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S P E C I F I C A T I O N P R E - F A B R I C A T E D T I M B E R R O O F T R U S S E S

CAWANGAN KEJURUTERAAN AWAM STRUKTUR & JAMBATAN
J A B A T A N K E R J A R A Y A M A L A Y S I A

SPECIFICATION
PRE-FABRICATED TIMBER
ROOF TRUSSES

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SCHEDULE A

REFERENCES

ACKNOWLEDGEMENT

1.0 DEFINITIONS

1.1 System Provider (S.P.)

A supplier of a proprietary roof truss system, approved by Jabatan Kerja Raya (JKR), and which employing Quality Assurance procedures in the design, detailing, connection, bracing, erection criteria and manufacture of truss components for the provided structural roof truss system.

1.2 Superintending Officer (S.O.)

An appointed government officer or his representative under the main contract of works, and of which who implement the duties defined for the work under the contract. Where applicable, it also represents the Project Director or his representative.

1.3 Contractor

Means the main contractor defined under the main contract of works, and of which who undertake the obligations for the work under the contract.

1.4 Fabricator

A licensed supplier of an approved S.P., who assembles the structural component and provide assembly details including the truss to truss details, bracing, tie-down, erection, lifting instructions to install the roof truss system in a manner approved by the S.P..

1.5 Installer

Trained personnel appointed by the S.P. or fabricator to assemble, erect and install the S.P.'s proprietary roofing truss system.

1.6 Professional Engineer (P.E.)

An appointed P.E. by S.P., who has a valid registration with the Board of Engineers, Malaysia (BEM) and still permitted to practice in the registered field.

1.7 Construction Drawing

Drawing approved by the P.E. representing the design principle and parameter containing adequate information to produce fabrication drawings, and on works to be done in the construction of all or a portion of the building structure.

1.8 Fabrication Drawing

Drawing or set of drawings produced by the fabricator and verified by the P.E. to explain the fabrication and/or installation to the installation team. The fabrication drawing shows more details than the construction drawings but shall not modify the design principle and technical specification stipulated in the construction drawings.

1.9 As-built Drawing

Revised set of drawing submitted by S.P. to the contractor showing the dimensions, geometry, and location of all elements of the work completed under a contract. It shall include all changes made to the specifications and construction drawings during the construction process but which solely due to the construction or installation limitation or constraint.

2.0 GENERAL REQUIREMENT

2.1 Specification Outline

This specification outlines the requirements for the analysis, design, detailing, drawing, manufacture, material, handling and erection of the roof members, and their associated ancillary fixing products and methods to ensure that all items act together as an integral structure, which is structurally stable under all the specified combinations of loading conditions.

2.2 General Truss Limitation

This specification is intended to apply to timber roof trusses with metal plate fasteners within the following general limitations:-

- i) Maximum unsupported truss span 12.00 metres with permitted deviation of ± 0.05 metres.
- ii) Maximum truss spacing of 1.200 metres with permitted deviation of ± 0.025 metres.
- iii) The minimum basic wind speed shall be 35 m/s. However, the minimum basic wind speed shall be increased to 41 m/s for lightweight roof covering.
- iv) Maximum roof pitch of 45° (100:100)

2.3 Fabricator

All S.P. trusses shall only be assembled by licensed fabricators by the S.P. and registered with Malaysia Construction Industries Development Board (CIDB). A copy of CIDB registration certificate shall be submitted to the S.O. for verification.

2.4 Installer

All fabrication and installation works shall be executed and supervised by qualified personnel with valid certificate issued by CIDB. The S.O. shall verify the identification and qualification of the Installer prior to the installation.

The specification requires that all roofing systems up to 12 metres span shall have the loading, assembly, stacking, lifting, bracing, tie-down and battening, and truss to truss connections be endorsed by the S.P. and erected by trained erection teams.

2.5 S.O.'s Approval

Prior to manufacture of the proposed roof truss system, the S.P. through the contractor shall provide two (2) copies of the truss analysis and design reports, construction drawings and quality assurance program, together with the particulars of the Fabricator, Installer and P.E. including valid licences or other certificates to the S.O. for his approval.

The proposal shall be attached together with the application form (Lampiran C) in Appendix 1, Appendix 3 or any revision of the form circulated in writing by Pengarah Kanan, Cawangan Kejuruteraan Awam, Struktur & Jambatan (CKASJ) or any other official means of circulation accepted by Government.

All analysis, design reports and construction drawings shall be duly signed by S.P. and certified by the P.E.. The S.O. shall reserve the right to reject any of these system if found to be unsuitable. The Contractor shall be responsible to obtain a written approval from the S.O. prior to the commencement of work of the roof truss systems.

2.6 Analysis, Design Report and Drawings Submission

The S.P. shall propose to the S.O. a roof truss system which is safe, functional and conforming to design standard. Submission of proposal shall include truss analysis, design report, and construction drawings. The truss analysis shall indicate all loads, load combinations, connection criteria, bracings and tie-downs of the truss. Design output of the truss members, battens, connections, tie-downs and wall plates, anchors, bracings, truss accessories, splicing and stiffeners whereby related to the analysis shall be included in the design report.

All details in the construction drawing shall be sufficient as such to enable checking against the analysis and design report, by specifying and providing not limited to; the truss layout and configuration, timber grades, section properties of members, length of members in each truss configuration, properties of truss accessories, specification of corrosion protection, specification of preservative protection, specification of nail, metal plate fastener, and anchor, tie-down and anchoring details and all type of connection details including the connection of all attachments to the trusses.

Technical specifications or mill certificates for metal plate fastener and anchor of which the designs refers to, grading summary approval by Malaysian Timber Industry Board (MTIB) and timber treatment certificate shall also be included in the submission. Verification test certificate from an approved accredited laboratory on the technical parameter specified in the technical specifications or mill certificates shall be submitted upon request by the S.O..

2.7 Long Span Trusses

The S.P. shall ensure that the long span truss shall have loading, assembly, stacking, lifting, bracing, tie-down and battening, and truss to truss connections, verified by the P.E. and erected by trained and competent erection teams endorsed by the S.P..

Except to the extent that the context otherwise requires, all minimum requirements for trusses up to 12 metres shall be deemed to apply to the long span trusses.

2.8 Standards

Where Malaysian Standard (M.S) and Malaysia National Annex (N.A), are available for respective Euro code (E.C), Australian Standard (A.S) or ISO Standard (I.S.O.), the M.S. and the N.A. shall be adopted as the principal standard for design, testing, transportation, erection and installation of the truss system. In the absent of N.A., British Standard National Annex (B.S.N.A) may be adopted where appropriate. All normative or indispensable standards to the principal standard shall be read in conjunction with the adopted principal standard.

The value, symbols, description or performance from the standard cited by clauses, tables or appendices in this specification shall be deemed to include the value, symbols, description or performance to such standard as amended, revised, supplemented, varied or replaced from time to time by publisher.

2.9 Duties of P.E.

The P.E shall involve and certify every process of the truss system delivery:

- i) Preparation of roof truss analysis and design;
- ii) Preparation of drawing;
- iii) Design changes in every stage of work;
- iv) Certification for roof truss installation completion;
- v) Final certification for roof truss installation prior to issuance of Certificate of Practical Completion (CPC) for the whole Works to the Contractor.

2.10 Fire Protection

The S.P. shall ensure that the roof system proposed are in compliance with the fire resistance requirements mentioned in the Uniform Building By-Laws. This compliance shall be certified by an independent P.E.. The S.P shall also ensure roof truss materials and systems, must show evidence that they have been subjected to the fire resistance test in accordance with BS 476 or other approved equivalent standards.

3.0 QUALITY ASSURANCE AND CONTROL

3.1 Quality Assurance Program

The Contractor shall submit to the S.O. a process flow chart and checklist on Quality Assurance and Control. The process flow charts will describe overall system quality check at the truss plant. The checklist is to check for adequacy of truss design, fabricating equipment condition, site measurement and installation procedure.

Refer to Appendix 6 for the document submission requirements.

3.2 Testing and Inspection

The Contractor shall notify the S.O. on dates of actual tests and the S.O. may exercise his sole discretion as to whether to witness such tests or otherwise. In any event, the Contractor shall be fully responsible to carry out such tests and to forward a copy of such test results together with its status jointly certified by the S.P. for the S.O.'s acceptance and approval.

The S.O. at his absolute discretion may also request for additional tests to be conducted as specified in other Sections of this Specification. The Contractor shall provide all attendance and facilities for such tests.

4.0 DESIGN, FABRICATION, SUPPLY AND INSTALLATION WARRANTY

4.1 All roof truss components shall be manufactured only by approved S.P. producing quality assured products and services to the approval of the S.O..

4.2 Prior to the fabrication of the roof truss system, the Contractor shall submit to the S.O. two (2) copies of the drawings certified by a P.E.

Where possible, a copy of the S.P.'s current ISO 9002 accreditation certificate issued by a Malaysian approved and accredited body shall also be submitted.

4.3 Prior to the completion of the defect liability period, the S.P. shall inspect and certify that all the connections have been checked for tensioning, corrosion protection and any inadequacies rectified.

4.4 Immediately after the completion of the installation of the roof truss system and prior to the issuance of the CPC, the Contractor shall submit the following documents to the S.O. for information and record :

- i) System Provider's Warranty against any defects or damages which may arise during a period of ten (10) years from the Date of Practical Completion of Works due to any defect, fault or insufficiency in design, materials or workmanship or against any other failure which an experienced Contractor may reasonably contemplate but shall not include normal replacement and maintenance.

- ii) Certification that the metal plate fastener conform to the relevant standards and are protected against corrosion, together with proof that such certifications have been verified by test carried out, by SIRIM for the current year or the previous year.
- iii) Certification that the correct timber grades were used in the fabrication of the trusses and roof structure by including a copy of the grading summary for the timber used in the truss system, certified by timber graders registered with Malaysian Timber Industry Board or other statutory bodies.
- iv) Certification that the timber used in the fabrication of the trusses and roof structure has been adequately treated by including a copy of the treatment certificate for preservation on the batch of timber that was in the preservation.
- v) Two (2) sets of as built drawings of the roof truss system signed by the S.P. and certified by a P.E..

Refer to Appendix 4 for the contents of warranty certificate.

5.0 DESIGN REQUIREMENT

5.1 Design Data

5.1.1 Load Item

All loads shall be clearly itemised as below:-

i) Dead Load

Dead load shall be specified as per requirement in BS 6399: Part 1 or BS EN 1991-1-1, whichever standard adopted. However, the actual weight of ceiling, mechanical and electrical (M&E) services shall not be less than 0.25 kN/m^2 .

ii) Imposed Load

The value and requirement of imposed load shall be as per BS 6399: Part 1 and Part 3 or BS EN 1991-1-1, whichever standard adopted. Notwithstanding to the value in the standard, the minimum value of imposed load shall be 0.25 kN/m^2 distributed uniformly over the whole area supported and 0.9 kN concentrated over a length of 125 mm (or in the case of coverings, over a square of 125 mm side so placed as to produce maximum stresses in the affected members).

iii) Wind Load

The requirement of wind load shall be as per MS 1553, BS 6399: Part 2 or BS EN 1991-1-4, whichever standard adopted, with the minimum basic wind speed as per Clause 2.2 of this specification or the value in MS 1553 whichever higher.

Load cases and load duration shall be clearly identified (as per BS 5950-5 or BS EN 1993-1-3 or other equivalent standards recognised internationally) and itemised to enable design checking to be carried out upon the most adverse conditions or the effect (e.g. effect of uplift or load reversal) under consideration.

5.1.2 Building Services Load

The S.P. shall ascertain the final M&E loads from the contractor and shall check the final requirements before submitting construction drawings. The data on the actual weight, location and route of these services shall be acquired by the S.P. and incorporated in the analysis and design of the truss. Load from the M&E services shall be considered to act upon the bottom chord of truss. Value of local effect of M&E loads shall also be checked.

Any other source of superimpose point load such as stage lighting shall be investigated and incorporated into the analysis. Load from water tank shall not be allowed. Potential source of vibration shall be investigated to prevent the vibration of the truss systems to its natural frequencies.

5.2 Design Standards

The design of timber truss members, bracings, connections, wall plate and truss accessories shall be in accordance to the following alternative of principal standards:-

- i) MS 544 : Part 1, 2 and 3
- ii) MS 544 : Part 5

5.3 Truss Analysis

Section properties of timber for design shall be based on actual size (not nominal size).

All engineering drawings shall specify member sizes, grades, permissible timber undersize, connector size, truss camber, web cutting details, locations and orientations at each joint.

5.3.1 Truss Geometry

Truss shapes and geometry must be fully triangulated system

5.3.2 Chord Panel Length

Maximum top chord panel lengths for heavy roofing types is limited to 2.5m whereas for lightweight roofing is limited to 3.0m. For greater panel lengths, vertical slenderness shall be considered. The maximum bottom chord panels is limited to 3.5m length.

5.3.3 Splicing

Splicing location shall consider stresses in the roof truss member. Splices are not allowed to be provided on web.

5.3.4 Coverage of nail plate

Nail plate shall be adequately covered the roof truss member intersection and able to transmit forces from truss to supporting member.

5.3.5 Deflection

Interpanel and panel points deflection shall be checked. Deflection at panel points under dead loads shall be calculated and as considered as camber during manufacture.

Large deflections under adverse design conditions may result in differential deflections due to timber, load and span variations shall be avoided.

5.4 Eccentricity

The centroidal axes of the connected members and nail plates should meet at a point, otherwise the effect of eccentricity of the connection together with the effect of primary and secondary stresses should be taken into account in the design of the members and their connections.

5.5 Additional Design Consideration

Roof trusses shall be designed to take into account the following requirements:-

5.5.1 Ceiling

In the case, where the roof trusses are designed at centres which do not suit or facilitate the fixing of the ceiling, the designer shall include in his design of the roof trusses for any additional bearers, tie-beam, ceiling joists, etc required to facilitate the ceiling panels.

5.5.2 Architectural Features

The S.P. shall consider also in his design suitability of timber roof trusses with architectural features requirements such as exposed roof trusses, cantilever overhang, shape of trusses and height of trusses. For exposed roof truss, timber roof truss with nail plate may not be suitable for aesthetical appearance unless agreed by the architect.

5.5.3 Roof Coverings

The S.P. shall consider type of roof coverings system to be used. In the case of roof shingles installation, the S.P. shall facilitate the fixings of the shingles.

5.5.4 M&E Services

The S.P. shall indicate on the drawing, that M&E services shall be installed using strap fixed on bottom chord member. Installation on purlins is not allowed. Rod to support ducting shall be designed to be installed on web plane member or stronger axis to decrease twisting on truss member. Drilling is strictly prohibited on all truss members.

5.5.5 Water Tank

Water tank shall not be placed on roof trusses and shall be supported independently. The S.P. should be advised by the contractor on the location of water tank and supporting beams during preliminary design works to allow provisions for truss openings in the truss section drawings.

5.5.6 Non-Load Bearing Wall

Non-load bearing wall shall not carry any load from truss system and bracing system.

5.5.7 Roof Pitch

Adequate roof slope and drainage shall be provided during design stage to prevent ponding and leakage of water. For flat or nearly flat roof trusses, some pitch must be provided or the trusses must be designed to resist progressive ponding.

6.0 DETAILING AND DRAWINGS

Construction drawing shall consist of:

6.1 Layout Drawings

Layout drawings shall indicate the plan view of all trusses together with ties, bracing, and under purlins. The drawings shall identify the number of the truss or member and the wind loading for which it has been designed.

6.2 Design Detail Drawings

The design detail drawings shall clearly indicate the following:-

- i) Shape of member and truss.
- ii) Span, height, spacing, pitch, overhang and camber.
- iii) Designed wind load.
- iv) Magnitude and direction of forces transferred to the supporting structure.
- v) Bracing on truss.
- vi) Under purlin detail.

Each truss shall be clearly drawn on a separate drawing that clearly itemises all member sizes, grade, lengths, angles, connector sizes, orientations and positions.

The recommended method for each of these items is to be provided in general form to avoid secondary stresses or curvature being introduced to the members after assembly and prior to installation.

6.3 Bracing

Bracing layout and details drawing shall be provided for the total roof structure, which is to specify the type of bracing and the connection details at the apex, top plate splice and the standard connection details. These connection details shall be shown in the drawings and at the positions on the roof structure. Where bracings are provided at different planes on the roof system, then such bracing details shall be clearly shown in the drawings. Refer to Figure 1 for suggested type of web bracing (Isometric View).

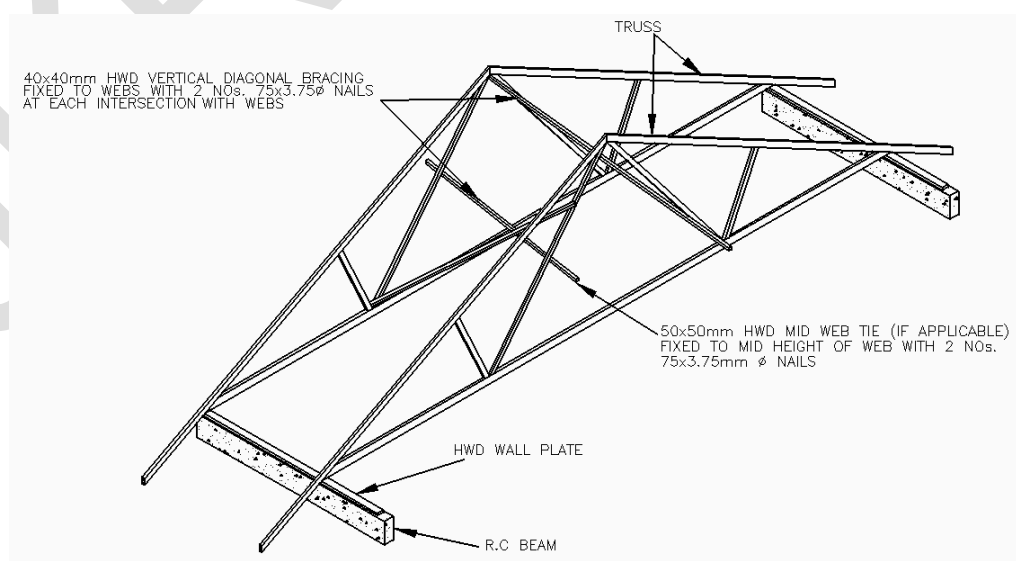


FIGURE 1: Isometric View of Bracing Layout

6.4 Connection

The connection method and fixing type of each member to member or truss to truss connection shall be clearly detailed to enable checking, installation and inspection. Each truss to truss connection shall be shown in isolation and in combination with the total roof structure.

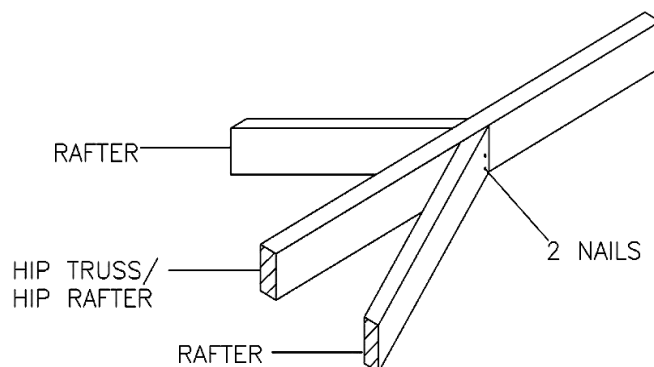


FIGURE 2: Rafter/Jack Truss Shorter Than 1800mm

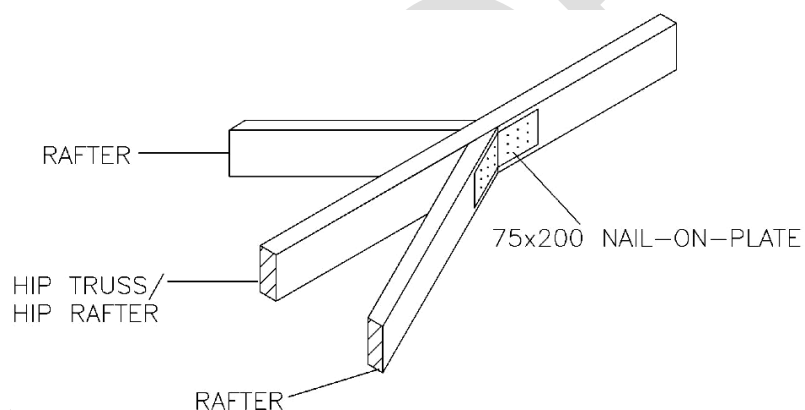


FIGURE 3: Rafter/Jack Truss Longer Than 1800mm

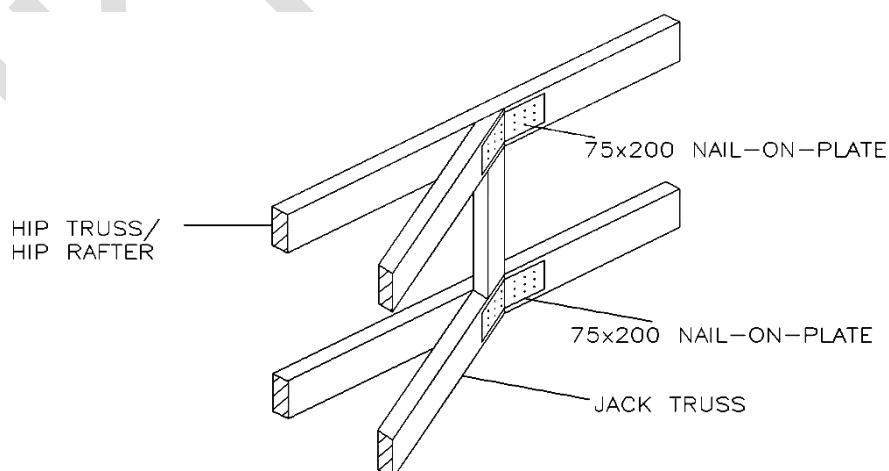


FIGURE 4: Jack Truss To Hip Truss Connection

6.5 Roof Battens

Roof battens layout drawing shall be provided to indicate arrangement and roof position of batten. Roof battens or top chord restraints, shall be indicated in shape, size and thickness. The spacing of the battens on the top chord or rafter shall be indicated and they shall be fastened with minimum of two (2) nos. Nails as per design. Refer to Figure 5 for suggested roof batten detail. Roof battens can be solid timber or laminated veneer timber.

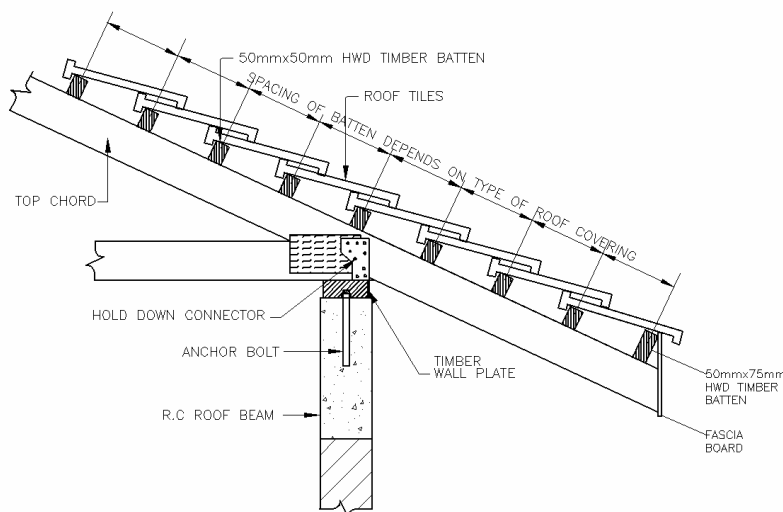


FIGURE 5: Roof Batten Detail

6.6 Bottom Chord Restraints

Bottom chord restraints, wherever applicable, shall be indicated in shape, size and thickness. The spacing of the battens on the bottom chord or ceiling joist shall be indicated and they shall be fixed with minimum of two (2) nos. Hexagon washer-head or wafer-head self-drilling tek screws.

6.7 Tie-Down and Hanger

Tie-down of truss or rafter and ceiling joist shall be indicated with appropriate metal fixing type and its numbers together with the number and placement of fasteners. The fasteners or anchor bolt diameter, length and coatings, if any shall also be specified.

All trusses unless specified otherwise, shall be adequately anchored with proprietary types of fixings such as triple grips or multi grips, to the supporting structure to resist uplift and horizontal loads. Typical tie down connection as shown in Figure 6 and Figure 7.

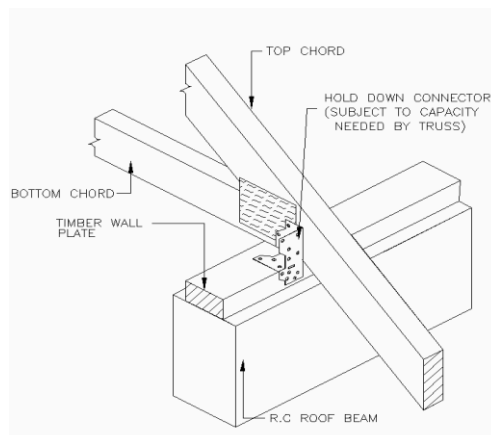
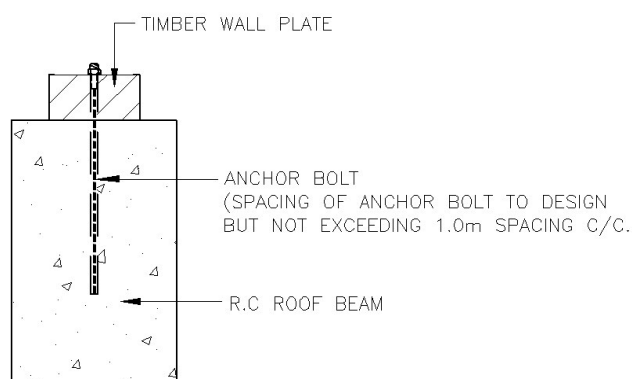


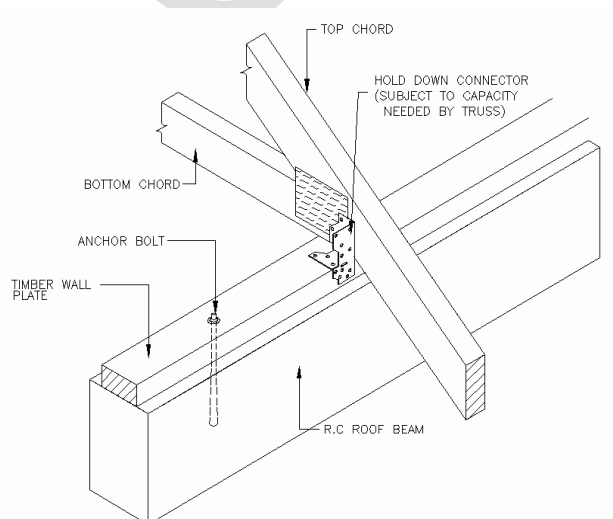
FIGURE 6: Holding Down Connection for Timber Roof Truss**FIGURE 7: Section View for Wall Plate and Anchor Bolt**

6.8 Wall Plate

All roof trusses supported on top of concrete beam shall be adequately anchored with fixing such as triple grips or multi grips to wall plate. Wall plate must be designed to resist vertical and horizontal forces, able to provide bearing and distribute the load to the supporting beam. The wall plate must be anchored to the supporting beam by means of anchor bolts.

6.8.1 Timber Wall Plate

The minimum size of timber wall plate must be 50 mm x 100 mm and must be anchored to the supporting beam by means of anchor bolts. All timber wall plate shall be minimum grade of SG2. Refer to Figure 8 for suggested connection detail for timber wall plate and Figure 8: Suggested connection Detail of Timber Wall Plate to RC Beam.

**FIGURE 8: Connection Detail for Timber Wall Plate**

7.0 MATERIAL AND TESTING

7.1 Timber Requirement

7.1.1 General

The materials used shall comply with the appropriate MS 544. Unless otherwise specified or shown in the drawings, the timber species used for the truss or roof members shall be selected from Strength Groups of timber, SG1 to SG4 and in accordance with MS 544. All timbers used for structural works should be stress graded based on MS 1714.

The use of different species of timber within a truss shall only be acceptable provided that no species is of lower stress grade or weaker joint group than that provided in the design specifications and that they are of consistent moisture content and thickness. Timber packs shall be covered with plastic sheeting so that the effect of rain and sun is minimised when stored outside.

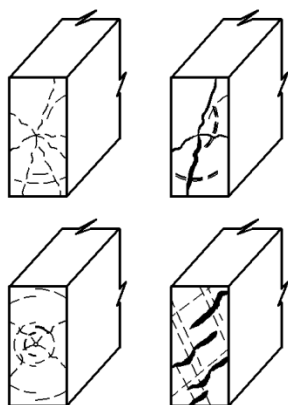
The contractor shall submit work method statement to S.O. on how timber stress grade and durability treatment specification will be complied with.

7.1.2 Visual Grading

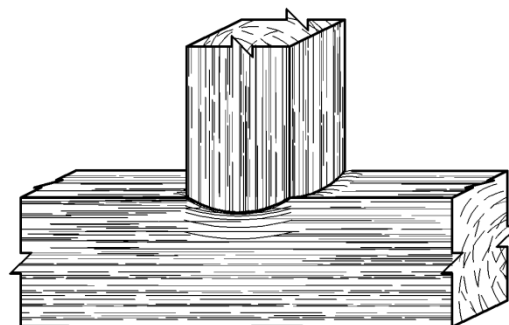
All timber shall be of select grade in accordance with MS 544. The timber shall be graded in accordance with the Malaysian Grading Rules for Sawn Hardwood Timber or the appropriate British Standard for Glued Laminated timber members by graders registered with the Malaysia Timber Industry Board (MTIB) or others statutory bodies in accordance to MS 1714 and MS 544.

Any piece which contains abnormal defects such as brittle heart, compression failure, tension wood, damage, combinations of knots, insect damage, fungal decay and/or other characteristic, which may cause a decrease in strength properties to an amount which threatens its serviceability, shall not be used.

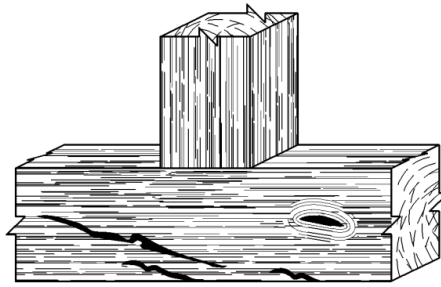
All timber components shall be examined for suitability prior to cutting and assembly. Defects such as shakes, slope of grain, spiral grain, wane, bowing and knots are permitted within the limits specified by the MS 1714 or MS 544. However, any warped, cupping, twisted, crooked, split timber, or defects which would interfere with the proper placement and pressing of fasteners, or any other defects such as knots and wane which would result in the reduction of the joint strength shall not be permitted.



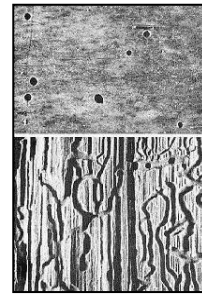
a) Combinations of Brittle heart/Shakes



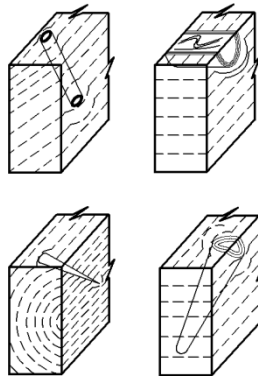
b) Compression Failure



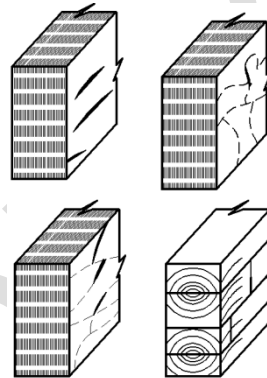
c) Tension Wood



d) Insect Damage



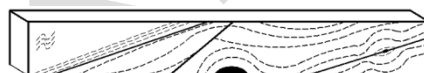
e) Combinations of Knots



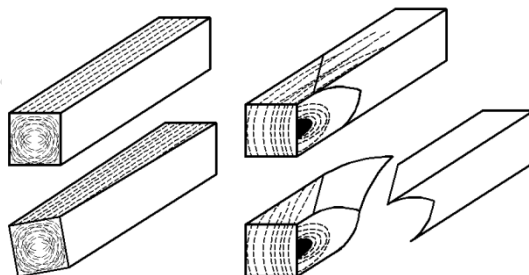
f) Damage Wood



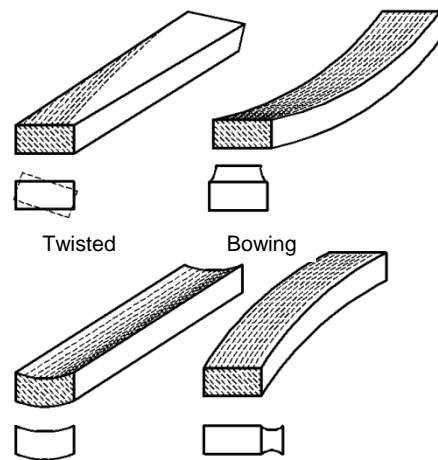
g) Fungal Decay



Slope of Grain



h) Combination of Grain



Twisted

Bowing

Cupping

Crooked

i) Combination of Warped

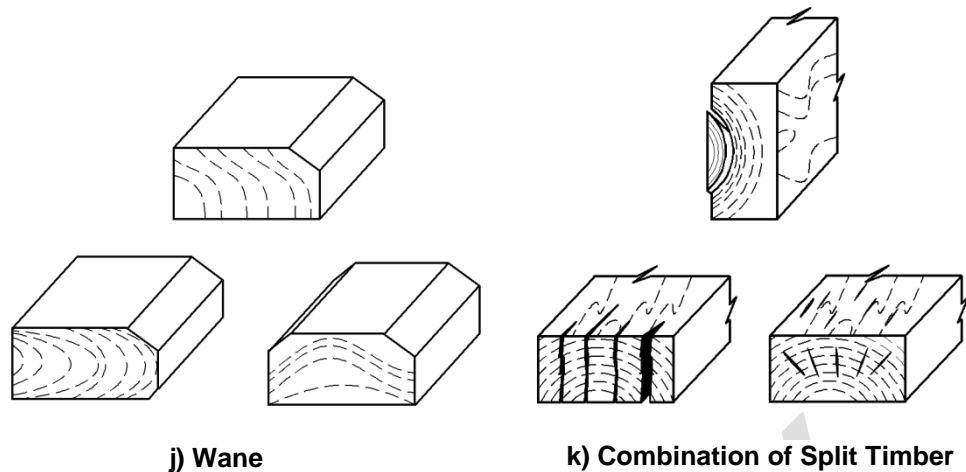


FIGURE 9: Defects of Timber

7.1.3 Preservative Treatment

All timber other than the heartwood of the naturally durable timber used in truss fabrication shall be treated. Sapwood of all species is considered not durable unless suitably treated.

The preservative treatment shall be accordance in MS 544 Part 10. The composition and the processes by which preservatives are applied are shown in Table 1.0.

Table 1.0: Preservatives Treatment

Preservatives	Composition	Application / Process
CCA	MS 733	MS 360
Boron compound	MS 995	MS 995
Light Organic solvent (LOS)	MS 1302	AS/NZS 1604

It is essential that the moisture content of the timber is at the correct level for the type of treatment to be given according to Standards in Table 1.0. Detail methods of determining moisture content shall be in accordance to MS 837.

The timber shall be in its final shape and size with all machining, cutting, boring of holes completed prior to treatment. Where cutting cannot be avoided, or where further dressing is required, all such surfaces shall be liberally swabbed with the approved preservative.

7.1.3.1 Copper/Chrome/Arsenic (CCA)

CCA preservatives should be applied in accordance with MS 360 or MS 544 Part 10. The minimum net dry salt retention for CCA shall be 5.6 kg/m³ and minimum depth of penetration shall be 12mm. At the time of installation, the moisture content of the timber for the various applications shall not exceed 30% Moisture content greater than this will not allow sufficient absorption and retention of the CCA preservative during the treatment.

7.1.3.2 Boron Compound

Boron compound can be used through diffusion and vacuum pressure process (Full-cell Bethell process). Boron diffusion treatment has to be carried out on unseasoned timber at source.

7.1.3.3 Light Organic Solvent

Organic solvent complying with MS 1302, could be applied. It is normally used for treatment of finished timber component.

7.2 Fastener Requirement

7.2.1 Metal Plate Fastener

Steel grade used for the metal plate fasteners shall conform to structural quality steel in MS 1196 or AS 1397 and shall be at least of grade galvanised steel with a minimum yield stress of 250 MPa. Unless the fasteners are of the proven type, all such fasteners shall be subjected to the tests specified in AS 1649 to establish the working loads in accordance with the procedures specified therein.

Two types of metal plate fastener are punched metal plate and nail plate. A punched metal plate having integral projections punched out in one direction and bend perpendicular to the base of the plate. It shall be manufactured with teeth or nails formed from the parent metal to provide effective structural joints between timber members.

Nail plate with pre formed holes are capable of receiving hand placed nails. The nails should be a tight driving fit in the plate holes.

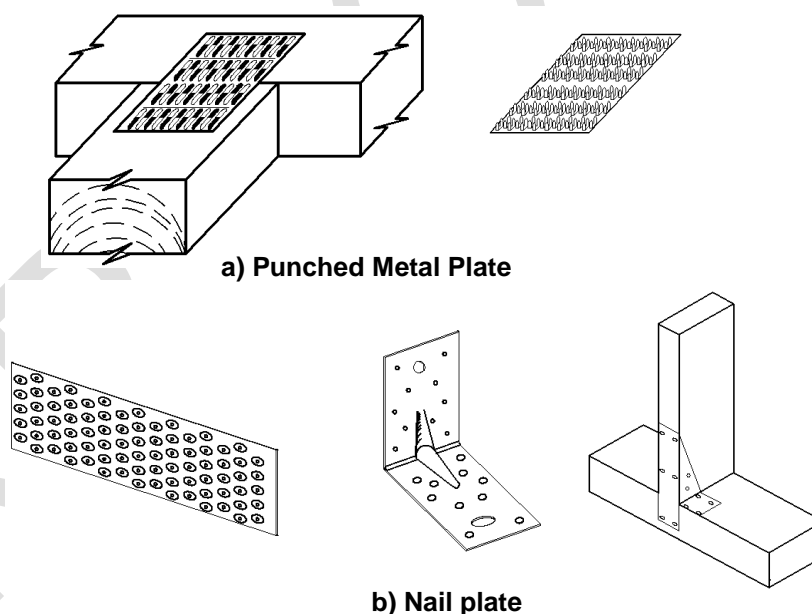


FIGURE 10 : Examples of Metal Plate Fastener

7.2.2 Nails

All requirements for nails shall comply with AS 2334 including material and mechanical properties, shape, dimensions and finishing. Nails shall be straight and true in shape. The surface of all nails shall be free from excessive oxidation.

7.3 Coating Requirement

Minimum coating mass of base metal plate on each surface shall be in accordance to MS 740, MS 2384 or AS1397. When the base steel-thickness exceeds 1.2 mm, the steel shall be hot-dipped galvanized with a zinc coating conforming to class Z275. For

base steel thickness less than or equal to 1.2 mm, the minimum coating classes shall be Z200 or AZ150. Where truss system constructed in area with outdoor atmospheric environment to ISO 9223 is classified under the corrosivity category, C3 (medium corrosivity), then the coating mass of base steel shall conform to the minimum of anti-corrosion performance of Z450 or AZ150.

Stainless steel fasteners, if used, shall be bare austenitic stainless steel of a grade defined in BS EN ISO 3506. Other grades of stainless steel shall not be used.

All nails used in timber truss constructions shall be coated protectively by hot-dip galvanizing, sherardizing or other suitable treatment against corrosion.

7.4 Anchor Requirement

All anchors in which all the metal parts directly anchored in the concrete and designer to transmit the applied loads including uplift load are made of carbon steel or stainless steel. The anchors shall be placed into drilled holes in concrete and anchored by expansion. The types of anchor installation shall be approved by S.O.. The anchor properties shall be based on design requirements. All carbon steel anchors shall be protective coated by hot-dipped galvanized or sherardized to a minimum thickness of 42 micron.

7.5 Wall Plate Requirement

Timber strength group used for the wall plate support and the treatment shall refer to MS 544: Part 2 and Part 10.

7.6 Bracing Requirement

Steel grade used for the steel brace shall conform to structural quality steel in MS 1196 or AS 1397 with a minimum thickness of 1.0mm. Pre punched holes shall be provided for driving of nails into the truss timbers. The coating specification shall be in accordance to Clause 7.3

7.7 Other Requirement

The steel used in the manufacture of any bracket, tie and splicing plate shall conform to structural quality steel in MS 1196 or AS 1397 and shall be at least of grade galvanized steel with a minimum yield stress of 250 MPa. Pre punched holes shall be provided for driving of nails into the truss timbers. The coating specification shall be in accordance to Clause 7.3.

7.8 Mill Certificate and Test Report

7.8.1 Timber

For a particular batch of timber, the S.P. shall furnish the S.O. with valid copy of test certificate from Forest Research Institute Malaysia (FRIM) or other approved testing laboratory confirming the compliance of species, strength, moisture content, properties and treatment to the standards requirement as per Appendix 2.

7.8.2 Metal Plate Fastener and Accessories

For a particular batch of metal plate fastener, tie, splicing and bracket, the SP shall furnish the S.O. with valid copy of test certificate from SIRIM Berhad or other approved testing laboratory confirming the compliance of dimension,

strength, coating class to the standards requirement and testing method as per Appendix 2. The validity of test certificate shall be two (2) years from the date of testing submission.

7.8.3 Anchor

For a particular batch of anchor, the SP shall furnish the S.O. with valid copy of test certificate from SIRIM Berhad or other approved testing laboratory confirming the compliance of strength and coating thickness to the standards requirement and testing method as per Appendix 2. The validity of test certificate shall be two (2) years from the date of testing submission.

7.8.4 Nail

For a particular batch of nail, the SP shall furnish the S.O. with valid copy of test certificate from SIRIM Berhad or other approved testing laboratory confirming the compliance of strength and coating thickness to the standards requirement and testing method as per Appendix 2. The validity of test certificate shall be two (2) years from the date of testing submission.

8.0 TRUSS FABRICATIONS

Unless otherwise approved by the S.O., roof trusses shall be assembled and fabricated in the factory.

8.1 Factory Fabrication

The Contractor shall submit the proposal to the S.O. for approval prior to the fabrication of the trusses. Submission shall be all of the following:-

- i) Factory location;
- ii) Method statement for fabrication;
- iii) Method of transporting and handling of roof trusses to the site;
- iv) Quality Assurance document.

S.O. reserves the right to visit the factory before giving any approval.

8.2 On-Site Fabrication

For the fabrication on site, the contractor shall provide:-

- i) Covered fabrication and storage facility;
- ii) Fabrication equipment;
- iii) Truss fabrication drawings;
- iv) Method statement for fabrication;
- v) Quality Assurance document;
- vi) Qualified S.P. site fabrication team.

The S.O. shall withdraw his approval for the site fabrication if the quality of fabrication does not meet the specified requirements.

Timber cutting, punching or drilling shall be performed using sawing or shearing type of tools and other suitable mechanised equipment.

8.3 Site Measurement

All truss support locations and dimensions shall be checked and verified by the P.E at site prior to manufacture of the sections for fabrication.

8.4 Camber

Camber for all trusses shall be provided as specified with a maximum tolerance of 3 mm. The camber shall not be subtracted from the overall height of the truss. During setting out, the height of the truss (rise) shall be measured from the underside of the bottom chord at the point of maximum camber. In trusses with parallel chords, both the top and bottom chords shall be cambered. The support points are to have zero camber. Special care is to be taken in dealing with trusses with cantilevers, or half trusses in conjunction with full trusses.

8.5 Identification of Completed Trusses

All completed trusses shall be labelled for identification. In addition, all internal support positions and mid web tie positions shall be clearly marked.

8.6 Splicing

Unless clearly indicated in the fabrication drawing, no splicing of members shall be allowed in the truss.

8.7 Drilling

Unless clearly indicated in the fabrication drawing, no drilling of members shall be allowed in the truss.

8.8 Connections

8.8.1 Metal Plate Fasteners

Metal plate fasteners shall only be embedded into timber, which is free from defects.

All plates shall be pressed, impacted or rolled to within 1.5mm of the timber faces at the time of fabrication and without embedding the rest of the plate into the timber for more than 0.5mm.

A plate fastener embedment shall be deemed inadequate if a feeler gauge equal in thickness to ten percent (10%) of the tooth length or 1.5mm, whichever is less, can be inserted between a plate fastener and the timber surface.

Tooth length is measured from the tip of the shortest tooth to the nearest face of the plate. Plate fasteners with 10% or more of the teeth showing evidence of flattening shall not be accepted.

All embedment of fasteners shall be carried out by type of presses and associated equipments approved by the S.P.. The pressing force to embed the plate fastener onto the timber faces shall be applied uniformly on the fastener face. Uneven pressing or pressing only on one end of the plate fastener causing indentations on the plate surface (which may result in shear fracture of the parent metal) shall not be permitted.

The metal plate fasteners shall not project outside the outer edges of the truss.

8.8.2 Staples

Staples may be used for positioning purposes before the embedment of the metal plate fastener. Skewed nails shall be avoided at joints.

9.0 TRUSS HANDLING AND INSTALLATION

9.1 Handling

- 9.1.1 All trusses shall be handled in such a manner to avoid damage during handling, storage transportation and installation. Members which have been distorted and their structural integrity are impaired or lost shall not be used. The Contractor shall submit to the S.O. a method statement on the roof truss storage, handling and installation. The trusses shall be protected from the weather elements when stored outside. All installation of roof trusses shall be checked and verified by the P.E..
- 9.1.2 During handling, correct lifting equipment shall be used. All roof components must be protected from damages due to straps, chains and wire ropes. Units which are transported in nested bundles should be separable without damage to the units. Care should be taken when handling long units or bundles. Consideration should be given to the use of lifting beams with appropriately spaced lifting points and slings or lifting with properly spaced forklift tines.
- 9.1.3 During lifting, all roof trusses shall be propped in a manner that minimizes lateral bending and distortion, and strain on the joints.
- 9.1.4 Where trusses are stored on site (Figure 11a and Figure 11b), they should be placed above the firm ground on supporting block to protect them from ground water as follows :-
 - a) If the trusses are stored horizontally, the supporting block should be at 2.0m to 2.5m centres or as required at joints, to prevent bending of the trusses.
 - b) If the trusses are stored vertically, they should be supported at the designed support locations or bottom chord panel points, and in a manner that will prevent tipping or toppling

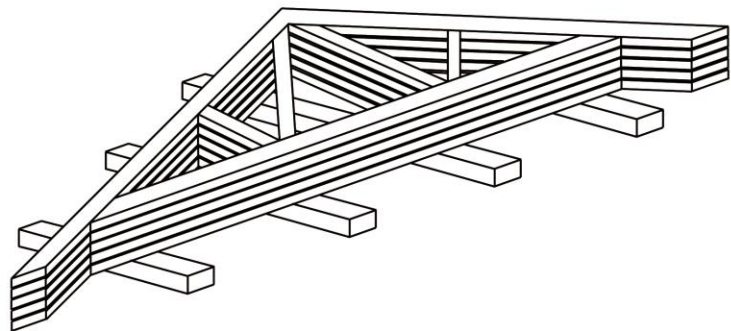


FIGURE 11a: Storage of Trusses at Site
(Trussed Rafter Stacked Horizontally)

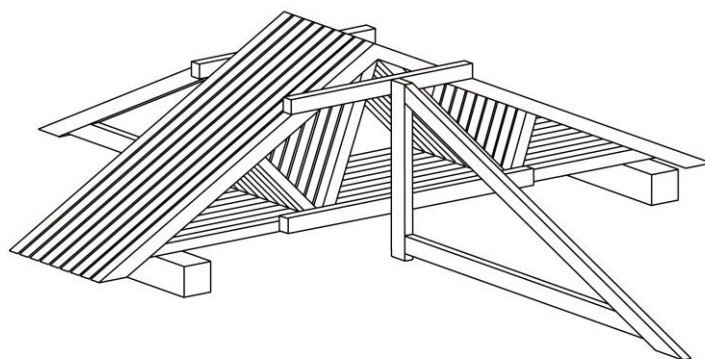


FIGURE 11b: Storage of Trusses at Site
(Trussed Rafter stacked vertically before covering)

9.2 Installation

During erection, roof trusses must be transversely braced to provide stability in accordance to method statement prepared by the S.P. and approved by S.O.. Diagonal bracings shall be provided for this purpose. Panel points and any change in pitch line shall also be restrained. To avoid inverted installation, all parallel trusses, shall be marked on the side of the top chord, so that such mark will be clearly visible after installation.

9.3 Installation Tolerances

The maximum allowable tolerances are as detailed below. If bow or tilt is evident to the naked eye, then it is deemed that these tolerances have been exceeded and the Contractor shall make good these defects.

9.3.1 Verticality

All trusses, Figure 12a and Figure 12b must not be out-of-plumb, or out-of-line or out-of-position by more than the least of the following:-

- a) $\text{Span}/200$
- b) 50mm
- c) $H/50$

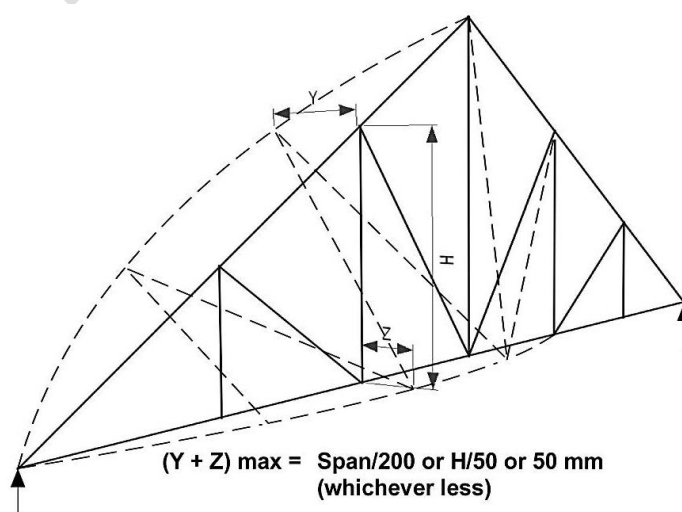


Figure 12a: Tolerance on verticality (local)

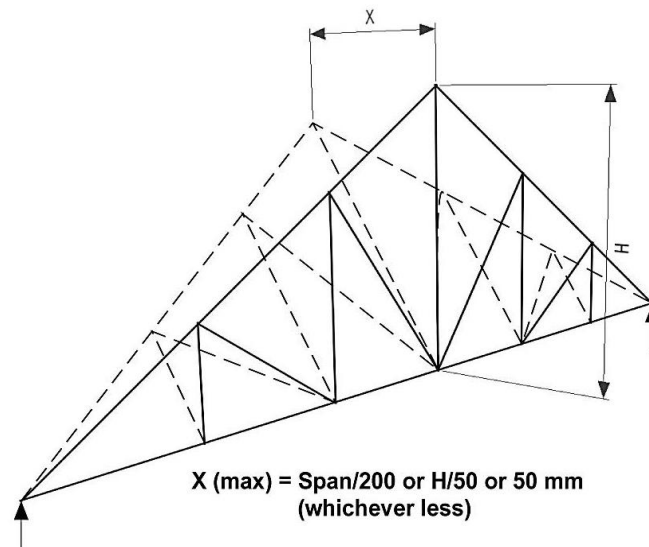


FIGURE 12b: Tolerance on Verticality (global)

9.3.2 Straightness

Trusses shall be erected (Figure 13) such that at no point does the out-of-line dimension measured from a line between the centres of the supports to the outside edge exceed the lesser of:

- a) $\text{Span}/200$
- b) 50mm

At no point shall the out-of-line dimension between the centrelines of two adjacent panel points exceed the panel length divided by 200.

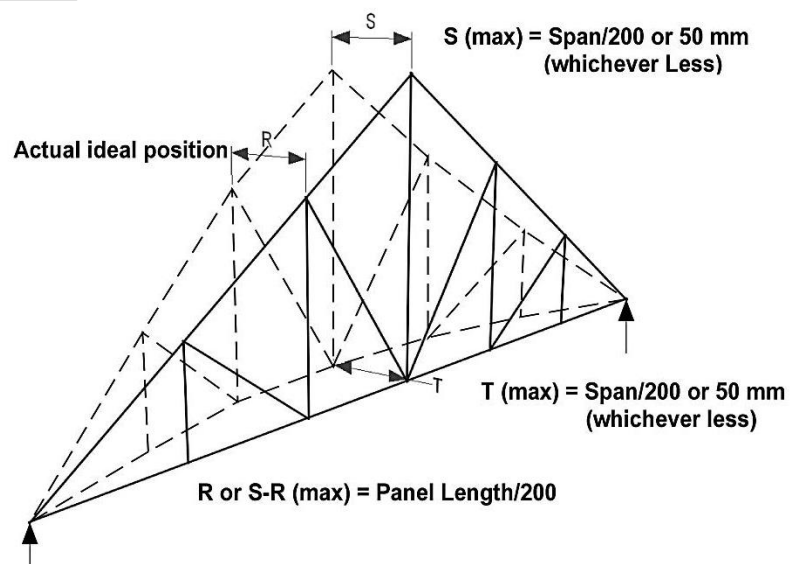


FIGURE 13: Tolerance on Straightness

9.3.3 Position

Trusses shall be erected such that their spacing at centres of support does not exceed the specified spacing by more than 50mm, (Figure 14). However, the average spacing of the trusses shall not exceed the specified spacing.

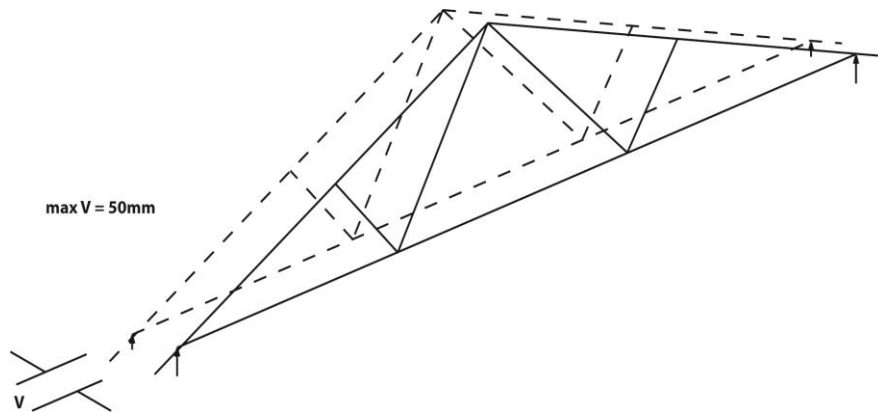


FIGURE 14: Tolerance on Position

9.3.4 Squareness

The first truss erected (Figure 15) shall be correctly plumbed and aligned so as to serve as the reference truss from which all subsequent trusses shall be positioned. All subsequent trusses shall be erected such that the out-of-square dimension at the centre of the end supports relative to each other does not exceed the lesser of :-

- a) $\text{Span}/200$
- b) 50mm

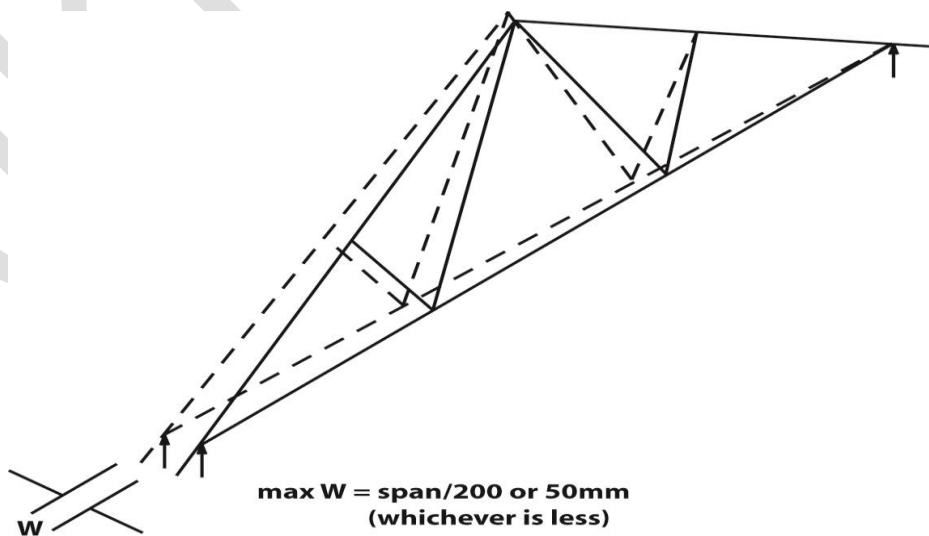


FIGURE 15: Tolerance on Squareness

9.4 Anchoring of Trusses to Supporting Structure

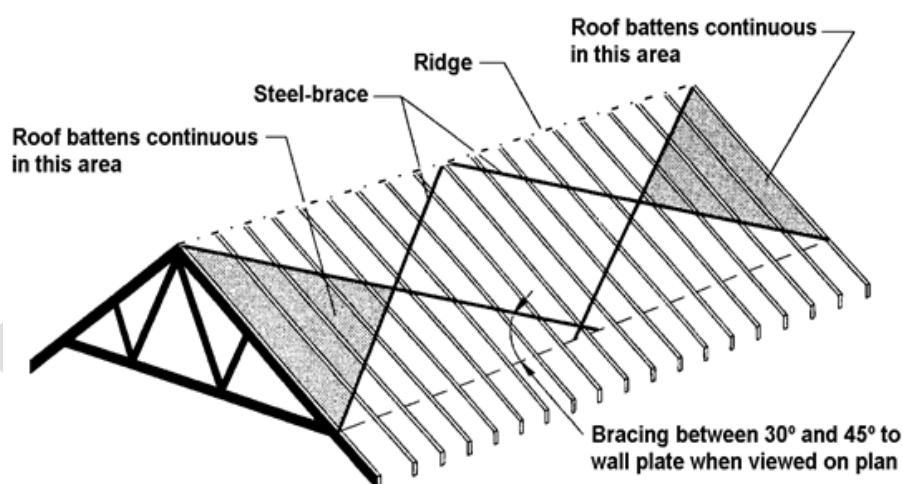
The wall plates shall be mounted to the supporting structure in such a manner that there are no gaps between them and the anchor bolt adequately tied down into the supporting structure. Any apparent gaps or spaces between the wall plate and supporting structure shall be packed and evened out by using approved non-shrink cement grout.

9.5 Roof Frame Bracing

9.5.1 Permanent bracings shall be applied to ensure that all the elements on roof frame act together as an integral structure that is stable under specified loading conditions. All bracings used to provide initial stability during installation shall remain and not to be removed. The materials for these bracings shall also comply with Clause 7.0.

9.5.2 Lateral Restraint

Roof battens/purlins whenever considered to provide lateral restraints shall be so arranged that on any truss line, not more than one third of the roof battens/purlins are spliced and that no two splices are adjacent. Particular attention is drawn to the need to provide lateral restraints on the bottom chord of trusses that are not directly braced by the ceiling frame. In areas where battens are not bound on both sides by diagonal bracing, battens shall be continuous (Figure 16).

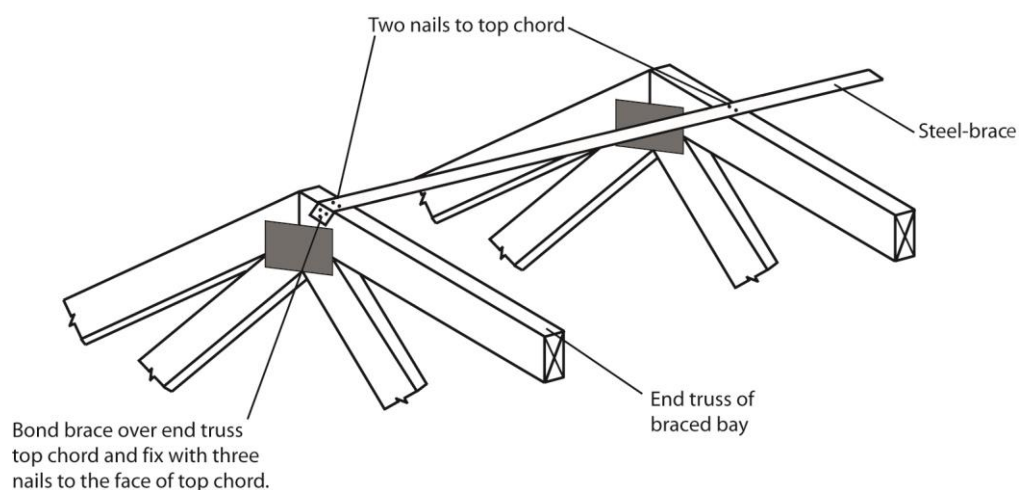


**FIGURE 16: Batten Continuous in Areas Unbound by Bracing
(Avoid splicing in area of roof battens continuos)**

9.5.3 Lateral restraints, where specified, shall be fastened to truss members at all intersections. Battens/purlins must be sufficiently anchored to trusses in a manner that provides positional stability as well as anchorage against net up-lifting forces. Stronger anchorage is required to hold down purlins for roof using sheet roofing.

9.5.4 All lateral restraints shall be braced back to rigid points on the main structure through the use of diagonal ties or bracing laid according to the fabrication drawings. All steel bracing, if specified, shall be laid in opposing pairs and properly tensioned with approved tensioning devices. The design of the tensioning devices shall be such that it does not contribute more than 2.5mm to the extension of the bracing system when a 5.5kN load is applied. The steel brace shall be fixed to each truss and supports as shown in Figure 16a.

- 9.5.5 The angle from the steel brace to wall frame shall be between 30° and 45° . Bracing bays shall extend from the end trusses of the roof, unless otherwise specified.



**FIGURE 16a: Fixing Details of Steel Brace
(For Illustration only)**

9.5.6 Steel Brace

The minimum working load for the steel brace shall be as shown in Table 2.0.

Table 2.0: Minimum Basic Working Load for Steel Brace

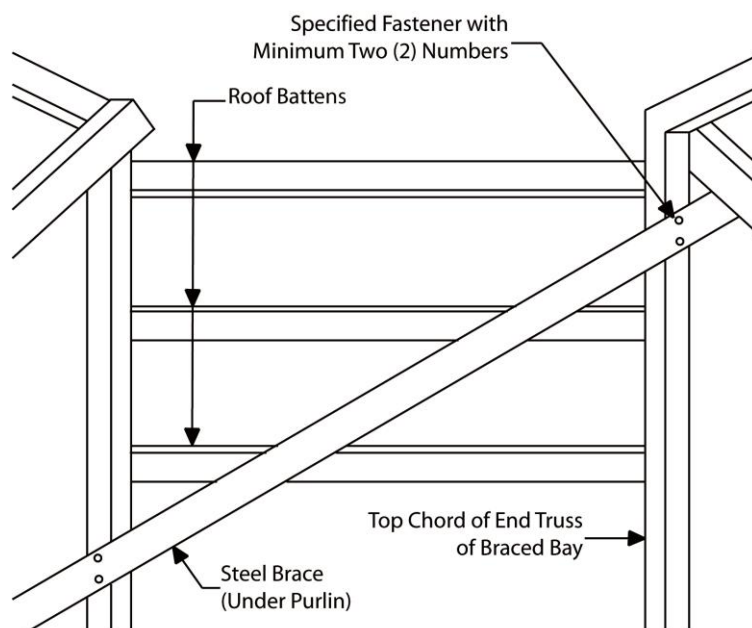
Working Load	Minimum Value (kN)
i) Steel Tension Capacity	5.50
ii) End Fixing Capacity	5.50
iii) Braced to intermediate truss fixing capacity	0.55
iv) Wrap-around splice capacity	5.50

The steel brace shall be designed such that the sagging does not exceed the distance between support point/500 when installed.

9.5.7 Top Chord Bracing

All steel bracing, if specified, shall be laid in opposing pairs. The steel brace shall be fixed to each truss and supports as shown in Figure 17 and Figure 18. The angle from the steel brace to wall frame shall be between 30° and 45° . Bracing bays shall extend from the end trusses of the roof, unless otherwise specified.

If lapping of steel braces are required, it shall be positioned and nailed to the truss. The total number of steel brace layers at any location of the nail at a lap position shall not be more than three (3) layers, with a maximum total thickness of 3.2 mm. (The nail must be embedded into trusses).



**FIGURE 17: Fixing Detail of Under-Purlin Bracing
(View from beneath the truss)**

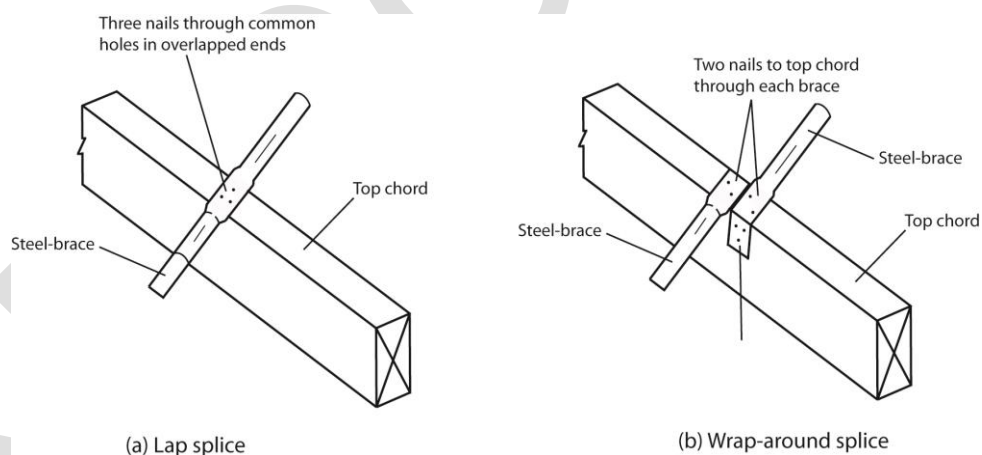


FIGURE 18: Typical Spliced Detail of Steel Brace

In addition to the battens, the top chords shall also be braced with diagonal steel braces. All steel braces shall be fixed to the top chord of each truss it crosses or the tie battens, as the case maybe, and anchored to the wall plates. For suggested roof bracing layout, refer to Figure 19, Figure 20 and Figure 21.

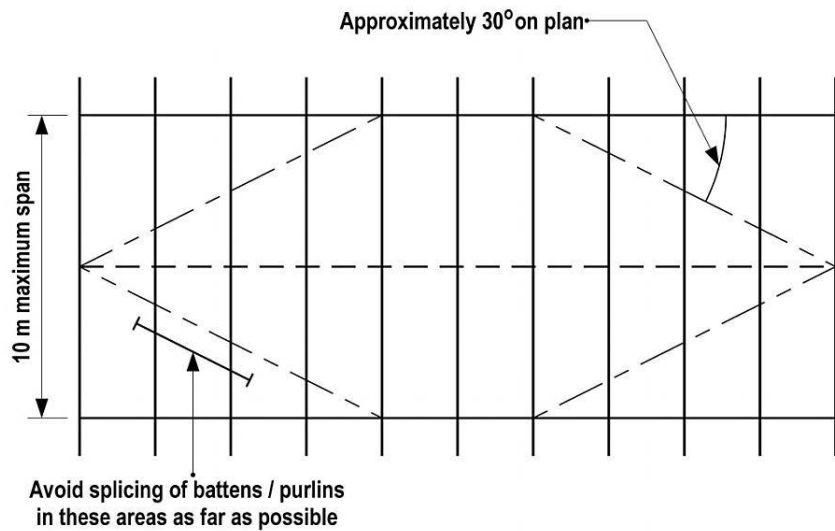
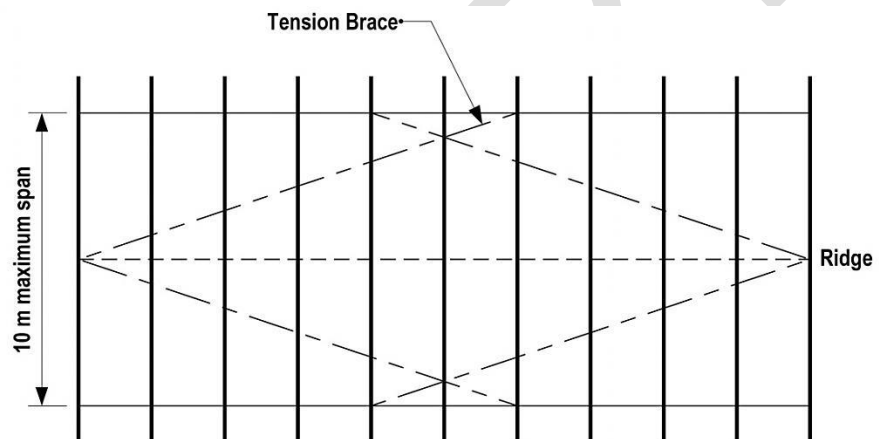
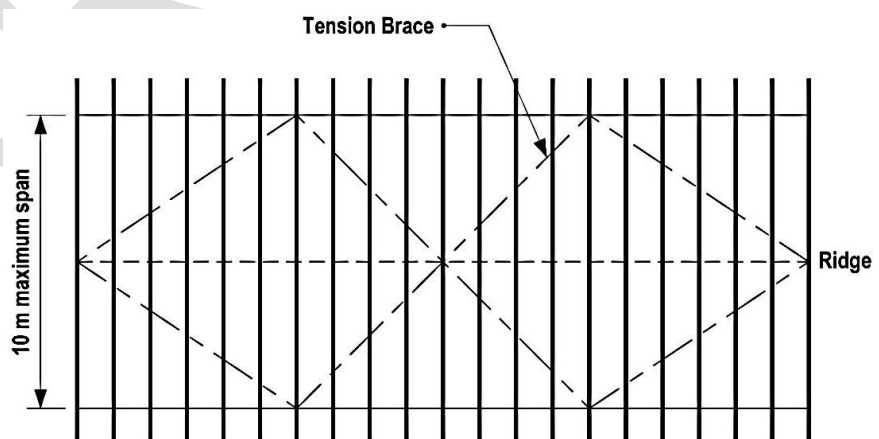


FIGURE 19: Suggested Roof Bracing Layout



a) Short roof, i.e less than 2 x span of truss



b) Medium long roof, i.e roof length = more than 2x span of truss

**FIGURE 20: Suggested Roof Bracing Layout (Tension)
Trusses up to 10 m span**

Notes :

- i) Angle between bracing and trusses viewed on plan, should be about 30°
- ii) Avoid spacing of batten / purlins in area bounded by bracing as far as possible.

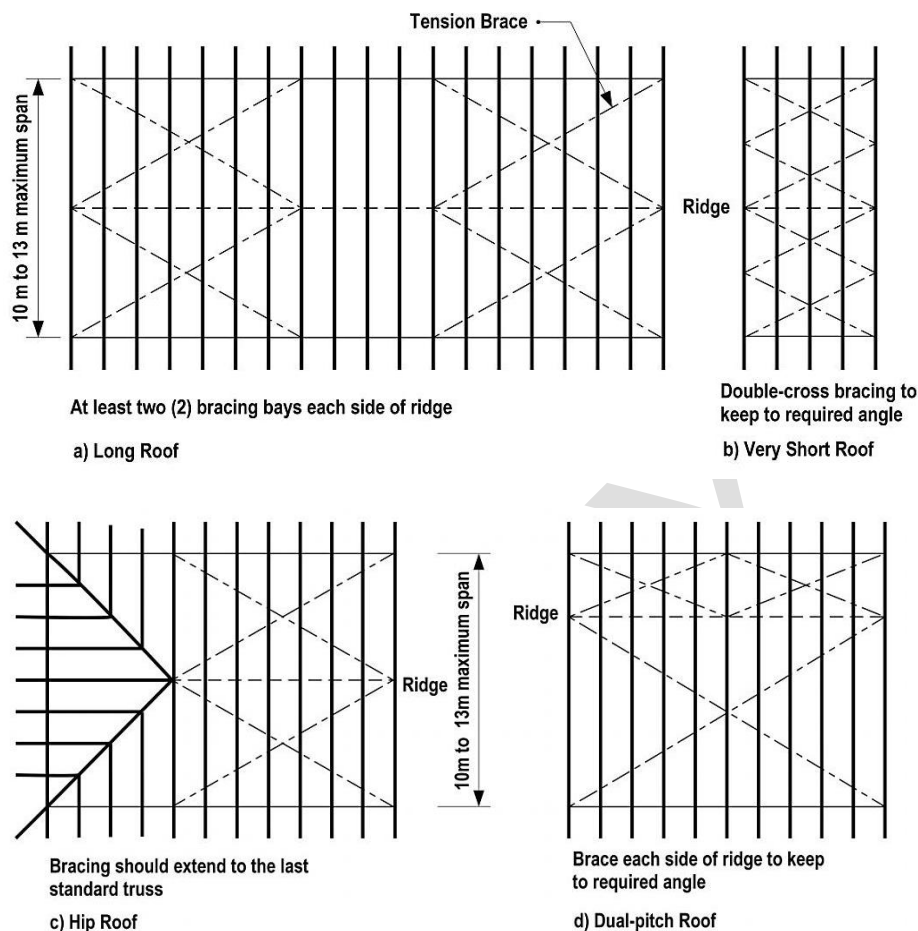


FIGURE 21: Suggested Roof Bracing Layout (Tension)
Trusses Spans 10m to 12m

Notes:

- i) Angle between bracing and trusses view on plan, should be about 30°
- ii) Avoid splicing of battens / purlins in areas not bounded by bracing as far as possible (refer to figure 16). Splicing is only allowed on top of truss.
- iii) All bracing on each side of the ridge should be crosses (refer to figure 16)

Where roof frame are built-up with saddle back, or cap trusses (Figure 22), the horizontal top chords of lower trusses shall also be braced according to the design requirements as stated in the fabrication drawings. Where the top chords are tied by continuous lateral battens, the battens shall be adequately fixed at all crossings of the top chords. Unless otherwise provided, all timber battens which are 70mmx45mm or larger shall be nailed with minimum two (2) nos. of nails.

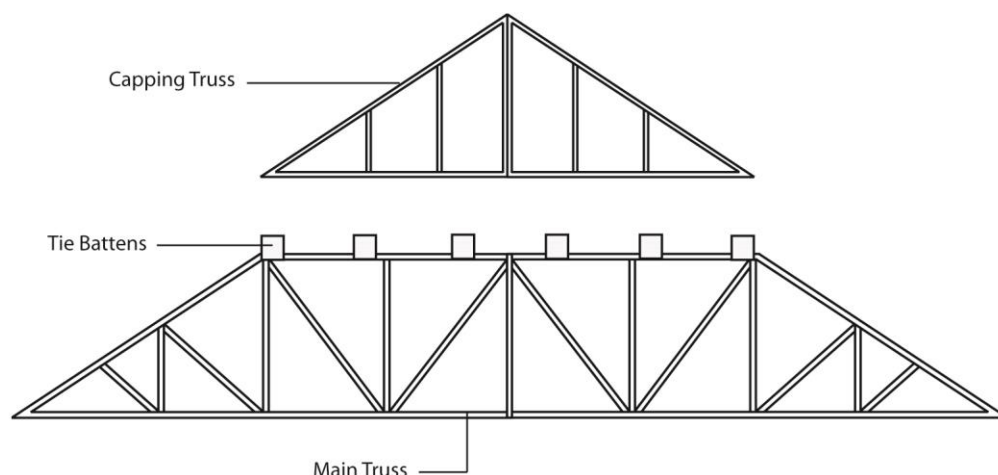


FIGURE 22: Typical Main and Capping Truss

9.5.8 Bottom Chord Bracing

Where bottom chord ties are provided, they shall be braced and anchored to a building element such as the wall plate, in the same manner as for top chord bracing or the compression chord bracing of the main trusses. A permanent bracing at the bottom chord shall be provided to restrain truss bottom chords against lateral buckling under wind uplift conditions if required.

9.5.9 Web bracing

Where web bracings are provided in the design, the web steel ties shall be fixed to the web of each truss at even spacing of the web with minimum two (2) nos. nails and braced to the truss with one bay of crossed steel braced at each end. Steel web ties shall be continuous, or where required, spliced by lapping over at least two adjacent trusses. (Figure 23)

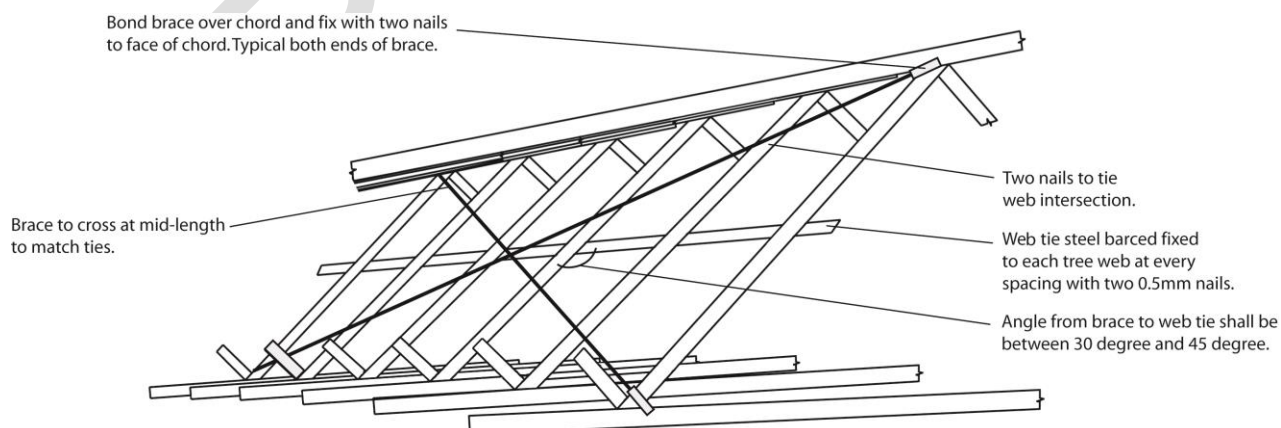


FIGURE 23: Suggested Web Ties and Fixing Details

9.6 Member Splicing

Hardwood truss members shall only be spliced at positions, as specified by the P.E..(Figure 24)

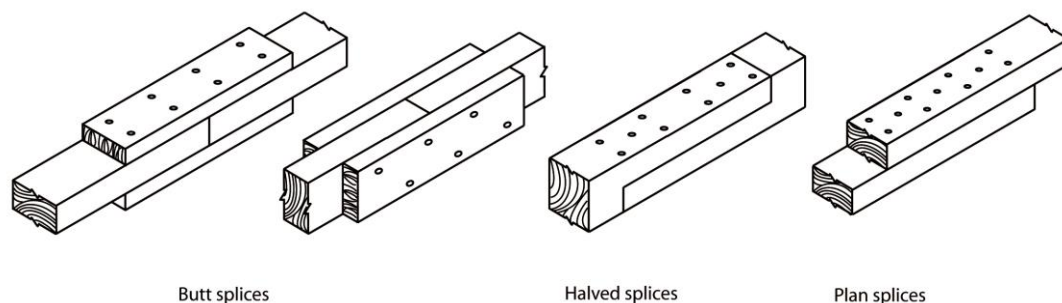


FIGURE 24: Splicing Details

9.7 Multiple Trusses

Where multiple trusses (i.e. 2 or more trusses acting together) are specified to support heavy loads or where a truss is required to support a large roof area due to its location as a girder truss, then all the elements of each multiple truss must act together to support the common load. Multiple truss elements must be nailed or bolted together in the specified manner prior to installation / loading.(Refer to Figure 22)

9.8 Installation of Roof Covering

9.8.1 Exposure of Roof Trusses

All roof trusses must be covered within two weeks from completion of installation. In situations where the Contractor is unable to comply with the above requirements, the contractor shall take appropriate steps to cover such trusses with approved temporary plastic sheeting until such time that they are ready to be covered with the permanent roof sheeting / tiles. All temporary coverings shall be well maintained and adequately ventilated at all times.

9.8.2 Roof Tiles

Roof tiles shall not be stacked on the roof trusses directly during laying out stage. Crane sling shall always remain taut (tension) throughout the process of unloading the tiles on the roof structure.

A palette is only allowed to sit onto trusses provided not more than 40 tiles or 150kg in weight are on the palette at any time during the work. Timber palette sizing shall conform to the spacing of the trusses i.e. the palette legs support must be able to sit on two trusses on each lift.

The tile stacks shall be distributed in staggered manner and evenly over the roof area. Tile stacks shall not be grouped or bundled into small areas which may cause overloading of top chord section.

The stack of roof tiles already hoisted shall not be left overnight and the tiler shall plan enough time for arranging the tiles before finishing off for the day.

9.8.3 Lightweight Covering

Lightweight coverings shall not be stacked on the roof trusses directly during laying out stage. Crane sling shall always remain taut (tension) throughout the process of unloading the lightweight coverings on the roof structure.

The lightweight covering stacks shall be distributed in staggered manner and evenly over the roof area. Lightweight covering stacks shall not be grouped or bundled into small areas which may cause overloading of top chord section. The weight of the lightweight covering stack shall not exceed 25kg/m^2 .

The stack of lightweight coverings already hoisted shall not be left overnight and the lightweight covering installer shall plan enough time for arranging the lightweight coverings before finishing off for the day.

10.0 ALTERATION TO TRUSSES

- 10.1 Element of the roof trusses, roof frames or roof ancillary members shall be cut, notched, removed or otherwise altered from its original state without the prior written approval of the S.P. and certified by the P.E.. All alteration shall be informed to the S.O..
- 10.2 Where defects exceeding the limits or permitted tolerances are detected, rectification works shall be carried out with the approval of the P.E.

Permohonan Penggunaan Sistem Kekuda Bumbung :

☐ Pre-Fabricated Cold Formed Steel☐ Factory Fabrication☐ Pre-Fabricated Timber☐ On-site Fabrication**A. Maklumat Asas Projek**

- i. Nama projek :
- ii. No. Kontrak :
- iii. Nama dan Alamat :
- Kontraktor Utama :

B. Maklumat Cadangan Sistem Kekuda

Adalah saya Kontraktor Utama projek ini memohon untuk menggunakan sistem kekuda pasangsiap tersebut sebagaimana butiran di bawah :

- i. Nama dan Alamat Pembekal Sistem :
- ii. Nama dan Alamat Perekabentuk:
- (Alamat Perekabentuk)
- (Nombor Pendaftaran LJM)
- iii. Nama dan Alamat Pemasang Bertauliah:
- (Sila sertakan Surat Perakuan Pemasang Bertauliah dari Pembekal Sistem)

C. Perakuan Kontraktor Utama

Adalah saya Kontraktor Utama projek ini yang memohon untuk menggunakan kekuda pasangsiap seperti butiran di atas, mengakui bahawa saya adalah bertanggungjawab sepenuhnya terhadap pembekalan, rekabentuk dan pemasangan kekuda pasangsiap tersebut.

Tarikh :

(Tandatangan Kontraktor Utama dan Cop Mohor)

D. Perakuan Pembekal Sistem

Saya mengesahkan bahawa sistem kekuda syarikat kami dicadangkan untuk projek di atas mencapai segala keperluan yang dinyatakan di dalam spesifikasi.

Tarikh :

(Tandatangan Pembekal Sistem dan Cop Mohor)

Appendix 2: Material Testing Requirements

No.	Item	Standard	Validity of Test Certificate (Year)	Check
1.0	Base steel			
1.1	Tensile test of base steel material	MS 1196 or MS ISO 6892	2	<input type="checkbox"/>
1.2	Determine adhesion and mass of aluminium-zinc base coating	MS 1196	2	<input type="checkbox"/>
1.3	Determine adhesion of zinc base coating	AS 1397	2	<input type="checkbox"/>
1.4	Determine mass of zinc base coating	AS 1397	2	<input type="checkbox"/>
1.5	Chemical composition	AS/NZS 1050	2	<input type="checkbox"/>
2.0	Fasteners			
2.1	Tensile, torsional and surface hardness	AS 3566.1	2	<input type="checkbox"/>
2.2	Shear	AS/NZS 4600	2	<input type="checkbox"/>
2.3	Salt spray	AS 3566.2	2	<input type="checkbox"/>
2.4	Coating composition and thickness	AS 3566.2	2	<input type="checkbox"/>
3.0	Anchor			
3.1	Pull out test	BS 5080: Part 1	2	<input type="checkbox"/>
3.2	Coating composition and thickness	AS 3566.2	2	<input type="checkbox"/>
4.0	Timber			
4.1	Identification of species & visual Grading	MS 1714:	Per project	<input type="checkbox"/>
4.2	Moisture content, density and specific gravity	BS 373 & MS 837	Per project	<input type="checkbox"/>
4.3	Dry salt retention	MS 360, MS 821 & MS 544: Part 10	Per project	<input type="checkbox"/>
4.4	Depth of penetration	MS 360 & MS 544: Part 10	Per project	<input type="checkbox"/>
4.5	Static bending & Compression parallel to grain <i>(Optional: where testing required for verification, the principal standard shall be selected, for the S.O.'s approval)</i>	BS 373	Per project	<input type="checkbox"/>

Appendix 3: Checklist on the Contractor Submission

A. Document Submission

No.	Submission Item	Check
1.	Completed Application Form	<input type="checkbox"/>
2.	Construction Drawing	<input type="checkbox"/>
3.	Analysis and Design Calculation	<input type="checkbox"/>
4.	Curriculum Vitae:	
i)	Professional Engineer	<input type="checkbox"/>
ii)	Installer	<input type="checkbox"/>
5.	Particular of the Fabricator	<input type="checkbox"/>
6.	Base Steel Mill Certificate(if required)	<input type="checkbox"/>
7.	Timber Test Certificate	<input type="checkbox"/>
8.	Technical Specification for Screw, Nail, Bolt and Anchor Bolt	<input type="checkbox"/>
9.	Fastener Lab Test Certificate (if required)	<input type="checkbox"/>
10.	Bomba's approval	<input type="checkbox"/>
11.	Quality Assurance and Quality Control	<input type="checkbox"/>

B. Completeness of submission

No.	Submission Item	Check
1.0	Application Form:	
-	Completed with type of fabrication	<input type="checkbox"/>
-	Information on P.E, Fabricator and installer	<input type="checkbox"/>
-	Endorsed by the S.P.	<input type="checkbox"/>
2.0	Particular and the C.V:	
-	Valid P.E. registration with Board of Engineer Malaysia (BEM).	<input type="checkbox"/>
-	Fabricator appointment document by the S.P..	<input type="checkbox"/>
-	Fabricator acceptance document on the appointment.	<input type="checkbox"/>
-	Fabricator registration certificate with CIDB.	<input type="checkbox"/>
-	Installer competency certificate from CIDB.	<input type="checkbox"/>
3.0	Analysis and Design Calculation	
-	Endorsed by the P.E.	<input type="checkbox"/>
-	Loading criteria	<input type="checkbox"/>
-	Truss analysis	<input type="checkbox"/>
-	Member design	<input type="checkbox"/>
-	Bracing design	<input type="checkbox"/>
-	Tie down and anchorage design	<input type="checkbox"/>
-	Connection design	<input type="checkbox"/>
-	Fastener and anchor technical specification	<input type="checkbox"/>
-	Base steel mill certificate	<input type="checkbox"/>

Appendix 3: Checklist on the Contractor Submission

No.	Submission Item	Check
4.0	Construction Drawing (minimum content):	
-	Endorsed by the P.E. on every sheet of drawings	<input type="checkbox"/>
-	Layout drawing	<input type="checkbox"/>
-	Section properties	<input type="checkbox"/>
-	Accessories properties (ex. L-Bracket, Triple L-grip etc)	<input type="checkbox"/>
-	Bracing layout	<input type="checkbox"/>
-	Truss configuration	<input type="checkbox"/>
-	Connection detail	<input type="checkbox"/>
-	Support detail (wall plate and anchor)	<input type="checkbox"/>
-	Technical notes on base steel, fastener, anchor bolt and protective coating	<input type="checkbox"/>
5.0	Construction Drawing (Compliance to specification):	
-	Maximum span : 12 m	<input type="checkbox"/>
-	Maximum spacing : 1.2 m	<input type="checkbox"/>
-	Maximum top chord lengths (heavy roofing types) : 2.5 m	<input type="checkbox"/>
-	Maximum top chord lengths (lightweight roofing types) : 3.0 m	<input type="checkbox"/>
-	Maximum bottom chord panels length : 3.5 m	<input type="checkbox"/>
-	Minimum size timber (wall plate) : 50 mm x 100 mm	<input type="checkbox"/>
6.0	Technical notes and certificate compliance to specification:	
-	Minimum grade for timber to the requirement of Clause 7.1	<input type="checkbox"/>
-	Minimum for fastener (grade & strength) to the requirement of Clause 7.2	<input type="checkbox"/>
-	Minimum protective coating for base steel to the requirement of Clause 7.3	<input type="checkbox"/>
-	Minimum protective coating for anchor to the requirement of Clause 7.4	<input type="checkbox"/>
-	Minimum for wall plate (grade and strength) to the requirement of Clause 7.5	<input type="checkbox"/>
-	Minimum size for bracing to the requirement of Clause 7.6	<input type="checkbox"/>
7.0	Quality Assurance and Control	
-	Quality Assurance and Control Plan	<input type="checkbox"/>
-	Method Statement	<input type="checkbox"/>
-	Installation Team Chart	<input type="checkbox"/>
-	Inspection Checklist	<input type="checkbox"/>

Appendix 4: Guidelines on the Contents of Warranty Certificate

Warranty certificate from the S.P. shall have contents not limited to the followings;

- 1) Statement that the S.P. is registered with the regulatory body by stating the registered name, registration type, field, category or class; whichever applicable, registration number and registered business address.
- 2) Statement that the truss system has been design in accordance to the adopted principal design standard.
- 3) Statement that the truss system has been designed, fabricated, supplied and installed by the S.P. in accordance to the S.P.'s requirements and this specification.
- 4) Statement that the warranty will be extended to the Government of Malaysia as the users of the truss system.
- 5) Statements that the period of warranty shall not be less than ten (10) years commencing from the date of Certificate of Practical Completion (CPC) issued to the main contractor. Commencement and expiry date of warranty shall be clearly written in the warranty certificate.
- 6) Statement that the S.P. warrants all elements encompass the truss system; the steel sections, fasteners, bracing, batten and anchor:-
 - i) Will not corrode under the specified environment corrosivity within the warranty period;
 - ii) Will not deflect excessively beyond the specified tolerance or fail under the intended designed parameter within the warranty period;
 - iii) Shall not have any defect and damages; corrosion, perforation, buckle, twisting or distorted, due to workmanship at the time of issuance of CPC.
- 7) Statement that, if truss system under warranty period are found to have defect or damage under the S.P.'s fault, the S.P. will undertake to investigate, test, repair or replace at S.P.'s own cost.
- 8) The S.P. may insert the term and condition in the warranty statement for the warranted item, but shall be limited to the extent that such term and conditions are not effecting or reducing the S.P.'s undertaking in paragraph (7).
- 9) The warranty statements shall be signed-off only by the S.P.'s where information on the names, I/C. no. and designation shall be clearly stated. The warranty statements shall then be endorsed with S.P.'s seal.

Appendix 5: Special Provisions for Timber Roof Truss with Span more than 12 m but not exceeding 16 m

The information not limited to the followings shall be submitted to Pengarah Kanan, Cawangan Kejuruteraan Awam, Struktur & Jambatan (CKASJ) for the design, fabrication and installation of roof truss with span more than 12 m but not exceeding 16 m:-

1.0 Analysis, design and drawings duly endorsed by the P.E.:-

- 1.1 Actual design load data which also included construction loads; Raw data submission without analysis is unacceptable.
- 1.2 Truss stability design and drawings with information on:-
 - 1.2.1 Permanent bracing and ties design at every plane of trusses;
 - 1.2.2 Design for hoisting and temporary stability;
 - 1.2.3 Analytical magnitude of translation or rotation at trusses hill points; at truss support position;
 - 1.2.4 Checking on the truss supporting structure;
 - 1.2.5 Details of bracings termination points;
 - 1.2.6 Deflection limits and camber requirement;
 - 1.2.7 Drawings on the truss layout and bracings; clearly presented to enable checking.
- 1.3 Truss member design and drawings with information on:-
 - 1.3.1 Specified position of permanent restraint of compression steel section on both directions of the section's local axes;
 - 1.3.2 Where applicable, a design shall consider effect of construction in stages;
 - 1.3.3 Splicing or stiffeners design at a specified location;
 - 1.3.4 Local buckling check at the location of point load;
 - 1.3.5 Drawings with clear member length for every truss configuration.
- 1.4 Design and drawings of joints with information on:-
 - 1.4.1 Type, strength and dimension of fastener;
 - 1.4.2 Type, strength and dimension of truss accessories whereby connected to the fastener;
 - 1.4.3 Where applicable, a design shall consider effect of construction in stages;
 - 1.4.4 Stress distribution at every point of fastener;
 - 1.4.5 Design calculation of joint;
 - 1.4.6 Design of truss accessories;
 - 1.4.7 Design of joint for splicing or stiffeners;
 - 1.4.8 Joint details with specified spacing of fastener;
 - 1.4.9 Joint details at support and bracings termination point.
- 1.5 Information that all minimum provisions for trusses up to 12 m have been included.

Appendix 5: Special Provision for Timber Roof Truss with Span more than 12 m but not exceeding 16 m

2.0 Storage, handling, hoisting, erection and fixing procedure duly endorsed by the P.E.:-

- 2.1 Detailed method statement with information on:-
 - 2.1.1 Loadings including construction loadings.
 - 2.1.2 Supporting structure must be stable and adequately restrained and braced;
 - 2.1.3 Temporary restraint and bracing plan;
 - 2.1.4 Type of lifting equipment and special hoisting requirements;
 - 2.1.5 Competent crane operator;
 - 2.1.6 Hoisting point on trusses as per design;
 - 2.1.7 Temporary interior support;
 - 2.1.8 Procedure for site fixings of joints, supports and splicing;
 - 2.1.9 Maximum stack of tiles during installation;
 - 2.1.10 Deflection, movement or rotation check methods during and after the release of temporary supports.
- 2.2 Fabrication process on factory.
- 2.3 Designated fabrication and installation team.
- 2.4 Inspection checklist for trusses pre-installation process.
- 2.5 Inspection checklist for trusses post installation process.

Appendix 6: Document Submission For Quality Assurance and Control

1.0 Process Flow Charts

- 1.1 Total System Quality Check
- 1.2 Truss Plant Equipment Maintenance Process
- 1.3 Timber Selection Check in Truss Plant
- 1.4 Verification for Timber at:
 - i. Truss Fabricator/Sawmill with licensed timber grader
 - ii. Truss Fabricator with treatment facilities
 - iii. Truss Fabricator without treatment facilities

2.0 Checklists

- 2.1 Truss Design and Detail
- 2.2 Truss Fabricating Equipment
- 2.3 Documentation for Site Measurement
- 2.4 Timber and Trusses at Truss Plant
- 2.5 Truss Installation

SCHEDULE A : Strength Groups of Timber (MS 544-Table 2.3)

S.G1	S.G2	S.G3	S.G4	S.G5	S.G6	S.G7
A) Naturally Durable						
Balau	Belian	Bekak	Giam	Jati		
Bitis	Mata ulat	Delek	Malabera	Tembusu		
Chenga	Kekaton	KerANJI	Merbau			
Penaga			Resak			
B) Requiring Treatment						
	Dedaru	Agoho	Berangan	Alan Bunga	Bayur	Ara
	Kempas	Balau,Merah	Dedali	Babal	Damar Minyak	Batai
	Merbatu	Kelat	Derum	Balek Angin Bopeng	Durian	Geronggang
	Mertas	Kembang Semangkuk	Kapur	Bintangor	Jelutung	Laran
		Kulim	Kasai	Brazil Nut	Janitri	Pelajau
		Pauh Kijang	Keruntum	Gerutu	Jongkong	Pulai
		Penyau	Mempening	Kundur	Kasah	Sesendok
		Perah	Meransi	Kedondong	Machang	Terentang
		Pelaling	Meranti Bakau	Keledang	Medang	
		Ranggu	Merawan	Keruing	Melantai/Kawang	
		Ru	Merpauh	Ketapang	Meranti,Merah Muda	
		Surian Batu	Nyalin	Kungkur	Meranti, Kuning	
		Tualang	Perupuk	Melunak	Mersawa	
			Punah	Mempisang	Sengkurat	
			Rengas	Mengkulang	Terap	
			Simpoh	Meranti,MerahTua		
				Meranti,Putih		
				Nyatuh		
				Penarahan		
				Petai		
				Ramin		
				Kayu Getah		
				Sengkuang		
				Sepetir		
				Tetebu		
NOTES:						
1. For naturally durable timbers, sapwood should be excluded. If sapwood is included, preservative treatment is necessary. (Source:MS360,1986)						
2. For Timber requiring treatment, they should be amenable to preservative treatment.						

REFERENCES

Malaysian Standard

- [1] **MS 360** :Treatment of timber with Copper/Chrome/Arsenic wood preservatives-specification
- [2] **MS 544 : PART 1** : Code of practice for structural use of timber: Part 1 - General
- [3] **MS 544 : PART 2** : Code of practice for structural use of timber: Part 2 - Permissible stress design of solid timber
- [4] **MS 544 : PART 5** : Code of practice for structural use of timber: Part 5 - Timber Joints
- [5] **MS 544: PART 10** : Code of practice for structural use of timber: Part 10 - Preservative treatment of structural timber
- [6] **MS 696** : Specification for Coal Tar Creosote for the preservation of timber
- [7] **MS 733** : Specification for Copper/Chrome/Arsenic wood preservatives
- [8] **MS 734** : Specification for wood preservation by means of pressure Creosoting
- [9] **MS 740** : Specification for hot-dip galvanized coatings on iron and steel
- [10] **MS 821** : Method for quantitative analysis of copper/chrome/arsenic preservative formulation and treated timber (DSR calculation based on sodium salt)
- [11] **MS 833** : Method for the qualitative analysis of wood preservatives and treated timber
- [12] **MS 837** : Method for the determination of moisture content of timber
- [13] **MS 995** : Specification for Boron timber preservatives
- [14] **MS 1196** : Continuous hot-dip aluminium/zinc coated steel sheet of commercial, drawing and structural qualities
- [15] **MS 1302** : Specification for Light Organic Solvent Preservative (LOSP) treatment of timber
- [16] **MS 1553** : Code of practice on wind loading for building structure.
- [17] **MS 1714** : Specification for visual strength grading of tropical hardwood
- [18] **MS 2384**: Continuous Hot-Dip Zinc-Coated Carbon Steel Sheet of Structural Quality

British Standard

- [1] **BS 373** : Methods of testing small clear specimens of timber (static bending, Compression parallel to grain and Moisture content, Density & Specific gravity.
- [2] **BS 5080: Part 1** : Structural fixings in concrete and masonry. Method of test for tensile loading
- [3] **BS EN ISO 3506** : Mechanical properties of corrosion-resistant stainless steel fasteners

Australia Standard and Australian/New Zealand Standard

- [1] **AS 1397** :Steel sheet and strip—Hot-dipped zinc-coated or aluminium/zinc-coated
- [2] **AS 2334** : Steel nails – Metric Series
- [3] **AS 1649** : Timber – Methods of Test for Mechanical Fasteners and Connectors – basic Working Loads and Characteristics Strength
- [4] **AS/NZS** : Specification for Preservative Treatment

International Organization for Standardization Standard (ISO Standard)

- [1] **ISO 9223**: Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation

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