# Foreword

According to the requirements of Document JIANBIAO[2009]No.88 issued by the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD)—"Notice on Printing and Distributing' the Development and Revision Plan of National Engineering Construction Standards and Codes in 2009 '", this code was revised by the Survey and Design Committee of China National Coal Construction Association, together with Handan Design Engineering Co., Ltd. of China Coal.

In the process of the code revision, the development team carried out extensive investigations, summarized the experiences and lessons of major earthquakes at home and abroad, and on the basis of extensive consultation, after many discussions, the final draft was examined and finalized.

The code consists of 9 chapters, covering: general provisions, basic requirements, geotechnical engineering, general plan and outside road, underground engineering, ground engineering, preparation plant engineering, power supply distribution and integrated informatization, water supply and drainage, heating and gas storage and distribution.

The provisions printed in bold type are mandatory ones and must be implemented strictly.

The Ministry of Housing and Urban-Rural Development of the People's Republic of China is in charge of administration of this code and the explanation of the compulsory provisions hereof. China Coal Construction Association is in charge of routine management, and China Handan Design and Engineering Co., Ltd. is in charge of explanation of technical specifications. All relevant organizations are kindly requested to sum up and accumulate your experiences in actual practices during the process of implementing this code. The relevant opinions and advice, whenever necessary, can be posted or passed on to the compilation group of *Code for Mine Seismic Design of Coal Industry* of Handan Design Engineering Co., Ltd. (Address: No. 114 of Fuhe Street, Handan City, Hebei Province, Postcode: 056031) for future revision of the standard.

Chief Development Organizations, Co-Development Organizations, Chief Drafters and Chief Reviewers of the original Chinese version as follows.

**Chief Development Organizations:**

Survey and Design Committee of China Coal Construction Association

Handan Design Engineering Co., Ltd. of China Coal

**Co-Development Organizations:**

Beijing Huayu Engineering Co., Ltd. of China Coal International Engineering Group

Chongqing Design and Research Institute of China Coal International Engineering Group

Tangshan Kailuan Survey and Design Co., Ltd.

**Chief Drafters:**

WANG Zongxiang　JIANG Chunqiu　SHAO Yimou　REN Aiguo

ZHANG Guohuan　REN Baoli　YANG Yilong　FENG Guanxue　LI Yicai

ZHANG Xiaosi　SONG Gang　MA Zhongcheng　LU Zhongke　GUO Dalin

ZHANG Baobao　MENG Jian　KONG Fanping　ZHANG Bo　WU Rui
TAO Youshan　WU Ying　LI Yujin　ZHENG Jie　XIE Ziqiang
PENG Chengrong　LU Yihong　HU Shifeng　ZHANG Qingfu
WEN Zongqiang　HUANG Chungang

**Chief Reviewers:**

WANG Buyun　GENG Jianping　ZHOU Bengang　WANG Zhijie　LI Dechun
LI Ding　CUI Yuanrui　LI Shuxing　DONG Jibin　CHEN Hong　XIA Junwu

**Chief Translator Organization:**

Handan Design Engineering Co., Ltd.of China Coal

**Participating Translator Organizations:**

China University of Mining and Technology
Hebei University of Engineering
Coal Industry Taiyuan Design and Research Institute Group Co., Ltd.
China Coal First Construction Co., Ltd.

**Chief Translators:**

WANG Zongxiang　MA Zhongcheng　GUO Dalin　SONG Gang
ZHAO Yinzhuan　XIA Junwu　KONG Fanping　HU Guangyuan　LU Zhongke
DING Haifang　REN Aiguo　ZHANG Guohuan　REN Baoli　YANG Yilong
ZHANG Baobao　MENG Jian　WU Rui　WANG Libin　WANG Ruize
LI Dan　WANG Xiangyu　CHANG Hongfei　MENG Wenqing　SHI Huawang
ZHANG Yapeng　LI Zhaoliang　YANG Xuan　ZHENG Xin　NIU Pengxiang
HU Guangwei

**Chief Translator Reviewers:**

WANG Zhijie　CHEN Hong　DONG Jibin　JIANG Jian　YIN Yue

# Contents

# 1 General provisions

**1.0.1** This code is formulated in combination with the characteristics of coal industry, the purpose of carrying out the national Law of the People's Republic of China on Protecting against and Mitigating Earthquake Disasters, implementing the principle of prevention, reasonable seismic precaution, reducing earthquake disaster, avoiding causalities, and reducing economic loss.

**1.0.2** This code is applicable to seismic design for projects and facilities of coal mine and preparation plant, which be built, rebuilt and expanded in regions with seismic precautionary intensity 6 and above.

**1.0.3 The seismic precautionary intensity shall be defined in accordance with the current National Standard GB 18306 *Seismic Ground Motion Parameters Zonation Map of China* or the documents approved and issued in accordance with the authority granted. The seismic precautionary intensity for mine and coal preparation plant shall be defined according to the location of the industrial site.**

**1.0.4** The seismic design of mine and preparation plant engineering shall meet the following requirements:

**1** Emphasis should be laid on, coordination should be made and post-earthquake recovery should be facilitated.

**2** Secondary disasters such as mine flooding, fire hazard and explosion should be prevented during strong earthquakes.

**3** The safety of escape passage and its water, electricity and ventilation facilities should be guaranteed.

**1.0.5** The new concept and idea of seismic design should be adopted in the course of mine and preparation plant design based on their functions and characteristics.

**1.0.6** In addition to the requirements of stipulated in this code, the seismic design of mine and preparation plant engineering also shall comply with those stipulated in the current relevant standards of the nation.

# 2 Basic requirements

## 2.1 Seismic precautionary classification

**2.1.1** The seismic precautionary category of mine and preparation plant engineering shall meet the following requirements:

1 For engineering related to lifelines whose functions cannot be interrupted during the earthquake or need to be restored as soon as possible after the earthquake, and engineering that during an earthquake may lead to a massive casualties or other major disaster, and that require upgrading the precautionary standards, they shall be classified as major precautionary category (Category B).

2 For engineering with precautions standard other than Category B and D, they shall be classified as standard precautionary category (Category C).

3 For engineering with few personnel and no secondary disasters caused by earthquake, and that are allowed to reduce appropriately the level of seismic precautions as compared with the requirements of basic seismic precautions for this region, they must be classified as appropriate precautionary category (Category D). The seismic precautions shall not be reduced when the seismic precautionary intensity is 6.

**2.1.2** The category of seismic precaution for mine and preparation plant engineering shall be determined according to the industry specifics, the casualties, economic losses and difficulty of its recovery, specified in Table 2.1.2.

Table 2.1.2 Category for seismic precaution for mine and preparation plant engineering

| No. | System | Project name | Category |
|---|---|---|---|
| 1 | Underground engineering | Underground safe refuge chamber, shaft emergency exit, shaft, pit bottom, main intake airway, return airways | B |
| 2 | Hoisting system | Headframe, shaft tower, head sheave, hoist house, lodge room | B |
| 3 | Preparation plant | Sedimentation tank, material shed | D |
| 4 | Ventilator system | Ventilation shaft head, ventilator room, gas extraction pump room | B |
| 5 | Water supply and drainage system | Water supply system tank, water tower, water supply pipelines and water intake structures, underground drainage pump room | B |
| 6 | Power supply and distribution system | Important power facilities | B |
| 7 | Communication system | Communication center, dispatching and monitory center | B |
| 8 | Auxiliary facilities | Compressed air station (also used for emergency rescue system) | B |
| | | Material shed, equipment shed | D |
| 9 | Mine rescue and fire protection device | Ambulance garage and multi-function building, fire protection | B |
| 10 | Road and bridge engineering | Mine main roads and bridges, culverts, retaining works, etc. Important overpass objects at the general roads of mine | B |
| | | Other mine road bridges, culverts, retaining works | D |

Notes: 1 The unlisted mine and preparation plant engineering are pertain to the Category C.

2 The seismic precautionary category of administrative public buildings, etc. in mine engineering shall be determined in accordance with the current national standard GB 50223 *Standard for Classification of Seismic Protection of Building Constructions* and GB 50592 *Code for Design of Colliery Building and Structure of Coal Mine*.

## 2.2 Structural system

**2.2.1** The structural system of mine and preparation plant engineering shall meet the following

requirements:

**1** The structural system shall have a clear analysis model and reasonable paths for the transmission of seismic action.

**2** The structural system shall have adequate robustness to avoid the loss of seismic capacity due to the failure of structure or components.

**3** The structural system shall have necessary seismic capacity, favorable deformation ability and seismic energy dissipation ability.

**4** For the weak portions, necessary measures shall be taken to improve seismic capacity.

**2.2.2** The structure system of mine and preparation plant engineering should meet the following requirements:

**1** Multi-defence seismic energy dissipation subsystems should be determined by the structural system.

**2** The structural system should have a reasonable distribution of stiffness and resistance to eliminate the occurrence of weak portions where excessive concentrations of stress or plastic deformation might be produced due to local weakening or abrupt changes.

**3** The heavy cantilever structures with heavy self-weighted should not to be used.

**4** The structure should have similar dynamic characteristics in the directions of two main axes.

**2.2.3** The seismic bearing system of mine and preparation plant engineering shall ensure the integrity and stability of the whole structure and reliably transmit the horizontal seismic action during earthquake.

### 2.3 Isolation and energy-dissipation

**2.3.1** The isolation and energy-dissipation design may be applied to the mine and preparation plant engineering which have higher requirements for seismic safety and needed function.

**2.3.2** Mines and coal preparation plant engineering classified as category B for seismic precautions shall conform to the following requirements:

**1** When the seismic precautionary intensity is 8, shock isolation, energy dissipation and shock absorption design should be adopted.

**2** When the seismic precautionary intensity is 9, shock isolation, energy dissipation and shock absorption design shall be adopted.

**2.3.3** The isolation and energy-dissipation shall meet the requirements of the current national standard GB 50011 *Code for Seismic Design of Buildings* .

### 2.4 Materials and construction

**2.4.1** Where special requirements about materials and construction quality, for the construction and installation of seismic structures, water supply and drainage, power supply and distribution facilities and important mechanical equipment, It shall be clearly stated in the design documents.

**2.4.2** Special construction methods such as sliding-form construction and large-span construction in mine and coal preparation plant shall be approved by design confirmation before construction.

**2.4.3** The property indexes of materials shall meet the current national standard GB 50191 *Code for Seismic Design of Special Structures.*

# 3 Geotechnical engineering

## 3.1 General requirements

**3.1.1** Where the selection of construction site, the geological structure, topography, engineering geology, hydrogeological conditions and seismic geologic conditions, etc. shall be investigated, mapped, explored and tested, and the impact of earthquake on the construction site shall be preliminarily evaluated.

**3.1.2** The geotechnical engineering investigation shall analyze and evaluate the stability and suitability of the construction site for mine construction, and shall divide the construction site into seismic favorable, general, unfavorable or dangerous area, which shall comply with the requirements of the current National standard GB 51144 *Code for Investigation of Geotechnical Engineering of Mine Construction in Coal Industry* .

**3.1.3** For the sites with seismic precautionary intensity 7 and above, the seismic action shall be analyzed and evaluated. For the category B except underground engineering, and category C of large and tall engineering in the 6 as shown in Table 2.1.2, The liquefaction evaluation shall be carried out by 7 degree.

## 3.2 Liquefaction evaluation

**3.2.1** Except the following factors shall take into account such as topography, groundwater property, soil sensitivity and particle size distribution, etc., the preliminary determination of seismic liquefaction of saturated soil also other approved methods should be used such as cone penetration test and relative density test, etc.. Further evaluation shall be carried out when the possibility of liquefaction has been determined by the preliminary investigation.

**3.2.2** The liquefaction discrimination of saturated sandy soil and general saturated silt shall meet the provisions of current National standard GB 50011 *Code for Seismic Design of Buildings*. The liquefaction discrimination of saturated loess should meet to the provisions of current National standard GB 51144 *Code for Investigation of Geotechnical Engineering of Mine Construction in Coal Industry*.

**3.2.3** The extent of seismic liquefaction hazard shall be comprehensively analyzed and evaluated not only take into account the liquefaction grade, but also according to the topographic characteristic of site, the burial depth, thickness and effective covering pressure of liquefied soil layer, particle composition, gradation and relative density of soil, as well as groundwater property, variation of water level and conditions of recharge and discharge.

**3.2.4** For the sites that have experienced earthquake liquefaction in history, the possibility of re-liquefaction shall be re-analyzed and re-evaluated with the supplement of exploration and testing. For the inclined site or the liquefied soil layer that existing free surface, the possibility of sliding caused by soil liquefaction shall also be evaluated.

## 3.3 Subsidence seismic evaluation

**3.3.1** The thick layer of soft soil distribution area with seismic precautionary intensity 7 and above

shall be analyzed and evaluated according to the current Industry standard JGJ 83 *Specification for Geotechnical Investigation in Soft Clay Area*. When the thick layer of soft soil distribution area with seismic precautionary intensity 9 and above, the feasibility of natural subsoil shall be specially studied.

**3.3.2** For the building structures with natural subsoil, specialized analysis and calculation of subsidence seismic shall be carried out when the seismic precautionary category is B.

**3.3.3** The subsidence seismic in coal mine goaf shall meet the provisions of current national standard GB 51044 *Code for Investigation of Geotechnical Engineering in the Coal Mine Goaf*. For the sites with seismic precautionary intensity 7 and above, the subsidence seismic action of earthquake on the stable old goaf shall be taken into account. For the tall building engineering in category B and C with seismic precautionary intensity 9, the stability of goaf shall be specially studied.

### 3.4 Active fault

**3.4.1** For the industrial sites with seismic precautionary intensity 7 and above, special investigation of active faults shall be carried out, and the location and type of faults shall be ascertained. The activity of active faults shall be analyzed simultaneously and the influence of active faults on mine and preparation plant engineering shall be evaluated. For the key mine construction projects, the special work of "seismic safety evaluation of engineering site" shall also be carried out.

**3.4.2** Non-active faults may not be avoided in mine and coal preparation plant engineering, but it shall be treated as non-uniform foundation when the thickness of soil layer on the non-active faults is small and fracture zone is developed.

**3.4.3** The influence of dislocation of seismogenic faults on mine and coal preparation plant engineering may be ignored when one of the following conditions is satisfied:

**1** Seismic precautionary intensity is less than 7.

**2** It is a non-active fault.

**3** The seismic precautionary intensity of the area is 7 or 8 and the thickness of the soil layers overlying the hidden fault is greater more than 60m, or the seismic precautionary intensity of the area is 9 and the thickness of the soil layers overlying the hidden fault is greater more than 90m.

**3.4.4** For the mine and preparation plant engineering that do not satisfy the conditions of Table 3.4.3, the main fault zone shall be avoided and the avoidance distance should not be less than the requirements by Table 3.4.4.

**Table 3.4.4 Minimum avoidance distance of causative fault(m)**

| Seismic precautionary intensity | Seismic precautionary category of mine and preparation plant engineering | | |
|---|---|---|---|
| | B | C | D |
| 7 or 8 | 200 | 100 | Non-avoidance |
| 9 | 400 | 200 | Non-avoidance |

Notes:1 The avoidance distance refers to the distance between the fault edge and the proposed ground construction project, and width of the fault zone shall be deducted from the distance.

2 It is applicable to such project categories as bridges and structures below bridges within the road and bridge engineering.

# 4 General plan and outside road

## 4.1 Site selection

**4.1.1** In addition to meeting the requirements of chapter 3 of this code, the selection of construction sites for mine and coal preparation plant shall meet the following requirements:

**1** Adverse geological effects such as mountain collapse, landslide, debris flow, ground subsidence, goaf subsidence, active fault zone and ground fissure shall be dealt with or avoid.

**2** The site should not be located in the downstream area of reservoirs with lower flood control standards than are used for mine and the coal preparation plant. If it's unavoidable, measures shall be taken to prevent the occurrence of secondary disasters related with the wellhead and the site flooding.

**4.1.2** The selection of industrial sites shall not affect the immediate water supply recovery after earthquake.

## 4.2 General plan layout

**4.2.1** The projects of precautionary category B and category C should be arranged within the construction site in the favorable area to earthquake resistance.

**4.2.2** The main substation of the mine and construction site substations with voltage higher than or equal to 35kV shall be arranged separately. The distance between the input and output utility pole and the adjacent ground project shall not be less than the cornice height of the adjacent ground project.

**4.2.3** For high personnel density administrative and public buildings, nearby public area shall be used as emergency shelters.

**4.2.4** In addition to the lodge room, anti-collapse measures shall be taken at the projects near the wellbore when be used as emergency exits.

**4.2.5** The distance between the protruding edge of the water tower and the adjacent category B projects and densely populated structures shall be greater than 1/2 of the water tower height. The distance between the masonry chimney and the adjacent category B projects and the densely populated structures shall be greater than 1/3 of the chimney height.

**4.2.6** The distance between the masonry enclosure wall and the outer protruding edge of important outdoor equipment and the pavement edge of firefighting access passage shall be greater than the enclosure wall height.

**4.2.7** Main pipelines for the water supply, power supply and distribution, ventilation and compressed air supply at the site should be arranged along both sides of the road.

## 4.3 Road and bridge

**4.3.1** When selecting the place for roads and bridges within the mine site the sections favorable for earthquake resistance shall be adopted, and the following sections should be avoid:

**1** Area where landslide and collapse may occur during the earthquake.

**2** Underground river, solutional caves and other karst area that may collapse during the earthquake.

**3** Existing mine goafs and potential goafs of proposed mines, proposed coal mines which can produce new goafs and gob area.

**4** The sections in the riverbed where the bedrock has inclined river channel with deep cut weak surface structure.

**5** Seismogenic fault sections.

**4.3.2** If the route of the mine road has to pass through a seismogenic fault, it should be placed in the area with rather narrow fracture zone. When the route must be parallel to a seismogenic fault, it should be placed on the footwall of the fault. The low fill and shallow excavation design should be adopted when drawing up the route.

**4.3.3** If there is seismogenic fracture within the scope of the bridge project site, the impact of seismogenic fracture on the project shall be evaluated, and shall meet the following requirements:

**1** If the Article 3.4.3 of this code can be satisfied, the impact of seismogenic fault on the bridge project can be excluded and make no reckoning.

**2** If the Article 3.4.3 of this code cannot be satisfied, the following measures should be taken:

**1)** For extreme large bridges with the single span exceeding 150m, the main fault zone should be avoided. For the area with the seismic precautionary intensity of 8 or 9, the avoidance distance between the main fault zone and the bridge pier edge should be greater than 300m and 500m respectively.

**2)** Medium and small bridges should be adopt the structure with smaller span and easy to repair. If a seismogenic fault is unavoidable, it is should arrange all the piers on the same footwall of the fault.

**4.3.4** For projects such as the mine roads, bridges, culverts, retaining works and so on, anti-seismic design shall be drawn up according to the seismic precautionary categories and the seismic activity.

**4.3.5** The seismic design of mine road (highway) engineering and its bridges, tunnels, culverts, retaining works, as well as seismic measures shall conform to the current Industry standard JTG B02 *Specification of Seismic Design for Highway Engineering* and JTG/T B02-01 *Gaidelines for Seismic Design of Highway Bridges*.

# 5 Underground engineering

## 5.1 General requirements

**5.1.1** Active faults shall be avoided in sinking and driving engineering.

**5.1.2** The shaft shall be located in area with stable bedrock, relatively thin topsoil and advantageous engineering geological conditions, and shall avoid dangerous area.

**5.1.3** The special seismic design shall be carried out for the mine projects situated near the lodge where the height of rock slope exceeds 30m and that of soil slope exceeds 15m.

## 5.2 Mine support

**5.2.1** Vertical shaft support methods shall meet the following requirements:

**1** When the seismic precautionary intensity is 6 or 7, the reinforced concrete structures shall be used within 30 meters below the surface.

**2** When the seismic precautionary intensity is 8 and above, the reinforced concrete structures shall be adopted within 50 meters below the surface.

**5.2.2** Slope and drift support methods shall meet the following requirements:

**1** When the seismic precautionary intensity is 6 or 7, the reinforced concrete structures shall be adopted within 20 meters below the surface.

**2** When the seismic precautionary intensity is 8 and above, the reinforced concrete structures shall be used within 30 meters below the surface.

**5.2.3** Reinforced concrete structures shall be used for fan drift and emergency exits.

**5.2.4** The arch section should be used when the underground roadway passes through faults and fractured zones, and strengthened supporting measures should be taken.

**5.2.5** The mouth of inclined slope and drift shall be provided with doorways, and the connecting section between the end wall and doorways shall be grouted wholly or short reinforcing bar should be additionally mounted at its joint.

## 5.3 Emergency exit

**5.3.1** When the seismic precautionary intensity is 8 and above, a foldback layout of ladder roadways shall be used.

**5.3.2** When the seismic precautionary intensity is 9, a platform shall be set up every 200m in vertical shaft as an emergency exit. In non-freezing section, a niche can be excavated on the shaft wall. In the freezing section, the platform may be arranged in the form of enlarging the landing platform.

## 5.4 Underground main drainage

**5.4.1** When the seismic precautionary intensity is 8 and above, the main drainage pump house shall be arranged according to the hydrogeological conditions and water inflow, and the position of one or two pumps shall be reserved.

**5.4.2** The drainage engineering facilities at the upper level should be retained in the mine with

downward horizontal extension.

**5.4.3** When the seismic precautionary intensity is 9, an additional submersible pump should be installed, with independent power supply system, which drainage capacity not less than the maximum water inflow.

### 5.5 Hoist facilities

**5.5.1** In the seismic fortification area, when there is only one set of hoisting equipment in the auxiliary shaft of a mine with a all vertical shaft development form and deeper 500m, the hoisting equipment of the traffic tank shall be mounted for the emergency lifting requirements.

**5.5.2** While the seismic precautionary intensity is 8 and above, a floor-standing layout should be adopted while multi-rope hoist is used as mine hoisting equipment.

**5.5.3** The bridge crane mounted in hoist room shall have anti-falling protective means.

**5.5.4** Horizontal installation mode should be used for cage or skip installation into the shaft tower.

# 6 Ground engineering

## 6.1 General requirements

**6.1.1** For category B mine projects with seismic precautionary intensity of 6, 7 or 8, the basic seismic precautionary intensity of the area shall be raised by one degree for the purpose of earthquake effect and the seismic capacity calculation of structural component section as well as corresponding details of seismic design shall be taken.

**6.1.2** The selection of subsoil and foundation type for the ground engineering should meet the following requirements:

**1** Except for rock base, the burial depth of the foundation on soil should not be less than 1/15 of the building height.

**2** The burial depth of pile foundation (excluding the length of the pile) should not be less than 1/18 of the building height.

**3** The foundation of the one structural unit should not be built on the subsoil with entirely different features, and partial natural subsoil and partial pile foundation for the same unit should not be used.

**6.1.3** Category B and C buildings shall not be built in dangerous area, but if it is unavoidable, correspondent measures shall be taken to eliminate factors.

**6.1.4** The horizontal and vertical layout of surface buildings should be simple, uniform, regular and symmetric, and the mass distribution and stiffness ratio should be uniform, and the staggered-floor structure should be avoided.

**6.1.5** For ground surface buildings with a complicated structure or sudden changes of rigidity, seismic joint or details of seismic design should be taken.

**6.1.6** The nonstructural components shall be connected with the main structure reliably, their disadvantage effects on the main structure shall be considered.

**6.1.7** The equipment supports arranged on stories shall be carried out with seismic design.

## 6.2 Head frame

**6.2.1** Steel or reinforced concrete structures shall be adopted for the head frame.

**6.2.2** For multi-rope hoisting head frame arranged in area with the seismic precautionary intensity of 8 or above, double inclined bracing steel head frame should be adopted.

**6.2.3** Suspension connection should be adopted for lift holding frame the double braced steel head frame, and the lower end of the support can be connected with the horizontal frame of the shaft mouth by horizontal constraints and vertical sliding connections.

**6.2.4** Seismic grade of the head frame shall be determined according to those specified in Table 6.2.4.

**Table 6.2.4 Head frame seismic grade**

| Precautionary intensity | 6 | 7 | 8 | 9 |
|---|---|---|---|---|
| Reinforced concrete head frame | Ⅲ | Ⅱ | Ⅰ | Ⅰ |
| Steel head frame with height≤50m | Ⅳ | Ⅲ | Ⅱ | Ⅰ |
| Steel head frame with height>50m | Ⅲ | Ⅱ | Ⅰ | Ⅰ |

Note: Seismic grade of the major precautionary category (category B) shall be selected from the table according to the seismic precautionary intensity of the area.

**6.2.5** The seismic action sustained by a head frame shall be calculated in two major axes, and shall meet the following requirements:

**1** When the seismic precautionary intensity is 6, no-calculation of horizontal seismic action may be permitted.

**2** When the seismic precautionary intensity is 7 or 8, horizontal seismic action shall be calculated.

**3** When the seismic precautionary intensity is 9, calculation of vertical seismic action sustained by a head frame shall be carried out, as well as calculation of unfavorable combination of vertical and horizontal seismic action.

**6.2.6** When calculating the limit state of the head frame bearing capacity, the following requirements shall be meet:

**1** When only the horizontal seismic action is calculated, the cross-section seismic capacity calculation shall be carried out using the following formula:

$$S \leqslant R/\gamma_{RE} \tag{6.2.6-1}$$

**2** When only the vertical seismic action is calculated, the following formula shall be used for cross-section seismic capacity calculation:

$$S \leqslant R \tag{6.2.6-2}$$

Where, $S$–The design value of internal force of structural components sustained the seismic action;

$R$–The design value of structural components' bearing capacity;

$\gamma_{RE}$–The seismic adjustment coefficient of bearing capacity which shall meet the provisions of GB 50191 *Code for Seismic Design of Special Structures*.

**3** When linear elastic analysis is conducted for the head frame, the horizontal seismic action calculation needn't carry out along with vertical seismic action calculation. When calculating the seismic action using elastic-plastic limit state under a rare earthquake occurrence condition, the possibility of simultaneous action of horizontal and vertical seismic action shall be calculated, and the partial coefficient for the horizontal and vertical seismic action may be taken as 1.3 and 0.5 respectively.

**4** When calculating the seismic action, the partial coefficient for the lifting working load may be taken as 1.3, the partial coefficient for the gravity load may be taken as 1.2, and that for the other loads may be taken as 1.0.

**5** For the head frame higher than 60m, constructed in the area with seismic precautionary intensity of 9 and strong typhoon activity, the partial coefficient of the wind load may be taken as 0.2.

**6.2.7** The horizontal displacement of the head frame determined in the course of the seismic action calculation shall not be greater than $H/600$ of its height.

Note: $H$–head frame height, the distance between the shaft top surface and head pulley axis(m).

**6.2.8** The stability of the head frame under seismic action shall be checked, and the overturning resistance shall be checked according to the following formula:

$$M_G/M_Q \geqslant 1.3 \tag{6.2.8}$$

Where, $M_G$–anti-overturning moment;

$M_Q$–overturning moment.

**6.2.9** Seismic joint shall be set between the head frame and adjacent building structures. The minimum width of the seismic joint shall meet the requirements of the Table 6.2.9.

**Table 6.2.9 The minimum width of seismic joint of the head frame**

| Structure type | Hoisting equipment type | Seismic precautionary intensity | | | |
|---|---|---|---|---|---|
| | | 6 | 7 | 8 | 9 |
| Reinforced concrete structure | cage | $h$/140(70) | $h$/140(70) | $h$/125(80) | $h$/90(110) |
| | skip | $h$/250(80) | $h$/200(90) | $h$/150(100) | $h$/100(140) |
| Steel structure | cage | $h$/115(130) | $h$/115(130) | $h$/70(210) | $h$/40(370) |
| | skip | $h$/185(160) | $h$/185(160) | $h$/120(250) | $h$/70(430) |

Notes:1 In the table, figures in the brackets are the minimum width of seismic joint, and $h$ is the height of the building structure adjacent to the head frame.

2 The distance between the head frame and the lodge room shall be adjusted according to the displacement caused by the seismic action.

3 In case of mixed hoisting head frame, the width of the seismic joint shall be determined according to the value for skip hoisting head frame.

**6.2.10** The foundation of the brace for the steel head frame should not be connected with the foundation of the hoisting machine room. Under the action of earthquake, zero-stress area should not exist at the bottom of the foundation.

**6.2.11** Seismic capacity calculation shall be carried out for the anchor bolts of the brace foundation for the steel head frame. Cracking-resistant reinforcement shall be arranged near the surface of the brace foundation.

## 6.3 Shaft tower

**6.3.1** Reinforced concrete or steel structure shall be adopted for the shaft tower. When the seismic precautionary intensity is 9 and the height of the shaft tower exceeds 60m, steel structure should be adopted.

**6.3.2** The applicable maximum height of the shaft tower constructed within the seismic precautionary area should not exceed the provisions of the Table 6.3.2.

**Table 6.3.2 Applicable maximum height of the shaft tower(m)**

| Shaft tower type | | Seismic precautionary intensity | | | |
|---|---|---|---|---|---|
| | | 6 | 7 | 8 | 9 |
| Reinforced concrete shaft tower | Frame structure | 60 | 50 | 40 | – |
| | Box(cylinder)structure | 140 | 120 | 80 | 60 |
| Steel shaft tower | Frame structure | 110 | 100 | 80 | 50 |
| | Braced frame structure | No limitation | No limitation | 100 | 80 |

Notes:1 Shaft tower height refers to the height from the outdoor ground surface to the top of the main roof panel(excluding partial roof protrusion).

2 The cylinder structure includes the cylinder, the cylinder-and-frame and the cylinder-in-cylinder structure.

3 The maximum applicable height is determined according to the seismic precautionary intensity.

**6.3.3** The seismic grade of the shaft tower shall be determined according to those specified in Table 6.3.3.

**Table 6.3.3 Seismic grade of shaft tower**

| Shaft tower type | | Seismic precautionary intensity | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 6 | | 7 | | 8 | | 9 |
| Reinforced concrete frame structure shaft tower | Height(m) | ≤30 | >30 | ≤30 | >30 | ≤40 | | – |
| | Frame | Ⅲ | Ⅱ | Ⅱ | Ⅰ | Ⅰ | | – |
| Reinforced concrete cylinder structure(box type) | Height(m) | ≤60 | >60 | ≤60 | >60 | ≤60 | >60 | ≤60 |
| | Frame | Ⅲ | Ⅱ | Ⅱ | Ⅰ | Ⅰ | Ⅰ | Ⅰ |
| | Cylinder walls | Ⅱ | Ⅱ | Ⅰ | Ⅰ | Ⅰ | Ⅰ | Ⅰ |
| Steel shaft tower | Height(m) | ≤50 | >50 | ≤50 | >50 | ≤50 | >50 | ≤80 |
| | Frame, frame and brace structure | Ⅳ | Ⅲ | Ⅲ | Ⅱ | Ⅱ | Ⅰ | Ⅰ |

Notes: 1 Seismic grade of key precautionary category(category B)shaft towers shall be selected from the table according to the seismic precautionary intensity of the area.

2 When construction site belongs to the category Ⅰ, the seismic grade of the shaft tower shall be determined as one degree lower than the seismic precautionary intensity of the area, no further reduction is allowed when the seismic grade is 4.

3 When the upper limit of this table is exceeded, more effective details of seismic design shall be taken than that for the corresponding seismic levels.

**6.3.4** A rectangular configuration should be adopted for the layout of reinforced concrete shaft tower, the platform can be symmetrical to the center line of the shaft, and the shape should be the same along the height direction. When the seismic precautionary intensity is 8 and above, a cantilever structure should not be adopted when erecting the hoisting hall.

**6.3.5** Cylinder structure should be adopted for the reinforced concrete shaft tower. Except for the ground floor and the hoisting hall, the vertical spacing of each floor should be evenly arranged.

**6.3.6** Seismic joint shall be set between the shaft tower and the adjacent building structure, and the minimum width of seismic joint shall meet the provisions of Table 6.3.6. The minimum width of seismic joint shall not be less than 100mm when the adjacent building is a reinforced concrete frame-bent structure. The minimum width of seismic joint shall not be less than 150mm when the adjacent building is a steel structure.

**Table 6.3.6 Seismic joint width of shaft tower**

| Shaft tower type | Seismic precautionary intensity | | | |
|---|---|---|---|---|
| | 6 | 7 | 8 | 9 |
| Reinforced concrete shaft tower | $h/250$ | $h/200$ | $h/175$ | $h/125$ |
| Steel shaft tower | $h/150$ | $h/140$ | $h/120$ | $h/100$ |

Note: $h$ is the height of the adjacent building structure.

**6.3.7** The seismic action sustained by shaft tower shall be calculated in two major axes, and shall comply with the following requirements:

**1** When seismic precautionary intensity is 6, 7 or 8, the horizontal seismic action shall be calculated.

**2** When the seismic precautionary intensity is 9, the vertical seismic action and its unfavorable combination with horizontal seismic action shall be calculated.

**6.3.8** The seismic capacity calculation and seismic resistance of shaft tower shall meet to the provisions of GB 50191 *Code for Seismic Design of Special Structures*.

**6.3.9** The column shall not be interrupted at the ground floor, the wall panel and the steel brace shall

has bidirectional layout, and should be continuous along the height direction.

**6.3.10** Doors and windows openings in the wall boards of reinforced concrete shaft tower should be aligned along the height direction. The distance between the opening edge and end wall should not be less than 1000mm.

**6.3.11** Pilasters should be installed in the wall boards of reinforced concrete shaft tower. The thickness of the wall boards should not be less than 1/35 of the floor height or 1/35 of the distance between the pilasters, and its thickness shall not be less than 250mm. When the thickness of the wall boards does not meet the above requirements, the stability check calculation shall be carried out, and the double layer double direction reinforcement shall be arranged in the wall boards.

**6.3.12** Cast-in-situ reinforced concrete structure shall be adopted for the slab of the shaft tower. The openings in floor slabs made at the place of casing and hoisting holes shall meet the following requirements:

**1** The thickness of the floor slab around the hole should not be less than 150mm, the one-layer unidirectional reinforcement ratio should not be less than 0.3%, the space between the reinforcement bars shall not be greater than 150mm, the diameter of bars shall not be less than 8mm, and double layer bidirectional reinforcement should be used.

**2** Edge beam and hidden beam should be mounted at the edge of the hole. The diameter of the longitudinal reinforcement bars in the hidden beam shall not be less than 14mm, and the number of longitudinal bars shall not be less than 4.

**6.3.13** The beam-column or beam-pilaster joint of the concrete shaft tower shall meet the following requirements:

**1** The anchorage length of the longitudinal tensile reinforcement bars of the beam inside the column or pilaster, and the anchorage length of the longitudinal tensile reinforcement bars of the column inside the foundation shall be.

**2** The spacing between stirrup in the area of densely arranged stirrups at the end of beam and column should not be larger than 8d, and the diameter shall not be less than 10mm.

**3** In the core area of the beam-column joint, the maximum stirrup spacing shall be 8d and shall not be larger than 100mm, and its diameter shall not be less than 10mm. The characteristic values of stirrups in the core area of the frame joint of the grade 1, 2 and 3 should not be less than 0.12, 0.10 and 0.08, and the transverse stirrups reinforcement ratio should not be less than 0.6%, 0.5% and 0.4%, respectively.

Note: $d$ is the diameter of the longitudinal reinforcement bars.

**6.3.14** The connections of the steel structure shaft tower shall meet the following requirements:

**1** The column through connection shall be adopted for the beam-column connections. The cantilever beam and column rigid connection should be adopted for the frame beam. The beam on-site split joint may adopt the bolt and welding or the only bolt connection.

**2** The web plate of the joint area shall be thickened, or horizontal and diagonal stiffeners shall be used.

**3** The steel beam of the steel tower shall be firmly connected with the floor slab.

### 6.4 Hoist building

**6.4.1** Steel structure should be adopted for the hoist house, and reinforced concrete structure shall be adopted for the underground part.

**6.4.2** The foundation of the hoister, the hoist house and the working platform should be separated. Those foundations should be arranged on the soil base layer with the same characteristics.

**6.4.3** The lightweight wall should be adopted for the gable wall of the hoist house.

**6.4.4** Process equipment and ancillary buildings shall not be installed on the roof of the hoist house.

### 6.5 Lodge room

**6.5.1** Reinforced concrete structures or steel structures shall be adopted for the lodge room, steel structures should be adopted when the seismic precautionary intensity is 8 or above.

**6.5.2** Foundation of the main inclined shaft lodge room and foundation of conveyor transmission equipment mounted in the inclined shaft lodge room shall be separated.

**6.5.3** The high voltage distribution room, air heating room, frequency converter room, main control room and other ancillary buildings to co-construct with the lodge room shall adopt the same structural ancillary buildings as the lodge room.

# 7 Preparation plant engineering

## 7.1 Process layout

**7.1.1** The process layout of the production plant building of a coal preparation plant should meet to the following requirements:

**1** The plant building should be simple in shape, regular in plane and vertical projection, and shall avoid local protrusion or serious irregularity.

**2** The height of storey and column network should be unified, staggered-floor structure should not be adopted, and long-span multi-storey and compound frame structure should not be adopted.

**3** Large-scale machinery and equipment should be arranged in a lower position or separately equipped with equipment platforms, which shall be separated from the overall integral framework of the plant building.

**4** When the seismic precautionary intensity is 8 and above, the equipments on each floor of the workshop should be evenly arranged in plane and vertical direction. The major vibration direction of vibration equipment of the same type mounted on the same floor should be unified. The buffer bunker should not be arranged on the top floor of the factory building, and the water tank shall not be installed on the roof.

**7.1.2** When the seismic precautionary intensity is 8 and above, the crushing system of raw coal screening machinery shall not be placed on the top of the coal bunker.

**7.1.3** The main machinery and equipment of coal preparation plant shall not be layout across seismic joint.

**7.1.4** Sedimentation tower should not be used when seismic precautionary intensity is 8 and above. Concentration tank shall be arranged on the ground.

## 7.2 Building structure

**7.2.1** The structural type selection of the main production plant in preparation plant should meet the following requirements:

**1** When the seismic precautionary intensity is 6 and above, the reinforced concrete structure may be selected.

**2** When seismic precautionary intensity is 8 and above, steel structure should be selected.

**7.2.2** When adopting modular layout of coal preparation plant, the following requirements shall be met:

**1** The major structure of the workshop shall be separated from the modular structure.

**2** The steel structure should be used for the modules.

**3** Seismic joint shall be set between the modules, and the width of the joint shall not be less than 100mm.

**4** The modular load-bearing structures shall be calculated for seismic action.

**7.2.3** In the plane of the structural unit of the plant building, the lateral resistance members should be symmetrically and evenly arranged, and should be set along the full height of the structure. The lateral stiffness of columns should be uniform, and the sudden change of lateral stiffness should be avoided.

**7.2.4** When large-span frame structure is adopted for major production plant building, the bearing

capacity of frame column shall be improved, steel structure should be adopted for the roof, and the connections between support and roof structure shall be strengthened.

**7.2.5** The selection and arrangement of roof and its brace shall transfer the seismic action sustained by the roof to the lower support structure.

**7.2.6** Multi-storey building with frame structure shall not adopt the mixed support form with partial masonry load-bearing structure. Stairs, elevator rooms and elevator machine rooms with partially prominent roofs, staircases and water tank rooms shall adopt frame load-bearing structure instead of masonry wall load-bearing structure.

**7.2.7** The enclosure structure of the main production plant building shall meet the following requirements:

**1** The enclosure structure shall be reliably connected with the main structure.

**2** The infilled wall and partition wall of frame structure should be made of light wall material.

**3** When using masonry infilled wall, it shall meet the current national standard GB 50011 *Code for Seismic Design of Buildings*.

**7.2.8** When setting up deformation joint, the setting requirements of seismic joint shall be met at the same time.

**7.2.9** The maximum applicable height and seismic grade of cast-in-situ reinforced concrete workshop, the frame structure with funnel bunker or water pool, frame-bent and frame-shear wall structure, and the seismic design of steel structure workshop, which shall meet the current national standard GB 50191 *Code for Seismic Design of Special Structures*.

**7.2.10** The production workshop of coal preparation plant should adopt spatial structure calculation model for the seismic capacity calculation, section seismic check calculation and seismic deformation check calculation.

**7.2.11** When calculating the seismic action and checking the structural seismic resistance of the coal preparation plant production workshop, the load value and the combination coefficient of variable load shall meet to the following requirements:

**1** The representative values of the building gravity load shall be the sum of the representative values of gravity loads of structures, components and decorations, the representative values of gravity loads of mechanical and electrical equipment and the combination values of variable loads.

**2** The combination coefficient of variable loads shall be selected according to the Table 7.2.11, unless otherwise specified for the plant buildings and structures.

**Table 7.2.11 Combination coefficient of variable load**

| Variable load types | | Combination coefficient |
|---|---|---|
| Snow load | | 0.5 |
| Ash load on roof | | 0.5 |
| Roof live load | | Not included |
| Dynamic load generated by vibration equipment | | Not included |
| Floor live load | Uniform live load | 0.9 |
| | Material and equipment load coal bunker and material load | 0.9 |
| | Pipeline load | 0.9 |
| Gravity of crane suspension | Hard hook crane | 0.3 |
| | Flexible hook crane | Not included |

Note: The own weight of equipment is determined as the permanent load.

**7.2.12** The effect of horizontal seismic action shall be taken into account when the height of support structure of hanging storage bunker or electromechanical equipment exceeds 1.0m from the floor level.

**7.2.13** When calculating the seismic action and checking the structural seismic resistance of production workshop of the coal preparation plant, the following requirements shall be met:

**1** If the plane and vertical layout of production plant are irregular and extremely irregular, and there are funnel bunker, water tank, large-size mechanical and electrical equipment, when structural analysis is carried out, the effect of sudden change of stiffness on internal force of structure shall be taken into account. A practical calculation model shall be established, and the structure torsional effect under two-way horizontal seismic action shall be taken into account.

**2** The vertical seismic action shall be calculated for the roof structure of large-span coal storage yards, coal bunker with height of 40 meters or above in area with seismic precautionary intensity of 8 or above, the trestle bridge support frames with height of 30 meters or above and the high-rise workshops in area with seismic precautionary intensity of 9.

**7.2.14** Seismic resistance calculation of coal bunker shall meet the following requirements:

**1** The calculation of horizontal seismic action and action effect shall be carried out for the coal bunker, which can be calculated by the bottom shear method. Earthquake influence coefficient shall conform to the current national standard GB 50191 *Code for Seismic Design of Special Structures*.

**2** When calculating the natural vibration period and seismic action on the coal bunker, 80% of the standard value of the full storage load may be used as the storage load of the coal bunker.

**3** The standard value of seismic force and seismic resistance of coal bunker section checking calculation shall conform to the current national standard GB 50077 *Standard for Design of Reinforced Concrete Silos*.

**7.2.15** Seismic action combination sustained by coal bunker shall be calculated according to the following formula:

$$S=\gamma_G \cdot S_{GE}+\gamma_{Eh} \cdot S_{Ek} \tag{7.2.15}$$

Where, $S$–Seismic action combination value;

$\gamma_G$–Partial coefficient of gravity load can be taken as 1.2, and 1.0 when it is beneficial to the structure;

$S_{GE}$–Representative value effect of gravity load;

$\gamma_{Eh}$–Partial coefficient of seismic action can be taken as 1.3;

$S_{Ek}$–Standard value effect of horizontal seismic action.

**7.2.16** Seismic resistance of coal bunker structure shall be calculated according to the following formula:

$$S=1.2R \tag{7.2.16}$$

Where, $R$–Design Value of the Structure Bearing Capacity.

**7.2.17** Under the action of fundamental combination of loads, zero stress zone shall not occur at the bottom surface of coal bunker foundation. When the aspect ratio(ratio of height to diameter)is above 4, zero stress zone should not occur under the seismic action; when aspect ratio(ratio of height to diameter) is less than 4, zero stress zone can occur, but the area of zero stress zone shall not be greater than 15% of the total area of the foundation bottom.

**7.2.18** The following structures should be checked for elastic-plastic deformation under the action of seldomly occurred earthquakes:

**1** The reinforced concrete frame structure and frame-bent structure with extremely irregular layout, seismic precautionary intensity is 8 and above and the yield strength coefficient of the floor is less than 0.5.

**2** Coal bunkers structure supported by pillars.

**3** Single-span reinforced concrete workshop structures with height above 24m.

**4** Trestle bridge support structure with height above 40m.

**5** Structures of seismic isolation and energy dissipation shock absorbing design.

**7.2.19** The maximum elastic inter-storey displacement angle and elastic-plastic displacement angle limit inside the floor of the workshop structure shall meet the functional requirements of the coal preparation plant as well as allowable deformation value of the workshop structure, and should meet the requirements of Table 7.2.19.

**Table 7.2.19 Elastic and elastic-plastic inter-storey displacement angle limits**

| Structural type | Elastic [$\theta_e$] | Elastic-plastic [$\theta_p$] |
|---|---|---|
| Reinforced concrete frame | 1/450 | 1/50 |
| Steel structure | 1/200 | 1/50 |

## 7.3 Details of design

**7.3.1** The basic details of seismic design for workshop shall meet to the provisions of GB 50191 *Code for Seismic Design of Special Structures*.

**7.3.2** For irregular layout production workshop of a coal preparation plant, the details of seismic design shall be taken to increase the seismic precautionary intensity for one degree according to the current national standard GB 50191 *Code for Seismic Design of Special Structures*. When the seismic precautionary intensity reaches special first level, it may not to be increased any more.

**7.3.3** Details of seismic design for coal bunker shall meet the following requirements:

**1** The seismic precautionary intensity is 6 or 7, the thickness of the wall of silo and supporting wall should not be less than 180mm, or not less than 200mm when the seismic precautionary intensity is 8 or 9.

**2** Double-layer bidirectional reinforcement shall be adopted for wall of silo and supporting wall, and the total reinforcement ratio in horizontal and height direction shall not be less than 0.4%. Tie bars shall be installed between the inner and outer layers of reinforcement bars, and their diameters should not be less than 6mm. When the seismic precautionary intensity is 6 or 7, the spacing between the tie bars should not be greater than 600mm. When the seismic precautionary intensity is 8 or 9, the spacing between the tie bars should not exceed 400mm.

## 7.4 Trestle bridge

**7.4.1** Trestle bridge design shall meet the following requirements:

**1** For trestle bridge which eaves height is larger than 10m and the span is larger than 18m, steel structure should be adopted.

**2** When supporting srtucture adopts steel, trestle bridge srtucture shall also adopts steel.

**3** When making seismic resistant unit partition of trestle bridge, the sections between the corresponding seismic joint may be selected.

**7.4.2** When a hinge support for trestle bridge is set up, enough travel route shall be left, and energy dissipation and anti-falling measures shall be taken.

**7.4.3** The supporting structure design of trestle bridge shall meet the following requirements:

**1** Reinforced concrete structure or steel structure shall be adopted.

**2** The same materials should be used in all supporting structures of the same seismic unit.

**7.4.4** The internal force combination calculation of the supporting structure under seismic action and the shearing strength calculation of connecting bolts shall be carried out.

**7.4.5** The maximum elastic inter-storey displacement angle and elastic-plastic displacement angle limit of trestle support structure inside of the floor shall meet functional requirements of the coal preparation plant and allowable deformation requirements of plant building structure, and also should meet the provisions of Article 7.2.19 of this code.

**7.4.6** When a steel structure is used for supporting structures, the slenderness ratio of the member bars shall not exceed the values stated in the Table 7.4.6.

**Table 7.4.6 Allowable slenderness ratio of supporting members**

| Name of member | Seismic precautionary intensity | | |
|---|---|---|---|
| | 6,7 | 8 | 9 |
| Frame column | 120 | | 100 |
| Fundamental web member | 150 | | 120 |
| Diagonal web member | 250 | 200 | 150 |

Note: The values in the table are applicable to Q235 steel. When using other grades of steel, they shall be multiplied by $\sqrt{235/f_{ay}}$.

**7.4.7** Seismic joint shall be set up between the end of trestle bridge and adjacent buildings. The width of the anti-seismic joint shall meet to the provisions of GB 50191 *Code for Seismic Design of Special Structures*.

## 7.5 Coal bunker

**7.5.1** The design of coal bunker in seismic precautionary zone shall meet the following requirements:

**1** The shape of coal bunker should be simple and regular, and the quality and stiffness should be uniform and symmetrical.

**2** The plane shape of bunker should be round. The bunker should be adopted reinforced concrete structure.

**3** When a square layout of bunker is adopted, single-span frame structure may be adopted after the structure strengthening measures have been taken.

**7.5.2** Coal bunker with diameter above 18m should be laid out independently. Deformation joint should be set up between the coal bunker and adjacent building structures. The width of deformation joint shall meet the requirements of seismic joint. The width of deformation joint should be determined according to the results of the structure relative deformation analysis, and shall not be less than 100mm.

**7.5.3** When the bunker has an overlap joint with trestle bridge, the support point of the coal bunker should meet the requirements of relative displacement at seismic action.

**7.5.4** Reinforced concrete bunker should be supported by cylinder wall(tubbing)supporting structures. Cylinder wall, cylinder wall with pilasters and mixed support of pillars and cylinder wall may be used as forms of supporting structure. For deep bunkers with diameter exceeding 15m, the structure should be

supported by both cylinder wall(tubbing)and inner column.

**7.5.5** The design of rectangular and trough shape coal bunker shall meet the following requirements:

**1** When rectangular or trough shape coal bunker adopts frame structure system, the supporting columns shall extend to the top of the bunker and shall be connected with the walls of the bunker.

**2** Inter-column bracings should be set on supporting columns under the bunker, and the stiffness of supporting columns under the bunker shall be strengthened.

**3** The fixed effect of foundation on supporting column shall be strengthened.

**7.5.6** The structure above bunker shall meet the following requirements:

**1** Steel structure should be adopted, its enclosure structure shall be made of lightweight materials, and the column foot shall meet the shearing strength requirements.

**2** When adopting reinforced concrete frame structure, lightweight materials should be selected for enclosure structure.

**3** Lightweight steel structure should be used for roof.

**4** The structure above bunker should not exceed 2 stories.

**5** The bunker wall should extend to the top as the supporting structure of structure above bunker. When the seismic precautionary intensity is 9, columns or circular shape cylinder walls extending upward shall be used as load-bearing structures for bunker superstructure.

**7.5.7** The calculation of seismic action sustained on the coal bunker shall meet the current national standard GB 50191 *Code for Seismic Design of Special Structures*.

**7.5.8** When the seismic precautionary intensity is 8 or less, when the wall of reinforced concrete tubbing supported circular coal bunker is connected with the bottom of the bunker, the seismic capacity calculation of horizontal seismic action on the bunker walls and bottom may not to be carried out, and the structural members of the bunker shall meet the requirements of the corresponding details of seismic design.

**7.5.9** The design of cylinder bearing wall of tubbing supported reinforced concrete coal bunker shall meet the following requirements:

**1** When the seismic precautionary intensity is 6 or 7, the wall should not be less than 180mm, and when the seismic precautionary intensity is 8 or 9, it should not be less than 200mm.

**2** Double-layer two-way reinforcements shall be adopted for the bunker cylinder wall. The total reinforcement ratio of vertical or circumferential reinforcement should not be less than 0.4%. Tie bars shall be connected between the inner and outer steel bars. Their diameters should be greater than 6mm and less than 500mm.

**3** The opening ratio of cylindrical supporting walls under the bunker should not exceed 50%, and the central angle between the openings should be larger than 45°.

**7.5.10** When the seismic precautionary intensity is 6 or 7, the seismic measures according to the third level of seismic grade shall be adopted for the frame structure of structure above bunker, the seismic measures according to the second level of seismic grade shall be adopted under the 8 and the first level seismic measures shall be taken 9 .

# 8 Power supply distribution and integrated informatization

## 8.1 General requirements

**8.1.1** The following facilities shall be considered as important power facilities:

**1** Main transformer, distribution substation and underground main transformer and distribution substation in mine.

**2** Transformer(distribution)substation directly supplying power to the first level load.

**3** Emergency power supply of mine.

**4** Power transformer(distribution)substations, systems or units that are important for mitigating earthquake disasters and production recovery after earthquakes.

**5** Power supply line of mine.

**8.1.2** Electrical equipment in important power facilities shall be designed in accordance with the requirements of the current national standards GB 50260 *Code for Seismic Design of Electrical Installations* and GB 50556 *Code for Aseismic Design of Electrical Facilities in Industrial Plants*.

## 8.2 Power distribution

**8.2.1** The location and layout of main transformer(distribution)power stations in mines shall meet the Article 4.2.2 of this code.

**8.2.2** When the seismic precautionary intensity is 8 or more, outdoor distribution facilities of medium-profile layout should be adopted for arrangement of electric distribution devices of 35kV or above voltage levels.

**8.2.3** Route for mine power supply lines and 6kV–110kV overhead lines supplying power to important power facilities shall be selected in accordance with the following requirements:

**1** The route shall avoid the area of collapse, landslide, debris flow, ground fissure, stratum dislocation and should avoid liquefiable sand subsoil.

**2** When the seismic precautionary intensity is 8 and above, each power line shall be erected as a single circuit and all circuits shall pass along different routes.

**3** When it is necessary to erect different electric lines along the same route, the distance between different power lines shall exceed the length of pole-collapse.

**8.2.4** When the seismic precautionary intensity is 7 and above, the laying of mine power supply lines and cables supplying power to important power facilities shall meet the following requirements:

**1** The route should avoid the area of collapse, landslide, debris flow, ground fissure and stratum dislocation.

**2** Two different circuit cables shall be laid down along different routes. When they need to be laid down in the same cable trench only, flame-retardant cables shall be used and laid them down on both sides of the trench respectively.

**3** When laying electric cables in a cable tunnel, the electric power load level of lighting, ventilation, drainage and other equipment in the tunnel shall not be lower than the highest load level of all the loads which are supply by the cables laid down in the tunnel.

### 8.3 The installation of power distribution equipment

**8.3.1** When the seismic precautionary intensity is 7 and above, the transformer, arc suppression coil and integrated capacitor design of the mine main transformer (distribution) substation shall meet the following requirements:

**1** Rollers and tracks shall be removed, and the equipment fixed directly on the foundation, while the foundation shall be broadened.

**2** Flexible conductors shall be used for equipment wire lead and connection between equipment, and flexible conductors should not be too long; when rigid conductors are used, flexible conductors or expansion joints with sufficient expansion length shall be used as a connecting adaptor.

**3** When the seismic precautionary intensity is 8 and above, the main transformer of 35kV and above should be additionally furnished with diagonal pull wiring.

**8.3.2** When seismic precautionary intensity is 7 or above, flameproof or intrinsically safe electrical apparatus should be used for underground power supply and distribution apparatus in high-gas mines; when seismic precautionary intensity is 9, flameproof or intrinsically safe electrical apparatus shall be used, and flexible connections shall be adopted between the electrical apparatus.

**8.3.3** When the seismic precautionary intensity is 8 and above, oil-free electrical apparatus should be used in important power facilities.

**8.3.4** Porcelain corss-arm insulator shall not be used in mine power supply lines and 6kV–110kV overhead lines supplying power to important power facilities.

### 8.4 Integrated informatization

**8.4.1** Information system shall be set up in mine, and its dispatching and monitoring center should be set up independently.

**8.4.2** Underground circled network equipment should be installed on the floor of the mining chamber.

**8.4.3** Satellite communication facilities should be set up in mines.

**8.4.4** The surface part of mine underground telephone cable should be buried under ground or laid along a cable trench, and shall not be hanged along the external wall of the building structure.

**8.4.5** The power supply of communication center shall be designed according to second-class load standard and equipped with UPS as standby power supply. The capacity of continuing power supply by the UPS shall not be less than 8 hours.

**8.4.6** Installation of equipment in dispatching and monitoring center computer room shall meet the current professional standard YD 5059 *Design Specification for Seismic Installation of Telecommunication Equipment*.

# 9 Water supply and drainage, heating and gas storage and distribution

## 9.1 Source of water

**9.1.1** Selection of mine water sources shall meet the following requirements:

**1** Mines should build their own water sources, the number of water sources should not be less than two, and different types of water sources should be used.

**2** When the seismic precautionary intensity is 8 and above, the mine shall have two or more sources of drinking water, one of which shall be designed according to the requirements to water source used for earthquake relief.

**3** Less exposed to seismic damage and advantageous post-disaster using conditions water source shall be chosen as the water source for earthquake relief.

**4** Groundwater in water bearing bedrock may be used as the water source for earthquake relief, and confined water with shallow water level or artesian water should be chosen as a water source for earthquake relief.

**9.1.2** The design of water source engineering used for earthquake relief shall meet the following requirements:

**1** The site selection and structural design of water source project shall meet the current national standard GB 50032 *Code of Seismic Design of Outdoor Water Supply, Sewerage, Gas and Heating Engineering*.

**2** Submersible pumps should be adopted the water intake equipment in deep well .

**3** There shall be redundancy when determine the depth of the pump installation in pipe wells.

**4** The intake pump house shall have the conditions for equipment handling using manpower.

**9.1.3** According to hydrogeology and technical-economic conditions, the following measures shall be taken to ensure the capacity of water supply after the disaster by the water source selected as the water source for earthquake relief:

**1** Underground water source which normally supplies water to underground only shall have the possibility to be temporarily converted to the water source which supplies water to ground facilities.

**2** Underground water sources that normally supply water to the ground facilities should be provided with possibility for temporary increasing of water supply capacity.

## 9.2 Water supply and drainage

**9.2.1** Mine water supply and drainage engineering design shall not only meet the normal functional requirements, but also take measures to prevent and mitigate disasters and provide services for post-earthquake disaster relief according to specific conditions.

**9.2.2** Seismic design of mine water supply and drainage engineering shall meet the current national standard GB 50032 *Code of Seismic Design of Outdoor Water Supply, Sewerage, Gas and Heating Engineering*.

**9.2.3** When the seismic precautionary intensity is 8 and above, the design of the ground water pipeline shall meet the following requirements:

**1** Pipeline should avoid coal mining ground subsidence area.

**2** Double-pipe water supply shall be adopted for water pipeline, and two different routes should be adopted for two pipes.

**3** The water pipeline laid down across the ground subsidence area shall adopt the technical measures which are beneficial to adapting the pipes to the ground surface deformation.

**4** Pipelines laid down within the area with predicted great extent ground deformation should install retractable pipe fittings.

**5** Pipeline connections shall be tension resistant.

**6** Corrosion protection shall be strengthened for steel pipe connections, fittings and pipeline parts.

**9.2.4** When the seismic precautionary intensity is 8 and above, the main water supply pipeline at the mine should be laid inside a trench.

**9.2.5** The circular reinforced concrete structure should be adopted for the storage tank of the water supply system at the mine site. When the seismic precautionary intensity is 8 and above, the capacity of a single pool should not exceed 500m$^3$.

**9.2.6** For water supply and control facilities arranged at mine sites and residential area, high-level pools or frequency control speed adjustable water supply devices should be used. Water towers shall not be used in area with seismic precautionary intensity of 8 or above. High-level pools shall not be located in seismic unfavorable or dangerous area.

**9.2.7** When the seismic precautionary intensity of 8 and above, the design of mine water supply treatment facilities, mine water treatment facilities and sewage water treatment facilities shall meet the following requirements:

**1** An integral structure of multi-unit facilities combination should be adopted.

**2** When calculating the water head between upstream and downstream structures a redundancy of 0.3m or more should be provided.

**3** Number of intermediate members of water lifting should be reduced.

**4** Overflow outlets shall be set up in water-holding structures, and overflow water shall be discharged and drained in an organized manner.

**9.2.8** When the seismic precautionary intensity of 8 and above, the design slope gradient redundancy of drainage pipeline should be increased. If drainage system is directly discharged to the water body, measures shall be taken to prevent backflow.

**9.2.9** When the seismic precautionary intensity of 8 and above, expansion bolts shall not be used for retaining works, hangers and brackets mounted on the structures and buildings.

### 9.3 Heating

**9.3.1** Boiler frame shall not be used as stress-bearing member of structure at the same time. Connecting pieces such as connecting platform between the boiler frame and structures shall be fixed at one end and simply supported at the other end.

**9.3.2** Vertical boilers, horizontal fast-loading boilers, thermal deaerators and other large-size equipment shall be fixed on the equipment foundation, and shall not have a floating attachment. The foundation of pumps and motors shall adopt integral type.

**9.3.3** The water tank of thermal deaerators shall have a level limit device, but it shall not affect the thermal expansion of the water tank.

**9.3.4** Safety valve should adopt spring type valve. When using a lever safety valve, there shall be provided a fixing device to prevent the weight from moving.

**9.3.5** The gas-distributing cylinder and water heater shall not be fixed on the masonry wall, but should be supported by piers or frameworks mounted on the floor. When the seismic precautionary intensity is 9, it shall be supported by piers or frameworks mounted on the floor. Masonry structure shall not be used for piers.

**9.3.6** The stay wire of steel chimney shall not be anchored on the masonry wall.

**9.3.7** The heating source system shall be equipped with emergency water discharge facilities, and flexible connection between equipment and pipelines shall be adopted.

### 9.4 Gas storage and distribution

**9.4.1** The selection of construction site for gas storage and distribution station shall meet the current national standard GB 50032 *Code for Seismic Design of Outdoor Water Supply, Sewerage, Gas and Heating Engineering*.

**9.4.2** The facilities of gas storage and distribution stations shall meet the following requirements:

**1** Quick shut-off valves shall be installed on the main inlet and outlet pipes of the station, and their positions shall be located in easy-to-operate places.

**2** The foundation of pump and motor shall adopt integral type.

**3** Cast iron shall not be used for piping components inside of the station.

**4** The inlet and outlet pipes of compressors and pumps shall be provided with flexible connections.

**5** Pressure regulators, filters and front and rear valves of gas pressure regulating stations shall be provided with brackets and clamps.

**9.4.3** The design of water tank type gas storage tank shall meet the following requirements:

**1** When checking the seismic resistance of gas holders, only the horizontal seismic action should be considered.

**2** The height to diameter ratio of tank should not be greater than 1.2 for wet gas holders located at the sites of Ⅲ and Ⅳ.

**3** Compensators, metal hoses or other flexible connection measures shall be provided for the inlet and outlet of gas pipes connected with gas holders.

**4** In seismic precautionary zone, when the thickness of outer ring plate of the water tank bottom plate is 10mm and above, the inner fillet weld shall be welded into unequal fillet weld with arc transition, and its throat height shall not be less than the thickness of edge plate.

**9.4.4** The guide wheels and rails of water tank type spiral rail gas holder shall be checked for seismic resistance calculation according to the current national standard GB 50032 *Code of Seismic Design of Outdoor Water Supply, Sewerage, Gas and Heating Engineering*.

## Explanation of wording in this code

**1** Words used for different degrees of strictness are explained as follows in order to mark the differences in implementing the requirements of 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.

**4**) "May" is used to express the option available, sometimes with the conditional permit.

**2** "Shall comply with..." or "shall meet the requirements of..." is used in this standard to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

## List of quoted standards

GB 50011 *Code for Seismic Design of Buildings*

GB 50032 *Code of Seismic Design of Outdoor Water Supply, Sewerage, Gas and Heating Engineering*

GB 50077 *Standard for Design of Reinforced Concrete Silos*

GB 50191 *Code for Seismic Design of Special Structures*

GB 50223 *Standard for Classification of Seismic Protection of Building Constructions*

GB 50260 *Code for Seismic Design of Electrical Installations*

GB 50556 *Code for Aseismic Design of Electrical Facilities in Industrial Plants*

GB 50592 *Code for Design of Colliery Building and Structure of Coal Mine*

GB 51044 *Code for Investigation of Geotechnical Engineering in the Coal Mine Goaf*

GB 51144 *Code for Investigation of Geotechnical Engineering of Mine Construction in Coal Industry*

GB 18306 *Seismic Ground Motion Parameters Zonation Map of China*

JGJ 83 *Specification for Geotechnical Investigation in Soft Clay Area*

JTG B02 *Specification of Seismic Design for Highway Engineering*

JTG/T B02-01 *Guidelines for Seismic Design of Highway Bridges*

YD 5059 *Design Specification for Seismic Installation of Telecommunication Equipment*