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Standard for design of timber structures

木结构设计标准

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Standard for design of timber structures

1 General provisions

1.0.1 In order to implement the national technical and economic policies in the design of timber structures, to achieve advanced technology, safety and applicability, economic rationality, quality and environmental protection, this standard is hereby formulated.

1.0.2 This standard applies to the design of swan & log timber structure, glued laminated-timber structure, light-wood frame construction for construction engineering.

1.0.3 In addition to complying with this standard, the design of the timber structure shall also comply with the requirements of current relevant national standards.

2 Terms and symbols

2.1 Terms

2.1.1

Timber structure

A load-bearing structure made of wood-based members.

2.1.2

Log

Short-cut wood which is made through branch-removal of the felled trunk and bucking process.

2.1.3

Sawn timber

Finished or semi-finished materials which are made through bucking process of logs, divided into plank and square timber.

2.1.4

Square timber

Sawn timber which has a right-angle sawing and a width-to-thickness ratio of less than 3, also known as square-edged timber.

2.1.5

Plank

Sawn timber which has a right-angle sawing and a width-to-thickness ratio more than or equal to 3.

2.1.6

Dimension lumber

The normalized timber which is made by processing the timber according to the specified sizes of cross-sectional width and height.

2.1.7

Structural composite lumber

also known as laminated timber or structural glulam.

2.1.14

Cross laminated timber

A timber product obtained by laminating, assembling, gluing the orthogonal laminates which have a thickness of 15 mm ~ 45 mm, also known as orthogonal laminated timber.

2.1.15

Laminated log

A timber product obtained by gluing a sawn timber which has a thickness of more than 30 mm and number of layers of not more than 4 in the direction parallel to grain. It is commonly used in log cabins or beam-post timber structure.

2.1.16

Wood I-joist

A bending member which has an I-shaped cross-section, formed by using the dimension lumber or structural composite lumber as flange, the wood-based structural planks as web, the structural adhesive for gluing.

2.1.17

Stud

Vertical load-bearing frame members in light wood frame structure which are arranged at regular intervals.

2.1.18

Visually stressed-graded lumber

The timber the grade of which is determined by visual inspection.

2.1.19

Machine stress-rated lumber

The timber the strength grade of which is determined based on the timber's bending strength and elastic modulus which are obtained by using a mechanical stress measuring device to carry out non-destructive test against the timber.

An architectural structure consisting of timber-frame walls, floor panels, roof systems which are made of dimension lumber, wood-based structural panels, or gypsum board.

2.1.27

Glued laminated timber structures

An architectural structure whose load-bearing members are mainly made of glued-timber, also known as glued laminated timber structure.

2.1.28

Log cabins; log house

The timber structure whose main load-bearing system is made from the well-shaped timber wall which uses the logs, square timbers, laminated log whose cross-section is appropriately processed as the basic members, superimpose the members in layers upwards, uses the inter-layer cross-bite connection at the intersection ends of the members.

2.1.29

CHUANDOU-style timber structure

According to the spacing of the roof purlin, erect a row of timber columns along the depth direction of a house, the purlin is directly braced by column, there is no beam between columns, which are laterally-tied by the square-column which penetrates through the column, to form a truss of timber structure. Use DOUFANG and pike to connect every two trusses of timber structures to form a load-bearing spatial timber-frame.

2.1.30

TAILIANG-style timber structure

In the direction of the depth of the house, brace the timber beam above the timber column; above the timber beam, use short column to brace the above layer of shortened timber beams; follow this method to superimpose several layers of gradually-shortening beams to form a truss of timber structure. The roof purline is placed at the ends of beams of each layer.

2.1.31

Post and beam with shear wall construction

In the square timber log structure, the timber structure system which mainly uses the ground-beam, beam, transverse beam and column to form a

R_f - The design value of the bearing capacity of the residual timber members after combustion at fire endurance;

S_d - The design value of the effect of action-combinations;

S_k - The design value which is used to verify the effect of the accidental combination of loads of the damaged timber members after a fire;

T_r - The design value of the tensile capacity of truss plate;

V - The design value of shear force;

V_d - The design value of the shear capacity of shear wall, floor and roof;

V_r - The design value of the shear capacity of truss plate;

W_d - The design value of uplifting capacity of hex-head timber screws;

Z_d - The design value of the shear capacity of each shear-plane of the dowel-type fastener;

Z - The reference design value of shear capacity;

w - The deflection of a member as calculated according to the standard combination of load effects;

w_x, W_y - The deflection as calculated according to the standard combination of load effects along the x-axis and y-axis directions of the cross-section of the member.

2.2.2 Design indicators for material properties or structure

C_{r1}, C_{r2} - The design value of the shear-tensile composite strength of truss plate along the l_1 and l_2 directions;

E - The average modulus of elasticity of the timber material;

E_k - The standard modulus of elasticity of the timber material;

f_{ck}, f_c - The standard value and design value of compressive strength and bearing strength of timber materials along the direction parallel to grain;

f_{ca} - The design value of the bearing strength of timber materials along the direction at an angle to grain;

$f_{c,90}$ - The design value of the bearing strength of timber materials along the direction perpendicular to grain;

f_{mk}, f_m - The standard value and design value of bending strength of timber

B_c - The effective width of the floor, roof parallel to the loading direction;

b - The cross-sectional width of the member;

b_n - The effective side length of the cross-section of the variable-section compressive member;

b_t - The calculated width of the cross-section of the truss plate perpendicular to the direction of the tensile force;

b_v - The width of the shear plane, or the width of the shear cross-section of the truss plate parallel to the shear direction

d - The diameter of the log or dowel-type fastener;

d_{ef} - The thickness of the effective carbonized layer;

e_0 - The initial eccentricity of the member;

h - The height of the cross-section of the member;

h_d - The effective length of the threaded portion of the hex-head screw as driven into the primary member;

h_n - The height of the net cross-section of the flexural member at the incision;

h_w - The height of the shear wall;

I - The full-section moment of inertia of the member;

i - The radius of gyration of the cross-section of the member;

l - The length of the member;

l_0 - The calculated length of the compressive member;

l_e - The calculated length of the flexural member;

l_v - The calculated length of sheared plane;

S - The area moment of the cross-sectional area above the shear plane versus the neutral axis;

t_m - The thickness of the thicker or middle members in case of single-shear connection or double-shear connection;

t_s - The thickness of the thinner or edge members in case of single-shear connection or double-shear connection;

W - The full-section resistance moment of the member;

1. Welded members or connectors that directly withstand dynamic or vibration loads;

2. Members or connectors which have an operating temperature equal to or lower than -30 °C.

3.2.4 The steel used in the load-bearing timber structure shall have the qualification guarantee of tensile strength, elongation, yield strength, sulfur and phosphorus content. The welding member or connector shall also have the qualification guarantee of carbon content. The steel used for the tie-bar of the steel-timber truss which has a lower-chord diameter d more than 20 mm, as well as the steel for the welded load-bearing structure or important non-welded load-bearing structure shall also have the qualification guarantee for the cold-bending test.

3.2.5 The ordinary bolts selected shall comply with the provisions of the current national standard “Hexagon head bolts” GB/T 5782 and “Hexagon head bolts - Product grade C” GB/T 5780.

3.2.6 High-strength bolts shall comply with the provisions of the current national standard “High strength bolts with large hexagon head for steel structures” GB/T 1228, “High strength large hexagon nuts for steel structures” GB/T 1229, “High strength plain washers for steel structures” GB/T 1230, “Specifications of high strength bolts with large hexagon head, large hexagon nuts, plain washers for steel structures” GB/T 1231, “Sets of torshear type high strength bolt hexagon nut and plain washer for steel structures” GB/T 3632.

3.2.7 Anchor bolts can be made of Q235 steel as specified in the current national standard “Carbon structural steels” GB/T 700 or Q345 steel as specified in “High strength low alloy structural steels” GB/T 1591.

3.2.8 The nails shall comply with the provisions of the current national standard “Steel nails” GB 27704.

3.2.9 Welding electrodes for steel members shall comply with the provisions of the current national standards “Covered electrodes for manual metal arc welding of non-alloy and fine grain steels” GB/T 5117 and “Hot-strength steel welding electrode” GB/T 5118. The model of electrode shall be compatible with the mechanical properties of the main metal.

3.2.10 Metal connectors and screws shall be subjected to anti-corrosion treatment or use stainless-steel products. Metal connectors and screws that are in direct contact with the preservative timber shall be protected from corrosion caused by preservatives.

3.2.11 For load-bearing steel members that are exposed to the outdoor environment and have special anti-corrosion requirements or under the action

interlayer displacement of timber structures shall not exceed 1/250 of the structure's layer height.

4.1.11 The horizontal force of the floor of the timber structure should be distributed according to the subordinate area of the anti-lateral force member or the ratio of the representative value of the gravity load on the subordinate area. At this time, the distribution of horizontal force may not consider the torsional effect. But for the longer wall, it should be multiplied by a magnification factor of 1.05 ~ 1.10.

4.1.12 Under the action of wind load, the horizontal shear force as distributed to the edge wall of the light wood frame structure should be multiplied by the adjustment factor of 1.2.

4.1.13 Timber structures shall be reliably protected against timber decay or worm-damage. It shall ensure that it reaches the designed service life.

4.1.14 The glue for load-bearing structure must meet the requirements of the strength and durability of the binding portion. It shall ensure that the gluing strength is not lower than the tensile strength of the timber along the direction parallel to grain and the tensile strength of the timber along the direction perpendicular to grain. Meanwhile it shall meet the requirements of environmental protection.

4.1.15 The design of steel members in timber structures shall comply with the provisions of the current national standard "Code for design of steel structures" GB 50017.

4.2 Seismic design

4.2.1 The seismic design of timber structure buildings shall comply with the relevant provisions of the current national standard "Code for seismic design of buildings" GB 50011.

4.2.2 For the timber structure building, it shall follow the provisions of the current national standard "Standard for classification of seismic protection of building constructions" GB 50223 to determine its seismic fortification category and corresponding seismic fortification criteria.

4.2.3 The structural system of timber structures shall comply with the following provisions:

1. The plane layout should be simple and regular, with as less eccentricity as possible. The floor plane should be continuous, it should not have large bumps or openings.

2. For timber structures with weak layers, the shear force of the weak layer shall be multiplied by an increase factor of not less than 1.15;

3. For the light wood frame structure, when verifying the connection strength and local pressure-bearing of the roof panel and the lower structure, the lateral-force as caused by the seismic action is multiplied by the increase factor of 1.2.

4.2.14 For the non-structural members such as the retaining wall, partition wall, curtain wall, decorative veneer, auxiliary electromechanical equipment system installed on the floor and roof structure, as well as the connection with the main structure, it shall carry out seismic design. When the non-structural member is subjected to seismic verification, the seismic adjustment factor γ_{RE} of the bearing capacity of the connector may take 1.0.

4.2.15 The design of timber structure building in the area where the seismic fortification intensity is 8 degrees and 9 degrees, it may use the shock-isolation and energy-dissipation design.

4.3 Design values and allowable deformation limits

4.3.1 The design indicators for timber such as square timber, logs, ordinary glued laminated timbers, laminated logs shall be determined according to the following provisions:

1. **The strength grade of timber shall be selected according to the tree species selected from Table 4.3.1-1 and Table 4.3.1-2;**

of the flexural member as a lateral brace;

3. When 5 < h/b < 6.5, the pressed edge is directly fixed on the densely-paved deck or directly fixed on the joist which has a spacing of not more than 610 mm;

4. When 6.5 < h/b < 7.5, the pressed edge is directly fixed on the densely-paved deck or directly fixed on the joist which has a spacing of not more than 610 mm; meanwhile the lateral diaphragm is installed between flexural members, the interval is not more than 8 times the cross-sectional height of the flexural member;

5. When 7.5 < h/b ≤ 9, there is continuous members to limit the lateral displacement of the upper and lower edges of the flexural member along the length direction.

5.2.4 The shear capacity of the flexural members shall be verified as follows:

$$\frac{VS}{Ib} \leqslant f_v \qquad (5.2.4)$$

Where:

f_v - The design value of the shear strength along the direction parallel to grain of the member material (N/mm^2);

V - The design value of the shear force of flexural member (N), which shall comply with the provisions of clause 5.2.5 of this standard;

I - The full-section moment of inertia of the member (mm^4);

b - The sectional width of the member (mm);

S - The area moment of the cross-sectional area above the shear plane versus the neutral axis (mm^3).

5.2.5 If the load acts on the top surface of the beam, when calculating the design value of shear force V of the flexural member, it may not consider the action of all loads on the beam within the distance range from the support at the beam's end to the height of the beam's cross-section.

5.2.6 The design of the incision on the flexural members shall comply with the following requirements:

1. It shall minimize the stress concentration as caused by the incision. It should use the gradually-changed tapered incision; it should not use the right-angled incision;

Where:

[w] - The deflection limit of the flexural member (mm), which shall be used according to the provisions of Table 4.3.15 of this standard;

w - The deflection of the member as calculated by the standard combination of load effects (mm).

5.2.10 The bidirectional flexural members shall be verified according to the following provisions:

1. When verified according to the bearing capacity, it shall be verified as follows:

$$\frac{M_x}{W_{nx} f_{mx}} + \frac{M_y}{W_{ny} f_{my}} \leqslant 1 \qquad (5.2.10\text{-}1)$$

2. When verified according to the deflection, it shall be verified as follows:

$$w = \sqrt{w_x^2 + w_y^2} \qquad (5.2.10\text{-}2)$$

Where:

M_x, M_y - The design value of the bending moment as generated relative to the x-axis and y-axis of the member's cross-section (N • mm);

f_{mx}, f_{my} - The design value of the bending strength of the member in forward bending or lateral bending (N/mm^2);

W_{nx}, W_{ny} - The resistance moment of the net cross-section of the member's cross-section along the x-axis and y-axis (mm^3);

w_x, w_y - The deflection for the x-axis and y-axis direction of the cross-section of the member as calculated on the standard combination of load effects (mm).

5.3 Combined bending and axial loading members

5.3.1 The bearing capacity of the tension-flexural members shall be verified as follows:

$$\frac{N}{A_n f_t} + \frac{M}{W_n f_m} \leqslant 1 \qquad (5.3.1)$$

Where:

N, M - Design value of axial tensile force (N), design value of bending

4. The tooth's depth of the step joint shall not be less than 20 mm for square timber and shall not be less than 30 mm for logs.

5. The tooth's depth at the seat's node of the truss shall be not more than h/3, the tooth's depth of the intermediate node shall be not more than h/4, where h is the member's cross-section height along the depth direction of tooth.

6. In the double-tooth connection, the depth h_c of the second tooth shall be at least 20 mm larger than the depth h_{c1} of the first tooth. The length of the sheared plane of the single tooth and the first tooth of double tooth shall not be less than 4.5 times the tooth's depth.

7. When it can only be made by wet materials due to restrictions of conditions, the length of the sheared plane of the step joint at the seat's node of timber truss shall be 50 mm longer than the calculated value.

6.1.2 Single-tooth connections shall be verified according to the following provisions:

1. When the timber is compressed, it shall be verified as follows:

$$\frac{N}{A_c} \leqslant f_{c\alpha} \qquad (6.1.2\text{-}1)$$

Where:

$f_{c\alpha}$ - The design value of the compressive strength along the direction at an angle to grain of timber (N/mm^2), which shall be determined according to the provisions of clause 4.3.3 of this standard;

N - The design value of axial pressure which acts on the tooth's surface (N);

A_c - The area of the compressive plane of tooth, (mm^2).

2. When the timber is sheared, it shall be verified as follows:

$$\frac{V}{l_v b_v} \leqslant \psi_v f_v \qquad (6.1.2\text{-}2)$$

Where:

f_v - The design value of the shear strength along the direction parallel to grain of the timber (N/mm^2);

V - The design value of shear force acting on the shear plane (N);

l_v - The calculated length of the shear plane (mm), which shall not be more than 8 times the tooth's depth h_c;

of the lower-chord.

6.1.5 The setting and verification of the shear bolts shall comply with the following requirements:

1. The shear bolt shall be perpendicular to the axis of the upper-chord.

2. The shear bolts shall be subjected to the tensile verification of the net cross-section according to the provisions of clause 4.1.15 of this standard, the axial tension shall be determined by the following formula:

$$N_b = N\tan(60^\circ - \alpha) \qquad (6.1.5)$$

Where:

N_b - The axial tension of the shear bolt (N);

N - The design value of the axial pressure of upper-chord (N);

α - The angle between the upper-chord and lower-chord (°).

3. The design value of strength of the shear bolt shall be multiplied by an adjustment factor of 1.25.

4. The double-tooth connections should use two shear bolts of the same diameter, but the adjustment factors as specified in 7.1.12 of this standard are not considered.

6.2 Dowel-type fasteners

6.2.1 The minimum size of the end pitch, margin, spacing and line spacing of the dowel-type fasteners shall comply with the requirements of Table 6.2.1. When using bolts, pins or hexagonal timber screws as fasteners, the diameter shall not be less than 6 mm.

α - The angle between the load and the direction of grain.

4. When d < 6 mm, the compressive capacity of the dowel-groove f_e shall be determined as follows:

$$f_e = 115G^{1.81} \qquad (6.2.8\text{-}4)$$

5. When the dowel-type fastener is inserted into the end of the main member and parallel to the timber's grain direction of the main member, the compressive strength of the dowel-groove on the main member is taken as $f_{e,90}$.

6. The compressive strength of the fasteners on the steel is calculated according to 1.1 times the design value of the compressive strength of the dowel-groove of the bolt-connected member as specified in "Code for design of steel structures" GB 50017.

7. The compressive strength of the fasteners on the concrete members is calculated as 1.57 times the standard value of the compressive strength of the concrete cube.

6.2.9 When the penetration depth of the dowel-type fastener is less than 10 times the dowel's diameter, the length of the bearing surface shall not include the length of the tip portion of the dowel.

6.2.10 When three members which are mutually asymmetrical are connected, the design value Z_d of the bearing capacity of shear plane shall, based on the side member which has the minimum compressive length of the dowel-groove of the two side members as the calculation criteria, use the calculation of symmetrical connection to obtain the design value of the bearing capacity of the minimum shear plane, as the design value of the bearing capacity of the connected shear plane.

6.2.11 When four or more members are connected, each shear plane shall be calculated as a single-shear connection. The design value of bearing capacity of the connection shall take the result of the design value of the bearing capacity of the minimum shear plane multiplied by the number of shear planes and the number of dowels.

6.2.12 When the load in the single-shear connection is at an angle other than 90° from the axis of the fastener, the load component acting perpendicular to the axis of the fastener shall not exceed the design value of the bearing capacity of the shear plane of the fastener. For the load component which is parallel to the axis direction of fastener, it shall take reliable measures to meet the local pressure requirements.

C_{r1} - Deign value of shear-tension composite bearing capacity of truss plate along the l_1 direction (N/mm);

C_{r2} - Deign value of shear-tension composite bearing capacity of truss plate along the l_2 direction (N/mm);

l_1 - The length of the considered rod as covered by the truss plate along the l_1 direction (mm);

l_2 - The length of the considered rod as covered by the truss plate along the l_2 direction (mm);

V_{r1} - Design value of shear strength of the truss plate along the l_1 direction (N/mm);

V_{r2} - Design value of shear strength of the truss plate along the l_2 direction (N/mm);

T_{r1} - Design value of tensile strength of the truss plate along the l_1 direction (N/mm);

T_{r2} - Design value of tensile strength of the truss plate along the l_2 direction (N/mm);

θ - The angle between the axis of the bars (°).

6.3.10 The anti-sliding bearing capacity of the plate's teeth shall be calculated as follows:

$$N_s = n_s A \qquad (6.3.10)$$

Where:

N_s - The anti-sliding bearing capacity of the plate's teeth (N);

Ns - Design value of the anti-sliding strength of the plate's teeth (N/mm^2), which shall be valued according to the provisions of Appendix B of this standard;

A - The net cross-section of the truss plate's surface (mm2).

6.3.11 At the butt-joint of chord, when it needs considering the bending capacity of the truss plate, the design value of the bending capacity of the truss plate M_r shall be calculated according to the following formula:

7 Sawn and log timber structures

7.1 General requirements

7.1.1 Swan and log timber structures may use the following structural types:

1. CHUANDOU style timber structure;

2. TAILIANG style timber structure;

3. Log cabin;

4. Post and beam with shear wall construction;

5. Beam-column timber structure;

6. Mixed timber structure where it is used as a floor or roof in concrete structure, masonry structure, steel structure in a combination manner.

7.1.2 The swan and log timber structural members shall be either made of square timber or logs as stress-graded at construction site or in factory, or made by structural composite lumber and laminated log.

7.1.3 The horizontal force generated by seismic action or wind load shall be shared by the column, shear wall, floor, roof. The basic structural requirements for post and beam with shear wall construction may be implemented according to the relevant provisions of clause 9.1 of this standard.

7.1.4 The design of swan and log timber structure shall meet the following requirements:

1. Timber should be used for compressed or flexural members of the structure;

2. At the tensioned side of the flexural member, it shall have neither holes nor notches;

3. For timber species that are easy to warp during the drying process, when it is used to make truss, it should use the steel lower-chord; when using timber lower-chord, its span should not exceed 15 m for logs, not exceed 12 m for square timber, meanwhile it shall take effective measures to avoid cracking;

4. Timber roof should be externally drained; when it is internally drained, it shall not use timber gutter;

5. It shall ensure that the strength, rigidity, stability of timber members, especially steel-timber trusses, during transportation and installation. It should state the considerations in the work drawings:

6. The steel part of the timber structure shall have anti-rust measures.

7.1.5 In typhoon areas and mountainous wind opening areas that may cause disasters, the design of swan and log timber structures shall adopt effective measures to improve the wind-resistance of buildings and shall meet the following requirements:

1. It shall minimize the height and span of the skylight;

2. It shall use the short-cornice or closed-out. Except that the tile surface of the cornice shall be pressed by brick or ash, the tile surface of other parts should also be pressed by brick or ash;

3. The gable shall be a hard gable;

4. The connection between rafters and trusses or gables, trusses and walls or columns, door & window frames and walls shall take reliable anchoring measures.

7.1.6 When there are two or more different connection modes in the same node or joint of the structure, during calculation, it considers that only one type of connection transfers internal force, it shall not consider the joint work of multiple connections.

7.1.7 For the timber members in the truss structure, where it is symmetrically weakened, the net cross-sectional area shall be not less than 50% of the gross cross-sectional area of the members; where it is asymmetrically weakened, the net cross-sectional area shall not be less than 60% of the cross-sectional area of the member.

7.1.8 The diameter of round-steel tie-bar and tension bolt shall be determined by calculation, but it should be not less than 12 mm. The size of the square steel base-plate of round-steel tie-bar and tension bolt can be calculated according to the following formula:

1. Base-plate's area (mm^2)

$$A = \frac{N}{f_{ca}} \qquad (7.1.8\text{-}1)$$

2. Base-plate's thickness (mm)

7.2 Posts and beams

7.2.1 When the two ends of the timber beam are braced by the wall or the beam, they shall be calculated according to the flexural members simply-braced at both ends. The column shall be calculated as hinged at both ends.

7.2.2 The cross-sectional size of rectangular timber columns should not be less than 100 mm x 100 mm, meanwhile it shall not be less than the cross-sectional width of the column-braced members.

7.2.3 There shall be reliable anchorage between the bottom of the column and the foundation or the ground-beam which is fixed to the foundation. The contact surface between the timber column and the concrete foundation shall take measures to prevent corrosion and moisture. The bottom of the timber column on the ground floor shall be 300 mm above the outdoor ground plane. The anchorage between column and foundation may use the U-shaped flat steel, angle steel, column boot.

7.2.4 The minimum brace length of the beam on the support shall not be less than 90 mm, the beam and the brace shall be in close contact.

7.2.5 For the timber beam, it shall provide a lateral brace at the support to prevent it from rollover as well as a reliable anchor to prevent it from lateral displacement. When the beam is made of square timber, the cross-sectional aspect ratio should not be more than 4. For timber beams with an aspect ratio more than 4, it shall, based on the calculation results of the stable bearing capacity, take necessary measures to guarantee lateral stability.

7.2.6 For the timber beams and timber columns or steel columns at the support, it may use the U-shaped connector or connecting steel plate for connection. When the timber beams are connected to the masonry or concrete, the timber beams shall not be in direct contact with the masonry or concrete members, meanwhile it shall provide a damp-proof course

7.3 Walls

7.3.1 The walls of the swan and log timber structure shall be selected according to the following construction types:

1. The wall shall use the lightweight wall-panel as the filler wall, meanwhile it shall be directly connected to the timber-frame;

2. The timber-frame composite wall shall be made of wall-panel and dimension lumber, meanwhile it shall be directly connected to the timber-frame;

as the shear wall, the design value of shear capacity of the shear wall shall be calculated according to the following formula:

$$V_d = \sum f_{vd} l \qquad (7.3.5)$$

Where:

f_{vd} - The design value of the shear strength of the shear wall whose single-face uses wood-based structural panel as surface panel (kN/m), shall be determined according to the provisions of Appendix N of this standard;

l - The length of shear wall's limb parallel to the load direction (m).

7.3.6 Shear walls of the post and beam with shear wall construction shall comply with the following requirements:

1. The joints at both ends of the wall shall be provided with end-columns of not less than 105 mm x 105 mm;

2. When the thickness of the wood-based structural panel used in the wall is not less than 24 mm and the length of the wall is not less than 1000 mm, it shall provide columns or studs at the middle of walls;

3. When the thickness of the wood-based structural panel used is less than 24 mm and the length of the wall is not less than 600 mm, it shall provide stud at the middle of walls;

4. The wall-panels should be laid vertically. When they are laid laterally, it shall provide cross-brace at the joints of panels; the wall-panel shall be connected to the cross bracing, the stud or the column by nails;

5. The cross-sectional size of the stud shall be more than 30 mm x 60 mm, the cross-sectional size of the studs which are used for connection at the end of the wall shall be more than 45 mm x 60 mm.

7.3.7 When the post and beam with shear wall construction uses an exposed-column shear wall, the cross-sectional size of the stud and end-connecting column of the shear wall shall be more than 30 mm x 60 mm. The end-connecting columns shall be connected to the columns and beams by nails which have a diameter more than 3.40 mm, a length more than 75 mm, a spacing of less than 200 mm. When the thickness of the panel is not less than 24 mm, the diameter of the nail for fixing the end-connecting column shall be more than 3.8 mm, the length shall be more than 90 mm, the spacing shall be less than 100 mm.

7.3.8 The horizontal displacement of the top of the single-side-cladded shear wall which uses nail connection shall be calculated as follows:

$$\Delta = \frac{V_k h_w}{K_w} \qquad (7.3.8)$$

Where:

Δ - The horizontal displacement of the top of the shear wall (mm);

V_k - The standard value of horizontal shear undertaken by the top of the shear wall per meter (kN/m);

h_w - The height of the shear wall (mm);

K_w - The shear stiffness of the shear wall, which shall be valued according to the provisions of Table N.0.1 of the Appendix to this standard.

7.3.9 The cross-sectional form of the wall members of log cabin may be selected according to the provisions of Table 7.3.9. The cross-sectional width of the rectangular member should not be less than 70 mm, the height should not be less than 95 mm; the cross-sectional diameter of the circular member should be not less than 130 mm.

7.3.10 Except for the gable of the log cabin, the height of each floor should be not more than 3.6 m. It shall use the timber dowel or other means to connect the upper and lower layers of the horizontal members of the wall. The distance from the end-connecting point to the end of wall shall be not more than 700 mm, the spacing between the connection points at the same layer shall be not more than 2.0 m, meanwhile the connection points of the adjacent upper and lower layers shall be in staggered arrangement.

7.3.11 When using the timber dowel to make the upper and lower connections of the horizontal members, it shall use the square timber dowel which has a cross-sectional size of not less than 25 mm x 25 mm. At the connecting point, it shall reserve a round-hole on the member, the diameter of the round-hole shall be 3 mm ~ 5 mm less than the diagonal line of the cross-section of the timber dowel.

7.3.12 At the wall-corner and intersection of the log cabin, the intersected horizontal member shall be mutually overlapped by the use of the concave & convex wedges. The distance from the overlapping position of the concave & convex wedge to the end of the member shall be not less than the thickness of the timber wall, meanwhile it shall be not less than 150 mm. At the end of the overlapping position of the concave & convex wedge on the exterior wall, it shall use the through-height tightness-adjustable anchor bolt to strengthen it (Figure 7.3.1). In areas where the seismic fortification intensity is equal to 6 degrees, the diameter of the anchor bolts shall not be less than 12 mm; in areas where the seismic fortification intensity is more than 6 degrees, the diameter of the anchor bolts shall not be less than 20 mm.

3. The burial depth of the anchor bolt in the foundation shall be less than 300 mm. There shall be one anchor bolt at each end of each bedding timber, the end spacing shall be 100 mm ~ 300 mm.

7.3.18 At the door & window openings of the wall of log cabins, it should take effective measures to prevent deformation or damage of door & window due to settlement of wall. At the openings of walls without door & window, it shall take the reinforcing measures at the wall end to prevent the deformation of wall.

7.3.19 The load-bearing column in the log cabin shall be provided with a height-adjustable facility. There shall be a reliable connection between the roof member and the wall structure, meanwhile the connection shall have a sliding-adjustment function.

7.3.20 In the area where the seismic fortification intensity is 8 degrees, 9 degrees or where there is strong storm, the through-height tension-bolt and anchor-bolt of the log cabin's wall shall be tightly anchored to the concrete foundation.

7.4 Floors and roofs

7.4.1 The timber base-layer of the timber roof shall be composed of roof batten, roof panels, rafters, purlins and other members. During design, it shall, according to the waterproofing materials used in the roof, the requirements for the use of the house, the local meteorological conditions, select the different combinations of timber base-layer.

7.4.2 The verification of the flexural members in the timber base-layer of roof shall comply with the following requirements:

1. The strength shall be verified by the combination of constant load and live load, or combination of constant load and snow load, as well as the combination of constant load and concentrated construction load;

2. Deflection shall be verified by the combination of constant load and live load, or by combination of constant load and snow load;

3. Under the action of constant load and concentrated construction load, when verifying the bearing capacity during construction or maintenance phase, the design value of the strength of structural material shall be multiplied by the adjustment factor as specified in Table 4.3.9-1 of this standard.

7.4.3 For timber-framed houses which have forging hammers or other large vibration equipment, the roof should be provided with a roofing structural layer composed of wood-based structural panels.

purlin is laid obliquely, the aspect ratio of the cross-section shall not be more than 2, meanwhile it shall be calculated as the two-way flexural member. If there are reliable measures to eliminate or reduce the bending moment and deflection of the purlin along the roof direction, it can be calculated according to the situation after taking the measures.

7.4.9 When steel-timber purlin is used, it shall take measures to ensure lateral stability of the tensioned steel bar at the breaking point of lower-chord.

7.4.10 The rafters of the double-slope roof shall be firmly connected to each other at the ridge.

7.4.11 The seismic design of the timber base-layer of the roof in the area of seismic fortification intensity of 8 degrees and 9 degrees shall meet the following requirements:

1. **When using the obliquely-laid purlin, it shall provide the wood-based structural panel or densely-paved roof panels, the cornice tile shall be fixed on the roof battens;**

2. **The purlin shall be firmly connected to the roof truss, the double-ridge purlin shall be tied to each other, the purlin at the upper-chord's node shall be bolted to the upper-chord of the roof truss;**

3. **The purlins braced on the masonry gables shall have a bracing length of not less than 120 mm, the purlins at the nodes shall be bolted to the horizontal beam of gables.**

7.4.12 The roof members of the log cabin shall be fixed to the timber wall members by the use of bolts, nails or connectors.

7.4.13 The purlin at the following positions shall be anchored to the upper-chord of truss, it shall also be anchored to the horizontal beam of the gable, if any:

1. At the nodes of supports, including the purlin stressed, as shown in Figure 7.7.2 of this standard;

2. The brace points as required to ensure the lateral stability of the upper-chord of the truss;

3. At the ridge's node of the roof truss.

7.4.14 The anchoring method of the purlins may be selected according to the span of the house, the bracing method, the conditions of use, such as bolts, snap-plate (Figure 7.4.14), dowels or other reliable means. The laterally-braced diagonal bars of the upper-chord shall be anchored to the upper-chord of truss by bolts.

When steel-timber truss is used, it shall use the profile-steel lower-chord.

7.5.10 When there is a suspended-ceiling, it shall maintain a net spacing of not less than 100 mm between the lower-chord of truss and the suspended-ceiling members.

7.5.11 The seismic design of roof trusses in an area where the seismic fortification intensity is 8 degrees and 9 degrees shall comply with the following requirements:

1. Steel-timber truss should use the profile-steel lower-chord. The chord and web of the truss shall be fastened by bolts. All round-steel tie-bars and tension-bolts in the truss shall use double nuts;

2. The end of the truss shall be anchored to the walls and columns by anchor bolts of not less than Φ20.

7.5.12 When the truss's span is not less than 9 m, the bracing of truss shall be anchored to the wall and column by bolts. When the truss is connected to timber column, the legs of timber column shall be anchored to the foundations by bolts.

7.5.13 When designing a light roof of a timber roof for an open building, regardless of the size of the truss's span, it shall anchor the purlin at the node of upper-chord to the truss, the truss to the column, the timber column to the foundation, etc.

7.6 Skylights

7.6.1 The setting of skylights shall meet the following requirements:

1. When setting the double-sided skylight, the span of the skylight's frame shall not be more than 1/3 of the span of the truss;

2. The column of the single-sided skylight shall be placed at the node of the roof truss;

3. The load of the double-sided skylight should be shared by the ridge's node and its adjacent upper-chord's node, meanwhile it shall set the diagonal bar to connect the upper-chord of roof truss, to ensure the stability of the skylight's frame;

4. It should not install skylights between the open spaces at both ends of the house.

5. The column of the skylight shall be firmly connected to the upper-chord of the truss. When using the through-length timber splint, the splint should not be directly connected to the lower-chord of the truss (Figure 7.6.1).

1. The vertical pole of the support of the trapezoidal roof truss;

2. The breaking point of the sunken roof truss whose lower-chord is lower than the support;

3. The hanging rail where the hanging crane is provided;

4. The compressive parts of the arch and frame structure of rod series;

5. The support of the large-span beam.

7.7.4 The vertical bracing shall be set up according to the following requirements:

1. It shall, according to the size of the roof truss's span, provide one or two vertical bracings along the span direction;

2. Except for the structure where crane is installed, it may be provided in the first bay at both ends of the house without gables or in the second bay at both ends of the house with gables, but it shall provide the horizontal through-length tie-bars in the other bays;

3. For the structure where crane is installed, it shall be arranged at certain interval along the longitudinal direction of the house, meanwhile it shall provide the through-length longitudinal horizontal tie-bar of roof truss's lower-chord at the lower end of the vertical bracing;

4. For roofs where lateral bracing is provided at the upper-chord, when vertical bracing is added, it can be set only in the bay whose upper-chord has lateral bracing, but it shall provide the through-length longitudinal horizontal tie-bar of lower-chord in other bays.

7.7.5 The roof shall, according to the form and span of structure, the roof structure, load conditions, select the lateral bracing or vertical bracing of upper-chord. However, when the house has a larger span or otherwise is impacted by the vibration of forging hammer or crane, in addition to providing the lateral bracing of upper-chord, it shall also provide the vertical bracing. The cross-sectional size of the bracing member may be determined according to constructional requirements.

7.7.6 In the timber-column load-bearing house, if there is no rigid wall or shear wall of wood-based structural panel between columns, in addition to providing the through-length horizontal tie-bar at the top of column, it shall also provide the inter-column bracings at the both ends of house as well as along the longitudinal direction of house at the interval of 20 m ~ 30 m. It shall provide the wind-resistant diagonal bracing between the timber column and the truss. The upper end of the diagonal bracing shall be connected to the upper-chord's node

of the truss, the angle between the diagonal bracing and the timber column shall not be less than 30°.

7.7.7 For non-open houses in the following cases, it may not provide bracings:

1. There are densely-paved panels and gables, which have a span of not more than 9 m;

2. The house is a four-slope roof, meanwhile the half-roof is reliably connected to the main roof truss;

3. When the two ends of the roof are connected to other buildings which have higher rigidity; however, for the case where the longitudinal direction of the house is very long, it shall provide a bracing along the longitudinal direction at the interval of 20 m ~ 30 m.

7.7.8 When the roof truss is provided with double-sided skylight, it shall provide the skylight bracing according to the provisions of clauses 7.7.3 and 7.7.5 of this standard. At the columns at both sides of the skylight frame, it shall follow the provisions of clause 7.7.6 of this standard to provide the inter-column bracing, meanwhile at the ridge node and support node along the main roof truss within the range of skylight, it shall provide a through-length longitudinal horizontal tie-bar.

7.7.9 In the seismic areas, the setting of bracings shall meet the following requirements:

1. In the region where the seismic fortification intensity is 6 degrees and 7 degrees, the layout of bracings shall be according to this clause;

2. In the region where the seismic fortification intensity is 8 degrees, for the timber structure whose roof uses cold-paved tiles or sparsely-paved roof panels, regardless of the presence of vertical bracing, it shall provide one course of lateral bracing of upper-chord in the second bay at both ends of the house unit as well as the interval of 20 m;

3. In the region where the seismic fortification intensity is 9 degrees, for the timber structure whose roof uses densely-paved roof panels, regardless of the presence of vertical bracing, it shall provide one course of lateral bracing of upper-chord in the second bay at both ends of the house unit;

4. In the region where the seismic fortification intensity is 9 degrees, for the timber structure whose roof uses cold-paved tiles or sparsely-paved roof panels, in addition to providing one course of cross-bracing of upper-chord and cross-bracing of lower-chord in the second bay at both ends of the house unit as well as the interval of 20 m, it shall also provide the vertical bracing in rooms in an alternative manner, meanwhile add the through-

8 Glued laminated timber structures

8.0.1 Glued laminated-timber structure shall be divided into glued laminated timber structure and cross laminated timber structure. The glued laminated timber structure is suitable for single-floored or multi-floored timber structures which have large span and large space. The cross laminated timber structure is suitable for floor and roof structures, or otherwise the single-floored or multi-floored box-shaped timber-frame structure which is composed of the cross laminated timbers.

8.0.2 The fiber direction of each layer of timber of the glued laminated timber members shall be consistent with the length direction of the member. The number of layers of the lamina at the cross-section of the glued laminated timber members shall not be less than 4.

8.0.3 The fiber direction between different layers of lamina of the cross laminated timber member shall be mutually laminated and orthogonally intersected, the number of the lamina of the cross-section shall be neither less than 3 nor more than 9. The total thickness shall be not more than 500 mm.

8.0.4 When designing the glued laminated timber member and the cross laminated timber member, it shall indicate the requirements for the structural glues based on the environment of use, the member manufacturer shall strictly follow the requirements of design.

8.0.5 The design and construction requirements of the glued laminated timber member shall comply with the relevant provisions of the current national standard “Technical code of glued laminated timber structures” GB/T 50708.

8.0.6 The requirements for the manufacturing of the glued laminated timber member shall comply with the relevant provisions of the current national standard “Technical code of glued laminated timber structures” GB/T 50708 and “Structural glued laminated timber” GB/T 26899.

8.0.7 The sizes of the timber panels used to make cross laminated timber shall comply with the following requirements:

1. Thickness of lamina t is: 15 mm ≤ t ≤ 45 mm;

2. Width of lamina b is: 80 mm ≤ b ≤ 250 mm.

8.0.8 The cross laminated timber shall use the timber panels of the same length and thickness to form a lamina. The timber panel may be lengthened by the finger joint. The strength of the finger joint shall comply with one of the following formulas:

1. When following the relevant national test standard to carry out the verification test for the strength at the finger joint's node, the standard value of the flexural strength at the node shall be not less than the standard value of the flexural strength of the finger-jointed member as required by design;

2. When it does not carry out verification test for the strength at the finger joint's node of the member, the design values of the flexural strength and tensile strength of the member at the node of finger joint may be valued as 67% of that of the member without finger joint, the design value of the compressive strength may be same as that of the member without finger joint.

8.0.13 When the cross laminated timber is glued, the surface of the timber panel shall be smooth, free from dust, impurities, contaminants or other exudates that affect the bond. After the glue is applied to the lamina, it shall be pressure-bonded within the time specified by the adhesive used. The glued surface shall not be contaminated before being laminated.

8.0.14 The splicing surface between the outer timber panels parallel to grain at the same layer of the cross laminated timber should be glued by the use of adhesive. The splicing surface between the inner timber panel parallel to grain of the same layer and the timber panel perpendicular to grain of the same layer may be spliced, but the splicing joint shall not exceed 6 mm.

8.0.15 Adhesives used in cross laminated timber shall meet the requirements of strength and durability. The type and performance requirements of adhesives shall comply with the current national standards "Technical code of glued laminated timber structures" GB/T 50708 and "Structural glued laminated timber" GB/T 26899.

9 Light wood frame construction

9.1 General requirements

9.1.1 The number of floors of light wood frame construction shall not exceed 3. For a composite building whose superstructure uses the light wood frame construction, the number of floors of wood structure shall not exceed 3, meanwhile the total number of floors of this building shall not exceed 7.

9.1.2 The plane layout of the light wood frame construction shall be regular, the change of mass and stiffness shall be uniform. All members shall have a reliable connection, necessary anchoring, bracing, sufficient bearing capacity, to ensure the rigidity of the normal use of the structure as well as good integrity.

9.1.3 Members and connections shall, according to the selected tree species, material grade, action load, connection form, relevant size, be designed according to the relevant clauses of this standard.

9.1.4 When verifying the connection strength and local compression at the joint between the roof and the substructure, the uplift force caused by the wind load shall be multiplied by a factor of 1.2.

9.1.5 Shear walls of light wood frame construction shall withstand all shear forces resulting from seismic or wind loads. The horizontal shear force undertaken by each shear wall may be distributed according to the area distribution method and the stiffness distribution method. When distributed according to the stiffness distribution method, the horizontal shear force of each wall may be calculated as follows:

$$V_j = \frac{K_{wj} L_j}{\sum_{i=1}^{n} K_{wi} L_i} V \qquad (9.1.5)$$

Where:

V_j - The horizontal shear force undertaken by the j^{th} shear wall;

V - The total horizontal shear force in the X-direction or Y-direction of floor produced by seismic or wind loads;

K_{wi}, K_{wj} - The shear stiffness per unit length of the i^{th} and j^{th} shear wall, which shall be adopted according to the provisions of Appendix N of this standard;

L_i, L_j - The length of the i^{th} and j^{th} shear walls; when the wall opening's size

floor and roof (kN/m), generally taking half of the lateral uniformly-distributed load q;

L - The length of the floor and roof perpendicular to the load direction (m);

l - The size of opening perpendicular to the load direction (m), which shall be neither more than B/2 nor more than 3.5 m.

9.2.7 For the boundary bars of the floor and roof parallel to the load direction, when the shear force which actions above and below the boundary bars is different, it shall verify the axial force of the boundary bars.

9.2.8 The boundary bars in the length range of the floor and the roof should be continuous; where it is disconnected at the middle, it shall take the connection-reinforcing measures which can withstand the axial force applied. The covering panel of floor and roof shall not be used as the connecting plate of the boundary bars.

9.2.9 When the boundary bars of the floor and roof are subjected to the axial force as well as the vertical force transmitted by the floor and roof, the bars shall be designed as compression-flexure member or tension-flexure member.

9.3 Walls

9.3.1 The stud shall be designed as a compressive member which are hinged at both ends. The calculated length of the member outside the plane shall be the length of the stud. Where wood-based structural panel or gypsum board are arranged at both sides of the stud as the covering panels, it may carry out strength verification only within the plane.

9.3.2 When the initial eccentricity of the axial pressure of the stud is zero, the initial eccentricity shall be determined as 0.05 times the member's cross-sectional height.

9.3.3 For the studs of exterior wall, it shall consider the combination of wind load's effects, be designed as the compression-flexural member as hinged at both ends. When the enclosing materials of exterior wall use heavier materials such as brick or stone, it shall consider the seismic action outside the stud's plane as generated by the enclosing materials.

9.3.4 Shear walls of light wood frame constructions shall be designed according to the following provisions:

1. The aspect ratio of the limb of the shear wall shall not be more than 3.5.

2. The design value of the shear capacity of the light-weight timber shear

9.4.2 The truss's static calculation model shall meet the following conditions:

1. The chord shall be a multi-span continuous rod;

2. The chord shall use hinged node at the ridge's node, the slope-changing node, the butt-jointed node;

3. When the chord's butt-jointed node is used for bending resistance, it shall be the rigid-jointed node;

4. The nodes at both ends of the web shall be hinged nodes;

5. The end of the truss which connects the substructure shall be a fixed hinge and the other end shall be a movable hinge.

9.4.3 The calculation assumption of the corresponding nodes of various categories in the truss design model shall be according to the relevant provisions of the current industry standard "Technical code for light wood trusses" JGJ/T 265.

9.4.4 When designing the frame member, the values of the axial force and bending moment of each bar shall comply with the following requirements:

1. The axial force of the bar shall take the average value of the axial force at both ends of the bar;

2. The segmental bending moment of the chord shall take the maximum bending moment that the segment is subjected to;

3. For tension-flexural or compression-flexural bars, the axial force shall take the average value of the axial force at both ends of the bar. The bending moment shall be the bending moment at the mid-span of bar or the bending moment at both ends, whichever is larger.

9.4.5 When verifying the stability of the truss's compressive members, the calculated length l_0 shall comply with the following provisions:

1. Within the plane, it shall take 0.8 times the central spacing of the node;

2. Outside the plane, it shall take the distance between the connection points of the upper-chord and the adjacent purlin for the upper-chord of truss, or the central distance of node for the web. If the lower-chord is compressed, the calculated length shall take the distance between the lateral bracing points.

9.4.6 When the number of identical trusses is more than or equal to 3, the spacing between trusses is not more than 610 mm, all trusses are reliably connected to the floor panel or roof panel, the design value of flexural strength

n - Number of trusses that make up the composite truss;

s - The spacing of the nail connections (mm);

n_r - The number of rows of nails;

q - The average linear load acting on the composite truss (N/mm).

9.4.10 The connection of the timber truss to the substructure shall comply with the following provisions:

1. When the timber truss is not subjected to the uplifting force, the timber truss and the substructure shall be connected by nails. The number of nails shall not be less than 3, the length of the nail shall not be less than 80 mm. The timber trusses at the end of the roof and on both sides of the opening should be connected by metal connectors, the spacing shall not exceed 2.4 m.

2. When the end of the timber truss is subjected to the uplifting force, at a distance of not more than 2.4 m, there shall be a metal uplifting connector to connect each timber truss and the substructure.

9.5 Design of hybrid light wood frame construction

9.5.1 The seismic design of composite buildings should adopt the mode-decomposition reaction spectrum method. When the ratio of the average lateral-stiffness of the bottom structure to the average lateral-stiffness of the upper adjacent timber structure is more than 10, meanwhile the basic natural vibration period of the overall structure is not more than 1.1 times the basic natural vibration period of the upper timber structure, the upper timber structure and the lower timber structure can be separately subjected to seismic calculation by the bottom shearing method. When verifying the substructure, it shall consider the shear action from the bottom of upper timber structure.

9.5.2 For the multi-floored civil buildings which use the light timber roof, the seismic action of the main structure shall comply with the relevant provisions of the current national standard “Code for seismic design of buildings” GB 50011. The timber roof can be used as the top-floor mass point which actions to the support of truss. The equivalent gravity load of the top-floor mass point may take the sum of the representative value of the gravity load of the timber roof and 1/2 of the representative value of the gravity load of wall. For other mass points, it may take 85% of the representative value of gravity load. The horizontal load which actions onto the light timber roof shall be determined as follows:

Figure 9.5.3 -- Schematics of timber roof used as lateral-bracing of wall

1 - Connection of boundary nail; 2 - Pre-embedded tie-bar; 3 - Structural composite panel; 4 - Hanging member of joist; 5 - End-closing joist; 6 - Pre-embedded rebar; 7 - Joist

9.6 Detailing requirements

9.6.1 The stud shall meet the following requirements:

1. The cross-sectional size of the stud of the load-bearing wall shall be determined by calculation;

2. The stud shall be continuous in the floor height, it may use finger joint, but it shall not be connected by connecting plate;

3. The spacing of the studs shall not exceed 610 mm;

4. The stud shall be strengthened at the corner and junction of the wall, the number of studs at the corner shall not be less than 3 (Figure 9.6.1);

5. For the walls whose opening width is more than the spacing of the studs, the studs at both sides of opening shall use double studs. For the walls whose opening width is less than or equal to the net spacing of the studs and the opening is located between the studs, it may use the single stud at both sides of opening;

6. The minimum cross-sectional size and the maximum spacing of the studs shall comply with the provisions of clause B.2 of Appendix B of this standard;

7. For door openings of non-load-bearing walls, when it needs to consider the requirements of fire endurance of wall, it shall use at least two dimension lumbers whose cross-sectional height is same as the width of the bottom-beam slab aside the door opening to strengthen it.

(a) Joist's cross-bracing **(b) Diagonal-bracing**

Figure 9.6.8 -- Schematics of inter-joist bracings

1. For the end-closing joists that are around the opening and perpendicular to the joists, when the length is more than 1.2 m, it shall use two pieces of end-closing joists; when the length is more than 3.2 m, the size of the end-closing joist shall be determined by calculation.

2. For the side-closing joists that are around the opening and parallel to the joists, when the length of the end-closing joists exceeds 800 mm, it shall use two pieces of side-closing joists; when the length of the end-closing joist exceeds 2.0 m, the cross-sectional size of the side-closing joist shall be determined by calculation.

3. For the end-closing joists around the opening and the joists which are cut by the opening, when relying on the floor joist's bracing, it shall select appropriate metal joist bracket or use correct nail connection.

9.6.10 The floor joists which brace the wall shall comply with the following requirements:

1. Non-load-bearing walls parallel to the joists shall be located on the joists or the cross-bracing between the joists. The cross-bracing can be made of dimension lumbers which have a cross-sectional size of not less than 40 mm x 90 mm, the spacing of the cross-bracings shall not exceed 1.2 m;

2. The load-bearing interior-wall parallel to the joist shall not be braced on the joist but braced on the beam or wall;

3. The non-load-bearing interior-wall perpendicular to the joist or at an angle almost perpendicular to the joist may be at any positions on the joists.

4. The load-bearing interior-wall perpendicular to the joist shall not be more than 610 mm from the joist's support. Otherwise, the size of the joist shall be determined by calculation.

9.6.11 For the cantilevered floor joists, when the cross-sectional size is 40 mm x 185 mm, the overhang length shall not exceed 400 mm; when the cross-sectional size is not less than 40 mm x 235 mm, the overhang length shall not be more than 610 mm. Uncalculated overhanging portion of joists shall not be subjected to other loads.

When the cantilever joist is perpendicular to the main joist, the length of the non-overhanging portion shall not be less than 6 times the length of the overhanging portion, the end portion shall be connected to the two side-frame

shall be not less than 50 mm;

2. It is allowed to make notch on the joist, but the notch shall be located on the top surface of the joist. The distance from the notch to the edge of support shall not be more than 1/2 of the cross-sectional height of the joist, the height of notch shall be not more than 1/3 of the cross-sectional height of the joist;

3. The remaining height of the stud of the load-bearing wall after making opening or notch on the cross-section shall not be less than 2/3 of the cross-sectional height. It shall be not less than 40 mm for the non-load-bearing wall;

4. The remaining width of the top-beam panel of wall after making opening or notch shall not be less than 50 mm;

5. Unless otherwise specified by design, it shall not arbitrarily make opening or notch on the roof truss members.

9.6.19 The bracing length of the beam on the support shall not be less than 90 mm, the surface of the support shall be flat, the beam and the support shall be in close contact.

9.6.20 The split-section beam made by multiple dimension lumbers through nail connections (Figure 9.6.20) shall comply with the following requirements:

1. The butt-joint position of the single dimension lumber in the split-section beam shall be located at the support of the beam.

2. When the split-section beam is a continuous beam, the butt-joint position of a single dimension lumber in the beam shall be within 150 mm of 1/4 beam's net span from the support. The adjacent single dimension lumber shall not be butt-jointed at the same position. The number of the butt-jointed dimension lumbers shall not exceed half of the total number of dimension lumbers of split-jointed beam. There shall be not more than one joints of the same dimension lumber within the same span, meanwhile re-butt-joint shall not be allowed in the adjacent span which has joint. It shall not allow butt-joint in the side-span.

3. When the split-section beam is composed of 40 mm wide dimension lumbers, it shall use two rows of nails in equal arrangement along the beam's height direction to connect the dimension lumbers, the nail's length shall be not more than 90 mm, the nail's spacing shall be not more than 450 mm, the nail's end spacing shall be 100 mm ~ 150 mm.

4. When the split-section beams are connected by the 40 mm wide dimension lumbers through bolts, the bolt's diameter shall not be less than

2. When the split column is bolted, the connection of the split column shall meet the following requirements:

1) It shall use the metal gasket between the dimension lumber and the nut. After tightening the nut, the dimension lumbers shall be in close contact with each other;

2) The spacing between bolts along the length direction of column shall be neither more than 6 times the thickness of a single dimension lumber nor less than 4 times the bolt's diameter. The bolt's end spacing shall be more than 7d and less than 8.5d;

3) When the width of a single dimension lumber in the split column is more than 3 times its thickness, it shall provide at least two rows of bolts in the width direction;

4) When providing two or more rows of bolts along the width direction of column, the row-spacing of bolts shall be neither less than 1.5d nor more than 10d; the margin shall be neither less than 1.5d nor more than 10d.

9.6.22 The ground-beam panel as connected to the top surface of the foundation shall be anchored to the foundation by the use of anchor bolts which have a diameter of not less than 12 mm, the spacing shall not exceed 2.0 m. The burial depth of the anchor bolt in the foundation shall not be less than 300 mm. There shall be one anchor bolt at each end of each ground- beam panel, the end spacing shall be 100 mm ~ 300 mm.

9.6.23 The wall of light wood frame construction shall be braced on the concrete foundation or the concrete ring beam on the top surface of the masonry foundation. The top surface mortar of the concrete foundation or ring beam shall be flat, the slope shall not exceed 2‰.

10.1.9 For the construction materials used in timber structures, the technical indicators of their combustion performance shall comply with the provisions of the current national standard “Classification for burning behavior of building materials and products” GB 8624.

10.2 Construction details of fire protection

10.2.1 In light timber structures, the following areas with confined spaces shall use the continuous fire separation measures:

1. When the floor height is more than 3 m, except that the top-beam panel or bottom-beam panel at each floor and roof may be used as vertical fire separation, it shall, at the interval of 3 m along the wall height, provide the vertical fire separation between the studs. When the floor height is less than or equal to 3 m, the top-beam panel or bottom-beam panel at each floor and roof may be used as the vertical fire separation.

2. It shall provide horizontal fire separation within the floor and roof, the length or width of the horizontal compartment shall be not more than 20 m, the area of the compartment shall be not more than 300 m^2.

3. It shall provide the fire separation at the joint between the horizontal members of the roof, the floor, the suspended-ceiling and the vertical members of the wall.

4. It shall provide the fire separation at the junction between the first step of stair in both the downwards and upwards directions and the floor.

10.2.2 When the fire separation is set for the light wood frame construction, the fire separation may be made of the following materials:

1. Dimension lumber which has a cross-sectional width of not less than 40 mm;

2. Gypsum board which has a thickness of not less than 12 mm;

3. Laminated panel or oriented timber panel which has a thickness of not less than 12 mm;

4. Steel plate which has a thickness of not less than 0.4 mm;

5. Inorganic reinforced cement board which has a thickness of not less than 6 mm;

6. Other materials that meet fire protection requirements.

10.2.3 When the pipeline penetrates the timber wall, it shall use the fireproof

sectional thickness of not less than 40 mm as an additional fire protection course on the surface;

3. Wrap the beam-column joint in a wall which has a fire resistance of 1.00 h;

4. Use the refractory gypsum plaster board which has a thickness of more than 15 mm for separative protection at the beam-column joint.

10.2.7 The laying of the power distribution lines in timber structural buildings shall use the following fireproof measures:

1. Fire-fighting power distribution lines shall be made of flame-retardant and fire-resistant wires, cables or mineral-insulated cables;

2. Power supply trunk lines for important timber structure public buildings shall be made of mineral-insulated cables;

3. When the wires and cables are laid in an exposed manner, they shall pass through the metal tube or metal raceway for protection; when using the mineral-insulated cables, they may be laid directly in an exposed manner;

4. When wires or cables penetrate walls, floors, or roofs, they shall pass through metal sleeves, meanwhile it shall use the fireproof sealing materials to plug the gaps.

10.2.8 Switches, sockets, junction boxes installed on timber members shall comply with the following requirements:

1. When the switch, socket, junction box are protected by a metal sleeve, it shall use the metal box;

2. When the switch, socket, junction box are protected by mineral wool, it may use the flame-retardant box;

3. When installing on the timber-frame wall, on the two lateral panels between the two adjacent timber studs in the wall, it shall install the switch, socket, junction box on only one side; when the design requires providing switches, sockets, junction boxes at the two lateral panels between the two adjacent timber studs in the wall, it shall take local fire separation measure shall be taken.

10.2.9 The lighting fixtures installed on the floor, roof, suspended-ceiling of timber structure shall use metal box, meanwhile it shall use the gypsum board which has a fire endurance of not less than that of the wall or floor or roof at the location where it is located to realize separative protection for the metal box.

10.2.10 When the fluid in the pipeline causes the outer-wall temperature of the

likelihood and consequences of a lightning accident.

2. Timber structure buildings should use the lightning-protection nets or lightning-protection belts installed on the roof as lightning arresters for direct lightning protection. All metal members protruding from the roof shall be reliably welded to the lightning protection devices.

3. The downlead should be laid along the exterior wall of the timber structure building by the use of exposed clips, it shall also set connecting clip 1.8 m above the outdoor floor, there shall be obvious mark at the position of connecting plate. When the downlead is laid in the wall in a concealed manner, it shall use the insulated sleeve for protection.

4. A segment of grounding wire from 1.7 m above the ground to 0.3 m below the ground shall be protected by a modified plastic tube or a rubber tube.

5. The distance between the indoor cable, the conductor and the lightning-protection downlead shall not be less than 2.0 m.

10.2.16 For the laminated timber member, when it considers the requirements for fire endurance, the lamina assembly shall, in addition to complying with the requirements of the strength design of the member, also comply with the following requirements of fireproof construction:

1. For laminated timber members which have a fire endurance of 1.00 h, when the members are asymmetrical non-equivalent combination, it shall reduce one layer of middle lamina from the tensioned side, meanwhile it shall add one layer of surface tension lamina. When the members are symmetrical non-equivalent combinations, it shall reduce one layer of middle lamina from each of the upper side of lower side, meanwhile it shall add one layer of surface tension lamina for each. During design of a member, the design value of strength shall be determined according to the combination of the unchanged lamina.

2. For the laminated timber members which have a fire endurance of 1.50 h or 2.00 h, when the members are asymmetrical non-equivalent combination, it shall reduce two layers of middle lamina from the tensioned side, meanwhile it shall add two layers of surface tension lamina. When the members are symmetrical non-equivalent combinations, it shall reduce two layers of middle lamina from each of the upper side of lower side, meanwhile it shall add two layers of surface tension lamina for each. During design of a member, the design value of strength shall be determined according to the combination of the unchanged lamina.

whose net thickness should be above 10 mm. The effective clearance shall be not less than 70% of the total clearance of the water-drainage ventilated air-layer; it shall provide a continuous fly net at the openings of gap.

11.2.5 It shall take such effective measures as drainage, waterproof, moisture proof around the concrete foundation, insider the basement and the overhead floor, to prevent moisture invading from ground. Between the timber member and the concrete member, it shall pave moisture-proof membrane. The height difference between the indoor and outdoor floor of the building shall be not less than 300 mm. When the bottom floor of building uses timber floor, the height from the bottom of the timber member to the outdoor floor shall be not less than 300 mm.

11.2.6 The timber structure building should use pitched roof. In the roof space, it should provide ventilation holes. When using natural ventilation, the total area of the ventilation holes shall be not less than 1/300 of the area of the thermally-insulated suspended-ceiling. Ventilation holes shall be evenly-arranged, it shall take measures to prevent insects or rainwater from entering.

11.2.7 Exterior walls and non-ventilated roofs shall be designed to reduce internal condensation of steam and to promote moisture emissions. In freezing cold and cold regions, the inner side of the exterior wall and the non-ventilated roof shall have a lower vapor-permeability; in areas where it is hot in summer and warm in winter as well as the hot areas, the outer side shall have a lower vapor-permeability.

11.2.8 It shall take structural measures for waterproof, moisture-proof, drainage at the openings of door & window, roof, opening on exterior wall, roof terrace, balcony, etc. It shall make effective use of the flooding materials to promote local drainage. The final slope of the outward-sloped flashing plate shall not be less than 5%. The final drainage slope of the roof terrace and balcony floor shall not be less than 2%.

11.2.9 Waterproof and moisture-proof measures for timber structures shall be set as follows:

1. **When the trusses and girders are braced on masonry or concrete, it shall provide a moisture barrier under the support of trusses and girders;**

2. **The support node of truss and girder or other load-bearing timber members shall not be enclosed in the wall or thermal-insulation layer;**

3. **The bottom of the timber column as braced on the masonry or concrete shall be provided with a base-plate. It is strictly forbidden to directly pave the timber column into the masonry or pour it into the concrete;**

the foundation soil;

3. When excavating the foundation, it shall thoroughly remove the stumps, roots and other timber buried in the soil;

4. All timber formwork, waste timber, paper products and other organic waste generated during construction shall be cleaned up in time during construction or after completion;

5. All timber, other forest products, soil and greening trees entering the site shall be quarantined for termites. During construction, it shall not use any materials infected with termites;

6. It shall follow the design requirements to implement other measures to prevent and control termites.

11.3.3 When the timber structure buildings are located in the area of the termite hazardous zone Z3 and Z4, the termite-proof design of the timber structure building shall comply with the following provisions:

1. The foundation and exterior wall in direct contact to soil shall use the concrete or brick-stone structure; the width of gap occurred in the foundation and exterior wall shall be not more than 0.3 m;

2. Where there is no basement, the ground floor shall use concrete structure and it should use the integrally-poured concrete floor;

3. For the gap of equipment cable leading from underground to indoor, the gap of openings for pipeline, the joint between the top surface of foundation and the concrete terrain of bottom-floor, it shall use the anti-termite physical barrier or a soil chemical barrier for local treatment;

4. It shall provide a continuous insect net shall be provided at the opening of the water-drainage ventilated air-layer of the exterior wall, the bore-diameter of the insect screen shall be less than 1 mm;

5. The outer drainage layer or the outer thermal-insulation layer of the foundation should not be higher than the outdoor floor, otherwise it shall be subjected to local anti-termite treatment.

11.3.4 In areas where the termite hazardous zone is grade Z3 and Z4, it shall use the anti-termite soil-chemical treatment and termite-bite system or other insect control measures. The anti-termite physical barrier or a soil chemical barrier shall use the chemical agents that are harmless to human body and environment.

11.4 Wood preservation

11.4.1 The anti-corrosion and anti-insect construction measures adopted for timber structures shall be indicated in the design drawings.

11.4.2 All timber members used outdoors or in direct contact with the soil shall be preservative timber. Under the conditions of not being in direct contact to soil, it may use other durable timber or durable timber products.

11.4.3 When the timber members are in direct contact with the concrete or masonry, the timber members shall be made of preservative timber.

11.4.4 When the load-bearing structure uses Pinus massoniana, Pinus yunnanensis, Pinus elliottii, birch, meanwhile it is located in a place that is prone to decay or susceptible to insect, it shall use the preservative timber.

11.4.5 In areas where the termite hazardous zone is grade Z4, the timber structure building should use the preservative timber which has the termite-proof function.

11.4.6 The mechanical processing of timber members shall be carried out before the antiseptic and insect-repellent treatment. After being subjected to antiseptic and insect-repellent treatment, it shall avoid the timber members from cut or drilling again. Due to technical reasons, if it is necessary to make local trimming, the exposed surface of timber shall be coated with sufficient chemical agents of the same brands or same types.

11.4.7 When metal connectors, truss plates and screws are in contact with timber treated by copper-contained preservatives, metal connectors, truss plates and screws shall be protected from corrosion by preservatives, meanwhile it shall use the hot-dip galvanizing or stainless-steel products.

11.4.8 Formulations and technical indicators of antiseptic and insect-repellents shall comply with the relevant provisions of the current national standard “Wood preservatives” GB/T 27654. Under no circumstances shall an unqualified chemical agent be used. The classification and requirements for the use of preservative timber shall comply with the relevant provisions of the current internal standard “Use category and specification for preservative-treated wood” GB/T 27651.

11.4.9 When the timber structure uses the chemical-agent pressurized-treatment for anti-corrosion and insect-repellency, the retaining amount and penetration of the chemical agent in the timber shall meet the requirements as specified in the design documents. If it is not specified in design, it shall comply with the relevant provisions of the current national standard “Code for acceptance of construction quality of timber structures” GB 50206.

Appendix C

Requirements for inspection & maintenance of timber structures

C.0.1 Timber structure work shall be thoroughly inspected prior to delivery for use. It shall focus inspecting the following items:

1. The member's support node and the member's connection node shall be inspected one by one; any loose bolts shall be tightened;

2. Whether the arching position and height of the beam and truss with larger spans are consistent with the design;

3. All round-steel tie-bars and bolts shall be inspected one by one. Any loose bolts shall be tightened. Check whether the threaded portion is normal, whether the net area of the thread is excessively weakened, whether there are anti-rust measures.

C.0.2 Within two years after the project is delivered, the owner or property management department shall arrange a routine inspection every year based on the local climate characteristics before and after the snow season, rainy season and wind season. Inspections after two years may be arranged based on actual conditions, but the time interval for routine inspections shall not exceed 5 years.

C.0.3 The items for routine inspection shall focus on the following items:

1. Whether the timber truss's support node is damped, corroded or worm-damaged; whether the gutter and the skylight are leaking or poorly drained; whether there is pull-off at the lower-chord's joint of the timber truss, whether there is a crack near the screw hole of the splint.

2. Whether the timber truss is obviously drooped or inclined; whether the tie-bar is rusted, whether the nut is loose, whether the base-plate is deformed.

3. Whether the timber in the member's support and connection is damped or decayed.

4. Whether the connection nodes between members are loose. When the metal connector is used, whether the fixing nut is loose, whether the metal member shows signs of chemical attack.

5. Whether there any serious corrosion on the surface of the truss plate of the light timber truss, whether the truss plate is loose or falling off.

6. For timber members that are exposed outdoors or often in a humid

Appendix F

Determination of characteristic values for manufactured structural timber

F.0.1 This Appendix is applicable to the determination of the standard value and design index of strength of structural timber that have not been included in the strength design index of this standard and are scale-produced in factory.

F.0.2 The structural timber scale-produced in the factory shall include the following timber products:

1. Structural composite timber

1) Laminated veneer lumber (LVL);

2) Parallel strand lumber (PSL);

3) Laminated strand lumber (LSL);

4) Oriented strand lumber (OSL);

5) Other composite timber products of other similar features;

2. Visually stress-graded or machine stress-graded dimension lumber of domestic tree species;

3. I-shaped timber joists.

F.0.3 The manufacturer of the structural timber shall establish a quality assurance system for the production of the product, which shall be certified by a third-party quality appraisal institute and accept its monitoring of the production process.

F.0.4 Each type of product of structural timber shall be tested according to the test methods as specified by the relevant national standards, to determine its standard value f_k and design value f of the flexural strength, modulus of elasticity, tensile strength parallel to grain, compressive strength parallel to grain, compressive strength perpendicular to grain, shear strength.

F.0.5 When testing the strength parameters of structural timber, the test pieces shall be sufficiently representative, various factors affecting the bearing capacity of the members shall be tested separately.

F.0.6 For each factory producing structural materials, it may, according to their own production capability and product needs, determine the test of a certain

Appendix H

Names of timber and main characteristics of common species in this standard

H.1 The name of the timber used in this standard

H.1.1 The name of the classified timber shall be adopted as follows:

1. Chinese timber:

1) Northeast larch includes two types: Xing'an larch and L. olgensis (Changbai larch);

2) Hemlock includes Tsuga spp., T. dumosa, T. forrestii;

3) Spruce includes P. brachytyla, P. brachytyla/var. complanata, P. neoveitchii, P. purpurea and P. Asperata produced from west of Sichuan;

4) Northwest spruce includes the P. purpurea and P. Asperata produced from Gansu and Qinghai

5) Red pine includes red pine, P. armandi, P. kwangtungensis, P. Taiwanensis, P. fenzeliana

6) Fir includes abies timber produced from different regions, including A. delavayi, A. fabric, A. faxoniana, A.holophylla, A. Nepheolepis, A.georgei

7) Oak includes Q. acutissima, Q. Aliena, Q. monolica, quercus chenli, Q. Liaotungensis, Quercus glandulifera, Q. variabilis;

8) Oriental white oak includes oriental white oak, Quercus myrsinifolia, C. Bambusaefolia, C. myrsinaefolia, Panke cyclobalanopsis, C. glaucoides, C. Chungii, C. delavayi, etc.;

9) Lithocarpus spp. includes L. longipedicellatus, L. cleistocarpus, L. dealbatus, etc.;

10) Castanea henryi includes Castanopsis spp., C. carlesii, C. sclerophylla, C. fabri, Catanopsis megaphylla, C. fargesii, C. fordii, C. delavayi, Castanopsis kawakamii, C. Eyrei, etc.;

11) Birch includes B. platyphylla, Betula costata, B. alnoide, B. Dahurica

2. Imported timber:

1) Douglas fir-larch includes P. menziesii and L. occidentalis;

Table H.2.2 (continued)

No.	Timber	Tree species	Division	Main origin	Key points of timber identification	Basic characteristics and main processing properties of timber
3	Castanopsis spp.	C. carlesii, C. fabri, C. fargesii, C. Fissa, C. indica	Fageceae	Fujian, Zhejiang, Jiangxi, Guangdong, Hainan, Guangxi, Hunan, Hubei, Guizhou, Sichuan, Tibet, Taiwan	The timber is light reddish brown or light yellowish red, the timber-core is not distinct from the timber-side. It has gloss but no special taste or odor. The growth ring is slightly obvious. It is a ring-porous timber. It changes sharply from early-wood to late-wood. The axial thin-walled texture is in large amount and obvious in magnifying glass, mainly in star-scattered - concentrated and pipe strip shape. It has wide radial and narrow radial	The air-dry density is about 0.5 g/cm^3 ~ 0.59 g/cm^3. The strength is low or moderate, it is not corrosion-resistant. The dry-shrinkage is small or moderate, it is easy to crack, deform, shrink-wrinkling. The crack may penetrate the entire log. It is easy to work, it has low nail-holding capacity, is easy to bond
4	Castanopsis spp.	C. concinna C. fordii C. hystrix	Fagaceae	Fujian, Guangdong, Jiangxi, Guangxi, Hunan, Zhejiang, Guizhou, Yunan, Tibet	The timber-side is dark reddish brown and distinct from the timber-core. The timber-core is red brown, reddish brown or brick-red. It has gloss but no special taste or odor. The growth ring is slightly obvious. It is a ring-porous timber or semi-ring-porous to diffuse-porous timber. It has thylose. It changes slightly-gradually from early-wood to late-wood. For the axial thin-walled texture, the wet-cutting plane is visible in magnifying glass, in apotracheal banded shape and similar-paratracheal shape. It generally has narrow wood-radial	The air-dry density is about 0.73 g/cm^3. The strength is moderate, it is strong in corrosion-resistance. The dry-shrinkage is moderate, it is hard to dry. It is slightly cracked. It has moderate and high nail-holding capacity, is easy to bond. It has inclined texture; the structure is fine to moderate

Table H.2.2 (continued)

No.	Timber	Tree species	Division	Main origin	Key points of timber identification	Basic characteristics and main processing properties of timber
9	Lithocarpus spp.	L. dealbatus L. glaber L. longipedicellatus	Fagaceae	Guangdong, Guangxi, Yunnan, Guizhou, Fujian, Zhejiang, Hainan	The timber-side is grey-red brown or light-red brown, and distinct from the timber-core. The timber-core is reddish brown or reddish brown with purple. The growth ring is slightly obvious or not obvious. It is a diffuse-porous timber, occasionally with thylose. The axial thin-walled texture is in large amount, visible to obvious in magnifying glass, mainly in apotracheal banded shape. The wood radial includes wide radial and narrow radial	The air-dry density is about 0.65 g/cm^3 ~ 0.91 g/cm^3. The strength is moderate, it is not corrosion-resistant. The dry-shrinkage is moderate, it is hard to dry. It is not hard to work; the cutting plane is smooth. It has high nail-holding capacity, is easy to bond. It has inclined texture; the structure is moderate and uniform
10	Lithocarpus spp.	L. cleistocarpus L. fenestratus	Fagaceae	Guangxi, Guangdong, Hunan, Jiangxi, Fujian, Guizhou, Yunnan, Sichuan, Tibet	The timber-side is light grey-red brown or dark brown, and not obviously distinct from the timber-core. The growth ring is not obvious. It is a diffuse-porous to semi-annular-porous timber, occasionally with thylose. The axial thin-walled texture is in large amount, visible to obvious in magnifying glass, in thin-string and apotracheal banded shape. The wood radial includes wide radial and narrow radial	The air-dry density is about 0.65 g/cm^3 ~ 0.91 g/cm^3. The strength is moderate, it is not corrosion-resistant. The dry-shrinkage is moderate, it is hard to dry. It is not hard to work; the cutting plane is smooth. It has high nail-holding capacity, is easy to bond. It has inclined texture; the structure is moderate and uniform

Table J.0.2 -- Imported broadleaved timbers

No.	Timber	Tree species	Name of commodity timber	Division	Main origin	Key points of timber identification	Basic characteristics and main processing properties of timber
1	Hymeneae spp.	H. Courbaril H. oblongifolia	Jatoba Courbaril, Jotaba, Jutai, Jatai, Algarrobo, Locust	Caesalpi-niaceae	Central america, South America, Caribbean, the West Indies	Timber-side is white or light grey, with light-reddish brown; timber-core is yellowish brown to reddish brown, with stripes. The timber-core is distinctive from timber-side. The growth ring is clear, the pore is unevenly and separately distributed, containing resin. The axial thin-walled texture is in ring-boundary shape, wing shape, or concentrated-wing shape, with abundant wood radials. The radial surface has obvious sliver-light stripe, the side grain has no wave-mark, with intercellular canal. The timber has gloss, the texture is straight or staggered	The air-dry density is about 0.88 g/cm^3 ~ 0.96 g/cm^3. It is high in strength and corrosion-resistant. It is fast to dry and easy to work
2	Koompassia	Malaccensis	Kempas	Caesalpin-iaceae	Malaysia, Indonesia, Brunei	Timber-side is white or light yellow; the new-cutting plane of timber-core is light-red to brick-red, then it changes deep orange after a long-term. The growth ring is unclear, with uniformly-distributed diffuse-pores, with thylose. The axial thin-walled texture is in ring-tubular shape, wing-like shape, continuous segmented narrow-band shape. The wood radial is visible, which shows a stripe in radial-plane and wave in chord plane. There is no intercellular canal. The timber has gloss and yellowish-brown strip, there is wave stripe in the staggered texture	The air-dry density is about 0.77 g/cm^3 ~ 1.1 g/cm^3. It is high in strength and corrosion-resistant. The dry-shrinkage is small. It is sound in drying performance, hard to work, easy to split-crack when nailed

Table J.0.2 (continued)

No.	Timber	Tree species	Name of commodity timber	Division	Main origin	Key points of timber identification	Basic characteristics and main processing properties of timber
5	Dipterocarpus spp.	D. alatus D. grandiflorus	Apitong, Keruing, Keroeing, Gurjun, Yang	Dipterocarpaceae	Philippine, Malaysia, Thailand, India, Burma, Laos,	Timber-side is grey brown to grey yellow or purple grey. The new-cutting plane of timber-core is purple-red to brick-red, then it changes deep purple-brown or light reddish-brown after a long-term. The timber-core is distinctive from the timber-side. The growth ring is unclear, with non-uniformly-distributed diffuse-pores, without thylose, containing brown gum. The axial thin-walled texture is in paratracheal shape and apotracheal shape. The periphery thin-walled texture is in wing-shape around the intercellular canal. The wood radial is visible, with radial intercellular canal, in white-spot shape in the cross-section	The air-dry density is generally 0.7 g/cm^3 ~ 0.8 g/cm^3. It is high in strength. The timber-core is slightly corrosion-resistant, whilst the timber-side is not corrosion-resistant. It is easy to be anti-corrosion treated. The dry-shrinkage is large and uneven, it is slow to dry, easy to warp, hard to work, easy to be nailed, with good bonding performance
6	Dryobalanops spp.	D. fursca	Kapur	Dipterocarpaceae	Malaysia, Indonesia	Timber-side is light yellowish brown or slightly purple. The new-cutting plane of timber-core is pink to deep red, then it changes red brown, deep brown, or purple brown. The timber-core is distinctive from the timber-side. The growth ring is unclear, with uniformly-distributed separate-pores, with thylose. The axial thin-walled texture is in paratracheal shape or wing shape. The wood radial is rare, with stripe in the radial-plane and wave-stripe in the chord plane. It has axial intercellular canal, which is in white-spot shape, independent or interrupted long-chord row. The timber has gloss, the new-cutting plane has camphorwood-like odor, the texture is slightly staggered to apparently staggered	The air-dry density is about 0.8 g/cm^3. It is high in strength, corrosion-resistant. But it is hard for anti-corrosion treatment, large in dry-shrinkage, slow to dry, easy to split-crack, hard to work, not hard to be nailed, with good bonding performance

Where:

l - The joist span of vibration control (m);

b - Joist's spacing (m);

h_j - Joist's height (m);

h_s - Floor's thickness (m);

f_t - Floor panel's thickness (m);

E_jA_j - Joist's axial stiffness (N);

E_s // A_s - The axial stiffness of the floor parallel to the joist (N/m), which is valued according to the provisions of Table Q.0.1-1;

$E_s \perp A_s$ - The axial stiffness of the floor perpendicular to the joist (N/m), which is valued according to the provisions of Table Q.0.1-1;

E_tA_t - The axial stiffness of the floor panel (N/m), which is valued according to the provisions of Table Q.0.1-2;

E_jI_j - Joist's flexural stiffness (N • m^2/m);

$E_{s//}I_s$ - The flexural stiffness of the floor parallel to the joist (N • m^2/m), which is valued according to the provisions of Table Q.0.1-1;

$E_s \perp I_s$ - The flexural stiffness of the floor perpendicular to the joist (N • m^2/m), which is valued according to the provisions of Table Q.0.1-1;

E_tI_t - The flexural stiffness of the floor panel (N • m^2/m), which is valued according to the provisions of Table Q.0.1-2;

m - The linear density of the equivalent T-beam (kg/m), including the floor panel, the wood-based structural panel, the joists;

K_s - An adjustment factor that takes into account the effects of lateral stiffness of the floor and floor panel;

S_n - Load-displacement elastic modulus of joist-floor connection (N/m/m), which is valued according to the provisions of Table Q.0.1-3;

l_1 - Calculated distance of floor panel's joist (m); where the floor has not surface panel, it takes the distance between the floor joint perpendicular to the joist; where the floor has surface panel, it takes the joist's span.

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