



S P E C I F I C A T I O N PRE FABRICATED COLD FORMED STEEL ROOF TRUSSES

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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 in addition 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 shall also contain adequate information on work 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 reflects 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.

This specification also supersedes Clause 12.0, Prefabricated Cold Formed Steel Roof Trusses, JKR Standard Specification for Structural Steel Work. JKR No. 20600-0019-99.

2.2 General Truss Limitation

This specification is intended to apply to cold formed roof trusses within the following general limitations:-

- i) Maximum unsupported truss span 13.00 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) Minimum base steel thickness for main truss member shall be:-
 - i) 1.0 mm for unsymmetrical section or open cross section;
 - ii) 0.6 mm for symmetrical machine-manufactured box or closed cross section.
- v) Minimum base steel thickness for other truss element shall be:-
 - i) 0.5 mm for batten or purlin;
 - ii) 1.2 mm for wall plate;
 - iii) 1.0 mm for all bracings.
- vi) Minimum depth shall be 75 mm in the direction of local major axis of truss member section.
- vii) Minimum flange width shall be 35 mm in the direction of local minor axis of truss member section.
- viii) Connector shall only be of hexagon head or wafer-head self-tapping screw or bolt. Welding is not allowed as fastener.

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.

This specification requires that all roofing system up to 13 metres span shall have 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 drawing 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 in Appendix 1 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 the 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, connections 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, splicings 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, steel grades, section properties of members, length of members in each truss configuration, properties of truss accessories, specification of corrosion protection, specification of 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 base steel, fastener and anchor of which the designs refers to 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

For trusses more than 13 metres but not exceeding 20 metres span, the S.O. shall only issue approval after obtaining clearance in writing by Pengarah Kanan, CKASJ or any person or persons delegated in writing by him. Refer to Appendix 5 for the submission requirements and conditions or any updated version of the appendix circulated in writing by Pengarah Kanan, CKASJ or any other official means of circulation accepted by the government. Approval shall be solely based on project to project basis.

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 13 m 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 the respective Eurocode (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 absence 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 standards 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 the 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) Certification prior to issuance of Certificate of Practical Completion (CPC) by the Contractor.

2.10 Fire Protection

Unless otherwise indicated in the drawings, all fire protection 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. 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 then obtain endorsement from the Jabatan Bomba dan Penyelamat Malaysia and provide a copy of the valid endorsed certification through the Contractor to the S.O..

3.0 QUALITY ASSURANCE AND CONTROL

3.1 Quality Assurance Program

The Contractor shall submit to the S.O. a program on Quality Assurance on the roof truss fabrication, handling, storage, transportation and installation. The program shall indicate the nature, frequency and the schedule of all compliance and verification tests to be carried out by the Contractor.

3.2 Test Result Approval

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.

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. as required in Clause 2.5 of this specification.

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 bolted 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 steel sections and fasteners conform to the relevant standards and are protected against corrosion, together with proof that such certification has been verified by tests carried out by SIRIM or any other recognised institutions, for the current year or the previous year.
- iii) Certification that the correct steel grades were used in the fabrication of the trusses and roof structure by including a copy of the mill test certificate and Data sheets for the steel used in the truss system.
- iv) Two (2) sets of as built drawings of the roof truss system signed by the S.P. and certified by a P.E..

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: 2002, whichever standard adopted. However, the actual weight of ceiling, mechanical and electrical (M&E) services shall not be less than 0.25 kN/m².

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: 2002, whichever standard adopted. Notwithstanding to the value in the standard, the minimum value of imposed load shall be 0.25 kN/m² 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: 2002, BS 6399: Part 2 or BS EN 1991-1-4: 2005, whichever standard adopted, with the minimum basic wind speed as per Clause 2.2 of this specification or the value in MS 1553: 2002 whichever higher.

Load combinations shall be clearly identified (as per BS 5950-5:1998 or BS EN 1993-1-3: 2006 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) 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 steel truss members, bracings, connections, wall plate and truss accessories shall be in accordance to the following alternative of principal standards:-

- i) AS/NZS 4600: 2005
- ii) BS EN 1993-1-3: 2006

5.3 Eccentricity

The centroidal axes of the connected members should meet at a point, otherwise the effect of eccentricity of the connection should be taken into account in the design of the members and their connections.

5.4 Additional Design Consideration

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

5.4.1 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.

5.4.2 Architectural Features

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

5.4.3 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.

5.4.4 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.

5.4.5 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.

5.4.6 Non-Load Bearing Wall

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

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 shall be indicated in the drawing.
- 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 typical isometric view of bracing layout.

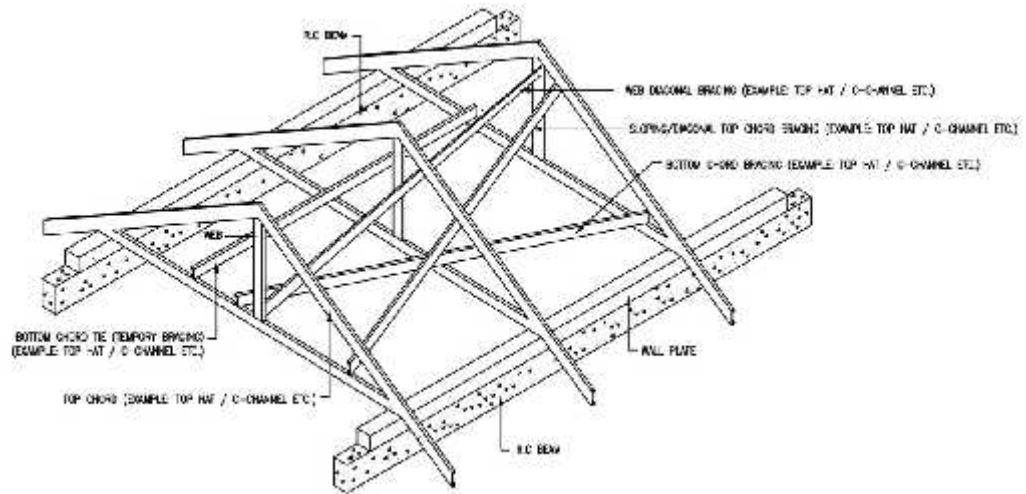


FIGURE 1: Isometric View of Bracing Layout

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. Roof truss member shall be connected with minimum of three (3) nos. of fasteners.

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. of hexagon washer-head or wafer-head self-drilling tek screws. Refer to Figure 2 for suggested roof batten detail.

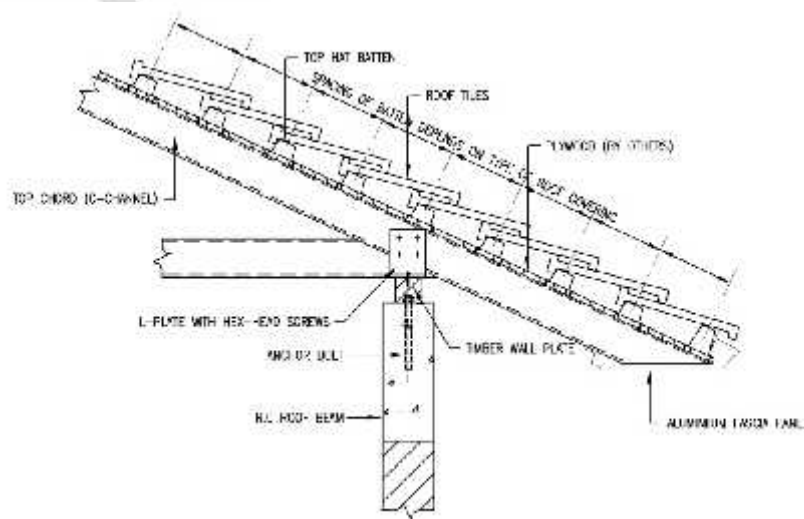


FIGURE 2: Roof Batten Detail

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. Refer to Figure 3, 3a & 3b for suggested ceiling batten detail.

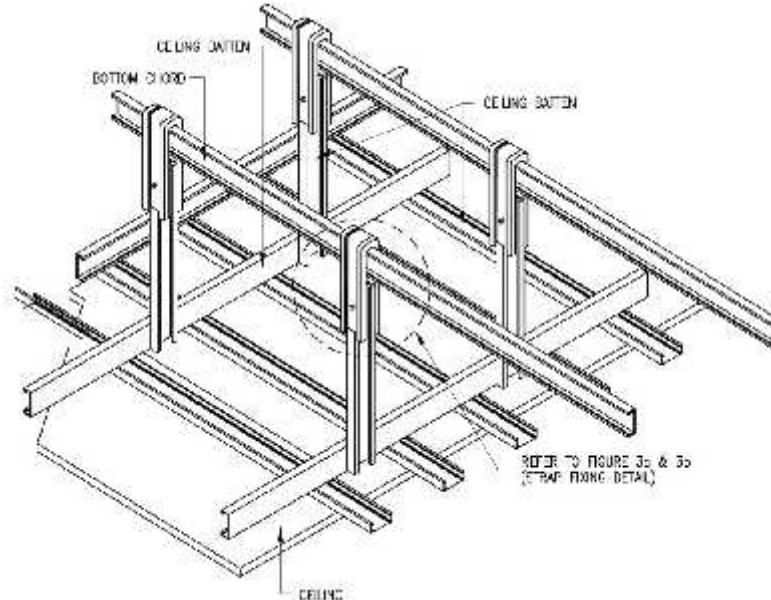
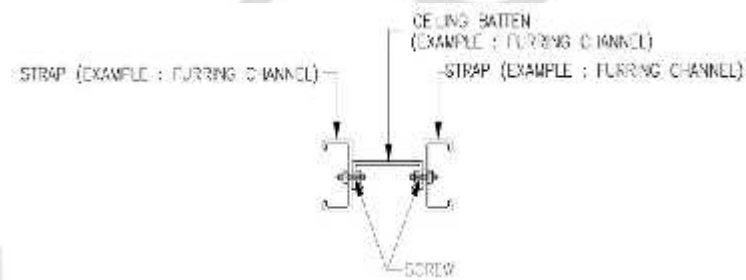
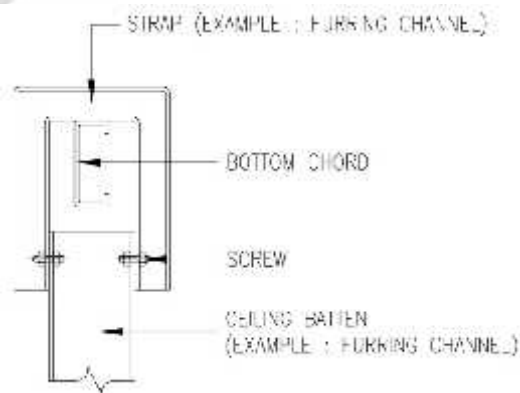


FIGURE 3: Ceiling Battens Details



**FIGURE 3a: Strap Fixing Detail
(Plan View)**



**FIGURE 3b: Strap Fixing Detail
(Section View)**

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. Suggested tie down as shown in Figure 4, Figure 5 & Figure 6

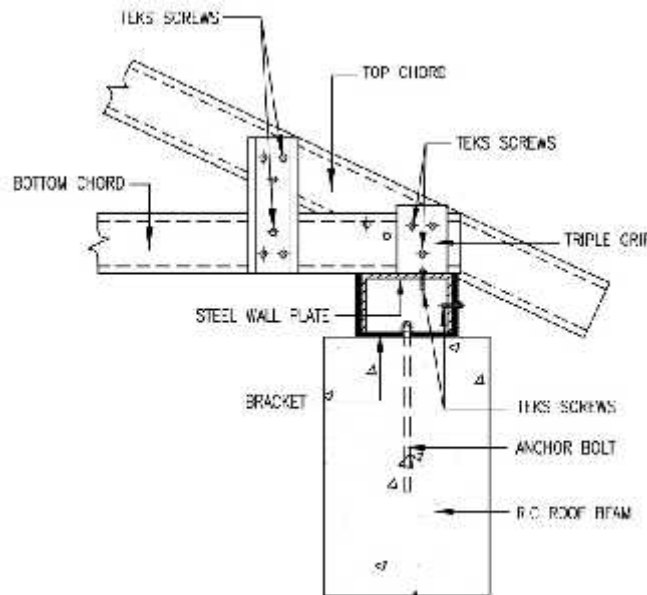


FIGURE 4: Holding Down Connection for Steel Wall Plate

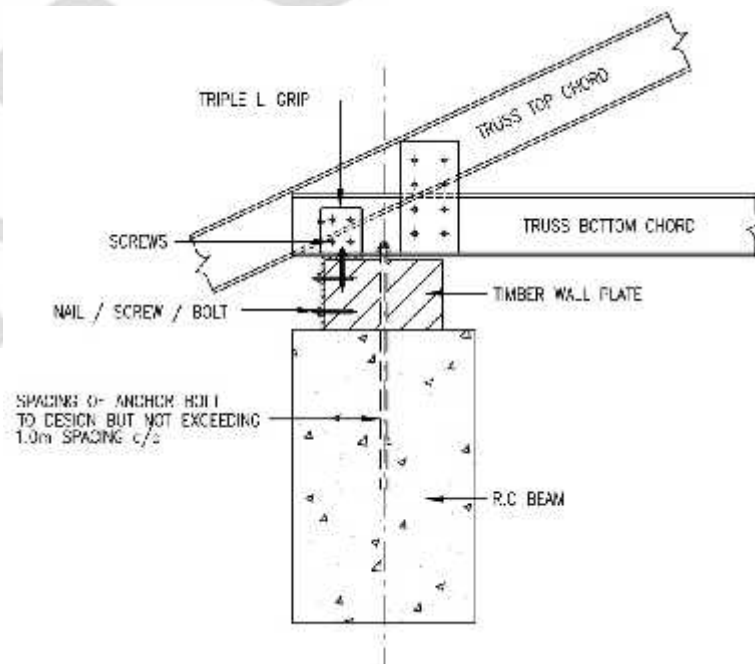


FIGURE 5: Holding Down Connection for Timber Wall Plate

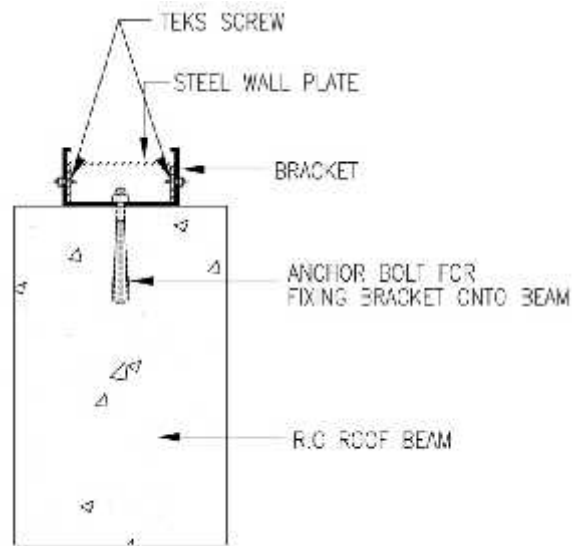


FIGURE 6: Section View for Bracket and Anchor Bolt

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 Steel Wall Plate

Thickness of bearing wall plate shall be based on design but the minimum base steel thickness shall not less than 1.2 mm. Width of the bearing wall plate shall not be less 75 mm for span not exceeding 10 m. For clear span between 10 m to 13 m, the minimum width of the bearing wall plate shall be 100 mm. The spacing of anchor bolts shall be in accordance to design but not exceeding 1.0 m spacing centre to centre. Refer to Figure 7 for suggested connection detail for steel wall plate.

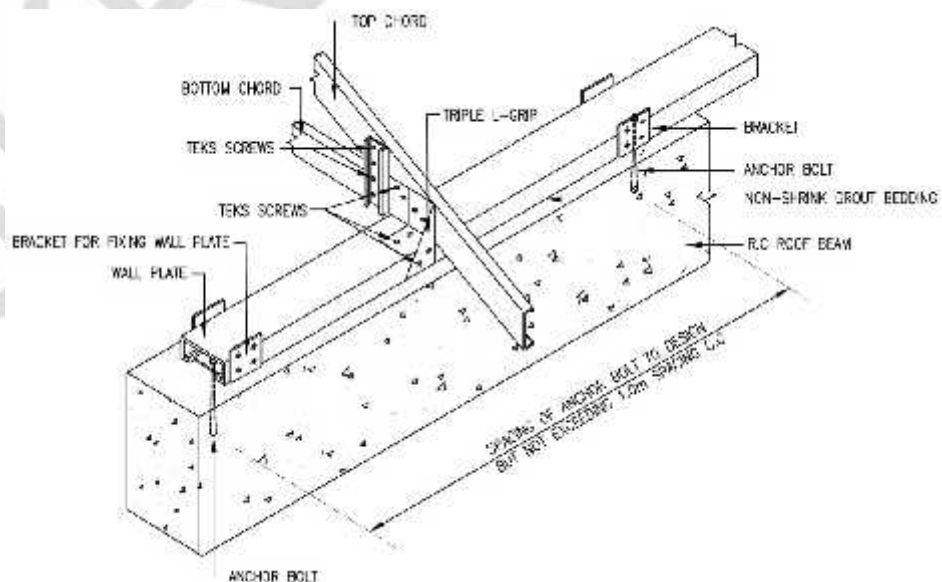


FIGURE 7: Connection Detail for Steel Wall Plate

6.8.2 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. Refer to Figure 8 for suggested connection detail for timber wall plate.

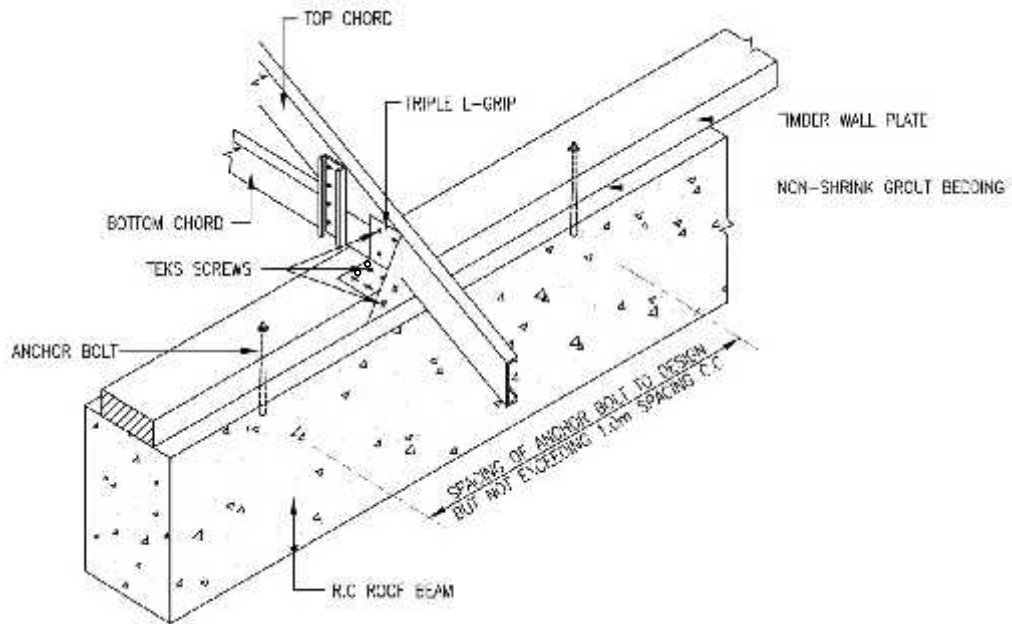


FIGURE 8: Connection Detail for Timber Wall Plate

7.0 MATERIAL AND TESTING

7.1 Steel Requirement

7.1.1 Base Steel Specification

Steel grade used for the roof truss system shall conform to structural-quality steel in MS 1196: 2004. For steel with a base steel thickness of less than or equal to 1.2 mm, the steel grade shall be G550 with the minimum lower yield stress of 550 MPa. For steel with a base steel thickness of greater than 1.2 mm, the steel grade shall be G450 with the minimum lower yield stress of 450 MPa. All steel braces shall have at least a structural-quality steel with minimum base steel thickness of 1.0 mm and minimum lower yield stress of 250 MPa. Where steel grade is not specified in MS 1196: 2004, the grade shall conform to AS 1397.

7.1.2 Coating Specification

Minimum coating mass of base steel on each surface shall be in accordance to AS 1397-2001. 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. All steel braces shall be hot-dipped galvanized with a zinc coating conforming to Class Z275.

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.

7.2 Fastener Requirement

7.2.1 Specification

All requirements for fasteners shall comply with AS 3566.1-2002 for self-drilling screw or BS EN 14399-1 for bolt and shall be of a gauge and length recommended by the S.P.. The usage of rubber washer shall not be allowed on a permanent basis.

For self-drilling screw, coarse thread fasteners (up to 16 threads per inch) shall be used for fastening steel up to 2.4 mm. Fine thread fasteners (more than 16 threads per inch) shall be used for fastening thicker steel sections where the thickness between 2.4 mm - 3.2 mm.

Self-drilling screws for fixing to timber with hexagon washer-heads shall be able to penetrate steel of 0.48 mm thickness and grade G550 to AS 1397-2001. The full form threads shall extend close to the head.

7.2.2 Coating

All fasteners; self-drilling screw, bolt, etc, used in roof truss construction, shall be coated by hot-dip galvanizing, sherardizing or other suitable treatment against corrosion and shall comply with minimum Class 2 corrosion resistances to Table 2, AS 3566.2-2002.

Where truss system constructed in area with the outdoor atmospheric environment to ISO 9223 is classified under the corrosivity category, C3 (medium corrosivity), then the coating shall comply with the minimum Class 3 corrosion resistances.

7.3 Anchor Requirement

7.3.1 Specification

All anchors in which all the metal parts directly anchored in the concrete and designed 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.

7.3.2 Coating

All carbon steel anchors shall be protective coated by hot-dipped galvanized or sherardized to a minimum thickness of 42 micron.

7.4 Wall Plate

7.4.1 Base Steel Specification

Steel grade used for the wall plate shall conform to structural-quality steel in MS 1196: 2004 with the minimum base steel thickness 1.2 mm. The steel grade shall be G450 with the minimum lower yield stress of 450 MPa. The coating specification according shall be in accordance to Clause 7.1.2.

7.4.2 Timber Specification

Timber strength group used for the wall plate support and the treatment shall refer to MS 544: Part 2: 2001, MS 544: Part 10: 2003 and MS 733: 2008. The strength group shall be SG1, SG2, or SG3. The minimum size of the timber shall be 50 mm x 100 mm.

7.5 Mill Certificate and Test Report

7.5.1 Base Steel

The S.P. shall submit mill test certificates confirming the grade of the steel from the steel manufacturer.

For a particular lot of coil for section production, the S.P. shall furnish the S.O. with valid copy of test certificate from SIRIM Berhad or other S.O. approved testing laboratory confirming the compliance of the properties, performance, coating and chemical composition to the standards requirement and testing method as per Appendix 2. The validity of test certificate shall be 2 years from the date of testing submission.

7.5.2 Fastener

The S.P. shall submit technical specification from the fastener manufacturer confirming the dimension compliance, strength and coating properties of fastener to standard.

For a particular batch of fastener, the S.P. 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 as per Appendix 2. The validity of test certificate shall be two (2) years from the date of testing submission.

7.5.3 Anchor

For a particular batch of anchor, the S.P. 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 as per Appendix 2. The validity of test certificate shall be two (2) years from the date of testing submission.

7.5.4 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.

8.0 MANUFACTURING

8.1 Manufacturing Capability

8.1.1 Production Premise

All production premises shall have appropriate licenses or permits issued by relevant Local Authority allowing the S.P. to conduct manufacturing activities at the premises. The address of the premises as appeared on the Local Authority licenses or permits shall be the same with the address stated in the application documents approved by JKR.

8.1.2 Machinery

Machines shall be operated in accordance with their manufacturer's operating manual. They shall be regularly checked and maintained in accordance with manufacturer's recommendations. They shall also be calibrated at least annually and the certificates of calibration shall be submitted to the S.O. for verification.

All roof truss components shall be factory made. The S.P. shall make available for inspection at the production premises the appropriate rolling and cutting machines used to produce proposed section.

All equipment shall be checked and inspected in accordance with the S.P.'s quality control plan. The inspection records shall be made available to the S.O. for verification.

8.2 Production Quality Control

8.2.1 Material

Quality of the material shall be checked before and after the production cycle. The records shall be produced as and when required by the S.O..

All documents including mill certificates, SIRIM or other approved testing laboratory test results and in-house test results shall be retained by the S.P. for a period equivalent to the project warranty period with a copy retained by the S.O..

8.2.2 Material Storage

The S.P. shall store raw materials on raised supports, protected from weather and covered with waterproof covering. The S.P. shall also ensure adequate air circulation and ventilation are available and no deterioration or damage occur before and during the manufacturing process.

8.2.3 Production Process

The S.P. shall submit to the S.O. the Quality Assurance Documents together with Quality Control Plan relevant to the production process. The S.P. shall maintain all documents generated as a result of implementing the Quality Control Plan at all time for inspection. Quality audit shall be carried out annually to ensure the Quality Control Plan are implemented and their requirements adhered to. Quality Reports shall be produced as and when required by the S.O..

The S.P. shall demonstrate that material traceability records and identification marks on finished products are traceable to the Mill Test Certificate and/or Production Certificate. Such identification marks shall allow relevant information such as but not limited to, sizes, length, steel grade and corrosion protection to be easily identified. The marks shall also be made permanent on surface of the product.

9.0 TRUSS FABRICATIONS

Unless otherwise approved by the S.O., roof trusses shall be preferably assembled and fabricated in the factory against on-site fabrication.

9.1 Factory Fabrication

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

Steel cutting, punching or drilling shall be performed using sawing or shearing type of tools and equipment.

9.2 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.

Steel cutting, punching or drilling shall be performed using sawing or shearing type of tools and equipment.

9.3 Site Measurement

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

9.4 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.

9.5 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.

9.6 Splicing

Unless expressly provided for in the design, no splicing of members shall be allowed in the truss.

9.7 Drilling

Unless expressly provided for in the design, no splicing of members shall be allowed in the truss.

10.0 TRUSS HANDLING AND INSTALLATION

10.1 Handling

10.1.1 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. All installation of roof trusses shall be checked and certified by the P.E..

10.1.2 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 or their coatings. 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.

10.1.3 During lifting, all roof trusses shall be propped in a manner that minimizes lateral bending and distortion, and strain on the joints.

10.1.4 Where trusses are stored on site (Figure 9(a) and Figure 9(b)), 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 2.0 m to 2.5 m 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

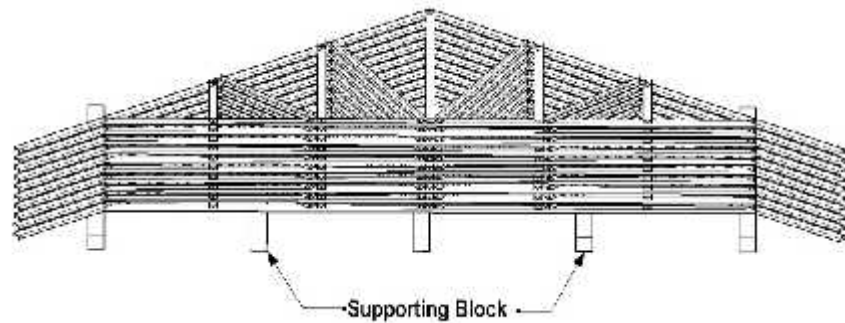


FIGURE 9(a): Storage of Trusses at Site
(Trussed Rafter Stacked Horizontally)

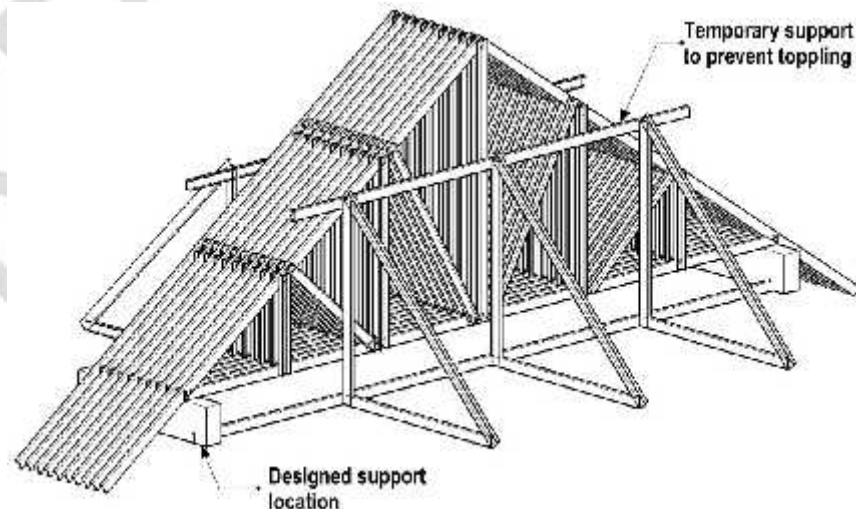


FIGURE 9(b): Storage of Trusses at Site
(Trussed Rafter stacked vertically before covering)

10.2 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.

10.3 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.

10.3.1 Verticality

All trusses, Figure 10(a) and Figure 10(b) 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) 50 mm
- c) $H/50$

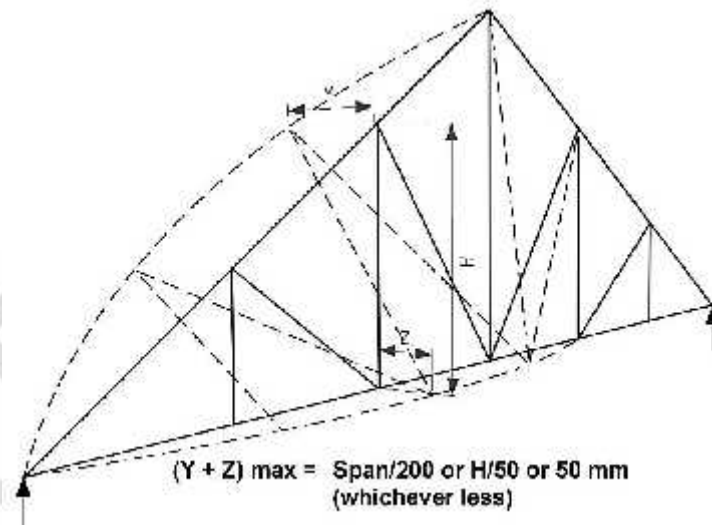


Figure 10(a): Tolerance on verticality (local)

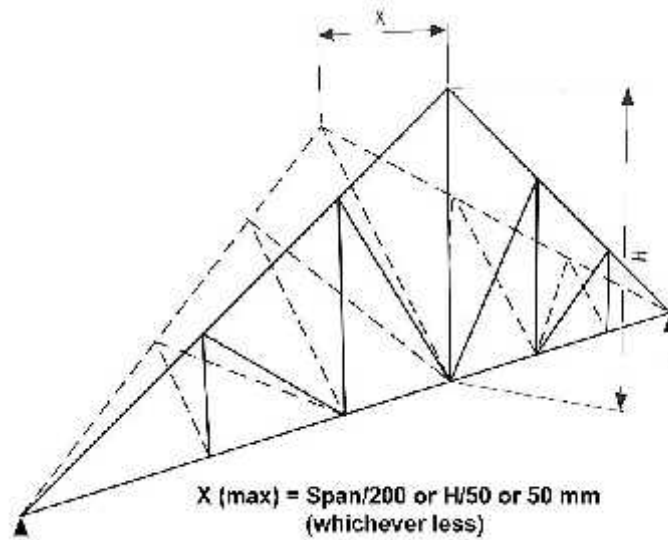


FIGURE 10(b): Tolerance on Verticality (global)

10.3.2 Straightness

Trusses shall be erected (Figure 11) 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) Span/200
- b) 50 mm

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

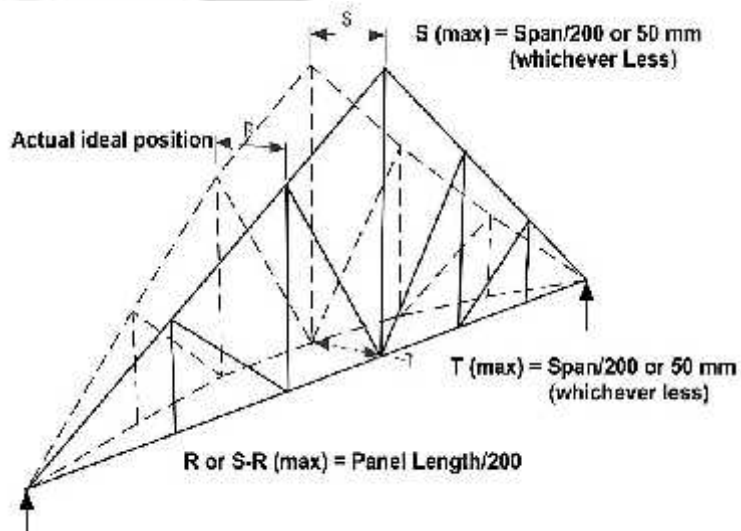


FIGURE 11: Tolerance on Straightness

10.3.3 Position

Trusses shall be erected such that their spacing at centres of support does not exceed the specified spacing by more than 25 mm, (Figure 12). However, the average spacing of the trusses shall not exceed the specified spacing.

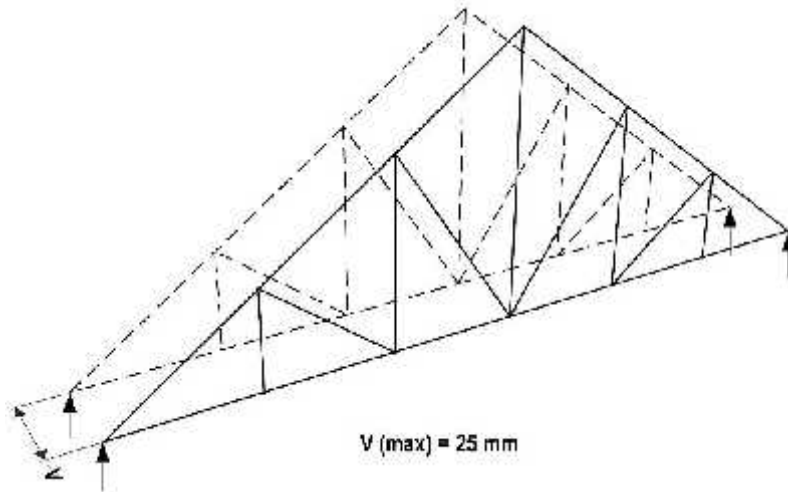


FIGURE 12: Tolerance on Position

10.3.4 Squareness

The first truss erected (Figure 13) shall be correctly plumb 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) 25 mm

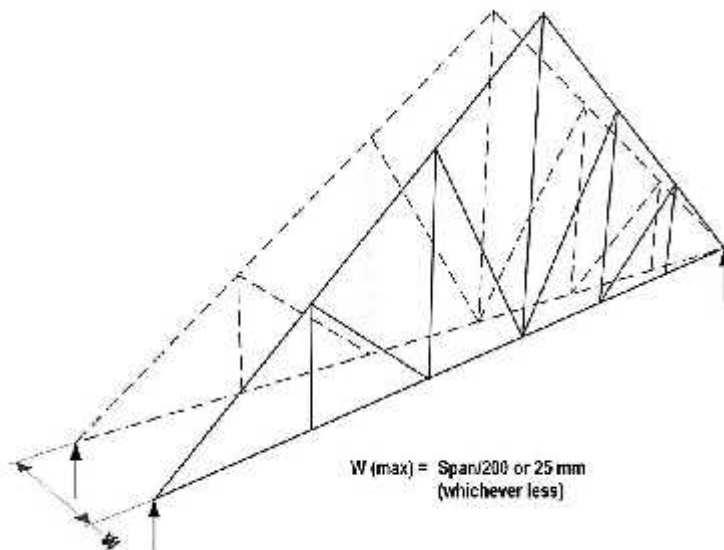


FIGURE 13: Tolerance on Squareness

10.4 Bolted Connection

10.4.1 In the case of bolted connections, the S.P. shall ascertain that appropriate hardened washers have been fitted under every bolt head and nut where one is required. The bolts shall protrude by at least one thread above the nut heads.

10.4.2 A random sampling of the bolts shall also be checked for the correct minimum tension as required by means of calibrated hand wrench or impact tool. If it is found that a substantial number of the bolts in the sample require tightening, then the entire bolted connections shall be tested and tightened. The tensioning in the bolted connections shall be inspected periodically by the S.P. and tightened if necessary particularly during the duration of the defects liability period. All such inspections, which shall be witnessed by the S.O., shall be documented and forwarded to the S.O. for retention.

10.5 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. 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.

10.6 Roof Frame Bracing

10.6.1 Permanent bracing 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 be removed. The materials for these bracing shall also comply with Clause 2.2 (v).

10.6.2 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 14).

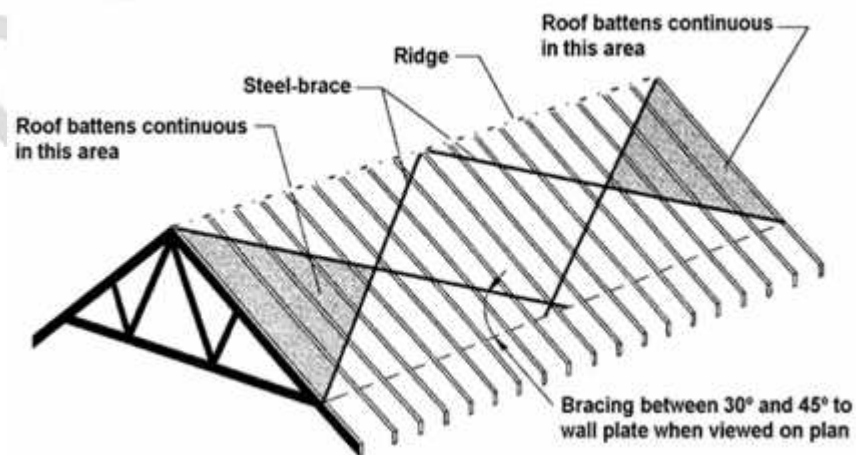


FIGURE 14: Batten Continuous in Areas Unbound by Bracing

- 10.6.3 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.
- 10.6.4 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.
- 10.6.5 Steel Brace

The minimum working load for the steel brace shall be as shown in Table 1.0.

Table 1.0: 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.

10.6.6 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 15 and Figure 16. 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 fastened to the truss. The total no. of steel brace layers at any location of the self-drilling screw at a lap position shall not be more than three (3) layers, with a maximum total thickness of 3.2 mm.

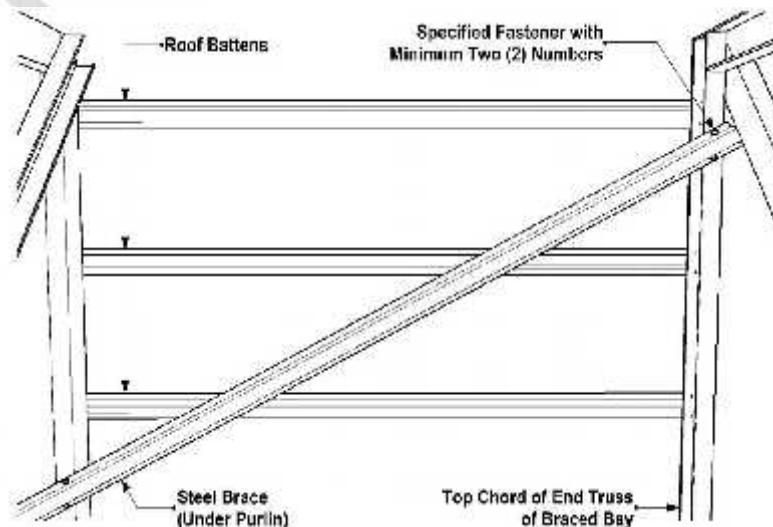


FIGURE 15: Fixing Detail of Under-Purlin Bracing

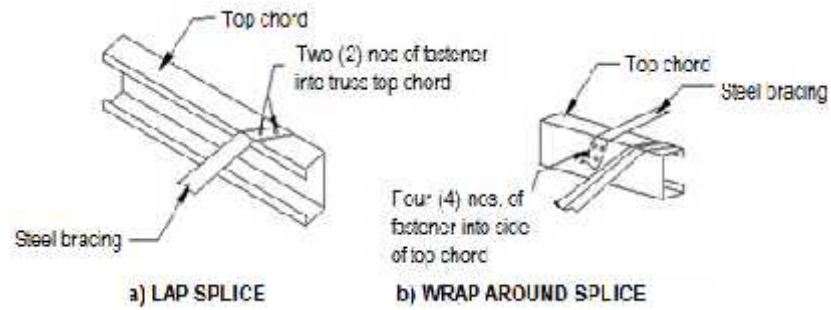


FIGURE 16: Typical Spliced Detail of Steel Brace

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 may be anchored to the wall plates. For suggested roof bracing layout, refer to Figure 17, Figure 18 and Figure 19.

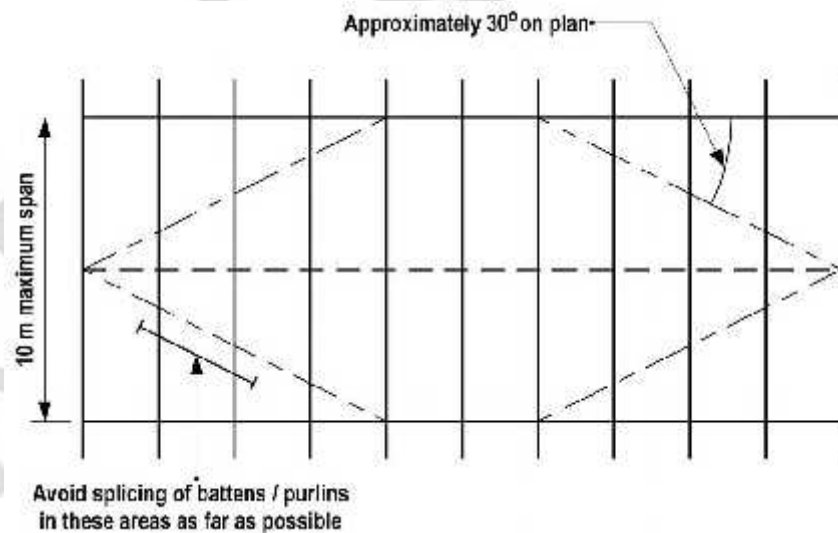
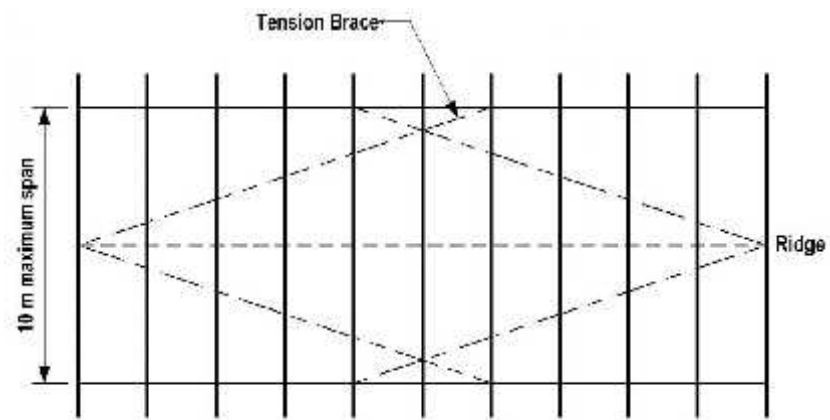
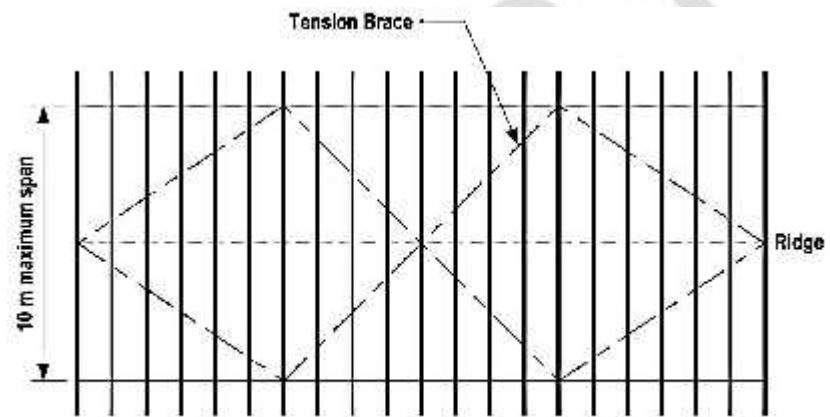


FIGURE 17: Suggested Roof Bracing Layout



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

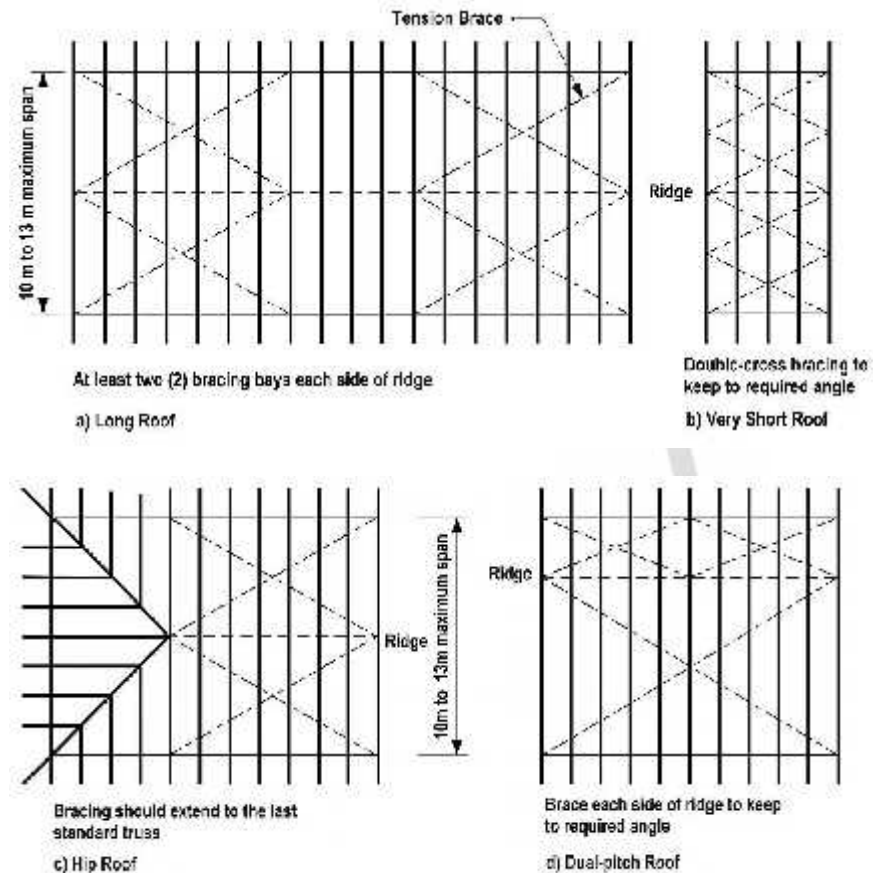


b) Medium long roof, i.e roof length = more than 2x span of truss

FIGURE 18: 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 19: Suggested Roof Bracing Layout (Tension)
Trusses Spans 10 m to 13 m**

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
- iii) All bracing on each side of the ridge should be crosses

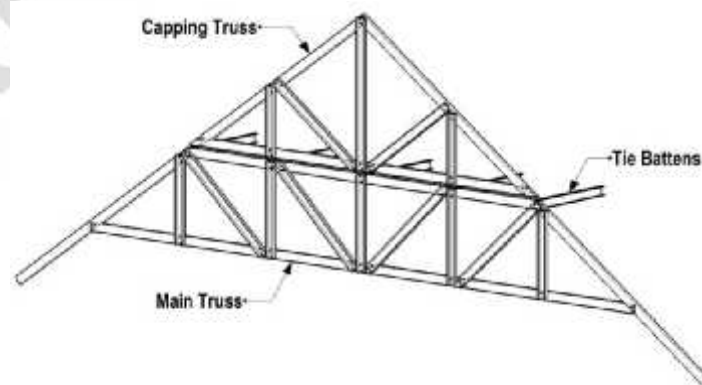


FIGURE 20: Typical Main and Capping Truss

Where roof frame are built-up with saddle back, or cap trusses (Figure 20), 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 steel battens shall be fastened with minimum two (2) nos. of fasteners.

10.6.7 Bottom Chord Bracing

A permanent bracing at the bottom chord shall be provided to restrain truss bottom chords against lateral buckling under wind uplift conditions if required. 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.

10.6.8 Web bracing

Where web bracing is provided in 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. of fasteners 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 21)

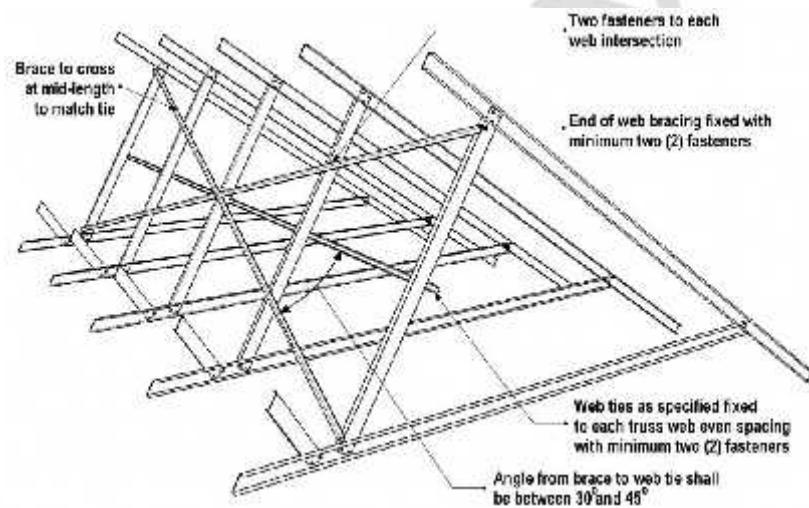


FIGURE 21: Suggested Web Ties and Fixing Details

10.7 Member Stiffener

Steel stiffeners for truss members shall only be spliced at positions, as specified by the P.E..(Figure 22)

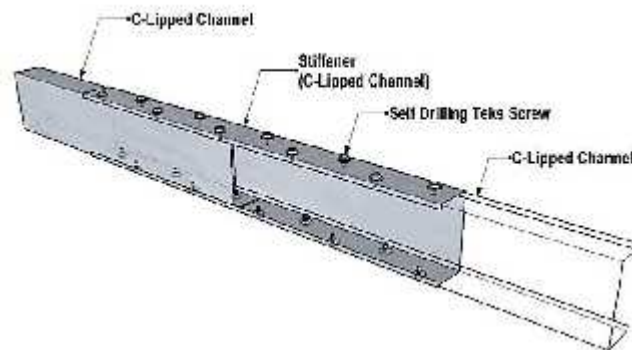


FIGURE 22: C-Lipped Section Stiffener Detail with Screw

10.8 Multiple Trusses

Where multiple truss (i.e. 2 or more trusses acting together) is 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 screwed or bolted together in the specified manner prior to installation / loading.

10.9 Installation of Roof Covering

10.9.1 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.

10.9.2 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 only allowed to seat onto trusses provided not more than 40 tiles or 150 kg 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 seat or bear weight 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 area which may cause overloading of top chord section.

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

10.9.3 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 area which may cause overloading of top chord section. The weight of the lightweight covering stack shall not exceed 25 kg/m².

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

11.0 ALTERATION TO TRUSSES

11.1 No element of the roof trusses, roof frames or roof ancillary members shall be cut or notched or removed or otherwise altered from its original state without the prior written approval of the S.P..

11.2 Where defects exceeding the limits or permitted tolerances are detected, rectification works shall be carried out based on the recommendations made by the P.E. and to the approval of the S.O..

Permohonan Penggunaan Sistem Kekuda Bumbung :

- ☐ *Pre-Fabricated Cold Formed Steel*
☐ *Pre-Fabricated Timber*

- ☐ *Factory Fabrication*
☐ *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: 2004 or MS ISO 6892	2	<input type="checkbox"/>
1.2	Determine adhesion and mass of aluminium-zinc base coating	MS 1196: 2004	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"/>
1.6	Point bending test	Verification of section properties	-	<input type="checkbox"/>
2.0	Fasteners			
2.1	Tensile, torsional and surface hardness	AS 3566.1-2002	2	<input type="checkbox"/>
2.2	Shear	AS/NZS 4600: 2005	2	<input type="checkbox"/>
2.3	Salt spray	AS 3566.2-2002	2	<input type="checkbox"/>
2.4	Coating composition and thickness	AS 3566.2-2002	2	<input type="checkbox"/>
3.0	Anchor			
3.1	Pull out test	BS 5080: Part 1: 1986	2	<input type="checkbox"/>
3.2	Coating composition and thickness	AS 3566.2-2002	2	<input type="checkbox"/>
4.0	Timber			
4.1	Identification of species & visual Grading	MS 1714: 2003	Per project	<input type="checkbox"/>
4.2	Moisture content, density and specific gravity	BS 373: 1957 & MS 837: 2006	Per project	<input type="checkbox"/>
4.3	Dry salt retention	MS 360: 2006, MS 821: 2011 & MS 544: Part 10: 2003	Per project	<input type="checkbox"/>
4.4	Depth of penetration	MS 360: 2006 & MS 544: Part 10: 2003	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: 1957	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	<input type="checkbox"/>
7.	Base Steel Lab Test Certificate (if required)	<input type="checkbox"/>
8.	Technical Specification for Screw, 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"/>

Appendix 3: Checklist on the Contractor Submission

B. Completeness of submission

No.	Submission Item	Check
1.0	Application Form:	
	- Completed with type of fabrication	<input type="checkbox"/>
	- Information on P.E. and Fabricator	<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"/>
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 : 13 m	<input type="checkbox"/>
	- Maximum spacing : 1.2 m	<input type="checkbox"/>
	- Minimum base steel thickness (truss member: open section & bracing) : 1.0 mm	<input type="checkbox"/>
	- Minimum base steel thickness (truss member: closed section) : 0.6 mm	<input type="checkbox"/>
	- Minimum base steel thickness (batten) : 0.5 mm	<input type="checkbox"/>
	- Minimum base steel thickness (wall plate) : 1.2 mm	<input type="checkbox"/>
	- Minimum depth of section (open section) : 75 mm	<input type="checkbox"/>
	- Minimum width of section : 35 mm	<input type="checkbox"/>

Appendix 3: Checklist on the Contractor Submission

No.	Submission Item	Check
6.0	Technical notes and certificate compliance to specification:	
	- Minimum grade for base steel to the requirement of Clause 7.1.1	<input type="checkbox"/>
	- Minimum thread of screw to the requirement of Clause 7.2.1	<input type="checkbox"/>
	- Minimum protective coating for base steel to the requirement of Clause 7.1.2	<input type="checkbox"/>
	- Minimum protective coating for fastener to the requirement of Clause 7.2.2	<input type="checkbox"/>
	- Minimum protective coating for anchor to the requirement of Clause 7.3.2	<input type="checkbox"/>
	- Minimum for wall plate (grade and strength) to the requirement of Clause 7.4	<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 cold formed steel roof truss with span more than 13 m but not exceeding 20 m

The information not limited to the followings shall be submitted to Pengarah Kanan, Cawangan Kejuruteraan Awam, Struktur & Jambatan (CKASJ) for the written consent on the construction of roof truss with span more than 13 m but not exceeding 20 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 Provision of thermal expansion
 - 1.2.8 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 Splicings 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 fasteners/connector;
 - 1.4.2 Type, strength and dimension of truss accessories whereby connected to the fasteners/connectors;
 - 1.4.3 Where applicable, a design shall consider effect of construction in stages;
 - 1.4.4 Stress distribution at every point of fastener/connector;
 - 1.4.5 Design calculation of joint;
 - 1.4.6 Design of truss accessories;
 - 1.4.7 Design of joint for splicings or stiffeners;
 - 1.4.8 Joint details with specified spacing of fasteners/connectors;
 - 1.4.9 Joint details at support and bracings termination point.
- 1.5 Information that all minimum provisions for trusses up to 13 m have been included.

Appendix 5: Special provision for cold formed roof truss with span more than 13 m but not exceeding 20 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 splicings;
 - 2.1.9 Maximum stack of tiles during installation;
 - 2.1.10 Construction of on the provision of thermal expansion;
 - 2.1.11 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.

BIBLIOGRAPHY

Malaysian Standard

- [1] **MS EN 1993-1-1:2010-** *Design of steel structure-Part 1-1:General Rules and rules for buildings*
- [2] **MS ISO 6892:** *Metallic material- Tensile testing at ambient temperature (ISO 6892: 1998, IDT)*
- [3] **MS 360: 2006:** *Treatment of timber with Copper/Chrome/Arsenic wood preservatives-specification (third revision)*
- [4] **MS 544 : PART 1: 2001:** *Code of practice for structural use of timber: Part 1- General (First revision)*
- [5] **MS 544 : PART 2: 2001:** *Code of practice for structural use of timber: Part 2: Permissible stress design of solid timber (First Revision)*
- [6] **MS 544 : PART 7: 2001:** *Code of practice for structural use of timber: Part 7 Testing (First revision)*
- [7] **MS 544: PART 10: 2003:** *Code of practice for structural use of timber: Part 10- Preservative treatment of structural timber*
- [8] **MS 733: 2008:** *Wood preservatives for Copper/Chromium/Arsenic (CCA) specification (Second revision)*
- [9] **MS 821: 2011:** *Copper/Chrome/Arsenic treated timber and preservative formulations quantitative analysis (second revision)*
- [10] **MS 833: 1984:** *Method for the qualitative analysis of wood preservatives and treated timber*
- [11] **MS 837: 2006:** *Solid timber – Determination of moisture content*
- [12] **MS 1714: 2003:** *Specification for visual strength grading of tropical hardwood*
- [13] **MS 1174: 2010:** *Large wooden pallets – Principal dimensions and tolerances (Second revision)*
- [14] **MS 1196: 2004** –*Continuous hot-dip aluminium/zinc coated steel sheet of commercial, drawing and structural qualities (First revision)*
- [15] **MS 1553: 2002-** *Code of practice on wind loading for building structure.*

British Standard

- [1] **BS EN 1993-1-3: 2006:** *General rules-Supplementary rules for cold-formed members and sheeting*
- [2] **BS EN ISO 1460: 1995:** *Metallic coatings – Hot di galvanized coatings on ferrous materials – Gravimetric determination of the mass per unit area*
- [3] **BS EN 1090-2:2008+A1:** *Execution of steel structures and aluminium structures - Part 2:Technical requirements for steel structures*
- [4] **BS EN ISO 1473-1:2009:** *Zinc coatings-Guidelines and recommendation for the protection against corrosion of iron and steel in structures- Part 1: General principals of design and corrosion resistance (ISO 14713-1:2003)*

- [5] **BS 6954-2:1988, ISO 3443-2:1979:** *Tolerances for building. Recommendations for statistical basis for predicting fit between components having a normal distribution of sizes*
- [6] **BS 5080-1:1993:** *Structural fixings in concrete and masonry. Method of test for tensile loading*
- [7] **BS 5080-2:1986:** *Structural fixings in concrete and masonry. Method for determination of resistance to loading in shear*
- [8] **BS 5950-5: 1998:** *Structural use of steelwork in building: Part 5. Code of practice for design of cold formed thin gauge sections*
- [9] **BS EN 408: 2010:** *Timber structures — Structural timber and glued laminated timber — Determination of some physical and mechanical properties*

Australia Standard and Australian/New Zealand Standard

- [1] **AS/NZS 4600: 2005** - *Cold Formed Steel Structure*
- [2] **AS/NZS 1050.1: 1996** -*Methods for the analysis of iron and steel - Sampling iron and steel for chemical analysis*
- [3] **AS 1397-2001:** *Steel Sheet and Strip – Hot-dip zinc coated or aluminium/zinc-coated Cold Formed Steel Structure*
- [4] **AS 3566.1- 2002:** *Self-drilling screws for the building and construction industries Part 1: General requirements and mechanical properties*
- [5] **AS 3566.2 – 2002:** *Self-drilling screws for the building and construction industries Part 2: Corrosion resistance and requirements*
- [6] **DR AS 1397:** *Continuous hot-dip metallic coated steel sheet and strip-Coatings of aluminium, zinc and magnesium (revision of AS 1397-2001)*
- [7] **DR AS/NZS 3566.2** *Self-drilling screws for the building and construction Industries Part 2: Corrosion resistance requirements and requirements for non-conductive seals (Revision of AS 3566.2—2002)*

International Organization for Standardization Standard (ISO Standard)

- [1] **ISO 1461 (Second Edition 199-02-01):** *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*
- [2] **ISO 9223:** *Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation*

ASTM Standard

- [1] **ASTM D143 – 09:** *Standard Test Methods for Small Clear Specimens of Timber*

Specification and Research Report

- [1] **JKR-20600-0022-2001 (Oktober 2001) :** *Pre-fabricated cold form Steel Roof Trusses*
- [2] **JKR 20601-LK0015-KS-04:** *Prefabricated Cold Formed Steel Roof Truss- The Level of Compliance of System Provider to JKR Specification, 2004*

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