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Technical specification for low-rise cold-formed thin-walled steel buildings

底层冷弯薄壁型钢房屋建筑技术规程

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[Translator note: Above “Contents” is the original contents from the Chinese version]

Technical specification for low-rise cold-formed thin-walled steel buildings

1 General provisions

1.0.1 This specification is established for the purposes of standardizing the design, fabrication, erection and acceptance of low-rise cold-formed thin-walled steel buildings, in order to realize advanced technology, reasonable economics, safety and applicability, and high quality.

1.0.2 This specification is applicable to the design, construction and acceptance of low-rise buildings with cold-formed thin-walled steel as the main bearing steel-members [Translator note: For the purpose of this standard, "steel-" is additionally prefixed in front of "member", hereafter the same], having not more than 3 floors, AND with the eave height not more than 12m.

1.0.3 This specification is established in accordance with the principles as specified in current national standards "Unified standard for reliability design of building structures" GB 50068, "Load code for the design of building structures" GB 50009, "Code for seismic design buildings" GB 50011, "Code for design of steel structures" GB 50017, "Technical code of cold-formed thin-wall steel structures" GB 50018, and "Code for acceptance of construction quality of steel structures" GB 50205, and so on, AND combining with the low-rise cold-formed thin-walled steel building characteristics.

1.0.4 When designing the low-rise cold-formed thin-walled steel buildings, it shall reasonably select the materials, structural programs and construction measures, AND ensure the structures comply with the strength, stability, and rigidity requirements, as well as the fireproofing and anticorrosion requirements.

1.0.5 The design, construction and acceptance of low-rise cold-formed thin-walled steel buildings shall, in addition to complying with this specification, also comply with the provisions of the relevant current national standards.

2 Terms and symbols

2.1 Terms

2.1.1

Web stiffener [Translator note: This term, in bold, is the original English term in the Chinese version, hereafter the same**]**

It refers to the steel-member connected to the web to prevent buckling of the web.

2.2.2 Calculation indices

E - Elastic modulus of steel;

f - Design value of the tensile, compressive, and bending strength of steel;

f_y - Yield strength of steel;

f_v - Design value of the shear strength of steel;

f^s_v - Design value of the shear strength of screw material;

f_e - Design value of compressive strength of steel end face;

K - Shear rigidity;

M_d - Design value of the distortional buckling bending bearing capacity;

M_C - Design value of the overall instability buckling bearing capacity considering the effect of axial force;

M_A - Design value of the distortional buckling bearing capacity considering the effect of axial force;

N_u - Design value of stable bearing capacity;

N_C - Design value of axial bearing capacity in case of overall instability;

N_A - Design value of axial bearing capacity in case of distortional buckling;

P_{nom} - Nominal shear strength;

V_j - Design value of the horizontal shear force on the j^{th} shear wall;

S_h - Design value of the horizontal shear force on the unit calculation length of the shear wall;

S* - Design value of load effect;

R_d - Design value of bearing capacity;

Δ - The maximum elastic interlayer displacement in the floor due to the standard value of the wind load or the standard value of the frequent earthquake effect; the perpendicularity; the shear deformation.

2.2.3 Geometric parameters

A - Gross cross-sectional area;

A_0 - Opening total area;

A_e - Effective cross-sectional area;

A_{en} - Effective net cross-sectional area;

A_{cd} - Effective cross-sectional area at distortional buckling;

α - Edge curled height;

b - The width of the section or plate;

f - Lateral bending rise;

H - The height from the base top to the highest point of the building; the floor height of the building; the height of the shear wall;

h - The height of section or plate;

H_0 - The calculated height of web;

I - The inertia moment of gross section;

I_{sf} - The inertia moment of the center axis of the stiffened plate;

L - Length or span;

L - Length or span; distance between lateral support points;

t - Thickness;

t_s - Equivalent plate thickness;

W - Section modulus;

W_e - Effective section modulus;

λ - Slenderness ratio; steel-member distortional buckling half-wavelength;

$λ_{cd}$ - The dimensionless slenderness ratio used to determine the A_{cd};

λmd - The dimensionless slenderness ratio used to determine the M_d.

2.2.4 Calculation factor and others

$k_Φ$ - The factor used to calculate the bearing capacity and the stability of the bending steel-member;

k_t - The factor considering the variability of structural sample;

k_{sc} - Structural characteristic variation factor;

k_f - Geometric dimension uncertainty variation factor;

k_m - Material strength uncertainty variation factor;

N'_E - The factor used to calculate the bearing capacity and the stability of the compressive bending steel-member;

n - Number of screws; number of shear walls;

T - Basic self-vibration period of structure;

α - Roof slope; reduction factor;

β_m - Equivalent bending moment factor;

γ_R - Resistance partial factor;

γ_{RE} - Seismic adjustment factor of bearing capacity;

μ_x, μ_y, μ_w - Calculation length factor;

μ_r - Roof snow distribution factor;

φ - The overall stability factor of the axial compressive steel-member;

η - Factor used to calculate the overall stability of the bending steel-members; axial force correction factor;

ξ - Bearing capacity reduction factor for multiple screw connections.

3 Materials and design indices

3.1 Material selection

3.1.1 The steel selection shall comply with the following requirements:

1. The steels used for the bearing structure of the low-rise cold-rolled steel building shall adopt the grade Q235 and Q345 steels which comply with the requirements of the current national standard “Carbon structural steels” GB/T 700 and “High strength low alloy structural steels” GB/T 1591 OR the grade 550 steels which comply with the requirements the current national standard “Continuously hot-dip zinc-coated steel sheet and strip” GB/T 2518 and “Continuously hot-dip aluminum-zinc alloy coated steel sheet and strip” GB/T 14978. When there is a reliable basis, it may use the steels of other designations, BUT the steels used shall comply with the provisions of the relevant national standards.

Note: In this specification, the grade 550 steel is named as LQ550.

2. The cold-rolled thin-walled steel section shall guarantee the qualified tensile strength, elongation, yield strength, cold bending test, and sulfur and phosphorus content; AND the butt welding structure shall also guarantee the qualified carbon content.

1) Calculating the steel-member bearing capacity and connection based on axial force: 0.85;

2) Calculating the steel-member stability based on axial compression: 0.6 + 0.0014λ.

Note: For the non-connected single-angle steel bars, λ is the slenderness ratio of the bar which is calculated by the minimum turning radius.

3. The connection of the two steel-members is by either overlapping OR the connection with a pad filled in, AND the asymmetrical connections of a single cover plate: 0.90.

When the above conditions exist at the same time, the corresponding reduction factors shall be multiplied.

4 Basic design requirements

4.1 Design principles

4.1.1 The structure design of this specification adopts the limit state design method based on the probability theory, AND conduct calculation using the partial factor design expression.

4.1.2 The bearing structure in this specification shall be designed in accordance with the bearing capacity limit state and the normal use limit state.

4.1.3 When the structural steel-members and connections are designed in accordance with the bearing capacity limit state without considering the earthquake action, it shall be calculated in accordance with the basic combinations of the load effects as specified in the current national standard “Load code for the design of building structures” GB 50009. When the structural steel-members and connections are designed in accordance with the bearing capacity limit state considering the earthquake action, it shall be calculated in accordance with the basic combinations of the load effects as specified in the current national standard “Code for seismic design buildings” GB 50011, wherein the bearing capacity seismic adjustment factor γ_{RE} is taken as 0.9.

4.1.4 When the structural steel-members are designed in accordance with the normal use limit state, it shall be based on the standard combination of the load effect as specified in the current national standard “Load code for the design of building structures” GB 50009 AND the load effect combination as specified in the current national standard “Code for seismic design buildings” GB 50011.

4.1.5 The tensile strength of structural steel-members shall be calculated in accordance with the net cross section; the compressive strength shall be calculated in accordance with the effective net cross section; the stability shall be calculated in accordance with the effective section; AND the deformation

8.3.3 The detailing of the wall opening shall comply with the following provisions:

1. Above and at both sides of the door & window openings of the bearing wall, it shall respectively arrange the header and the opening side stud, AND it is preferable for the opening side stud to directly pass below the wall bottom directly to the wall top or header bottom, and to connect the wall bottom track and wall top track.

2. The form of the opening header may be of solid web type or truss type.

3. When using the truss type header, it is preferable for the upper concentrated load to act onto the joint of the truss.

4. The door and window opening side stud shall be built-up by two or more edge curled cold-formed channel steel.

8.3.4 The arrangement and detailing of the wall stud shall comply with the following requirements:

1. As for the shear wall for which there is not wall framing plate at both sides to connect to the wall stud, it shall arrange the cross support and horizontal support. The cross support may adopt flat strap tie bar having a width of not less than 40mm and thickness of not less than 0.8mm, which is preferable to be arranged at both sides of the wall; the horizontal support may adopt flat strap tie bar and blocking, which is preferable to be arranged at the 1/2 height of the wall stud for the shear wall of the floor height less than 2.7m, AND is preferable to be arranged at the 1/3 height of the wall stud for the shear wall of the floor height more than or equal to 2.7m. The horizontal blocking shall be arranged at both ends of the wall, AND it is not preferable for the horizontal spacing to be more than 3.5m. The blocking shall adopt the channel section having the same width of the wall stud, the flange shall be connected with the flat strap tie bar by screws AND the end is bent and connected to the wall stud (Figure 8.3.4a, c).

2. As for the shear wall for which there is no wall framing plate at one side, it shall arrange the horizontal support at this side in accordance with the requirements of item 1 in this clause (Figure 8.3.4b).

3. In areas where the basic seismic acceleration is 0.30g and above OR the basic wind pressure is 0.70kN/m^2 and above, the shear wall shall be provided with cross support and horizontal support. The support cross-section shall be determined by calculation.

8.3.5 The detailing of the connection between shear wall and foundation (Figure 8.3.5) shall comply with the following requirements:

1. The arrangement of the anchor bolts connecting the wall bottom track and foundation shall be determined by calculation, the anchor bolt diameter shall be not less than 12mm, the spacing shall be not more than 1200mm,

than 180g/m^2 (double-sided) OR the aluminum-zinc alloy amount shall be not less than 100g/m^2 (double-sided); as for the region of high corrosion OR special buildings, the zinc amount of the coating shall be not less than 275g/m^2 (double-sided) OR the aluminum-zinc alloy amount shall be not less than 100g/m^2 (double-sided), AND meanwhile it shall comply with the requirements of the current national or industrial standards.

10.2.2 The connection piece of the cold-formed thin-walled steel structure shall use zinc coated material or aluminum-zinc alloy coated material based on the different corrosive region.

10.2.3 It is prohibited for the cold-formed thin-walled steel structure to be hot cut.

10.2.4 In between the cold-formed thin-walled steel section and other materials, it shall use the following effective isolation measures for protection, in order to avoid the contact corrosion of the two materials:

1. It shall place rubber washer between the metal pipeline and the steel-members, in order to avoid direct contact between the two.

2. It shall place anticorrosion and moisture proof cushion between the wall and the concrete foundation.

10.2.5 When the cold-formed thin-walled steel-member are placed in the open-air environment, it shall avoid the steel-member and its surface coating from being corroded by such climatic environments as rain, snow, sunlight, and hail, etc.

10.2.6 When the steel-member surface coating is locally damaged, it shall make it subjected to anticorrosion treatment.

10.3 Erection

10.3.1 Erection of cold-formed thin-walled steel-members shall be carried out in strict accordance with the design drawings.

10.3.2 In carrying out the overall assembly, it shall comply with the following requirements:

1. It is required for the wall framing system to be added with temporary support and cross support.

2. The floor joist shall be added with inter-joist support.

3. It shall add horizontal and vertical support between the roof truss units.

4. It shall take effective measures to distribute the construction load to a larger area.

documents for the energy saving work quality, AND the energy saving work quality acceptance shall comply with the provisions of project shall be in accordance with the provisions of “Code for acceptance of energy efficient building construction” GB 50411.

11.1.3 The heat preservation materials and energy saving equipment which are used for the low-rise cold-formed thin-walled steel building project must comply with the design requirements AND the provisions of the relevant current national standards. The heat preservation and insulation materials shall have good long-term thermal resistance retention. In the heat preservation product label, it shall clearly specify the thermal conductivity (or thermal resistance) of the material, OR otherwise provide the written proof for the thermal conductivity (or thermal resistance) of the heat preservation material, AND it shall comply with the design requirements.

11.2 Detailing of heat preservation and insulation

11.2.1 As for the heat preservation and insulation of exterior wall, it may fill the fiber type heat preservation materials in the wall cavity AND/OR pave hard board type heat preservation materials outside the wall. When filling fiber type heat preservation materials in the wall cavity, it shall consider the effect of thermal bridge steel-member such as stud in the calculation of the thermal resistance, the width of the heat preservation materials shall be equal to OR slightly larger than the stud spacing, AND it is not preferable for the thickness to be less than the stud cross-section height.

11.2.2 The roof heat preservation and insulation may be realized by laying the heat preservation materials along the roof slope OR horizontal laying the heat preservation materials above the top suspended ceiling. When horizontal laying the heat preservation materials above the top suspended ceiling, at the top floor wall top and the connection between the wall and the roof system, it shall ensure the continuity and sealing performance of the heat preservation material, steam barrier, and damp proof layer.

11.3 Detailing of damp proof

11.3.1 Outer cladding of exterior walls and roofs shall comply with the durability, adaptability and fireproof requirements which are specified in the current national or industrial standards. Inside of the outer cladding AND outside the structural facing plate, it shall arrange damp proof layer, AND its physical performance, waterproof performance and water vapor permeability shall comply with the design requirements.

11.3.2 The periphery of the door and window openings AND the periphery of the steel-members projecting from the wall or roof shall be subjected to sealing treatment by special purpose flashing materials, which may be of self-adhesive waterproof membrane or sheet metal and so on.

11.3.3 Building envelope shall be so designed as able to prevent the adverse water vapor condensation. If the building exterior wall, overhang floor and roof

in the severe cold and cold areas do not take ventilation measures, it is preferable to provide a layer of steam barrier at the higher temperature side of the heat preservation material (in winter).

11.3.4 It shall ensure the continuity, sealing performance, and integrity of the heat preservation material, damp proof layer, and steam barrier in construction.

11.3.5 It is preferable for the roof space between the roof heat preservation materials and the roof structural plate to use ventilation design, AND it shall ensure the smooth air flow channel within the roof air space. At the roof vents, it shall provide a protective net to prevent the harmful insects such as termites from entering into the roof ventilation interlayer. It is preferable for the indoor ventilation pipeline to lead outside, AND it is not preferable to exhaust the indoor air into the roof ventilation interlayer.

12 Fireproofing

12.0.1 The fireproofing design of the low-rise cold-formed thin-walled steel building shall, in addition to complying with the provisions of this specification, also comply with the relevant provisions of the current national standard “Code for design on building fire protection and prevention” GB 50016.

12.0.2 The following parts of the building shall be separated from other parts by the non-inflammable wall and floor having a fire endurance of not less than 1.00h:

1. **Power distribution room, boiler room, motor vehicle garage.**

2. **Reference room, archives (room), storage room.**

3. **Public kitchen.**

12.0.3 As for the motor vehicle garage attached to a cold-formed thin-walled steel residential building AND used only for this building, the door which is connected with the residential part shall adopt class B fire door, AND there shall be no opening on the garage partition wall within 100mm to the ground.

12.0.4 As for the door and window openings at both sides of wall between the residential units, the horizontal spacing between the nearest edges shall be not less than 1.0m.

12.0.5 As for the cold-formed thin-walled steel building consisting of different heights, the minimum distance between the skylight on the roof of the lower part and the door & window opening on the exterior wall of the higher part shall be not less than 4.0m. However, this distance is not limited if one of the following conditions is met:

1. The lower part is equipped with the automatic sprinkler system OR the skylight is class B fire window.

B.0.4 The choice of measuring instruments shall comply with the maximum range of ultimate damage of the test piece, AND its resolution shall comply with the resolution capability under the minimum load. It is not preferable for the minimum scale value of the instrument for displacement measurement to be greater than 0.5% of the measured total displacement, AND the allowable indication error shall be not more than ± 1% of the full range of the instrument. The accuracy of the various recorders shall not be less than ± 0.5% of the full range.

B.0.5 The loading method of the shear test of the cold-formed thin-walled steel section composite wall may be conducted as follows in accordance with the objectives of the test:

1. The size of the vertical load shall be the target test load of the test piece, AND the vertical load shall be applied once to the expected value in accordance with the static loading requirements before applying the horizontal load, AND be kept constant.

2. In case of monotonous horizontal loading, before the test piece yielding, it shall use the load control AND apply load in stages, AND it is preferable to reduce the load range when approaching to the yield load; after the test piece is yielded, it shall use the deformation control loading in stages. AND it may collect and record the data of each measuring point after the load of each stage is maintained for 2min ~ 3min, until it is damaged.

3. During low-cycle repeated horizontal loading, it shall conduct the pre-applied repeated load test for 2 times before the formal test, AND it is not preferable for the pre-applied load value to exceed 30% of the yield load of the test piece. During formal test, before the test piece yielding, it shall use the load control AND apply load in stages, AND it is preferable to reduce the load range when approaching to the yield load; after the test piece is yielded, it shall use the deformation control, AND the deformation value shall be taken as the maximum displacement of the test piece at the time of yielding, AND the times of this displacement value is used as the range to conduct loading control. Before yielding, each stage of load may be repeated for one time, AND it is preferable to repeat it for three times after yielding. In the test process, it shall maintain the continuity and evenness of the repeated loading, AND it is preferable for the loading rate or unloading rate to be consistent.

B.0.6 The data processing of the shear test of the cold-formed thin-walled steel section composite wall may follow the principles below:

1. The shear deformation of the test piece under the action of the horizontal load shall be deducted by the horizontal sliding and rotation of the test piece.

2. The yield strength and yield displacement of the test piece may be determined in accordance with the load-displacement curve of monotonous horizontal loading OR the skeleton curve of low-cycle

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