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Unified standard for safety of scaffold in construction

建筑施工脚手架安全技术统一标准

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Unified standard for safety of scaffold in construction

1 General provisions

1.0.1 This standard is formulated in order to unify the design, construction, use, management of construction scaffolding and ensure that it is technologically advanced, safe, applicable, economical, reasonable.

1.0.2 This standard applies to the design, construction, use, management of scaffolding for housing construction projects and municipal engineering construction.

1.0.3 In addition to complying with this standard, the design, construction, use, management of construction scaffolding shall also comply with the relevant national standards.

2 Terms and symbols

2.1 Terms

2.1.1 Scaffold

It is a structural frame composed of rods or structural units and accessories that are reliably connected, can withstand corresponding loads, has safety protection functions, provides operating conditions for building construction. It includes operation scaffold and shoring scaffold.

2.1.2 Operation scaffold

Scaffolding which is composed of rods or structural units and accessories through reliable connections, supported on the ground, buildings or attached to engineering structures, to provide a working platform and safety protection for construction. It includes floor-standing operation scaffold, cantilever scaffold, attached lifting scaffold, etc. as formed by various types of rods (components), which are referred to as operation scaffold.

2.1.3 Shoring scaffold

Scaffolding which is composed of rods or structural units and accessories that are reliably connected and supported on the ground or structure, can withstand various loads, has safety protection functions, provides support and working platforms for building construction, including structural installation shoring scaffold, formwork

shoring scaffold for concrete construction, etc. as formed by various types of rods (components), which are referred to as shoring scaffold.

2.1.4 Closed operation scaffold

An operation scaffold which uses materials such as dense mesh safety nets or steel wire mesh to cover the entire outer facade.

2.1.5 Open operation scaffold

An operation scaffold which has an unobstructed non-enclosed outer facade.

2.1.6 Compositive safety factor

The overall safety factor of a scaffolding structure or main components, which is the ratio -- of the ultimate bearing capacity of the scaffolding structure or components to its design bearing capacity.

2.1.7 Normal value of geometrical parameter

The nominal value of the geometric parameters determined by the design, or the average value of the geometric parameters determined by statistical probability distribution based on the actual measurement results.

2.1.8 Scaffold detailing

The structural form, connection method, mutual relationship of the scaffold, which is composed of frame members, structural units, accessories.

2.1.9 Scaffold structure test

A test to evaluate the mechanical properties of the scaffolding structure or main components, through the test method of applied load.

2.1.10 Scaffold model test

A scaffold structural performance test, which is conducted using a prototype sample with the same size and structure as the typical structural unit of the actual scaffold.

2.1.11 Scaffold unit structure test

Scaffold structure test, which is carried out using the same materials and components as the scaffolding used in the project and setting up the test frame according to specific structural requirements.

grade steel in the current national standard "Carbon structural steels" GB/T 700. The thickness of the steel plate of the stamped steel scaffold planking shall not be less than 1.5 mm; the diameter of the inscribed circle of the planking punching hole shall be less than 25 mm.

4.0.7 The base plate and base jack shall be processed and manufactured after design and calculation; their materials shall comply with the steel grade Q235 requirements of current national standards "Carbon structural steels" GB/T 700, or the steel grade Q345 requirements of "High strength low alloy structural steels" GB/T 1591. Meanwhile it shall also comply with the following requirements:

- 1** The thickness of the steel base plate shall not be less than 6 mm; the thickness of the U-shaped steel base jack shall not be less than 5 mm. The steel plate and the screw shall be circumferentially welded. The height of the weld shall not be less than the thickness of the steel plate; stiffening plates should be provided;
- 2** The fitting tolerance -- of the adjustable base plate and adjustable base jack inserted into the steel pipe of the scaffolding standard -- shall be less than 2.5 mm;
- 3** The bearing capacity of the adjustable base plate and adjustable base jack, when the screw rod meshes with the adjustable nut, shall be higher than that of the adjustable base plate and adjustable base jack. The number of teeth meshing between the screw rod and the adjusting nut shall be determined through calculation. The thickness of the nut shall not be less than 30 mm.

4.0.8 The standard values of the geometric parameters of materials and accessories shall adopt the nominal values specified in the design; the measured average value of the geometric parameters of factory-produced accessories shall comply with the design nominal values.

4.0.9 The materials of steel lifting rings or embedded anchor bolts shall comply with the provisions of the current national standard "Code for design of concrete structures" GB 50010.

4.0.10 The wire ropes used in scaffolding shall comply with the requirements of current national standards "Steel wire ropes for general purpose" GB/T 20118, "Quality steel wire ropes" GB/T 8918, "General purpose thimbles for use with steel wire ropes" GB/T 5974.1, "Wire rope grips" GB/T 5976.

4.0.11 The structural connection materials of metal scaffolding shall comply with the following requirements:

- 1** The welding rods used for manual welding shall comply with the current national standards "Covered electrodes for manual metal arc welding of non-alloy and fine grain steels" GB/T 5117 or "Covered electrodes for manual metal arc welding of creep-resisting steels" GB/T 5118. The type of welding rod selected shall be

compatible with the physical properties of metal being welded.

2 The welding electrodes used for automatic or semi-automatic welding shall comply with the current national standards "Steel wires for melt welding" GB/T 14957, "Welding electrodes and rods for gas shielding arc welding of carbon and low alloy steel" GB/T 8110, "Carbon steel flux cored electrodes for arc welding" GB/T 10045, "Low alloy steel flux cored electrodes for arc welding" GB/T 17493. The selected welding electrode and flux shall be compatible with the physical properties of the metal to be welded.

3 Ordinary bolts shall comply with the provisions of the current national standard "Hexagon head bolts - Product grade C" GB/T 5780; their mechanical properties shall comply with the provisions of the current national standard "Mechanical properties of fasteners - Bolts, screws and studs" GB/T 3098.1.

4.0.12 The connectors of the scaffolding buckle-type connection and socket-type connection shall have measures to prevent withdrawal or falling off.

4.0.13 Maintenance and inspection criteria shall be formulated for scaffolding rods and accessories used for turnover. After each installation and disassembly cycle, they shall be inspected, classified, maintained, serviced in a timely manner; unqualified products shall be scrapped in a timely manner.

4.0.14 Scaffolding accessories shall have good interchangeability and be reusable. The exit-factory quality of accessories shall meet the requirements of the current relevant national product standards. The appearance quality of rods and accessories shall comply with the following requirements:

- 1** Do not use steel pipes with cracks, creases, obvious surface dents, or severe corrosion;
- 2** The surface of the casting shall be smooth, without defects such as blisters, pores, cracks, pouring and riser residues; any sand adhering to the surface shall be removed;
- 3** Stamping parts must not have burrs, cracks, obvious deformation, oxide scale or other defects;
- 4** The welds of the welded parts shall be full; the welding slag shall be removed; there shall be no defects such as incomplete penetration, slag inclusions, overlap, cracks, etc.

4.0.15 Factory-made accessories shall have the manufacturer's logo.

5 Load

5.1 Load classification and normal value

5.1.1 The load acting on the scaffold shall be divided into permanent load and variable load.

5.1.2 The permanent load of the scaffolding shall include the following items:

- 1 The self-weight of the scaffolding structural components;
- 2 The self-weight of scaffold planking, safety nets, guardrails and other accessories;
- 3 The self-weight of the support system of the shoring scaffold;
- 4 The self-weight of the building structural materials and stacked materials on the shoring scaffold;
- 5 Other loads that can be calculated as permanent loads.

5.1.3 The variable load of the scaffold shall include the following items:

- 1 Construction load;
- 2 Wind load;
- 3 Other variable loads.

5.1.4 The standard value of the permanent load of the scaffold shall comply with the following requirements:

- 1 The self-weight value of materials and accessories can be taken as the standard load value according to the current national standard "Load code for the design of building structures" GB 50009;
- 2 For products such as tools and mechanical equipment, the load standard value can be determined according to the general theoretical weight and relevant standards;
- 3 Representative sampling measurements can be taken and mathematical statistical analysis can be carried out. The measured average value plus 2 times the mean square error can be used as the standard load value.

5.1.5 The standard value of the variable load of scaffold shall comply with the following requirements:

- 1 The standard value of the construction load on the operating layer of the operation

strength, or fail due to slippage of connecting nodes, or are unsuitable for continued load-bearing due to excessive deformation;

- 2) The entire scaffolding structure or part of it is out of balance;
- 3) The scaffolding structure is transformed into a mobile system;
- 4) The overall or partial rods of the scaffolding structure are unstable;
- 5) The foundation loses its ability to continue bearing load.

2 When the scaffold appears in one of the following conditions, it shall be judged to have exceeded the normal use limit condition:

- 1) Deformation that affects normal use;
- 2) Other states that affect normal use.

6.1.3 Scaffolding shall be designed according to normal installation and normal use conditions; temporary effects, accidental effects, seismic loads may not be taken into account.

6.1.4 The design calculation content of scaffold shall be determined based on factors such as scaffold structure, installation location, usage function, load, etc. Calculations for floor-landing operation scaffold and shoring scaffold shall include the following content:

1 Floor-standing operation scaffold:

- 1) Bending strength and deflection of horizontal rods, as well as node connection strength;
- 2) Stable bearing capacity of the standards;
- 3) Foundation bearing capacity;
- 4) Strength, stable bearing capacity, connection strength of tie members;
- 5) Bearing capacity and connection strength of wind ropes.

2 Shoring scaffold:

- 1) Bending strength and deflection of horizontal members, as well as node connection strength;
- 2) Stable bearing capacity of standard;
- 3) The scaffold's ability to resist overturning;

Where:

M_d - Design value of bending moment of bending members of shoring scaffold (N·mm);

ΣM_{Gk} - The sum of the standard bending moment values of the bending members of the shoring scaffold caused by the permanent load (N · mm);

ΣM_{Qk} - The sum of the standard bending moment values of the bending members of the shoring scaffold caused by variable loads (N · mm);

Ψ_c - The variable load combination value factor, which shall be used in accordance with the current national standard "Load code for the design of building structures" GB 50009.

6.2.10 The calculation of the stable bearing capacity of shoring scaffold standards (standards of gate scaffold) shall meet the following requirements:

- 1 The stable bearing capacity of shoring scaffold standards, as erected indoors or in a windless environment, shall be calculated according to the formula (6.2.4-1) of this standard. The design value of the axial force of the standards shall be calculated according to the formula (6.2.11-1) and formula (6.2.11-2) of this standard, respectively; the larger value shall be taken.
- 2 The stable bearing capacity of shoring scaffold standards, as erected outdoors, shall be calculated according to the formula (6.2.4-1) and formula (6.2.4-2) of this standard, respectively. Meanwhile, it shall meet the stable bearing capacity requirements. The calculation of the axial force and bending moment of the standards shall comply with the following requirements:
 - 1) When calculated according to formula (6.2.4-1), the design value of the axial force of the standard shall be calculated according to formula (6.2.11-3) and formula (6.2.11-4) of this standard, respectively; the larger value shall be taken;
 - 2) When calculated according to formula (6.2.4-2), the design value of the axial force of the standard shall be calculated according to formula (6.2.11-1) and formula (6.2.11-2) of this standard, respectively; the larger value shall be taken. The standard value of the bending moment of the standards, as caused by wind load, shall be calculated according to the formula (6.2.12) of this standard.
- 3 The stability factor φ of the axial compression member of the shoring scaffold standard shall be taken, based on the slenderness ratio λ of the standard that reflects the overall stability factor of the shoring scaffold (for the gate scaffold, it shall be converted into the slenderness ratio based on the standard), in accordance with the current national standard "Technical code of cold-formed thin-wall steel structures" GB 50018. The slenderness ratio λ of the standard shall be calculated according to the current national standards related to scaffold.

and structural testing.

7.1.2 The newly developed scaffolding shall be subjected to structural tests to determine its structural resistance value under different structures and construction states, and to verify the rationality and applicability of the scaffold structure. The following tests shall be conducted:

- 1 Ultimate bearing capacity test of operation scaffold structure;
- 2 Ultimate bearing capacity test of shoring scaffold structure;
- 3 Structural stress and deformation test, anti-fall device performance test, synchronization performance test, overload and loss-of-load test of attached lifting scaffold;
- 4 Tests on other factors affecting the performance of scaffold structures.

7.1.3 The physical and mechanical properties of scaffold accessories shall be determined or verified through tests. During type inspection of scaffold accessories, the following tests shall be carried out:

- 1 Strength and bearing capacity test of accessories;
- 2 Bearing capacity test of rod connection nodes;
- 3 Test on the load-bearing capacity of buckle-type connectors against falling off;
- 4 Tests on other factors that affect the performance of accessories.

7.1.4 Before testing the scaffolding structure and scaffold accessories, a test plan shall be developed. The content of the test plan shall include the test purpose, test materials, test equipment, test methods, collection and analysis of test results, etc. The test method for mechanical properties of scaffold shall comply with the provisions of Appendix A of this standard.

7.1.5 The test of scaffold structure and scaffold structure accessories shall adopt random sampling method to select test pieces; the sample for testing shall be representative of the technical quality characteristics of the materials and accessories under inspection.

7.1.6 The scaffolding structure test site shall be a flat concrete floor or steel platform. There shall be no accumulation of water in the site. The test scaffold shall be dry. The ambient temperature should be 5 °C ~ 30 °C.

Testing of scaffolding accessories should be conducted indoors at an ambient temperature of 5 °C to 30 °C; when testing bamboo and wooden accessories, the ambient humidity shall be controlled within the range of 40% to 80%.

7.1.7 Before testing the scaffolding structure and scaffolding structure accessories, it

analysis of the scaffold structure resistance design value;

3 Verify the established calculation formula for scaffolding structure design.

7.1.11 During the production process of scaffolding structure accessories, the manufacturer shall conduct type inspection of the scaffolding structure accessories and the scaffolding structure they constitute. When scaffolding accessories leave the factory, the manufacturer shall provide product certificates and type inspection reports. When entering the construction site of scaffolding structure accessories, the user shall check the product certificate and type inspection report.

7.1.12 During the construction process of the project, when it is necessary to test the scaffolding structure according to the design and construction needs, a test plan shall be prepared according to the actual conditions of the project; the following tests should be carried out:

- 1** Inspection of design value of scaffolding structure bearing capacity;
- 2** Under the action of the design load value, the frame structure deformation inspection;
- 3** Other items that shall be inspected according to project needs.

7.2 Frame test and analysis

7.2.1 The basic assumptions and calculation models used in the structural analysis of the scaffold shall be determined based on the structure, construction, stress characteristics of the scaffold in its working state. When the structure and construction of the scaffold change, the calculation parameters of the scaffold shall be re-determined. The application of analysis and calculation results shall take into account the compositive safety factor. Scaffolding shall be analyzed based on the elastic state of the scaffold structure.

7.2.2 When conducting scaffolding structural analysis, the following factors shall be included:

- 1** Frame structure type and purpose;
- 2** Performance, specifications, geometric defects of materials and accessories;
- 3** Force characteristics and force transmission paths;
- 4** Node connection methods and constraint conditions;
- 5** The structural form of the scaffold.

7.2.3 The scaffolding structure test shall be carried out using the unit structure test

method; the unit structure test results shall be compared and analyzed with the model test results to comprehensively determine the bearing capacity value of the scaffolding structure, which shall comply with the following requirements:

- 1 The structural test of operation scaffold shall adopt the B series unit structure test. The test results shall be compared and analyzed with the model test results of operation scaffold, which is specified in Article A.2.9 of Appendix A of this standard.
- 2 The structural test of the shoring scaffold shall adopt the C series unit structure test. The test results shall be compared and analyzed with the model test results of the shoring scaffold, which is specified in Article A.2.11 of Appendix A of this standard.
- 3 When comparing and analyzing the unit structure test results of operation scaffolds and shoring scaffolds with their model test results, if the deviation of the two test data does not exceed $\pm 15\%$, the unit structure test results shall be used as the bearing capacity value; if the deviation of the two test data exceeds $\pm 15\%$, it shall find the causes and repeat the tests; or it shall correct the unit structure test results based on the model test results.

7.2.4 The analysis and evaluation of scaffolding structure test results shall comply with the following provisions:

- 1 The performance and failure mode of the test sample shall be compared and verified with the theoretical prediction value and failure mode. When there is a large difference between the two results, it shall analyze the reasons and conduct additional tests if necessary;
- 2 The test results shall be evaluated using mathematical statistics based on the obtained test data; the test conclusions shall be consistent with the test evaluation results;
- 3 The evaluation results of scaffolding structure tests shall only be valid for scaffolds under the same conditions.

7.2.5 When the test conditions are different from the actual use conditions, the test results can be corrected by using a conversion factor. The conversion factor shall be determined through testing or empirical analysis. The main factors can include size effects, time effects, boundary conditions of the specimen, environmental conditions, construction process conditions, test loading conditions, etc.

7.2.6 When determining the design value of scaffolding structure resistance and determining or verifying the calculation method based on test results, the influence of test quantity and accuracy shall be taken into account.

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