reduced in order to meet the trip demand of passengers; the departure time and arrival time between major stations shall be regular.
   2 As for passenger stations with more transport demands, non-stop trains and skip-stop trains shall be organized.

4.1.3 Stations distribution of high-speed railway shall meet following demands:
   1 Distribution of passenger flow and travel demand of urban dwellers along the railway.
   2 The demand of optimizing train operation scheme.
   3 The demand of designed capability and maintenance.
   4 Passenger stations shall be arranged at large and medium sized cities, important traffic hub and tourist resorts, etc..

4.2 Train Working Diagram

4.2.1 The train working diagram shall be made in line with following rules:
   1 Different train headways shall be calculated and determined according to traction and braking performance of train, train control mode, the number of arrival-departure tracks and turnout layout of stations.
   2 The train running time between stations shall conform with traction calculation result.
   3 The additional time for train starting and stopping shall refer to traction calculation result, the additional time for train starting shall not be longer than 2.5 min, and for train stopping shall not be longer than 1.5 min.
   4 The possessive interval for comprehensive maintenance shall not be shorter than 240 min.
   5 The operation time for quick turn-back EMU should not be longer than 24 min;
and the operation time of EMU at service depot & workshop (depot) should be 120 min.

4.3 Carrying Capacity and Traffic Capacity of Line

4.3.1 The carrying capacity of railway sections shall be calculated according to districts of passenger transport and be expressed with the pairs of train with the highest speed level. Graphic method or analysis and calculation method will be used to calculate carrying capacity in following situations:

1. The carrying capacity of sections of parallel working diagram with entire high-speed train.

2. The carrying capacity of sections of non-parallel working diagram with entire high-speed train and carrying capacity of sections in peak hours.

3. The carrying capacity of sections with trains at different speed levels running on one line.

4. The traffic capacity of the line with trains of entire high-speed running and that with trains of different speed levels running shall be calculated respectively.

4.3.2 The calculation of carrying capacity of stations shall follow principles below:

1. The carrying capacity of stations shall take into consideration of equipment layout and operation organization plane, shall follow the principles of making the best of parallel route and using tracks in a balanced and reasonable way, shall calculate the carrying capacities of arrival and departure tracks and throat zone of all day as well as in peak hours.

2. The time standard of various operations in occupation of station equipment shall be calculated in detail and step-by-step according to the layout of station type, train operation control mode and turnout type, etc.
5 Alignment

5.1 General Requirements

5.1.1 To enhance ride comfort, the parameters of plane and profile shall be selected in such a way that the smoothness of space curve alignment shall be taken more attention.

5.1.2 For the deceleration/acceleration area connected with station where all trains stop, the standard corresponding to designed operation speed may be used; and for deceleration/acceleration area connected with the station where partial trains stop, corresponding technical standard shall be used according to speed differences, so as to fulfill the requirements of ride comfort.

5.1.3 The design of plane and profile shall comply with required precision of track laying.

5.2 Plane

5.2.1 The plane curve radii of main line shall be selected according to geographical and environmental conditions. The plane curve radii matching different speeds are listed in Table 5.2.1.

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350/250</th>
<th>300/200</th>
<th>250/200</th>
<th>250/160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballast track</td>
<td>Recommended 8 000～10 000; Normal min. 7 000; Special case min. 6 000</td>
<td>Recommended 6 000～8 000; Normal min. 5 000; Special case min. 4 500</td>
<td>Recommended 4 500～7 000; Normal min. 3 500; Special case min. 3 000</td>
<td>Recommended 4 500～7 000; Normal min. 4 000; Special case min. 3 500</td>
</tr>
<tr>
<td>Ballastless track</td>
<td>Recommended 8 000～10 000; Normal min. 7 000; Special case min. 5 500</td>
<td>Recommended 6 000～8 000; Normal min. 5 000; Special case min. 4 500</td>
<td>Recommended 4 500～7 000; Normal min. 3 200; Special case min. 2 800</td>
<td>Recommended 4 500～7 000; Normal min. 4 000; Special case min. 3 500</td>
</tr>
<tr>
<td>Max. Radius</td>
<td>12 000</td>
<td>12 000</td>
<td>12 000</td>
<td>12 000</td>
</tr>
</tbody>
</table>

Note: The use of minimum allowable radius on special case may only be allowed on prerequisite of technical and economic comparison with full verification by Ministry of Railways.

5.2.2 Compound curve shall not be designed on the main line.

5.2.3 Straight of main line in section should be designed as parallel double track with constant distance between centers of lines, and curves of main line in section should be
designed as concentric circles.

5.2.4 The distance between centers of lines shall comply with the following requirements:

1. The distance between centers of main lines in section and station shall not be less than the standard values listed in Table 5.2.4, and it needs no widening as for curve sections.

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. distance b/t centers of lines (m)</td>
<td>5.0</td>
<td>4.8</td>
<td>4.6</td>
</tr>
</tbody>
</table>

2. The distance between centers of tracks in parallel sections of main line with connecting line or EMU running line, which shall be determined comprehensively according to the train operation speed and its technical requirements of the adjacent line on one side and the subgrade level relationship of adjacent lines as well as by taking related technical conditions of E&M equipment, subgrade drainage equipment, sound barrier, bridge and culvert and working passage for ensuring the safety of technical operation staff etc. into consideration, shall not be less than 5.0m at the least.

3. The distance between centers of tracks in parallel sections of main line with existing railway and mixed passenger and freight railway shall not be less than 5.3m. The minimum distance between centers of tracks shall be determined comprehensively according to related technical conditions when the parallel lines are not in the same level or equipment is set up between tracks.

4. The distance between centers of two lines in double-tube tunnel shall be determined according to geological condition, tunnel structure and requirements of disaster prevention and relief after comprehensive analysis and study.

5.2.5 The straight line and circular curve shall be connected by the transition curve, which shall be the form of cubic parabola curve. Then length of transition curve shall be selected from Table 5.2.5 with regard to speeds, curve radii and geological conditions. Under normal conditions, values in column (1) shall be selected.

<table>
<thead>
<tr>
<th>Curve radius (m)</th>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>12000</td>
<td>(1)</td>
<td>370</td>
<td>330</td>
<td>300</td>
</tr>
<tr>
<td>11000</td>
<td>(1)</td>
<td>410</td>
<td>370</td>
<td>330</td>
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<tr>
<td>10000</td>
<td>(1)</td>
<td>470</td>
<td>420</td>
<td>380</td>
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<td>9000</td>
<td>(1)</td>
<td>530</td>
<td>470</td>
<td>430</td>
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<td>8000</td>
<td>(1)</td>
<td>590</td>
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<td></td>
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<tr>
<td></td>
<td>550*</td>
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### Table 5.2.5 (continued)

<table>
<thead>
<tr>
<th>Curve radius (m)</th>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(1)</td>
</tr>
<tr>
<td>6000</td>
<td>670</td>
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<td>540</td>
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<td></td>
<td>680*</td>
<td>610*</td>
<td>550*</td>
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</tr>
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<td>5500</td>
<td>670</td>
<td>590</td>
<td>540</td>
<td>490</td>
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<td></td>
<td>680*</td>
<td>610*</td>
<td>550*</td>
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<td></td>
<td></td>
<td></td>
<td>585*</td>
</tr>
<tr>
<td>3500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. In the Table above, the condition values in column (1) indicate excellent comfort; the condition values in column (2) indicate good comfort; and the condition values in column (3) indicate general comfort.
2. Symbol * indicates the values that will be taken when the curve cant is designed as 175mm.

### 5.2.6
The minimum lengths of the intermediate straight line between two adjacent curves and the circular curve between two transition curves shall be calculated with the following formulas and shall conform to the values listed in Table 5.2.6.

#### Table 5.2.6 Minimum Length of Circular Curve or Intermediate Straight Line

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum length of circular curve or intermediate straight line (m)</td>
<td>280(210)</td>
<td>240(180)</td>
<td>200(150)</td>
</tr>
</tbody>
</table>

**Note:** Values in brackets are the minimum values selected under difficult conditions.

- under general condition: $L \geq 0.8V$  \[ (5.2.6-1) \]
- under difficult condition: $L \geq 0.6V$  \[ (5.2.6-2) \]

where, $L$ —— length of circular curve or intermediate straight line (m);

$V$ —— speed (km/h).

### 5.2.7
The bridge with continuous girder, steel girder or comparatively large span girder should be located on straight line, curve may also be used on prerequisite of technical and economic comparison.

### 5.2.8
The tunnel should be located on straight line, curve may only be used where the environment is limited by topographic and geological conditions, and the plane should not be designed as reverse curves.
5.2.9 The length of station site shall be determined according to the long-term layout of the station.

5.2.10 The stations shall be located on straight line.

5.2.11 On main lines, the length of straight-line between transition curve and turnout shall be calculated according to formulas below and shall be conform to the values specified in Table 5.2.11.

under general condition; \( L \geq 0.6V \)  
under difficult condition; \( L \geq 0.5V \)  

\[ (5.2.11-1) \]  
\[ (5.2.11-2) \]

where, \( L \) —— the length of straight line (m);  
\( V \) —— speed (km/h).

Table 5.2.11 Min. Length of Straight-line between Transition Curve and Turnout on Main Line

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. length</td>
<td>210(170)</td>
<td>180(150)</td>
<td>150(120)</td>
</tr>
</tbody>
</table>

Note: The values in brackets are the minimum values selected under difficult conditions.

5.2.12 The expansion rail joint shall not be located in the region of curves.

5.3 Profile

5.3.1 The maximum gradient of main line in sections should not be larger than 20\%, and under difficult conditions, shall not be larger than 30\% after technical and economic comparison.

The maximum gradient of EMU running line shall not be larger than 35\%.

5.3.2 Main lines should be designed as long grade sections whose minimum length shall comply with the values given in Table 5.3.2. The minimum length of grade section should not be used continuously under general conditions, shall not be used continuously under difficult conditions.

Table 5.3.2 Minimum Length of Grade Section

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>2 000</td>
<td>1 200</td>
<td>1 200</td>
</tr>
<tr>
<td>Difficult</td>
<td>900</td>
<td>900</td>
<td>900</td>
</tr>
</tbody>
</table>

Note: The minimum length of grade section under difficult conditions may be used after technical and economic comparison with full verification by Ministry of Railways.

5.3.3 The connections between grade sections shall comply with the following requirements:

1 When the gradient difference between adjacent gradients of main line is larger than or equal to 1\%, vertical curve in circular arc shall be used for connection. The minimum allowable vertical curve radius shall be selected from Table 5.3.3-1 according to the long-time designed speed of the section; the maximum vertical curve radius shall not be larger than 30 000 m. The minimum length of vertical curve must not be shorter than 25 m.
Table 5.3.3-1 Minimum Vertical Curve Radius

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{v}}$ (m)</td>
<td>25000</td>
<td>25000</td>
<td>20000</td>
</tr>
</tbody>
</table>

2. The vertical curve (or gradient change point) must not be located in the same region with transition curve, turnout and expansion rail joint.

3. The vertical curve should not be located in the same region with the plane circular curve, and under difficult conditions, the value of vertical curve shall conform to the values in Table 5.3.3-2.

Table 5.3.3-2 Minimum Curve Radius When Vertical Curve and Plane Circular Curve Are Located in the Same Region

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>350</th>
<th>300</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. plane circular curve (m)</td>
<td>Ballast track</td>
<td>7000</td>
<td>5000</td>
</tr>
<tr>
<td>Ballastless track</td>
<td>6000</td>
<td>4500</td>
<td>3000</td>
</tr>
<tr>
<td>Min. vertical curve radius (m)</td>
<td>25000</td>
<td>25000</td>
<td>20000</td>
</tr>
</tbody>
</table>

4. When the gradient difference between adjacent gradients of EMU running line more than 3%o, the grades shall be connected with vertical circular arc. The radius of vertical curve is 5000m under general condition and 3000m under difficult conditions.

5.3.4 When two main lines are parallel, the elevation of top of rail (ToR) of two lines should be designed as equal altitude (inner rail top designed as equal altitude on curves).

When the main line is in parallel with connecting line, EMU running line or existing line, the elevation of ToR of the main line shall be determined according to the design of cross section of subgrade.

5.3.5 The profile of bridge with continuous girder, steel girder and large-span girder shall meet the technical requirements of bridge design.

5.3.6 The gradient in tunnel may be designed as one-way slope or double spur, double spur should be used for long tunnel with rich ground water and its gradient shall not be less than 3%o.

The gradient at cutting section should not be less than 2%o.

5.3.7 As for the bridge approach subgrade of super-long bridge, major or medium bridge across the flood discharge rivers and as for the permeable embankment located in the reservoir or near river area, flood discharge area, flood retention area etc., the elevation of the shoulder shall be designed according to relevant design codes with reference of national flood prevention standard.

5.3.8 Station site should be arranged on level grade, and may be set on the gradient not larger than 1%o under difficult conditions, and on grade with gradient not larger than 2.5%o under extremely difficult conditions. Overtaking station may be set on the gradient not larger than 6%o. One grade section should be used within the scope of the effective length of arrival-departure line.
The gradient of main line at station throat section should be in accordance with that of station site. Under difficult conditions, it may be appropriately enlarged, but should not be larger than 2.5%, and shall not be larger than 6% for extremely difficult conditions.

5.4 Intersections, Subsidiary Facilities and Others

5.4.1 The intersection of railway and highway (road) shall be designed as whole grade separation mode.

5.4.2 The profile of bridges across navigable rivers shall be designed to meet the requirements of not only hydrologic condition and bridge structure, but also navigation clearance.

5.4.3 Section line shall be closed completely with protective fence, and the type selection of the protective fence shall meet relevant requirements. The protective fence shall be arranged at 0.5m inside the right-of-way of railway in the whole subgrade section, plain and rolling terrain as well as dry bridge section near city and town. Warning signs shall be set at the maintenance access and every 200m along the protective fence.

The access for vehicles used for repair and maintenance purpose shall be set in the comprehensive maintenance depots and station. As for in sections, the access used for maintenance purpose shall be arranged according to ground traffic condition of the area and other maintenance requirements.

5.4.4 The landmark (post) for main line and station shall be buried on railway boundary and at turning point of the boundary. The intervals of buried landmarks (post) should be 150m for straight line and 40m for curve.

5.4.5 The safety protection zone post shall be arranged at safety protection zone boundary of both sides of railway according to relevant regulations stipulated in Railway Transport Safety Protection Rules.

5.4.6 When the highway and high-speed railway are parallel and the ground elevation of highway is higher or lower within 1.5m than that of railway, the protective fence and monitoring equipment shall be installed at proper location between highway and high-speed railway.
6 Earth Structure

6.1 General Requirements

6.1.1 Design of the main project of subgrade shall be based on the earth structures. Earth structure engineering shall strengthen the geological mapping, exploration and testing works, ascertain the geological formation and their physical-mechanical properties of the foundation, cutting slope and retaining structure foundation, identify the unfavorable geological conditions, investigate properties and distribution of the geomaterials etc., and the design shall be carried out on the basis of reliable geological data.

6.1.2 Designed life-time of the main project of subgrade is 100 years. Designed life-time of the subgrade drainage facilities is 30 years, and designed life-time of the slope protection structure is 60 years.

6.1.3 Earth structure shall ensure the safety and comfortability for trains running with high speeds. Stiffness of the formation upper layer shall meet the requirement that the elastic deformation of the subgrade due to the running train can be controlled within a certain range; strength of the formation upper layer shall be able to withstand a long-term effect of the train load; while thickness of the formation upper layer shall make the load distribution effect protects the underlying surface from too high a dynamic stress exceeding the long term bearing capacity of the formation lower layer. Filling materials for the subgrade shall be of fine gradation, higher density and strength as well as good water-stability, and shall be able to protects the subgrade soils from surface water and leading to the soil softening and causing mud-pumping, frost heaving and other faults.

6.1.4 Quality, gradation and water-stability of the geomaterials for subgrade shall conform to the technical requirements of high-speed railways, the compaction of the filling materials shall comply with relevant standards.

6.1.5 The maximum diameter of the filling materials within the lower layer of formation shall be less than 60 mm, while that for the embankment below the formation shall be less than 75 mm.

6.1.6 In-situ filling test shall be carried out before the construction of embankment.

6.1.7 At the transition zone, between embankment and bridge, between embankment and embankment cross structures, between embankment and tunnels, between embankment and cuttings, and between ballasted track and ballastless track etc., the approach embankment should be arranged to ensure an gradual change of the stiffness and deformation along the line longitudinally.
6.1.8 Settlement after civil works of embankments shall be controlled within the allowable range. Treatment measures of the foundation shall be based on the topography and geological conditions, embankment height, filling materials and construction duration etc. and be determined by calculation and analysis. For approach embankment between bridge and embankment, cross structures and embankment, for places where stratigraphic fluctuation is larger, and for transition zones where different foundation treatment measures are adopted, the method of gradual transition foundation treatment shall be applied to minimized uneven settlements. Systematic observations of settlement shall be carried out during embankment construction. Analysis and evaluation based on the observed settlement data is required before track-laying. When it is sure that settlement after civil works meets the requirements, track-laying is allowed.

6.1.9 Retaining and protection structure of the subgrade shall be consistent with the requirement of safety and stability of high-speed railway. The subgrade slope should be protected with green plants, and taken into account the requirements of landscape and environmental protection, soil conservation, land conservation etc.

6.1.10 The subgrade waterproofing and drainage system shall be planed systematically, meet the waterproofing and drainage requirements, and be implemented timely.

6.1.11 Design of the earth structure shall comply with the disaster prevention and mitigation requirements, and enhance the resistance capability of subgrade to continuous heavy rainfall, floods, earthquakes and natural disasters.

6.1.12 Height and distribution width of filling height by converting track and axle load on the formation surface shall be consistent with the requirements listed in Table 6.1.12.

<table>
<thead>
<tr>
<th>Type of live load of train</th>
<th>Designed axle load (kN)</th>
<th>Type of track</th>
<th>Distribution width (m)</th>
<th>Calculated height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unit weight of soil (kN/m³)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18  19  20  21  22</td>
</tr>
<tr>
<td>ZK live load</td>
<td>200</td>
<td>CRS I type ballastless slab track</td>
<td>3.0</td>
<td>3.1  2.9  2.8  2.6  2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS I type ballastless bi-block track</td>
<td>3.4</td>
<td>2.8  2.7  2.6  2.4  2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CRS II type ballastless slab track</td>
<td>3.25</td>
<td>2.9  2.7  2.6  2.5  2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ballasted track</td>
<td>3.4</td>
<td>3.0  2.8  2.7  2.6  2.4</td>
</tr>
</tbody>
</table>

6.1.13 The subgrade design standards for main lines at two ends of the station, sections where existing railway is utilized, connecting lines, EMU running lines and maintenance train running lines shall be determined in accordance with their design maximum speeds. Transition sections no less than 10m shall be arranged at the places where formation structures change.

6.1.14 Earth structure engineering shall enhance design of the interfaces, and rationally arrange the associated works like cable trench, transferring cables through tracks, catenary
supporting foundation, sound barrier foundation and integrated earthing etc., to refrain the associated works from affecting the subgrade waterproofing and drainage system, the subgrade strength and stability.

6.2 Shape and Width of Formation Surface

6.2.1 Formation surface may be arranged horizontally within the bottom of the ballastless track supporting layer (or base). Lateral drainage slopes with a gradient of no less than 4% are arranged on both sides of the formation surface outside of the supporting layer (or base). Shape of the ballasted track formation surface shall be a triangle, and the lateral drainage slopes with a gradient of no less than 4% shall be arranged from the formation surface center to both sides. The formation surface shall remain a triangle when the width is getting wider at the curve.

6.2.2 The width of formation shoulder on both sides of the ballasted track shall be no less than 1.4m for double track and no less than 1.5m for single track.

6.2.3 Standard width of formation surface at straight sections shall be consistent with requirements listed in Table 6.2.3.

Table 6.2.3 Standard Width of Formation Surface

<table>
<thead>
<tr>
<th>Type of track</th>
<th>Designed maximum speed (km/h)</th>
<th>Distance btw. Centers of 2 tracks (m)</th>
<th>Width of formation surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single track (m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Double track (m)</td>
</tr>
<tr>
<td>Ballastless track</td>
<td>250</td>
<td>4.6</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>4.8</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>5.0</td>
<td>8.6</td>
</tr>
<tr>
<td>Ballasted track</td>
<td>250</td>
<td>4.6</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>4.8</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>5.0</td>
<td>8.8</td>
</tr>
</tbody>
</table>

6.2.4 Formation surface of the curved sections of the ballastless track main line is generally not widening. When there are special requirements for installation of such facilities like track structures and catenary supporting etc., decisions are made in accordance with the specific situation. For curved sections of the ballasted track main line, the formation surface widening shall be outside of the curve and the widening value shall be in accordance with what Table 6.2.4 requires.

Table 6.2.4 Widening Value of formation Surface at the Curved Sections for Ballasted Track

<table>
<thead>
<tr>
<th>Designed maximum speed (km/h)</th>
<th>Curve radius $R$ (m)</th>
<th>Widening value outside of the formation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>$R \geq 10,000$</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>$10,000 &gt; R \geq 7,000$</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>$7,000 &gt; R \geq 5,000$</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>$5,000 &gt; R \geq 4,000$</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>$R &lt; 4,000$</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Table 6.2.4 (continued)

<table>
<thead>
<tr>
<th>Designed maximum speed (km/h)</th>
<th>Curve radius $R$ (m)</th>
<th>Widening value outside of the formation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>$R \geq 14,000$</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>$14,000 &gt; R \geq 9,000$</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>$9,000 &gt; R \geq 7,000$</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>$7,000 &gt; R \geq 5,000$</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>$R &lt; 5,000$</td>
<td>0.6</td>
</tr>
<tr>
<td>350</td>
<td>$R &gt; 12,000$</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>$12,000 &gt; R \geq 9,000$</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>$9,000 &gt; R \geq 6,000$</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>$R &lt; 6,000$</td>
<td>0.6</td>
</tr>
</tbody>
</table>

6.2.5 Standard cross sections of the subgrade are shown as Figures 6.2.5-1〜6.2.5-8.

Figure 6.2.5-1 Standard Cross Section of Embankment for the Ballastless Double Track

Figure 6.2.5-2 Standard Hard Rock Cutting Cross Section of the Ballastless Double Track

Figure 6.2.5-3 Standard Non-Hard Rock Cutting Cross Section of the Ballastless Double Track
Figure 6.2.5-4 Standard Cross Section of Embankment for the Ballastless Single Track

Figure 6.2.5-5 Standard Cross Section of Embankment for the Ballasted Double Track

Figure 6.2.5-6 Standard Hard Rock Cutting Cross Section of the Ballasted Double Track

Figure 6.2.5-7 Standard Non-Hard Rock Cutting Cross Section of the Ballasted Double Track
Figure 6.2.5—8 Standard Cross Section of Embankment for the Ballasted Single Track

6.3 Formation

6.3.1 Formation shall be composed of upper layer and lower layer. Thickness of the upper layer of the formation is 0.4m for ballastless track and 0.7m for ballasted track, thickness of the lower layer is 2.3m.

6.3.2 Upper layer of the formation shall be filled with graded crushed stone; the compacting criteria shall be in accordance with the requirements listed in Table 6.3.2—1.

<table>
<thead>
<tr>
<th>Table 6.3.2—1 Compact Criteria of the Formation Upper Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact criteria</td>
</tr>
<tr>
<td>Compacting factor $K$</td>
</tr>
<tr>
<td>Coefficient of subgrade $K_{30}$ (MPa/m)</td>
</tr>
<tr>
<td>Dynamic deformation modulus $E_{d1}$ (MPa)</td>
</tr>
</tbody>
</table>

Note; $K_{30}$ or $E_{d1}$ may be adopted for ballastless track. When $E_{d1}$ is adopted the control criteria are $E_{d1} \geq 120$ MPa and $E_{d1}/E_{d2} \leq 2.3$.

The material specification shall be in accordance with the following requirements:

1 Materials for graded crushed stone of the formation upper layer are crushed and sieved from the crushed block stones, natural screens or sand gravels.

2 Diameter grading of the graded crushed stone for the formation upper layer shall be in accordance with the requirements listed in Table 6.3.2—2. The non-uniformity coefficient $C_u$ shall not be less than 15. The grain with size of less than 0.02 mm must take no larger than 3% of the total weight. Figure 6.3.2 shows the size grading curve.

<table>
<thead>
<tr>
<th>Table 6.3.2—2 Grain Size Grading of the Graded Crushed Stone for the Upper Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side length of sieve with square openings (mm)</td>
</tr>
<tr>
<td>Percentage of sieving quality (%)</td>
</tr>
</tbody>
</table>

Note: number inside the bracket is suitable for railways in freezing area.
3 The graded crushed stone of the formation upper layer and the filled soil below shall meet the requirement of $D_{15} < 4d_{85}$. When the requirement is not met, a double layer structure with different granule pellet grading shall be adopted for the formation upper layer, or composite geotextile be laid on top of the formation lower layer. When the filled soil below is improved soil, it may not conform to the aforementioned requirement.

4 The pellets with a tattered surface shall take at least 30% of the total weight of the coarse pellets with a diameter of more than 22.4 mm.

5 The Los Angeles wearing ratio of the pellets with a diameter of more than 1.7 mm is no larger than 30%, and the portion of pellets damaged when dipping in sodium sulfate solution is no larger than 6%. Liquid limit of the fine pellets with a diameter of less than 0.5 mm is no larger than 25%', while the plasticity index is less than 6. Clay and other foreign substances are not allowed.

6.3.3 Group A or B filling materials or improved soil shall be used for the lower layer of the formation. The pellet diameter grading of the group A and B filling materials shall be in accordance with the compaction requirement; the frozen impact depth of filling materials in cold region shall be in accordance with the frost heaving protection requirement. The compaction criteria for the lower layer of the formation shall be in line with the requirements listed in Table 6.3.3.

**Table 6.3.3 Filling Materials and Compaction Criteria of the Lower Layer of the Formation**

<table>
<thead>
<tr>
<th>Compaction criteria</th>
<th>Chemic improved soil</th>
<th>Sandy soil and fine gravel soil</th>
<th>Crushed stone and coarse gravel soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction factor $K$</td>
<td>$\geq 0.95$</td>
<td>$\geq 0.95$</td>
<td>$\geq 0.95$</td>
</tr>
<tr>
<td>Coefficient of subgrade $K_{30}$ (MPa/m)</td>
<td>—</td>
<td>$\geq 130$</td>
<td>$\geq 150$</td>
</tr>
<tr>
<td>Dynamic deformation modules $E_{ov}$ (MPa)</td>
<td>—</td>
<td>$\geq 40$</td>
<td>$\geq 40$</td>
</tr>
<tr>
<td>Unconfined compressive saturated strength in 7d (kPa)</td>
<td>$\geq 350$ (550)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: 1 $K_{30}$ or $E_{ov}$ may be adopted for ballastless track. When $E_{ov}$ is adopted, the control criteria are $E_{ov} \geq 80$ MPa and $E_{ov}/E_{41} \leq 2.5$.

2 Number inside the bracket is the necessary compressive strength taking into account of the freezing thawing cycles on the chemic improved soil in cold area.
6.4 Embankment

6.4.1 For embankment below the formation, fills of group A and B or crushed stones and gravel fills of group C should be adopted, and the pellet diameter grading shall be in accordance with the compaction requirement; when fine fills of group C was adopted, improvement shall be carried out based on the filling material properties. Compaction criteria of the embankment below the formation shall be in accordance with the requirement listed in Table 6.4.1.

Table 6.4.1 Fill Materials and Compaction Criteria of the Embankment below the Formation

<table>
<thead>
<tr>
<th>Compaction criteria</th>
<th>Chemic improved soil</th>
<th>Sandy soil and fine gravel soil</th>
<th>Crushed stone and coarse gravel soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction factor $K$</td>
<td>$\geq 0.92$</td>
<td>$\geq 0.92$</td>
<td>$\geq 0.92$</td>
</tr>
<tr>
<td>Coefficient of subgrade $K_{30}$ (MPa/m)</td>
<td>$-$</td>
<td>$\geq 110$</td>
<td>$\geq 130$</td>
</tr>
<tr>
<td>Unconfined compressive saturated strength in 7d (kPa)</td>
<td>$\geq 250$</td>
<td>$-$</td>
<td>$-$</td>
</tr>
</tbody>
</table>

Note: $K_{30}$ or $E_{eq}$ may be adopted for ballastless track. When $E_{eq}$ is adopted, the control criteria are $E_{eq} \geq 45$ MPa and $E_{eq} / E_{cl} \leq 2.6$.

6.4.2 Settlement after civil works of embankment shall be in line with the following requirements:

1. Subgrade settlement of the ballastless track after civil works shall be in accordance with the adjust ability of fastener and meet the requirement of roundrate of vertical arc of the track. The settlement after civil works should not exceed 15mm; when the settlement is regular and the vertical arc radius after adjusting the rail top level meets the requirements listed in 6.4.2, the allowed settlement after civil works is 30mm.

$$R_{ah} \geq 0.4 \ V_{b}^{2}$$  

(6.4.2)

The differential settlement after civil works between approach embankment and bridge, tunnel and cross structures shall not be larger than 5mm, and the tangent angle caused by differential settlement shall not be larger than 1/1000.

2. Subgrade settlement after civil works of the ballasted track shall meet the requirement listed in Table 6.4.2.

Table 6.4.2 Control Criteria of the Settlement after Civil Works of Subgrade

<table>
<thead>
<tr>
<th>Design running speed (km/h)</th>
<th>Settlement at general sections (cm)</th>
<th>Settlement at the transition section of the abutment end (cm)</th>
<th>Settlement rate (cm/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>$\leq 10$</td>
<td>$\leq 5$</td>
<td>$\leq 3$</td>
</tr>
<tr>
<td>300,350</td>
<td>$\leq 5$</td>
<td>$\leq 3$</td>
<td>$\leq 2$</td>
</tr>
</tbody>
</table>

6.4.3 When taking into account the train load, the stability factor of subgrade shall not be less than 1.25.

6.4.4 Settlement of the soft foundation may be calculated in according to Appendix B of • 28 •
the Standard, and the calculated settlement value shall be tested and corrected by the field observation data.

6.4.5 For subgrade on soft foundation, the behavior of the subgrade and foundation shall be tested in advance on typical sections according to the actual situation of the project.

6.4.6 For the parts of the embankment which are scoured by floods or rivers and immersed by waters, water permeable materials with good water stability shall be used to fill with, and the side slope gradient shall be eased, platform of side slope shall be arranged, protection measures of side slope shall be strengthened.

6.4.7 For the low-lying sections where water is stagnant in rainy season or water drainage isn’t smooth, the immersion affected places shall be filled with water permeable materials, and dredging measures for water drainage shall be adopted.

6.4.8 When filling embankment on cohesive soil foundation with a high groundwater table (Groundwater table is not greater than 0.5 m from the ground surface), the embankment bottom shall be filled with water permeable materials. When it is permitted, measures to lower the groundwater table should be adopted.

6.4.9 Side slope gradient of the embankment shall be determined after a comprehensive analysis of the factors like subgrade fill, subgrade height, seismic force, geological condition of the subgrade foundation, hydrological and climate conditions.

6.4.10 For embankment in seismic regions, fill materials with good vibration stability shall be adopted. Crushed stones (gravels) or coarse sand mixed with crushed stones (gravels), fine sand or medium sand shall not be used for the base mattress.

6.4.11 When filling embankment on foundations which may get liquefaction, aseismatic measures like soil replacement, arranging berm or ground stabilization etc. shall be adopted according to the specific situations.

6.4.12 For subgrade in loess zone, waterproofing and water drainage measures shall be strengthened; treatment principles as closed waterproofing, interception and dredging shall be adopted; comprehensive drainage facilities and protection works which are anti-scouring, anti-seepage and to the benefit of soil and water conservation shall be built; mutual interference between the subgrade and the irrigation and water conservancy facilities shall be managed appropriately.

When the loess is of a higher collapsibility or compressibility, treatment measures to the collapsible loess shall be determined based on the foundation soil properties, the embankment height and the subgrade deformation controlling requirements. For ballastless track, reliable measures shall be taken to eliminate the collapsible influence of the foundation.

6.4.13 For subgrade in karst zone, the harmfulness of karst on the subgrade project shall be differentiated and appropriate treatment measures shall be taken based on the project reality (like the surface configuration of karst, surface runoff, groundwater activities etc.).
6.4.14 For subgrade in man-made pothole section, comprehensive analysis based on the formation time, depth, height, roof lithology, mechanical properties, hydro geological conditions and engineering geological conditions of the pothole shall be made, and construction measures like open-cut and backfill, or boring-and-filling, grouting etc. shall be adopted respectively.

6.4.15 For expansive soil subgrade, deformation properties of the expansive soil as foundation shall be analyzed, treatment measures like excavation and replacement may be adopted, and waterproofing, drainage as well as side slope protection works shall be strengthened.

6.5 Cutting

6.5.1 For formation of hard rock which is not easily weathering, it is required to follow the provisions listed below:

1. For ballastless track laying, it is required to excavate to the subgrade surface and directly build the supporting layer or base on the excavation surface.

2. For ballasted track laying, it is required to excavate to 0.2 m below the subgrade surface, and horizontal drainage slope with a gradient of 4% is built from the subgrade center to both sides on the excavation surface, then graded crushed stones are filled on top of it.

3. Loosed rock on the excavation surface shall be cleared away. The unflattering places of the excavated surface shall be patched up by concrete with a strength level of no less than C25.

6.5.2 Formation of soft rock and soil shall meet requirements of Articles 6.3.2 and 6.3.3 of this Code; foundation within the scope of the formation shall not be soil of $P_r < 1.5$ MPa or $\sigma_0 < 0.18$ MPa. When it does not meet the requirement, reinforcement measures shall be taken and in accordance with the following provisions:

1. Upper layer of the formation shall be replaced with graded crushed stones, and in accordance with what Article 6.3.2 requires.

2. When the natural foundation is in line with requirements of the lower layer soil of the formation, measures like dig-over and backfill or strengthening compaction may be adopted.

3. When the natural foundation does not meet requirements of the lower layer soil of the formation, measures like replacement, foundation improvement or reinforcement may be taken. The replacement scope shall be determined based on calculation and analysis of the specific situation.

4. When treatment measures of digging over, replacement or improvement, reinforcement are applied to the formation, enhanced drainage and seepage control measures shall be taken. And the hierarchical compaction shall be in accordance with standards of the corresponding parts of the formation.

6.5.3 For parts of the formation with special soil like expansive, loess soil etc., measures like dig-over and backfill, watertight and seepage control shall be taken based on
the specific situation. For expansive and loess soil under the formation, measures of enclosed waterproofing, drainage or foundation treatment shall be adopted on the basis of the subgrade deformation analysis.

6.5.4 For cutting-filling subgrade, when cutting and filling transversely under the track, replacement of the cutting part may be used to adjust the differences in strength and stiffness with the filling part, and the replacement thickness shall be determined based on the height of the filling part and the foundation conditions.

6.5.5 Side ditch platform shall be arranged for all cuttings, and the platform width should be no less than 1.0m. Side slope platform shall be arranged at the boundary between earth and stone, the interface between the permeable layer and the impermeable layer, as well as the place where the cutting slope height is larger; the platform width should be no less than 2.0 m, and in accordance with the requirement of stability of the cutting slope. Waterproofing and reinforcement works shall be well done on the side slope platform.

6.5.6 Form and rate of the cutting slope shall be determined synthetically by mechanical analysis based on factors like the engineering geology, hydro-geology, meteorological conditions, waterproofing and drainage measures as well as construction methods etc.

6.6 Approach Embankment

6.6.1 Approach embankment shall be arranged at the transition zone between the embankment and bridge abutments. The inverted trapezoidal transitional pattern longitudinally along the line may be adopted, as Figure 6.6.1 shows. And the following provisions shall be met;

Figure 6.6.1 Diagram of Approach Embankment Arrangement at the End of the Abutment
1 Length of the approach embankment is defined by Formula 6.6.1, and is no less than 20 m.

\[ L = a + (H - h) \times n \] (6.6.1)

Where, \( L \) — length of the approach embankment (m);
\( H \) — height of the embankment behind the abutment (m);
\( h \) — thickness of the upper layer of the formation (m);
\( a \) — length of the bottom of the inverted trapezoid along the line, take \( 3 \sim 5 \) m;
\( n \) — constant, take \( 2 \sim 5 \).

2 Upper layer of the formation at the approach embankment shall be in accordance with the requirements listed in Article 6.3.2 of this Code, and shall be mixed with 5% of cement. The part of the inverted trapezoid below the formation upper layer shall be filled in layers with graded crushed stone mixed with 3% of cement; the grading scope of the graded crushed stone shall be in line with what Table 6.6.1 requires. The compaction criteria shall be consistent with compaction coefficient \( K \geq 0.95 \), coefficient of subgrade \( K_\text{soil} \geq 150 \) MPa/m, and dynamic deformation modulus \( E_n \geq 50 \) MPa.

**Table 6.6.1 Grading Scope of Crushed Stones**

<table>
<thead>
<tr>
<th>Grading number</th>
<th>Percentage (%) of weight passing the sieve hole (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Note: percentage of the needle-like crushed stones and flake crushed stones shall be no larger than 20%; the percentage of soft and weak crushed stones shall not exceed 10%.

3 The abutment foundation pit at the approach embankment shall be backfilled with concrete or be filled in layers with crushed stones and lime soil, and be rolled and compacted with small machines. The concrete shall satisfy requirement of the designed strength, while the crushed stones and the lime soil shall meet the requirement of \( E_n \geq 30 \) MPa.

4 When the foundation of the transition zone needs to be stabilized, the harmonious graded change with the adjacent lots shall be considered.

5 The approach embankment shall be consistent with the requirements of special structure of the track.

6 Approach embankment of the transition zone shall be constructed simultaneously with the embankment connected, and be filled in layers with roughly the same height. Small machines shall be used for rolling and compacting within the scope of 2.0 m from back of the abutment, and the filling thickness in layers shall be appropriately reduced.

7 Treatment measures and construction technology of the approach embankment shall be tested in-situ combined with the engineering reality.

6.6.2 Approach embankment shall be arranged at junctions between the embankment and the cross structures (interchange frame structure, box culvert etc.). The inverted...
trapezoidal transitional pattern longitudinally along the line may be adopted, as shown in Figure 6.6.2-1. Top of the cross structure and the upper layer of the formation of the approach embankment shall be in accordance with the requirements listed in Article 6.3.2 of this Code. Fill material of the approach embankment, compaction criteria and backfill of the foundation pit shall be in accordance with the requirements listed in Article 6.6.1 of this Code. The frost protection ability of the fill materials for the transition zone with the cross structures which are under influence of the frost shall be taken fully into consideration when arranging the approach embankment at cold regions, as shown in Figure 6.6.2-2. When height of the fill soils on top of the cross structure is no larger than 1.0 m, the graded crushed stones for the upper layer of formation of the cross structure and within 20 m on both sides of it shall be mixed with 5% of cement, as shown in Figure 6.6.2-3.

Figure 6.6.2-1 The Transition Zone between General Embankment and Cross Structures (h>1.0 m)

Figure 6.6.2-2 The Transition Zone between General Embankment and Cross Structures (h>1.0 m) at Cold Region

Note: t represents the maximum freezing thickness, when t<0.3 m, top of the culvert shall be filled with frost protective material totally.
6.6.3 Approach embankment shall be arranged at transition zone between embankment and cutting. The following arrangement patterns may be adopted for the transition zone:

1. When the transition zone between embankment and cutting is hard rock cutting, footsteps shall be excavated longitudinally along the original ground on one side of the cutting, the digging depth of each footstep shall be no less than 1.0m from the original slope surface, and height of the step is about 0.6 m. Approach embankment shall be set up on one side of the embankment, as shown in Figure 6.6.3-1. Filling requirements of the transition zone shall be consistent with the provisions listed in Item 2 of Article 6.6.1 of this Code.

Figure 6.6.3-1 The Approach Embankment between Hard Rock Cutting and Embankment

Figure 6.6.3-2 The Transition Zone between Soft Rock or Soil Cutting and Embankment
2 When the junction between embankment and cutting is soft rock or soil cutting, footsteps shall be excavated along the original ground, the digging depth of each footsteps shall be no less than 1.0 m, and height of the step is about 0.6 m. Filling requirements of the excavated part shall be the same as those of the corresponding part of the embankment, as shown in Figure 6.6.3—2.

6.6.4 Track transition shall be arranged at the transition zone between the soil, or soft rock cutting and tunnel, and be filled with gradually changed thickness of concrete or graded crushed stone mixed with 5% of cement.

6.6.5 Track transition shall be arranged for subgrade at the transition zone between the ballastless track and the ballasted track, and shall be in accordance with the transition requirements of the track pattern.

6.6.6 For short subgrades between two bridges, two tunnels, bridge and tunnel, appropriate measures should be taken for smooth transition; when the subgrade between two bridges is non-hard rock cutting with a length of less than 150m, deck and pile system or engineering measures ensuring a smooth transition of the stiffness may be adopted for the subgrade foundation.

6.7 Drainage

6.7.1 The designed rainfall reappearing period of the subgrade drainage facility is 50 years.

6.7.2 Design of drainage for the formation surface shall take comprehensive consideration of factors as track form, cable trench, foundation of catenary pole, foundation of sound barrier etc.

Drainage between lines shall be considered comprehensively, taking the routes and the impact of weather conditions on the track circuit into account. When conditions are met, lateral direct drainage mode shall be given priority. When the track structure is requiring using water-collecting well for drainage, location of the wells, material, structure and size as well as the depth and methods of the drainage pipes shall be determined based on comprehensive consideration of the load, rainfall, and the requirements of frost and seepage protection.

6.7.3 The side ditch, gutter and drainage ditch shall be poured with concrete or prefabricated and assembled, mortar rubble is prohibited.

6.7.4 For low embankment or cutting sections, when the groundwater level is higher or there is not a fixed water bed, facilities like open trench, drainage channel, french drain, slope leak ditch, supporting leak ditch etc. may be adopted to get rid of the groundwater; when the underground is buried deep or fixed water bed endangers the subgrade, then facilities like leak tunnel, leaching well, leaky pipe or inclined borehole etc. may be used to drain off the groundwater. Filters shall be arranged for french drain and other underground drainage facilities.
Longitudinal gradient of the french drain and the leak tunnel shall be no less than 5% and no less than 2% when the condition is difficult. Steeper longitudinal gradient shall be arranged at the exits.

In areas where frost heaving is prone to happen, the french drain and the leak tunnel shall be set at least 0.25 m below the maximum freezing depth or necessary frost protection facilities shall be adopted. In freezing cold areas, frost protection measures shall be taken for water outlet.

6.7.5 The subgrade drainage facilities shall connect and coordinate with other drainage facilities of the bridges, culverts, tunnels and stations, and shall be combined with the comprehensive utilization of the soil and water conservation and irrigation and water conservancy facilities. The arrangement of drainage facilities shall meet the following requirements:

1 For the embankment section, drainage ditch is arranged outside of the natural berm for one side or both sides of embankment.

2 For the cutting section, side ditches shall be arranged on both sides of the subgrade shoulder. And gutter is arranged outside of the top of cutting slope for one side or both sides of the cutting.

3 For places where the annual precipitation is greater than or equals to 400 mm, intercepting ditch shall be arranged on bench of the cutting slope.

4 For sections of ground with great steep incline lateral slope, the drainage ditch and the gutter may be arranged on one side above the lateral slope. When the ground without great steep, the drainage ditch and the gutter should be set on both sides of the embankment.

5 Longitudinal gradient of the ground drainage facilities shall be no less than 2%.

6 Top of the drainage ditch shall be at least 0.2 m higher than the designed water level.

7 It is not allowed to drain off water from gutter to the side ditch of cutting. When it demands to drain off the water to side ditch subjecting to terrain constraints, chute must be arranged and size of the side ditch cross section downstream be adjusted according to the flow.

6.7.6 Drainage of the subgrade should be incorporated into the design of the relevant drainage facilities according to the drainage conditions of the location.

6.8 Slope Protection

6.8.1 Slope protection works shall be set for slope of embankment, the protective form shall be determined based on the specific conditions like the surrounding environment, properties of the fill materials, climatic conditions, slope height, immersion and scouring etc. in the light of local conditions and meet the following requirements:

1 When slope of embankment is suitable for plant protection, and stability of the
slope can be guaranteed, the green protective measures should be adopted, other than masonry protection for the whole slope.

2 When height of the embankment slope is high, geogrid and other geosynthetics with a width of no less than 3 m may be laid in layers within the slope on both sides.

3 For immerseable sections where the subgrade slope is scoured by water, protective measures of strong erosion resistance ability shall be adopted based on the velocity, flow and scouring depth.

6.8.2 slope surface of soil and soft rock cutting (including slope bench, side ditch platform) shall be protected or reinforced, and in accordance with the following requirements:

1 For slope of soil cutting, the plant protection measure may be used; for higher soil cutting slope, measures like framing or beam with anchored rod frame may be adopted depending on the nature of the stratum.

2 For soft rock cutting, reinforcement measures of the slope shall be determined based on the rock mass structure, occurrence of structural plane, degree of weathering, groundwater and climate conditions etc.; measures such as spraying combined vegetation, spraying combination within the anchor bolt framed beam or foreign soil vegetation may be adopted for slope protection.

6.8.3 Slope of hard rock cutting which is more complete shall be protected with pre-splitting, smooth blasting in conjunction with embedded patching and anchor bolt framed beam. When rock mass of the slope is fractured or joints of the rock are growing, protection measures like praying combined vegetation, spraying combination within the anchor bolt framed beam or foreign soil vegetation may be adopted according to height of the slope. When the slope is higher, anchor-based steel rope hanging protection may be set inside the anchor bolt framed beam.

6.8.4 Generally the structure with an intercepting trench shall be adopted for framework revetment. Buried depth of the framework shall be greater than 0.6 m; space between two adjacent frameworks should be no more than 3 m.

6.8.5 For slopes of growing groundwater cutting and expansive soil cutting, reinforcement of leaking ditch and supporting french drain for slope shall be adopted in combination of with slope protection. If necessary, groundwater discharging shall be strengthened in combination with deep drainage holes.

6.9 Retaining Structure

6.9.1 For sections of subgrade with steep incline, deep cutting, or near the cities and towns etc., retaining structures may be arranged in order to ensure the stability of slope, lower the slope height and reduce the removing and land using.

6.9.2 When calculating the retaining structures, the height and distribution width of conversion soil column of the track and train load in Table 6.1.12 may be used to design
for the calculation of retaining structure; when the height of the shoulder wall is low, the calculation model for which the loads were contributed over the full may be used for subgrade surface. When there are girder transporting and erecting vehicles passing, the embankments and the retaining structures of subgrade shoulders shall taken the effects of the special loads like girder transporting and erecting vehicle into consideration.

6.9.3 Load of the girder carrier and erecting vehicle should be converted into double soil columns. Formula 6.9.3 is used for load conversion:

\[ H_0 = \frac{NG}{\gamma B_0 L} \]  

(6.9.3)

Where, \( N \) — number of vehicles transversely distributed, take 1;
\( G \) — weight of 1 vehicle, take the weight of heavy vehicle (kN);
\( B_0 \) — width between centers of the tires of laterally distributed vehicles plus the distance between the outer edge of one side of the tire (m);
\( L \) — wheelbase plus length of the tire touching on the ground vertically (m);
\( \gamma \) — unit weight of soil (kN/m³).

6.9.4 In the cities and around the scenic spots, appropriate light retaining structures which are harmonious with the surrounding landscape such as the cantilever type, the counterfort type, pile-sheet and reinforced earth retaining wall etc. should be adopted according to conditions on-site. For seismic region, flexible retaining structures like the reinforced earth retaining wall etc. should be adopted.

6.9.5 Height of the gravity retaining structures should be no greater than 6m for subgrade wall and no greater than 8m for wall of subgrade.

6.9.6 Concrete shall be adopted to build the gravity retaining wall. The filter blanket directly behind the retaining wall should adopt sand-gravel wicks or geosynthetics.

6.10 Observation and Evaluation of Subgrade Deformation

6.10.1 Systematic evaluation of the subgrade deformation shall be carried out before laying track on the subgrade, so as to ensure that the subgrade deformation is in compliance with relevant requirements.

There shall be an observation and adjustment period of no less than 6 months after the completion of embankment filling or after the pre-loading being applied. When the observation data are insufficient for evaluation or the evaluation of settlement after civil works does not meet the requirements, the observation shall be continued or necessary measures to accelerate or control the settlement shall be adopted.

6.10.2 Observation of the subgrade settlement shall put stress on settlement of subgrade surface and settlement of foundation. Settlement plates, observation posts or observation devices for profile settlement may be arranged, and the following requirements shall be met:

1 Settings of the observation cross-section of embankment settlement and the
observation content shall be determined on the basis of specific conditions such as settlement control requirements, topographic and geologic conditions, foundation treatment methods, embankment height, preloading and in combination with the construction schedule.

2 Generally, distance between the observation cross-sections of settlement should be no larger than 50 m; and it may be extended to 100 m for embankments and cuttings with flat terrain, even and favorable foundation conditions, even good, a height of less than 5 m; while for transition zone where the topographic and geologic conditions change greatly, the distance shall be properly endensed.

6.10.3 The precision leveling instrument, cross-section settlement instrument and theodolite may be used as observation instrument, and they shall meet the measurement precision control requirements.

6.10.4 Frequency of the subgrade settlement observation shall be no less than what required in Table 6.10.4. Timely observations shall be made when the environmental conditions change.

<table>
<thead>
<tr>
<th>Filling or stacking</th>
<th>In general</th>
<th>Once a day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abrupt changes in settlement</td>
<td>Twice or three times a day</td>
</tr>
<tr>
<td></td>
<td>Interval between two fillings is long</td>
<td>Once per three day</td>
</tr>
<tr>
<td>Preloading or completion of subgrade filling</td>
<td>The 1st~3rd months</td>
<td>Once a week</td>
</tr>
<tr>
<td></td>
<td>The 4th~6th months</td>
<td>Once per 2 weeks</td>
</tr>
<tr>
<td></td>
<td>After 6 months</td>
<td>Once a month</td>
</tr>
<tr>
<td></td>
<td>The first month</td>
<td>Once per 2 weeks</td>
</tr>
<tr>
<td></td>
<td>The 2nd~3rd months</td>
<td>Once a month</td>
</tr>
<tr>
<td></td>
<td>After 2 months</td>
<td>Once per 2 months</td>
</tr>
</tbody>
</table>

6.10.5 The repeatability precision of settlement leveling is no less than ±1 mm, the reading takes 0.1 mm; the repeatability precision of cross-section settlement observation is no less than ±4 mm/30 m.

6.10.6 The subgrade evaluation shall be made on the basis of comprehensive analysis based on the design, construction and supervision data as well as the results of handing-over inspection and re-examination.

6.10.7 Nonlinear regression method shall be used to predict the subgrade settlement and the following requirements shall be met:

1 Regression analysis of a variety of curves shall be done based on the actual observation data to determine the trend of settlement deformation, the correlated coefficient of nonlinear regression shall be no less than 0.92.

2 The prediction reliability of settlement shall be subject to verification, deviation of two adjacent predictions with an interval of 3~6 months shall be no larger than 8 mm.
3 The final settlement prediction before track laying shall be consistent with the basic requirement for the accuracy of the predictions, that is, the settlement after the completion of embankment filling or preloading and the prediction time of settlement \( t \) shall be consistent with Formula 6.10.7.

\[
s(t)/s(t = \infty) \geq 75\%
\]  \hspace{1cm} (6.10.7)

Where, \( s(t) \) — settlement actually occurred at the time of evaluation;
\( s(t = \infty) \) — the predicted total settlement.

6.10.8 Evaluation of subgrade settlement after civil works shall combine with interrelation among each cross section of subgrade, and make comprehensive analysis according to settlement status of adjacent bridges and tunnels. Subgrade settlement and the differential settlement between each cross section and between subgrade and adjacent bridge or tunnel shall accord with the requirements in Article 6.4.2 of this Code.

6.11 Interfaces Design

6.11.1 The various embedded devices and foundations on the subgrade shall be planed as a whole with subgrade filling, and designed systematically and implemented step by step to ensure the strength, stability, water proofing and drainage performance of the subgrade.

6.11.2 The cable trench shall be placed on the subgrade shoulder outside of the catenary supporting, and attention shall be paid on the smooth connection with the bridges, tunnels and cable wells on the plane.

6.11.3 Foundation of sound barrier shall be installed at the outside of the shoulder, and shall be in coordination with the drainage facility of subgrade surface.

6.11.4 The continuous earthing wire at the subgrade section shall be placed under the cable trench as specified in relevant provisions of Chapter 21 of this Code. Accessing branch cables to the grounding device should be done by connecting continuous earthing wire through the embedded pipe.

6.11.5 The cable trench and the drainage ditch cover shall be produced in plant, and shall give priority to use high-intensity materials like reactive powder concrete (RPC) etc.
7 Bridge and Culvert

7.1 General Requirements

7.1.1 Flood frequency standard for bridge and culvert shall comply with the provisions for Class I main railway line in the current Basic Code for Design of Railway Bridge and Culvert TB 10002.1.

7.1.2 Structures of bridge and culvert shall be simple, aesthetic, standardized as much as possible and easy for construction and maintenance. The structures shall be of sufficient vertical stiffness, lateral stiffness, torsion stiffness, durability and good dynamic performances. They shall also meet the requirements on track stability and regularity, and comply with the requirements on running safety of high speed train and riding comfort of passengers.

7.1.3 Main structures of bridge and culvert shall be designed for a service life of 100 years.

7.1.4 Materials used for structures of bridge and culvert shall comply with relevant national and professional standards.

7.1.5 The superstructure of bridge shall be selected by considering comprehensively various conditions such as functions, hydrological conditions of rivers, engineering geological conditions, types of tracks and construction equipment.

As for superstructure of bridge, structure of pre-stressed concrete should be used, or structure of reinforced concrete, steel, or steel-concrete may be applied.

Simply supported beam with pre-stressed concrete structure should be of box section, and may also use other cross sections with good integrity and sufficient structural stiffness.

7.1.6 Structure of bridge shall be designed as orthogonal crossing. When oblique crossing is unavoidable, the angle between the axle line of bridge and the supporting line should not be less than 60°, and side line at the end of abutment shall be perpendicular to the central line of track, otherwise, special measures shall be taken for the transition to subgrade.

7.1.7 Bridge deck shall be arranged to meet requirements for track type and setting of bridge deck facilities and their maintenances.

7.1.8 Rectangular frame of reinforced concrete should be used for culverts.

7.1.9 Length of embankment between neighboring bridges or culverts shall be appropriately determined based on comprehensive consideration of the requirements for smoothness of high speed train operation, construction technology of the transition between subgrade and bridge (culvert) and the cost efficiency. Length of embankment between the ends of two abutments shall not be less than 150m, while the length of embankment between culverts (frame structure) and that between the end of abutment and culvert (frame structure)
shall not be less than 30m. In case of special conditions where the embankment could not meet the above requirements, subgrade shall be specially treated.

7.1.10 Bridge and culvert shall be arranged with good connection to natural water system and local irrigation and drainage network and satisfy the requirement for subgrade drainage.

7.1.11 When a line is located in such special topographic and geological areas as incised gully, the plan of crossing shall be determined through comparison of bridge and culvert plans.

7.1.12 Reference points shall be set to observe and analyze systematically deformation of bridge and culvert with the ballastless track and their foundation settlement. Arrangement of the points, observation frequency and interval shall comply with provisions on assessment of conditions for ballastless track laying.

7.1.13 Concrete structures of bridge and culvert shall comply with relevant requirements about durability design of railway concrete structures.

7.2 Design Load

7.2.1 Structures of bridge and culvert shall be designed according to structure characteristics and calculation results and the following loads listed in Table 7.2.1 under the most unfavorable combined conditions.

<table>
<thead>
<tr>
<th>Table 7.2.1 Loads of Bridge and Culvert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Dead load</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Main force</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Live loads</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table 7.2.1 (continued)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special load</td>
<td>Load from train derailment</td>
</tr>
<tr>
<td></td>
<td>Impact force of vessel or raft</td>
</tr>
<tr>
<td></td>
<td>Impact force of car</td>
</tr>
<tr>
<td></td>
<td>Construction load</td>
</tr>
<tr>
<td></td>
<td>Seismic force</td>
</tr>
<tr>
<td></td>
<td>Breaking force of long rail</td>
</tr>
</tbody>
</table>

Notes: 1 When bar members are used primarily to bear a certain secondary force, the secondary force shall be regarded as the main force in calculation of such members;
2 Combination of expansion force, deflection force, breaking force of long rail and braking force or traction force shall comply with provisions for design of CWR on railway bridge. The force of CRTS II slab track shall be defined otherwise according to actual conditions;
3 Fluviation pressure shall not be combined with ice pressure, and neither of them shall be combined with braking force or traction force;
4 Load of train derailment, impact force of vessel or raft, impact force of car and breaking force of long rail shall not be combined with secondary forces. And only one of them is calculated in combination with main forces;
5 Combination of earthquake force and other loads shall comply with relevant provision in current national standard as Code for Seismic Design of Railway Engineering GB 50111.

7.2.2 Combination of main forces with secondary forces in one direction (along the bridge or transverse to the bridge) shall be considered in structure design.

7.2.3 In structure design, basic allowable stress of materials and allowable bearing capacity of foundations shall be multiplied by different improving coefficients according to load combinations. Different safety coefficients shall be taken to calculate the strength and crack resistance of pre-stressed concrete structure. These shall comply with relevant specifications.

7.2.4 The bulk weight of common materials shall comply with relevant provisions under current Basic Code for Design of Railway Bridge and Culvert TB 10002.1 when calculating dead weight of structural members and auxiliary devices.

7.2.5 Lateral earth pressure acting on pier and abutment shall be calculated as per requirements of current Basic Code for Design of Railway Bridge and Culvert TB 10002.1. The inner angle of friction of the backfill at the back of abutment shall be determined according to the design of backfill of the transitional section behind the abutment.

7.2.6 ZK live load (as shown in Figure 1.0.7–1 and Figure 1.0.7–2) shall be used as static vertical live load of the train, and it shall comply with the following requirements:
   1 For bridge and culvert with single or double tracks, ZK live load shall be considered for each track.
   2 For bridge and culvert with more than two tracks, ZK live load shall be considered according to following most unfavorable conditions:
      1) Two tracks bear ZK live load at the most unfavorable positions and other tracks
don’t bear live load of the train;
2) All tracks bear 75% of ZK Live load at the most unfavorable positions.
3) Live load schema may be cut randomly in design of load. As for influence line with multi-symbols, live load shall be applied on each segment with same symbols, and live load shall be considered for segments with different symbols according to following two cases:
1) Live loaded may not be applied when the segment is no more than 15 m;
2) Static live load of 10kN/m of empty train is taken when the length of the segment with different symbols is more than 15 m.
4) When an empty train is used to calculate components of the bridge, the vertical live load of the train shall be taken as 10 kN/m.
5) Loads on span, pier or abutment shall be calculated according to possible loads generated by construction machines actually applied and maintenance activities.
7.2.7 When the vertical dynamic force acted by live load of the train is considered, vertical live load of the train shall be equal to vertical static live load of the train multiplying the dynamic coefficient \(1 + \mu\), which is calculated as per the following formula:

Under ZK live load:

1) Bridge:

\[
1 + \mu = 1 + \left( \frac{1.44}{L_p^{0.2} - 0.2} - 0.18 \right)
\]

(7.2.7-1)

Where, \(L_p\) is the length of loading (m); when \(L_p < 3.61\) m, it is taken as 3.61 m; when simply supported beam is used, \(L_p\) shall be equal to the span of beam; when continuous beams with \(n\) spans are used, \(L_p\) equals to average span length multiplying following coefficients:

\[
\begin{align*}
n &= 21.20 \\
n &= 31.30 \\
n &= 41.40 \\
n &\geq 51.50
\end{align*}
\]

When \(L_p\) calculated is less than the maximum span, the later is taken.
When \((1 + \mu)\) calculated is less than 1.0, 1.0 is taken.

2) In case of bearing structure with backfill on the top of culvert and structure, when the thickness of the top backfill \(H_b > 3\) m, dynamic effect of the train is not considered, when \(H_b \leq 3\) m, the dynamic effect is calculated according to following formula:

\[
1 + \mu = 1 + \left( \frac{1.44}{L_p^{0.5} - 0.2} - 0.18 \right) - 0.1 (H_b - 1.0)
\]

(7.2.7-2)

where, \(L_p\) —— loading length (m), when \(L_p < 3.61\) m, it is taken as 3.61 m;
\(H_b\) —— thickness of backfill from the top of culvert and structure to the bottom of rail; when \((1 + \mu)\) calculated is less than 1.0, it is taken as 1.0.

3) Coefficient of dynamic effect is not considered in calculation of solid pier and abutment, foundation and earth pressure.

4) The calculation formula of bearing’s dynamic coefficient shall use the corresponding
formula for dynamic coefficient $(1 + \mu)$ of bridge span structure.

7.2.8 As for curved bridges, centrifugal force generated by vertical static live load of the train shall be considered. And the centrifugal force shall be calculated according to following requirements:

1. Centrifugal force shall be calculated as per the following formula:

   for concentrated live load $N$: \[ F = \frac{V^2}{127R}(f \cdot N) \]  
   \[ (7.2.8-1) \]

   for distributed live load $q$: \[ F = \frac{V^2}{127R}(f \cdot q \cdot L) \]  
   \[ (7.2.8-2) \]

Where, $N$ = concentrated live load in ZK live load pattern (kN);
$q$ = distributed live load in ZK live load pattern (kN/m);
$V$ = designed speed (km/h);
$R$ = curve radius (m);
$f$ = reduction coefficient of vertical live load; when $L \leq 2.88$ m or $V \leq 120$ km/h, $f$ is taken as 1.0; when $f$ calculated is more than 1.0, it is taken as 1.0; when $L > 150$ m, 150 m is taken to calculate $f$. When designed speed $V > 300$ km/h, $V = 300$ km/h is taken to calculate $f$.

   \[ f = 1.25 - \frac{V - 120}{800}(0.814 \frac{1}{V} + 1.75)(1 - \sqrt[3]{\frac{2.88}{L}}) \]  
   \[ (7.2.8-3) \]

Where, $L$ = loading length (m) of the curve on bridge.

2. Centrifugal force acts at 1.8 m above rail top where in a horizontal and outward way.

3. When the designed speed is more than 120 km/h, the combination of centrifugal force and vertical live load shall be considered as per the following three cases:

1) Unreduced ZK live load and centrifugal force calculated as per 120 km/h ($f = 1.0$);
2) Reduced ZK live load ($f \cdot N$, $f \cdot q \cdot L$) and the centrifugal force calculated as per the designed speed ($f < 1.0$);
3) For curved bridges, train live load without centrifugal force shall also be considered.

7.2.9 Lateral swaying force shall be taken as 100 kN as a concentrated load to act on rail top horizontally and perpendicular to track center line at the most unfavorable position.

For bridges with multi-tracks, only the lateral swaying force acting on any one of the tracks is calculated.

7.2.10 Braking force or traction force of the train on bridge shall be calculated as 10% of vertical static live load of the train. However, when either of them is calculated in together with centrifugal force or vertical dynamic force of the train, the braking force or traction force shall be taken as 7% of the vertical static live load of the train. The specific acting position shall comply with relevant provisions in the current *Fundamental Code for Design*.
on Railway Bridge and Culvert TB 10002. 1.

For bridges with double-track between stations, the braking force or traction force for single track shall be taken. For bridges with double-track within a station, the situation that braking force and traction force occur simultaneously shall be considered according their structures in design. For bridges with three or more tracks, the braking force or traction force for two tracks shall be taken.

7.2.11 Lateral earth pressure caused by the damaged prism at the back of abutment under vertical static live load of the train shall be calculated by converting live load into equivalent thickness of evenly distributed soil, as shown in Figure 7.2.11.

![Figure 7.2.11 Earth Thickness Converted from Live Load](image)

Equivalent thickness of evenly distributed soil \( h_0 \) converted from live load may be calculated as per the following formula:

\[
h_0 = \frac{q}{\gamma}
\]  

(7.2.11)

Where, \( q \) — vertical pressure of live load (kPa) on the rail bottom plane. For calculation of such vertical pressure, transverse distribution width is taken as 3.0 m; longitudinal distribution width equals to wheel base when concentrated axle load is applied, and is taken as 1.0 m when load per linear meter is applied;

\( \gamma \) — earth gravity density (kN/m³).

The calculated width for live load of back abutment on each line may be taken as 3.0 m.

7.2.12 For bridges longer than 15m, train derailment load shall be considered. Train derailment load is calculated without dynamic coefficient.

For bridges of multi-tracks, only derailment load on a single track is considered and no live load of the train acts on other tracks. Train derailment load shall be considered according to the following two cases:

1 In case that wheels on one side are still within the area of track on deck after derailment;

Two line loads, with 1.4m distance and in parallel to track center line, acts at the most unfavorable positions on one side within 2.2 m from the track center line and not beyond protection wall. Such line load is taken as 50 kN/m on a section of 6.4 m long, and as 25 kN/m on each side of this section, as shown in Figure 7.2.12—1.
In case that the train runs out of the area of track after derailment, but does not fall off the bridge and remains at the edge of the deck.

One line load of 20m long and in parallel to track center line acts on the inside of protection wall, and is taken as 64 kN/m, as shown in Figure 7.2.12—2.

7.2.13 When service passages are arranged on deck, they shall be designed with vertical static live load taken as 5 kN/m². When an inspection trolley running on the bridge, it shall also be considered to inspect vertical load of the trolley. In the design of main beam, the vertical static live load of the service passage shall not be calculated in together with the train live load.

In calculation of the column and handrail of railing, horizontal thrust shall be taken as 0.75 kN/m.

As for the column, horizontal thrust acts on the top of the column. The column and handrail shall be calculated with a concentrated load taken as 1.0 kN.

7.2.14 Longitudinally horizontal force on the tops of pier and abutment resulted from expansion force, deflection force, breaking force of long rail shall be calculated by regarding it as the joint effect of beam and track.

Breaking force of rail is regarded as a special load and only that of one piece of rail shall be considered for bridges with single track and multi-tracks.

7.2.15 Wind force, fluviation pressure, water buoyancy, ice pressure, frost heaving force, impact force of vessel or raft, and construction load acting on the bridge shall be calculated according to provisions in the current Basic Code for Design of Railway Bridge and Culvert TB 10002. 1.
7.2.16 In case that pier columns or stems are likely to be bumped by cars, solid and firm protection works shall be set. Otherwise, the impact force on columns or stems by cars shall be considered. And the impact force along the traffic direction shall be taken as 1000 kN, while that across the traffic direction shall be taken as 500 kN. These two forces act at 1.20 m above the road surface, and shall not be considered together.

7.2.17 Effect of temperature variation (such as integral temperature increase and decrease, sunshine and cold wave) shall be calculated as per the requirements in the current Basic Code for Design of Railway Bridge and Culvert TB 10002.1. and Code for Design on Reinforced and Prestressed Concrete Structure of Railway Bridge and Culvert TB 10002.3.

For structural components, the stresses and displacements generated by temperature differences at different sides of the cross section or between inside and outside surfaces shall be considered.

7.2.18 Effect of seismic force shall be calculated as per the provisions in the current national standard as Code for Seismic Design of Railway Engineering GB 50111.

![Aerodynamic force on structure or components generated by a passing train](image)

Figure 7.2.19 Aerodynamic force on structure or components generated by a passing train

7.2.19 Calculation of aerodynamic force shall comply with the following requirements:

Aerodynamic pressure and suction generated by a passing train shall be the combination of the load $+ q$ of 5 m long moving plane and the load $- q$ of 5 m long moving plane.

Aerodynamic force shall be divided into a horizontal aerodynamic force $q_h$ and a vertical aerodynamic force $q_v$. The maximum height where the horizontal aerodynamic force acts on
the rail top is 5m. The horizontal aerodynamic force $q_h$ may be obtained from the curves shown in Figure 7.2.19. While the vertical aerodynamic force $q_v$ shall be calculated as per the following formula:

$$q_v = 2q_h \cdot \frac{7D + 30}{100} \text{ (kN/m²)}$$  

(7.2.19)

Where, $q_h$ — horizontal aerodynamic force (kN/m²);

$D$ — distance between acting line and track center (m).

For structure or components under top cover, $q_h$ and $q_v$ shall be multiplied by resistance factor 1.5. For the design of sound barrier, $q_h$ and $q_v$ shall be superposed with the wind load generated by a passing train.

For structures with possible free vibration caused by aerodynamic force, a dynamic amplification factor shall also be considered for the aerodynamic force. And the factor is determined through studies.

### 7.3 Limits for Structural Deformation, Displacement and Free Vibration Frequency

#### 7.3.1 The limits defined under this section for the rigidities of the bridge beam and pier and abutment are only applicable to concrete structures with spans less than 96 m.

#### 7.3.2 Limits for vertical deformation and displacement of beam body shall comply with the following requirements:

1. For beam bridge structures under ZK vertical load, vertical deflection of the beam body shall not be more than the limits shown in Table 7.3.2.

#### Table 7.3.2 Limits for Vertical Deflection of Beam Body

<table>
<thead>
<tr>
<th>Designed speed</th>
<th>Range of span</th>
<th>$L \leq 40$ m</th>
<th>$40 &lt; L \leq 80$ m</th>
<th>$L &gt; 80$ m</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 km/h</td>
<td>$L/1 , 400$</td>
<td>$L/1 , 400$</td>
<td>$L/1 , 000$</td>
<td></td>
</tr>
<tr>
<td>300 km/h</td>
<td>$L/1 , 500$</td>
<td>$L/1 , 600$</td>
<td>$L/1 , 100$</td>
<td></td>
</tr>
<tr>
<td>350 km/h</td>
<td>$L/1 , 600$</td>
<td>$L/1 , 900$</td>
<td>$L/1 , 500$</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Limits in the table are applicable to simply supported beam for double track with more than 3 spans. For one-unit continuous beam with 3 spans and above, limits for the vertical deflection of beam body shall be taken as 110% of the values in the Table. For one-unit continuous beam with 2 spans and simply supported beams with 2 spans and less for double track, the limits for the vertical deflection of the beam body shall be taken as 140% of the values in the Table.

2. For simply supported beam or continuous beam for single track, the limits for the vertical deflection of the beam body shall be taken as 60% of the limits for corresponding double track bridge.

2. For arch bridge, rigid frame bridge and continuous beam bridge, vertical static live load of the train and influence of temperature shall be considered together to determine the vertical deflection. Value of vertical deflection of the beam body shall be taken according to the more unfavorable one between the following cases:
1) The sum of the deflection value generated under the vertical static live load of the train and the deflection value generated at the temperature multiplied by 0.5.

2) The sum of the deflection value generated under the vertical static live load of the train multiplied by 0.63 and the full deflection value generated at the temperature.

3) Auxiliary facilities of deck should be installed before track laying as much as possible. After track laying, the vertical residual creep and deformation of pre-stressed concrete beam shall meet the following requirements:

1) Ballasted bridge deck: vertical deformation of the beam body shall not be more than 20 mm.

2) Ballastless bridge deck: when \( L \leq 50 \text{ m} \), the vertical deformation shall not be more than 10 mm; when \( L > 50 \text{ m} \), the vertical deformation shall not be more than \( L/5 \ 000 \) and not more than 20 mm.

4) For ballastless bridges with longitudinal gradient, the impact on track structure from relative vertical displacement of rail supporting points on both sides of beam crevice caused by longitudinal expansion of beam body shall be considered.

7.3.3 Limits for transverse deformation of beam body shall meet the following requirements:

1) Under the effects of transverse swaying force, centrifugal force of the train, wind force and temperature, transverse deflection of the beam body shall not be more than \( 1/4 \ 000 \) of the calculated beam body span.

2) Relative transverse displacement of rail supporting points on both sides of neighboring beam ends of ballastless bridge shall not be more than 1 mm.

7.3.4 Limits for irregularity of rail surface resulted from the torsion of beam body under ZK static live load shall be based on a 3 m long track section. The relative vertical deformation of the two rails on one track shall not be more than 1.5 mm.

7.3.5 Limits for vertical free vibration frequency of simply supported beam shall meet the following requirements:

1) Vertical free vibration frequency of simply supported beam shall not be less than the following limits:

\[
L \leq 20 \text{ m} \quad n_0 = \frac{80}{L} \quad (7.3.5-1) \\
20 < L \leq 96 \text{ m} \quad n_0 = 23.58 \ L^{-0.592} \quad (7.3.5-2)
\]

Where, \( n_0 \) —— limit for the vertical free vibration frequency of simply supported beam (Hz);

\( L \) —— span of the simply supported beam.

2) As for EMU of 24 ~ 26 m long, double-track simply supported box beams of concrete or pre-stressed concrete with \( L \leq 32 \text{ m} \), when free vibration frequency of the beam body is not less than the limits shown in Table 7.3.5, train-bridge coupling dynamic response analysis may not be conducted in design of beam structure.
Table 7.3.5 Limits for vertical free vibration frequency when no dynamic calculation is required for double-track simply supported beams with common spans

<table>
<thead>
<tr>
<th>Span (m)</th>
<th>Design speed 250 km/h</th>
<th>300 km/h</th>
<th>350 km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100/L</td>
<td>100/L</td>
<td>120/L</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>100/L</td>
<td>100/L</td>
<td>120/L</td>
</tr>
<tr>
<td>20</td>
<td>100/L</td>
<td>100/L</td>
<td>120/L</td>
</tr>
<tr>
<td>24</td>
<td>100/L</td>
<td>120/L</td>
<td>140/L</td>
</tr>
<tr>
<td>32</td>
<td>120/L</td>
<td>130/L</td>
<td>150/L</td>
</tr>
</tbody>
</table>

7.3.6 For simply supported beams and other bridge beams, which fail to meet the requirements in Table 7.3.5, train-bridge coupling dynamic response analysis shall be conducted according to the actual conditions when the passenger trains are the passing bridge (the maximum calculation speed shall be taken as 120% of the design speed) in addition to static force analysis in design of structure. And following requirements shall be complied with:

1. Derailment coefficient, wheel unloading rate, transversely horizontal force of wheelset, vertical and transverse vibrating acceleration of train body, index of passenger riding comfort shall meet the following requirements:
   - Derailment coefficient: \( Q/P \leq 0.8 \)
   - Wheel unloading rate: \( \Delta P/P \leq 0.6 \)
   - Transversely horizontal force of wheelset: \( Q \leq 10 + P_0/3 \) (\( P_0 \) is static axle load, unit: kN)
   - Vertical vibrating acceleration of train body: \( a_v \leq 0.13 \text{ g} \) (half peak value) (g, gravity acceleration)
   - Transverse vibrating acceleration of train body: \( a_t \leq 0.10 \text{ g} \) (half peak value)
   - Speling comfort index: \( W \leq 2.50 \) excellent
     - \( 2.50 < W \leq 2.75 \), good
     - \( 2.75 < W \leq 3.00 \), qualified

2. Limits for vertical vibrating acceleration of deck slab under strong vibration with the frequency of 20 Hz and below shall meet the following requirements:
   1) Ballasted deck: \( \leq 0.35 \text{ g} \);
   2) Ballastless deck: \( \leq 0.50 \text{ g} \).

7.3.7 Limits for vertical rotation angle at the beam end, under ZK vertical static live load, shall comply with the requirements in Table 7.3.7. The vertical rotation angle at beam end is shown in Figure 7.3.7.

Table 7.3.7 Limits for Rotation Angle at Beam End

<table>
<thead>
<tr>
<th>Track Type on bridge</th>
<th>Position</th>
<th>Limit (rad)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballasted track</td>
<td>Between abutment and beam</td>
<td>( \theta \leq 2.0% )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between two spans of beam</td>
<td>( \theta_1 + \theta_2 \leq 4.0% )</td>
<td></td>
</tr>
</tbody>
</table>
Table 7.3.7 (continued)

<table>
<thead>
<tr>
<th>Track Type on bridge</th>
<th>Position</th>
<th>Limit (rad)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballastless track</td>
<td>Between abutment and beam</td>
<td>( \theta \leq 1.5% )</td>
<td>Suspended length of the beam end ( \leq 0.55 ) m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \theta \leq 1.0% )</td>
<td>( 0.55 ) m &lt; Suspended length of the beam end ( \leq 0.75 ) m</td>
</tr>
<tr>
<td></td>
<td>Between two spans of beam</td>
<td>( \theta_1 + \theta_2 \leq 3.0% )</td>
<td>Suspended length of the beam end ( \leq 0.55 ) m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \theta_1 + \theta_2 \leq 2.0% )</td>
<td>( 0.55 ) m &lt; Suspended length of the beam end ( \leq 0.75 ) m</td>
</tr>
</tbody>
</table>

Notes: The sum of rotation angles of the neighboring two spans of beam \( (\theta_1 + \theta_2) \) shall meet the limits specified in this section, and the rotation angle of each span of beam shall also comply with the requirements on "Limits for Rotation Angle between Abutment and Beam" of this section.

Figure 7.3.7 Sketch of rotation angle at beam end

7.3.8 For the simply supported concrete beam located in the fixed section of ballasted CWR, the longitudinally horizontal line stiffness on top of pier and abutment shall comply with the limits in Table 7.3.8.

Table 7.3.8 Limits for longitudinally horizontal line stiffness on top of pier and abutment

<table>
<thead>
<tr>
<th>Pier/abutment</th>
<th>Span (m)</th>
<th>Minimum horizontal line stiffness (kN/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Double track</td>
</tr>
<tr>
<td>Pier</td>
<td>( \leq 12 )</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>720</td>
</tr>
<tr>
<td>Abutment</td>
<td>3000</td>
<td>1500</td>
</tr>
</tbody>
</table>

Notes: Limits for the minimum horizontal line rigidities of double-track bridge piers and abutments within the area of effective length of the receiving-departure track in elevated stations shall be taken as 200% of the limits for the minimum horizontal line rigidities of single-track bridge piers and abutments specified in the table.

7.3.9 Transversely horizontal line stiffness of pier and abutment shall meet requirements for the safety and riding comfort of high speed trains. And transversely elastic horizontal displacement of the top of pier and abutment under most unfavorable load shall be calculated.

Under the effects of ZK live load, transverse swaying force, centrifugal force, wind force and temperature, the horizontal angle of the beam end resulted from the transversely
horizontal displacement of the pier top shall not be more than the radian of 1.0°. The horizontal angle of beam end is shown in Figure 7.3.9.

![Figure 7.3.9 Sketch of horizontal angle](image)

7.3.10 Settlement of pier and abutment foundation shall be calculated as dead load, and the settlement after construction shall not be more than those values specified in Table 7.3.10.

**Table 7.3.10 Settlement Limits after Construction of Pier and Abutment Foundations of Super Statically Indeterminate Structure**

<table>
<thead>
<tr>
<th>Type of settlement</th>
<th>Track type on bridge</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Even settlement of pier and abutment</td>
<td>Ballasted track</td>
<td>30 mm</td>
</tr>
<tr>
<td></td>
<td>Ballastless track</td>
<td>20 mm</td>
</tr>
<tr>
<td>Settlement difference between adjacent piers and abutments</td>
<td>Ballasted track</td>
<td>15 mm</td>
</tr>
<tr>
<td></td>
<td>Ballastless track</td>
<td>5 mm</td>
</tr>
</tbody>
</table>

Notes: Settlement difference between adjacent piers and abutments of super statically indeterminate structure shall comply with above-mentioned specifications, and shall be determined according to the additional stress on structure caused by such difference.

7.3.11 Settlement limits after construction of culverts shall be identical to those of neighboring subgrade.

7.4 Structure Calculation and Design

7.4.1 Requirements on calculation and design of structures of bridge and culvert shall comply with this Code, and those not specified in this Code shall follow relevant provisions in the current *Fundamental Code for Design on Railway Bridge and Culvert* TB 10002.1; *Code for Design on Steel Structure of Railway Bridge* TB 10002.2; *Code for Design on Reinforced and Pre-stressed Concrete Structure of Railway Bridge and Culvert* TB 10002.3; *Code for Design on Concrete and Block Masonry Structure of Railway Bridge and Culvert* TB 10002.4 and *Code for Design on Subsoil and Foundation of Railway Bridge and Culvert* TB 10002.5.

7.4.2 Calculation and design of reinforced concrete and pre-stressed concrete structures shall meet the following requirements:

1) Box beam

1) Net height inside the box beam shall not be less than 1.6 m. And man holes shall be set when necessary. The man hole should be set at the crevice of two neighboring beams or at the bottom plate near beam end.
2) Pre-stressed tensile reinforcement at beam end along the bridge axle shall have at least 1/2 extending out of the supporting point and be anchored.

3) Partial stress analysis for such parts as each chamfer position of box beam end, joint between the top slab bellow the lifting point and the haunch position, bottom plate at beam end and man hole in construction stages like pre-set of stress, beam storage, transport and erection of beam. And reinforcement measures shall be taken in design of these parts to prevent generation of crack.

4) For box beams with larger width-span ratio, the effect of shear lag shall be considered in design of the cross section. And compensation factor of effective width may be taken according to Appendix D.

5) Impact on the forces of box beam by temperature gradients under various conditions from construction period before ballast laying (before laying of ballastless track) to completion of bridge shall be considered in the design of box beams for both ballasted and ballastless tracks.

6) For prefabricated (cast-in-situ) box beams, the impact on the box beam caused by the passing of transport and erection equipment shall also be considered.

7) Integral calculation shall be used for analysis of transverse inner force of box beams with double-track.

2 T beam

1) Height of T beam-end diaphragm plate shall be 10 cm less than that upward from beam bottom.

2) Multi-piece T beam shall form a transverse integral cross section to enable the live load to be shared between main beams. The diaphragm plate and flanges must be connected together after all beams are erected in success, and transverse pre-stress shall be applied.

3) Multi-piece T beam can be analyzed as a lattice structure formed by main beams and cross beams.

4) When prefabricated T beams are erected one after another, width of the wet joint should not be less than 300 mm. And arrangement of the reinforcement at the wet joint shall meet the force-bearing requirements of integral cross section.

3 Pre-stressed reinforcement or duct

1) Net distance between pre-stressed reinforcement or duct shall not be less than 40 mm in case of duct diameter less than or equal to 55 mm, and shall not be less than duct diameter in case of the diameter larger than 55 mm.

2) Thickness of the protection layer between the surface of pre-stressed reinforcement or duct and the surface of structure shall not be less than 100% of the duct diameter at the top and side of the structure, and shall not be less than 50 mm; and not less than 60 mm at the bottom of the structure.

4 When requirement is raised to control strictly structural creep and deformation.
the concrete stress under dead load should not be more than 40% of the compressive strength of concrete axle. And the concrete creep and deformation shall be calculated by phases according to the corresponding age of concrete.

5 Waterproof measures shall be taken in the arrangement to prevent rainwater infiltration at the positions where pre-stressed concrete beam is anchored and jointed. The crevices shall be away as much as possible from the positions under the most unfavorable environment impact. Common reinforcement shall be added properly to prevent cracks in the structural parts where cracks are likely to appear.

7.4.3 Bearing design shall comply with the following requirements:

1 Pot type rubber bearing or steel bearing should be used for beam bearing. The rubber bearing shall be arranged horizontally. As for bridges in sections where settlement is hard to control, adjustable bearing may be applied after technical and economic comparison.

2 For beams of larger transverse width, their bearings must be able to shift and turn transversely. Otherwise, the constraint acting on the bearing line caused by bending moment at the cross beam and the fixing end of the end cross frame shall be considered in calculation of the bearing.

3 As for skew beams, the longitudinal displacement of the bearing shall be in the same direction as those of the beam axle or the tangent line.

4 Arrangement of bearing shall meet the requirements for inspection, maintenance and replacement. The beam top space shall be considered in determining the distance between bearing plinth and the edge of pier and abutment and the height of bearing plinth.

5 The distances from longitudinal and transverse outermost edges of the bearing shim plate to the edges of pier and abutment shall be more than the values specified in Table 7.4.3.

Table 7.4.3 Distance between the Edge of the Bearing Plate and the Edges of Pier and Abutment

<table>
<thead>
<tr>
<th>Span (m)</th>
<th>( L&lt;16 )</th>
<th>( 16 \leq L &lt; 20 )</th>
<th>( 20 \leq L &lt; 32 )</th>
<th>( 32 \leq L &lt; 40 )</th>
<th>( L \geq 40 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (cm)</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

7.4.4 Design of pier and abutment shall comply with the following requirements:

1 Concrete or reinforced concrete structure should be used for pier and abutment.

2 When the arrangement of foundation of pile cap meets the requirements for rigid angle, one layer of reinforcement shall be placed at the bottom of the pile cap. If the diameter of bored pile is 1.00 m, the diameter of reinforcement shall not be less than 20 mm; if the diameter of the bored pile is 1.25 m or 1.50 m, the diameter of reinforcement shall not be less than 25 mm. The spacing between reinforcements shall be 10 cm for all.

3 For solid concrete pier, surface protection reinforcement shall be applied. Diameter of the reinforcements for vertical surface protection should not be less than 14 mm, and the
spacing for these reinforcements not more than 15 cm. The diameter of circular stirrups shall not be less than 10 mm, the spacing shall not be more than 20 cm and be taken as 10 cm in the densified zone at the bottom of pier. The stirrup spacing for hollow pier shall be 10 cm in the impacted area at the fixed end, and not more than 20 cm for other sections.

4 Dimensions of tops of pier and abutment shall meet the requirements for erection, inspection, maintenance and replacement of bearing and beam top. Drainage slopes shall be arranged.

7.4.5 Design of culvert shall comply with the following requirements;

1 Distance from top of culvert to rail base should not be less than 1.5 m.
2 Culvert may be skewed, but the skew angle should not be more than 45°.
3 Reinforced concrete frame structure should be used for culvert. Settlement joint shall not be arranged under sleeper or under ballastless track slab, it may be placed between two tracks. The section of culvert under track should not be less than 5m long.
4 For culverts located on soft foundation, the subsoil shall be treated in a way that is coordinated with the ways of treating foundations of subgrade on both sides.

7.5 Deck Arrangement and Auxiliary Facilities

7.5.1 Arrangement of deck shall comply with the following requirements;

1 Thickness of ballast under sleepers under rail on bridge shall not be less than 0.35 m.
2 Ballast retaining wall or protection wall shall be set on the bridge, with the height equal to the height of rail surface of neighboring track. The walls on straight line and curve line (inside and outside of curve line) may have different heights.

As for bridges with ballasted track on straight line, the net distance from track center line to the inside of ballast retaining wall shall not be less than 2.2 m.

3 Enlargement of structure clearance on bridge in curve section shall follow the provisions in Appendix A.

4 Positions shall be reserved on deck for installation of main equipment.

5 Height of handrails on bridge shall not be less than 1.0 m.

6 Wind-proof facilities shall be arranged in sections at wind gap. When wind-proof is set, it shall be considered in combination with handrails or sound barriers on the bridge, and with requirements for sight view of passengers.

7 The distance from track center line to the inside edge of the catenary post shall not be less than 3.0 m. And in curve sections, such distance shall meet the requirement for the enlargement of construction clearance. When the catenary post is installed on the deck, it should not be placed at the middle of the span.

8 Cover plates should be installed at the end of the cantilever slab of the main beam flange.

9 The deck width shall be calculated and determined according to the requirements for constructional widths related to construction clearance, operational maintenance corridor, cable rabbet and catenary post.
7.5.2 For bridges longer than 3km, conditions of ground road shall be considered, passages accessible to the bridge for rescue and evacuation shall be established in a staggered way on both sides of the track, with an interval of 3km (or 6km on one side). And exits shall be reserved at the corresponding positions of handrails and sound barriers on the bridge for rescue and evacuation passages.

7.5.3 Structures of bridge and culvert shall be easy for inspection and maintenance, and inspection facilities shall be arranged as needed.

7.5.4 Good waterproof and drainage facilities shall be arranged on the bridge and meet the following requirements:

1. Surfaces of beam, pier and abutment shall be convenient to water drainage. Horizontal surfaces possibly exposed to rain or water accumulation shall be changed into slopes. A transversal drainage slope of no less than 2% shall be arranged at the bridge top, while a drainage slope of no less than 3% shall be arranged at the tops of pier and abutment.

2. Effective waterproof structure shall be used at beam ends to prevent wastewater from flowing back to and polluting surfaces of bearing and beam end.

3. Two-row drainage mode shall be used for deck of the bridge with ballasted track or CRTS I double-block ballastless track. And three-row drainage mode shall be used for deck of the bridge with CRTS I slab ballastless track and CRTS II double-block ballastless track.

7.6 Bridge Structure of Elevated Station

7.6.1 Bridge structure of elevated station shall not only meet the requirements for station service functions, but also for aesthetics and environmental protection. And the relationship between railway station and urban transport and planning shall be managed.

7.6.2 Bridge structure in turnout area shall meet requirements on relative deformation and displacement of structure by the turnout.

7.6.3 For bridges with multi-track in turnout areas (beyond fouling point indicator), only two tracks shall be considered as bearing live load of train at the most unfavorable positions, and other tracks are not considered. For bridges with multi-track in station area (within fouling point indicator), relevant provisions in Article 7.2.6 and Article 7.2.10 shall be followed.

7.6.4 Station-bridge separated structure may be used for elevated station. In case of the separated structure, the deformation, displacement and free vibration frequency of the beam on the main line in station shall comply with the provisions in Section 7.3 of this Code; the vertical deflection resulted from the static live load of beam for station track shall comply with the provisions in Section 4.1 of the current Code for Design on Reinforced and Pre-stressed Concrete Structure of Railway Bridge and Culvert TB J10002.3—2005. When integral elevated structure is used, the influence of combined deformation shall be considered.
7.7  Interface Design

7.7.1 Design of interfaces between bridge and other special works shall comply with the following principles:

1  Interfaces between bridge and other special works shall be considered comprehensively.
2  Interaction and structural coordination between bridge and track shall be considered for design of bridge.
3  Requirements for arrangement of facilities such as sound barrier, catenary, integrated earthing device of bridge, settlement observation sign, rescue and evacuation passage shall be considered comprehensively for design of bridge.
4  Requirements on specialized cables accessing the bridge by communication, signaling, electric traction power supply and power supply shall be considered for design of bridge.
5  Requirements for environment protection shall be considered for design of bridge.

7.7.2 Design of interfaces between bridge and other special works shall comply with the following provisions:

1  Systematic design shall be made according to track types in design of bridge. Arrangement of expansion joints on the bridge shall be determined carefully after sufficient economic and technical comparison and evaluation. The arrangement of expansion joints shall comply with the technical requirements for track.
2  Bridge rescue and evacuation passages shall be considered in together with maintenance passages under the bridge, green passages and ground roads.
3  Connection and transition to the subgrade shall be considered soundly in the design of bridge.
4  Foundations for sound barrier on the bridge shall be reserved according to the requirements for environment protection. Arrangement of rescue and evacuation passages on the bridge should avoid the areas of sound barrier.
5  Integrated earthing devices shall be set on foundation, pier, abutment and beam according to the requirements for signaling and integrated earthing.
6  Conditions for arrangement of facilities like cable trough, device for cable accessing bridge, and catenary post shall be reserved according to requirements for communication, signaling, power supply and electrification.
7  As for installation bridge within the area of station, positions shall be reserved for outdoor equipment such as switching machine according to requirements for signaling in design of bridge; design of pier in station shall comply with the requirements for overall architectural design.
8  As for highway bridges crossing over high speed railway, falling-prevention net and protection wall shall be set. When monitoring and warning device of falling object is to be installed on the highway bridge by disaster prevention department, relevant conditions shall be reserved on the bridge.
8 Tunnel

8.1 General Requirements

8.1.1 The adverse impacts on the train operation, passenger comfort degree, tunnel structure and environment imposed by the aerodynamic effect generated by trains entering the tunnel must be taken into account in the tunnel design.

8.1.2 The cross-section of the lined tunnels shall comply with the requirements of construction clearance, equipment installation, service space, structural loading and aerodynamic effect reducing.

8.1.3 The tunnel structure shall comply with the durability requirements. The designed service life of the body structure of the tunnel shall be 100 years.

8.1.4 The deformation of the foundation bases of tunnels in special geotechnical conditions and/or poor geological conditions shall be observed after the construction of the tunnel bodies is completed.

8.1.5 The requirements of construction, disaster-prevention, rescue, evacuation and aerodynamic effect reducing shall be taken into account in the arrangement of the auxiliary adits.

8.1.6 The structural waterproofing of tunnels shall comply with the requirements of Grade I standard.

8.2 Cross-section of Lined Tunnel

8.2.1 The following factors shall be taken into account in the determination of the cross-sections of lined tunnels:

1. Construction clearance of tunnels;
2. Number of tracks and distance between tracks;
3. Space occupied by equipment in tunnels;
4. Aerodynamic effect;
5. Structural types of tracks and the maintenance modes of the tracks during operation.

8.2.2 The effective area of the tunnel clearance shall comply with the following stipulations;

1. In case the designed target speed of the trains is 300 km/h or 350 km/h, the effective area of the clearance of double-track tunnels shall not be less than 100 m² and that of single-track tunnels shall not be less than 70 m².
2. In case the designed target speed of the trains is 250 km/h, the effective area of the clearance of double-track tunnels shall not be less than 90 m² and that of single-track
tunnels shall not be less than 58 m².

8.2.3 The cross-section of the lined tunnels on curved sections may not be widened.

8.2.4 Rescue passages and safety space shall be provided in tunnels, which shall comply with the following stipulations:

1 Rescue passages

1) Continuous rescue passages shall be provided in tunnels. For single-track tunnels, rescue passages shall be provided on one side; for double-track tunnels, rescue passages shall be provided on both sides. The distance between the rescue passages and the center lines of the tracks shall not be less than 2.3 m.

2) The widths of the rescue passages should not be less than 1.5 m, which may be properly reduced where devices and equipments are installed. The heights of the rescue passages shall not be less than 2.2 m.

3) The pavement surface of the rescue passages shall not be lower than the rail top and shall be flat, smooth and stable.

2 Safety space

1) Safety space shall be provided 3.0 m away from the center line of the track. For single-track tunnels, the safety space shall be provided along one side of the rescue passages; for multi-track tunnels, the safety space shall be provided along both sides of the rescue passages.

2) The safety space shall not be less than 0.8 m in width and shall not be less than 2.2 m in height.

8.2.5 The cross-sections of lined double-track tunnels and single-track tunnels are shown in Figure 8.2.5–1~8.2.5–4.

![Figure 8.2.5–1 Cross-section of lined double-track tunnels for trains with 250 km/h speed (unit: cm)](image-url)
Figure 8.2.5-2  Cross-section of lined double-track tunnels for trains with 300 km/h and/or 350 km/h speed (unit: cm)

Figure 8.2.5-3  Cross-section of lined single-track tunnels for trains with 250 km/h speed (unit: cm)

Figure 8.2.5-4  Cross-section of lined single-track tunnels for trains with 300 km/h and/or 350 km/h speed (unit: cm)
8.3 Tunnel Lining

8.3.1 For mined tunnels, composite lining shall be used. For open-cut tunnels, monolithic lining shall be used.

8.3.2 For water-proofing type tunnels, the impact of the hydrostatic pressure on the tunnel structure shall be taken into account in the design of the tunnel lining.

8.3.3 For tunnels in Grade Ⅰ and Grade Ⅱ surrounding rock mass, the lining structure consisting of curved walls and bottom slabs should be adopted. For tunnels in Grade Ⅲ to Grade Ⅵ surrounding rock mass, the lining structure consisting of curved walls and inverts shall be adopted.

8.3.4 Circular shape should be adopted for the cross-section of lined tunnels. For single-track tunnels, three-centered circular cross-section may be adopted and the side walls shall be smoothly connected with the invert.

8.3.5 The strength grade of the lining concrete of tunnels shall not be lower than C30. The strength grade of the reinforced concrete of the tunnel lining shall not be lower than C35. For tunnels in Grade Ⅰ and Grade Ⅱ surrounding rock mass, the thickness of the bottom slabs of the tunnel lining shall not be less than 30cm. The strength grade of the concrete for the bottom slabs shall not be lower than C35 and two layers of reinforcement bars shall be placed. The strength grade of the concrete for the invert filling shall not be lower than C20.

8.3.6 For the secondary lining of tunnels in Grade Ⅳ to Grade Ⅵ surrounding rock mass, reinforced concrete should be used. For the secondary lining of tunnels in Grade Ⅰ to Grade Ⅲ surrounding rock mass, concrete should be used, to which fibers may be mixed.

8.4 Auxiliary Structures in Tunnel

8.4.1 Chambers dedicated for equipments in tunnels shall be provided in accordance with the requirements of different professions. The refuge niches for maintenance labors may be cancelled.

8.4.2 Cable troughs shall be provided along both sides in tunnels. The cover slabs of the troughs shall be flat and shall be placed stably.

8.4.3 The distance from the outer edges of the water ditch structures or from the outer edges of the cable trough structures to the centerlines of the tracks on the same side shall not be less than 2.20 m. Structural re-bars shall be arranged for the ditch (trough) bodies toward the ballast bed side.

8.4.4 For tunnels with more than 500 m length, cable chambers shall be provided to store residue cables. The cable chambers shall be arranged in coordination with the other dedicated chambers. The cable chambers shall be distributed in a stagger pattern along
both sides of tunnels. The intervals between the cable chambers on either side should be 500 m. For tunnels with 500～1 000 m length, only one cable chamber may be arranged in the middle point of the tunnel.

8.4.5 For tunnels with more than 2 000 m length, anchoring sections may be arranged in the tunnels in accordance with the design requirements of the overhead contact systems. The anchoring sections should be arranged in zones with good geological conditions.

In case embedded chutes are used to fix the overhead contact systems in tunnels, necessary measures shall be taken to reinforce the lining structures of the tunnels.

8.4.6 The facilities for the integrated earthing systems shall be embedded in the lining structures of tunnels in accordance with the relevant requirements. Embedded track-crossing pipes should be used for cables to cross the tracks.

8.4.7 The impact on the bodies and fixing instruments of the auxiliary structures in tunnels imposed by the pressure variations and wind caused by the high speed trains passing through tunnels shall be taken into account in the design of the auxiliary structures. The auxiliary structures shall be designed on basis of the most disadvantageous combination of different conditions.

8.5 Portal Structures

8.5.1 Tunnel portals shall be designed in accordance with the topographic, geological, environmental and landscaping conditions. The design principle of “early entrance and late exit” (means properly extending the portal sections of tunnels to avoid slope cut so as to minimize adverse impact on the environment) shall be followed. Regarding the structures of the tunnel portals, priority shall be given to bamboo-truncated structure and brim-style structure.

8.5.2 Where there are buildings near tunnel portals or there are special environmental requirements, portal buffer structures should be arranged in accordance with the requirements in Table 8.5.2.

<table>
<thead>
<tr>
<th>Distance from buildings to tunnel portals</th>
<th>Is there any special environmental requirement for the buildings?</th>
<th>Monitoring point</th>
<th>Peak values of micro-pressure waves</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50 m</td>
<td>Yes</td>
<td>Buildings</td>
<td>As per the requirements</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>≤20 Pa</td>
</tr>
<tr>
<td>≥50 m</td>
<td>Yes</td>
<td>Places 20m from tunnel portals</td>
<td>&lt;50 Pa</td>
</tr>
</tbody>
</table>

8.5.3 The types and lengths of the trains, the lengths of the tunnels, the effective area of the clearances of the tunnels, the types of the tracks in the tunnels and the topographic conditions and the residential situations near the tunnel portals shall be taken into account in the arrangement of the portal buffer structures.
8.5.4 The design of the portal buffer structures shall comply with the following stipulations:

1. The types of the buffer structures shall be determined with a practical and aesthetic view and in accordance with the environmental conditions near the portals. Perforated buffer structures that have the shape similar to that of the cross-sections of the lined tunnels should be adopted. Other types of buffer structures may also be applied.

2. In case the cross-sections of the buffer structures remain the same, pressure-releasing holes shall be arranged on the side and top of the buffer structures. The area of the pressure-releasing holes may be determined in accordance with the actual conditions and should be 1/5 ~ 1/3 of the effective area of the tunnel clearance.

3. Reinforced concrete structure should be adopted for the buffer structures.

4. In case of tunnel portals where buffer structures are to be arranged, retaining walls of the subgrade, if any, shall be placed beyond the scope of the buffer structures.

8.5.5 In case of highways crossing over tunnel portals, the highways shall be provided with protection fences and monitoring devices.

8.5.6 In case the distance between the portals of two neighboring tunnels is less than 30m, the two tunnels should be connected by an open tunnel.

8.6 Water-proofing and Drainage

8.6.1 The design of the water-proofing and drainage of tunnels shall be determined in accordance with the requirements of the water conditions and hydrological conditions of the tunnels. The principle of “taking comprehensive water control measures, including water prevention, water sealing, water intercepting and water releasing, in accordance with the actual conditions” shall be followed. For tunnels with high ground water environment protection requirements and tunnels with shallow covers, fully-enveloped water-proofing mode shall be taken.

8.6.2 Water-proofing membranes shall be placed between the primary reinforcement structure and the secondary lining. The thickness of the water-proofing membranes shall not be less than 1.5mm.

8.6.3 For newly-built double-track railway tunnels, side ditches and central ditches shall be provided. The central ditches shall be connected with the side ditches. For dry tunnels or tunnels with small drainage amount, the central ditches may be cancelled.

8.6.4 Circumferential and longitudinal filter pipes connected to the drainage ditches shall be installed on the back of the tunnel lining. The filter pipes shall lead water directly into the side ditches.

8.6.5 The cross-sections of the drainage ditches shall be determined in accordance with the water volumes. The requirements of the cleaning and inspection of the drainage ditches shall be taken into account in the arrangement of the drainage ditches. Inspection holes shall be provided for concealed central drainage ditches. The intervals between the inspection holes should not be more than 50 m. The cover slabs of the inspection holes
should be at the same level with the tunnel bottom filling surface.

8.6.6 Side drainage ditches shall be provided with water inlet holes on the side toward the side wall lining. The intervals between the water inlet holes should not be more than 4m. Drainage pipes with no more than 50m interval shall be placed to connect the side drainage ditches and the central drainage ditches.

8.6.7 For the construction joints and expansion joints of the lining structures, reliable water-proofing measures shall be taken in accordance with Grade I water-proofing requirements.

8.6.8 The drainage systems inside tunnels shall be well connected with those outside the tunnels. If necessary, surge tanks shall be installed to facilitate inspection and maintenance.

8.6.9 The drainage facilities outside tunnels shall comply with the following stipulations:

1. The drainage facilities outside tunnels shall not be located in poor and unstable geological conditions. The water shall be discharged to naturally stable valleys via short routes. In case water is discharged via side ditches of road channels or culverts, joint-free connection shall be adopted. The capacity of the drainage facilities shall comply with the relevant requirements so as to avoid back water.

2. For the surface runoffs, pits, funnels, caves and cracks within the scope of the tunnel portals that may jeopardize the construction and operation of the tunnels, measures such as sealing, diverting and intercepting shall be taken to eliminate the hidden dangers.

3. For the natural gullies and canals crossing the tunnel portals, priority shall be given to the water drainage option of installing aqueducts on top of open tunnels in case the elevations of the gully bottoms are higher than those of the tunnel crowns.

8.7 Operation Ventilation

8.7.1 The operation ventilation of tunnels shall be designed in accordance with the lengths of the tunnels, the plan and longitudinal profiles of the tunnels, the types of the ballast beds, the train intervals, the natural conditions, the meteorological conditions and the topographic conditions at both portals. For tunnels longer than 20 km, operation ventilation should be provided.

8.7.2 Emergency rescue stations shall be provided with disaster-prevention ventilation facilities. Refuge ports and tunnels with emergency exits shall be provided with emergency ventilation facilities. The disaster-prevention ventilation facilities shall have the function to control the direction of smokes in case of fire and shall ensure that the airflow speed in the direction opposite to the evacuation shall not be less than 2.0 m/s. The disaster-prevention ventilation system shall be designed in coordination with the operation ventilation system.

8.7.3 The mode of tunnel ventilation shall be determined by comparison and contrast in terms of technical and economical conditions, operational maintenance, disaster-prevention and rescue.
8.8 Disaster-prevention, Rescue and Evacuation

8.8.1 The principle of “people oriented, well prepared for emergency, convenient for self-rescue and safe evacuation” shall be followed in the design of the disaster-prevention, rescue and evacuation systems of tunnels. The disaster-prevention, rescue and evacuation systems shall be well established to avoid disasters and in case disaster occurs, to minimize the adverse effects.

8.8.2 For tunnels with more than 10 km length, twin-tube structure should be adopted.

8.8.3 Tunnels with 20 km or more length shall be provided with emergency rescue stations. The intervals between the rescue stations shall not be more than 20 km. Tunnels with 10~20 km length shall be provided with refuge ports. Tunnels with 10~3 km length may be provided with emergency exits in coordination with the arrangement of the auxiliary adits.

8.8.4 The emergency rescue stations in tunnels shall comply with the following stipulations;

1. The length of the emergency rescue stations shall be determined on basis of the length of the passenger trains plus certain allowance and in general cases may be 450~500 m.

2. The intervals between the cross evacuation passages in the emergency rescue stations should not be more than 60 m. Two sealing protection doors shall be installed for each cross passages. The passing width of the sealing protection doors shall not be less than 3.4 m.

3. The emergency rescue stations shall be provided with evacuation platforms. The widths of the evacuation platforms should be 2.3 m. The heights of the evacuation platforms shall comply with the requirements of the safe evacuation of the passengers. The evacuation platforms shall not interfere into the basic construction clearance.

4. The space accommodating passengers in the emergency rescue stations shall be designed as per the requirements of 0.5 m²/person.

5. The emergency rescue stations shall be provided with facilities such as disaster-prevention ventilation facilities, emergency illumination facilities, emergency communication facilities and firefighting facilities.

8.8.5 The refuge ports in tunnels shall be provided with emergency ventilation facilities, emergency illumination facilities and emergency communication facilities. The area of the refuge ports shall comply with the requirements of 0.5 m²/person.

8.8.6 Parallel adits and horizontal adits shall be used, with priority, as emergency exits of tunnels. The widths of the emergency exits shall not be less than 3.0 m and the heights shall not be less than 2.2 m. In case inclined shafts are used as emergency exits, the horizontal lengths of the inclined shafts should not be more than 500m and the longitudinal gradients should not be more than 12%.

8.8.7 Rescue passages, emergency rescue stations, refuge ports, emergency exits and cross passages shall be provided with evacuation guiding signs.
8.9 Seismic Design

8.9.1 For portal sections, shallow-covered sections, unsymmetrical-loaded sections and tunnel sections in faults and fracture zones, earthquake resistance measures shall be taken and the lining structures shall be strengthened in accordance with the relevant regulations specified in China's current national standard *Code for Seismic Design of Railway Engineering* GB 50111. For tunnel sections in active faults and fracture zones, larger cross-section clearance may be provided in accordance with the actual conditions if necessary. The lengths of the portal sections for which earthquake resistance measures are to be taken may be determined in accordance with the topographic conditions, geological conditions and earthquake fortification intensity and shall not be less than 2.5 times of the excavation widths of the tunnels.

8.9.2 For earthquake-resistant tunnel sections, composite lining structures with curved side walls and inverts shall be adopted and deformation joints shall be arranged.

8.9.3 Tunnel portals in seismic areas shall not be located in zones with high side slopes. Flexible protection measures should be taken for the side slopes and front slopes. The open tunnel sections should be properly extended.

8.10 Interface Design

8.10.1 The requirements of installing relevant facilities in tunnels shall be taken into account in the tunnel design. The arrangement of all the facilities in tunnels shall be considered with a comprehensive manner so as to minimize the number of the facility chambers. Smooth transition and good connection shall be ensured for the interfaces between tunnels and works of relevant professions.

8.10.2 The design of the interfaces between tunnels and earth structure and bridges shall comply with the following stipulations:

1. The protection of the portal side slopes shall be designed in coordination with the subgrade side slopes.

2. Transition sections shall be arranged at the interfaces between tunnels and subgrade.

3. The drainage ditches in tunnels shall be smoothly connected with those of the subgrade so as to ensure successful discharge of the ground water produced in tunnels.

4. The direction-turning radius of the transition sections of the cable troughs from tunnels to subgrade or bridges shall comply with the cable placement requirements.

5. In case tunnels are connected with bridges, the rescue passages in the tunnels shall be smoothly connected with the foot passages on the bridges.

8.10.3 The design of the interfaces between tunnels and overhead contact systems, communication systems, signal systems and integrated earthing systems shall comply with the following stipulations:
1 The requirements of the anchoring of the overhead contact systems and the installing of the integrated earthing systems and other works shall be taken into account in the design of the tunnel lining structure. The installation of these equipments shall not have negative impact on the safety and waterproofing effect of the tunnels.

2 The pipes that cross underneath the tracks in tunnels shall be embedded in the bottom filling concrete of the tunnels with sufficient depth so that deformation and damage can be avoided. The diameter of the pipes should not be more than 100mm.

8.10.4 The design of the interfaces between tunnels and ballastless tracks shall comply with the following stipulations:

1 The bottom slabs and invert filling of tunnels shall be designed in coordination with the base layers of the ballastless tracks.

2 After the completion of the tunnel construction, the settlement and deformation of the tunnel structures shall be observed and the bottom structures of the tunnels shall be tested.

3 The bottom structures of tunnels shall be evaluated before ballastless tracks are laid. The ballastless tracks shall not be laid until the bottom structures of the tunnels pass the evaluation.
9 Track

9.1 General Requirements

9.1.1 The main line and arrival-departure tracks shall be designed by standards for laying of trans-section continuously welded rail (CWR).

9.1.2 The track structure of main lines shall be reasonably selected by considering the speed, under-track engineering conditions and conducting technical and economics validation. Ballastless track should be selected. Both ballastless track and ballast track shall be laid by sections, with transition section track laid between the two different track sections.

9.1.3 Ballastless track structure shall be reasonably selected by considering the under-track engineering and environmental conditions, with technical solutions and economic comparison. Different ballastless track structures could be used for one railway line, with the same type track laid concentratedly.

9.1.4 Track components and engineering materials shall be in accordance with relevant country and industry standards.

9.1.5 Main structure of the ballastless track shall be designed with a life-time no less than 60 years.

9.1.6 More requirements for damping and noise control performance shall be taken into account.

9.1.7 Drainage system of good performance shall be applied for the track structure, and the anti-frost performance of that shall be considered in severe cold area.

9.2 Rail and Auxiliary Parts

9.2.1 The new 100 m-long 60 kg/m rails without bolt hole shall be used for the main line track, with quality in accordance with relevant standards for corresponding speed.

9.2.2 The elastic fasteners matching the sleepers shall be used for the ballast track, with static stiffness of the elastic pad under rail should be $(60 \pm 10) \text{kN/mm}$.

9.2.3 The elastic fasteners shall be used, which match the track slab or bi-block sleepers within ballastless track, with static stiffness of the elastic pad under rail should be $(25 \pm 5) \text{kN/mm}$.

9.3 Accuracy for Track Laying (static)

9.3.1 Static accuracy standards for laying of main line shall be in accordance with the regulations in Table 9.3.1—1, 9.3.1—2 and 9.3.1—3.
### Table 9.3.1-1 Static accuracy standards for laying of ballast track

<table>
<thead>
<tr>
<th>No.</th>
<th>Items</th>
<th>Allowable Deviation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gauge</td>
<td>±1 mm</td>
<td>For standard gauge 1435 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/1 500</td>
<td>Deviation rate</td>
</tr>
<tr>
<td>2</td>
<td>Alignment</td>
<td>2 mm</td>
<td>For 10 m long chord line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 mm / 5 m</td>
<td>For 30 m long base line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mm / 150 m</td>
<td>For 300 m long base line</td>
</tr>
<tr>
<td>3</td>
<td>Longitudinal level</td>
<td>2 mm</td>
<td>For 10 m long chord line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 mm / 5 m</td>
<td>For 30 m long base line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mm / 150 m</td>
<td>For 300 m long base line</td>
</tr>
<tr>
<td>4</td>
<td>Cross level</td>
<td>2 mm</td>
<td>Excluding the super-elevation in curve and transition curve sections</td>
</tr>
<tr>
<td>5</td>
<td>Twist</td>
<td>2 mm</td>
<td>For 3 m long base line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Including the twist caused by super-elevation slope transition curves</td>
</tr>
<tr>
<td>6</td>
<td>Deviation from design elevation</td>
<td>10 mm</td>
<td>Rail surface elevation in the platform shall be no less than designed value</td>
</tr>
<tr>
<td>7</td>
<td>Deviation from design central line</td>
<td>10 mm</td>
<td></td>
</tr>
</tbody>
</table>

### Table 9.3.1-2 Static accuracy standard for laying of ballastless track

<table>
<thead>
<tr>
<th>No.</th>
<th>Items</th>
<th>Allowable deviation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gauge</td>
<td>±1 mm</td>
<td>For standard gauge 1435 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/1 500</td>
<td>Deviation rate</td>
</tr>
<tr>
<td>2</td>
<td>Alignment</td>
<td>2 mm</td>
<td>For 10 m long chord line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 mm / interval distance between measuring points 8a(m)</td>
<td>For 48a(m) long base line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mm / interval distance between measuring points 240a(m)</td>
<td>For 480a(m) long base line</td>
</tr>
<tr>
<td>3</td>
<td>Longitudinal level</td>
<td>2 mm</td>
<td>For 10 m long chord line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 mm / interval distance between measuring points 8a(m)</td>
<td>For 48a(m) long base line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mm / interval distance between measuring points 240a(m)</td>
<td>For 480a(m) long base line</td>
</tr>
<tr>
<td>4</td>
<td>Cross level</td>
<td>2 mm</td>
<td>Excluding the super-elevation in curve and transition curve sections</td>
</tr>
<tr>
<td>5</td>
<td>Twist</td>
<td>2 mm</td>
<td>For 3 m long base line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>including the twist caused by super-elevation slope in transition curves</td>
</tr>
</tbody>
</table>
### Table 9.3.1—2 (continued)

<table>
<thead>
<tr>
<th>No.</th>
<th>Items</th>
<th>Allowable deviation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Deviation from design elevation</td>
<td>10 mm</td>
<td>Rail surface elevation in the platform shall be no less than designed value</td>
</tr>
<tr>
<td>7</td>
<td>Deviation from design center line</td>
<td>10 mm</td>
<td></td>
</tr>
</tbody>
</table>

Note: a—interval distance between fastener nodes, m.

### Table 9.3.1—3 Static accuracy standards for laying of turnouts (straight)

<table>
<thead>
<tr>
<th>Amplitude (mm)</th>
<th>Longitudinal level</th>
<th>Alignment</th>
<th>Cross level</th>
<th>Twist (3 m base line)</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>±1</td>
</tr>
</tbody>
</table>

Chord length (m) 10

### Table 9.3.2 Static accuracy standards for laying of turnouts for stations tracks

<table>
<thead>
<tr>
<th>Arrival and departure track (mm)</th>
<th>Longitudinal level</th>
<th>Alignment</th>
<th>Cross level</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>+3/−2</td>
</tr>
<tr>
<td>Other track (mm)</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

### 9.3.2 Static accuracy standards for laying of turnouts for stations tracks shall be in accordance with the regulations in Table 9.3.2.

### Table 9.3.2 Static accuracy standards for laying of turnouts for stations tracks

<table>
<thead>
<tr>
<th>Arrival and departure track (mm)</th>
<th>Longitudinal level</th>
<th>Alignment</th>
<th>Cross level</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>+3/−2</td>
</tr>
<tr>
<td>Other track (mm)</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

### 9.4 Ballastless Track

#### 9.4.1 Structure design of ballastless track shall be in accordance with the following requirements:

1. Design loads of ballastless track shall include train load, temperature load, traction/braking load, etc. Meanwhile the influence of foundation deformation to the track structure shall be taken into account.

2. Train load

   1) Vertical design load shall be calculated according to the following formula:

   \[ P_a = a \cdot P_f \]  

   Where, \( P_a \) —vertical design load;
   
   \( a \) —dynamic load coefficient, which should be 3.0 for running speed of 300 km/h and above, 2.5 for running speed of 250 km/h;
   
   \( P_f \) —static wheel load.

   2) Lateral design load shall be calculated according to the following formula:

   \[ Q = 0.8 \cdot P_f \]  

   Where, \( Q \) —lateral design load

3. Fatigue check load of the structure

   \[ \text{Fatigue check load} \]
1) Vertical fatigue check load shall be calculated according to the following formula:

\[ P_i = 1.5 \cdot P_f \]  
(9.4.1-3)

Where, \( P_f \) — vertical fatigue check load

2) Lateral fatigue check load shall be calculated according to the following formula:

\[ Q_i = 0.4 \cdot P_f \]  
(9.4.1-4)

Where, \( Q_i \) — lateral fatigue check load

4) Temperature load and the influence of concrete shrinkage

1) The temperature difference for open-air sections (including the zone 200 m from tunnel entrance) shall be defined according to local weather conditions.

2) The vertical temperature gradient is set as 45 °C/m.

3) The concrete shrinkage is determined as equal effect as 10 °C decreasing.

5) The interval distance between fastener nodes should not be larger than 650 mm. For special conditions that the distance exceeds 650 mm, design checking shall be made and the sections should not be continuously set.

9.4.2 Structure design of the CRTS I slab track shall be in accordance with the following requirements:

1) The track structure could be composed of rail, elastic fasteners, track slab, cement asphalt emulsion mortar filling layer, base layer, bollard and the surrounding resin fillings, etc.

2) Structure and dimensions:

1) The slab track structure could be classified as prestressed concrete plain slab, prestressed concrete frame slab and reinforced concrete frame slab. The track slab type shall be selected according to environmental and foundation conditions.

Standard track slab features the length of 4 962 mm, the width of 2 400 mm and the thickness no less than 190 mm. The semicircular holes are set at both ends, with the radius of 300 mm.

2) The thickness of cement-emulsified asphalt layer shall be 50 mm, with that of damping slab track to be 40 mm. Performance of the cement-emulsified asphalt mortar and its raw materials shall be in accordance with relevant regulations, with the mortar grouted in bags.

3) The base layer structure shall be designed by considering the influence of the train load, the temperature load and concrete shrinkage, with strength and crack width checked. Meanwhile the influence of foundation deformation shall be considered, with structure strength checked.

The reinforced concrete structure shall be used for base layer, with concrete strength of C40. External dimension of the base layer shall be defined according to design load. Inner thickness of the base layer in curve sections shall be no less than 100 mm.

4) The bollard shall be designed as cantilever component which is fixed on the concrete base, with shape of circular and semi-circular, and concrete strength of C40. Resin
material is filled between the bollard and track slab with design thickness of 40 mm. The resin fillings shall be grouted in bags with its performance in accordance with relevant regulations.

3 Curve super-elevation is set on base layer, which takes the surface of inner rail top as standard. The outer rail is lifted and linear transition is made in the transition curve.

4 Lateral drainage slope shall be set on top of the base layer outside the track slab.

5 The CRTS I slab track in subgrade sections is shown in Figure 9.4.2-1. The structure design shall be in accordance with the following requirements:
   1) The base layer shall be set on the surface of subgrade foundation.
   2) For certain distance, the lateral expansion gap shall be set on the base layer matching the center of the bollard.
   3) The drainage system between the tracks shall be designed according to line and environmental conditions, like the longitudinal slope or bridge and culvert. When the drainage well is used, interval distance between wells shall be determined according to water catchment area and local weather conditions.
   4) The subgrade surface of railway two sides and that between tracks shall be waterproof.

![Figure 9.4.2-1 Standard cross-sectional profile of CRTS I slab track in subgrade section (unit: mm)](image)

6 The CRTS I slab track in bridge section is shown in Figure 9.4.2-2, the design shall be in accordance with the following specifications:
   1) The base layer is set on the bridge deck, which is connected with the bridge via the pre-embedded sleeve rebar or pre-embedded bar. The bridge deck surface shall be treated for galling roughening within 2.6 m from the track center.
   2) Lateral expansion gap is set in the base layer matching the center line of the bollard for each track slab.
   3) Water-proof layer and protection layer are not set on surface of the bridge deck within scope of the base layer.
   4) Longitudinal resistance of the fastener on the bridge and fastener structure at the girder end shall be determined by calculations.
5) Three-lines drainage system shall be used on the bridge deck.

Figure 9.4.2-2 Standard cross-sectional profile of CRTS I slab track in bridge section (unit: mm)

7 The CRTS I slab track structure in tunnel section is shown in Figure 9.4.2-3, the design shall be in accordance with the following requirements:

Figure 9.4.2-3 Standard cross-sectional profile of CRTS I slab track in tunnel section (unit: mm)
1) In tunnels with inverted arch, the base layer shall be set on the refilling layer. Along the longitudinal direction of track and for certain distance, lateral expansion gap shall be set in the base layer matching the center line of the bollard. Expansion gap shall be set in the base layer matching the tunnel settlement joint. Surface of the refilling layer shall be treated for galling roughening within the scope of the base layer.

2) In tunnel section without inverted arch, the base layer and tunnel base plate shall be set together and continuously laid. In curve sections, the super-elevation is generally set on the tunnel base plate.

3) Steel bar shall be used to connect the refilling layer and base layer within 100 m from the tunnel entrance.

9.4.3 Structural design of the CRTS I bi-block sleeper track shall be in accordance with the following requirements:

1) The track concrete layer shall be reinforced and in-situ cast, with C40 concrete strength applied.

2) The CRTS I bi-block sleeper track in subgrade sections is shown in Figure 9.4.3—1, the design shall be in accordance with the following requirements:

![Figure 9.4.3—1 Standard cross-sectional profile of CRTS I bi-block sleeper track in subgrade section (unit: mm)](image)

1) The structure is composed of rail, elastic fastener, bi-block sleeper, track concrete layer and the supporting layer.

2) The supporting layer is set on the surface of subgrade bed, with its performance in accordance with relevant regulations. The top width should be 3 200 mm, the bottom width should be 3 400 mm and the thickness should be 300 mm. Along longitudinal direction of the track, a lateral pre-splitting joint shall be set no more than every 5 m length with the depth of the joint should be one third of the layer thick. Surface of the supporting layer shall be treated for galling roughening within width of the track concrete layer.

3) The track concrete layer is a longitudinally continues reinforced structure which is on top of the supporting layer. The track concrete layer is 2 800 mm wide and
260 mm thick.

4) The curve super-elevation is set on the surface of subgrade bed.

5) The drainage system between tracks shall be designed by considering the track conditions like longitudinal slope, bridge and tunnels as well as environmental conditions. When drainage well is used, interval distance between the wells shall be determined according to water catchment area and weather conditions.

6) The subgrade surface of railway two sides and that between tracks shall be waterproof.

3 The CRTS I bi-block sleeper track in bridge sections is shown in Figure 9.4.3-2, the design shall be in accordance with the following specifications;

![Figure 9.4.3-2 Standard cross-sectional profile of CRTS I bi-block sleeper track in bridge section (unit:mm)](image)

1) The structure is composed of rail, elastic fastener, bi-block sleeper, track concrete layer, isolation layer, base layer and elastic pad around the trough.

2) The track concrete layer and base layer shall be constructed segment by segment on the bridge deck along the track, with the segment 5.0～7.0 m long. Clearance between neighbor track concrete slabs and base layers shall be 100 mm. The width of the track concrete slab should be 2 800 mm and the thickness should be 260 mm. The width of the base layer should be 2 800 mm, with thickness of base layer in tangent sections to be no less than 210 mm and to be no less than 100 mm at inner side in curve sections.

3) The base layer is connected with bridge via pre-embedded sleeve rebar or pre-embedded steel bar, with bridge deck surface treated for galling roughening within 2.6 m from center line of track.

4) The superelevation of curve is set on base layer.

5) The isolation layer shall be set on top of the base layer. For each slab, shift-resistanting flute is set in the base layer with its dimension determined by calculations of design load. Elastic pad is set at side of the trough.

6) The water-proof layer and protection layer are not set on the bridge deck surface.
within scope of the base layer.

7) Longitudinal resistance of fasteners on the bridge and structure of fastener at the girder end shall be determined by calculations.

8) Two lines drainage system shall be used on the bridge.

4) The CRTS I bi-block sleeper track in tunnel sections is shown in Figure 9.4.3—3, with design shall be in accordance with the following specifications;

1) The structure is composed of rail, elastic fasteners, bi-block sleepers, track concrete layer, etc.

2) The track concrete layer is a longitudinal continuous reinforced concrete structure which is directly constructed on the refilling layer of inverted arch (tunnels with inverted arch) or base plate (tunnels without inverted arch). The width of track concrete layer should be 2,800 mm and thickness of 260 mm. Within the track concrete layer width, surface of the refilling layer and the base plate shall be treated for galling roughening.

3) The curve super-elevation is set on the track concrete layer.
4) The track concrete layer structure within 200 m from entrance of the tunnel is the same as that in subgrade section. In other sections it shall be designed according to corresponding design load.

9.4.4 Structure of the CRTS II slab track shall be designed in accordance with the following specifications:

1) The track slab is prestressed concrete structure with the concrete strength of C55. Standard track slab has a length of 6 450 mm, width of 2 550 mm and thickness of 200 mm. Compensation slab and special slab are allocated according to specific conditions.

2) The thickness of the cement-emulsified-bitumen mortar filling layer is 30 mm, with performance of the mortar and raw materials in accordance with relevant regulations.

3) The CRTS II slab track in subgrade section is shown in Figure 9.4.4—1, the design shall be in accordance with the following requirements:

![Figure 9.4.4—1 Standard cross-sectional profile of CRTS II slab track in subgrade section (unit: mm)](image)

1) The track structure is composed of rail, elastic fastener, track slab, cement-emulsified-bitumen mortar filling layer, supporting layer, etc.

2) The supporting layer is set on top surface of the subgrade bed, with its performance in accordance with relevant regulations. The width of top surface is 2 950 mm, the width of bottom is 3 250 mm and the thickness is 300 mm. A lateral pre-splitting joint is set no more than every 5 m along the longitudinal direction, with depth of the joint should be one third of the supporting layer thickness. Surface of the supporting layer within scope of the track slab shall be treated for galling roughening.

3) The curve super-elevation is set on top surface of the subgrade bed.

4) The drainage system between tracks shall be designed by considering track conditions like longitudinal slope, bridge and tunnels and environmental conditions. When drainage well is used, interval distance between wells shall be determined according to water catchment area and local weather conditions.

5) The subgrade surface of railway two sides and that between tracks shall be water-proof.

4) CRTS II slab track in bridge section is shown in Figure 9.4.4—2, with design shall be in accordance with the following requirements:
Figure 9.4.4—2 Cross-sectional profile of CRTSII slab track in bridge section (unit: mm)

1) The structure is composed of rail, elastic fasteners, track slab, cement asphalt emulsion mortar filling, base layer, sliding layer, high strength extruded polyurethane foam, side resisting pole, anchor structure at abutment end, etc.

2) The base layer is longitudinal and continuous reinforcing concrete structure, with concrete strength of C30. The width of the base layer should be 2950 mm; the thickness of base layer in straight section should be no less than 190 mm; curve super-elevation is set on the base layer, with thickness of base layer at the inner side should not less than 175 mm.

3) Certain amount of concrete post-pouring strip and steel plate connector could be set in the base layer structure according to construction organization.

4) The sliding layer is set on the bridge deck surface within width of the base layer, with its structure and performance in accordance with relevant regulations.

5) The longitudinal movement-resistance structure for the base layer shall be set on the bridge deck above the fixed support, with anti-shear flute and anchor bar docking set at corresponding locations. The dimension and quantity shall be determined by calculations.

6) The side resisting pole shall be set for certain distance on both sides of the base layer and steel bar docking set at proper place of the girder. Elastic limiting plate shall be set between the side resisting pole and base layer, with its performance in accordance with relevant regulations.

7) The high strength extruded polyurethane foam shall be set on the bridge deck certain distance away from the girder end, with thickness of the plate to be 50mm and performance in accordance with relevant regulations.
8) The lateral drainage slope shall be set on top of base layer outside the track slab, with three-lines drainage system applied on bridge surface.

9) The anchor structure and transition slab shall be set in subgrade at the abutment end, with structures and dimensions determined by calculations.

5 The CRTS II slab track in tunnel section is shown in Figure 9.4.4-3, with the design shall be in accordance with the following requirements:

1) The track is composed of rail, elastic fastener, track slab, cement-emulsified-bitumen mortar filling layer, supporting layer, etc.

2) When the supporting layer applies concrete structure, the curve super-elevation could be set on the supporting layer; when the supporting layer applies hydraulic mixture, the curve super-elevation could be set on the back-filling layer of inverted arch (tunnel with inverted arch) or on the base plate (tunnel without inverted arch).

3) Other requirements are the same as that in subgrade sections.

Figure 9.4.4-3 Standard cross-sectional profile of CRTS II slab track in tunnel section (unit:mm)
9.4.5 Ballastless track with sleeper embedded in turnout sections shall be designed in accordance with the following requirements:

1. The structure is composed of turnout rail components, elastic fasteners, turnout sleeper, track concrete layer, base layer, etc.
2. The sleeper spacing in turnout sections should be 600 mm, with that in special locations determined according to turnout structure.
3. Reinforced concrete structure with concrete strength of C40 shall be applied in track concrete layer. Structure of the track concrete layer shall be determined according to design load.
4. Reinforced concrete structure with the concrete strength of C30 shall be applied for the base layer. The thickness of the base layer should be 300 mm, with the width determined according to dimension of the turnout structure. Steel bar shall be used to connect the base with track concrete layer in switch and frog sections.
5. Lateral drainage slope shall be set on top surface of track concrete layer.
6. Track stiffness shall be even in the turnout section and meanwhile match with track stiffness in the track section.
7. The design of ballastless track structure shall meet the installation requirements of turnout outside signaling room and track circuit equipment.

9.4.6 Ballastless track with slab in turnout section shall be designed in accordance with the following requirements:

1. The structure is composed of turnout rail components, elastic fasteners, turnout slab, base layer, etc.
2. The sleeper spacing in turnout sections should be 600 mm, with that in special locations determined according to design of turnout structure.
3. The reinforced concrete structure with concrete strength of C50 shall be applied in turnout slab. The thickness of turnout slab should be 240 mm, with the width determined according to dimension of the turnout structure. Lateral drainage slope shall be set on top of turnout slab.
4. Reinforced concrete structure with concrete strength of C40 and thickness no less than 180 mm shall be used for the base layer. The width shall be determined according to dimension of turnout structure.
5. Track stiffness shall be even in the turnout section and match with track stiffness in the track section.
6. The design of ballastless track structure shall comply with the installation requirements of turnout outside signaling room and track circuit equipments.

9.5 Ballasted Track for Main Line

9.5.1 The 2.6 m long concrete sleeper shall be used for ballasted track of main line, with 1667 sleepers laid per km. Concrete turnout sleepers shall be laid for turnout sections.
9.5.2 Design of ballast bed shall be in accordance with the following requirements:

1 Extra grade crushed stone ballast shall be used with mechanical and physical performance complied with relevant regulations. The ballast shall be cleaned before being laid on track with the cleanliness complied with relevant requirements.

2 Top of the ballast bed shall be 40 mm lower than rail supporting surface of sleeper and meanwhile shall be no higher than the middle top surface of sleeper.

3 Single track in subgrade section shall feature a top width of ballast bed of 3.6 m, thickness of 0.35 m, side slope of 1:1.75 and ballast shoulder height of 0.15 m. Top width of ballast bed of double tracks shall be designed as the same way as that for single track. Elastic sleeper or elastic pad under ballast shall be used in stone cutting sections.

4 Standards for ballast bed on bridge shall be the same as that in subgrade sections, with elastic sleeper or elastic pad under ballast applied. Ballast is used to fill the space between ballast shoulder and ballast retaining wall.

5 Standards for ballast bed in tunnels shall be the same as that in subgrade sections with elastic sleeper or elastic pad under ballast applied. Ballast is used to fill the space between ballast shoulder and side wall (or water ditch at the higher side).

6 Before opening to traffic, density of ballast bed shall be no less than 1.75 g/cm³, supporting stiffness of sleeper no less than 120 kN/mm, longitudinal resistance no less than 14 kN per sleeper and lateral resistance no less than 12 kN per sleeper.

9.6 Transition Section for Track Structure

9.6.1 Design of track transition shall be in accordance with the following requirements:

1 Different track structures shall be transited on the same sub-foundation.

2 The transition section between different track structures shall avoid using in-site welding joint.

9.6.2 Track transition from ballastless track to ballasted track shall be in accordance with the following requirements:

1 The base layer or supporting layer for ballastless track structure shall extend no less than 10 m from the transition point to the ballasted track and meanwhile comply with requirements for minimum roadbed thickness in ballasted track section.

2 The ballastless track in track transition in certain extent shall ensure reliable connection between track slab or track concrete layer and the supporting layer.

3 60 kg/m auxiliary rail and matching fasteners shall be used in track transition, with the auxiliary rail 25 m long (5 m in ballastless track section and 20 m in ballasted track section). Location of auxiliary rail shall not influence the large scale mechanical maintenance work.

4 Track stiffness in transition section shall be designed by grade.

5 The ballast glue could be used in certain transition section to bond different parts of crushed stone ballast bed.
9.6.3 The height difference of the track shall be considered in the design of track transition between different ballastless track structures.

9.7 Rail Expansion Joint

9.7.1 Bridge, alignment and track shall be systematically designed with less rail expansion joint used as much as possible. The rail expansion joint shall not be used in plane curve section and vertical curve section.

9.7.2 The distance between welding joints at stock rail start or point rail heel of rail expansion joint and bridge girder joint shall be no less than 2 m.

9.7.3 Stiffness of track within the scope of rail expansion joint shall be even and match with stiffness of track in the track section.

9.8 Interface Design

9.8.1 The technical requirements of interface with other principles shall be considered. Systematic plan and design shall be made.

9.8.2 Interfaces between track structure and civil project like earth structure, bridge and tunnel shall be designed in accordance with the following requirements:

1. The track design shall propose the requirements of embedded parts, evenness and elevation for earth structure, bridge and tunnel, etc.

2. Drainage system for track structure shall be designed by considering the drainage systems for civil project like earth structure, bridge and tunnel, etc.

3. Track structure for turnout on bridge shall be designed by considering the bridge and turnout structure.

9.8.3 The interface design between track system, signaling system and earthing system shall be in accordance with the following requirements:

1. Design of track structure shall consider the installation requirements of outdoor signaling equipments and the general earthing system.

2. Leakage resistance for roadbed of ballasted track shall be no less than 2 $\Omega \cdot$ km and that for roadbed of ballastless track shall be no less than 3.0 $\Omega \cdot$ km.

3. Insulation treatment for ballastless track shall be in accordance with the following requirements:

1) Steel bar mesh in the track slab for CRTS I slab track shall be insulated and meanwhile earthing rebar and earthing terminal shall be set.

2) Steel bar mesh in the track slab for CRTS II slab track and tensile fastener between neighbor slabs shall be insulated and earthing rebar and earthing terminal shall be set in the track concrete layer.

3) Steel bar mesh in the track concrete layer for CRTS I bi-block sleeper track shall be insulated and earthing rebar and earthing terminal shall be set.

4) Steel bar mesh in track concrete layer or turnout slab in turnout section shall be
insulated and earthing rebar and earthing terminal shall be set.

5) In general conditions, steel bar mesh in base layer for ballastless track is not treated for insulation.

9.9 Station Track

9.9.1 When the main line is ballastless track, the two arrival and departure tracks next to the main line should be ballastless track. Others could be ballast track with broaden concrete sleepers. In elevated stations or stations with elevated layers in platform, the arrival and departure track should be ballastless track.

9.9.2 Ballasted track used for station track shall be designed in accordance with the following specifications:

1  60 kg/m new rail without bolt hole shall be used for the arrival-departure track, with 50 kg/m rail used for other station track.

2 Concrete sleeper shall be used for the arrival-departure track, with 1667 sleepers laid per km and 1760 laid per km when broaden concrete sleepers are used. 1440 sleepers shall be laid per km for other station tracks.

3 Class 1 crushed stone ballast shall be used for the station track. The ballast bed of the arrival-departure track shall feature a surface width of 3.4 m, thickness of 0.35 m and side slope of 1:1.75. The ballast bed of other tracks shall feature a surface width of 2.9 m, thickness of 0.25 m and side slope of 1:1.5.

4 Elastic type II fasteners should be used for concrete sleeper for station track.

9.10 Auxiliary Equipments and Stock Materials for Track

9.10.1 Foundation piles shall be set for the main line.

9.10.2 A series marks including those for railway line, land and administration boundary shall be used for main line. Railway line marks including the marks for kilometer, half-kilometer, curves, bridge, tunnel, culvert, gradient and equipment administration organization. The railway line marks shall be in accordance with the following requirements:

1 The railway line marks shall be set on the nearest post of the overhead contact system (OCS post), with the actual location marked on rail waist or ballastless track structure.

2 Bottom of the marks for kilometer and semi-kilometer shall be 3.0m away from rail surface and bottom of sign post for curve, for gradient and bridge shall be 0.5 m away from rail surface.

3 Marks for curve, gradient and bridge in bridge section could be set on the protection wall at one side, with top of the mark 0.1 m away from top of the protection wall.

4 Marks in the tunnel section could be set on the side wall, with their heights 3.0 m
away from the rail surface.

5 For stations without OCS post, corresponding marks shall be set at one side of platform.

9.10.3 Quantity of stock materials for both ballasted track and ballastless track for the main line could be in accordance with the specifications in Table 9.10.3—1 and Table 9.10.3—2.

| Table 9.10.3—1 Quantity of Stock Materials for Ballasted Track of the Main Line |
|----------------------------------------|------------------------------------------|
| **Materials**                           | **Quantity of Stock materials**          |
| Concrete sleeper                       | 2 rails /km for single track             |
| Fastener and plate                     | 5 sets/km for single track               |
| First-aid device for broken rail       | 1 set/km for single track                |
| Buckle bar                             | 1 set/km for single track                |
| 25 m long holeless rail                | 6 rails for each general work area       |
| 6 m short rail with hole               | 6 rails for each general work area       |
| 25 m 6 long glued insulated rail with hole | 6 rails for each general work area     |
| 25 m holeless glued insulated rail     | 6 rails for each general work area       |
| Joint bolt and washer                  | 36 sets for each general work area       |
| Joint bar                              | 24 pieces for each general work area     |
| **Turnout**                            |                                          |
| Whole turnout (including auxiliary parts and turnout sleeper) | 1 set spared every 1 000 extended kilometers for each type of single-way turnout |
| Turnout sleeper                        | 1 set spared for every 100 sets          |
| Frog (including matched fasteners)     | 1 set spared for every 20 sets for each type in each new station |
| Point rail (including matched fasteners) | 1 set spared for every 30 sets in reconstructed or scale-up constructed station |
| Stock rail (including matched fasteners) | 1 pair spared for every 20 sets for each type in each new station |
| **Rail expansion joint**               |                                          |
| Whole set of rail expansion joint (including auxiliary parts and sleeper) | 1 set spared every 1 000 extended kilometers for each type |
| Sleepers                               | 1 set spared for every 100 sets          |
| Point rail (including matched fasteners and auxiliary parts) | 1 pair spared for every 20 sets for each type |
| Stock rail (including matched fasteners and auxiliary parts) | 1 pair spared for every 20 sets for each type |
### Table 9.10.3—2 Quantity of Stock Materials for Ballastless Track of the Main Line

<table>
<thead>
<tr>
<th></th>
<th>Materials</th>
<th>Quantity of Stock materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRTS I slab track</td>
<td>Cement-emulsified-bitumen mortar patching material</td>
<td>0.1 m³/km for single track</td>
</tr>
<tr>
<td></td>
<td>Resin patching material for bollard</td>
<td>0.01 m³/km for single track</td>
</tr>
<tr>
<td>CRTS II slab track</td>
<td>Cement-emulsified-bitumen mortar patching material</td>
<td>0.1 m³/km for single track</td>
</tr>
<tr>
<td>Transition section</td>
<td>Fastener and plate for auxiliary rail in transition section</td>
<td>5 sets for every 20 places</td>
</tr>
<tr>
<td></td>
<td>Fastener and plate for stock rail in transition section</td>
<td>5 sets for every 20 places</td>
</tr>
<tr>
<td></td>
<td>sleeper in transition section</td>
<td>5 sets for every 20 places</td>
</tr>
</tbody>
</table>

Note: the rail components, including the fastener and plate, first-aid device for broken rail, buckle bar, 25 m holeless rail, 6 m short rail with hole, 6.25 m glued insulated rail with hole, 25 m holeless glued insulated rail, joint bar, turnout and rail expansion joint used for ballastless track, shall be designed according to the quantity in Table 9.10.3—1.

### 9.10.4 The quantity of stock materials for the arrival-departure track shall be prepared in accordance with standards for the main line, with the stock materials for station track (jointed rail) prepared according to Table 9.10.4.

### Table 9.10.4 Quantity of Stock Materials for Station Track (Jointed Rail)

<table>
<thead>
<tr>
<th>Materials</th>
<th>Quantity of Stock Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail</td>
<td>(25 m long rails) 0.5 set/km for single track</td>
</tr>
<tr>
<td>Auxiliary materials for rail joint</td>
<td>2 sets/km for single track</td>
</tr>
<tr>
<td>Joint bolt and washer</td>
<td>2 sets/km for single track</td>
</tr>
<tr>
<td>Concrete sleeper</td>
<td>1 set/km for single track</td>
</tr>
<tr>
<td>Concrete sleeper fastener and pad</td>
<td>2 sets/km for single track</td>
</tr>
<tr>
<td>Turnout</td>
<td></td>
</tr>
<tr>
<td>Turnout sleeper</td>
<td>1 set spared every 100 sets</td>
</tr>
<tr>
<td>Frog (including matching fasteners and auxiliary parts)</td>
<td>1 set spared every 20 sets</td>
</tr>
<tr>
<td>Point rail (including matching fasteners and auxiliary parts)</td>
<td>1 pair every 20 sets</td>
</tr>
<tr>
<td>Stock rail (including matching fasteners and auxiliary parts)</td>
<td>1 pair every 20 sets</td>
</tr>
</tbody>
</table>
10 Station and Yard

10.1 General Requirements

10.1.1 The station design shall comply with the requirement of system function, meet the traffic demand, be easy for the operation management and convenient for boarding and alighting of passengers. Besides, the conditions for further development shall be reserved.

10.1.2 The number of passenger stations in a terminal shall be determined by comprehensive comparing and appraisalling of factors, such as the passenger traffic volume at the terminals, the number of lead-in tracks, passenger train operation scheme, the existing equipment configuration, the passenger traffic layout of the terminal, as well as the overall urban planning, etc.

10.1.3 To decide location of passenger stations shall be determined by taking into consideration of the following factors, i.e. the alignment strike of lead-in lines, the location and conditions of the existing passenger stations, the overall urban planning, and the topographical and geological conditions, etc. The priority selection shall be the existing passenger stations or the locations in urban area. Given the circumstance of two or more selected passenger stations, there should be convenient links among the passenger stations.

10.1.4 If there are two or more passenger stations in the terminal, the work division of passenger station shall follow the principles of smooth routing for passenger trains, well-coordinated transport capacity between stations and line, and convenient boarding and deboarding of passengers and be carried out according to the direction of lead-in tracks, the types of passenger trains, and the passenger train operation scheme, etc.

10.1.5 For the passenger and freight traffic layout in the large railway terminal, the way of “separate track for passenger and freight traffic, passenger traffic inside city while freight traffic outside city” should be used. The large passenger stations shall be integrated with the urban traffic system and constructed as a comprehensive traffic hub, realizing the convenient interchange for passengers.

10.1.6 In the large passenger stations with multiple lead-in lines, the layout should be carried out according to the different functions and types of the lead-in lines. Under difficult circumstances, separate lines and yards may be laid in grade separation type, and the connecting line for running cross-line train shall be set up according to the traffic demand and the principle of connecting for primary lines and passenger transfer for secondary lines. As for the passenger station with lines only connected from the third direction, a combined yard may be laid out based on directions.

10.1.7 The stations may be classified into three types, i.e. the overtaking station, the
intermediate station, and the originating train station, according to the character of technical working. They may also be classified into four types, i.e. super-large station, large station, medium station, and small station, according to the passenger traffic volume.

10.1.8 The effective length of the arrival-departure track in station shall be 650m and be designed as two-way route.

10.1.9 The untwining lines and connecting lines shall be linked with the main lines or the arrival-departure tracks in the station. If they have to be linked with the main lines in the section, a block post shall be set up at the link area and the catch siding shall be built according to the need of train operation.

The private siding and depot-managed siding shall be linked with the arrival-departure tracks in the station, and the catch siding shall also be built. It is not necessary to set up catch siding if there are parallel route and separated turnout as well as the interlocking equipment in the station.

In intermediate station, the catch sidings shall be set up at both ends of the arrival-departure tracks on which the trains would stay for a long time. It is not necessary to set up catch siding if there are other route and turnout separated with the main line as well as the interlocking equipment in the station.

10.1.10 At the station which has a down-grade of over 6‰ in the entrance direction outside the home signal and within the braking distance, the catch siding shall be set up at the end of the receiving direction of the main line or the arrival-departure track.

10.1.11 The catch siding shall conform to the following requirements:

1. The effective length of the catch siding shall be no less than 50m.
2. The longitudinal grade of the catch siding shall be designed as level grade or the up grade facing the bumper.
3. The buffer shall be applied to the end of the catch siding.
4. The guard rails shall be set out at both sides of the catch siding. If the catch siding is on subgrade, formation pattern for wheel-stopping shall be set.
5. The distance between the end of the curve catch siding and the adjacent track shall guarantee that the adjacent tracks remain safety once there is a rollover accident of locomotive or vehicle happening.
6. The catch siding should not be built on the bridge or in the tunnel.

10.1.12 At the straight line section in station, the distance from the main buildings and facilities to the railway axis shall conform to the rules in Table 10.1.12.

10.1.13 In the curve section of station, the distance from all kinds of buildings and equipment to the center line of the track shall be widened according to the Appendix A in this Code.

10.1.14 At the straight section, the distance between the centers of two adjacent lines in station shall comply with the following rules:

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### Table 10.1.12  The distance from the main buildings and facilities to the railway axis

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Name of the buildings and equipment</th>
<th>The distance (mm) to the center of line</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Edges of grade separated bridge column, over bridge column, and poles of electric lighting and rainproof canopy, etc.</td>
<td>Located on the side of the main lines  [2.4 \text{ mm}] Located on the side of the station track [2.15 \text{ mm}] Located on the outer side of the outermost line in the station and yard [3.1 \text{ mm}]</td>
</tr>
<tr>
<td>2</td>
<td>Edge of passenger platform</td>
<td>Located on the side of the station track [1.75 \text{ mm}]</td>
</tr>
<tr>
<td>3</td>
<td>Edges of the continuous wall, guardrail, and sound barrier</td>
<td>Located on the outer side of the main lines or station track (Where nobody pass) Outside the subgrade surface</td>
</tr>
<tr>
<td>4</td>
<td>Edge of catenary pole</td>
<td>Located on the side of the main lines  [3 \text{ mm}] Ballastless [2.5 \text{ mm}] Located on the side of the station track [3.1 \text{ mm}]</td>
</tr>
</tbody>
</table>

**Note:**
1. When the large-sized maintenance mechanic operation is applied to the ballastless track, the distance from the main buildings and facilities of Serial No. 1 to the track center line should be 3.100 mm.
2. Under difficult conditions, the distance between the catenary pole edge and the track center line shall be no less than 2.500 mm on the side of the main track, and no less than 2.150 mm on the side of the station track.

1. The distance between the centers of two main lines shall be the same as that of two main lines in section.

2. If there is no building or equipment between two lines, the distance between the center of the main line and its adjacent arrival and departure track, centers of the two arrival and departure tracks, or centers of the arrival and departure track and other tracks shall be no less than 5.0 m.

3. If there are buildings or equipment between two tracks, the distance between the centers of two tracks shall be calculated according to Table 10.1.12 which contains the standard distance between the buildings and equipment and the center line of the track as well as the structure width of buildings and equipment.

10.1.15 The EMU depot & workshop (depot) should be set up near the station with room to be reserved for its extension, and should be laid in a longitudinal type outside the throat zone with less receiving and departure trains.

10.1.16 Overhead contact line shall be erected for the tracks in station and EMU depot & workshop (depot) such as arrival-departure track, turnaround line, tracks in and out depots, storage siding, maintenance line, car wash line, as well as catch siding where the EMU go through. It may not be erected for the tracks in the comprehensive maintenance depot (work area).
10.1.17 As for the flyover bridge across electrified railway inside the station or EMU depot & workshop (depot), the height from its beam bottom to the rail top under the bridge in straight line section shall meet the following requirements:

1. As for the flyover bridge that crosses the high speed main line, the height under the bridge shall not be lower than 7250 mm.

2. As for the flyover bridge that crosses the turnaround line and the tracks inside the EMU depot & workshop (depot), the height under the bridge shall not be lower than 6550 mm, and shall not be lower than 6200 mm in difficult cases. For the existing flyover bridge, the height under the bridge shall not be lower than 5800 mm when there is enough reason.

If the beam bottom of the flyover bridge locates in the curve superelevation section, the headroom of the flyover bridge shall be heightened according to calculation.

10.1.18 In the stations of heavily snowy regions, the railway turnout on the main track and arrival and departure track shall be equipped with snow-melting devices.

10.1.19 In the section where the station road is parallel to the main track, the road shoulder shall not be less 0.7 m lower than the railway shoulder. If it does not meet the requirement, safety provision shall be set up between road and railway.

10.1.20 The landscaping of the station shall be designed taking into consideration of the surrounding environment, architectural style, and noise abatement as well.

10.1.21 The name of the station shall be given in accordance with the following requirements:

1. The station name shall be in line with the name of the place where it locates, while different from other names across the country.

2. If the station is located inside an urban district or city suburban, it shall be named after the city. Meanwhile, if it lies in a county, town, or village, then it shall have the name of that county, town, or village.

3. If more than one station are set up in an urban district or city suburban, the station with the most passenger services should have the name of the city, while the other stations may be named after the city added with the orientation words (i.e. east, west, south, and north), or named after the local place.

4. As for the station located in secondary districts or exurban area, it shall not be named after the city or added with the orientation words.

10.2 Station Layout

10.2.1 The plan layout of the station shall be determined by the quantity of the lead-in lines, carrying capacity, working amount of passenger trains and operation scheme, station functions and operational requirements as well.

10.2.2 The quantity of arrival-departure track for overtaking station shall be 2, and may be 2~4 for intermediate station. As for originating train station and intermediate station
with quick turnaround work, the quantity shall be determined by the pair number and function of the passenger train that the station actually assumes, the train operation scheme, the quantity of the lead-in lines, and the procedures of the technical work of the station as well, and shall meet the requirements of dense train arrival and departure in peak hours.

10.2.3 The layout in throat area of the station shall meet the requirements of defined arrival and departure routes for trains and use for the arrival and departure tracks.

10.2.4 The layout in throat area shall be tight and the quantity of turnouts in main track shall be reduced. Where there are the access of EMU depot & workshop (depot) leading in, the layout in throat zone at the leading in end shall meet the quantity requirements of the parallel operation for the arrival and departure of train and EMU going to and from the depot & workshop (depot).

10.2.5 A single crossover may be laid in the two ends of the station to form a splayed crossover, except the station with short distance from the adjoining one. A group of splayed crossovers shall be set up at two ends of the originating train station and the end of the intermediate station with departing work.

10.2.6 If the main line is about 100km long, a hold track inside the station should be set up for the construction train, and a parking base in every 200km for the large-sized track maintenance machinery, ballast unloading vehicle, and rail replacing train. The effective length of the hold track or the tracks inside the parking base shall be 650 m.

10.2.7 The turnouts in the main lines and the arrival-departure track in station should use movable-point frog, and have the same type of rail as the main line and the arrival-departure track.

10.2.8 The selection of turnout number shall meet the following requirements:

1 The straight passing speed of turnout in main line shall not be lower than the design speed in the section.

2 The lateral turnout connecting the main line and the connecting line for cross-line passenger train shall be determined by the design speed of the train. High speed turnout with the permissible lateral passing speed of 160km/h or 220 km/h should be selected. If the connecting track for the cross-line trains connects with the station where all the cross-line trains stop, the high speed turnout (1:18) with the permissible lateral passing speed of 80 km/h may be used.

3 High speed turnout with the permissible lateral passing speed of 80 km/h should be used in the crossover between two main lines in the station throat area, while the turnout (1:12) be used for the large stations for renovation and extension in difficult conditions.

4 The high speed turnout (1:18) with the permissible lateral passing speed of 80 km/h shall be used for the lateral turnout connecting the main line and the arrival-departure track.
5 The lateral turnout (1 : 18) with the permissible lateral passing speed of 80 km/h shall be used when the arrival-departure track inter-connects with each other, while the turnout (1 : 12) be used for the station where all or most trains stop and the large stations for renovation and extension in difficult conditions.

6 At least the turnout (1 : 12) shall be used when the running line of EMU and maintenance vehicles connecting with the arrival-departure track. The turnout (1 : 9) may be used when the depot siding and maintenance line connecting with the arrival-departure track.

7 The turnout (1 : 12) is suitable for the arrival (departure) end in the parking yard of the EMU depot & workshop (depot), the turnout (1 : 9) may be used in difficult cases and for other turnouts.

10.2.9 The length of the rail inserted between adjoining turnouts shall meet the following requirements:

1 If the turnouts in main lines are opposite arrangement, and two trains pass the two sidings at the same time, the rail with a length at least 50 m shall be inserted, and the rail with a length at least 33 m shall be inserted if limited by the length of station site. If no trains pass the two sidings at the same time, or the turnouts are set up in consequent positions, then rail with a length at least 25 m may be inserted.

2 If the trains pass the two sidings at the same time, the rail with a length at least 25 m shall be inserted between the two turnouts in the arrival-departure track, and the rail with a length at least 12.5 m shall be used in difficult case. If no trains pass at the same time, then the rail with a length at least 12.5 m shall be inserted.

10.3 Plane and Profile of Station Tracks

10.3.1 If the turnout (1 : 18) is adopted in the station throat area, the curve radius in the arrival-departure route shall not be less than 800 m. Meanwhile, if the turnout (1 : 12) is used, the relevant regulations in Code for Design of Railway Station and Terminal GB 50091 shall be followed.

10.3.2 The superelevation of outer rail shall be set for the curve in arrival-departure route. The curve superelevation value shall be determined by the plane curve radius and train passing speed, meeting the requirements of allowable deficient superelevation, allowable surplus superelevation, and the allowable value of their sum while not less than 20 mm.

10.3.3 The transition curve shall be set on the curve in the arrival-departure route and its length shall be determined by the train passing speed, the curve designed time-varying rate of superelevation, (deficient) superelevation, and the superelevation slope ratio, while not less than 20 m. If the curve radius is more than 1200 m, the transition curve may not be set up.

10.3.4 When the transition curve is designed in the arrival-departure route, the length of the intermediate straight line between the transition curves and circular arc between transition curves shall not be less than 25 m. On the contrary, if the transition curve is not
set up, the length of straight line without superelevation between two curves shall not be less than 20 m.

10.3.5 The length of straight line from the turnout on arrival-departure route to the end of superelevation slope area shall not be less than 20 m, while the straight line connected to the rear end of turnout shall be in accordance with the length of \( L' \) from the rear end of the turnout to the last turnout tie. As for the distance between other turnouts and curves, *Code for Design of Railway Station and Terminal GB 50091* shall be followed.

10.3.6 A single grade section inside the effective range of the arrival and departure track should be designed, while the length of the grade section within the platform range shall not be less than 450 m in difficult case.

If the gradient differences between the adjoining grade sections in the arrival-departure track is above 3‰, the vertical curve shall be used, and its radius may be 10,000 m. Meanwhile the vertical curve shall not overlap with the transition curve.

10.3.7 The turnout in the station shall not overlap with the vertical curve and the grade change point. The distance between the turnout in main track and the starting point, ending point of the vertical curve or grade change point should not be less than 20 m.

10.3.8 The rail top of the main line and the arrival-departure track as well as the rail top of the arrival-departure track and the arrival-departure track should be designed to be of the equal height. If the height difference exists in the rail top of the throat area, its smooth connection shall be designed while taking into account the transverse grade of the subgrade surface and the depth of ballast bed, and the range of smooth connection grade shall be from the common sleeper adjoining the rear end of turnout to the starting point of the train stop post, with the gradient not more than 6‰, the differences between the adjoining grade sections not higher than 3‰, and the grade length at least 50 m.

The smooth connection grade in other lines shall follow the requirements in *Code for Design of Railway Station and Terminal GB 50091*.

10.3.9 As for the stations with considerable quick turnaround work, the turnaround line should be set up at the end of the train receiving direction. If a lot of trains running on the main line, the grade separation turnaround lines shall be set up. The turnaround line shall meet the following requirements:

1. The effective length of the turnaround line shall not be less than 480 m.
2. The turnaround line should be set in straight line, or in curves with at least a 600 m radius in difficult case.
3. The turnaround line should be set in level grade, or in grade with the gradient not exceeding 6‰ in difficult case.
4. The plane curve radius in the running part of the turnaround line should not be less than 400 m, with the gradient not exceeding 30‰.

10.3.10 The plane layout of the EMU depot & workshop (depot) shall meet the following requirements:
The yard tracks shall be set in straight line.

The connecting curve radius after the turnout shall at least equal the lead curve radius of the adjoining turnout, while not be less than 250 m.

The length of the straight line section between curve and the front end of turnout curve shall not be less than 6.0 m, and the distance between curve and rear end of turnout shall not be less than the sum of the distance from the rear end of turnout to the last turnout tie with the minimum straight line length required for the gauge widening on curve and the curve superelevation.

The decline gauge widening shall not exceed 2‰, and 3‰ in difficult case, while the rate of curve superelevation slope ratio not exceed 2‰.

Curve section may not have transition curve.

10.3.11 The plane design in comprehensive working area (maintenance location) shall follow the requirements in Code for Design of Railway Station and Terminal GB 50091.

10.3.12 The lines inside the EMU depot & workshop (depot), comprehensive working area (maintenance location), and large-sized track maintenance depot should be set up in level grade, or in a grade not exceeding 1‰ in difficult case. The throat area may be located in a grade not more than 2.5‰, or not more than 6‰ in difficult case.

The gradient of the running line for the maintenance train shall not exceed 30‰ in difficult case, while not exceeding 6‰ for the draw-out track.

10.4 Equipment for Passenger Transportation

10.4.1 The design of the passenger platform shall meet the following requirements:

1 The platform shall be 450 m long, and 230 m for the railway station with only 8-car formation EMU, while being at least 220 m in difficult cases.

2 The platform shall be 1.25 m higher than the top of rail.

3 The width of the platform shall be determined by the station function, platform type, density of passenger flow, safety range, and the width of platform entrance and exit as well. The following Table 10.4.1 may be referred to.

<table>
<thead>
<tr>
<th>Name</th>
<th>Super-large or large station(m)</th>
<th>Medium station(m)</th>
<th>Small station(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between the margins of projecting part of the station building(operation room) and the platform</td>
<td>15.0～20.0</td>
<td>12.0～15.0</td>
<td>≥8.0 Where the access lies opposite the station building ≥10.0</td>
</tr>
<tr>
<td>Island intermediate platform</td>
<td>11.5～12.0</td>
<td>10.5～12.0</td>
<td>10.0～11.0</td>
</tr>
<tr>
<td>Side intermediate platform</td>
<td>8.5～9.0</td>
<td>7.5～8.0</td>
<td>7.0～8.0</td>
</tr>
</tbody>
</table>

Note: As for the width of passenger main platform, if the access entrance and exit are set up outside the station building, it shall not be less than the width of side intermediate platform.
4 The platform shall not be laid on both sides of the main line which passenger train goes through. If the platform is set on one side of the arrival-departure track, its security guard line shall be 1.0m from its margin. The security guard line should be colored in yellow and laid with the warning blind sidewalks, not exceeding 250mm and at least 17mm wide.

5 The platform should be set up in straight line. If it is laid in curve, the curve radius should not be less than 800m. If the turnout (1:12) is adopted, the curve radius shall not be less than 600m in difficult cases.

6 Width of the end of platform should not be less than 5.0 m.

7 Steps, slopes or protecting fence shall be laid on both sides of the platform, and the stockade gate shall not be less than 1.0m wide, marked with “No Entry”.

8 The train stop signs shall be set on the platform in accordance with the requirements of the railway administration.

10.4.2 The setting of passenger entrance and exit access shall take into account the flow line of passenger going and from station comprehensively, while meeting the following requirements:

1 The entrance and exit of the passenger platform shall be bidirectional, with the width following the requirements in Table 10.4.2. If escalators or elevators are laid in the access entrance and exit, the width shall be widened according to the quantity and requirements of the lifting equipment.

2 Where the high speed railway is led to the existing passenger station, the entrance and exit access for passengers may be used on condition that it meets the requirements of function and safety.

<table>
<thead>
<tr>
<th>Table 10.4.2 Width of entrance and exit for the passenger platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Basic platform, island intermediate platform</td>
</tr>
<tr>
<td>Side intermediate platform</td>
</tr>
</tbody>
</table>

Note: the width of the passenger entrance and exit access in super-large and large station includes the width of an escalator.

10.4.3 The distance between the margin of the passenger station platform beside the track and the platform entrance and exit or the building margin, shall not be less than 3.0 m, 2.5 m for medium or small station in difficult case, and shall not be less than 2.0 m on one side where the existing station is reconstructed.

10.4.4 If luggage and mail operation is to be done in the station, access for transporting luggage and postbag shall be set up while meeting the requirements as follows:

1 Quantity of the access: 2 for large station, and at least 1 for medium and small stations.
2 Width of the access; the width of access shall not be less than 5.2 m.
3 The clear height of the access should not be less than 3.0 m.
4 The access entrance and exit to the passenger platform is should be designed as a single way, with the width at least 4.5 m.
5 The access shall be laid at the end of the platform.

10.4.5 Grade crossing shall not be set in the station where high speed train goes through.
10.4.6 The protective fence shall be laid on both sides of the station while connecting with the section protective fence. The protecting fence shall be laid at 0.5 m inside right-of-way of railway.
10.4.7 The track numbering for super-large and large passenger station shall meet the requirements as follows:
   1 The numbering of the main line in passenger train yard and the arrival-departure track shall start from the side of the station building, ranging from 1, 2, 3, etc. in sequences, which is the same for the branch yards in transversal type layout.
   2 If the station buildings are laid on both sides of passenger train yard, the track numbering shall start from the track on the main station building side to the secondary station building in sequences.
   3 As for other tracks in the passenger train yard, the track numbering shall start from the side of the station building to the opposite side in sequences of up track and down track after the main line and the arrival-departure track have been numbered.
   4 As for other yards or depot & workshop (depot) linking with the passenger train yard, shall be numbered separately and added with the yard name or number.
   5 The arrival-departure track and the station track shall be numbered in Arabic numerals, and in capital Roman numerals for main line.
10.4.8 As for the super-large and large passenger station platform, shall be numbered according to platform surface while in accordance with the track number. If the track is not close to the platform, the platform may not be numbered in sequences.

10.5 Earth Structure, Drainage for Station Yard

10.5.1 The distance between the track centerline and the margin of the subgrade surface inside the station shall meet the requirements as follows:
   1 Standard of the main line inside the station shall be in accordance with that of the section main line;
   2 As for the outermost arrival-departure track of the yard, the distance shall not be less than 4.4 m, and at least 3.5 m for other tracks, while the minimum width of shoulder shall not be less than 0.6 m.
10.5.2 The subgrade of the station yard shall be designed according to the following requirements:
   • 96 •
1 The subgrade of the main line inside the station shall be the same standard as the section main line.

2 If the arrival-departure track is on the same subgrade with the main line, its subgrade shall have the same standard with the main line. Meanwhile, if the facilities including longitudinal drain trough and platform, etc. are set up between the arrival-departure track and the main line, their subgrade are allowed to be designed separately.

3 If the subgrade of arrival-departure track and the main line are set separately, the subgrade filling material and compacting criteria for arrival-departure track shall follow the standard of Class II mixed passenger and freight railway, with 0.6 m depth of upper layer of formation, 1.9 m depth of lower layer, and 2.5 m of total depth of the formation.

4 As for other tracks except the arrival-departure track, the EMU depot & workshop (depot) and comprehensive depot (maintenance point), the subgrade filling material and compacting criteria shall follow the standard of Class II railway, with 0.3 m depth of upper layer of formation, 0.9 m depth of lower layer, and 1.2 m of total depth of the formation.

5 As for the reconstruction and extension section based on existing station, strengthening measures of the main line subgrade inside the station shall be determined by the maximum passing speed of the train.

6 When building drainage ditch and platform wall in the subgrade of the high speed railway, the backfill of subgrade shall meet the compacting criteria with corresponding parts.

10.5.3 As for the top surface of formation upper layer, top surface and bottom surface of formation lower layer of arrival-departure tracks, its crossfall of water drainage shall be 4%. For upper layer of formation of other tracks, the crossfall of water drainage should be determined while taking into account the annual rainfall in each region, better not to less than 2%.

10.5.4 Setting of the discharge trough in the station and yard shall follow the requirements below:

1 The longitudinal discharge trough within the range of station platform should be set up between the arrival-departure tracks or between the arrival-departure track and the platform, or between the arrival-departure track and main line in difficult cases.

2 At the grade change point of the convave longitudinal grade for longitudinal discharge trough, the transverse discharge trough should be set up, and it should not cross with the main line.

3 The discharge trough inside the station, yard, and depot shall have cover board.

4 Width of the longitudinal discharge trough should be 0.4m at the bottom, if the depth is 1.2m above, the bottom width shall be 0.6m.

5 The quantity of tracks on a single slope should not exceed 2.

6 The drainage facilities in the station yard shall not cross with the catenary pole,
and the canopy post base. In difficult cases, the facilities may pass round them while not decreasing the drainage capacity.

7 Pipes such as water pipes and ventilation pipes shall be designed systematically to avoid intervention with the drainage facilities.

8 In ballastless turnout area, measures shall be taken to avoid standing water.

9 Other drainage facilities shall follow the requirements in Design Code for Railway Station and Terminal GB50091.

10.5.5 The gutter inside the station shall not drain off water to the side ditch of the cutting. When draining off water into the side ditch limited by the geography, chutes must be laid and the sectional dimension of downstream side ditch shall be regulated according to the gutter flow.

10.5.6 The side ditch, gutter and drainage ditch in the station shall be concreted or pre-fabricated, with the concrete grade C25 at least. In addition, the foundation, seam and seep proof design shall be done.

10.6 Interface Design

10.6.1 The posts, nets and comprehensive pipelines inside the station shall be designed systematically while taking comprehensive consideration and harmonious with the station layout.

10.6.2 Width of the interface of subgrade bed inside the station and the section subgrade shall be linked well, the subgrade protection and afforested standard inside the station shall keep harmonious with the section.

10.6.3 The cable trench between the station and the section, the subgrade and the bridge or culvert area shall be laid in accordance with the technology requirements.

10.6.4 E/M facilities like cable trench, pipeline crossing track and access holes, etc. shall be designed and constructed at the same time with the station subgrade.

10.6.5 The subgrade width inside the station shall meet the setting requirements of the cable trench and sound barrier.

10.6.6 As for the station platform surface, canopy, and stockade with metal structure shall be introduced to integrated through earth wire according to related technical specifications.

10.6.7 The interface design for drainage of the station and yard shall meet the following requirements:

1 The drainage facilities of the station & yard and the section shall be interlinked.

2 The drainage system shall be designed systematically while taking into account the bridge and culvert, railway drainage pipelines, and city drainage system as well.

3 If the drainage of the station and yard is led to the bridge or culvert, the inlet elevation shall be higher than the drainage outlet elevation of the bridge or culvert.

4 If the catenary pole and canopy post are laid between tracks where ischarge troughs
are located inside the station, the related post base shall be designed uniformly with the discharge trough.

10.6.8 The turnout layout shall meet the requirements of the transition section for the ballast and ballastless tracks, jointed and jointless tracks, and should not be set in the transition section between the subgrade and bridge (or culvert), subgrade and tunnel, or embankment and cut.

10.6.9 The passenger access shall be designed and constructed at the same time with the subgrade in station, while its position and elevation shall meet the technical requirements of pipelines such as the discharge trough and cable trench.
11 Traction Power Supply

11.1 General Requirements

11.1.1 The capacity of the traction power supply system shall be matched with the capacity of the railway to be built and its role in the railway network.

11.1.2 The traction power supply system shall be reliable, independent and complete. With the principle of ensuring reliable and safe power supply of high speed railway as well as convenient operation, the power supply system could also feed to adjacent railway line or railway terminals when conditions are available.

11.1.3 Safety of personnel and equipment shall be ensured both under normal operation and failure of the traction power supply system.

11.2 Traction Power Supply

11.2.1 The traction load belongs to Grade 1 load; there shall be two separate incoming lines that are mutually hot standby; the voltage level of power source shall be 220 kV or above; the power quality of electric system shall meet the requirements of relevant national specifications.

11.2.2 The nominal voltage of overhead contact line system (OCS) is 25 kV; its long-term maximum voltage is 27.5 kV and short-term (5 min) maximum voltage is 29 kV. The designed minimum voltage is 20 kV.

11.2.3 Traction feeding type of 2×25 kV shall be adopted for electric traction system of mainline; traction feeding type of 1×25 kV may be adopted for the liaison line in railway terminal for cross-line trains, as well as running track and depot and workshop (depot) for electric multiple unit (EMU).

11.2.4 The arrangement of traction substation shall be designed according to the marshaling scheme and headway determined by operation organization of the EMU with maximum designed speed.

11.2.5 There shall be two power sources for the EMU depot and workshop (depot) with one to be an independent power source at least.

11.2.6 Single phase connection is preferred for traction transformer; other connecting type may be adopted under difficult conditions.

11.2.7 Fixed standby mode shall be adopted for traction transformer and auto transformer (AT); under normal operation, one traction transformer is in service and the other is as standby.

11.2.8 The installation capacity of traction transformer shall be defined according to
traffic volume of the line in the fifth year after operation, and capacity condition shall be reserved according to the long-term traffic volume; the overload capability of traction transformer and AT transformer shall meet the requirements of loads in peak hours.

11.2.9 While the short-circuit impedance is selected for traction transformer, the lowering of the short-circuit current shall be taken into consideration with principle that the voltage requirement is satisfied.

11.2.10 One way feeding from the same phase is adopted for electric traction system. AT post and section switching post shall be capable of providing parallel power supply for up track and down track.

11.2.11 Verify the over-zone feeding capability of the traction substation under normal power supply arrangement as a precondition. The over-zone feeding capability shall guarantee at least that a pair of EMU is running under the designed speed at the section.

11.2.12 The long-term continuous touch voltage value shall not be higher than 60 V and its instantaneous (0.1 s) value shall not be higher than 842 V.

11.2.13 The average power factor of the primary side in traction substation shall be designed as not lower than 0.9; the effect of negative sequence and harmonics on electric system caused by the traction power supply system shall be minimized.

11.2.14 The normal maximum induction potential of 27.5 kV single core power cable shall meet the following requirements:

1. It shall not be higher than 60 V when efficient safety measures have not been taken to prevent personnel from contacting with metallic protection layer.

2. It shall not be higher than 300 V except the above mentioned situation.

11.3 Traction Substation System

11.3.1 The single line diagram at the power source side in traction substation shall be determined by taking consideration of the external power source conditions, which should use the connection mode of transformer group or branch connection. The connection at the feeder side should apply the mode that the circuit breakers of up track and down track are mutually standby, and also meet with the operation requirements of respective and parallel power supply mode between the up track and down track.

11.3.2 The up track and down track parallel feeding at the same feeding section and the over-zone feeding under abnormal operation shall be designed for single line diagram of section switching post. Circuit breaker connection mode shall be adopted for the parallel feeding of up and down track, and disconnector switching connection mode shall be adopted for the over-zone feeding.

11.3.3 The parallel feeding of up and down track for single line diagram of AT post shall be designed. The circuit breaker connection mode shall be selected.

11.3.4 No load tap changer mode shall be selected for traction transformer and its tap changer shall be under remote control and monitoring.
11.3.5 Usually, outdoor single arrangement is adopted for 220kV distribution installation. Gas insulated switchgear (GIS) is used for regions and important cities with difficult geometrical condition or heavy pollution.

GIS switch cabinet should be adopted for 27.5 kV distribution installation of high speed railway with speed equal to or exceeding 300 km/h.

11.3.6 Indoor arrangement should be applied for 220 kV GIS. The arrangement of each component shall be determined according to the requirements of installation, maintenance, testing and operation. The minimum safety clearance of outdoor live part shall meet the requirements in the current Design Code for Railway Electric Traction System TB 10009.

11.3.7 The indoor arrangement of 27.5 kV GIS shall be in accordance with the following requirements:

1 The minimum width of passage for operation and maintenance shall be in accordance with the requirements in Table 11.3.7.

<table>
<thead>
<tr>
<th>Table 11.3.7 Table of the Minimum Passage Width for Operation and Maintenance of GIS Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single row arrangement</strong></td>
</tr>
<tr>
<td>Operation passage</td>
</tr>
<tr>
<td>1.5 m</td>
</tr>
</tbody>
</table>

Notes: 1. It is allowed to reduce 0.2 m of passage width in humps on wall columns.
2. Passage width shall be no less than the maximum size of equipment plus 0.4 m for easy movement.

2 When GIS is arranged close to wall, the distance between rear of panel and the wall should be 0.05 m.

3 Cable interlayer shall be arranged for 27.5 kV high voltage room and auxiliary transformer room.

11.3.8 Comprehensive automatic system with remote terminal shall be adopted for traction substation, switching post, section switching post and AT post.

Comprehensive automatic system with remote terminal consists of local monitor and control unit, protection and testing unit, safety monitor and control unit; it should have been equipped with interface with other intelligent equipment such as DC & AC system monitor and control unit to realize remote monitor and control via remote control channel.

11.3.9 The unmanned mode shall be designed for traction substation, switching post, section switching post and AT post. Additionally the manned mode shall be considered for traction substation.

11.3.10 The configuration of relay protection shall be in accordance with the following requirements:

1 No-voltage protection shall be set for power source incoming line in traction substation; differential protection, overload protection, over-current protection with low voltage start up, gas protection and oil temperature protection shall be set for traction substation; the protection of impedance, over-current and current increment shall be set for feeder.

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The protection of no-voltage, impedance, over-current and current increment shall be set for section switching post.

No-voltage protection shall be arranged for the feeder in AT post.

The protection of differential, overload, over-current, gas and oil temperature shall be set for auto-transformer.

11.3.11 The configuration of automatic installation shall be in accordance with the following requirements:

1. Automatic switching in devices is set for the power source incoming lines that are mutually standby in traction substation and switching post.
2. Automatic switching in device is set for traction transformers and auto-transformers that are mutually standby.
3. Single shot auto-reclosing device is set for the feeder in traction substation.
4. Voltage inspection and reclosing device is set for section switching post and AT post.
5. Fault location device is arranged for the feeder in traction substation.

11.3.12 The earthing device shall be set in accordance with the following requirements:

1. Grid type earthing device of electrical equipment with the horizontal earthing body as the major part shall be set for traction substation, switching post, section switching post and AT post, the earthing device shall be integrated into comprehensive earthing system.
2. Outdoor centralized earthing & current return box shall be set for traction substation, switching post, section switching post and AT post with indoor earthing bus bar. The earthing & current return bus bar in box and indoor earthing bus bar shall be connected to earthing devices in the substation and posts separately.

3. The earthing body of outdoor earthing device shall be made of copper material.

11.3.13 The current return device shall be set in accordance with the following requirements:

1. Current return conductor shall be set for traction substation, section switching post and AT post and shall be connected to the current return wire of overhead contact line system and the middle point of the signal choke coil.
2. Cable or bare conductor may be adopted as current return conductor.

11.3.14 The selection of 27.5 kV specific cable shall be executed in accordance with the following requirements:

1. AC, single core and cross-linked polyethylene insulation cable with copper conductor shall be adopted.
2. Non-magnetic metal armor sheath shall be adopted for outer sheath.
3. \( n + 1 \) standby mode should be adopted for the cable of each circuit of 27.5 kV feeder in traction substation.

11.3.15 27.5 kV specific cable laying shall be executed in accordance with the following requirements:

1. 27.5 kV specific cable in substation and from substation to railway subgrade or to
bridge should be laid in cable trench. 27.5 kV specific cables of different circuits shall be arranged on different layers of the rack.

2 27.5 kV specific cable and control cable should be laid in different trenches or on different layers of the same trench. Up track and down track 27.5 kV specific cables from substation to subgrade or bridge should be laid in different trenches; while up track and down track 27.5 kV specific cables from section switching post or AT post to subgrade or bridge may be laid in the same trench.

3 When a part of 27.5 kV specific cable is laid horizontally on bridge or subgrade, it may be laid in the same trench together with the power cable; but isolation measures shall be taken.

4 When 27.5 kV specific cable is laid in tunnel, cable bracket shall be set along the tunnel wall or cable pipe passing through the wall shall be set. The cable bracket shall be set in accordance with the requirements of fire proof, moisture proof and anti-corrosion.

11.3.16 The earthing mode of the metallic sheath of 27.5 kV specific cable shall be in accordance with the following requirements:

1 When the cable route is not long, the mode of single point direct earthing should be adopted; when the cable route is long, the cable shall be divided properly into segments, and insulation isolation shall be conducted for cable metal sheath of each segment so as to realize the single point direct earthing.

2 When the mode of single point direct earthing is adopted, sheath-voltage limiter shall be arranged at the other end.

11.3.17 The selection and arrangement of the cable terminal of 27.5 kV specific cable shall be conducted in accordance with the following requirements:

1 When cable is connected to conductor, prefabricated cable terminal should be selected, and its mechanical strength shall be able to meet the requirements of tension of the lead wire, wind force and earthquake at the installation point.

2 When connection is made between cable and electrical equipment that have integrated plug in function, separable(plug in)cable terminal shall be selected.

11.3.18 On line temperature supervision system shall be set for 27.5 kV specific cable in traction substation and switching post, and shall be able to realize remote monitoring.

11.3.19 When the power sources of motorized operation mechanisms of disconnectors (load switches)of overhead contact line system are provided by traction substation, section switching post, switching post or AT post, then surge protection device(SPD)shall be set for the power source cable in substation.

11.4 Power Supply Dispatching System

11.4.1 Power supply dispatching system shall be set for high speed railway. As independent subsystem of operation dispatching system, its design shall be executed in accordance with the general layout of railway informatization and meet the requirements of railway operation.
transportation with full consideration of the system function and the link with relative systems such as operation or dispatching system as well as the share of information.

11.4.2 Power supply dispatching system consists of remote control system and power supply maintenance management subsystem. Specific information processing platform should be established for each subsystem. Railway data communication network should be adopted as communication carrying platform between subsystems. The integrated dispatching mode for electric traction system and power system shall be adopted for remote control system.

11.4.3 Remote control system consists of the control station in dispatching post, the controlled stations in traction substation, switching post, section switching post, AT post, OCS switch control stations, substation, power distribution station and switching station as well as indication equipment and transmission channels. One to n centralized supervision and control mode should be selected as the structure mode of remote control system. For the comparably large scale remote control system, its information channels should be divided in layers or in groups.

The monitored and controlled objects include tele-control (tele-regulating), tele-signaling and tele-metering. The exact monitored and controlled objects shall meet the operation requirements.

11.4.4 Traction power supply maintenance management system consists of the maintenance management master station and the terminal unit located in maintenance base, the terminal unit and channels in the comprehensive maintenance workshop and the work section. One computerized maintenance management system is formed according to the mode of design in layers and management in levels.

11.5 **Overhead Contact Line System** (abbreviated as OCS)

11.5.1 The major basic data of OCS shall be in accordance with the following requirements;

1. The meteorological conditions such as temperature and ice coating for OCS design shall be determined according to the current national standard *Standard of Climate Regionalization for Architecture* GB 50178 and the records of the meteorological information of the region along the line for last 25 years or over. The maximum temperature variation range of 100 K shall be taken for OCS normal operation.

2. The operation basic wind speed shall be determined according to normal operation wind speed. When there is no specific information, the basic operation wind speed shall be determined according to current *Code for Design of Traction Power Supply* TB 10009. The structural basic wind speed shall be calculated and determined by the basic wind pressure in a period of 50 years according to the current national standard *Code for Design of Building Structural Load* GB 50009. When calculating the operation design wind speed and structural design wind speed, the corresponding wind speed shall be modified according to the region, topography and altitude; and the main structure of OCS shall not be
damaged under the structural design wind speed. For the structure inside tunnel, the effect of aerodynamic force caused by the train operation shall be taken into consideration.

3 The selection and classification of pollution grade shall be determined under consideration of the geography environment with combination of the specific working conditions. The creepage distance for 25 kV insulators shall be no less than 1 400 mm.

4 OCS design shall be executed in accordance with the requirements for locomotive clearance and the dynamic envelope of pantograph.

5 The suspension mode of OCS should match with the operation of single pantograph, double pantograph, multi pantograph in terms of their corresponding positions and intervals on the top of EMU.

6 The designed service lifespan of OCS shall be no less than 30 years. The service lifespan of contact wire shall be determined by its wearing or shall withstand no less than 2 million passages of pantograph.

7 OCS shall comply with the requirements of reliability and safety in natural environment with sufficient mechanical, electrical strength and safety performance.

11.5.2 The simulation evaluation of the dynamic performance matching between contact wire and pantograph shall be carried out for the system design of high speed OCS. When the multi pantographs are uplifted and operated, then the simulation evaluation of the current collection for each pantograph shall be made. The evaluation standard shall be in accordance with the following requirements:

1 The dynamic contact force shall be in accordance with the requirements in Table 11.5.2.

<table>
<thead>
<tr>
<th>Speed(km/h)</th>
<th>250</th>
<th>300</th>
<th>350</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average contact force $F_m$ (N)</td>
<td>$\leq 130$</td>
<td>$\leq 150$</td>
<td>$\leq 180$</td>
</tr>
<tr>
<td>The maximum force $F_{max}$ (N)</td>
<td>$\leq 250$</td>
<td>$\leq 250$</td>
<td>$\leq 350$</td>
</tr>
<tr>
<td>The minimum force $F_{min}$ (N)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2 The dewire rate in simulation calculation shall not be higher than 1%.

3 The ratio of the maximum design speed to the wave propagation speed of contact wire shall not be bigger than 0.7.

4 The elastic ununiformity of overhead contact line with stitch catenary suspension shall not be higher than 10%; that of the overhead contact line with simple catenary suspension should not be higher than 40% when the speed is 250 km/h or 300 k/h, and that should not be higher than 25% when the speed is 350 km/h.

5 The lateral sway of dynamic envelope of pantograph and the maximum dynamic uplift should be determined according to the simulation data of interaction between OCS and pantograph or the operation measuring data of at least 10 years, the lateral sway of dynamic envelope of pantograph should be designed as 250 mm in straight section while 350 mm in curve section. The maximum dynamic uplift shall not be less than 150 mm.
11.5.3 The system design of OCS shall be executed in accordance with the following requirements:

1) The suspension mode of OCS shall be simple catenary suspension with auto tensioning devices for both contact wire and messenger wire or shall be stitch catenary suspension with auto tensioning devices for both contact wire and messenger wire. The stitch catenary suspension should be adopted for current collection of double pantograph or multiple pantograph.

2) The contact wire and messenger wire shall be made of copper alloy material. The contact wire for the designed speed of 300 ~ 350 km/h shall be made of copper alloy material with high tensile strength.

3) The nominal working tension force of contact wire and messenger wire shall be determined in accordance with the following specifications:

1) The nominal working tension force of contact wire and messenger wire shall be determined in accordance with the safety requirements of the allowed working tensile stress.

2) The nominal working tension force of contact wire shall be determined in accordance with the requirements for wave propagation speed and shall be determined after system simulation evaluation. The safety coefficient shall not be less than 2.0. After taking into consideration of reduction coefficient caused by the factors such as allowed working temperature of contact wire and messenger wire, the maximum wear of contact wire, wind load, ice load, the precision of tensioning device, the allowed working tensile stress of contact wire and messenger wire shall be no higher than 65% of their tensile strength or breaking force.

3) When designed speed is 250 km/h or 300 km/h, the cross section of contact wire and messenger wire and their working tensions shall be determined after the traction power supply calculation and the simulation calculation for the interaction between contact wire and pantograph according to actual operation condition. Normally when copper alloy contact wire with cross section of 150 mm² is selected, the rated working tension shall be no less than 25 kN; while the copper alloy contact wire with cross section of 120 mm² is selected, it shall be no less than 15 kN.

4) When the designed speed is 350 km/h, the rated working tension of 150 mm² contact wire with copper alloy shall not be less than 28.5 kN.

4 The nominal contact wire height should not be less than 5 300 mm. The minimum height of contact wire at the lowest point should not be less than 5 150 mm. Except in overlap section, the designed gradient of contact wire shall be 0 for speed higher than 250 km/h, the designed gradient of contact wire shall be 0.1% and the gradient variation rate should not be higher than 0.05% with speed of 250 km/h.

5 The system height should be 1.6 m. Under special situations, the shortest dropper length should be no less than 600 mm, the system height should be no less than 1.1 m in
the section with speed of 300～350 km/h while the shortest dropper length should not be less than 500 mm in the section with speed of 250 km/h.

6 The span length should be determined after the system simulation evaluation and should be selected according to Table 11.5.3–1.

<table>
<thead>
<tr>
<th>Table 11.5.3–1  The selection of span length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design speed</td>
</tr>
<tr>
<td>Simple careenary suspension</td>
</tr>
<tr>
<td>Nominal span length (m)</td>
</tr>
<tr>
<td>Maximum span length (m)</td>
</tr>
<tr>
<td>Stitch cetenary suspension</td>
</tr>
<tr>
<td>Standard span length (m)</td>
</tr>
<tr>
<td>Maximum span length (m)</td>
</tr>
</tbody>
</table>

7 The air insulation gap shall be in accordance with the specifications in Table 11.5.3–2.

<table>
<thead>
<tr>
<th>Table 11.5.3–2  Air insulation gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item no.</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>5</td>
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8 The initial contact zone above the turnout or overlap shall be a special area composed of a distance of 600～1 050 mm away from the center of pantograph and an uplift of 150 mm (200 mm for speed of 300 km/h or above).

9 The landscape design with coordination between OCS and overall system in high speed railway station and natural scenic spot should be carried out in consideration of humanity and regional features and based on the key factors i.e. balance, shape, form, color and sport.

1) Single type cantilever should be selected for OCS masts on mainline. Some schemes such as masts between tracks, masts shared with those of rain shed, or drop tubes in elevated station house should be adopted for station platform area. Masts shall be avoided in the platform area in station without rain shed. Light weight portal structure may be selected for throat areas.
2) Cantilever mast should be visual light weight type such as H mast. Steel reinforced concrete equi-diameter round poles are normally selected for the multi-track open section with speed of 250 km/h; hot-dipped galvanized and hot rolled H type mast are selected on bridges or between tracks in stations. Hot-dipped galvanized and hot rolled H type masts are normally used as cantilever mast for the line with speed of 300 or 350 km/h. The diameter of the round pole of equi-diameter shall not be bigger than 350 mm; the width of H type steel mast vertical to the line shall not be bigger than 300 mm.

3) The heights above rail top of OCS mast in section should be identical. Normally, the distance between the top of mast and the exposed end of upper bracket of contact suspension shall not be higher than 300 mm.

4) The cantilever structure and insulators should be low-purity color tone and be harmonic with the background landscape.

10 OCS design shall be executed in accordance with the requirements of reliability, availability, maintainability and safety. The reliable system distribution design shall be carried out to determine the reasonable, controllable and quantifiable reliability index of each part.

11 Lightning protection measures shall be taken, such as adding of zinc oxide surge arrester at important areas with heavily pollution or high thundering and with high subgrade, viaduct as well as entrance of tunnel, adoption of composite rod type insulators for OCS anchoring and section insulator. The earthing devices, earthing lead wires, connection wires, or connection measures shall be in accordance with the requirements of system insulation matching, thermal stability verification, mechanical strength and anti-corrosion.

11.5.4 The selection of major parts and components of OCS shall be executed in accordance with the following requirements:

1 Bolts or pins shall be used for connection between main strength withstanding parts and their structures, and loosening proof measures such as use of stop washers shall be taken.

2 Porcelain rod type insulator with bending resistance strength of 12 kN and above shall be used for cantilever. The insulator with bending resistance strength of 16kN shall be selected when speed is 300 or 350 km/h. Composite rod type insulators shall be adopted for anchoring device and section insulators.

3 The current carrying and integrated type dropper shall be used. Copper alloy stranded wire JTMH35 shall be selected for elastic stitch wire. Non-bolt type clamp shall be used as contact wire electrical connection clamp.

4 Swivel straight cantilever structure with high anti-corrosion shall be selected. Aluminum alloy steady arm with limitation and with equi-potential connection should be selected for mainline. The registration device should be adopted with wind stay support
and wind stay wire.

5 Section insulator with arc distinguishing function shall be used.

6 Proven and reliable ratchet or wheel pulley set shall be selected as tensioning compensation equipment on mainline. The transmission efficiency shall not be less than 97% and the transmission ratio should be 1 : 3. Iron balance weight is selected. Midpoint anchor on mainline shall adopt anti-breaking structure.

7 The foundations of mast, anchor mast, back stay wire shall be pre-embedded during civil construction. Pre-embedded structures shall be adopted for foundations in tunnel which are safe, reliable, able to withstand dynamic load, fire-proof, economic and easily adjustable.

11.5.5 The design of OCS feeding sections shall be executed in accordance with the following requirements:

1 The OCS feeding sections shall be in accordance with the maintenance conditions of the maintenance window and with the bi-directional operation and emergency repair. Overlap and electric disconnectors shall be set at both ends of stations and the entrance of long and wide tunnels.

2 Sectioning device shall be at least 500 m away from the home signal or be determined by the operation check and calculation, and its setting at gradient transition point, big current and acceleration sections shall be avoided. It should be installed at the section with gradient of 6% or lower.

3 Insulated overlap with neutral section shall be selected for sectioning device. Motorized load switches shall be used in neutral section and shall be connected with the onward side of OCS.

4 Feeders shall be aerial. Cables may be used as feeders in difficult section or at the point connecting to OCS. The switches connecting with OCS shall be of electrical type.

5 Section feeding and branch feeding shall be provided for OCS in large scale passenger stations according to the requirements of operation organization, the operation maintenance and the platform arrangement. It shall also be in accordance with the separate power cut maintenance requirements for basic platforms. When there is traction substation or switching post at the passenger station, separate feeders shall be set for branch feeding of OCS. Electric disconnector shall be set for branch feeding and it shall be integrated into the remote control system.

11.5.6 The layout of OCS shall be conducted in accordance with the following requirements:

1 For the contact wire at mainline, the wind deflection to the center of pantograph should not be larger than 450 mm, or shall not be larger than 500 mm within straight line section in difficult areas.

2 The difference between adjacent spans shall not be bigger than 10 m.

3 The tensioning length of mainline OCS should not be larger than 2×700 mm and shall not be larger than 2×700 mm in tunnel.
4 Overlap should be 5 or 4 span type. It should be 5 spans when the speed is 300 or 350 km/h.

5 OCS above the turnout on mainline should be non-crossing positioning type. For the turnouts area above the sideline with passing speed of 120 km/h, non-crossing positioning type with auxiliary suspension OCS may be used.

6 The variation of angle between contact wire and track at the suspension point should not be larger than 4°.

11.5.7 The installation design of OCS shall be conducted in accordance with the following requirements:

1 Any OCS equipment shall not be installed within the kinematic envelope of the pantograph.

2 Safety verification shall be carried out for the installation design at suspension point according to the requirement of no less than 1.5 times of the maximum dynamic uplift, and shall be no less than 2 times of the maximum dynamic uplift when limitation device does not work.

3 No any other clamp, equipment or component shall be installed except dropper clamps within initial contact area.

4 The side clearance from the inner side of mast to the center of rails on mainline shall not be less than 3.0 m for ballastless track, and shall not be less than 3.1 m for ballasted track. Within straight line section in station with difficult conditions, it shall not be less than 2.5 m.

11.5.8 The structural design of OCS shall be executed in accordance with the following requirements:

1 Load analysis shall be carried out for the structural design of OCS according to the current national standard Load Code for the Design of Building Structures GB50009. It shall be in accordance with the designed system life span requirement.

2 The consideration shall be given to the effects of permanent load, variable load and occasional load during the structural design of OCS, and it shall comply with the requirements of load effect combination under normal operation limit state and the load withstanding ability limit.

3 The consideration shall be given to the soil bearing capability and the underground water float. The consideration of support structural deflection and slope shall also be given to the clearance design of foundations and masts. The deflection of the mast at the suspension point of contact wire shall not be larger than 25 mm under variable load imposed under the designed wind speed.

4 The load partial coefficient of OCS structure design shall be selected according to the following parameters:

1) The load partial coefficient of permanent load(γG) is 1.35, when load is favorable to the structure, it may be 1.0;
2) The load partial coefficient of variable load (\( \gamma Q \)) is 1.4.

11.5.9 The current return and earthing design shall be in accordance with the following requirements:

1 The OCS earthing shall be integrated into the comprehensive earthing system that will lower the rail potential and thus guarantee the safety of personnel.

2 The traction network shall be designed as the parallel passage of rail return current. Current return wire or protection wire may be used as the flashover protection earthing compatibly.

3 The track crossing and parallel shall be arranged according to the calculated distance for current return wires or protection wires of up track and down track; they shall be connected to the comprehensive earthing system. Current return wires or protection wires shall be connected to the rails through the midpoints of choke coils. The interval of connecting to the adjacent choke coil should not be larger than 1,500 m, they shall be integrated into comprehensive earthing system. Traction power supply system will provide coordination for the signaling system on the verification and calculation of specific connection points and intervals.

4 For platforms with comparatively more passengers, comprehensive earthing measures to ensure the safety of passengers shall be taken.

11.5.10 The consideration shall be given to the requirements of error control on OCS design parameters which are subject to the influence of the construction and maintenance according relative standards.

11.6 Electro-magnetic Interference Prevention

11.6.1 The calculation methods and the allowed values of the hazard effects or noise interference of traction power supply system on wire communication installations shall be in accordance with the requirements in related national or industry standards. Meanwhile, the characteristics of harmonic caused by EMU shall be considered during the calculation of noise interference.

11.6.2 The clearance, yard, distance and signal-to-noise ratio of high speed railway to radio stations such as TV transposer station, AM receiving stations, wave message receiving station, ultra-short wave message receiving station, airport navigation station, orientation device, anti aircraft radar station, short wave radio direction survey set, and earthquake station shall be in accordance with the specifications in corresponding national and industry standards. The electro-magnetic radiation strengths with different operation speeds shall be comprehensively taken into consideration during calculation and analysis.

11.6.3 The electro-magnetic radiation of traction power supply system on oil and gas pipe, the safety distance between high speed railway and warehouses of combustible and explosive materials such as oil and gas shall be in accordance with the specifications in corresponding national standards.
11.6.4 When calculating and analyzing the effect of the electro-magnetic interference, the shielding effect of viaduct and city environment shall be taken into consideration.

11.6.5 When arranging the electro-magnetic interference prevention measures, operation safety shall not be affected, and the original function and performance of system shall not be changed or degraded.

11.6.6 During selection of line scheme, the requirements for the index of distance protection shall be satisfied once important radio station or national defense installation is encountered; for stations which are not avoidable to be encountered, the measures of overall or partial move, receiving antenna modification, message receiving ability improvement or laying conductor array may be taken after technical and economic comparison.

11.7 Interface Design

11.7.1 Interface design of traction power supply system shall be executed in accordance with the following requirements:

Information such as traction load, the installation capacity of traction transformer, annual power consumption shall be provided to national electricity department so as for his completion of introduction system proposal of traction power supply system. The national electricity department shall provide the relative railway sector the interface information of system short circuit capacity inducted to the primary side of traction substation so as to complete the calculation of protection setting.

11.7.2 The interface design for the traction substation shall be executed in accordance with the following requirements:

1. Traction substation system shall provide coordination to communication system for the interface design of communication houses in traction substation, switching post, section switching post and AT post.

2. Traction substation system shall provide coordination for house building system for the interface design of equipment houses, yard, access road, equipment foundation brace and cable layer, trench, pipe and hole in traction substation, switching post, section switching post and AT post.

3. Traction substation system shall provide design requirement for the channel of power supply dispatching system including the performance requirements for its structure composition, arrangement mode of major and standby channel, interface mode with information transmission channel.

11.7.3 Interface design between OCS and other system shall be executed in accordance with the following specifications:

1. OCS system shall provide coordination with bridge system for the completion of foundation reservation of masts and anchor stay wires, the arrangement and pre-embedding of comprehensive earthing of bridge (part of electric power and traction power supply), as well as the clearance requirements for the building crossing over the track and the interface
design of OCS special bridge mast, the reservation of trench, duct, pipe and hole.

2 OCS system shall coordinate with tunnel system to complete the interface design of OCS installation pre-embedded parts and their arrangement, setting and reservation of comprehensive earthing (electric power and traction power) inside of tunnel, overlap section and overlap section cave inside of tunnel, anchoring cave and reservation, cave reservation for OCS equipment installation and the reservation of trench, duct, pipe and hole.

3 OCS system shall coordinate with earth structure and structure system for the interface design of influence such as OCS reserved foundations on track, relation coordination between location and dimension of reserved foundation and cable trench and duct, OCS reserved foundation and its plane layout, reservation of trench, duct, pipe and cave, setting and pre-burying on subgrade of the comprehensive earthing system.

4 OCS system shall coordinate with station, yard and house building system to complete the interface design such as the requirements of OCS mast for line spacing, reserved foundation and its plane arrangement, support shared with the rain shed of the platform, setting and pre-embedding of the comprehensive earthing system of elevated station house (electric power and traction power supply), convergent transition line between OCS and station during reverse running of train, and the single transition line setting.

5 Structure system shall be responsible for the completion of interface design of OCS special portal structure, drop tube and mast, the pre-embedding parts of the buildings under the track, OCS mast foundation and stay wire foundation.

6 OCS system shall provide coordination for the completion of the interface design of flashover protection equi-potential of building structures i.e. bridge, earth structure, track crossing structure, ballastless track, station house, platform, rain shed, and OCS reserved foundation along the lines. They shall also coordinate with the earthing system for the interface design of the integration of traction power supply system into comprehensive earthing.

7 OCS system shall coordinate with EMU depot for the interface design of the confirmation of type and size of pantograph of locomotive, the number and the interval of pantograph, the specific allocation of the pantograph and the OCS operation inside depot.

8 OCS system shall coordinate with signaling system for the confirmation of the design of requirements of the OCS overlap positions for the signal arrangement, receiving device of sectioning device, train control information arrangement, as well as the current return connection of rail.

9 OCS system shall coordinate with comprehensive maintenance system to confirm the interface design such as the arrangement of comprehensive maintenance department, the position of comprehensive maintenance window and mode of application.

10 OCS system shall coordinate with disaster prevention and monitor system for the completion of the interface design of disaster prevention and diminishing measures.
integrated erection of disaster prevention and monitor facilities and OCS; OCS system shall coordinate with systems i.e. communication system to complete the interface design of the integrated erection of the leakage cables and OCS; and the completion of the interface design of integrated erection of the precise measuring equipment and OCS.

11 OCS system shall define the error control requirements during the interface design coordination with other systems so that rational construction techniques will be applied conveniently in the system interface design.
12 Electric Power

12.1 General Requirements

12.1.1 Electric power design shall guarantee the reliability, availability, maintainability and safety of the high speed railway power supply. With satisfaction of reliable power supply and convenience of the operation and management, the high speed railway lines may share power supply facilities with adjacent lines.

12.1.2 High speed railway power supply and distribution system shall be mainly composed of external power sources, substations and power distribution substations, two-circuit high-voltage power run-through lines along railway, power supply lines of station and yard.

12.1.3 High speed railway power supply and distribution system shall guarantee the mutual matching between each level of power supply and distribution systems, except the occurrence of the force majeure, its reliability shall meet the requirements of 24 h transport (including the maintenance window time) and power supply in different grades of loads.

12.2 Power Supply and Power Distribution System

12.2.1 Electric loads shall be classified into Grade 1, 2 and 3 in accordance with the requirements on power supply reliability and the degrees of loss or influence of the interruption of power supply on politics, economies and railway transportation, among which:

Grade 1 load shall include; communication, signaling, information, disaster prevention and safety supervision equipment which have close relations with train operation; EMU depot and workshop (depot) operation equipment; all operating power sources in substations and posts of electric power and traction power supply systems; public area lighting at large and extra large-scale stations, emergency lighting and tunnel emergency lighting; fire automatic alarming equipment of large-scale and important buildings; fire fighting equipment of extra-long tunnel etc.

Grade 2 load shall mainly include; air-conditioning dedicated for main equipment of communication and signaling; remote controlled disconnector power sources of overhead contact line system (OCS); inspection and repair equipment for electric multiple units (EMU); equipment for comprehensive inspection and repair, track maintenance engineering machinery, comprehensive maintenance, water supply and drainage etc.; public area lighting of intermediate station; video supervision equipment of railway sections; turnout snow melting equipment; and other loads except for Grade 1.

Load grades for other electricity consumption equipment shall comply with the
requirements in the current *Railway Electric Power Design Specifications* TB 10008 and in other relative regulations and specifications.

12. 2. 2 Grade 1 load shall be fed respectively by two independent power sources to the electric equipment or to the switching device of the low-voltage dual power sources, once one of the power sources fails, the other one shall not be damaged simultaneously.

12. 2. 3 Reliable external power source connected to the public grid shall be preferred for high speed railway power supply source, and after comprehensive technical and economical comparison and selection, it may share a common power source with the traction substation.

12. 2. 4 EMU depot and workshop( depot) shall be fed by two mutually independent and reliable external power sources.

12. 2. 5 Station with substation or power distribution substation shall be designed with two mutually independent and reliable external power sources; the quantity of power sources for station without substation or power distribution substation shall be determined in accordance with the load characteristics and capacity, technical, economical comparison and selection of power supply capability of external power sources and power run-through lines.

12. 2. 6 Grade 1 load related to train running such as communication and signaling for station and section shall be fed by two mutually independent power sources via electric power with Grade 1 load and compound load run-through line, the high voltage connection mode should be of loop net wiring and should be set with an independent substation; when power supply capacity is sufficient, the run-through line is allowed to feed other loads which have difficulties to get the external power sources.

12. 2. 7 The extra large-scale passenger station shall be equipped with emergency standby generator set.

12. 2. 8 Reactive power compensation for high speed railway power supply and power distribution system shall be made mainly in centralized compensation mode at the low voltage side with assistance in high voltage compensation mode. The power factor at transformer high voltage side during user’s peak time of load after compensation shall not be less than 0.90; induction reactive power compensation devices shall be equipped depending on the length of cables for the high voltage power run-through lines which are mainly composed of cables.

12. 2. 9 As for 10kV power run-through line fed by regulating transformer, earthing of the system neutral point shall be determined by taking consideration of power supply reliability, track alignment, equipment insulation degree, relay protection rules and anti-interference requirements of communication and signaling, and shall comply with the following requirements:

1 When single-phase earthing fault capacitive current of the system is no more than 30 A, the neutral point may adopt the non-earthing system, the fault capacitive current is
compensated by the reactor which is earthed in neutral point.

2 When single-phase earthing fault capacitive current of the system is no more than 150 A, low resistance earthing or arc distinguishing coil earthing may be adopted; when the system capacitive current is more than 150 A, low resistance earthing should be adopted.

3 Low resistance earthing mode should be adopted for full cable lines.

4 Earth fault instantaneous tripping mode, with single phase earthing current 200~400 A, should be selected for the earthing resistance of the low resistance earthing.

12.2.10 When neutral point of power run-through line system is earthed via arc distinguishing coil, the earth transformer should be adopted to form the neutral point; as the power run-through line neutral point is earthed via the low resistance, low resistance earthing mode may be adopted by means of low resistance earthing at secondary neutral point of regulating transformer; the connection mode of non-earthing at the neutral point should be adopted for the reactor used for reactive compensation.

12.3 Substation and Power Distribution Substation

12.3.1 Electric power substation and power distribution substation should be built at the same site with the traction substation after technical and economical comparison.

12.3.2 Single bus bar wiring in sections shall be adopted for 10(6) kV substation and power distribution substation with two power sources, substation and power distribution substation feeding to 10(6)kV run-through line in sections shall be equipped with load tap changer and special bus bar sections.

12.3.3 Maintenance free or less maintenance equipment should be adopted for substation and distribution substation. Outdoor equipment should be adopted for 110kV substation, and indoor gas insulated power distribution equipment (GIS) should be used when equipment installation space is limited; a whole set of indoor power distribution equipment should be adopted for 35(10)kV substation(distribution substation).

12.3.4 Under the circumstance that the capacitance of unit set dry type transformer is less than 1000 kVA, and that of unit set oil immersed transformer is less than 800 kVA, the load switch-fuse gas insulated switchgear may be used for protection.

12.3.5 Compact substation should be used at the place with less outgoing circuits, or at the place where indoor substation is impossible to be built up due to the limited space.

12.3.6 Design of combined substation shall comply with the following requirements:

1 A set of compact substation should be equipped with a set of transformer; when a compact substation is equipped with 2 sets of transformers, failure of one of them must not interfere with the power supply of the other one.

2 The basic ground elevation of the compact substation must not be lower than indoor floor elevation of the room where the equipment is fed by it, and the basic elevation of its foundation ventilation opening must not be lower than that of outdoor floor.
12.4 Electric Power Lines

12.4.1 The copper core cable lines should be adopted for high voltage electric power run-through lines and electric power lines in station and yard; single core cables should be adopted for the full cable electric power run-through lines.

12.4.2 As for the effective cross section area of metal shielding layer of electric cable, its temperature rise shall not be higher than average value of maximum temperature allowance for insulation and short circuit of outer shielding layer sheath.

12.4.3 Non-magnetic metal armor sheath shall be adopted for AC system single core cable, the steel cables without effective non-magnetic treatment must not be used. When single piece of AC single phase cable is passing through the pipe, the steel pipe without magnetic flux isolation must not be used.

12.4.4 AC single core electric power cable should be laid in upside-down "vee" shaped form or in mode of full transposition of three phase.

12.4.5 Single point direct earthing mode at one end or center of the line should be adopted for the cable metal sheath of 10 kV power run-through line, the continuous length of the cable metal sheath should not be longer than 3 km, and the maximum value of normal inductive voltage of any point at metal sheath of the cable line shall comply with the following requirements:

1. It must not be more than 60 V when safety measures are not taken effectively to prevent personnel from touching the metal sheath.

2. Except the situation above-mentioned, it must not be greater than 300 V.

12.4.6 Minimum width of the cable duct of 10 kV power run-through line should not be less than 200 mm. When electric power cables of the 10 kV power run-through line are laid together with communication and signaling cables, the objects shall be set for physical separation between them.

12.4.7 In the situation of laying of cables along the electric power cable troughs in the long and extra long tunnel, fire-retardant materials should be used, or fire prevention measures should be taken.

12.5 Electric Power Remote Control

12.5.1 Electric power remote control, as a part of railway power supply control system, shall have the main functions of remote control, telemetry, telecommunication and control over railway power supply equipment.

12.5.2 Electric power remote control shall be able to supervise and manage the HV electric equipment, AC and DC operating power sources of substation and distribution substation as well as the HV and LV electric equipment of substation which are closely related to train operation.

12.5.3 The design of electric power remote control shall comply with the provisions in
the current Standard of Design of Railway Power Supply Control System TB 10117.

12.6 Building Automation System (BAS) and automatic Fire Alarm System (FAS)

12.6.1 Important buildings like stations, depots (posts) and super-long tunnels shall be equipped with building automation system (shortened as BAS).

12.6.2 BAS is mainly composed of monitoring host, field monitor, field apparatus and communication network. The monitoring host of BAS in tunnel should be located at comprehensive maintenance depot or workshop.

12.6.3 Equipment monitored by BAS should include air-conditioner and ventilation, water supply and drainage, elevators and escalators, electric lighting and power transformation and distribution equipment in 10(6)/0.4 kV substation. The design of BAS shall comply with the provisions of the current national standard; Standard for Design of Intelligent Building GB/T 50314.

12.6.4 Buildings like stations, depots (posts) shall be equipped with automatic fire alarm system (shortened as FAS) in accordance with the current Code for Design of Automatic Fire Alarm System GB 50116 and related design specifications of fire prevention.

12.6.5 When the equipment shared by both smoke exhauster and the normal ventilation system is monitored and controlled by BAS, reliable communication interface shall be adopted between FAS and BAS. FAS gives instructions on the fire situations, BAS carries out corresponding procedures; the reliability of BAS communication network and power supply shall be guaranteed when fire occurs.

12.7 Lighting

12.7.1 Lighting design at station shall comply with the following provisions:

1 Design of the lighting shall comply with the main technical parameters of illuminance, evenness, restriction of glaring, color rendering, and power density etc., and shall match the general planning of the buildings, building styles, indoor decoration, natural lighting and local historical cultures.

2 Landscape lighting should be used for large-scale and extra large-scale station and yard; arrangement of landscape lighting for the medium and small size station and yard may be determined depending on the conditions of the size of the city, construction investment, etc.

3 High efficient and energy saving light sources such as metal halogenide lamps etc. should be adopted for places of high clearance like waiting room, ticketing hall, entrance hall and rain shed; the fluorescent of three base color and small diameter straight tube or compact fluorescent should be adopted for places with low clearance; LED should be preferred for the light source of the indication lamps.

4 Minimum illuminance on the floor under evacuation lighting shall not be lower than the following parameters:

- 120 -
1) 0.5 lx for evacuation passages;
2) 1.0 lx for entrance hall, waiting room, ticketing hall, transfer hall with lots of passengers;
3) 5.0 lx for stair cases.

5 Horizontal illuminance of standby lighting of ordinary places shall not be less than 10% of illuminance of normal lighting; the illuminance of standby lighting for emergency commanding, facilities and places like integrated control room and fire fighting control room of the stations, ticketing halls and power distribution rooms of large or extra-large-scale station, water pump rooms for fire fighting and exhauster rooms at medium and large-scale stations shall not be less than 50% of that of normal lighting.

6 Comprehensive considerations on energy saving shall be given to the lighting design, natural lighting shall be fully used during daytime; the direct lighting should be preferred for general places; the lights of large area places like waiting rooms, ticketing halls, entrance halls and rain sheds shall be grouped for control; intelligent lighting system should be adopted for large-scale or extra large-scale stations.

7 Protection level for lamp housings at baggage claim hall and baggage storage shall not be lower than Grade GB 4208 IP2X of national standard; Protection Grade of Lamp Housing (IP code).

8 Installation positions and installation modes of lamps and related equipment shall meet the requirements of operation and maintenance.

12.7.2 Lighting in tunnel is divided into fixed examining and repair lighting and emergency lighting, its arrangement shall comply with the following provisions:
1) Tunnels longer than 500 m shall be equipped with fixed examining and repair lighting.
2) Tunnels longer than 5 km or with emergency exit shall be equipped with emergency lighting.
3) Emergency lighting shall be installed at emergency exit and along its passage; the minimum luminance on the floor of evacuation passage shall not be less than 0.5 lx; the evacuation lighting signs should be installed on the wall less than 1m above the floor at the interval not longer than 30 m.
4) Lighting lamps and distribution circuits shall be moisture-proof, wind pressure-proof, corrosion-proof and vibration-proof; the protection level of lamp housing should not be lower than IP65 level specified in National Standard of Protection Grade of Lamp Housing GB 4208.
5) Lighting source which is able to be ignited quickly shall be preferred for the emergency lighting.
6) Duration of the continuous power supply by the standby power source shall not be less than 2.0 h.

7) Power supply to the emergency lighting in tunnel shall be provided by two
mutually independent power sources via power run-through line; the emergency lighting in tunnel with ventilation shall be equipped with emergency power supply (EPS).

12.8 Earthing and Safety

12.8.1 Scope for connection between high speed railway electric equipment and installation and the power run-through line and its relevant design requirements shall comply with the relative provisions in the Chapter 21 of this Code.

12.9 Reliability of Power Supply

12.9.1 Reliability of high speed railway power supply and power distribution system shall comply with the following requirements:

1. Power cut of one external power source in power supply network must not affect the power supply of Grade 1 load.

2. Interruption of one circuit of power supply in power supply network must not affect the power supply of Grade 1 load.

12.9.2 Main technical parameters concerning reliability of Grade 1 load power supply for high speed railway power distribution system should comply with the requirements in Table 12.9.2.

| Table 12.9.2 Power supply reliability index of high speed railway 10 kV customers |
|-----------------------------------|-----------------|
| AITC average interruption times of customer (times/year) | 0.3 |
| AIHC average interruption hours of customer (h/year) | 0.3 |
| Power supply reliability (%) | 99.95 |

12.10 Interface Design

12.10.1 Personnel of electric power system shall cooperate with those of relevant systems to complete the following interfaces:

1. Electric power cable troughs shall be set at both sides of the subgrade and on the shoulders of the subgrade.

2. Electric power cable pipes crossing underneath the rails shall be pre-embedded at subgrade, the cable hand hole and well shall be set at both sides of subgrade, and comply with the requirements of bending radius of the electric power cables.

3. Electric power cable troughs shall be set at both sides of the tunnel.

4. Electric power cable pipes passing underneath the rails shall be pre-embedded at integrated caves and rooms, transformer rooms and other equipment rooms inside tunnel, and shall meet the requirements of bending radius of the electric power cables.

5. Power transformation rooms shall be arranged at the center mileage of the tunnel longer than 3 km or at an interval of 3 km.

6. Electric power cable troughs shall be set at both sides of bridge. The conditions for...
installation of cable troughs shall be reserved when electric power cables are laid downwards from bridge top to the bottom.

7 Electric power cable troughs and ducts shall be set at stations and yards.

12.10.2 When a low voltage circuit in substation is monitored both by power supply dispatching system and BAS, the requirements of monitoring function are provided by power supply dispatching system, the design of monitoring unit is carried out by BAS, and the design of RTU is carried out by power supply dispatching system.

12.10.3 Interface between electric power system and section disaster-prevention monitoring system shall be located at bottom end of low voltage outgoing line switch of power distribution box in radio communication base station, the power supply circuits after the bottom end of the low voltage switch shall be integrated into the safety and disaster-prevention system.

12.10.4 It is required to assist the owner to submit the demands on power consumption and interface boundary to local power supplier during design of external power sources.
13 Communication

13.1 General Requirements

13.1.1 High-speed railway communication network shall provide stable, reliable and smooth voice, data and image communication service for transportation and railway operation management.

13.1.2 High-speed railway communication network shall be equipped with the systems such as communication lines, transmission and access network, data communication, telephone exchange, digital dispatching communication, GSM-R digital mobile communication, video conference, integrated video monitoring, emergency communication, integrated wiring, digital synchronization and time allocation, integrated communication network management, power supply, environment monitoring and communication power supply.

13.1.3 The high-speed railway communication network is part of the railway communication network and shall be connected with the established network, to make the best use of the existing resource.

13.1.4 A proper reservation for future development shall be considered for the design of the high-speed railway communication network, in conformity to the requirements of reliability, availability and maintainability.

13.2 Communication Lines

13.2.1 A long-distance communication optical cable shall be laid in cable trench precast at both sides of the railway line.

13.2.2 The number of fiber core shall fulfill not only the requirements of communication services, but also those of signal and other related systems. Besides, there should be a surplus of 50%.

13.2.3 Long-distance communication optical fiber cable shall be flame retardant.

13.2.4 Different physical paths should be applied for leading long-distance communication optical cables into the important nodes such as communication equipment room, sectional wireless base station and signal relay station.

13.2.5 Sectional optical cable needed by integrated video monitoring and optical fiber repeater shall be designed in entirety, but laid independently.

13.3 Transmission and Access

13.3.1 Synchronized Digital Hierarchy (SDH) technology system shall be used to construct multi service transfer platform (MSTP).
13.3.2 Transmission system shall satisfy the requirements of communication systems, signal system, electricity, traction power supply as well as information system in terms of channel type, service interface type and band width.

13.3.3 Hierarchy shall be applied in the transmission system, which should comprise backbone layer, relay layer and access layer. Backbone layer and relay layer of high-speed railway transmission system shall be combined in designing.

13.3.4 Optical cable laid respectively at both sides of the railway lines shall be used for backbone and relay layer to construct “1+1” double multi-service transmission system.

13.3.5 The system with rate of SDH 2.5 Gb/s or above shall be adopted for backbone and relay layer.

13.3.6 Access layer shall construct the network with optical cable laid at both sides of the railway line, and form one or more two-fiber self-healing ring in light of actual needs.

13.3.7 Multi-service transmission system with rate of SDH 622 Mb/s or above should be adopted for the node of access layer and that with rate of SDH 155 Mb/s or above should be adopted for other access nodes within the station.

13.3.8 Access Network (AN) shall provide the following interfaces such as POTS port, integrated services digital network (ISDN) port, DDN port (adopt subrate of 64 Kb/s or lower) and 2/4 audio interface.

13.3.9 A certain reservation for capacity of transmission system shall be considered, which should not less than 50% for channels of backbone layer and relay layer and not less than 40% for channels of access layer.

13.3.10 Detour protection should be provided for important transmission service by using the existing transmission system.

13.3.11 “1+1” hot standby mode shall be adopted for master board, crossing board, clock board and power board of transmission and access network. Group channel interface should be configured on different boards. “N+1” backup mode shall be used for branch board. Configuration of branch board should satisfy the requirements that key services be distributed on different branch boards.

13.3.12 Service interface boards shall be configured on the basis of interface type and function, and a surplus of not less than 30% shall be taken into consideration.

13.4 Data Communication Network

13.4.1 TCP/IP protocol shall be adopted in data communication network.

13.4.2 Data communication network shall provide data carrying service for information system, GSM-R, integrated video monitoring and video conference.

13.4.3 Wide area network (WAN) of data communication network comprises backbone network and regional network.

13.4.4 Regional network, consisting of core node, convergence node and access node, shall be established based on the governance of railway administration. Its settings shall
comply with the following requirements:

1. Core node shall be set at the dispatching post.
2. Convergence node shall be set at the place where services converge within governance of railway administration.
3. Access node shall be set at places where services demands are relatively high like railway administration, station and depot (section).

13.4.5 Core nodes in regional network shall be equipped with two core routers for converging and forwarding services of the regional network; two or more links shall be adopted in connecting upward with backbone network.

13.4.6 Convergence nodes in regional network shall be equipped with two convergence routers for converging services connected by this node; two or more links shall be adopted in connecting upward to the core node and the interconnection among the convergence nodes shall be performed as required.

13.4.7 Access node in regional network shall be equipped with one or two routers as required; two or more links shall be adopted in connecting upward to the core node or convergence node.

13.4.8 Interconnecting bandwidth among the equipments of the nodes shall be decided with network data flow, and a certain reservation shall be considered in addition to meeting recent service demands.

13.4.9 Data communication network shall provide the bit rate interfaces of V.35, E1, FE, GE, POSI55 Mb/s, CPOSI55 Mb/s and above.

13.4.10 MPLS VPN should be adopted in data communication network in conformity to the requirements of QoS and security.

13.4.11 Settings of IP address and autonomous (AS) area shall be in line with regulations of Ministry of Railways.

13.5 Telephone Exchange

13.5.1 Existing railway telephone exchange network should be utilized in high-speed railway telephone system.

13.5.2 Automatic telephone shall be set at attendant places.

13.6 Digital Dispatching Communication

13.6.1 Dispatching telephone, station-yard telephone, interstation train operation telephone and other dedicated telephone service shall be provided in digital dispatching communication system.

13.6.2 Digital dispatching communication system is constituted by dispatching switch, dispatching console, on-duty console, telephone extension, recording equipment and network management equipment.

13.6.3 Network from dispatching post to station or depot shall use ring or star topology.
which shall be constructed within the maintenance boundary of the railway administration. Relay line from dispatching post to the dispatching switches in the station or depot shall have detour protection function.

13.6.4 Dispatching switch in the dispatching post shall be interconnected with mobile switching center (MSC) of GSM-R system. Two or more relay lines with different paths should be equipped with.

13.6.5 Dispatching switch in the dispatching post shall be designed to have disaster prevention backup at different places in the same city.

13.6.6 Setting and configuration of equipment in the digital dispatching system shall be in accordance with the following requirements:
   1 Dispatching post shall be equipped with dispatching switch.
   2 Station, integrated maintenance base and EMU depot and workshop (or depot) shall be equipped with station dispatching switch.
   3 Dispatching console shall be available in the attendant office of the dispatching post, and attendant console shall be available at attendant office of station and depot.
   4 Dispatching switch shall be provided with multi-channel digital recording function, which may also be connected with the external centralized recording device via digital interface.
   5 1+1 hot standby mode shall be adopted for main control part, switch network and power board of the dispatching switch, and N+1 backup mode should be adopted for other boards.

13.7 GSM-R Digital Mobile Communication

13.7.1 GSM-R digital mobile communication system (hereinafter referred to as GSM-R System) shall provide voice service, data service, calling related service and railway specific service, and provide basic services function, mobile operation function, additional function of call processing and other functions.

13.7.2 GSM-R system is constituted by network subsystem, wireless subsystem, service and operation supporting subsystem and terminal equipment.

13.7.3 Base station controller (BSC) in wireless subsystem shall be established in entirety with the consideration of capacity, performance and service covering scope. Transcoder and rate adapter unit (TRAU) shall have the same address as MSC. Setting of the BSC shall avoid the frequent handover of mobile terminal crossing BSC, and shall also take into consideration access condition of adjacent railway line.

13.7.4 Design of radio field strength coverage shall be in accordance with the following requirements:
   1 Radio field strength redundancy coverage shall be realized according to the application service demands in CTCS-3 train control information section and other classes of train control switching section.
2 Length of overlapping section of radio field strength coverage shall satisfy the needs of cab integrated radio (CIR)/onboard communication unit (MT) for twice handover between sections. The handover location should be chosen at the place with better transmission conditions.

3 Junction center area, radio coverage of adjacent railway lines and frequency allocation shall be planned as a whole, which shall give first priority to train control sections.

4 The system index, such as required minimum RX level, C/I and C/A of the radio field strength etc., and other requirements of radio coverage scope shall satisfy the regulations of the current GSM-R system engineering design standards.

13.7.5 GSM-R shall be designed to have system redundancy in the sections transmitting CTCS-3 train control information.

13.7.6 Either base station and repeater plus leakage coaxial cable or base station and repeater plus antenna shall be adopted, on the basis of specific implementation conditions, in sections with weak field strength to realize radio coverage. In sections transmitting CTCS-3 train control information, repeaters shall be designed to satisfy requirements of radio field strength redundant coverage.

13.7.7 QoS of GSM-R system shall be designed to satisfy regulations of the current GSM-R system relevant engineering design standards.

13.7.8 Configuration of main equipment of the GSM-R system shall satisfy the following requirements:

1 Installation location and configuration of the core network equipment shall be in accordance with related regulations of Ministry of Railways. The capacity shall satisfy the current access demands of each line. Capacity of base station subsystem shall satisfy the traffic demands of various GSM-R subscribers within the coverage area.

2 Important boards or modular like main controller, clock, power supply and carrier frequency of GSM-R system shall be set with certain redundancy according to the work mode of hot standby.

3 Each kind of user's terminal, GSM-R application system and interface equipment shall be equipped as required by railway transportation.

13.7.9 GSM-R system interface monitoring equipment shall be equipped in sections transmitting CTCS-3 level train control information.

13.7.10 Equipment and installation within tunnels shall satisfy environmental requirements within tunnels in terms of temperature, humidity, dust protection, air pressure and vibration due to the passage of high-speed trains.

13.8 Video Conference

13.8.1 Video conference system of high-speed railway may adopt H.320 and H.323 protocol, and be connected with the existing video conference system.

13.8.2 Video conference system is mainly constituted by MCU, GK, GW, video conference
terminal, and network management equipment.

13.8.3 H.323 video conference system shall be carried in railway data network, and be constructed as star-type topology in its logic.

13.8.4 MCU cascade mode may be adopted in integrating the existing video conference system.

13.8.5 Configuration of the video conference system shall satisfy the following requirements:

1. MCU, GK, GW and network management equipment should be equipped in the dispatching post.

2. Based on actual demands, main conference hall may be established in the administration agency, and subordinate conference hall may be established in the comprehensive maintenance base, EMU depot and stations.

3. Meeting room shall be equipped with video conference terminal, camera, image display, microphone and acoustics.

13.8.6 Main equipment configuration of the video conference system shall be in accordance with the following requirements:

1. GK registerable capacity shall not be less than twice as many as the number of terminals of the video conference.

2. Quantity of MCU shall be decided according to real situation of the engineering. Port quantity of MCU shall not be less than 1.5 times as number of terminals of the video conference. MCU core board and modular shall have redundancy.

3. One set of video conference terminal shall be allocated for each meeting, and one set of terminal should be kept as standby for important meeting.

13.9 Integrated Video Monitoring Systems

13.9.1 High-speed railway integrated video monitoring system (hereinafter referred to as “integrated video system”) shall adopt digital network video monitoring technology, support MPEG-4, H.264, AVS, video compression coding and decoding standards, G.711/G.723.1/G.729 audio coding and decoding standards, and satisfy the regulations of the related technical standards.

13.9.2 Integrated video system shall be provided with the functions such as real-time video images monitor, storage, play back, Pan-tilt lens control, video distributing/ transferring, interconnection and linkage among systems and multi-level management and be in line with the video monitoring demands of dispatching, operational maintenance and department of public security, and shall also be provided with real-time remote image monitoring functions.

13.9.3 Integrated video system shall be constituted by core node of Ministry of Railways, node in the video area of the dispatching post, station (depot) access node, video collection equipment, video network and user’s terminal.

13.9.4 Integrated video system includes image acquisition equipment, video coding and
decoding equipment, video transferring equipment, video storage equipment, safety management equipment, network management and monitoring terminals.

13.9.5 Image content analysis and alarming functions should be available in such places as key monitoring points and key security protection area, which should adopt front-end analysis method.

13.9.6 Integrated video system shall be interconnected or linked with power supply and environmental monitoring system, SCADA, and passenger service information system. Corresponding interface network gateway shall be taken into consideration.

13.9.7 Integrated video system regional node and access node shall be configured as the following regulations:

1 Regional node shall be equipped with video transferring server and storage equipment; access node should be equipped with video distributing/ transferring server and storage equipment. Capacity of the server in terms of concurrent input and output shall satisfy the demands of the users. Storage equipment shall be able to store important images and alarming images.

2 Regional node shall be equipped with network management system equipment to realize centralized management of integrated video system. Access node shall be equipped with management terminal, which will perform maintenance service for the node and the operational status of the front-end equipment within its administrative area.

13.9.8 Quantity, location and equipment function of the video collection points shall be planned as a whole, while giving consideration to the real situation of the project. In addition, the following regulations shall be obeyed:

1 Video collection points shall be established at places like bridge evacuation channels, places with complex security issues in subgrade section, places where highway and railway crosses, tunnel entrance and other important areas, GSM-R communication iron tower, inside and outside of signal and communication room, traction and power supply room and electricity equipment room, railway station, passenger entrance and exit distributing hall, waiting hall, ticketing hall, elevator and stairs, security check corridor, area near luggage check-in facilities and help center, square in front of the station, passenger channel of the railway station, platform, station throat, parking lot of EMU depot, railway track throat area, both ends of each warehouse door, inspection warehouse and maintenance warehouse.

2 Camera supporting low illumination and wide dynamic function shall be chosen for the video collection points in light of on-site environmental illumination situation.

3 Around-the-clock monitoring function shall be available for equipment at the video collection points located in the bridge evacuation channel, cross-over of the culvert at the subgrade section, place outside section equipment room, points where highway and railway cross, tunnel entrance and station throat zone.

13.9.9 Video monitoring terminal should be allocated according to the number of user and video image channel. The number of local image concurrent channels invoked by each
set of user's monitoring terminal shall be designed according to the service demands. Remote image concurrent channel invoked should not be greater than four. Multi-screen monitoring terminal will be independently install in public security department along the railway line according to the scale.

13. 9. 10 Storage time and quality of various video information shall be in accordance with the following requirements:

1. Common video image should be stored for 3 days, and image resolution shall not be lower than CIF.
2. Video image of key targets and key area should be stored for 15 days, and image resolution shall not be lower than 4CIF.
3. Alarm image and alarm information should be stored for 30 days, and image resolution shall not be lower than 4CIF.

13. 10 Emergency Communication

13. 10. 1 Emergency communication system shall provide communication service including voice, data and image service for emergency handling center and the accident scenes.
13. 10. 2 Emergency communication system shall choose multiple transmission modes and provide diverse communication service means based on the actual situation, which shall satisfy regulations stipulated in Access Technical Conditions of Railway Emergency Communication TB/T 3204.
13. 10. 3 Emergency communication system is constituted by emergency handling center equipment, communication network, emergency communication on-site access equipment.
13. 10. 4 Configuration of the emergency handling center system shall be in accordance with the following requirements:

1. Emergency handling center equipment shall be established in Ministry of Railways and Railway Administration, which shall include main communication equipment of the emergency handling center, emergency handling supervising and dispatching console, emergency handling console, on-duty console, video and audio terminal as well as terminal of network management.
2. On-site access equipment of emergency handling communication shall be established according to the operation and maintenance administrative boundary, emergency response time and the traffic conditions.
13. 10. 5 Emergency handling center communication equipment shall be interconnected with the integrated video system and the video conference system.
13. 10. 6 Suitable emergency handling equipment shall be installed in the long tunnel where emergency rescue station is available.

13. 11 Integrated Wiring System

13. 11. 1 Integrated wiring system is constituted by building subsystem, work area ...
subsystem, horizontal subsystem, vertical subsystem, subsystem among equipments and management subsystem.

13. 11. 2 Integrated wiring system shall be established at station buildings and depot (section).

13. 11. 3 Establishment of the integrated wiring system and equipment configuration shall be in accordance with the following requirements:
   1 At least one management subsystem shall be established for each building.
   2 At least two shall be available every 5 m² at the information point of the office area, and not less than one be available every 10 m² at the information point of the station building.
   3 Vertical wiring adopt optical cable and twisted pair cable, and horizontal wiring adopt twisted pair cable of 6 type or above and optical cable.

13. 12 Digital Synchronization and Time Allocation

13. 12. 1 Digital synchronization network provides frequency synchronization signal for transmission, switch and GSM-R system.

13. 12. 2 The existing railway digital synchronization network resource shall be adopted for high-speed railway digital synchronization network.

13. 12. 3 Digital synchronization network is constituted by reference clock, BITS and clock synchronized information transmission links. The system adopts the mode of master-slave synchronization, and transmits system by grade using digital transmission system links.

13. 12. 4 Functions of digital synchronization network shall be in accordance with current regulations of Design Specifications of Digital Synchronization Network Engineering YD/T 5089 and Design Specifications of SDH Local Network Cable Transmission Engineering YD/T 5024.

13. 12. 5 Time synchronization network provide consistent reference time signal for each clock system of the railway transport service. High-speed railway time synchronization network shall be integrated into the existing railway time synchronization network.

13. 12. 6 Time synchronization network consists of three levels including Dispatching Center of Ministry of Railways, dispatching post and station as well as depot along the railway lines, which uses master-slave synchronization.

13. 12. 7 Functions of the time synchronization system shall be in accordance with regulations stipulated in the standards of Ministry of Railways.

13. 12. 8 Establishment of time synchronization network and equipment configuration shall be in accordance with the following requirements:
   1 Level I time synchronization equipment shall be established in the Dispatching Center of Ministry of Railways, constituted by satellite receiving equipment, mother clock, time display equipment and network management equipment.
2 Level II time synchronization equipment shall be establish in the dispatching post, constituted by satellite receiving equipment, mother clock, time display equipment and network management equipment.

3 Level III time synchronization equipment shall be established in station and depot (section) along railway lines, constituted by mother clock, time display equipment and network management equipment.

13.13 Integrated Network Management

13.13.1 Integrated communication network management system (hereinafter referred to as "integrated network management system") comprises two levels, one at the Ministry of Railways and the other at the dispatching post.

13.13.2 Communication system, managed by integrated network management system, shall include transmission and access network, data communication network, telephone switch system, digital dispatching communication system, GSM-R system, video conference system, integrated video monitoring system, power supply and environment monitoring system, digital synchronization and time allocation system.

13.13.3 Each communication system shall set up element level network management or monitoring system to perform safety, configuration, fault and performance management, which shall provide northbound interface connecting with integrated network management.

13.13.4 Integrated network management system shall be constituted by such hardware as server, disk array, optical fiber switch, network switch machine, router, firewall, protocol converter and terminal.

13.13.5 Maintenance terminal of the integrated network management system shall be established in the corresponding management agency.

13.14 Power Supply and Environment Monitoring System

13.14.1 Power supply and environment monitoring system shall perform centralized monitoring and management on communication power supply equipment, environment of communication, information, and signal equipment room, and shall have alarm functions of linking with integrated video and related systems.

13.14.2 Power supply and environment monitoring system is constituted by monitoring center (including monitoring terminal) and monitoring station.

13.14.3 Configuration of power supply and environment monitoring system shall be in accordance with the following requirements:

1 Monitoring center should be established at the communication maintenance agency.

2 Monitoring station shall be established in the monitored equipment room, and monitoring unit shall be established in the monitoring station.

3 Monitoring terminals shall be established at the corresponding maintenance agency of communication, signal and information system.
13.14.4 One shared monitoring unit should be established for the place where equipment rooms concentrates.

13.15 Communication Power Supply Equipment

13.15.1 Communication power supply equipment includes –48 V DC power supply and AC UPS.
13.15.2 Communication DC power supply equipment is constituted by high-frequency switch power supply equipment and valve-regulated battery group. \(N+1\) backup shall be adopted for high-frequency switch power supply rectification modular. Battery shall be set with two groups. Backup time of battery at the communication station and train station shall be configured as one hour, and that of sectional base station shall be three hours.
13.15.3 One group of battery shall be provide for AC UPS. Backup time of battery at the communication station and train station shall be configured as one hour, and that within sections shall be configured as three hours, and that of the sectional repeater shall be prolonged according to the local geological environment.
13.15.4 Power supply equipment of relevant systems may be shared at the places where communication equipment such as transformer substations shares the same equipment room with other systems. Communication equipments of traction substation and distribution substation may share power supply equipment with those of other specialties at places where they are located at the same equipment room.

13.16 Equipment Room, Lightening Protection, Electromagnetic Compatibility and Earthing

13.16.1 Communication equipment room shall be designed according to related technical standards, and also satisfy such requirements as lightening protection, electromagnetic barrier, vibration protection, dust proof, moist proof, fire and rat control.
13.16.2 Sectional base station may be located at the same equipment room with sectional signal relay station, and box-type communication equipment room should be adopted. Protective fence shall be established at the sectional communication equipment room.
13.16.3 Corresponding maintenance room shall be available according to operational maintenance requirements.
13.16.4 Electromagnetic compatibility of the communication system shall be designed in light of the current TB 10006 Design Specifications of Railway Communication, regulations in Section 11.6 of this Code as well as that in such technical standards as railway lightening protection, electromagnetic compatibility and earthing.
13.16.5 Communication earthing shall be in accordance with the following requirements;
   1 Earthing of equipment in the communication equipment room shall use the earthing device of the buildings.
   2 Independent earthing device shall be set for iron tower.
   3 Integrated earthing systems shall be led in when the distance between the earthing
device and run-through earthing cable of the integrated earthing system is within 20m.

13.16.6 Lightening protection of the communication system shall be in accordance with the following requirements:

1. Lightening protection of the communication system shall be designed systematically.
2. Communication lightening protection and building lightening protection may share the same group of earthing device when communication equipment room is located in the station building.

13.17 Interface Design

13.17.1 Interface shall be designed as per the following regulations when the system of communication provides optical fiber and channel for other related systems:

1. In providing dedicated optical fiber for signal system, engineering interface shall be established at the external cable side of the ODF( box) in the signal equipment room.

2. In providing dedicated optical fiber for electricity, traction feeding system, engineering interface should be established at the user’s side of the ODF( box) in the communication equipment room.

3. In providing 2 M or 10 M/100 M channels for information, signal, electricity, traction feeding system, interface should be established at the user’s side of the DDF, or RJ-45 DF or service port side of the communication equipment in the communication equipment room.

4. In providing audio channel for each monitoring system, interface should be established at the user’s side of VDF in the communication equipment room.

13.17.2 Interface design shall be in accordance with the following requirements when communication specialty instructs infrastructure department to preserve trough, pipe or hole:

1. Subgrade department is required to provide communication specialty with communication cable trench (including cover) at both sides of the track, crossing-rail pipes, joint and handhole and down-lead facilities.

2. Tunnel department is required to provide communication system with communication cable trench (including cover) at both sides of the tunnel, crossing-rail pipes, long cavity and equipment hole or room.

3. Bridge department is required to provide communication system with communication cable trench (including cover) at both sides of bridges and preservation of serrated holes to down-lead cables at the bridge pier. If leakage coaxial cable pole needs to be added on the bridge, general considerations shall be taken into the catenary pole on the bridge.

4. Station and yard department is required to provide communication system with cable trench at both sides of the station and yard. Building construction department is required to establish cable trenches on the platform. Cable trench between the station and yard and platform shall be connected smoothly.

13.17.3 When communication specialty requires other specialties to provide relevant
facilities, interface shall be designed according to the following requirements:

1. Communication specialty shall lodge requirements on construction of communication equipment room, preservation of iron tower foundation and earthing network near the base station and repeater room with the department of construction.

2. Communication department shall lodge requirements on power load level and capacity of the communication equipment with the power supply department.

3. Communication department shall lodge requirements on ventilation, air conditioning and fire control facilities of the communication equipment with the heating and ventilation department.

4. When the leakage coaxial cable is installed at the same pole of catenary, communication department will lodge requirements on suspension height and load of the leakage coaxial cable with the catenary department. The catenary department will be responsible for designing the type of catenary pole.

5. Communication department shall lodge requirements on earthing terminal with the integrated earthing department. Communication department will install connection wire and integrate it into the integrated earthing system.
14 Signaling

14.1 General Requirements

14.1.1 Signaling system shall be designed to meet the requirement of train operation with the maximum speed of the line, and also to comply with the requirement of interoperability of trains from other lines.

14.1.2 Signaling system shall be designed to meet the requirements of bi-directional train operation on double tracks. Automatic blocking shall be adopted for train running at the normal direction, while automatic inter-station blocking should be adopted for train operation at the reverse direction.

14.1.3 Signaling system shall be designed to meet the requirement of headway for train tracing operation.

14.1.4 Advanced, proven, economic, applicable, safe and reliable technology and equipment shall be used for the design of signaling system, and shall be in accordance with regulations stipulated in Regulations and Examples of Reliability, Availability, Maintainability and Safety in Rail Traffic GB/T 21562.

14.1.5 The design of signaling system and electric circuit related with train operation safety must be in accordance with fail-safe principle.

14.1.6 The spare parts of the key devices, amount of which should be 10%, shall be included in the integrated signaling equipment. The amount of the spare parts of the other key equipment or devices related with safety shall be calculated according to the principle of "fault-based maintenance" and stored in designated places.

14.1.7 Maintenance equipment for signaling system shall be provided according to corresponding operational maintenance system.

14.2 Fixed Trackside Signal

14.2.1 Home signal and starting signal shall be installed for stations (including sectional stations without sidings). Route signal, shunting signal and repeating signal may be provided for stations with great amount of operations if necessary. Shunting signal may not be necessary on train route for intermediate stations and overtaking stations with simple operations.

14.2.2 Home signal, starting signal and shunting signal should be provided for EMU depot and workshop (or depot).

14.2.3 The frame and mechanism stipulated in the current Code for Design of Railway Signaling TB 10007 shall be adopted for home signal and receiving route signal in the...
station. Dwarf signal with 7 lights may be adopted when signal is installed on bridges or in tunnels or on condition that the distance between high-pole signal profile and the electrified part of the catenary can’t meet safety requirement.

14.2.4 Dwarf signal with 3 lights of “red, green and white” shall be used for starting signal and starting route signal in the station. For call-on aspect of starting signal, red light and white light shall be lighted. The frame is shown in Figure 14.2.4.

14.2.5 Shunting signal shall adopt the dwarf shunting signal stipulated in Design Specifications of Railway Signaling TB 10007. The starting signal mechanism with green light blocked shall be adopted for shunting signal at the end of the arrival-departure line.

14.2.6 Passing signal with the same signal mechanism as home signal shall be installed for block station. For call-on aspect of passing signal, red light and white light shall be lighted.

14.2.7 Stop mark board as shown in Figure 14.2.7 shall be installed on the left side of the track at the boundary of the block section, and it should be installed on the catenary pole.

14.2.8 Distant signal shall not be installed for either home signal in station or passing signal in the block station, instead distant sign board shall be installed. Distant sign board shall be installed at the place of 900 m, 1,000 m and 1,100 m away from home signal or passing signal protecting the switch in the section. Distant sign board should be installed on the nearby catenary pole.

14.2.9 All train signals in the station and passing signals in the block station shall be turned off under normal conditions. If the onboard ATP is not installed or out of service, the corresponding train signal shall be turned on after manual confirmation.

14.2.10 When a trackside signal displays permissive signal, it only means that train or trainset is permitted to pass the signal. The route direction is not distinguished for starting signal.

14.2.11 Shunting signal and train signal of the EMU depot and workshop shall be turned on under normal conditions.

14.2.12 In station linking Passenger Dedicated Line (PDL) with passing signal and PDL without passing signal, the type of the signal mechanism shall be selected according to the main receiving and dispatching direction of the track respectively. Ordinary signal mechanism shall be adopted and the signal shall be turned on under normal conditions for tracks whose main receiving and dispatching direction is towards the section with passing signal; while PDL signal mechanism shall be adopted and the signal shall be turned off under normal conditions for tracks whose main receiving and dispatching direction is towards the section without passing signal.
14.2.13 Installation location of the signal shall be in accordance with following requirements:

1 Installation of home signal shall be in accordance with related regulations of the current *Regulations of Railway Technology Management*.

2 Starting signal shall be installed at the place no less than 55m (including 50m of overlap distance) away from the fouling point, or place no less than 50m away from the blade of point at the opposite direction.

3 Shunting signals on the EMU operation routes shall be installed at the place no less than 5m away from the fouling point. Shunting signals on other routes shall be installed at places no less than 3.5m away from the fouling point. Shunting signals with balise storing shunting dangerous message shall be installed at the place with distance as far as possible from the fouling point or protective point.

4 Home signal and section block sign board shall not be installed in the neutral section or certain range nearby.

14.2.14 Distance between the adjacent train signals with the same direction shall meet the requirements of braking distance at the stipulated speed. Indication relationship of the train signals in station shall be in accordance with the following requirements:

1 When a receiving route is set, the starting or route signal at the end of the receiving route shall display the red light. If the red light fails to be lighted, the signal protecting the receiving route shall display the red light.

2 When a passing route is set, the starting or route signal on the route shall display the permissive light. If the filament of permissive light is failure, the signal in the upstream shall be degraded correspondingly.

### 14.3 Traffic Dispatching

14.3.1 Centralized Traffic Control (CTC) system shall be established at high-speed railway dispatching center, station, block station and EMU depot and workshop (or depot), CTC system of the EMU depot and workshop shall cover the function of shunting assistant management.

14.3.2 CTC system should be planned together with operational dispatching system, and the interface shall also be unified. Network shall be constructed independently.

14.3.3 CTC system shall be constituted by dispatching center subsystem, station subsystem and network subsystem.

14.3.4 The design of the dispatching center subsystem shall be in accordance with the following requirements:

1 It shall be equipped with database server, application server, communication server, interface server and server providing information to other system. Inquiry server of the repeat terminal shall be installed if necessary.

2 It shall be equipped with dispatcher workstation, assistant dispatcher workstation,
dispatcher director workstation, control workstation, planner workstation, comprehensive maintenance workstation, network administration workstation, system maintenance workstation, simulation and training workstation, N+1 standby workstation. Terminals may also be equipped with dispatching workstations of other systems if necessary.

3 It shall be equipped with LAN and WAN equipment, Ethernet switch shall be available for LAN. Router, remote communication equipment, channel quality supervision equipment shall be available for WAN.

4 It shall be equipped with following network security equipment and system, such as centralized security management center, firewall, intrusion detection, virus protection, identity recognition, vulnerability evaluation, security access control, security audit and software patch distribution system, etc.

5 Large-screen projector and display equipment should be available according to the transportation requirement and the building conditions of the dispatching center, which may also be installed together with other systems.

6 It shall be equipped with time unifying equipment, power supply equipment and lightning protection equipment. Plotter device, printer and other related equipment may also be provided if necessary.

14.3.5 The design of station subsystem shall be in accordance with the following requirements:

1 Station self-regulated machine as well as equipment for collecting field element status and for controlling field element shall be installed for each station.

2 CTC terminals shall be installed for each station.

3 Power supply, lightning protection and interface equipment shall be installed for each station.

4 Serial communication interfaces shall be adopted among CTC station subsystem and other systems.

14.3.6 Key equipments of CTC system shall be equipped with redundancy. Double network structure shall be adopted for dispatching center and station network.

14.3.7 CTC dispatching workstation equipment shall be established according to dispatching area.

14.3.8 Information shall be exchanged, boundary shall be clearly defined and control scope shall not be overlapped between CTC system of this line and CTC/TDCS of adjacent lines.

CTC system shall be able to exchange information with dispatching center of Ministry of Railways.

The information exchange between CTC system and other information system shall be centralized in the dispatching center.

14.3.9 Main functions of the CTC system shall include controlling of train route and shunting route, monitoring of train operation, logical tracing of train number, adjustment
of train operation plan and setting of temporary speed restriction.

14.3.10 CTC system shall have two modes including decentralized self-regulated control mode and emergency station control mode. Automatic and manual route control modes shall be provided under the decentralized self-regulated control mode.

14.4 Train Operation Control

14.4.1 High-speed railway shall adopt Chinese Train Control System (CTCS), which shall be in accordance with the following requirements:

1. CTCS-3 system shall be designed for ground system on lines with the speed of 300 km/h and above.
2. CTCS-2 system shall be designed for ground system on lines with the speed of 250 km/h.
3. Train operational mode should be adopted for EMU running track. The corresponding CTCS level shall be chosen for EMU running track and EMU depot and workshop (or depot). Shunting operational mode may also be chosen according to transportation requirements.
4. Onboard train control equipment of EMU shall adapt to the trackside train control system at corresponding level.
5. Onboard train control equipment shall adopt continuous distance-to-go speed control mode to control train operation in safe way.
6. Key equipments of the train control system shall adopt safety redundancy hardware structure. Safety integrity level shall achieve SIL4 stipulated in Specifications and Examples on Reliability, Availability, Maintainability and Safety of Rail Traffic GB/T21562.
7. Onboard ATP indication is used as moving authority for train operation. Provided train is not equipped with onboard ATP or onboard ATP is out of service, train operation shall be organized according to the related operational regulations.
8. Onboard ATP equipment shall send neutral section order to EMU passing the neutral section automatically according to the fixed information of neutral section provided by the trackside equipment of the train control system.

14.4.2 CTCS-2 system shall be in accordance with the following requirements:

1. The trackside equipment is comprised of Temporary Speed Restriction Server (TSRS), Train Control Center (TCC), ZPW-2000 (UM) series track circuit, balise, Lineside Electronic Unit (LEU) and the related network equipment etc.
2. The onboard ATP equipment is comprised of Vital computer (VC), Track circuit reader (TCR), Balise Transmission Module (BTM), Speed Distance Unit (SDU), Juridical Recorder Unit (JRU), Driver Machine Interface (DMI), Train Interface Unit (TIU), track circuit information receiving antenna, and balise receiving antenna.
3. The transmission mode of track circuit plus balise shall be adopted for exchanging information between the trackside equipment and onboard equipment.
14.4.3 CTCS-3 system shall be in accordance with the following requirements:

1. The trackside equipment is comprised of TSRS, RBC, TCC, ZPW-2000 (UM) series track circuit, balise, LEU, GSM-R communication interface equipment and the related network equipment.

2. The onboard equipment of the CTCS-3 is comprised of VC, RTU of GSM-R system, TCR, BTM, SDU, JRU, DMI, TIU, track circuit information receiving antenna, balise receiving antenna, and GSM-R radio receiving antenna.

3. The transmission mode of GSM-R, track circuit plus balise shall be adopted for exchanging information between the trackside equipment and onboard equipment of CTCS-3 shall adopt. Track circuit shall transmit information according to the requirements of CTCS-2 system; balise shall transmit information of CTCS-2 system and CTCS-3 system, such as train positioning and RBC contact information etc; RBC and onboard equipment shall exchange such information as moving authority, track data, balise link, temporary speed restriction and train data via GSM-R system.

14.4.4 Temporary speed restriction (TSR) shall be designed in accordance with the following requirements:

1. TSRS should be centrally installed at the station along the railway line near the dispatching center, which can also be shared by other lines. TSRS shall send TSR information to TCC and RBC respectively.

2. TSR shall be set according to requirements of the corresponding CTCS level.

3. Temporary speed restriction area on the main track within the interval and station shall be set according to the actual mileage (unit: m). The resolution of the TSR value shall be 5km/h, and the minimum speed limit shall be 45km/h.

4. TSR of the station sidings shall be set by taking the throat area and the arrival-departure line as two basic units, and the TSR value shall be 45km/h. The value of 80 km/h shall be added for points with size number exceeding 18.

5. The number of TSR administrative area established at the same direction can not be more than 3 at the same time.

14.4.5 TCC shall be designed in accordance with the following requirements:

1. TCC shall be established at the station and relay station.

2. TCC may be installed for station without siding tracks, block station and CTCS-0 station connecting with CTCS-2 railway lines if necessary.

3. TCC shall control the low-frequency coding and carrier frequency selection of ZPW-2000 (UM) track circuit and the direction of sending/receiving end; realize real-time framing, coding and sending of switchable balise message; and control signal lighting and transmission of vital information between stations.

4. TCC shall adopt hardware structure with safety redundancy.

14.4.6 Establishment of track circuit shall be in accordance with the following requirements:

1. ZPW-2000 (UM) series jointless track circuit shall be adopted within the interval
to check train occupancy and provide ahead vacancy information of block sections to onboard.

2 Joint insulated track circuit with the same type as used in the section should be adopted in the overtaking station and intermediate station. Joint insulated track circuit with the same type as used in the section should be adopted on main tracks and arrival-departure track in comprehensive large station.

3 The design length of ZPW-2000 (UM) track circuit shall meet the requirements of enabling onboard equipment to receive track circuit information reliably and protecting against the interference of the adjacent tracks, it shall also meet the requirement of guaranteeing the reliable working of station interlocking if the track circuit is used in station. The design length of ZPW-2000 (UM) track circuit shall be in accordance with the regulations of Appendix E.

4 The minimum design length of the track circuit within the stations shall be:

1) If it is necessary to provide train control information in the section without points, the minimum length $L_{\text{min}}$ shall meet the requirements of formula (14.4.6-1) and (14.4.6-2).

$$L_{\text{min}} = V_{\text{max}} \times 2.5 \, s + L_{\text{Constant}}$$ \hspace{1cm} (14.4.6-1)

$$L_{\text{min}} = L_{\text{self}}$$ \hspace{1cm} (14.4.6-2)

2) If it is not necessary to provide train control information in the section without points, the minimum length $L_{\text{min}}$ shall meet the requirements of formula (14.4.6-2) and (14.4.6-3).

$$L_{\text{min}} = V_{\text{max}} \times T_{\text{fall}} - L_{\text{train}}$$ \hspace{1cm} (14.4.6-3)

Where, $V_{\text{max}}$ — the maximum permissive speed of the section, provided that it is not allowed by the conditions of the station or yard, the maximum permissive speed is CTCS-2 applicable speed (m/s);

$L_{\text{Constant}}$ — 20 m, residual value of the track circuit;

$T_{\text{fall}}$ — maximum dropping time of the track circuit receiving relay (s);

$L_{\text{train}}$ — train length (m);

$L_{\text{self}}$ — minimum length allowed by the track circuit itself (m).

3) According to whether it is necessary to provide train control information at the straight and side direction of the point area, the minimum length for sections with points can be decided with the above-mentioned methods.

5 Carrier frequency of the track circuits among intervals and stations shall be planned as a whole. Different carrier frequency shall be adopted at both sides of the insulation for block section, among which, 2 000 Hz and 2 600 Hz shall be adopted on main up track and siding arrival-departure up track; while 1 700 Hz and 2 300 Hz shall be adopted on main down track and siding arrival-departure down track.

6 The information coding interface of low frequency and carrier frequency of ZPW-2000 (UM) track circuit should be realized by means of computer communication.
7 Normal code sequence of the sectional track circuit shall be L5-L4-L3-L2-L-LU-U-HU (where L means green, U means yellow, H means red). Low-frequency of the track circuit on receiving and dispatching route shall be correspondence in meaning with the route conditions protected by its approaching signal.

8 Cable length for transmission of ZPW-2000 (UM) track circuit information shall not be longer than 10km; and that on high-speed railway with the speed of 300km/h and above should not be longer than 7.5km. If the cable length exceeds the above regulations, relay station should be established.

9 Certain measures should be taken to improve the shunting result of the track circuit for crossovers and shunting area in station.

14.4.7 A balise group shall be constituted by one to eight balises. The minimum distance between the adjacent balises in a group shall be 5.0 m±0.5 m.

14.4.8 Balises shall be installed for CTCS-2 system according to the following requirements:

1 Fixed balise group near block section boundary (Q) constituted by two or more fixed balises may be established every 2 block sections, which shall be set with a certain distance to the entrance of the blocking section, while 200 m±0.5 m away from the nearest BA or insulation joint at the entrance of blocking section (calculated from the balise close to the BA or insulation joint).

2 Balise group in relay station (ZJ) constituted by switchable balise and fixed balise should be established for up track and down track respectively. Distance between ZJ balise group shall be 100 m±0.5 m.

3 Balise group near home signal (JZ) constituted by switchable balise and fixed balise shall be established at the place 30 m±0.5 m away from the home signal (including the home signal for reverse direction) (calculated from the balise close to the insulation joint).

4 Balise group near the starting signal (CZ) constituted by one switchable balise and one fixed balise shall be installed at the starting signal on the arrival-departure track in the station and on the main track where train will operate turn-back according to operation diagram. CZ balise group on the arrival-departure track shall be installed at the place 20 m±0.5 m away from insulation joint of the starting signal (calculated from the balise close to the insulation joint). CZ balise group on the main track shall be installed at the place 30 m±0.5 m away from the insulation joint of the starting signal (calculated from the balise close to the insulation joint).

5 Balise group near route signal (JL) constituted by switchable balise and fixed balise shall be installed at the place 30 m±0.5 m away from the route signal (calculated from the balise close to the insulation joint). If there is only one route protected by the route signal, the switchable balise may be replaced by the fixed balise.

6 Shunting balise group near shunting signal (DC) constituted by one switchable balise and one fixed balise shall be installed at the appropriated place upstream of the shunting signal where shunting operation may endanger the safety of train operation.
7 Positioning balise group (DW) constituted by single balise shall be installed at the place 200 m ± 0.5 m away from the home signal (including home signal for reverse direction) and in the middle of the tracks in the station.

8 Balise group for large-number point (DD) constituted by switchable balise and fixed balise shall be installed at the place 200 m ± 0.5 m away from the entrance of the second blocking section upstream of the point whose size number is greater than 18 (excluding 18#).

9 If the balise is used to provide information of passing neutral section, pre-announcement balise and positioning balise group of the neutral section (DW-F) may be installed if necessary. Other balise groups in section or station can serve as pre-announcement balise and the positioning balise.

10 Balise group for broken chain (DL) constituted by the single balise should be dedicatedly installed at the boundary of the long and short chain.

11 Level transition balise among different CTCS level shall be set according to the following requirements:

1) Balise group with functions of pre-announcement (YGO/2) and execution (ZX0/2) shall be installed at the boundary of CTCS-2 area and CTCS-0 area. Pre-announcement balise group and execution balise group among CTCS-0/2 levels shall be constituted by two fixed balise as shown in Figure 14.4.8.

![Figure 14.4.8 Diagram of Layout of Level Transition Balise among CTCS-0/2 Levels](image)

2) Level transition execution point should be installed within area where less braking is performed, it should not be located near the passing neutral section.

3) Level transition execution balise group (ZX0/2) shall be installed at place 30 m ± 0.5 m away from the entrance of blocking section.

4) Distance between level transition pre-announcement point and execution point shall be greater than that of the train running at the maximum permitted speed for 5 seconds in the level transition area.

5) Two balise groups for CTCS-0 station (CZ-C0) constituted by switchable balise and fixed balise shall be installed at the exit (including that for reverse direction) of the CTCS-0 station near the execution point when transition from CTCS-0 to CTCS-2. Distance between the two balise groups shall be 100 m ± 0.5 m, and the group close to the level transition point shall be more than 450 m away from the transition boundary.
Balise groups with different functions should be combined in practical application. CTCS-3 balises shall be installed according to the following requirements in addition to those of CTCS-2 system:

1. Balise group near block section (Q) constituted by two or more fixed balises shall be installed at the entrance of each block section.

2. If the distance between two adjacent balise groups is greater than 1,500 m, positioning balise group (DW) constituted by single balise shall be added in the middle of the two balise groups.

3. Positioning balise group (DW) constituted by two fixed balises shall be installed at place 30 m ± 0.5 m away from the starting signal on main track in station without receiving and departure operation.

4. Balise group for transition from CTCS-2 to CTCS-3 level shall be established according to the following requirements (Figure 14.4.9-1).

1) RBC linking balise group (RL) shall be installed at the entrance of the transition area for transition from CTCS-2 to CTCS-3. The distance between the balise group and transition point of CTCS-2/CTCS-3 shall be greater than the running distance for train running at the maximum permitted speed of the tracks for 40 s.

2) Level transition pre-announcement balise group (YG-2/3) constituted by fixed balises shall be installed away from the level transition boundary (boundary of the blocking section) from CTCS-2 to CTCS-3 where the CTCS-3 route is the only choice inwards. Distance between the balise group and CTCS-2/CTCS-3 level transition point shall be greater than that for train running at the maximum permitted speed of the tracks for 20 seconds. The balise group shall be equipped by redundancy.

![Diagram for Layout of Level Transition Balise from CTCS-2 to CTCS-3](image-link)

3) Level transition execution balise group (ZX-2/3) shall be installed at the transition boundary from CTCS-2 to CTCS-3.

4) GSM-R network registry balise group (GRE) may be installed away from the level transition boundary from CTCS-2 to CTCS-3 within the coverage of GSM-R if necessary.

5) Balise group RL, YG, GRE and ZX may be shared with that at the entrance of the
5  RBC link cancelling balise group (RL-Q) and level transition pre-announcement cancelling balise group (YG-Q) shall be installed at place close to the point on the conjunction line when the train has linked with RBC where CTCS-3 system is not equipped, which is shown in Figure 14. 4. 9-2. RL-Q and YG-Q are constituted by two fixed balises.

6 Requirements of RBC Handover
1) Handover pre-announcement balise groups for two RBCs shall be installed with redundancy at the place away from the RBC handover boundary (boundary of blocking section), and the distance is greater than the train running at the permitted speed of that line for no less than 20 s.
2) RBC handover execution balise group shall be installed on both sides of and 30 m ± 0.5 m away from the RBC handover boundary (boundary of blocking section).
3) The handover area of RBC and that of GSM-R mobile switch center (MSC) should be separated.

14. 4. 10 Switchable balise shall transmit switchable data via LEU, and establishment of LEU shall be in accordance with the following requirements:
1 LEU should be centrally installed at the signal equipment room. The LEU controlling switchable balise located at home signal, passing signal of the block station, and at the relay station shall be configured with 1+1 redundancy structure. The LEU controlling switchable balise located at starting signal, shunting signal and point with big size number shall be configured with N+1 redundancy structure.
2 Dedicated data transmission cable shall be used to connect LEU and the controlled switchable balises. Cable length shall not be longer than 2 500 m. If it is longer than 2 500 m, LEU may be installed at the trackside, and dedicated optical fiber shall be used to connect train control center and LEU.
3 LEU shall be able to detect the broken of the balise cable.

14. 4. 11 RBC shall be established according to the following requirements:
1 RBC equipment should be installed centrally, and safety redundancy structure shall be adopted for the hardware.
2 Boundary of the RBC managing scope shall be the boundary of the blocking
section, which shall be planned together with maintenance boundary.

3 The number of trains controlled by RBC should choose the maximum number within the RBC administrative scope. When calculating the number of trains controlled by RBC, the number of trains that are on station tracks, main tracks (including the RBC handover coverage scope) and connecting lines shall be taken into consideration, and the following formula may be referenced:

\[ T_{\text{total}} = T_{\text{track}} + \left( \frac{L + L_1}{I} \right) \times n + T_{\text{branch}} + T_{\text{other}} \]  \hspace{1cm} (14. 4. 11—1)

\[ T_{\text{total}} + T_{\text{preserve}} \leq T_{\text{system}} \]  \hspace{1cm} (14. 4. 11—2)

Where, \( T_{\text{total}} \) — Total number of trains connecting with RBC at the same time within the single RBC control scope;

\( T_{\text{track}} \) — The number of trains connecting with RBC at the same time when the trains are parked at each station sidings within the single RBC control scope;

\( T_{\text{branch}} \) — The number of trains connecting with RBC at the same time at the starting point of the branch lines within the single RBC control scope;

\( T_{\text{other}} \) — The number of trains connecting with RBC at the same time in the special sections within the single RBC control scope;

\( T_{\text{system}} \) — The number of trains connecting with RBC at the same allowed by the single RBC system;

\( T_{\text{preserve}} \) — The preserved number of trains that can be connected with RBC at the same time within the single RBC control scope, value of which shall be 10% ~ 15% of the \( T_{\text{system}} \);

\( L \) — Length of the single main track within the single RBC control scope;

\( L_1 \) — Length between RBC handover pre-announcement point and the ejection point;

\( I \) — Headway of train operation;

\( n \) — Number of main tracks within the single RBC control scope;

\( II \) — Mathematic sign, which means round up.

4 If there are several yards in one station, and each yard adopts the CTCS-3 train control system, one RBC should be shared by each yard of the station if train can operate among different yards.

**14. 4. 12** Reverse operation shall be designed according to the following requirements:

1 For reverse direction track circuit shall send continuous code according to the tracing code sequence. The same coding principle as the normal direction shall also be adopted.

2 Reverse operation shall be designed to meet the requirements of onboard equipment to work in full supervision mode.
14.5 Station Interlocking

14.5.1 Computer based interlocking (CBI) equipment shall be adopted for station, block station and EMU depot and workshop (or depot).

14.5.2 CBI equipment in the station and block station shall adopt hardware safety redundancy structure, and the safety level shall be in accordance with SIL4 stipulated in Specifications and Examples on Reliability, Availability, Maintainability and Safety of Rail Transportation GB/T 21562.

14.5.3 Interlocking equipment should be installed at each yard separately for the station with more than one yard.

14.5.4 Points at section should be centrally controlled by adjacent station interlocking system. Points at shunting area should be centrally controlled by the station interlocking system. Provided that EMU depot is very close to the station, points in the EMU depot may be centrally controlled by the station interlocking.

14.5.5 The length of the approaching section of the trackside signal shall ensure that in case that the signal is turned off, the onboard ATP equipment will not trigger braking outside of the approaching section when the train is running at the maximum speed.

14.5.6 The local control terminal should be equipped for centralized interlocking equipment, but no local console will be installed.

14.5.7 Station CBI equipment may be integrated together with other signaling equipment, or be set separately.

14.5.8 The corresponding AC point machine shall be installed according to the design of the point. Protective measures against power failure shall be taken for point control.

14.5.9 Outside-locking and point closure detection device shall be installed for points whose size number is 18 and above, which shall adopt the mode of multi-engine traction and separate-circuit control and sequential moving. Trailing alarm function shall be realized. The points should be pulled with time separating and group separating in choosing and setting routes for interlocking system.

14.5.10 Pulling down device of the high-speed point shall be controlled by station CBI system.

14.5.11 Interlocking system shall be able to set the call-on route for home signal, starting signal and passing signal of block station.

14.5.12 In stations (including the stations without sidings) where the signal lights are turned off under normal conditions, vacancy detection between adjacent stations shall be carried out for starting signal or passing signal protecting the point at section to clear permissive aspect.

14.5.13 Filament alarm circuit shall be available for train signal.

14.5.14 Interlocking equipment shall be able to interface with CTC, TCC and monitoring equipment, it shall also be able to interface with RBC equipment within CTCS-3 area.
14.6 Signaling Inspection and Monitoring

14.6.1 Main signaling equipment (including the onboard equipment) shall have functions of self diagnosis, inspection, alarming, information storage and status replay. They shall agree with technical characteristics of high speed railway and meet the requirements of operation and maintenance.

14.6.2 Signaling centralized monitoring system shall be installed for high-speed railway, which is able to realize network connection for the whole line and perform remote control. It shall include the following contents:

1. Monitoring the voltage, current, frequency, power and the ground leakage current of the power supply.

2. Monitoring the current and action time of the point machine.

3. Monitoring the ground insulation of the cable cores.

4. Monitoring the current of the lighting circuit of train signal.

5. Monitoring the feeding out voltage, transmitting current, carrier frequency and low-frequency at the transmitter end of the ZPW-2000 series track circuit equipment (including the transmitting equipment with code overlapped track-circuit in station); monitoring access limit voltage, carrier frequency and low-frequency frequency at the receiving end; monitor voltage of other track circuits in the station.

6. Monitoring route operational status, route indication status, signal indication status, key relay status, status of the main signal filament, status of the fuse and so on.

7. Monitoring working status of signaling equipment like RBC, TCC, computer interlocking, CTC and signaling vital data network.

14.6.3 Signaling centralized monitoring system shall be constituted by the main equipment at the maintenance center level, the equipment at the station level, the terminals and data transmission network. The main equipment at the depot level shall have interface with the integrated maintenance management information system.

14.6.4 Signal centralized monitoring system shall have interface with CTC, RBC, TCC, computer interlocking, signaling vital data network administrative server, sectional track circuit, intelligent power supply panel and intelligent filament alarming unit to collect the related monitoring information.

14.6.5 Maintenance and inspection equipment for onboard signaling system shall be installed at the EMU depot and workshop (or depot).

14.6.6 High-speed railway shall be equipped with train control data management system including balise telegram management, dynamic monitoring of train control equipment, downloading and analysis of train control data.

14.7 Data Transmission Network

14.7.1 Data transmission among RBC, TCC, TSRS and interlocking system shall adopt
the signaling vital data network. CTC system and signal centralized monitoring system shall adopt data communication WAN.

14.7.2 Signaling vital data network shall be in accordance with the following requirements:

1. Industrial Ethernet equipment shall be used to construct redundancy double ring network. Dedicated single mode optical fiber shall be used to connect the network equipment.

2. Connecting optical fiber between double ring network equipment shall adopt different physical paths; connecting optical fiber between the same ring network equipment and the relay channel shall adopt different physical paths.

3. Length of the optical fiber connecting the adjacent network equipment shall not exceed 70km. If the length of the optical fiber cannot meet the requirement, relay equipment shall be added.

4. Network ring shall be separated into different sub-ring networks if the number of network equipment, like switch and relay device, of one independent ring network exceeds 40 or the length of the railway line is longer than 600km. Adjacent sub-ring networks shall be connected via the three layer industrial Ethernet switch.

5. Independent network administrative systems shall be established.

14.7.3 Configuration of the CTC digital communication WAN shall be in accordance with the following requirements:

1. WAN between the dispatching center and the station shall adopt the mode of double computers and double channels to construct the network. Digital network using the dedicated chains with different physical paths should be used to construct the network.

2. Star-typed, ring-typed or the combined structure shall be used according to the site condition. If ring-typed structure is adopted, one bypass channel connecting the dispatching center shall be added every 5~10 information source points.

3. The band-width of the channel shall not be less than 2 Mbit/s.

14.7.4 Signal centralized monitoring data communication WAN shall adopt communication data network. The transmission rate shall not be less than 2 Mbit/s. Transmission channel shall adopt redundancy modes like bypass, ring type or tapping. If the ring-typed structure is adopted, one bypass channel connecting the monitoring server shall be added every 8~15 information source points.

14.8 Signaling Power Supply

14.8.1 Integrated intelligent power supply panel shall be adopted for dispatching center, station, block station, signaling relay station and EMU depot and workshop (or depot) to provide power for signaling equipment including train control equipment, interlocking, CTC, signaling centralized monitoring and signal vital data network.

14.8.2 Power supply panel shall adopt the modular and redundant structure with self inspection function, which shall be able to provide power supply monitoring information
for signaling centralized monitoring system.

14.8.3 Two sets of UPS shall be installed for dispatching center, station, block station, signaling relay station and EMU depot and workshop (or depot), and the capacity shall be in accordance with the following requirements:

1. UPS capacity shall be calculated according to the load of all of the signaling equipment excluding point machine.

2. The continual power supply duration of the UPS at the places where maintenance people are on duty shall be no less than 30 min.

3. The continual power supply duration of the UPS at the places where no maintenance people are on duty should be no less than 2 h.

4. Single set of UPS shall be installed for signaling monitoring equipment in the maintenance base, comprehensive maintenance workshop and maintenance work district. The duration of the UPS shall be no less than 10 min.

14.9 Optical Fiber and Cable

14.9.1 Signaling transmission line shall adopt the corresponding cable or optical fiber required by the equipment.

14.9.2 Application of signaling cable shall be in accordance with the following requirements:

1. For the cable used for ZPW-2000 series track circuit, it is required that:
   1) The same cable shall not be adopted for signal transmitting and receiving with the same frequency.
   2) Signal transmitting with the same frequency shall not be established within the same shielded quad.
   3) Signal receiving with the same frequency shall not be established within the same shielded quad.

2. For the cable with two or more cores, there shall be two or more receiving with the same frequency in the cable.

3. For internal shielded digital signaling cable, if there are two or more sending or two or more receiving with the same frequency in the cable, the corresponding pairs shall be established.

4. Non internal shielded digital signaling cable should not be used if frequency of each transmitting and receiving in the cable is different. However, cable shall be used as pair according to the quad diagonal line.

5. Each set of switchable balise shall independently adopt the quad balise data transmission cable with 2 as main cores and 2 as standby cores.

6. Other signaling equipment shall adopt signaling cable with the aluminum protective sleeve or comprehensive protective sleeve.

14.9.3 Storage amount of outdoor signaling cable conductor shall satisfy the current regulations stipulated in Design Specifications of Railway Signaling TB10007.

14.9.4 Signaling cable in the tunnel and the comprehensive station building shall adopt the cables with halogen-free, flame-retardant and low-smoke materials.

14.9.5 Signaling cable among sections shall be buried within different trenches according
to the up and down direction.

14. 9. 6 Optical fiber of signaling system and communication system should be combined together.

14. 9. 7 Optical fiber and cable of the signaling cable among sections and within the stations shall adopt cable trough for protection. Cable trough of the signaling cable among sections and within the stations of the double track section shall be installed at both sides of the tracks and be through type. Signaling cable trough should be combined with communication optical fiber and cable trough. When signal optical fiber and cable as well as 10kV through electricity cable are laid together, solid isolation shall be adopted between the two kinds of optical fiber and cables. Cable trough on the sectional bridge and transitional section of the tunnel shall be connected by the mode of on-situ concrete.

14. 9. 8 Pre-buried pipe shall be adopted for the cable to cross the rails, and protection shall be centralized. Cable trench or hand holes shall be established if necessary. Cable trench should not be established among the railway main tracks. Cable trench within the station and yard should be established on arrival-departure track or places where cables on platforms are gathered to cross the rails. Cable between cable trough and the equipment room shall be protected by using pipe or trough.

14. 9. 9 Indoor optical fiber (cable) shall adopt pipe or trough to perform protection. Measures for protection against rat and fire shall also be adopted.

14. 10 Lightning Protection, Electromagnetic Compatibility and Earthing

14. 10. 1 Distance between the profile of signaling equipment and the electriferous part of the catenary shall be no less than 2m in electrified line. Metal structure of the signaling equipment within 5m to electriferous part of the catenary shall be earthed.

14. 10. 2 Dangerous influence interfered by traction power supply system on signaling cable shall not exceed the stipulated standards. Dangerous influence of both normal status and short-circuit status of the catenary shall be calculated separately.

14. 10. 3 Inducted longitudinal electromotive force between two points on the same core of the signaling cable shall be in accordance with the following regulations under the electromagnetic influence of the traction power supply system.

1  It shall not be greater than 60 V under the normal feeding conditions of the catenary.

2  It shall not be greater than 60% of the DC voltage endurance test or 85% of the AC voltage endurance test of the signaling cable under the fault conditions of the catenary.

14. 10. 4 Outdoor cable steel belt (aluminum protective sleeve) shall be earthed section by section at one end.

14. 10. 5 Earthing of the signaling equipment along the line shall be integrated into the comprehensive earthing system.

14. 10. 6 Lightning protection, electromagnetic compatibility and earthing design of the
signaling equipment and buildings shall be in accordance with the related regulations of the current standards.

14. 11 Signaling Buildings

14. 11. 1 Signaling equipment room in the station shall be combined with the room for other system. Signaling equipment room in the relay station and block station can be combined with communication base station, and container type equipment room should be adopted. Protective fence shall be installed for signal equipment room in section.

14. 11. 2 The area of signaling equipment room shall be designed according to the equipment type, equipment quantity and long-term development plan. Signaling buildings and comprehensive buildings with signaling equipment inside shall be designed according to the requirements of equipment overhaul replacement.

14. 11. 3 Signaling equipment room shall be designed according to related standards, and comply with the requirements of lightning protection, electromagnetic screening, vibration-proof, dust-proof, moisture-proof, fire-proof, rat-proof and so on.

14. 11. 4 Corresponding maintenance buildings shall be available according to operation maintenance mode.

14. 12 Snow Melting on Point

14. 12. 1 Snow melting on point system shall be adopted for points on the EMU receiving and dispatching route in the stations which are northward to 0 °C isotherm temperature line (Qinling-Huaihe area) and with more than 10 days of snowing for 20 years on average.

14. 12. 2 Snow melting on point system should be constituted by control terminal, control cabinet, electrically heating element, rail temperature sensor and snow amount detector.

14. 12. 3 Snow melting on point system shall be able to control in both automatic and manual modes. Establishment of the system shall not influence normal function of the point and the track circuit.

14. 12. 4 The control terminal should be installed in the station, and a remote terminal may be installed at the dispatching center if necessary.

14. 12. 5 Control cabinet may be installed either indoor or outdoor according to the mode of power supply, which receives order from control terminal in the station, and controls the electric heating element outside of the control room via isolating equipment.

14. 12. 6 Electric heating element shall be installed on middle of rail or bottom or sliding board or other suitable places at the blade (or frog) of the point or the stock rail (or wing rail). The power of the electric heating element shall be decided according to the point size number.

14. 12. 7 One or more rail temperature sensors may be installed in each throat area.

14. 12. 8 Electricity cable should be adopted between the control cabinet and tracksde snow melting device.
14. 12. 9 Load level of power supply for snow melting device shall be class II.

14. 13 Interface Design

14. 13. 1 Signaling section shall work together with station and yard section to decide the scope of interlocking turnout and non interlocking turnout. Signaling section chooses switching equipment based on the type of interlocking turnout.

14. 13. 2 Interface between signaling section and track section shall be in accordance with the following requirements:

1. Disposal of the rail-track should be offered to signal-designer by track-designer.
2. Insulative treatments for reinforced steel in the ballastless track should be offered by signal-designer to track-designer.

14. 13. 3 Signal cable trough, cable trench, hand hole and over-rail protective pipe or troughs should be offered by Signal-designer to bridge-designer, tunnel-designer, earth structure-designer, station& yard-designer, and construction-designer.

14. 13. 4 Interface design between signaling section and building construction as well as heating and A/C sections shall be in accordance with the following requirements:

1. Signaling section proposes design requirements on buildings for signaling equipment toward the building construction section.
2. Signaling section proposes design requirements on ventilation of buildings for signaling equipment as well as A/C and fire control facilities toward the building construction section.

14. 13. 5 Interface between signaling section and communication section shall be in accordance with the following requirements:

1. Signaling section proposes requirements on configuration of optical fibre and transmission channel specially for signal toward the communication section.
2. If the sectional signal relay station equipment shares the same building with communication base station and repeater, equipment allocation shall be discussed with the communication section.
3. Signaling section proposes requirements on radio field strength coverage scope within the CTCS-3 train control section and other train control level transferring section toward the communication section.

14. 13. 6 Signaling section proposes requirements on power supple grade and load toward the electricity section.

14. 13. 7 Interface between signaling section and electricity, traction & power supply section shall be in accordance with the following requirements:

1. Sectional signal sign shall be planned with catenary pole as a whole.
2. Type of choke transformer for track circuit shall be chosen according to the traction and power supply mode and traction current.
3. Signaling section shall install automatic passing phase splitting balise according to
the location of phase splitting section provided by electricity, traction and power supply section when using balise to provide passing phase splitting information. If allocation of balise is not qualified, two sections shall discuss on the installing location of the phase splitting section.

4 Installation location of the high-pole signal shall be designed in harmonious with catenary to ensure the distance between the fringe of signaling mechanism above the signal and electric part of the catenary is greater than the requirements.

5 Boosting cable and complete transverse connecting device of the track circuit shall be designed after discussion with electricity, traction and power supply section.

14.13.8 Interface between signaling section and operational organization section shall be in accordance with the following requirements:

1 Signaling section shall design the sectional signaling equipment according to the blocking mode, traction calculation and allocation data provided by the operational organization section.

2 Signaling section shall design operational dispatching station equipment according to the information of dispatching section classification provided by operational organization section.

14.3.9 Interface between signaling section and EMU section shall be in accordance with the following regulations:

1 Buildings of signaling equipment and allocation of cable and wire in the EMU depot and workshop (or depot) shall be arranged together with the EMU section.

2 Allocation of track signal in the parking lot of the EMU depot and workshop (or depot) shall satisfy requirements of train parking on tracks proposed by EMU section.

14.13.10 Interface of the signaling and disaster control & security monitoring section shall be designed according to the following requirements:

1 Signaling section has interface with foreign intrusion protection section by using relay interface.

2 If disaster weather like wind, rain and snow attacks, temporary speed limit set manually should be adopted to guarantee train running safety via train control section.
15 Information

15.1 General Requirements

15.1.1 The design of information system shall follow the principles for unified planning, unified standards and shared resources, and meet the requirements of safety, reliability, advancement and extensibility.

15.1.2 The design of the information systems closely related to transportation and production shall take into account the independent operation of the subsystem and the station and depot.

15.1.3 The compatibility with the existing information system shall be taken into consideration in the design of high-speed railway information system.

15.2 General Framework

15.2.1 The information system shall be set up to meet the requirements of high-speed railway's transportation organization, passenger traffic marketing and operation management, mainly including systems of operation dispatching control, passenger service, EMU management, integrated maintenance management, office management, public security management, construction project management and public basic platform.

15.2.2 The public basic platform shall include network basic platform, information sharing platform and information security platform.

15.2.3 The framework of information system shall adapt to the operations management mode of high-speed railway.

15.3 Operation and Dispatching System

15.3.1 The high-speed railway operation and dispatching system shall have the functions of plans compilation, operation management, rolling stock management, power supply management and passenger transport dispatching, and comply with the relevant regulations issued by the Ministry of Railways.

15.3.2 The operation and dispatching systems shall be set up in Ministry of Railways dispatching center, dispatching post, EMU depot and workshop (or depot), integrated maintenance bases and stations.

15.3.3 The design of operation and dispatching system shall comply with the following requirements:

1. The system shall be structured in hierarchy of Ministry of Railways control center, dispatching post and depot.
2 Data server, application server, communication server, storage device, dispatching console terminal, network equipment, network security and maintenance management equipment and large screen display equipment shall be set in Ministry of Railways dispatching Center and dispatching post.

3 The dispatching console shall include planning dispatching console, train dispatching console, EMU dispatching console, power supply dispatching console, integrated maintenance dispatching console and passenger transport dispatching console.

4 The control terminal and network equipment shall be set up in stations, EMU depot and workshop (or depot) and integrated maintenance bases in compliance with the demand for transportation operation activities.

15.3.4 The equipment configuration for operation and dispatching system shall comply with the following requirements:

1 The capacity of host computer, the data storage and network transmission capacity shall be appropriately advanced with consideration of a certain surplus.

2 High performance minicomputers shall be adopted for the database servers in Ministry of Railways dispatching Center and dispatching post, and the compact computers may be selected for application servers. The SAN-based (storage area network) framework storage system shall be used for the storage equipment.

15.3.5 The operation and dispatching system shall apply unified basic data codes. The system software shall select universal open platform. The application software shall meet the system function requirements with corresponding processing capability.

15.3.6 The network design of operation and dispatching system shall comply with the following provisions:

1 Double network shall be applied and the train operation subsystem, power supply control subsystem shall be designed on the basis of independent subsystem.

2 Dedicated line shall be used in the WAN interconnection channels among operation dispatching systems in related dispatching post.

15.3.7 The disaster prevention design for operation and dispatching system shall comply with the following requirements:

1 Ministry of Railways dispatching center shall be able to serve as a remote standby center for the passenger dedicated line dispatching post and may take over the commanding functions of the dispatching post as required.

2 Ministry of Railways control center shall adopt remote disaster prevention standby mode. Direct protection passages shall be preserved between passenger dedicated line dispatching post and the standby center so as to ensure that the backup center may take over the dispatching and commanding services in case of a failure in Ministry of Railways dispatching center.

15.3.8 The interconnection between the operation and dispatching system and other relevant systems shall comply with the following requirements:

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The operation and dispatching system shall interconnect with relevant systems, and the interfaces shall be placed in the dispatching post.

For the interconnection between the operation dispatching system and the remote control system of the power supply dispatching system, the interface shall be set in the dispatching post.

The operation and dispatching system shall be interconnected with Ministry of Railways ticket center system in Ministry of Railways dispatching center.

The operation and dispatching system shall be interconnected with the passenger service center of passenger service area center at the dispatching post.

For the interconnection between the operation dispatching system and the EMU management information system and integrated maintenance management system, the interface should be set in the dispatching post.

The operation and dispatching system shall be interconnected with disaster prevention and safety monitoring system, and the interface should be set in the dispatching post.

The operation and dispatching system shall be interconnected with relevant control systems, the interfaces shall be placed at Ministry of Railways control center or in the dispatching post.

15.4 Passenger Transport Service System

15.4.1 The passenger transport service system consists of ticketing system, passenger service system, marketing and planning system, integrated service platform, data platform and safety security platform. The functions of the systems shall comply with relevant provisions issued by Ministry of Railways.

15.4.2 The design of ticketing system shall comply with the following requirements:

1 System configuration requirements

1) The system shall be constructed in hierarchy of Ministry of Railways ticketing center and station ticketing system.

2) Magnetic paper ticket shall be used for the ticket system, and other tickets may also be used based on the demand.

3) Ministry of Railways ticket center shall be equipped with such devices as database server, application server, storage device, network equipment, network security, monitoring and maintenance terminal equipment to fulfill primarily ticket selling and booking, centralized management of seats and real-time transaction processing.

4) The region center shall be set up with network equipment, management terminals and monitoring terminals to realize the network converging of station ticketing systems within governance, the management of ticket selling and checking, and monitoring of ticketing system.

5) Ticketing systems of station level shall be set up with server, managing terminal, automatic ticket vending machine, booking office machine, automatic entrance gate
machine, automatic exit ticket checking system and compensating fair machine so as to fulfill primarily ticket selling, ticket checking, fare adjustment machine, ticket refunding and ticket endorsing.

6) The station ticket equipment shall be featured to perform off-line ticket selling, and the ticket checking terminal shall be featured to perform emergency evacuation functions such as channel power-off release and manual release.

2 Principles to determine the quantity of ticket selling and checking terminals
1) The number of ticket selling and checking terminals shall be calculated according to different calculation models and relevant parameters on the basis of station type and scale, the layout of passenger waiting space, and the passenger flow organization pattern.

2) The number of ticket selling terminal shall be calculated following the principle for quick and convenient ticket buying and take into account passenger flow, device capacity, space layout of ticket selling architecture, ticket selling ratio between in-station and out-of-station, ratio between auto ticket selling and window ticket selling.

3) The number of ticket checking terminals shall be calculated following the principle for quick passing and in the light of passenger flow, device capacity, ticket checking mode, layout of arrival and departure lines and platform, and layout of passenger waiting space.

3 Network Setting Requirements
1) Ministry of Railways ticket center, trunk network of station LAN shall apply double network structure of kilomega capacity.

2) WAN interconnection channels shall use dedicated lines.

15. 4. 3 The design of passenger service system shall comply with the following requirements:
1 System Configuration Requirements
1) The system consists of two levels of region center and station.

2) Central integrated management platform shall be set up at the region center to fulfill primarily basic data maintenance, drawing out and publishing passenger service strategies and centralized monitoring and management of the passenger service system within the governance of station.

3) Station integrated management platform shall be set up in the station to fulfill information sharing and unified management of passenger service subsystems. Based on station scale and requirements, the subsystems for passenger information system, public address system, closed-circuit television system, enquiry, clock, assistance application, luggage inspection, hand luggage storage and platform ticket shall be provided.

2 Region center level system and station level system should be interconnected via public data network.
3 Equipment configuration requirements

1) Full-color LED screen should be adopted for the centralized display screen in the distribution hall of large and supper-large passenger stations, to indicate information about waiting, guiding and announcement.

2) Digital public address system shall be used in large and supper-large passenger stations. The acoustic design of public address system shall be integrated with architecture acoustic design.

3) The setting of cameras for monitoring system shall comply with the requirements for passenger transport service and public security management and shall access integrated visual monitoring system.

4) Setting of the station passenger service system terminals shall be considered the entirety station scale, station plan, passenger flow line, function requirements and also take into account static guiding signs.

15. 4. 4 The design of marketing planning system shall comply with the following requirements:

1) The system shall be structured in hierarchy of Ministry of Railways control center and passenger region center.

2) Ministry of Railways systems shall be featured to fulfill market survey and analysis, passenger flow forecasting; ticket selling strategies formulation; ticket pricing formulation; running schedule design, customer relationship management etc.

3) Region center systems shall be featured to fulfill within the regional governance passenger flow statistics, analysis and forecasting; marketing information release; data collection, sorting and uploading to Ministry of Railways.

4) Marketing planning system shall be equipped with database and data warehouse server, application server, storage device, network equipment, monitoring and maintenance management terminal equipment.

15. 4. 5 The design of integrated service platform shall comply with following provisions:

1) The integrated service platform shall provide voice, short message and internet services for calling center system and provide passengers with enquiry, information, ticket booking, and complaint services.

2) The call center shall adopt centralized distribution structure with two levels of Ministry of Railways and passenger service region center.

3) By interconnecting with the ticketing system, passenger service system and relevant out-of-railway information systems, the region calling center shall fulfill data collection and editing and provide region service call access and information releasing. Ministry of Railways calling center gathers relevant business information, provides relevant business call access and information publishing services. Portal website shall be set in entirety by Ministry of Railways calling center.

4) Manual seating configuration shall be set in Ministry of Railways, passenger
service region centers and stations based on the service requirements and scale.

15.4.6 The interconnection between passenger service system and relevant systems shall comply with the following requirements:
1 Ticketing system shall be interconnected with existing ticketing and reservation system (TRS) at Ministry of Railways center.
2 The ticketing system shall be interconnected with operation and dispatching system at Ministry of Railways center.
3 The passenger service system shall be interconnected with operation and dispatching system at passenger service region center level.
4 The passenger service system, marketing planning system and integrated service platform shall be interconnected at both Ministry of Railways and passenger service region center.
5 The passenger service system at station level shall be interconnected with ticketing system.

15.5 EMU Management Information System

15.5.1 EMU management information system fulfills mainly EMU application management, maintenance management, technical management, spare parts logistic management, equipment management, safety and quality control, cost management, statistics and analysis.

15.5.2 The design of EMU management information system shall comply with the following requirements:
1 The system shall be structured in levels of Ministry of Railways, EMU depot and EMU application post.
2 Ministry of Railways, EMU depot and EMU application post shall be provided with database server, application server, communication server, storage device, various terminals and maintenance management workstation.
3 EMU depot dispatching office shall be provided with such terminals as on-duty dispatching, running dispatching, application dispatching, inspection and repairing dispatching and train operation dispatching so as to fulfill centralized dispatching and monitoring of EMU running and repairing activities within EMU depot. Inspection shed and repairing shed shall be provided with such terminals as production dispatching and operation monitoring station to fulfill sectioned operation dispatching and monitoring.
4 The dispatching office at EMU application post shall have terminals for plan dispatching, operation dispatching and production dispatching.
5 Work location terminals shall be established at such places as the inspection shed, casual repair shed, repair shed, bogie shed, wheel set tread diagnosing shop, car washing shed, spare part warehouse, and every repair workshop within the scope of the side span. The number of work location terminal in the inspection shed and repair shed should not be less than 3 sets per column and shall not be less than 1 set for each work profession in the
workshop.

6 Ethernet interface and other data collection interface devices shall be installed near the main control consoles of such automatic inspection and repair equipments as wheel-set tread diagnosing equipment, under-floor lathe, bogie replacing equipment and hollow axle detection equipment.

7 WLAN shall be installed, where necessary, in the inspection shed and repair shed with spaces of large span. Repairing staff shall be equipped with wireless portable terminal.

8 EMU depot and EMU application post shall be provided with on-board inspection data access devices.

15.5.3 The configuration of EMU management information system shall comply with the following requirements:

1 Ministry of Railways and EMU database server shall use compact computer, the application server may use compact computer and other servers should use micro-computers. Storage equipment shall use a storage system based on storage-area-network (SAN) structure.

2 EMU application post database server and application server should adopt micro-computer server. Storage equipment may use a storage system based on direct-addition-storage (DAS) structure.

15.5.4 EMU management information system shall adopt unified application software, and the system software shall adopt unified general open platform.

15.5.5 The LAN backbone network at EMU depot and EMU application post shall be constructed with a capacity of kilomega, and network nodes should be connected with optical fibers.

15.5.6 EMU management information system shall be interconnected with operation dispatching system and the interface should be located in the dispatching post.

15.5.7 The interface to connect centralized train control (CTC) system should be provided on the part of EMU management information system of EMU depot.

15.6 Integrated Maintenance Management Information System

15.6.1 The integrated maintenance management information system fulfills mainly functions of maintenance planning, maintenance dispatching and maintenance activities for equipment and facilities of high-speed railway lines, bridges, subgrade, tracks, communication, signal and power supply.

15.6.2 The design of integrated maintenance management information system shall comply with following specifications:

1 The system shall be structured in hierarchs of Ministry of Railways, integrated maintenance base, integrated maintenance workshop and integrated working section.

2 Ministry of Railways system performs primarily the review and management of
equipment/facilities’ upgrading and heavy repair planning.

3 The integrated maintenance base system fulfills primarily test of infrastructure performances and status, collection and analysis of maintenance information, compilation of repairing and maintenance plan, maintenance dispatching management and maintenance activities monitoring.

4 The integrated maintenance workshop system performs primarily test of infrastructure performances, collection and process of maintenance information, compilation of repairing and maintenance plan, dispatching and management of repair and maintenance, maintenance activities monitoring, management of maintenance equipments and spare parts.

5 The integrated working section system performs primarily monitoring of repairing and maintenance activities, feedback of real performance data.

15. 6. 3 The configuration of integrated maintenance information system equipment shall comply with following specifications:

1 The integrated maintenance base and integrated maintenance workshop shall be provided with database server, application server, interface server, storage device and network equipment.

2 The dispatching office at the integrated maintenance base shall be provided with terminals of general dispatching console, plan dispatching console, and maintenance dispatching console, and data analysis terminals shall be provided on the basis of work professions.

3 Work location terminals shall be set up at the side spans in the heavy equipment repair shed at the integrated maintenance base and at each equipment location, complex workshop of electrical repairing and measurements, and cubic warehouse of large machine spare parts. The repair workshop equipped with automatic inspection and repair facilities shall be provided with Ethernet interface and other data collection interface devices.

4 The dispatching office in the integrated maintenance workshop shall be provided with terminals of plan dispatching console and maintenance dispatching console, and redisplay terminals of power supply dispatching, electrification engineering monitoring, power environment monitoring, disaster prevention monitoring, and data analysis terminals shall be set up on the basis of work professions. Work location terminals shall be set up in repair workshop and track car shed; and management terminals shall be set up in terms of work teams.

5 The integrated working section may be provided with network facilities and maintenance dispatching console; and computer monitors of power supply dispatching, electrification engineering monitoring, power environment monitoring and disaster prevention monitoring. Work location terminals shall be set up on the basis of work professions to fulfill transmission of working sheets of maintenance activities and entry of repair maintenance performance information.

15. 6. 4 The configuration of integrated maintenance management information equipments
shall comply with following specifications:

1. The maintenance base database server shall use compact computer, the application server may use compact computer and the interface server should use micro computer. Storage equipment shall use a storage system based on SAN structure.

2. The integrated maintenance workshop database server may use compact computer, the application server and interface server should adopt micro-computer server. Storage equipment may use a storage system based on DAS structure.

15.6.5 The integrated maintenance management information system should adopt unified application software and the system software shall adopt unified and general open platform.

15.6.6 The main networks at the integrated maintenance base and integrated maintenance workshop should be constructed with a capacity of kilomega, and network nodes should be connected with optical fibers.

15.6.7 The interconnection between the integrated management information system and relevant systems shall comply with following specifications:

1. The integrated management information system shall be interconnected with operation dispatching system, and the interface should be located in the dispatching post of passenger dedicated lines.

2. The integrated management information system shall be interconnected with disaster prevention and safety monitoring system, and the interface should be located in the integrated maintenance workshop.

15.7 Other Information Systems and Auxiliary Facilities

15.7.1 The dispatching post, station, EMU depot (post), integrated maintenance base, integrated maintenance workshop, integrated working section shall be provided with office information system, which shall be structured based on their administrative levels.

15.7.2 The dispatching post, station, EMU depot (post), integrated maintenance base shall be provided with statistic system and financial system, which shall be structured in levels according to their administrative scope.

15.7.3 The construction of high speed railways shall be provided with construction project management information system.

15.7.4 Public security organizations such as public security department, local police station and train police team shall be provided with public security management information system, which shall be structured in levels of Ministry of Railways public bureau, railway public bureau, railway public security bureau department and grass root teams, and shall form an independent network.

15.7.5 The dispatching post, station, EMU depot (post), integrated maintenance base, integrated maintenance workshop and integrated section shall be provided with auxiliary facilities like access control system, and safety protection facilities shall be in the places around important locations.
15.8 Network Infrastructure Platform

15.8.1 The network infrastructure platform fulfills transmission of the information from passenger dedicated line information system according to the requirements for structures and interconnections of various information systems. It includes WAN and LAN. The network bandwidth and service quality shall comply with the requirements for transmission of the information from various information systems.

15.8.2 The interconnection between WANs of information systems shall comply with following specifications:

1 The sub-running dispatching system of the operation and dispatching system, the sub-power supply dispatching system and ticketing system, and the public security management information system shall adopt dedicated networks with dedicated lines to fulfill WAN interconnection between system levels.

2 Dedicated lines shall be employed to fulfill interconnection between operation and dispatching systems in relevant dispatching posts, and between operation and dispatching system and ticketing system.

3 Other information systems shall adopt railway data communication network to fulfill interconnection between system levels and with WANs of other relevant systems.

15.8.3 The design of LAN of the information system shall comply with following specifications:

1 The LAN main networks of operation and dispatching system and ticketing system shall employ double network structure with kilomega capacity. Each system forms an independent network section.

2 The LAN main network of the public security management information system may use double network with kilomega capacity and form an independent network section.

3 Other information systems may share LAN network section. The LAN main networks of the dispatching post, EMU depot and integrated maintenance base and integrated maintenance workshop may use double network of kilomega capacity. The LAN main networks of EMU application post, integrated maintenance section and station may use network with kilomega capacity.

15.9 Information Sharing Platform

15.9.1 The information sharing platform shall employ unified and specified sharing mechanism, interface and protocol to fulfill interconnection between and among the information systems serving traffic organization, passenger transport marketing, business management and shared information.

15.9.2 The dispatching post and region center should be provided with information sharing platform to fulfill information sharing at database level and application level. Such public basic information as public basic coding, basic traffic information and railway space...
information shall be provided, if required, for the information sharing platform.

15. 9. 3 Information sharing platform may be established accordingly at station and depot level to fulfill information sharing between relevant subsystems in relevant systems.

15. 10 Information Security

15. 10. 1 The high speed railway information system shall be designed for safety consideration according to the safety grade classifications related to national and railway information systems and the requirements for safety protection measures.

15. 10. 2 The design of high-speed railway information system security shall include environment safety, data safety, network and system safety, and shall comply with following specifications:

1 The environment safety shall protect the physical devices and communication links of the information system from being invaded and destructed, including the design of equipment room location and layout, equipment room access control, invasion warning and pipe line safety protection.

2 The data security shall include the design of system data storage, local data backup and remote data backup.

3 The network and system safety shall include access control and anti-virus. Access control measures is used to protect network from being invaded and attacked, covering the design of firewall, gateway, invasion inspection, encryption, identity certification. Anti-virus service shall provide the information systems at each level with network anti-virus system. Unified virus database updating and distribution shall be performed according to service management authority of the information system.

15. 11 Equipment Room, Power Supply, Lightening Protection and Earthing

15. 11. 1 The information equipment rooms of Ministry of Railways control center, ticket center and dispatching post shall meet Grade A standard specified in Specifications for the Design of Electronic Information System Machine Room GB 50174. The main information equipment rooms in EMU depot, integrated maintenance base and large passenger stations shall satisfy Grade B standard. Information equipment rooms in other station and depot shall meet Grade C standard.

15. 11. 2 Each information system should share equipment room.

15. 11. 3 Equipment room decoration, air conditioner, power supply, monitoring and pipe line shall be designed by virtue of integration.

15. 11. 4 Key equipment of the information system shall be provided with UPS. The standby time may be determined according to device functions and external power conditions.

15. 11. 5 The power system of the information system and outdoor communication line shall be designed with lightening protection.
15. 11. 6 Lightening protection of the information system shall comply with the specifications under the current national standard GB 50343 *Technical Specifications for Lightning Protection of Building Electronic Information System* and other technical specifications related to railway lightning protection, magnetic compatibility and earthing engineering.

15. 12 Interface Design

15. 12. 1 The design of interface between interconnected information systems shall comply with the requirements for independency and safety of each information system. Dedicated interface devices as interface server and protocol converter shall be used.

15. 12. 2 The design of interface within integrated information system shall adopt open interface and interfacing procedures as much as possible on the premise of conformity with the independency of each information system.

15. 12. 3 The design of interfaces between the information system and other specialties shall comply with following specifications:

1 Requirements shall be put forward involving the buildings of the information system, including the requirements for equipment room layout, decoration, fixtures, pipe trough and embedding, structural load and integral pipe lines. Equipment rooms shall meet the requirements for information system equipments.

2 Requirements shall be put forward to the electric power profession involving the load grade, load capacity and earthing required for information equipment.

3 Requirements shall be put forward to the heating and ventilation specialty involving the design of environment and fire-fighting facilities related to information equipments.

4 Requirements shall be put forward to the communication specialty involving information system channels, including channel type, channel networking, and environment monitoring over the information equipment room.

5 Requirements shall be put forward to the station and yard specialty involving the arrangement of pipe troughs.
Disaster Prevention and Safety Monitoring

16.1 General Requirements

16.1.1 The disaster prevention and safety monitoring system is an integrated system, including subsystems for monitoring wind, rain, snow, earthquake, intrusion etc. Corresponding motoring system shall be selected according to weather conditions geological conditions, environmental conditions along the high-speed railway line and the operation speed involved in a specific project to construct a reasonable and appropriate disaster prevention and safety monitoring system for high-speed railways.

16.1.2 The equipments for the disaster prevention and safety monitoring system shall be located within the railway land. The on-site monitoring equipment shall not be installed to intrude the construction clearance of high-speed railway.

16.1.3 The disaster prevention and safety monitoring system consists of site monitoring devices, monitoring data processing devices and dispatching post equipments, etc.

The on-site monitoring equipment shall include on-site monitoring sensor and monitoring unit, etc. The monitoring unit should be set in neighboring communication equipment room or information equipment room.

The monitoring data processing equipment shall include server, maintenance terminal, network equipment and power supply equipment, etc. These equipments may be installed in the station where the integrated maintenance workshop is located.

The dispatching post equipments include those for disaster prevention and safety monitoring terminal and communication interface equipment, etc.

16.1.4 The on-site devices of the disaster prevention and safety monitoring system shall meet the requirements of non-attendance. The system equipment shall be featured with the function to fulfill complete self diagnosing and maintenance.

16.1.5 The disaster prevention and safety monitoring system shall be able to provide the interface to connect the disaster information database.

16.1.6 The disaster prevention and safety monitoring system shall be able to provide the interface to connect national meteorological and seismological agents.

16.1.7 The equipment of the disaster prevention and safety monitoring system shall, according to site conditions, be connected to the integrated grounding system, or the grounding system of the traction power system, or the shared building grounding system.

16.1.8 The main hardwares of the disaster prevention and safety monitoring system should be of double redundant configuration. The on-site monitoring equipments shall be selected, as a principle, from those with durability, stability and reliability, less
maintenance, easy repairing and low cost.

16.2 Wind Monitoring

16.2.1 Wind speed and wind direction detecting point shall be set up in areas where the maximum wind speed is more than 15m/s.

16.2.2 In sections of mountain cross over, canyon and river valley, the wind speed and wind direction detecting points shall be distributed with 1～5 km average interval. In sections with bridge and high embankment, the average interval shall be 5～10 km.

16.2.3 The wind speed and wind direction detection point shall be equipped with wind gauge. The installation of wind gauge shall comply with following requirements:

1. The wind gauge shall be installed in double sets, to detect the parameters of atmospheric pressure and temperature.

2. Wind gauge shall be installed 4m above the rail surface on the catenary mast.

3. The installation location of wind gauge shall avoid the influence over the surrounding buildings on the detection data.

16.3 Rainfall Monitoring

16.3.1 Rainfall detection point shall be set up in areas where the annual rainfall is more than 200 mm.

16.3.2 In sections with continuous subgrade and on ballasted track lines, rainfall detection points shall be distributed normally with 15～20 km interval. On ballastless track lines, rainfall detection points shall be distributed normally with 20～25 km interval. The arrangement of rainfall detection points shall be adjusted according to the topographic, geomorphic, geological and vegetation conditions along the railway line.

In special sections with high embankment, high cut and tunnel portal, special consideration shall be taken and the number of rainfall detection point may be increased if necessary.

16.3.3 The rainfall detection point shall be equipped with pluviograph, and the installation of pluviographs shall meet the following requirements:

1. Pluviograph shall be provided in single unit.

2. Pluviograph shall be installed in unsheltered and spacious places, and should be located in the place same as wind gauge.

16.4 Snow Monitoring

16.4.1 In areas with frequent snowing or with maximum snow-cover of 36cm and above in terms of 10 years, snow inspection points shall be set up.

16.4.2 The snow volume inspection point shall be distributed with 50km interval in principle. The points are normally located in the station, integrated maintenance workshop and working section.
The snow volume inspection point shall be equipped with snow meter which shall be set up in unsheltered and spacious places.

16. 4. 3 Snow detector shall be provided in single set.

16. 5 Seismic Monitoring

16. 5. 1 In areas along the railway line with seismic peak acceleration of 0.1g or above, seismic monitoring points shall be set up. The seismic monitoring point shall be able to monitor S wave and provide P wave alert if possible.

16. 5. 2 The seismic monitoring point may be located in the traction substation, AT post and sectionalizing post with a 20 km interval, and shall be equipped with seismomometer.

16. 5. 3 The seismic monitoring point should be equipped with two seismometers within an interval of 40 m.

16. 6 Clearance Intrusion Monitoring

16. 6. 1 Clearance intrusion monitoring devices shall be installed at the bridge where the highway crosses over the railway, at the tunnel portal where danger may exist, and in the section where the highway parallels the railway.

16. 6. 2 The clearance intrusion monitoring subsystem monitors accidental objects intruding railway clearance and triggers the train control system to stop the train automatically.

16. 7 Power Supply

16. 7. 1 The equipment of the disaster prevention and safety monitoring system are powered as of Class 1 load.

16. 7. 2 Monitoring data processing equipment shall be equipped with double sets of UPS with the power supply duration not less than 30 min.

16. 7. 3 The devices of monitoring unit shall use UPS with service time of no less than 2 h.

16. 8 Interface Design

16. 8. 1 The communication interfaces of the disaster prevention and safety monitoring system with centralized traffic control system (CTC), the operation control system, the integrated maintenance management information system and the national meteorological and seismological agents shall adopt Ethernet interfaces and TCP/IP protocol.

16. 8. 2 The interface between the disaster prevention and safety monitoring system and the second class master clock devices of railway time synchronizing network shall adopt NTP protocol.

16. 8. 3 The interface between the disaster prevention and safety monitoring system and train control system shall adopt AX relay interface and comply with fault-safety principle.

16. 8. 4 The interface between the disaster prevention and safety monitoring system and the traction feeding system shall adopt relay interface circuit.
16.8.5 The bridge department shall design preserved installation interface on the highway bridge crossing over the railway for the disaster prevention and safety monitoring system. The relevant tunnel and track departments, according to on-site danger level, shall indicate the tunnel portals and highway/railway parallel locations where need to be equipped with clearance intrusion monitoring devices, and the interfaces for installation shall be reserved.
17 EMU Facilities

17.1 General Requirements

17.1.1 The EMU servicing, inspecting and repairing facilities shall be designed on the basis of power-distributed EMU. The maintenance schedules should be classified by I, II, III, IV and V level. The inspection and repair intervals shall be determined according to the allocated EMU models.

17.1.2 The EMU facilities shall be in accordance with the following requirements:

1. The allocation of EMU facilities shall comply with the PDL network plan and follow the principle of maintenance centralization and stabiling decentralization, meet the requirements of “repairing quickly, safety and reliability, and operation efficiently”.

2. The EMU inspection facilities shall focus on the inspection and service of the main models of allocated EMU, as well as other models, to fulfill quick inspection, improve EMU turnaround and operation efficiency. The maintenance system which is the combination of repair based on time and condition shall be adopted for the EMU repair facilities. It shall be focused on components exchange repair, special and concentrated repair for key parts.

17.1.3 The scale of EMU workshop (depot, yard) shall be determined according to the calculation based on the train pairs, train combination allocated EMU quantities, repair schedules and maintenance time.

17.1.4 EMU workshop (depot, yard) shall be designed according to the following scope:

1. EMU depot & workshop, which is allocated EMU, undertakes the repair of level I, II, III and above, temporary repair and service (including passenger traffic service) and stabiling.

2. EMU depot, which undertakes passenger traffic service, the repair of level I, II, temporary repair and stabiling for departure and arrival EMU at the passenger station where the EMU depot is located.

3. EMU yard, which undertakes EMU stabiling, is equipped service facilities (including passenger traffic service) if required.

17.1.5 The location of EMU workshop (depot, yard) shall be in accordance with the following specifications:

1. EMU workshop (depot, yard) should be located near the passenger station with more departure and arrival of EMU and it’s better to adopt the longitudinal layout with station. The entry and exit line of EMU workshop (depot, yard) shall avoid disturbing station operation as soon as possible and shall meet the station-style and traffic

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development. The entry and exit line should across over or under the main line.

2 EMU workshop (depot, yard) should be located away from the area with poor geological and hydrologic conditions and shall drain well.

17.1.6 The wastes and noise generated in EMU workshop (depot, yard) shall be treated comprehensively and comply with the standard of nation and local current regulations for environment protection.

17.2 General Layout

17.2.1 The general layout of EMU workshop (depot, yard) shall be in accordance with the following specifications:

1 The general layout shall be planned according to the long term plan. The inspection and repair workshops, the combination of workshops, buildings and other facilities shall be carried out according to the short term plan.

2 The general layout for buildings, tracks, roads, pipe lines and vegetation facilities in the EMU workshop (depot, yard) shall be designed according to the requirements for production process, environment protection, fire proof, sanitary, ventilation and lighting, also in consideration of the topographic, geological, hydrological and meteorological conditions. Reservation for future development shall be considered.

3 EMU depot & workshop should be arranged with longitudinal layout. Transverse layout may be applied when the quantity of the stabiling EMU is less than 10 or the geological condition is limited.

4 The tracks in EMU workshop (depot, yard) shall be controlled and managed automatically and concentrated.

5 The inspection and repair of EMU should be conducted on different tracks. Inspection shall be conducted in fixed position while repair may be conducted either in fixed position or in movable operation.

6 Roads in EMU workshop (depot, yard) shall be provided with the area for car turn around.

17.2.2 The arrangement of tracks in EMU workshop (depot, yard) shall be in accordance with the following specifications:

1 As for EMU depot & workshop, entry and exit line, shunting track, lead track, stabiling siding, train surface washing siding, wheel-set tread diagnosing track, inspection workshop track, repair workshop track, underfloor wheel lathe track, temporary repair siding shall be applied; material transport track, static test track, running test track, sewage discharge track and uncoupling track may be applied if required.

2 As for EMU depot, entry and exit line, shunting track, lead track, stabiling siding, train surface washing siding, wheel-set tread diagnosing track, inspection workshop track, underfloor wheel lathe track, temporary repair siding and sewage discharge track shall be applied. The sewage discharge track should be shared with
inspection workshop track or service track.

3 As for EMU yard, entry and exit line, shunting track and stabling siding should be applied, sewage discharge track and service track may be applied if required, it may be shared with each other.

17.2.3 Tracks in EMU workshop (depot, yard) shall be in accordance with the following specifications:

1 The number of entry and exit lines in EMU depot & workshop shall be not less than 2. When more stations are linked, the number of entry and exit lines leading to each individual station shall be calculated separately. 2 entry and exit lines shall be set in depot or yard, while 1 may be acceptable when the quantity of stabling EMU is no more than 10.

2 The quantity of stabling tracks shall be determined according to EMU turnaround diagram. The number of inspection workshop tracks in EMU depot & workshop (or depot) shall be included in the quantity of stabling tracks.

The effective length of stabling track shall satisfy the requirement of stabling one whole EMU plus extra safety distance.

The interval between stabling tracks, on which operations are conducted, shall be not less than 4.6 m; on which no operation is conducted and the requirement for signal installation is satisfied, shall be 4.2 m; among which there is OHL post or light bridge post, shall be not less than 6.5 m. The interval between service tracks shall be not less than 6.0 m.

OHL shall be hanged over stabling tracks. Lighting and fire-fighting equipment shall be set.

3 The train surface washing siding should be of through pattern. The effective lengths at both sides of the washing machine each shall be able to satisfy one EMU stabling. Movable washing machine may be used where condition is limited.

4 The tracks at both sides of the wheel-set tread diagnosing equipment each shall set a section of straight line for one vehicle.

5 The sewage discharge track shall be set when required. It may be shared with the inspection workshop track or the service track.

6 The temporary repair siding and the underfloor wheel lathe track may be arranged in through or stub-end pattern, their effective lengths shall be not less than the length of two trains plus the length of the shed, the length of the straight track shall be not less than the length of the shed plus two vehicles, each before and after the shed.

17.2.4 Static test track and running test track shall be set in EMU depot & workshop, and should be in accordance with the following specifications:

1 The length of the static test track shall meet the requirements of stabling one whole EMU.

2 The running test track should be flat and straight, and its length shall be determined comprehensively according to the performances, distances of acceleration and
brake, technical parameters and test requirements for EMU. Track closure measures shall be taken.

3 Ground facilities for ATC test shall be set aside the running test track.

17.2.5 Inspection workshop track, repair workshop track, service track and stabiling siding in EMU workshop (depot, yard) shall be flat.

17.2.6 The minimum curve radius of the tracks in EMU workshop (depot, yard) should be not less than 250 m. It shall be not less than 400 m for long-time stabiling tracks. The signals and turnouts shall be controlled and managed automatically and concentrated.

17.3 Service and Inspection Facilities

17.3.1 EMU service and inspection facilities shall be designed according to the requirements of EMU stabiling, service, and repair of level I and II, temporary repair and underfloor wheel lathe.

17.3.2 The facilities for EMU service and repair of level I and II shall be designed according to the following scopes:

1 Inspection and repair of EMU running gear, brake system, pantograph, electric system, air conditioning system, ATC and train network control system.

2 Collection, dump and treatment of train working information, supplementary of lubricating oil and grease, water supply and drainage, car internal cleaning and supplementary of consumables, WC sewage discharge and disposal, train surface washing, garbage collection and transport of inside car.

3 Provisions of sand feeding, food and beverage supply equipment shall also be considered if needed.

17.3.3 Inspection workshop and auxiliary shed (for detection devices, electric apparatus standby, electronic component standby, car inside equipment standby, braking equipment standby, and passenger traffic service), temporary repair shed, underfloor wheel lathe shed, train surface washing equipment, wheel-set tread diagnosing equipment, pantograph dynamic detection equipment and stabiling siding shall be set in depot.

17.3.4 The design of inspection workshop shall be in compliance with the following requirements:

1 The length of inspection workshop shall be determined according to the length of EMU, inspection and repair process, the width of transport passage, factory building arrangement and the requirements of building and structure design etc. The inspection workshop length with 1 track containing 2 short EMU positions (or 1 track for 1 long EMU position) should be 468m. The workshop length with 1 track containing 1 short EMU position should be 246 m.

2 The height of the inspection workshop shall be determined by the height of workers needed on the car-top, the safe distance as well as the height of the contact line comprehensively. The elevation of the bottom chord of the roof truss should be 7.8 m.
3 The width of the inspection workshop shall be calculated and determined according to the number of tracks, track interval, operation space, equipment dimension and the width of walking and transport passages. The tracks interval should be 7.0~8.0 m, and the distance from track center to workshop side wall should be 4.0~5.5 m.

4 The straight section of the track in front of the inspection workshop should be not less than 20 m.

17.3.5 The design of equipment in inspection workshop shall be in compliance with the following requirements:

1 Catenary section insulator, grounded isolator switch shall be installed in front of the inspection workshop. Sound and light warning devices interlocked with isolator switch shall be installed in it synchronously. Catenary section insulator shall be installed between the positions with the arrangement of 1 track containing 2 train positions.

2 The tracks in inspection workshop should adopt rail bridge pattern with inspection pit in place. Vertical inspection work platforms and worker safety protection facilities shall be installed in the workshop. Water closet facilities that connected with the in-shed water supply and drainage system shall be installed on the passage of the middle platform so as to meet the needs of service activities inside EMU. Illumination facilities shall be set under the platform and in the inspection pit.

3 Information system terminal devices and interfaces shall be provided for each work point in the workshop.

4 Compressed air pipe, water supply and drainage pipe, waste drainage pipe, power line shall be installed in the workshop. These pipe lines shall be better arranged, visual pleasing, clearly marked and easy for maintenance.

5 The devices for safety monitoring system and flaw detection of wheel web and rim shall be provided in the workshop. The data shall be included in EMU management information system.

6 EMU ground test power supply may be provided accordingly in the workshop.

17.3.6 The auxiliary workshops should be arranged collectively in the side spans of the inspection workshop, and be equipped with running gear inspection devices, flaw detection of wheel and axle, tridimensional storage facility of components, as well as inspection devices for pantograph, air conditioner, brake system and operation safety.

17.3.7 The design of the temporary repair shed shall be compliance with the following requirements:

1 The shed length should be determined to meet the requirement by replacing a bogie as well as repairing a car body. The width and height of the shed shall be calculated and determined based on following factors: inspection and repair process, EMU clearance, transport and operation passages, the space needed working on the top of the car, structural dimensions of crane. The height of catenary and the safe distance shall be taken into account while catenary in shed.
2 Bogie (wheel-set) replacement device and crane shall be adopted in the temporary repair shed. The space for standby bogies and large spare parts storing shall be preserved in it.

3 Movable rigid catenary line driving and control equipment shall be installed above the temporary repair siding. It should interlock with the crane in shed.

4 Work platform of the same length as a single car should be provided in the shed.

5 Safety monitoring system shall be present in the shed while catenary in it. Its data shall be interchanged with the information system of the EMU workshop (depot).

17.3.8 The underfloor wheel lathe house shall be in compliance with the following requirements:

1 Underfloor wheel lathe, car traction and locating device shall be provided in the house. Underfloor wheel lathe with double axles shall be installed in the case of heavy work loads.

2 A section of integral ballast bed with the length of a car should be placed both in front and after the foundation of the underfloor wheel lathe.

3 Data transmission passage shall be established between underfloor wheel lathe and wheel-set tread diagnosing device.

17.3.9 Train surface washing equipment shall be provided with water treatment and circulation system. The washing shed with drying facilities may be provided in cold areas.

17.3.10 Wheel-set tread diagnosing device shall apply through arrangement. Data of wheel-set tread diagnosing shall be transmitted to the underfloor wheel lathe shed via the inspection and repair management information system. Wheel-set tread diagnosing device should be located together with pantograph dynamic detection equipment.

17.3.11 EMU workshop (depot) shall be provided with fixed ground sewage discharge system, which should be located together with the equipment of passenger service and inspection level I and II. The stabling yard should be provided with movable sewage discharge facilities.

17.3.12 EMU stabling siding shall be equipped with visual monitoring system, illumination and fire fighting device. External power source may be provided if necessary.

17.4 Maintenance Facilities

17.4.1 The EMU maintenance facilities shall be designed according to the requirements for EMU repair level III, IV and V, the running parts, brake system, pantograph, electric system, air conditioning system, coupler mechanism, motor and gearing, HV and LV electric devices, in-car devices, car body, on-board network system, door and window mechanism and control system.

17.4.2 The maintenance buildings in EMU depot and workshop shall include repair workshop, bogie (wheel-set, axle box, and frame) repair workshop, car repair workshop, test (service) workshop and components inspection and repair workshop.
The maintenance buildings shall be arranged closely to each other. The main repair workshop shall be connected with combined spans. Houses closely related to the processes shall be located in the side spans of the repair workshop. The arrangement of buildings shall guarantee smooth and reasonable processing, best production flow, and reasonable consideration of pipe network for heat supply, air supply, water supply, power supply and steam supply.

17.4.3 EMU maintenance may be in fixed position or movable position. The design of workshop shall be in compliance with the following requirements:

1 The length of maintenance workshop shall be determined according to the factors such as the length of EMU, inspection and repair process flow, width of transport passage, buildings arrangement, and requirements for building and structure design.

2 The width of workshop shall be determined according to the calculations in terms of the number of tracks, track interval, operation space during inspection, equipment dimensions, walkway and transport passage, lifting capacity and span of crane. The track interval should be 10~12 m, and the distance from the center of outer track to the center line of the sidewall should be 5.0~6.5 m.

3 The height of workshop shall be determined comprehensively according to such factors as inspection and repair processes, EMU clearance, operations on car top and crane structural dimensions. The height needed by workers on the car-top and the safe distance shall also be considered while contact line in it. The top elevation of the crane rail should be 8.4~10.2 m. The ground in house shall be the same level as the rail top.

4 Pipe lines shall be better arranged, visual pleasing, clearly marked and easy for maintenance.

5 Information system terminals and interfaces shall be provided.

6 The straight section of the track in front should be not less than 20 m.

17.4.4 The maintenance workshop undertaking EMU repair level III shall comply with not only the requirements stipulated in 17.4.3, but also these following requirements:

1 Synchronized lifting jacks, bogie turntable and crane shall be equipped in this workshop. Work platforms and ground test power supply shall be provided according to the needs of operation activities.

2 Movable rigid catenary line driving and control equipment shall be installed in it, safety monitor system should also.

3 Running wheel-set weighing equipment should be provided in or outside the workshop.

17.4.5 The maintenance workshop undertaking EMU repair level IV and V shall comply with not only the requirements stipulated in 17.4.3, but also these following requirements:

1 Car body disassembling and assembling positions shall be established with associated inspection work platform or pit.
2 Car body moving equipment, disassembling and assembling equipment for bogie and major components, crane and car body tightness test equipment shall be installed.
3 Static wheel-set weighing equipment shall be equipped.
17.4.6 Bogie maintenance workshop shall be in compliance with the following requirements:
1 The scale of the workshop shall be determined according to the calculations in terms of bogie maintenance amounts, the repair process and the time under repair. In the case of large maintenance amounts, the movable positions should be applied.
2 Bogie disassembling, assembling and test devices shall be provided in the shed, devices for cleaning, repairing, detection, painting, testing and lifting of wheel-set, journal box and frame shall also be equipped.
3 Wheel-set and axle box should be stored tridimensional.
4 The workshop should be located near the maintenance workshop for level III, IV and V. Bogie transport between these sheds should be on tracks.
17.4.7 Car body repair workshop shall be in compliance with the following requirements:
1 The scale of car body repair workshop shall be determined according to the calculations in terms of maintenance amount, repair process and time under repair.
2 Equipment in it shall be satisfy disassembling, repairing, assembling and testing of car body parts, including transportation of car bodies and parts.
17.4.8 Car body painting workshop shall apply advanced painting process to minimize pollution. The scale of the painting workshop shall be determined in terms of car body maintenance amounts. In the case of large maintenance amounts, flow processing shall be applied. Equipment in the shed shall be provided with explosion protection.
17.4.9 Test (servicing) workshop shall be applied in EMU depot & workshop, which shall be provided with track bridge, working platform, ground test power supply, safety monitoring system and EMU performance test equipment. The test track shall be equipped with wheel-set weighing device.
17.4.10 EMU components can be repaired through in either local depot or entrusted plants. In the case of in local depot, component repair shed shall be established, which shall be located near the repair shed and equipped with necessary repair facilities. In the case of in entrusted plants, work sites shall be provided in EMU depot.

17.5 Others

17.5.1 The design of EMU maintenance management information system shall comply with the specifications detailed in Section 15.5.
17.5.2 EMU workshop (depot) shall be provided with material storage facilities according to the maintenance amount.
17.5.3 The supply of gas (steam) for production, living and heating in EMU workshop (depot, yard) shall be centralized, and power distribution facilities shall be set.
17.5.4 EMU rescue equipment shall be arranged according to the network plan
comprehensively.

17.5.5 Facilities for fire-proof, waste treatment, garbage collection, storage and transportation shall be set in EMU workshop (depot, yard).

17.5.6 Facilities for training crew members and maintenance workers shall be set in EMU depot & workshop.

17.5.7 Battery recharging and storing rooms and warehouse for storing dangerous materials shall be set in EMU depot & workshop.
18 Comprehensive Maintenance

18.1 General Requirements

18.1.1 The maintenance of route, track, subgrade, bridge and culvert, tunnel, traction power supply, electric power, communication and signal should be included in the comprehensive maintenance system of fixed facilities established for high-speed railway. The policy of "reinforce detection, focus on prevention, and combine prevention and remedy" shall be followed. Advanced inspection and monitoring technologies and means of maintenance shall be employed positively.

18.1.2 The maintenance for fixed facilities of high-speed railway shall include routine maintenance, preventive maintenance and corrective maintenance according to operation and management target.

18.1.3 The comprehensive maintenance shall be designed in "window" time according to the unified arrangements.

18.1.4 The comprehensive maintenance facilities may include maintenance base, comprehensive maintenance workshop and comprehensive section, their layout and scale shall be in combination with railway network plan.

18.1.5 The information system for comprehensive maintenance management shall be established for high-speed railway. To fulfill digitization and informationization of maintenance management, this system shall own functions of collecting, analyzing and processing information data associated with inspection, monitoring and maintenance of fixed facilities, making maintenance and repair program, and work schedule controlling activities. The information system design shall be complied with 15.6 section in this specification.

18.2 Inspection

18.2.1 Dynamic, static and patrol inspection etc. could be applied on high-speed railway according to route conditions. Dynamic inspection shall be focused on, while combined with static inspection at the same time.

18.2.2 Comprehensive inspection EMU should be used to inspect facilities of track, overhead contact system, communication and signal.

18.2.3 Control network of precise trackway measuring engineering shall be applied in static inspection for infrastructure.

18.2.4 Comprehensive inspection EMU, rail flaw detecting train, track inspection train, catenary inspection train etc. should be equipped with in maintenance base.
18.2.5 It should be equipped with track condition identification train, rail flaw detector, track geometry measuring trolley, catenary geometric parameter meter, conductor wire wear meter etc. in comprehensive section.

18.2.6 The mechanical patrol inspection equipment should be equipped in comprehensive maintenance workshop or comprehensive section according to efficiency and frequency.

18.2.7 There should be stabling and service track for parking inspection trains set in maintenance base and comprehensive maintenance workshop.

18.3 Maintenance

18.3.1 The design of comprehensive maintenance facilities should follow the principles of "special, mechanical and centralized repairing", and shall comply with the following requirements:

1 The maintenance base, comprehensive maintenance workshop and comprehensive section shall be located near the station, and avoid the areas with poor geological and hydrological engineering conditions, where draining easily.

2 The general layout shall be designed to locate buildings, routes, roads, pipe routes and green areas according to the requirements for production engineering, environment protection, fire precautions, sanitation, ventilation and lighting, and in consideration of the natural topographic, geological, hydrologic and weather conditions.

18.3.2 The design of maintenance base shall comply with the following requirements:

1 Its functions shall conclude overhaul and medium maintenances of these fixed facilities and servicing, inspecting and repairing of heavy-duty permanent way machinery and other maintenance facilities, storing and shifting of spare parts and components, and management information etc..

2 It should be located in the central area of high-speed railway network.

3 The general layout shall ensure technique process smoothly, avoid process intercrossing and interfering each other. Future developments should be taken into account on the premise of less land use with short and long term plan.

4 The scale shall be determined by the type, quantity, repair interval and time of fixed facilities within the base territory and the calculation of the type and quantity etc. of equipped maintenance vehicles.

5 Heavy-duty permanent way machinery, track vehicles, overhead contact system operation trains shall be equipped according to many factors such as the type of route and power supply equipment within the territory, detailed work content, work load, maintenance period, operation capacity of machine and "window" time etc.

6 Factory buildings, auxiliary production buildings (such as office buildings, material warehouses) and inspecting, repairing and testing devices shall be provided for the maintenance base according to the type of equipment, the maintenance rule, content, process and work load.

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7 Tracks in the maintenance base shall be arranged complying with the following requirements:

1) Entry and exit track, running track, service track, stabling track, repairing track, turnaround track, calibrating track, testing track, switching track, and material loading and unloading track shall be set in the maintenance base.

2) The number of service track, stabling track and repairing track for maintenance vehicles shall be determined according to the needs of repairing and parking.

3) The interval between outdoor tracks should be no less than 5.0 m, and no less than 4.2 m on difficult conditions. The interval of curves should be no less than 4.6 m, and that between tracks for service or testing should be no less than 6.5 m.

4) Tracks shall be flat. The slope of outdoor stabling tracks should not be more than 1‰ on difficult conditions.

5) Test tracks for heavy-duty permanent way machinery, rail flaw detecting vehicles and catenary operation vehicles should be applied independently.

The test track for heavy-duty permanent way machinery shall include S curve and a 300 m straight route section. The test track for rail flaw detecting vehicles should be equipped with ground equipment and reference damaged rail to meet the needs of measurement and test according to the requirements for train performances, acceleration, brake distance and test.

6) The minimum radius of routes shall be no less than 300 m, and the switches should be under centralized control.

18.3.3 The design of comprehensive maintenance workshop shall comply with the following requirements:

1) It shall undertake routine management and maintenance of fixed facilities in the territory, storage and allocation of materials, work with maintenance machine set and overhaul maintenance machine set, undertake quality acceptance and management after maintenance and repair, organize emergency repair, undertake insulation test of electric devices and repair in depot of switches in the territory. The design shall cover all above activities.

2) The length of single main route managed by comprehensive maintenance workshop should be 150～250 km, and the total length of main route should be 600～1 000 km.

3) The comprehensive maintenance workshop shall be located in the central part of the route managed by the workshop, where large station is located. The management shall cover the other routes in this territory.

4) The scale of comprehensive workshop shall be determined by calculations in terms of the type, quantity, maintenance interval and time of the fixed facilities, and maintenance vehicles equipped in this territory.

5) The general layout of comprehensive maintenance workshop shall facilitate inspection and repair activities, make sure the processes smoothly, avoid intercrossing and interfering during the
process.

6 Comprehensive maintenance information management system shall be provided to undertake collection, processing, storage and transferring the information concerning inspection and maintenance for fixed facilities.

7 The workshop shall be provided with devices for relevant professions according to the needs of inspection and repair of fixed facilities.

8 Tracks in comprehensive maintenance workshop shall be arranged complying with the following requirements:

1) Entry and exit track, running track, stabling track and material loading and unloading track should be provided in the comprehensive maintenance workshop.

2) The number of stabling track shall be determined by the needs of service, and parking of maintenance vehicles. The effective length of the stabling track shall be enough to accommodate a complete maintenance machine group plus 10m safety distance.

3) The interval between outdoor tracks should be no less than 5.0 m, and be no less than 4.2 m on difficulty conditions. The interval of curves should be no less than 4.6 m, and that between tracks for services should be no less than 6.5 m. The tracks in comprehensive maintenance workshop shall be flat. The slope of outdoor stabling tracks may be 1% under difficult conditions.

4) The minimum radius of the tracks in comprehensive maintenance workshop shall be no less than 300 m.

9 The material yard beside loading and unloading track shall take into account storage and transport of high-speed turnouts, yards to store tracks and pantograph spare parts of catenary. The warehouse to store other relevant materials, instruments and tools etc. should also be appropriately set.

10 Existing facilities shall be fully utilized to store materials.

18.3.4 The design of comprehensive section shall comply with the following requirements:

1 The comprehensive section shall undertake the routine patrol inspection, maintenance, casual and small-scale emergent repair of fixed facilities, and fulfill the maintenance task assorting with heavy-duty permanent way machinery.

2 The comprehensive section shall be located in the station with more complete facilities. Subordinated maintenance departments may be established in EMU workshop and depot with related buildings, personnel and tools.

3 It shall be provided with track vehicles such as track maintenance vehicles, track vehicles, catenary maintenance vehicles, and equipped with special tools and devices that required for maintenance and repairing activities. Spare parts may be provided according to needs.

4 The comprehensive section shall be equipped with management information system terminal for collecting and transmitting information from static inspecting of fixed
facilities, and monitoring message.

5 The setting of tracks in the comprehensive section shall comply with the following requirements:

1) Corresponding stabling tracks for heavy-duty permanent way machinery and auxiliary vehicles, track vehicles, catenary operation vehicles (including operation vehicles and washing vehicles) and material loading and unloading track shall be provided with according to the type and quantity of route in the territory.

2) The number of stabling track for heavy-duty permanent way machinery and track vehicles shall be determined by the needs of maintenance and park of maintenance vehicles. The length of the stabling track for heavy-duty permanent way machinery shall be determined by the length requirement to accommodate the maintenance machine set and its auxiliary vehicles on ballasted track section, and it should be determined by the length of the track to accommodate a rail grinding train on ballastless track section. The effective length of stabling track shall be the length that park a entire maintenance machine group plus 10 m safety distance.

3) The interval between outdoor tracks should be no less than 5.0 m, and be no less than 4.2 m under difficult conditions. The interval between tracks for service activities should be no less than 6.5 m.

4) The tracks shall be flat. The slope of outdoor tracks for parking vehicles may be 1% under difficult conditions.

5) The minimum curve radius of tracks should be no less than 300 m.

6 Production buildings such as corresponding tool depot, track vehicle depot, composite building shall be provided with. Material storage, transport yard and facilities section shall also be considered in comprehensive. Storage yard and facilities should be provided in view of the need of material stock for tracks in the territory and the rate of preparing materials of pantograph and catenary required for one anchoring section.

7 Stabling tracks for heavy-duty permanent way machinery should be provided with the equipment for water and power supply.

18.3.5 The design of comprehensive maintenance shall comply with the Articles 18.3.1~18.3.4 of this Code as well as the following specifications:

1 The setting of catenary operation shifts shall meet the requirement that it can reach the fault place in 30 min in case of emergency.

2 The interval between catenary emergency vehicles should meet the requirement that vehicles can reach the accident place in 90 min.

3 The stabling track along the route for heavy-duty permanent way machinery shall be located in the comprehensive section. Stabling track should be located in the station between comprehensive sections, in case the two neighboring comprehensive sections are more than 80 km apart.

4 For stations without comprehensive sections, buildings for maintenance should be
provided and arranged comprehensively with station buildings.

18.4 Interface Design

18.4.1 During the comprehensive maintenance design, the interface design of route, track, earth structure, bridge, tunnel, traction power supply, overhead contact system, disaster prevention and safety monitoring, comprehensive earthing, noisy absorber, heating and ventilation, water supply and drainage, synthetic dispatch, informationization, communication, signal etc. shall be considered. Besides, this design with infrastructure maintenance base of high-speed railway and the relevant existing maintenance departments shall also be coordinated.

18.4.2 The interface design of comprehensive maintenance with communication, signal and information shall comply with the following requirements:

1 The design should comply with the dispatch terminals, those are in comprehensive maintenance at all levels of maintenance bases, comprehensive maintenance workshops and comprehensive sections, receiving maintenance instructions and emergency maintenance instructions from the comprehensive maintenance dispatcher in the dispatcher’s office in case of calamities or serious accidents.

2 To fulfill the process management of comprehensive maintenance by computer, the information subsystem of comprehensive maintenance management shall be equipped in maintenance base, comprehensive maintenance workshop and comprehensive section. Comprehensive maintenance department puts up the requirements for communication liaison and information transmission related to inspection, monitoring and maintenance activities. Communication department shall provide channels.

3 The setting of maintenance dispatching, signal and the mode of interconnection shall meet the requirements of safety protection passages and facilities for activities in the section of comprehensive maintenance.

18.4.3 The interface design of comprehensive maintenance and disaster prevention and safety monitoring department shall comply with the following requirements:

The disaster prevention and safety monitoring system monitors the equipment and facilities closely related to high-speed railway operating safety, and opens interfaces to comprehensive maintenance. The corresponding organizations involved in comprehensive maintenance receive information from the system, analysis the trend of the facilities and take necessary measures according to dispatching instructions.

18.4.4 The interface design with comprehensive maintenance, route, track, bridge and tunnel shall comply with the following requirements:

1 Setting and configuration of maintenance facilities shall be performed according to the track structure, the scales of ballasted and ballastless tracks and their distribution along the routes.

2 Maintenance accesses, entrances and exits shall be set up comprehensively according to
the needs of maintenance and repair of route, bridge and tunnel etc.

3 Comprehensive maintenance shall propose passages for inspection and maintenance of abutments and beam bodies according to types of bridge structures, requirements of checking and monitoring.

4 Comprehensive maintenance shall propose passages for inspection and maintenance in tunnel according to tunnel conditions and the setting of escape passages.
19 Water Supply and Sewerage

19.1 General Requirements

19.1.1 Water supply and sewage discharge facilities for passenger trains should be set up at EMU depot and workshop (or depot). The water supply and waste discharge facilities shall not be placed between the main track and the receiving-departure track of the station.

19.1.2 When passing through railways, centralized vertical layout of the water supply and waste pipes should be adopted, and protection culverts shall be built. The protection culvert shall be considered as a whole with the main project.

19.1.3 Design of the water supply and waste pipes should be considered as a whole with the comprehensive piping trench, flood-discharging culvert and traffic culvert within the station.

19.1.4 Centralized monitoring shall be adopted for the water supply and drainage facilities of the station.

19.2 Water Supply

19.2.1 Water supply station for passenger trains should preferably be located in large stations and above, stations with EMU depot and workshop (or depot) and stations as origin and destination of passenger trains.

19.2.2 Water consumption and water quality for production shall be determined based on the production technology and requirements of the equipments, and it should use recycled water, multi-purpose used water and reused water.

19.2.3 Design of the water sources shall be in accordance with the following requirements:

1. Municipal tap water should be used for source of the railway water supply, and water pressuring, water storage as well as water treatment equipments shall be placed according to the water quality, water quantity, water pressure and level of assurance for water supply.

2. When it needs to self-built water source, water resources assessment shall be carried out according the national requirements. Health protection of the drinking water source shall be consistent with the relevant provisions of the current professional standard of environmental protection, Technical Guide For Delineating Source Water Protection Areas HJ/T 338. Quality of the water supply shall be consistent with the relevant regulations of the current national standard- Standards for Drinking Water Quality GB 5749.

19.2.4 Direct drinking water system should be established at extra large, large-scale
passenger stations, and the design shall be consistent with the relevant provisions of the current standard for urban and rural construction industry Technical Specification of Pipe System for Fine Drinking Water CJJ 110.

**19.2.5** Arrangement of water supply spigots for passenger trains shall meet the following requirements:

1. Water supply spigots for passenger trains should be arranged as single spigot per well.
2. Spacing between water supply spigots well of chambers for passenger trains should be 20~25 m.
3. Automatic rewinding device of watering hose should be adopted for water supply spigots of passenger trains, and anti-freezing measures shall be taken in frosty and cold regions.

**19.3 Sewerage**

**19.3.1** Arrangement of waste discharge stations (spot) for passenger trains shall be consistent with the national railway network planning and be of rational layout.

**19.3.2** The waste discharge quantity of the facilities within stations and EMU depot and workshop (or depot) shall be calculated and determined based on the volume and number of sewage bins. Drainage capacities of other production activities shall also be determined according to the characteristics of the production process.

**19.3.3** When passenger trains are discharging sewage inside the shed, the fixed waste discharge approach should be adopted; when discharging sewage at the station or outside the shed, the fixed or movable waste discharge approaches may be adopted. When adopting the fixed waste discharge by vacuum approach, it is desirable to configure at least 2 standby waste discharge trucks; when using the fixed waste discharge by gravity approach, it may be configured without the waste discharge truck.

**19.3.4** The fixed waste discharge system by vacuum shall be designed to meet the following requirements:

1. Waste discharge capacity of the vacuum waste discharge system shall meet requirements of the largest marshalling, the longest servicing time or dwell time, and the maximum serving numbers per day of the passenger cars.
2. The layout spacing of the waste discharge units shall meet the requirements of servicing different models of cars.
3. Arrangement of the waste discharging pipes shall meet the following requirements:
   1) The main vacuum waste discharging pipe may be laid under the working station, inside the repairing ditch or between the lines, the length shall meet the waste discharge requirements of trains in largest marshalling.
   2) Diameter of the main waste discharging pipe shall be no less than DN100 mm.
   3) The waste discharging pipes shall be downhill to the vacuum station, its gradient
should not be less than 1%.

4 The vacuum unit shall have standby capacities, and shall ensure that it meets the requirement of system vacuum degree in circumstance that one of the units is under inspection and repair.

5 Deodorization facilities should be located inside the housings for vacuum pump unit equipment with a vacuum sewage storage tank.

19.3.5 For fixed waste discharg system by gravity, diameter of the main pipe shall be calculated and determined, but shall be no less than DN 300 mm. The pipe shall have a gradient of no less than 5%, and shall be provided with anti-silt, dredging, ventilation measures.

19.3.6 When adopting the movable waste discharge approach, the number of waste discharging trucks shall be calculated and determined according to the number of EMUs under servicing simultaneously and the waste discharging time.

19.3.7 The waste discharge unit shall be arranged separately from the water supply spigots for passenger trains, the clear distance between them should be no less than 2 m, and should be clearly marked. The waste discharge unit at frosty and cold regions, anti-freezing measures shall be taken.

19.3.8 Treatment shall be applied to the discharged sewage and production waste of passenger trains, and the treated sewage shall meet the relevant regulations of the current national and local discharge standards.

19.4 Interface Design

19.4.1 When the water supply and waste pipes are passing through the railway line, setting requirements of the protection culvert shall be provided to the bridge department.

19.4.2 When the water supply and waste pipes are arranged parallel to the railway line inside the station, setting requirements of the preserved holes for facilities like water supply and waste pipeline layout, water supply spigots for passenger trains and waste discharge units etc. shall be provided to the station and yard, bridge and architecture departments.
20  Building Construction

20.1  General Requirements

20.1.1  Design of the building construction shall adopt the advanced technology which is safe, energy saving and in line with the environmental protection requirements, and shall be in accordance with the economic, applicable, aesthetic requirements, and be arranged reasonably and in combination according to the need of railway transportation and production.

20.1.2  In addition to meeting the requirements of architectural style and function, design of the building construction shall also meet the requirements of advanced structure technology and reasonable form, and be in accordance with the relevant provisions of the current national standard Code for Seismic Design of Buildings GB 50011.


20.1.4  The flow line of the passenger station square shall meet the requirement of safety, rapidness and convenience; the layout pattern with separated pedestrian and vehicular traffic shall be adopted, and shall match the layout pattern of the station building.

20.1.5  Layout of the railway passenger station shall meet the requirements of urban development and transportation, and the scale of buildings shall be rationally determined according to the local economic, transportation development conditions.

20.1.6  The architectural style of buildings of the passenger station shall be reasonably determined based on the form, site condition, management style and other characteristics of high-speed railway line.

20.1.7  Design of buildings of the passenger station shall be consistent with the relevant provisions of the current national standard Code for Design of Railway Passenger Station Building GB 50226, and the current Code for Design on Accessibility of Railway Passenger Station Buildings TB 10083 and Codes for Design on Accessibility of Urban Roads and Buildings JGJ 50.

20.1.8  The various dynamic and static passenger service information signs installed in the passenger stations shall be consistent with the provisions of the current Code for Design of Passenger Transport Information System of Railway Passenger Station TB 10074 and relevant national standards.

20.2  Station Buildings

20.2.1  Station buildings shall include the station main building and the passenger
transport buildings of station and yard, as well as houses, transfer spaces and other transportation and commercial spaces which are fixed up in combination with the station main building.

20. 2. 2  Scale of the station main building shall be determined with calculation based on the maximum passengers in waiting section and the peak hour departing quantum according to the current national standard *Code for Design of Railway Passenger Station Buildings GB 50226*.

20. 2. 3  The station main building is divided by functions into public area, administrative area and equipment area; the design shall meet the following requirements:

1  The above mentioned areas shall be divided rationally, of clear functions and convenient for management.

2  The space of public area shall be open, well ventilated and bright; the passenger service facilities shall be complete, of clear flow line and well organized.

3  The administrative area should be centrally located in the secondary place of the station main building, and of good conditions to connect with the public area; houses related with operation shall be close to the platform.

4  The equipment area shall be located far away from the public area, and make full use of the underground space.

20. 2. 4  Flow line design of the passenger entrance shall be combined with the passenger service, and the pass-type flow line shall be chiefly adopted, or a waiting-passing combination type shall be used.

20. 2. 5  Total floor area of the passenger waiting section shall be no less than 1.2 m²/person according to the maximum passenger number in waiting section, while number of the sanitary ware shall be determined on the basis of the maximum number of passengers in peak hours, and shall be in line with the relevant regulations of the current national standard *Code for Design of Railway Passenger Station Buildings GB 50226*.

20. 2. 6  Width of the entry and exit aisles, transfer aisles, staircases, escalators of the station main building shall be based on the number of passengers dispatched in peak hours and be determined according to Table 20. 2. 6, and shall comply with the requirements of fire-fighting and evacuation.

20. 2. 7  In cold areas, the wind break porch shall be fortified at the main entrance of the station main building; in other areas, the wind break porch should be built at the main entrance of the station main building; the porch shall be light and transparent.

<table>
<thead>
<tr>
<th>Table 20. 2. 6  Maximum Carrying Capacity of Each Part of the Station</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name of the Part</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Per meter wide staircase</td>
</tr>
<tr>
<td>Upward run</td>
</tr>
<tr>
<td>Downward run</td>
</tr>
<tr>
<td>Bi-direction</td>
</tr>
</tbody>
</table>

* 193 *
Table 20.2.6 (continued)

<table>
<thead>
<tr>
<th>Name of the Part</th>
<th>Carrying No. of people per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per meter wide passage</td>
<td></td>
</tr>
<tr>
<td>Unidirection</td>
<td>3,000</td>
</tr>
<tr>
<td>Bi-direction</td>
<td>2,400</td>
</tr>
<tr>
<td>Per meter wide escalator (0.65 m/s)</td>
<td>5,800</td>
</tr>
</tbody>
</table>

20.2.8 Luggage deposit office shall be arranged separately according to the passenger entry and exit flow line and shall be based on the requirements of traffic organization.

20.2.9 For passenger station buildings, complementing commercial facilities for passenger service may be reasonably set according to the characteristics of passenger flow.

20.2.10 For waiting sections and passage over the tracks, height of the upper edge of the breast board or the lower edge of the openable window shall be no less than 2.2 m. When height of the lower edge of the openable window is less than 2.2 m, reliable anti-dropping facilities shall be set up.

20.2.11 For station buildings under the railway, vibration reduction, sound insulation and noise reduction measures shall be adopted for the waiting section and booking section; for other forms of stations, vibration reduction, sound insulation and noise reduction measures should be adopted for public areas.

20.2.12 In frosty and cold regions, heating or comfortable air conditioning system shall be installed inside the station main building; in regions where it is hot in summer and cold in winter or hot in summer and warm in winter, comfortable air-conditioning system shall be installed.

20.2.13 For extra-large and large station main buildings in frosty and cold regions, equipment to supply warm water shall be installed in the washroom of public areas.

20.2.14 Points to supply cold and hot drinking water shall be arranged in public areas of the station main building.

20.2.15 The minimum clear width and clear height of the entry and exit pedestrian bridge and underpass paths shall be consistent with the requirements listed Table 20.2.15.

Table 20.2.15 Minimum Clear Width and Clear Height of the Pedestrian Bridge and Underpass Paths (m)

<table>
<thead>
<tr>
<th>Item</th>
<th>Pedestrian Bridge and Underpass Paths for Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Super-large, large stations</td>
</tr>
<tr>
<td>Minimum clear width</td>
<td>10</td>
</tr>
<tr>
<td>Minimum clear height</td>
<td>3.6</td>
</tr>
</tbody>
</table>

20.2.16 Height of the step of passenger pedestrian bridge and underpass paths should not be larger than 0.14 m, while width of the step should not be less than 0.32 m. When a parallel escalator is installed as the major ascending facility on one side of the staircase, the step of the staircase may have a width of 0.30 m and height of 0.15 m.

20.2.17 When the ascending and descending height difference of the main passenger
activity area is greater than 6 m, escalators shall be installed for large and super-larger stations, and should be installed for small and medium stations. The escalator should adopt an inclination of 30°, when it is parallel to the stairs, an inclination of 27.3° should be adopted.

20.2.18 Distance between the operating locations of two escalators oppositely installed in the station main building shall not be less than 16 m; and distance between the operating location of the escalator and the fixed facility in front which affect the traffic shall not be less than 8 m; when the escalator and the staircase are oppositely installed, distance between the operating location of the escalator and the first step of the staircase shall not be less than 12m.

20.2.19 Clear height of canopy without platform column and blank area of the roof shall be reasonably controlled. When the canopy above the tracks is not closed, diversion measures to block rains and thawed snows shall be taken at the edge of the canopy.

20.3 Production and Auxiliary Housing

20.3.1 Housings for communications, signals, information and electricity etc. within the boundary of the passenger station should be located in combination with the station main building, and be located relatively concentrated according to the functional subareas. Under special circumstances, the locations shall be reasonably determined according to the actual situation of the project.

20.3.2 Outside the inspection and repairing shed of MU depots and workshops (or depots), a loop type fire-fighting passage way shall be built. When it is difficult to do so, it shall be ensured to build the fire-fighting passage ways correspondingly on the two long sides, and a field which fits in with the turning radius of fire-fighting trucks shall be prepared at each end.

20.3.3 A transverse passage-way shall be arranged inside the inspection and repairing shed of MU depot and workshop (or depot), and the transverse passage way may be arranged in combination with the connecting passage way for cross-line repairing. The spacing shall be determined after calculation in accordance with the requirements of industrial building safety and evacuation listed in the current national standard Code of Design on Building Fire Protection and Prevention GB 50016, width of the passageway should not be less than 1.1 m.

20.3.4 Dedicated air-conditioning system with constant temperature and humidity shall be installed in the machine room of the information processing center of MU depots and workshops (or depots).

20.4 Interface Design

20.4.1 Design of the building construction shall be coordinated with other specialties like heating, ventilation and air conditioning, water supply and sewerage, fire fighting.
communications, signals, power, electric traction power supply, information etc., and shall be in accordance with the functional requirement of an integrated pipeline and the aesthetic requirements of tidiness and orderliness.

20.4.2 Design of the station main building shall be coordinated with the design department of urban planning, and shall be in line with the requirement that layout of the station square, the flow line and the station main building match each other.

20.4.3 When the station main building is co-constructed with the urban rail transport structure, it shall be consistent with the requirements of the structural system layout and load transferring.

20.4.4 Design of the station main building shall be coordinated with the relevant specialties, and meet the requirement that the entry and exit of the station main building are correspondingly connected with the layout location of the underground paths. The co-constructed part of the station main building and the underground path structure shall be consistent with the requirements of the structural system layout and load transferring.

20.4.5 When the station building is under the tracks by side, the station main building, the canopy structure and the platform retaining walls are co-constructed, it shall be consistent with the requirements of the structural system layout and load transferring.

20.4.6 When the station building is under the railway, the station main building, the canopy structure and the bridge are co-constructed, design of the station main building shall be coordinated with the bridge specialty in aspects of column position, load and embedded parts.

20.4.7 When columns are required to be erected among the tracks for the above-line-type station main building, the platform canopy and the pedestrian bridge, locations of the columns shall meet the requirement of clearance limits. When the station building, canopy and pedestrian bridge share the same structural system with the catenary to fit the station and yard and the catenary, the designs of clearance limits, loads and installation structures shall be well done.
21 Integrated Earthing

21.1 General Requirements

21.1.1 Integrated earthing system shall be installed for high-speed railway. The integrated earthing system consists of the run-through earthing cable, earthing electrode, earthing terminal, earthing connecting cable and other accessories.

21.1.2 Integrated earthing system shall be in accordance with the principle of equipotential bonding.

21.1.3 Electrical railway equipments and metal components within the range of 5 m around the catenary electrified zone shall be connected to the integrated earthing system.

21.1.4 Railway structures within the range of 20m on both sides of the track shall be connected to the integrated earthing system.

21.1.5 Independent earthing device for the lightning conductor shall be installed. If the distance between the earthing device and the run-through earthing cable is less than 15 m, the earthing device shall be connected to the integrated earthing system. The distance of earthing access point between earthing device and communication, signaling and other electronic equipments should be greater than 15m, and which shall be greater than 5 m if the condition is difficult.

21.1.6 Earthing resistance of the integrated earthing system shall not be greater than 1Ω.

21.1.7 Integrated earthing system shall use the non-prestressed steel bar inside the foundation structures of the bridges, tunnels and catenary mast.

21.2 Run-through Earthing Cable, Branch Earthing Cable and Transverse Bonding

21.2.1 Run-through earthing cables shall be respectively laid along both sides of the high speed railway.

21.2.2 Laying of the run-through earthing cables shall comply with the following requirements:

1 The run-through earthing cable at the bridge section shall be laid inside the cable trough on both sides of the track. Each run-through earthing cable shall be connected to the bridge earthing electrode once at the end of the beam of bridge through earthing terminals.

2 The run-through earthing cable at the tunnel section shall be laid inside the cable trough on both sides of the track. Each run-through earthing cable shall connect to the tunnel earthing electrode through earthing terminals with the interval of 100m.
3 The run-through earthing cable at the subgrade section shall be laid under the cable trough on both sides of the track; for the embankment, soil and soft rock intrench sections, the run-through earthing cable shall be buried $-300 \sim -400$ mm to the top surface of subgrade bed bottom layer; while for the hard rock intrench section, the run-through earthing cable shall be buried in the ditch $-200$ mm under the cable trough of subgrade shoulder, and be backfilled with granule soil.

21.2.3 Selection the cross-section of run-through earthing cable shall comply with the following requirements:

1. It shall be calculated based on the long-term traction current.
2. It shall meet the need of the top value of traction return current passing through the run-through earthing cable on normal conditions.
3. It shall meet the need of the thermal stability in case of the instantaneous peak current passing through the earthing cable due to short circuit of catenary (the time for short circuit is no more than 100 ms).
4. It shall be reasonably considered for each section according to the distributed conditions of the traction return currents in different sections.

21.2.4 Materials for the run-through earthing cable shall be anticorrosive.

21.2.5 Branch earthing cable connected with the run-through earthing cable shall be laid at the same mileage of the corresponding catenary mast in the subgrade sections, while the same material and cross-section as the run-through earthing cable should be applied.

21.2.6 The run-through earthing cable on both sides of the railway shall be transverse bonded. The transverse bonding should be laid for about every 500 m in the subgrade sections, and shall be the same material and cross-section as the run-through earthing cable; the transverse bonding is realized through the earthing steel bar at the end of the bridge, and through the tunnel earthing steel bar in tunnel section.

21.3 Earthing Electrode and Earthing Terminal

21.3.1 Earthing electrodes shall be set for the integrated earthing system in the bridge and tunnel sections; the catenary mast foundation shall be used as the earthing electrode in the subgrade section.

21.3.2 Setting of the bridge earthing electrode shall comply with the following requirements:

1. Bridge pier supported by pile foundation; the long structural reinforcing bar inside each pile at the periphery of the foundation shall be used and be ring linked at the supporting platform to constitute the earthing electrode.
2. Bridge pier supported by open cut foundation; one layer of steel mesh is laid at the bottom of foundation as horizontal earthing electrode, and it is connected to the earthing reinforcement of the beam through the structural reinforcing bar.
3. Beam; for concrete slab and ballast track which ballast thickness is less than 0.3 m, the structural reinforcing bar at the appropriate place on the surface of the beam...
shall be used as logitudinal and horizontal earthing steel bar. The logitudinal strctural reinforcing bar on the surface of protective wall on both sides of the steel rail on the bridge shall be used as earthing bar.

21.3.3 Setting of the tunnel earthing electrode shall comply with the following requirements:

1. It shall use the primary supporting anchor bolt, rigid frame, steel mesh or floor steel as the earthing electrode in the tunnel.

2. The anchor bolt earthing electrode shall be set every the length of a trolley, and the loop distance between the anchor bolts used as earthing electrodes is required to be double length of anchor bolt.

3. The tunnel floor reinforced steel bar may be selected as earthing electrode for every 1 m. The length of a trolley is considered as the length of the earthing electrode, and the earthing electrode is set for every double trolley length.

4. For tunnels and open cut tunnels with steel meshes in secondary lining, it shall use the inner logitudinal, loop reinforce steel bars of the secondary lining as the earthing steel bar; for the secondary lining without reinforcement, it shall consider only setting loop earthing steel bar connecting to the catenary mast foundation.

5. One logitudinal reinforce steel bar shall be respectively chosen from the outer edges on both sides of the track of the communication and signal cable trough, which shall be reliably welded with the tunnel anchor bolt earthing electrode or tunnel floor earthing electrode and the anti-flashover earthing steel bar in the secondary lining.

21.3.4 Setting of the subgrade earthing electrode shall use the reliably connecting reinforce steel bar of the catenary mast foundation as the earthing electrode.

21.3.5 Setting of the bridge earthing terminal shall comply with the following requirements:

1. The earthing terminal shall be set at the bridge pier coping, to connect the earthing electrode of pier and the earthing device of beam; the earthing terminal is reliably welded with the earthing reinforced steel bar.

2. The earthing terminals shall be set at both ends on the top of each beam, to connect the run-through earthing cable to the trackside equipments, facilities and etc.

3. The earthing terminals shall be set at both ends on the bottom of each beam, to connect the beam and the pier coping.

4. The earthing terminals of the beam shall be reliably welded inside the beam with other earthing steel bar.

5. The earthing terminal shall be set at −200 mm to the ground on each side of the pier perpendicular to the track direction for testing and bolting the additional earthing electrode.

21.3.6 Setting of the tunnel earthing terminals shall comply with the following requirements:

1. The earthing terminal shall be set for every 50 m on the outer edges by both sides of the track of the communication and signal cable trough, to connect the earthing of the
trackside equipments and facilities.

2. The earthing terminal shall be set on the lower part of the two siding walls perpendicular to the track direction of each tunnel chamber, to connect the earthing of the equipments and facilities inside the chambers.

3. All earthing terminals inside the tunnel shall be connected to the longitudinal earthing steel bar on the outer edge of the cable trough through the connecting steel.

21.3.7 Setting of the earthing terminals at the subgrade section shall comply with the following requirements:

1. Earthing terminals shall be prefabricated on the side of the catenary mast foundation, and be reliably connected to the run-through earthing cable directly through the branch earthing cable. The earthing terminal shall be reliably welded with the branch earthing cable inside the catenary mast foundation.

2. The earthing terminal may be installed at the appropriate place inside the cable trough if necessary, and be reliably connected to the run-through earthing cable through the branch earthing cable.

21.3.8 The earthing terminals shall be made of stainless steel material, and be fixed directly into the concrete products at the same time.

21.4 Earthing and Equipotential Bonding

21.4.1 If the distance between the earthing device of the structures and the integrated earthing system is less than 20 m, the earthing device shall be equipotentially connected to the integrated earthing system.

21.4.2 The reinforce steel bar along the line in each concrete slab shall be equipotentially connected to each other through the earthing terminal every 100 m, which shall be T-shape bonded once at single point with the embedded earthing terminal on the line side.

21.4.3 Earthing bonding in the platform area shall comply with the following requirements:

1. The earthing devices of platform wall which are composed of the reinforce steel bars along the line on the top of platform wall within the range of 0.6 m to the track side, a part of the transverse and longitudinal reinforce steel bars and earthing terminals inside the platform wall, are connected to the integrated earthing system for about every 100 m.

2. All metal components with a longitudinal length of more than 2 m on the platform shall be earthed reliably; and be connected to the integrated earthing system if possible.

3. The metallic shelf in station shall be reliably connected to the integrated earthing system.

21.4.4 Earthing of the traction power supply system shall comply with the following requirements:

1. The connecting point of run-through earthing cable with the integrated transverse bonding, together with the connecting point of the earth wire of protective wire (PW) or negative feeder line (NF) with the neutral point of the impedance transformer or the air
coil, should be set at the same mileage.

2. Distance between the access point of lightning protection earthing device of the traction network to the run-through earthing cable and the access point of other equipments to the run-through earthing cable shall be no less than 15 m.

3. Earthing devices shall be separately set for the traction substations, switch stations, AT stations and neural section stations within the range of 20 m to the integrated earthing system, and be equipotentially connected to the integrated earthing system.

4. Steel bars in the catenary mast foundations on the bridge shall be reliably connected to the earthing reinforcement.

5. Embedded parts of the catenary inside the tunnel and open-cut tunnel shall be reliably connected to the earthing reinforcement.

6. Earthing terminals of the catenary mast foundation in the subgrade section shall be reliably connected to the run-through earthing cable.

21.4.5 Earthing of the sound barriers shall comply with the following requirements:

1. The sound barrier and its bracket made of conductive materials shall be connected to the nearby integrated earthing system.

2. If the sound barrier is made of non-conductive materials, the protecting conductor shall be installed on the top, and be reliably connected to the integrated earthing system.

3. Two ends of sound barrier are respectively connected to the integrated earthing system, in addition, an appropriate connecting point in the middle is added to connect with the earthing system if necessary.

21.4.6 Earthing of other outdoor facilities shall comply with the following requirements:

1. Earthing of intermediate joints and terminals for power cable, transformers, switches and other equipments at the range of 20 m along the railway shall be connected to the nearby integrated earthing system.

2. The mast foundation of trackside communication leakage cables shall be connected to the nearby integrated earthing system.

3. The metal parts of the protective fence shall be reliably earthed.

4. For bridges overpassing across the railway, the reinforce steel bars on the surface layer of the bottom side of the beam above the track shall be used to constitute the protecting steel mesh or the metal protecting mesh should be added. The protecting mesh shall be equipotentially connected to the metal barriers on the bridge, and be connected to the integrated earthing system. In case of it’s difficult to do so, it may be separately earthed.

5. For other structures at the protecting range which may be influenced by the catenary flashover above the track, the earthing protective facilities shall be set, and be connected to the integrated earthing system.

21.4.7 The earthing terminals shall be used for connecting external facilities to the run-through earthing cable.
22 Environmental Protection

22.1 General Requirements

22.1.1 The alignment and site selection of high-speed railway shall be in accordance with the following environmental requirements:

1 The alignment and site selection of high-speed railway shall be consistent with relevant national and local laws. Statutory environmental sensitive areas, e.g. nature reserves, scenic spots, protected drinking water source, cultural relics etc., shall be bypassed by the alignment corridor and sites of various installations.

2 When it is inevitable for the alignment and site selection to pass through the statutory environmental sensitive areas after comparison and selection of several schemes, the relevant authorities for approvals shall be consulted according to the laws. In addition, appropriate protective measures to mitigate the adverse effects shall be taken at the same time.

3 The alignment and site selection shall be consistent with the local general urban planning and environmental protection planning.

4 The alignment shall be kept from passing through densely-populated residential areas in towns and cities in the middle which are already built, under construction or under planning.

22.1.2 Design of the ecological protection and soil & water conservation shall meet the following requirements:

1 Design of the high-speed railway shall pay attention to ecological protection and soil & water conservation, restrain the railway territory, occupy less arable land and protect the vegetation.

2 Large-scale temporary works shall be designed to occupy no or less arable land.

3 Green corridor design shall be carried out for high-speed railway combining the plant protection measures and the greening works.

4 Importance shall be attached to the harmonization of the high-speed railway main works with both the natural landscape and cultural landscape.

22.1.3 Engineering design of the environmental pollution control works shall include control of noise and vibration pollution, treatment of sewage and waste gas, disposal of solid wastes, prevention of electromagnetic interference etc., and shall be in accordance with the following requirements:

1 Environmental protection design shall have clear objectives and standards for pollution control. Discharge of pollutants shall be in accordance with relevant regulations.
of the state and / or local standards.

2 The environmental protection works should be determined based on the short-term construction scale, and technical conditions for long-term control and management shall be reserved.

3 Integrated control measures shall be adopted for railway noise and vibration pollution control with full consideration of the scale, distribution, environmental requirements, and other factors of the sensitive buildings and sensitive points.

4 Design of sewage and waste gas treatment and solid waste disposal shall be combined with energy-saving and emission reduction measures, to reduce emissions and improve the level of clean production.

5 Based on the impact scope of the electromagnetic interference (radiation) of the traction substations and the mobile communication base stations, selected sites for above installations shall keep an appropriate distance from the dwelling houses, schools, kindergartens, etc., for which protection design shall be carried out according to the environmental impact assessment.

22.1.4 Environmental protection design shall be implemented according to the environmental protection objectives and principles proposed by the environmental impact assessment. The environmental protection measures shall be fulfilled simultaneously with the main works.

22.2 Sound Barrier

22.2.1 Design of the sound barrier shall be in accordance with the following requirements:

1 When the ambient noise in the noise-sensitive areas (buildings) on both sides of the railway exceeds the national railway noise emission standard and other relevant standards owing to the contribution of railway noise sources, sound barrier may be installed or comprehensive control measures be taken. Comparative analysis in terms of economic and technical conditions shall be made during the sound barrier design for optimization among the sound barrier and other mitigation options.

2 Design of the sound barrier shall comply with the requirements of safety and applicability, advance in technology, cost effective, landscaping and scenario beautification.

3 Landscape design shall be taken into account in the sound barrier design. The shape, color, geometric dimensions, material, pattern and other relevant aspects of the sound barrier shall not only be matched with the main project, but also be assorted with the local natural environment, architectural style, and cultural environment.

22.2.2 Location of the sound barrier shall be in accordance with the following requirements:

1 The embankment sound barrier shall be installed on the subgrade shoulder with track maintenance requirements satisfied.

2 The sound barrier along the cut should be installed at the outer side of the slope top.
3 The bridge sound barrier shall be installed by the railing of the maintenance deck.
4 The sound barrier must not defilade the railway visual signals.
5 The sound barrier installed at other locations shall be in accordance with the provisions of railway structure clearance, and be in line with the requirements of repair and maintenance of railway facilities.

22.2.3 The structure of the sound barrier shall be in accordance with the following requirements:
1 The integral type shall be adopted for typhoon regions.
2 The column-plate type shall be adopted for other regions.
3 Transparent materials may be partially used for regions of higher landscape requirements.

22.2.4 Acoustic design shall be carried out for sound barrier based on the intensity of the noise source and the receiving noise limits for the sensitive receptors to be protected, and shall be in accordance with the following requirements:
1 The objective insertion loss of the sound barrier shall be reasonably determined based on the impact of noise source and the noise limits stipulated for the protected receptors. When an insertion loss more than 10 dB(A) is needed, a comparative analysis covering both technical and economic aspects shall be carried out for the sound barrier combining with other noise reduction measures to narrow down to an appropriate and integrated noise control design.
2 The insertion loss of sound barrier shall be calculated on the basis of octave band central frequency from 63~4,000 Hz.
3 Length of the sound barrier shall cover the distribution length of the sensitive receptors, with additional length at its two ends which should not be less than 50 m.
4 Height of the sound barrier shall not exceed 2050mm above the rail surface. Transparent materials should be adopted for the part that is higher than the elevation of 2050mm above the rail surface in special sections.

22.2.5 The structural design of the sound barrier shall be in accordance with the following requirements:
1 The structural design of the sound barrier shall be consistent with the relevant regulations of the currently effective national standards.
2 The structural form of the sound barrier shall be determined according to the engineering and environmental requirements. Integrated components should be preferred for the absorptive-insulating panel.
3 Design of the sound barrier shall take into account the dead load of the barrier, wind load, the fluctuating air pressure caused by high-speed train and other loads. The design load of the sound barrier shall be a combination of the loads which may simultaneously working on the sound barrier during the usage. And as such, the worst load condition shall be applied.
4 Cast-in-situ concrete connection or bolts (anchor bar, anchor bolt) connection should be adopted to connect the sound barrier and the bridge beams, or the sound barrier and precast foundation in the subgrade.

5 Expansion joints shall be set for the sound barrier and they must be sealed. A swing wedged or stepped connection shall be considered for the expansion joints seal in the bridge sound barrier. Expansion joints of the bridge sound barrier shall be set at the beam’s conjunction.

22.2.6 When installing sound barriers in sections where the running speed of the train is greater than 250km/h, the dynamic calculation about the train wind pressure dynamic load must be carried out to evaluates the maximum deformation, resonance effects and fatigue strength of the sound barrier structure.

22.2.7 The aerodynamic load calculation shall address the following concerns;
1. Deflection limits of the barrier’s panel unit and the column.
2. Natural frequency of the sound barrier structure.
3. Fatigue strength validation of the sound barrier structure.

22.2.8 The sound barrier performance and selection of sound absorptive and insulation materials shall be expected to satisfy the following requirements;
1. The average sound absorption coefficient of the sound absorption materials shall be greater than 0.6 and the frequency characteristics should coincide with that of the railway noise sources.
2. The weighting sound transmission loss \( R_w \) of the non-transparent sound insulation materials shall be greater than 25 dB, while that of the transparent sound insulation materials should be no less than 20 dB.
3. Light transmittance of the transparent insulation materials shall be no less than 90% and not fall down to a threshold of 85% after ten service years. In addition, there shall be anti-glaring and anti-bird measures.
4. The mechanical property of the sound barrier materials and the cementing between the sound absorptive material and the sound insulation material shall meet the requirements of the structural design.
5. The fire-proofing classification of the sound barrier materials shall be equal to or above B level of current national standard Classification for Burning Behavior of Building Materials and Products GB 8624.

6. The shock-proofing, anti-weathering, and corrosion resistance performances of the sound barrier’s acoustical component, as well as its exterior appearance shall meet the requirements of the current Technique Requirements and Measurement of Acoustic Elements of Railway’s Sound Barrier TB/T 3122.

7 Anti-corrosion treatment shall be applied to the surface of the exposed metal parts of the sound barrier.

22.2.9 Design of the auxiliary facilities of the sound barrier shall be in accordance with
the following requirements:

1. The subgrade sound barrier shall be furnished with drainage. Effluent to the subgrade slope from the drainage outlet shall be well guided to avoid erosion. And sound leakage shall be prevented.

2. When the continuous length of the subgrade sound barrier is greater than 500 m, the emergency exit shall be set up with clear width of at least 1.0m.

3. The emergency exit of the bridge sound barrier shall be utilized as the rescue and evacuation passage.

4. The safety door shall be opened outward from the inside of the barrier and not affect the noise reduction effects.

22.2.10 The interface design of the sound barrier shall be in accordance with the following requirements:

1. The sound barrier foundation shall be designed in coordination with the subgrade. The earth structure design shall take into account the requirements of the sound barrier's foundation and vice versa, the design of the sound barrier foundation shall also be coincided with the foundation works of the subgrade.

2. Installation of the bridge sound barrier shall match the embedded components on the bridge, precisely positioned as designated.

3. According to the requirements of integrated grounding, the sound barrier shall be electrically linked up by the structural steel bar or the metal component and connected to the integrated grounding terminal.

22.3 Refuse Transfer Facilities

22.3.1 Refuse transfer points shall be arranged for stations and EMU depot and workshop (or depot). Refuse classification and transfer facilities shall be arranged at platforms and inside the station buildings.

22.3.2 According to the environmental management requirements of the railway station, refuse transfer station shall be established in the station area where the EMU depot is located. The refuse transfer station may adopt the technological process of classification and transferring or classification, compression, and transferring. Based on the transfer technology and refuse volume, the refuse transfer station shall be equipped with different transfer trucks.

22.4 Vegetation Planting and Green Corridor

22.4.1 Design of vegetation planting and green corridor should be confined within the boundary of the right-of-way. When the local government provides land for greening, it may be properly extended to outside of the railway territory.

22.4.2 Design of the vegetation planting and green corridor shall follow the local conditions and preferentially select plants adaptable to local circumstance with local
meteorology, hydrology, soil, topography, the status quo of vegetation, etc. appropriately considered. Grass, shrub or arbor, whichever suitable is selected.

22. 4. 3 Design of the vegetation planting and green corridor shall be combined with the design of protection works of the subgrade slope and reinforcement of the front slope of tunnel entrance. On both sides of the subgrade slope, the shrub shall be planted near track and the arbor planted away from the track to form a multi-storey planting belt, giving consideration to both the aesthetic and landscape effects.

22. 4. 4 The greening design for stations, depots and service points may adopt gardening technology, and shall give consideration to the environmental requirements. The greening space within the station area shall satisfy relevant provisions of the currently effective national standards.

22. 4. 5 When the railway passes through regions highly sensitive in aesthetics like towns, scenic spots etc., the greening design shall give consideration to harmonization with the surrounding landscape and the aesthetic effects.

22. 4. 6 Vegetation planting under the bridge shall not block maintenance access. Shade enduring herbaceous plants and shrubs should be planted. If arbors are selected, the height of grown trees shall be controlled to make sure that falling of boughs shall not compromise the safety of bridge and train operation.
Appendix A  Widening of Construction Clearance in Curved Sections

A. 0. 1  The construction clearance in curved sections shall give consideration to inclination of the car body caused by the superelevation and widening the clearance of the curve waist. The widening value shall be calculated as the following formula:

\[ W = H \cdot \frac{h}{1500} \]  \hspace{1cm} (A. 0. 1)

Where,  
\( W \) —— widening value of the curve waist (mm);  
\( H \) —— height from the rail level to the calculated point (mm);  
\( h \) —— superelevation value of the outer rail (mm).

A. 0. 2  The widening extent of the construction clearance in curved sections include total circular curve, transition curve and partial straight line, and the ladder widening method as shown in Figure A. 0. 2 shall be adopted.

Figure A. 0. 2  Curve Widening Method of Construction Clearance of High-speed Railways
Appendix B  Calculation of the Soft Foundation Settlement

B. 0. 1 For the calculation of foundation settlement the calculated depth (or compressible thickness) is that at which the stress increment due to load equals to 0.1 time of the self-weight stress.

B. 0. 2 Generally the total settlement $S$ of the foundation is calculated as the sum of the immediate settlement $S_i$ and the primary consolidation settlement $S_c$. For stratum of peaty soil, clay with highly organic substances, or clay with high plasticity, it may take consideration to calculate the secondary consolidation settlement $S_s$, according to the situation.

1 To calculate the primary consolidation settlement $S_c$, the layer-wise summation method is adopted, and $e=p$ curve or $e=\lg p$ curve may be used to calculate the parameters of compression test.

1) when using the $e=p$ curve

$$S_c = \sum_{i=1}^{n} \frac{e_{oi} - e_{1i}}{1 + e_{oi}} \Delta h_i$$  \hspace{1cm} (B. 0. 2—1)

Where, $n$ — number of layers of the foundation;

$\Delta h_i$ — thickness of the $i$th layer (m);

$e_{oi}$ — void ratio corresponding to the self-weight stress of the mid point of $i$th layer;

$e_{1i}$ — void ratio corresponding to the sum of self-weight stress and stress increment of the mid point of $i$th layer.

2) when using the $e=\lg p$ curve

For normally consolidated and underconsolidated stratum:

$$S_c = \sum_{i=1}^{n} \frac{\Delta h_i}{1 + e_{oi}} C_a \log \left( \frac{P_{oi} + \Delta P_i}{P_a} \right)$$  \hspace{1cm} (B. 0. 2—2)

Where, $C_a$ — compression index of the stratum;

$P_{oi}$ — self-weight stress of the mid point of $i$th layer (kPa);

$e_{oi}$ — initial void ratio of the mid point of $i$th layer;

$P_a$ — preconsolidation pressure, $P_a = P_{oi}$ for normal consolidation;

$P_i$ — stress increment of the loading weight of the fill soil (kPa).

For overconsolidated stratum:

$$S_c = S'_c + S''_c$$  \hspace{1cm} (B. 0. 2—3)

For stratum where $\Delta P > P_c - P_0$:

$$S'_c = \sum_{i=1}^{n} \frac{\Delta h_i}{1 + e_{oi}} \left[ C_a \log \left( \frac{P_{oi}}{P_{oi}} \right) + C_a \log \left( \frac{P_{oi} + \Delta P_i}{P_a} \right) \right]$$  \hspace{1cm} (B. 0. 2—4)

For stratum where $\Delta P \leq P_c - P_0$:

$$S''_c = \sum_{i=1}^{n} \frac{\Delta h_i}{1 + e_{oi}} \left[ C_a \log \left( \frac{P_{oi} + \Delta P_i}{P_{oi}} \right) \right]$$  \hspace{1cm} (B. 0. 2—5)

Where, $C_s$ — rebound index.
2. The immediate settlement $S_d$ may be calculated by using the elastic theory formula, that is

$$S_d = \frac{PB}{Em} \quad \text{(B. 0. 2-6)}$$

Where, $P$ — vertical load of the bottom layer of the embankment (kPa);

$E$ — elastic modulus of the soil (may be attained from the unconfined compression test, take the weighted average thickness of each layer);

$m$ — settlement factor shown in Figure B. 0. 2;

$\mu$ — Poisson ratio, when lacking test data, it may take $\mu = 0.4 \sim 0.5$.

3. For the secondary consolidation settlement $S_s$,

When using the secondary consolidation factor for calculation, the secondary consolidation settlement may be calculated by the following formula.

$$S_s = \sum \frac{C_w}{1 + e_o} \frac{t_2}{t_1} \ln \left( \frac{t_2}{t_1} \right) h_i \quad \text{(B. 0. 2-7)}$$

Where, $C_w$ — secondary consolidation factor; it is the slope of the straight line which is the branch of the $e - \ln p$ curve after the primary consolidation. When there is no test data of $C_w$, it may consult the empirical value listed in Table B. 0. 2 or be calculated by Formula B. 0. 2-8;

$t_1$ — the time corresponding to the 100 percent primary consolidation point;

$t_2$ — the time at which the magnitude of primary consolidation is desired.

$$C_w = 0.018 w \quad \text{(B. 0. 2-8)}$$

Where, $w$ — the natural moisture content of soil (value taking is based on the decimal point).
Table B.0.2 Secondary Consolidation Factor

<table>
<thead>
<tr>
<th>Type of Soft Soil</th>
<th>Peat</th>
<th>Clay with highly organic substances</th>
<th>clay with high plasticity</th>
<th>Overconsolidated clay</th>
</tr>
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<tbody>
<tr>
<td>Characteristics</td>
<td>Fiber structure, feels like sponge</td>
<td>Content of organic substance $&gt;30%$</td>
<td>Plasticity index $&gt;25$</td>
<td>OCR $&gt;2$</td>
</tr>
<tr>
<td>$C_s$</td>
<td>0.1~0.3</td>
<td>0.005~0.03</td>
<td>$&gt;0.03$</td>
<td>$&lt;0.001$</td>
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</table>

B.0.3 The total settlement of the foundation may also calculated by using the settlement factor ($m$) and the primary consolidation settlement ($S_C$):

$$S = m \cdot S_C$$  \hspace{1cm} (B.0.3)

The settlement factor $m$ is an experiential factor, and is related to the foundation conditions, intensity of loading, rate of loading etc.. $m = 1.1 \sim 1.4$ for normally consolidated soil.

B.0.4 When calculating the settlement, the train loading of is calculated by loading for single track.
Appendix C  Equivalent Evenly Distributed Load Converted From ZK Live Load

Table C  Equivalent Evenly Distributed Load Converted From ZK Live Load (kN/m)

<table>
<thead>
<tr>
<th>L(m)</th>
<th>K(0.000)</th>
<th>K(0.125)</th>
<th>K(0.250)</th>
<th>K(0.375)</th>
<th>K(0.500)</th>
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Appendix D  Reduction Coefficient of Effective Width of Box Girder

D. 0. 1  Table D. 0. 1 shows reduction coefficient of effective width of the simply supported box girder with different width-span ratios. Related symbols of the width-span ratio ($\lambda_i = b_i/L$) of the simply supported box girder are as shown in Figure D. 0. 1.

<table>
<thead>
<tr>
<th>$\lambda_i = b_i/L$</th>
<th>Reduction coefficient of effective width</th>
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<td></td>
<td>Middle of the span</td>
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<td>1. 0</td>
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<td>0. 020</td>
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<td>0. 81</td>
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<td>0. 50</td>
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<td>0. 500</td>
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Figure D. 0. 1  Diagram of the Width-Span Ratio of Simply Supported Box Girders

D. 0. 2  As to the effective width of the flange of each span of the continuous box girder, it may be calculated as 0. 9 time the span of the side span of the simply supported box girder; the reduction coefficient of effective width of the flange of each intermediate span is shown in Table D. 0. 2.
Table D. 0. 2  Reduction Coefficient of Effective Width of Each Intermediate Span of the Continuous Box Girder

<table>
<thead>
<tr>
<th>( \lambda_i = \frac{b_i}{L} )</th>
<th>Reduction coefficient of effective width</th>
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Appendix E  Design Length of ZPW-2000 A Track Circuit

E. 0. 1 The maximum engineering design length of the block section track circuit of the section of ballastless track is as shown in Table E. 0. 1.

<table>
<thead>
<tr>
<th>Type of Track Structure</th>
<th>engineering design length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgrade</td>
<td></td>
</tr>
<tr>
<td>Without reinforced concrete base under the track</td>
<td>1 400</td>
</tr>
<tr>
<td>With reinforced concrete base under the track</td>
<td>1 000</td>
</tr>
<tr>
<td>Less than 300 m</td>
<td></td>
</tr>
<tr>
<td>Without reinforced concrete base under the track</td>
<td>1 400</td>
</tr>
<tr>
<td>With reinforced concrete base under the track</td>
<td>1 000</td>
</tr>
<tr>
<td>300～2 000 m</td>
<td></td>
</tr>
<tr>
<td>Without reinforced concrete base under the track</td>
<td>1 000</td>
</tr>
<tr>
<td>With reinforced concrete base under the track</td>
<td>800</td>
</tr>
<tr>
<td>More than 2 000 m</td>
<td></td>
</tr>
<tr>
<td>Without reinforced concrete base under the track</td>
<td>700</td>
</tr>
<tr>
<td>With reinforced concrete base under the track</td>
<td>600</td>
</tr>
<tr>
<td>Concrete bridge</td>
<td>1 000</td>
</tr>
</tbody>
</table>

The design conditions are as following:
1 Minimum leakage resistance of ballast: 3. 0Ω・km.
2 Standard shunting resistance: 0. 25Ω.
3 Parameters of rail: for subgrade sections, resistance of the rail shall not be larger than 2. 516Ω/km, and inductance of the rail is between 1194～1387 μH/km; while for concrete bridge and tunnel sections, resistance of the rail shall not be larger than 3. 52Ω/km, and inductance of the rail is between 1194～1356 μH/km.
4 Length of cable: 7. 5 km.

E. 0. 2 The minimum engineering design length of the track circuit in block section shall be larger than 150 m, and the minimum engineering design length of track circuit in station shall be larger than 60 m.

E. 0. 3 The maximum engineering design length of the track circuit in stations shall be in accordance with the following requirements:
1 The length of track circuit in station tracks shall not be larger than 650 m (the leakage resistance of ballast bed shall not be less than 3. 0Ω・km, the shunting resistance shall not be larger than 0. 25Ω or the leakage resistance of ballast bed shall not be less than 2. 0Ω・km, the shunting resistance shall not be larger than 0. 15Ω and when the distance between centers of tracks is no less than 5 m.)
2 The length of track circuit in turnout section shall be less than 400 m, and shall not be larger than 600 m in special conditions. There should not be more than 2 sets of turnout for each turnout section. If there is only one set of turnout, the length of non-powered branch (which is the length between the turnout center point and the insulating joint of the non-powered branch track circuit) shall not be larger than 160 m. When there are two turnouts in the turnout section, the length of each of the non-powered branch shall not be larger than 80 m and 160 m respectively.
Explanation of Wording in This Code

Words used for different degrees of strictness are explained as follows in order to mark the differences in executing the requirements in this Code.

1. Words denoting a very strict or mandatory requirement;
   “Must” is used for affirmation; “must not” for negation.

2. Words denoting a strict requirement under normal conditions;
   “Shall” is used for affirmation; “shall not” for negation.

3. Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit;
   “Should” is used for affirmation; “should not” for negation.
   “May” is used to express the option available, sometimes with the conditional permit.