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GB 55018-2021

General code for engineering survey

工程测量通用规范

Issued on: September 08, 2021

Implemented on: April 01, 2022

**Jointly issued by: Ministry of Housing and Urban-Rural Development of the
People's Republic of China;
State Administration for Market Regulation.**

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2 Basic regulations

2.1 Survey datum

2.1.1 The spatial datum of engineering survey shall meet the following requirements:

1 The 2000 national geodetic coordinate system shall be adopted as the geodetic coordinate system; when other coordinate systems are required, a connection shall be established with the 2000 national geodetic coordinate system.

2 The 1985 national height datum shall be used as the height datum; when other height datums are required, a connection shall be established with the 1985 national height datum.

3 For the depth datum, the theoretical lowest tidal level shall be adopted in coastal waters, and the design water level shall be adopted in inland waters. A connection shall be established between the depth datum and the height datum.

4 The 2000 national gravity basic network shall be used as the gravity datum.

2.1.2 The Gregorian calendar and Beijing time shall be adopted as the engineering measurement time system.

2.1.3 A unified spatial datum and time system shall be adopted for the surveys above ground and underground, the surveys inside and outside the tunnels, and the surveys in water areas and on land of the same project. For the measurement of different sections or different periods of the same project, a unified spatial datum and time system shall be adopted or converted.

2.2 Survey accuracy

2.2.1 The mean square error shall be used as the measure of accuracy in engineering survey, and twice the mean square error shall be used as the limit error.

2.2.2 During the implementation of engineering survey projects, the actual accuracy of the results shall be evaluated or tested, and the following regulations shall be met:

1 Accuracy assessment shall calculate the required mean square error of horizontal coordinates, elevation or other geometric parameters through survey adjustment.

2 During accuracy detection, high-precision or same-precision detection methods shall be used, and the difference between the detection data and the original measurement data shall be used to calculate the required mean square error of horizontal coordinates, elevation or other geometric parameters.

3 When the mean square error obtained by precision evaluation or precision testing is not greater than the corresponding mean square error stipulated in the technical design

of the project or the technical standard used, judge the accuracy of the result meeting the requirements; otherwise, judge the accuracy of the result not meeting the requirements, and process according to Article 2.3.4 Paragraph 4.

2.3 Survey process

2.3.1 Before the engineering survey task is implemented, the project technical design shall be carried out, and the project technical design document or survey task list shall be formed. The technical design of the project shall meet the following requirements:

- 1** The content, form, specification, accuracy and other quality requirements of the project tasks and results shall be determined according to the project contract and the agreed technical standards.
- 2** The technical standards, operating methods, instruments and equipment, software systems and quality control requirements used for project implementation shall be determined.
- 3** Priority shall be given to utilizing existing control measurement results. Before the existing control points are used, their point positions, horizontal coordinates and elevations shall be inspected and checked.

2.3.2 Instruments, equipment and software systems used in engineering surveys shall meet the following requirements:

- 1** Instruments and equipment that require metrological verification shall be verified in accordance with relevant technical standards and shall be used within the validity period of the verification.
- 2** Instruments and equipment shall be calibrated or inspected. When the equipment is abnormal, the measurement shall be stopped.
- 3** The software system shall be verified by evaluation or testing.

2.3.3 The engineering survey process shall be subject to quality control and shall comply with the following regulations:

- 1** The methods specified in the technical design of the project or the technical standards used shall be adopted for observation operations and adjustment calculations.
- 2** The original observation data shall be recorded on site and stored safely and reliably. Original observation data cannot be modified.
- 3** The observation data shall be checked and adjusted-calculated, and the existing gross errors and systematic errors shall be dealt with. When the observation tolerance or the required mean square error exceeds the technical design of the project or the technical standards used, reworking shall be performed immediately.

2 Results in digital form shall be stored in an open data format that can be shared and exchanged.

3 A project technical report shall be prepared. The project technical report shall completely and accurately describe the basic situation, technical quality requirements, operation methods, implementation process, quality management measures and actual technical quality indicators achieved by the results of the engineering survey project.

2.4.2 The management of engineering surveying results shall comply with the following regulations:

1 Recognizable and traceable marks shall be set.

2 The measurement results and data shall be archived according to the professional archives management regulations.

3 The results data that need to be submitted shall be subject to the management regulations on the submission of surveying and mapping results.

2.4.3 When the database system is used to manage the engineering surveying results, the following regulations shall be met:

1 The database system shall be safe and reliable.

2 Before storage, the correctness and integrity of the data content shall be checked.

3 After storage, the integrity and logical consistency of the database content shall be checked.

4 For the established results database, reliable data backup and security management shall be carried out.

2.5 Operational safety

2.5.1 The safety production management system shall be implemented for engineering surveying operations to avoid injury to operators and damage to instruments and equipment. For large-scale or special engineering survey projects, emergency plans for safety production shall be established, and they shall be able to be effectively implemented in response to emergencies.

2.5.2 On-site engineering survey operations shall comply with the following regulations:

1 For the safety control area where personnel are prohibited from entering and the area that does not have safe operating conditions, operators are strictly prohibited from entering.

2 When measuring in roads, rail transit, industrial factories and mines, construction sites and other dangerous areas, safety protective equipment such as safety helmets and warning suits must be worn correctly.

3 When working in live areas, measuring equipment with good insulation performance shall be used. Operators shall wear insulating protective equipment, and the distance from the charged body shall meet the minimum safety distance requirements.

4 When measuring in areas where there is gas, explosion-proof measuring instruments and equipment shall be used.

5 When measuring far away from cities, villages, factories and mines, there shall be reliable communication, transportation and other safety guarantees and emergency rescue measures.

2.5.3 The surveys in water area shall comply with the following regulations:

1 The vessel used shall be safe and reliable.

2 Life-saving equipment must be equipped.

3 The current, reef, dangerous shoal, shipwreck, etc. in the surveying area shall be mastered.

4 When the wind and waves endanger the safety of ships and personnel, water survey operations are not allowed.

2.5.4 The investigation and survey of underground pipelines, or other surveys in narrow underground spaces, shall comply with the following regulations:

1 Around the wellhead of the cellar and at the entrance of the narrow underground space, safety protection fences shall be set up, and special personnel shall be equipped. After the operation is completed, the cellar manhole cover shall be covered immediately or the entrance protection facilities shall be closed.

2 The excavation and investigation of underground pipelines shall be carried out under the condition of ensuring safety. The excavation of cables and gas pipelines shall be coordinated by personnel assigned by the owner unit.

3 When working underground or deploying probes and electrode wires, it is strictly forbidden to use open flames, and the concentration of harmful, toxic and flammable gases shall be measured, and pipelines exceeding the standard shall be operated after taking safety protection measures.

4 It is strictly forbidden to perform direct or charging operations by making charging points on oxygen, gas, acetylene and other combustion-supporting, flammable, and explosive pipelines. It is strictly forbidden to use needle probes on plastic pipes, gas pipes and high-voltage power lines.

3 Control survey

3.1 General provisions

3.1.1 The grades of horizontal control network and elevation control network shall be determined according to the project scale, purpose and precision requirements of the control network, and shall meet the technical design requirements of the project.

3.1.2 The quantity and distribution of control points shall be determined by design according to the surveying purpose, project scale and conditions of the measured area. The control point shall be selected at a firm, stable, easy-to-observe, and easy-to-protect position, and it shall be used after its signs are buried firmly.

3.1.3 Control measurement shall comply with the following regulations:

1 The projection length deformation value of the horizontal control network shall not be greater than 25 mm/km; when there are special requirements, it shall be determined through technical design of the project.

2 When land and water surveys are carried out at the same time, a unified control network mainly based on land survey shall be laid out.

3 For projects that are connected to each other, when the control networks are established separately, the conversion relationship between different control networks shall be determined through joint testing.

4 For tunnels and other underground projects, above-ground and underground contact surveys shall be implemented, and the contact surveys shall be checked.

5 The control network shall have redundant observations.

6 When it is necessary to retest the control network, the precision of the retest shall not be lower than that of the original testing.

3.1.4 When the horizontal control survey is carried out according to the satellite positioning survey method, the following regulations shall be complied with:

1 When laying out control points, the influence of multi-path and electromagnetic environment shall be avoided.

2 The technical indicators such as the average length of the control network baseline, satellite height cut-off angle, number of effective observation satellites, effective observation period length, position precision factor, asynchronous loop closure error, and relative mean square error of the weakest edge after adjustment shall comply with the technical design of the project or the technical standards used.

3.1.5 When using the leveling method for height control measurement, the following regulations shall be met:

- 1** It shall be laid out to conform to the leveling line or to close the leveling ring.
- 2** The technical indicators such as the leveling line length, the accidental mean square error of the height difference per kilometer, the total mean square error of the height difference per kilometer, the number of observations, the round-trip measurement range, the closure error of the joint or the loop line, etc. shall comply with the technical design of the project or the technical standards used.
- 3** When it is necessary to cross a water area exceeding 200 m, a double-leveling line forming a closed loop shall be used to cross the river.

3.1.6 When the vertical control survey is carried out according to the satellite positioning survey method, the following regulations shall be complied with:

- 1** Applicable grades shall be as specified in the technical standard used for the project.
- 2** The survey shall be carried out in the area covered by the height anomaly model or the refined quasi-geoid model. The accuracy of the height anomaly model or the refined quasi-geoid model shall meet the requirements of the technical design of the project or the technical standards used.
- 3** The results of the measured vertical control points shall be subject to a precision testing, where the number of testing points shall not be less than 3.

3.1.7 The results of the control survey shall include the control network layout diagram, the horizontal coordinates and elevation results table of the control points, as well as the project technical report, etc.

3.2 Control survey of current situation survey

3.2.1 The control points of the current situation survey shall give priority to the national and local level control points.

3.2.2 When the existing control points do not meet the current situation surveying needs, the control network shall be established using the national and local level control points as the starting point. The level and quantity of starting points of the control network shall comply with the technical design of the project or the technical standards used. The specific technical requirements for control survey shall comply with the technical design of the project or the technical standards used.

3.3 Control survey of engineering setting-out

3.3.1 National and local level control points shall be used for planning condition setting-out and verification. When the existing control points do not meet the needs, the encryption of the control points shall be carried out.

4 Current situation survey

4.1 General provisions

4.1.1 The current situation survey shall collect the geographical information data of the area where the construction project is located at the determined time point according to the project technical design, and make corresponding surveying results. The content and requirements of specific results shall be determined through project technical design according to project requirements and use of results.

4.1.2 The operation time point of current situation survey shall be determined according to the use of the result, current situation requirements and topographical change characteristics of the measured area, and shall meet the following regulations:

1 The current situation survey used for engineering planning, design or expansion reconstruction shall be carried out before engineering planning, design or expansion reconstruction starts.

2 The current situation survey used for project completion acceptance shall be carried out before project completion and delivery.

3 The current situation survey used for special survey or census shall be carried out before the special survey or census begins.

4.1.3 Current situation survey shall comply with the following regulations:

1 When it is necessary to survey and draw a digital line drawing with a scale larger than 1:500, its accuracy and other quality requirements shall be determined through the technical design of the project.

2 When it is necessary to use a digital line drawing with a scale of less than 1:10000, the results of the existing national basic scale topographic maps shall be collected; when the existing results do not meet the requirements of the project and new or revised surveys are required, the current national basic scale topographic map surveying and mapping regulations shall be implemented.

3 When it is necessary to establish a 3D model of buildings and facilities, the fineness and expression of the model shall be determined through project technical design, which shall meet the requirements of urban information model construction.

4.2 Ground status survey

4.2.1 The surveying and mapping of digital line drawing shall comply with the following regulations:

1 The basic contour interval shall not be greater than the provisions in Table 4.2.1-1, and the classification of terrain types shall comply with the provisions in Table 4.2.1-2.

elevation, a distinction shall be made between the elevation of the outer top and the elevation of the inner bottom of the pipeline. The mean square error at the horizontal position of the obvious feature points of the pipeline relative to the adjacent control points shall not be greater than 50 mm, and the mean square error of elevation shall not be greater than 30 mm.

2 The basic attribute information such as the pipeline type, ownership, cross-sectional shape and dimension, material, as well as purpose and structure type of the ancillary facilities, shall be investigated.

3 A collective diagram reflecting the relationship between underground pipelines, ancillary facilities and elements such as ground roads, green spaces and buildings shall be compiled.

4.3.2 The measurement of underground complexes, transportation facilities, buildings, and comprehensive pipe racks shall meet the following requirements:

1 The horizontal coordinates and elevations of various obvious feature points shall be determined. The mean square error at the horizontal position of the feature points relative to the adjacent control points shall not be greater than 100 mm, and the mean square error of elevation shall not be greater than 30 mm.

2 A plan that reflects the complete layout and type, location, shape and size of underground space facilities shall be surveyed and drawn. On the plan, the elevation points and the clearance height of the underground space shall be measured and noted; the entrances, exits, vents, passages, fire protection and other emergency facilities must be measured and fully expressed. For multi-layer underground spaces, layered plans shall be surveyed and drawn.

3 When compiling the collective diagram, elements such as ground buildings, roads, and green spaces related to underground space facilities shall be superimposed on the basis of the plan.

4 When surveying and drawing the cross-section diagram, the location and direction of the section shall be selected according to the basic characteristics of the underground space facilities.

4.4 Water area status survey

4.4.1 The water area status survey shall comply with the following regulations:

1 The above-water structures, underwater topography, water level or water surface elevation, as well as coastal topography at the junction of water and land shall be measured.

2 The survey of water structures and coastal topography shall comply with the relevant provisions of Section 4.2 of this Code.

5 Engineering setting-out

5.1 General provisions

5.1.1 Engineering setting-out shall use construction project planning conditions, design data and control point results used, to calculate the horizontal coordinates, elevations and related geometric parameters of project feature points, and shall conduct on-the-spot survey according to the accuracy required by the technical design of the project or the technical standards used.

5.1.2 Engineering setting-out shall meet the following requirements:

1 The calculated horizontal coordinates, elevations and related geometric parameters of engineering feature points shall be checked for correctness, and can be used for field survey and design only after they are confirmed to be correct;

2 When setting out a curve project, the horizontal coordinates and elevations of the main point of the curve and other feature points shall be calculated according to the type of curve and the elements of the curve;

3 The marks of various points and lines in the field survey and design shall be accurate and clear, and the original data records shall be true and complete;

4 After the field setting-out, the geometric relationship between adjacent points and lines shall be used for verification. It can be delivered or used for engineering construction only after it is confirmed to meet the requirements.

5.2 Setting-out and verification of planning conditions

5.2.1 The alignment survey, land allocation survey, planning and setting-out survey, planning and checking of building line and planning condition verification survey of construction, municipal and other projects shall be based on the project planning conditions or approved drawings.

5.2.2 The alignment survey and land allocation survey shall comply with the following regulations:

1 The mean square error of the centerline point and axis point determined by the alignment survey and the staking point determined by the land allocation survey relative to the adjacent control points shall not exceed 50 mm;

2 The condition points for determining the road centerline, sidelines and other feature sidelines shall be evenly distributed. The coverage of condition points shall not be less than 2/3 of the range specified in the planning conditions.

5.2.3 Planning and setting-out survey shall comply with the following regulations:

1 The influencing factors of specific engineering construction shall be analyzed, and the construction measurement accuracy shall be determined in accordance with the principle of equal influence according to the given building tolerance for engineering construction;

2 The difficulty of the operation shall be established and set out on site according to the engineering construction control network, and the accuracy of the construction control network and the accuracy of on-site setting-out shall be determined according to the accuracy of construction surveying;

3 The engineering construction control network shall be established in accordance with the relevant provisions in Chapter 3 of this Code;

4 On-the-spot setting-out such as axis projection, curve ranging, detail point setting out and elevation transfer shall be carried out according to the construction progress of the project.

5.3.2 On-the-spot setting-out shall meet the following requirements:

1 When the axis is projected, the axis of the engineering design shall be projected on each construction layer. Before projection, the axis control pile shall be checked. After the projection, the projected axis shall be checked according to the closing conditions. Only when it meets the technical design of the project or the tolerance requirements of the technical standards used can other setting-outs of the construction layer be carried out; otherwise, the projection of the axis shall be carried out again.

2 During the curve ranging, the principal points and other characteristic points of the curves that control the relative position of the curves shall be measured and set on the spot.

3 During the detail point setting out, the engineering design data and calculated engineering feature points shall be carried out for setting out. For special-shaped complex buildings, the three-dimensional measurement method shall be adopted for setting out.

4 During the elevation transfer, the elevation of engineering design shall be transferred to each construction layer. Large-scale and special projects shall be transferred separately from three places, and other projects shall be transferred separately from two places. When the elevation difference transferred is not greater than the tolerance of the technical design of the project or the technical standard used, the mean shall be taken as the reference elevation of the construction layer, otherwise the elevation transfer shall be carried out again.

5.3.3 When it is necessary to carry out third-party inspection on the results of setting out or related construction process, the following regulations shall be complied with:

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