SPECIFICATION FOR PREFABRICATED TIMBER ROOF TRUSSES

ACKNOWLEDGEMENT

The following interests are the working committee involved in preparing this Specification:

Ir. P.N. Selvanayagam - Head of Commitee	-	Public Works Department of Malaysia (JKR)
Hafliza bt. Abdullah Fakri	-	JKR
Nor Azizah Muhammad	-	JKR
Ng Wun Pin	-	Pryda (M) Sdn. Bhd.
Yew Ai Kian	-	Pryda (M) Sdn. Bhd.
Salina Hassan	-	Gang-Nail (M) Sdn. Bhd.
Noruzzaman Idris	-	Gang-Nail (M) Sdn. Bhd.
Othman Yaakob	-	General Lumber Roofing System (M) Sdn. Bhd.
Nicolas Roulant	-	General Lumber Roofing System (M) Sdn. Bhd.

Additional Interests participated in preparing of this Specification:

Ir. Dr. Judin Abd. Karim	-	JKR
Hilmi Md. Tahir	-	JKR

We would like to extend our warm appreciation to the following technical committee for their support and acknowledgement:

Tn. Hj. Mohamed Gading (chairman)	-	JKR
Roznita Othman	-	JKR
Norma Norman	-	JKR
Naelah Mat Kasa	-	JKR
Ir. Loh Yeim Phoi	-	JKR
Murfuah Mokhtar	-	JKR
Nik Nazirah Nik Ismail	-	JKR
Wan Sohaimi Wan Mohamad	-	JKR
Ir. Dr. Judin Abd. Karim	-	JKR
Ir. P. N. Selvanayagam	-	JKR
Sua Kau Sa	-	JKR
Low Poh Fee	-	JKR

TABLE OF CONTENTS

STANDARD SPECIFICATION FOR PREFABRICATED TIMBER ROOF TRUSSES

1.0 DEFINITIONS

System Provider (S.P.) - A supplier of a proprietary roofing system, approved by JKR, employing third party Quality Assurance procedures in the design, detailing, connection, bracing and erection criteria including machinery and manufacturing techniques for the structural roofing system provided. The System Provider shall guarantee the due performance of the entire roofing system.

Fabricator – A licensed supplier of an approved System Provider, who produces the structural and assembly details including the truss to truss details, bracing, tie-down, erection, lifting instructions in addition to producing and installing the roofing system in a manner approved by the S.P.

2.0 GENERAL

2.1 This specification outlines the requirements for the analysis, design, detailing, drawing, manufacture, 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 that is structurally stable under all the specified combinations of loading conditions.

2.2 All prefabricated roof trusses and ancillary roof products employing proprietary systems shall be only manufactured and assembled by licensed truss Fabricators of systems approved by JKR. Prior to manufacture of the proposed roofing system, the contractor shall provide three (3) copies of the roof design drawings indicating all loads, assembly drawings, connection criteria, bracing and tie-down, together with the particulars of the Fabricator including valid licenses or other certificates to the superintending officer (S.O.) for his approval. All drawings shall be certified by an independent Professional Engineer (P.E.).

2.3 The S.O. shall reserve the right to reject any of these systems if found to be unsuitable. The S.O. shall also reserve the right to reject any of the Fabricators forwarded if their track record in the sole opinion of the S.O. has been poor.

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

a) Maximum truss span 16metres.
b) Maximum truss spacing of:-

   (i) 1200mm for concrete/clay tiles, or
   (ii) 1800mm for metal sheet roofs in areas of design wind speed up to 41m/s;

c) Maximum roof pitch of 45° (100:100).

2.5 This specification requires that all roofing systems up to 13 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.

2.6 For roof trusses exceeding 13 metres but not more than 16 metres, S.P. shall ensure its design, and the erection to be carried out by trained erection teams endorsed by the S.P. under the supervision of an independent P.E.

3.0 DESIGN

3.1 Design data

All loads shall be clearly itemised as below: -

a) Dead Load
b) Imposed Load
c) Wind Load

The size, length and grade of timber shall be clearly specified in the design.

Reference, where applicable, shall be made to MS 544 and the Malaysian Uniform Building By-laws. Load combinations shall be clearly itemised and identified to enable design checking to be carried out upon the most adverse conditions.

3.2 Design standards

Timber member design and connection criteria shall be in accordance with MS544, AS 1720, AS 1649 and any other equivalent standards recognised internationally.

3.3 Design submissions

Analysis, design calculations and drawings shall be submitted to the S. O. prior to the commencement of work. The calculations and drawing details (3 copies) shall be duly signed by S.P. and certified by an independent P.E.

4.0 DETAILING AND DRAWINGS

The drawings shall be detailed as follows: -

4.1 Layout drawings

Layout drawing shall indicate the plan view of all trusses together with ties, bracings and battens. The drawing shall identify the number of the truss or member and the loadings for which it has been designed.

4.2 Design Detail Drawings

The design detail drawing shall clearly indicate the following: -

a) shape of member and truss
b) span, spacing, pitch, overhang and camber
c) height from ground

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

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.

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.

4.3 Bracing layout drawing

Bracing layout 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.

4.3.1 Tile battens

Tile battens, wherever applicable, shall be indicated in size and grade. The spacing and method of fixing of the battens to the top chord or rafter shall be indicated together with the diameter, length and position of the nail into the timber.

4.3.2 Ceiling battens

Ceiling battens or bottom chord restraints shall, wherever applicable, be indicated in size and grade. The spacing and method of fixing of the battens to the bottom chord or ceiling joist shall be indicated. Diameter and length of nail and its positioning into the timber shall be shown.

4.3.3 Tie-Down

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 nails. The nail diameter, length and coatings of the nails if any shall also be specified.

5.0 TIMBER

5.1 Species classification

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, as shown in schedule A of this specification and in accordance with MS 544. All timbers used for structural works should be stress graded based on the grading limit of Section J of the Malaysian Grading Rules for Sawn Hard Timber.

5.2 Visual Grading

All timber shall be of select grade in accordance with MS 544. Visual Grading shall be carried out by timber graders registered with the Malaysian Timber Industry Board (MTIB) according to Section J of Malaysian Grading Rules (MGR) and MS 544. All timber components shall be examined for suitability prior to cutting and assembly. Defects such as shakes, checks, slope of grain, wane and knots are permitted within the limits specified by the MGR or MS 544. However, any warped, twisted, crooked, split timber or defects which would interfere with the proper placement and pressing of connector plates, or any other defects such as knots and wane which would result in the reduction of the joint strength shall not be permitted.

5.3 Moisture Content

At the time of installation, the moisture content of the timber for the various applications shall not exceed 25%.

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.

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

6.0. TREATMENT OF TIMBER

6.1 All timber, unless the heartwood of the naturally durable timber as scheduled in MS 360, used in truss fabrication shall be pressure treated for preservation in accordance with the requirements of MS 360 using the Bethel full-cell process described below or other approved equivalent methods. Sapwood of all species is considered not durable unless suitably treated. 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.

Bethel Full-Cell Process:

In the full-cell process, an initial vacuum of about 700mm Hg shall be applied to the charge for a period of about 30 min. At the end of this period and while maintaining the vacuum, the cell is filled with the preservative. The vacuum is released and a pressure up to 14 bars is applied to the system and maintained until the gross absorption of the preservative has been achieved. At the end of this pressure cycle, which may be up to six hours, depending on the species and thickness of timber treated, the pressure and the preservative shall be released and the treated timber shall be subjected to a further final vacuum of about 700mm Hg for 10 minutes. This procedure is to recover "drip" or waste that would otherwise occur and to remove excessive preservative from the surface of the stock.

6.2 Freshly treated timber for copper/chrome/arsenic (CCA), shall be held at factory site for 48 hours before dispatched to the site as it needs time to fix itself into the wood. Where timber is treated with CCA wood preservatives, it is essential to ensure that the timber is subsequently redried after fixation before the plate fasteners are embedded to avoid corrosion risk. Unless expressly specified, inorganic flame retardant salts shall be avoided, as the plate fasteners are also susceptible to premature corrosion when timber is treated with inorganic flame retardant salts.

6.3 The minimum net dry salt retention is 5.6kg/m^3 for any timber used in roof structures.

6.4 All sapwood shall be penetrated by the preservative and the depth of penetration for heartwood shall be 12mm.

7.0 FASTENERS

7.1 Metal plate fasteners shall be manufactured from light gauge galvanized carbon steel with teeth or nails formed from the parent metal to provide effective structural joints between timber members. 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. All such tests shall be verified and authenticated SIRIM. The S.P. shall exercise adequate control to maintain a satisfactory standard of product with respect to quality of steel, plate and coating thickness, and teeth profile. It is the responsibility of the S.P. to validate the working load capacity of his fasteners on a regular basis with SIRIM and to produce the most current test

results from SIRIM whenever requested by the S.O.. The S.0. may also at his sole discretion carry out additional tests as specified in the AS 1649 to verify the basic working design values of the fasteners if proof of such tests for the current year or the previous year is not available.

7.2 The metal plate fasteners shall be pressed or impacted to opposite faces of the timber members with pressing equipment to form a spliced or gusseted type joint. The plate fastener; shall bear the mark which readily identifies the fastener manufacturer or supplier.

7.3 The steel used in the manufacture of the plate fasteners shall be hot-dip galvanized in accordance with MS 740, and shall be at least of commercial grade galvanized steel with a minimum yield stress of 250 MPa and with a minimum corrosion-resistance coating of 275g/m^2 of zinc. The minimum finished nominal thickness of the plate shall be I mm..

7.4 Metal plate fasteners shall not be used in highly corrosive marine or toxic environment without further protection. Such protective measures, which may include but not necessarily limited to heavier zinc or epoxy coatings, shall only be used with a written guarantee from, the S.P. on the effectiveness of such protective coatings on the fasteners. Stainless steel connectors, if used, shall be bare austenitic stainless steel of a grade defined in BS 1449: Part 2. Other grades of stainless steel shall not be used. All damaged or misformed plate connectors shall be rejected.

7.5 All nails used in roof construction shall be coated protectively by hot-dip galvanizing, sherardizing or other suitable treatment against corrosion.

7.6 All other timber fasteners such as split rings; shear connectors; bolts, nuts and washers shall comply with the requirements of MS 544. Each bolt and nut assembly shall include two washers, each of which is placed under the bolt head and the nut respectively. Bolts and nuts found to be defective shall be discarded and replaced by new ones. All splicing plates shall be hot-dip galvanized in accordance with MS 740.

8.0 TRUSS FABRICATION

8.1 All truss support locations and dimensions shall be checked at site prior to cutting of timber for fabrication. All fabrication of the trusses shall be carried out using a method statement as prepared by the S.P.. The contractor shall certify that he had carried out cheeks on the fabrication process by submitting a report to the S.O.

8.2 All timber shall be cut such that knots and wane (with or without bark exceeding 6 mm) and any other structural defect is avoided under a plate fastener. All timber shall be cut square to ensure a uniform and proper contact between any two members abutting at a joint. The tightness of the joints shall be such that the average gap between any two adjacent members at a joint shall not exceed 2nim unless specifically allowed for in the design of the joint.

8.3 Truss members shall be specified to nominal sizes in the green condition (unless otherwise specified). Wider members must not be used in place of specified sizes if this causes a reduction in the timber-to-plate fastener contact area in any of the members at a joint.

8.4 Camber for all trusses shall be provided as specified with a maximum tolerance of 3min. 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 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.

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

8.7 Staples may be used for positioning purposes before the embedment of the metal plate fasteners. Wherever possible, skewed nails shall be avoided at joints.

8.8 Bolts and nuts shall always be tightened in a staggered pattern and, where there are more than four bolts in a joint, then the tightening shall be from the middle of the joint outwards, in a staggered pattern. The method of tightening to be employed for all bolts shall be that of the Part-Turn method or Torque-Control method as described in BS 4604 Part 1. All tightening equipments used in the fabrication process shall be calibrated regularly.

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

9.0 TRUSS HANDLING AND INSTALLATION

9.1 All trusses shall be handled in such a manner to avoid damage during handling, storage, transportation and installation. The Contractor shall submit to the S.0. a Manual on the roof truss storage, handling and installation prepared by the S.P.. All installation of roof trusses shall be checked and certified by an independent P.E..

9.2 During handling, correct lifting equipment shall be used and timber components must be protected from the cutting effects of chains and wire ropes.

9.3 All trusses during lifting, before being located and aligned on the supporting structure, shall be propped in a manner that minimizes lateral bending and distortion, and strain on the joints.

9.4 As the trusses are erected, they must be transversely braced to provide stability in accordance with recommended guidelines as in the Manual prepared by the S.P.. Panel points and any change in pitch line shall also be restrained. Some diagonal bracings shall be provided for additional stability. 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.

9.5 Tolerances

The tolerances detailed below are the maximum acceptable in order to ensure a good roofline and an effective bracing system. 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.

9.5.1 Verticality (Fig. 1): All trusses must not be out-of-plumb, or out-of-line, or out-of-position by more than the least of the following.

a) Span/200
b) 50 mm
c) h/50 (See Fig. 1)

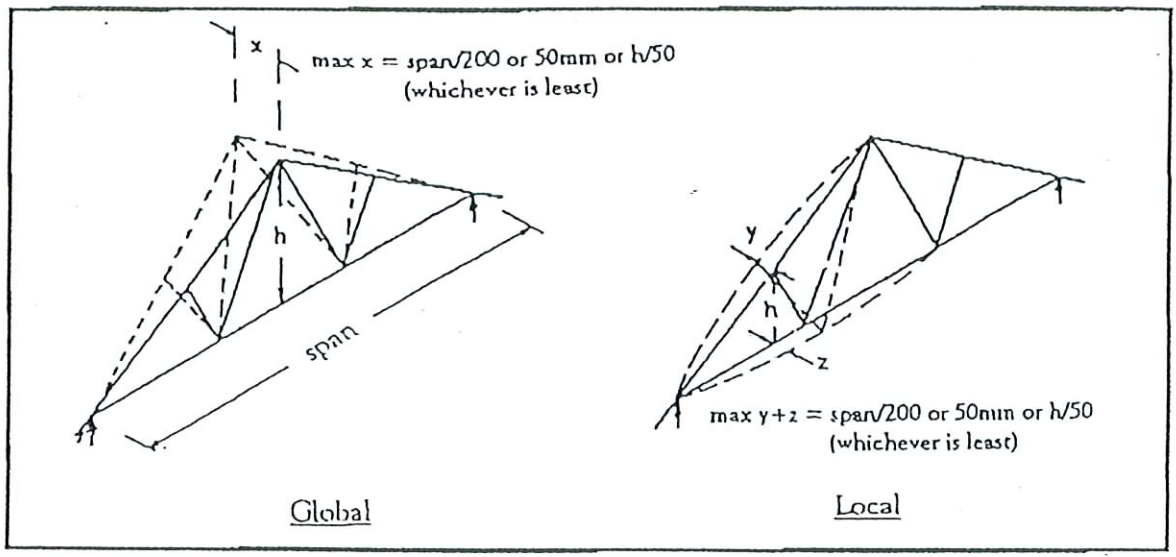


Fig. 1: Tolerance on Verticality

9.5.2 Straightness (Fig. 2): Trusses shall be erected such that at no point does the out-of-line dimension measured from a line between the centers of the supports to the outside edge exceed the lesser of:

a) Span/200
b) 50mm

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

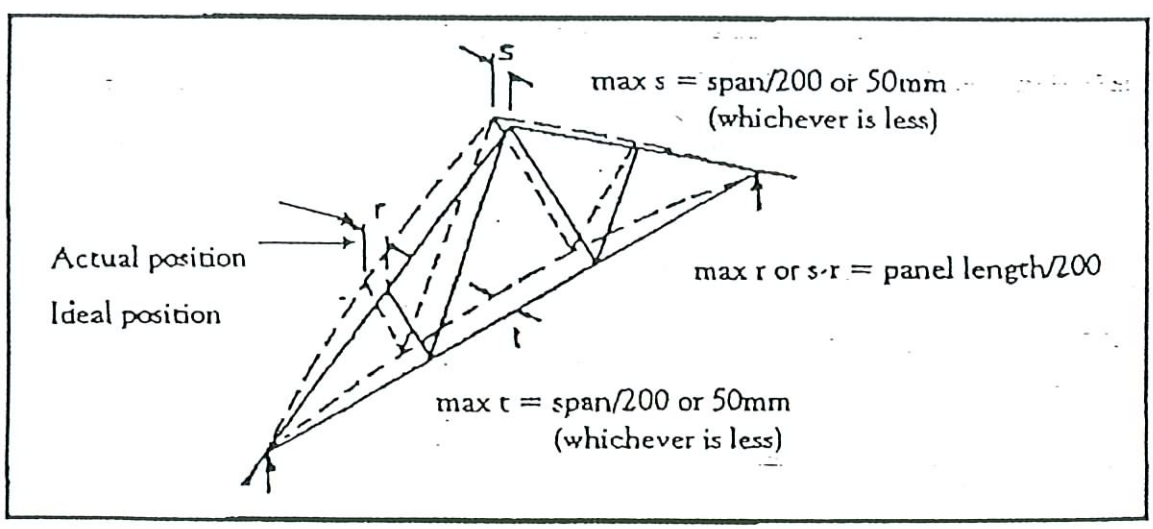


Fig. 2: Tolerance on Straightness

9.5.3 Position (Fig. 3): Trusses shall be erected such that their spacing at centers of support do not exceed the specified spacing by more than 50mm. However, the average spacing

of the trusses shall not exceed the specified spacing. Truss spacing shall not vary by more than 10% between adjacent trusses unless so designed or approved by the independent P.E. (designer) in writing.

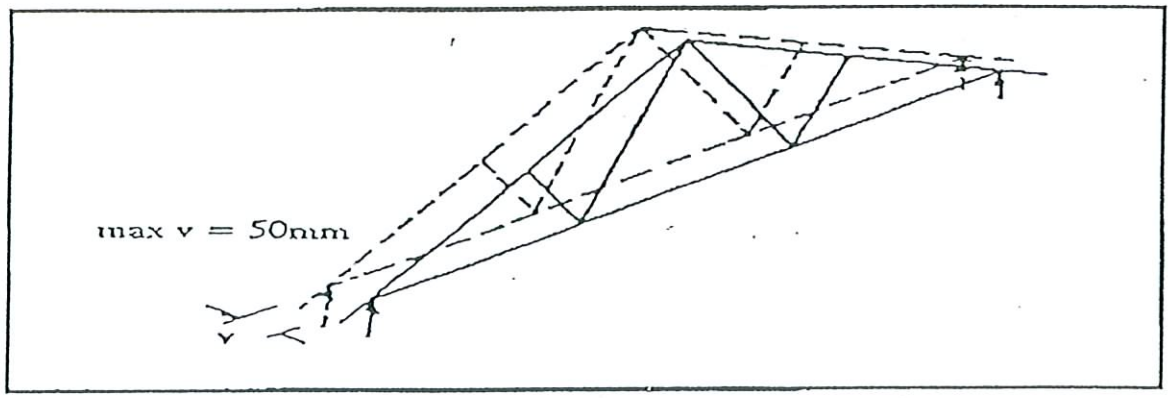


Fig. 3: Tolerance on Position

9.5.4 Squareness (Fig.4): The first truss erected 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 so erected such that the out-of-square dimension at the center of the end supports relative to each other does not exceed the lesser of: -

a) Span / 200
b) 50mm

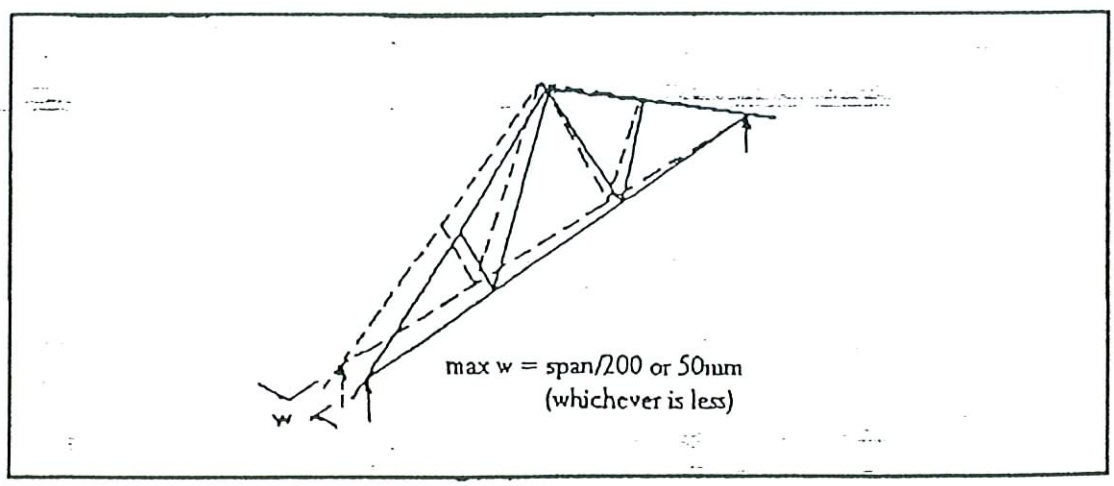


Fig. 4: Tolerance on Squareness

10.0 ANCHORING OF TRUSSES TO SUPPORTING STRUCTURE

10.1 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. For cases where trusses rest on timber wall plates, these wall plates shall be anchored to the supporting structure which are leveled, to resist all uplift and horizontal forces. The wall plates shall be mounted in such a manner to the supporting structure that there are no gaps between them. Any apparent gaps or spaces between the wall plate and supporting structure shall be packed and evened out using approved bedding mortar. Usage of packing pieces of timber to fill the gap in-between the wall plate and the supporting structure shall not be allowed on a permanent basis. Unless otherwise specified, the width of the bearing wall plate shall not be less than 0.008 x the span of the truss, with a minimum of 75mm.

11.0 ROOF FRAME BRACING

11.1 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. Erection (temporary) bracing shall be applied wherever necessary during the assembly stage.

11.2 Tiling battens / purlins whenever considered to provide lateral restraints, shall be so arranged that on any truss line, not more than one third of the tiling 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. (Fig. 5)

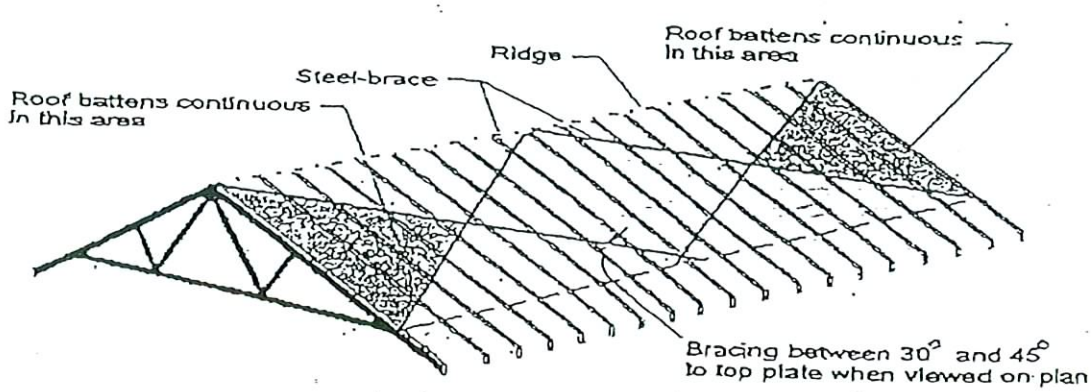


Fig. 5: Battens Continuous Unbound By Bracing

11.3 Lateral restraints, where specified, shall be nailed to truss members at all intersections. On top chords, tiling battens/purlins must continue running under saddle truss areas. 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 roofs using sheet roofing.

11.4 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 design 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 Fig. 6.

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

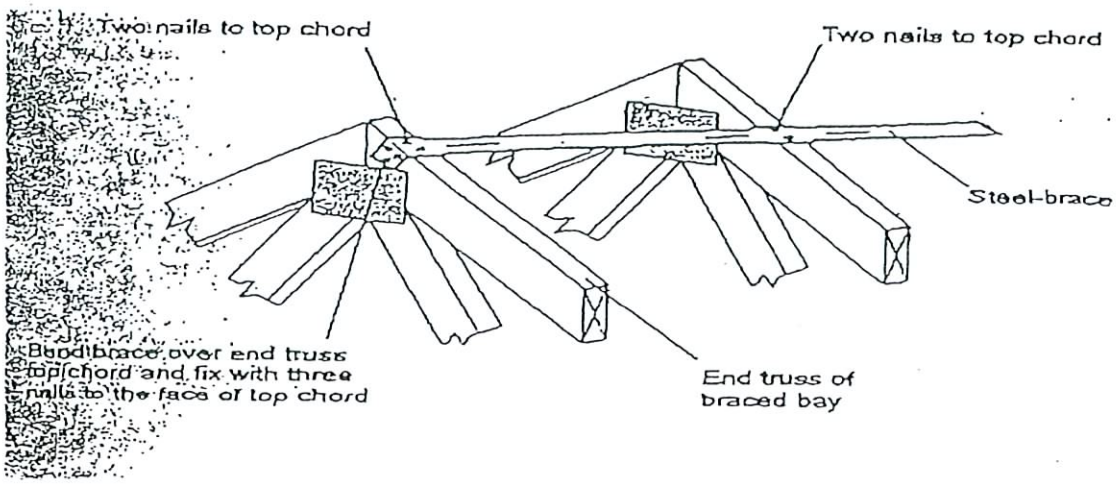


Fig. 6: Fixing Details of Steel Strap Brace

11.6 Steel brace

All steel braces shall have at least a minimum yield stress of 250 MPa, with a minimum thickness of 1.0mm, together with a hot-dipped zinc coating of 275g/m^2 for corrossionresistance. Pre-punched holes shall be provided for driving of nails into the truss timbers.

Minimum basic working loads, kN	TYPE OF STEEL BRACE	
	STRAP BRACE*	SPEED BRACE*
Steel Tension Capacity	3.5-5.5 kN	5.5 kN
End Fixing Capacity	3.5-5.5kN	5.5kN
Brace to intermediate truss fixing capacity	0.55 kN	0.45kN
Wrap-around splice capacity	3.5-5.5 kN	5.5 kN
Brace Cross-Section Dimensions (mm x mm)	(25-40) x 1.0	40 x 1.0
Nail size requirements	35 x 3.15Ø with reinforced heads	30 x 2.8Ø with reinforced heads

*Manufacturers' product names.

The steel brace shall be manufactured from structural grade steel and when installed, shall be such that the sag does not exceed the following: -

Sag < Distance between support point / 500.

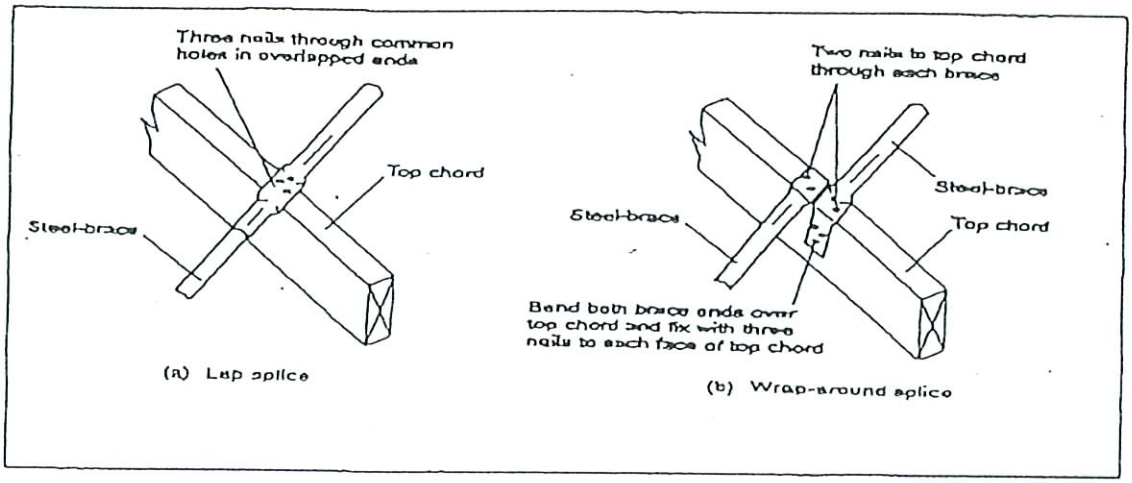


Fig. 7: Typical Spliced Detail of Steel Strap Brace

11.7 Where roof frames are built-up with saddleback, or cap trusses (Fig. 8), the horizontal top chords of lower trusses shall also be braced according to the design requirements as stated in the design 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 70mm x 45 mm or larger shall be nailed with 2 nos. of nails as a minimum.

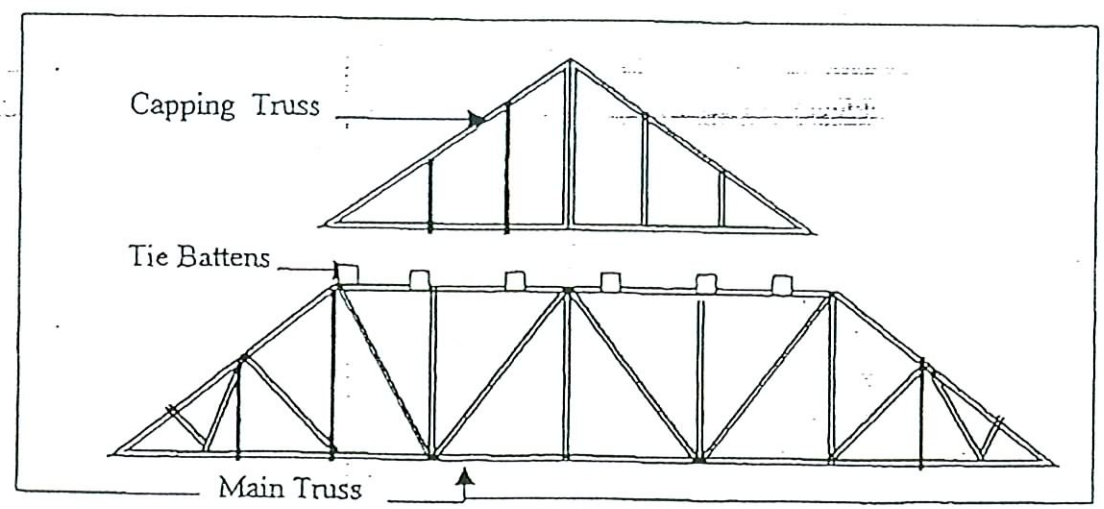


Fig.8: Typical Main and Capping Truss

In addition to the battens, the top chords shall also be br aced 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 and anchored to the wall plates. For suggested roof bracing layout, refer to Fig. 10, Fig. 11 and Fig 12.

11.8 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.

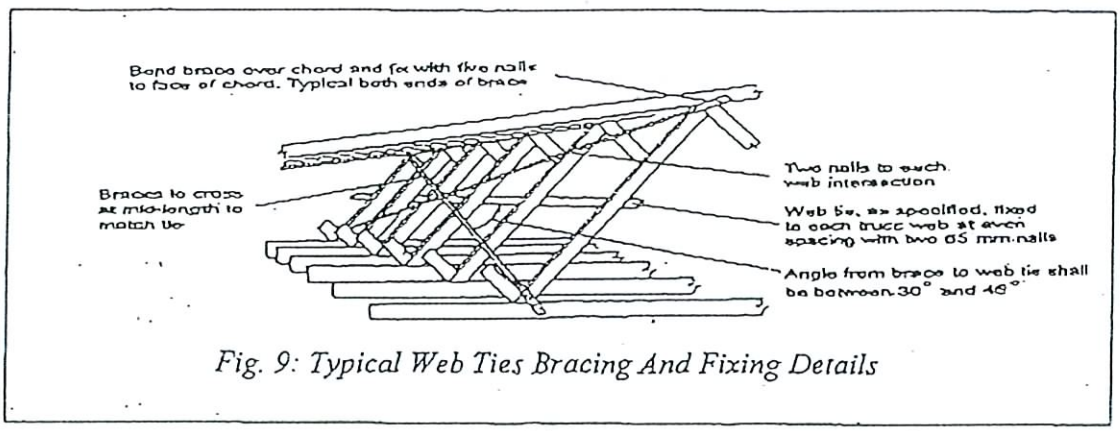


Fig. 9: Typical Web Ties Bracing And Fixing Details

11.9 Web bracing

Where web bracing is provided, the web timber ties shall be fixed to the web of each truss at even spacing of the web with two 65mm long nails and braced to the truss with one bay of crossed steel brace at each end. Web timber ties shall be continuous, or where required, spliced by lapping over at least two adjacent trusses. (Fig.9)

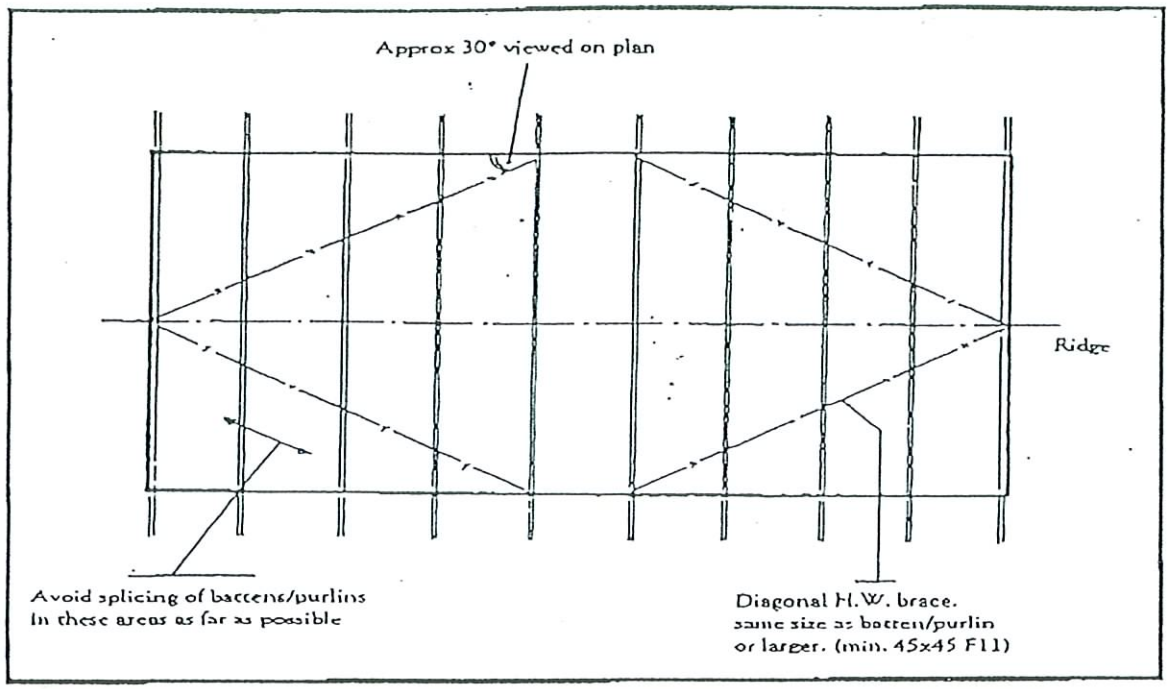
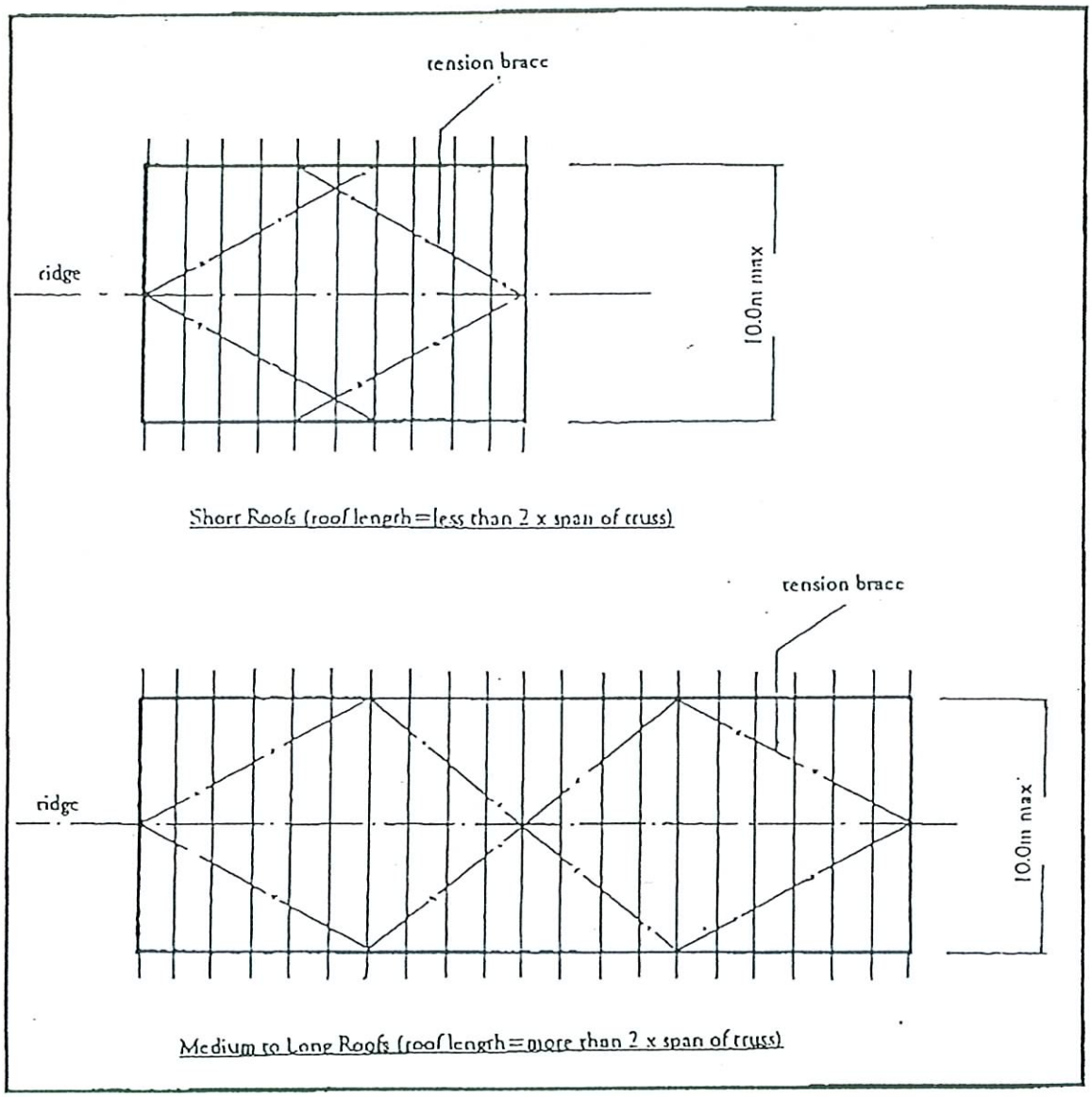


Fig. 10: Suggested Roof Bracing Layout (Timber Bracing)

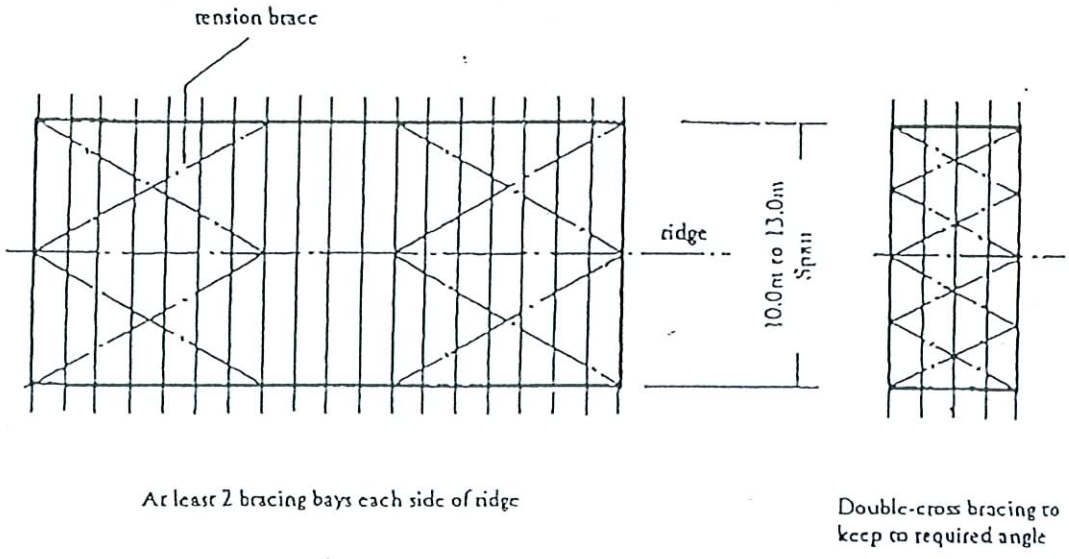
12.0 MEMBER STIFFENERS

12.1 Hardwood stiffeners for truss members shall only be spliced at positions, so specified by the truss designer.



Notes:
I. Angle between bracing and trusses viewed on plan, should be about 30°
II. Avoid splicing of battens/purlins in area not bounded by bracing as far as possible

Fig. 11: Suggested Roof Bracing Layout (Tension Bracing) Trusses up to 10.0m span

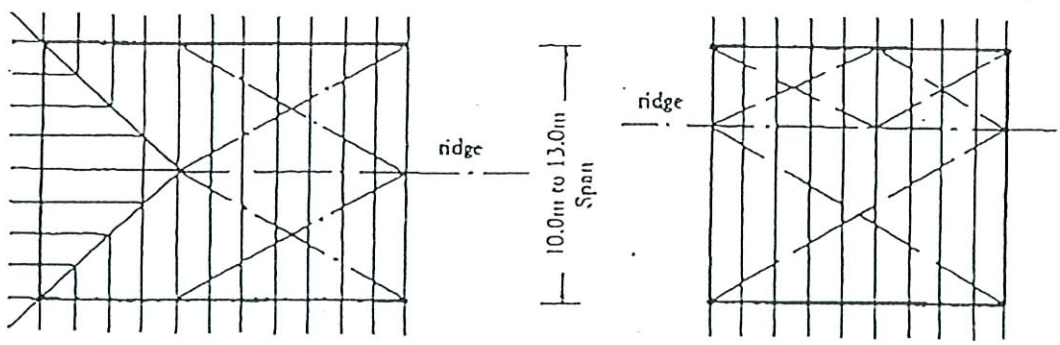


At least 2 bracing bays each side of ridge

a) Long roof

Double-cross bracing to keep to required angle

b) Very short roof



Bracing should extend to the last standard truss

c) Hip roof

Brace each side of ridge to keep to required angle

d) Dual-pitch roof

Notes:
I. Angle between bracing and trusses, viewed 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

Fig. 12: Suggested Roof Bracing Layout (Tension Bracing)
Trusses spans 10.0m to 13.0m

13.0 MULTIPLE TRUSSES

13.1 Where multiple truss (i.e. 2 or more trusses acting together) is specified to support heavy loads such as water tanks 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.

14.0 EXPOSURE OF ROOF TRUSSES

14.1 All roof trusses must be covered within two weeks from completion of installation. Where trusses are exposed for prolonged periods to the elements; excessive timber distortion, creep deflection, splitting, biological decay and/or joint degradation may occur. In situation 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.

14.2 Where trusses are stored on site, (Fig. 13), they should be blocked above the finn ground to protect them from ground water as follows: -

a) If the trusses are stored horizontally, the blocking 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.

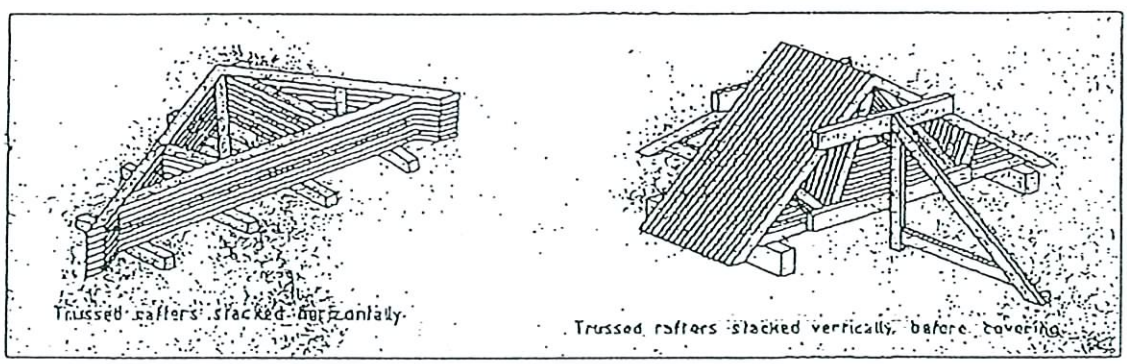


Fig. 13: Storage of Trusses at Site

15.0 ALTERATIONS TO TRUSSES

15.1 No element of the prefabricated timber roof trusses, roof frames or roof ancillary timbers shall be cut or notched or removed or otherwise altered from its original state without the prior written approval of the independent professional engineer.

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

16.0 Quality Assurance and Control

16.1 The Contractor shall submit to 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 on the Fabricator's Work Methodology and Quality Assurances. The Contractor shall notify the S.O. of the dates of the 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 conduct additional tests on the timber preservative treatment by taking samples from the trusses delivered and sending them to FRIM or any other approved laboratories for Salt Retention Tests. However, such sampling must not affect the structural integrity or the strength of the fabricated truss. For additional tests on the timber, the S.O. or his representative may, prior to the fabrication, obtain some truss members from the truss fabricator and send them to FRIM for species identification and mechanical properties of the timber. The Contractor shall provide all attendance and facilities for such tests.

16.2 In the case of bolted connections, the Contractor 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. A random sampling of the bolts shall also be checked for the correct minimum tension as required by means of a 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 Contractor 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.0 for retention. Prior to the completion of the defects liability period, the Contractor shall inspect and certify that all the bolted connections have been checked for tensioning and any inadequacies rectified.

17.0 DESIGN, FABRICATION, SUPPLY AND INSTALLATION GUARANTEE

17.1 All prefabricated components shall be manufactured only by approved licensed truss fabricators producing quality assured products and services to the approval of the S.O.. The design, supply, delivery and erection of the trusses shall be in accordance with JKR's Standard Specifications for Timber Roof Trusses No. 20600-0020-99.

17.2 Prior to the fabrication of the roof truss system, the Contractor shall submit to the Superintending Officer (S.O.) three (3) copies of the drawings, certified by an independent Professional Engineer as required in clause 6 of the JKR Standard Specification for Timber Roof Trusses, to be used in the construction and installation of the roof truss system.

17.3 As soon as practicable after the completion of the installation of the roof truss system and prior to the issuance of the Certificate of Practical Completion, the Contractor shall submit the following documents to the S.O. for information and record:

i) System Provider's Guarantee against any defects or damages which may arise during a period of five (5) 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. The terms of the Guarantee shall be such as shall be approved by the S.O..

ii) Certification that the metal plate connectors conform to the relevant standards and are protected against corrosion, together with proof that such certification have been verified by tests 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 a timber grader registered with the Malaysian Timber Industry Board.

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 used in the preservation.

v) Two (2) sets of as built drawings of the roof truss system signed by the S.P. and certified by an independent Professional Engineer.

SCHEDULE A: Strength groups of timber

S.G. 1	S.G. 2	S.G. 3	S.G. 4	S.G. 5	S.G. 6	S.G. 7
A) Naturally Durable						
Balau	Belian	Bekak	Glam	Teak		
Bitis	Mata ulat	Delek	Malabera	Tembusu		
Chengal			Merbau			
Penaga			Resak			
B) Requiring Treatment						
	Dedaru	Agoho	Berangan	Alan bunga	Bayur	Ara
	Kekalong	Balau,Red	Dedali	Babai	Damar Minyak	Balai
	Kempas	Kelat	Derum	Balek angin bopeng	Durian	Geronggang
	Merbatu	Kembang Semangkok	Kapur	Bintangor	Jelutong	Laran
	Mertas	Keranji	Kasai	Brazil nut	Jenitri	Pelajau
		Kulim	Keruntum	Gerutu	Jongkong	Pulai
		Pauh kijang	Mempening	Kayu kundur	Kasah	Sesendok
		Penyau	Meransi	Kedondong	Machang	Terentang
		Perah	Meranti bakau	Keledang	Medang	
		Petaling	Merawan	Keruing	Melantai / Kawang	
		Ranggu	Merpauh	Kelapang	Meranti, light red	
		Surian batu	Nyalin	Kungkur	Meranti, yellow	
		Tualang	Perupok	Melunak	Mersawa	
			Punah	Mempisang	Terap	
			Rengas	Mengkulang		
			Simpoh	Meranti,dark red		
				Meranti,white		
				Nyatoh		
				Penarahan		
				Petai		
				Ramin		
				Rubberwood		
				Sengkuang		
				Sepetir		

NOTES:

1. For naturally durable timbers, sapwood should be exluded. If sapwood is included, preservative treatment is necessary.(Source: MS360, 1986)
2. For timber requiring treatment, they should be amenable to preservative treatment.

BIBLIOGRAPHY

Malaysian Standards

MS 360 –– 1991 : SPECIFICATION FOR TREATMENT OF TIMBER WITH COPPER/CHROME/ARSENIC WOOD PRESERVATIVES

MS 544 --- 1978 : CODE OF PRACTICE FOR THE STRUCTURAL USE OF TIMBERS

MS 740 --- 1981 : SPECIFICATION FOR HOT-DIP GALVANIZED COATINGS ON IRON AND STEEL ARTICLES

Australian Standards

AS1720.1--- 1988: SAA TIMBER STRUCTURES CODE PART 1 - DESIGN METHODS

AS1720.2--- 1990: SAA TIMBER STRUCTURES CODE PART 2 - TIMBER PROPERTIES

AS1720 --- 1975: SAA TIMBER - ENGINEERING CODE SECTION 4.8 - TOOTH PLATE CONNECTORS

AS1170.1--- 1981: SAA LOADING CODE PART 1 - DEAD AND LIVE LOADS

AS1170.2--- 1989: SAA LOADING CODE PART 2 - WIND LOADS

AS1397 --- 1993: STEEL SHEET AND STRIP-HOT DIPPED ZINC-COATED OR ALUMINIUM/ZINC-COATED

AS1649 --- 1998: TIMBER - METHODS OF TESTS FOR MECHANICAL FASTENERS AND CONNECTORS -BASIC WORKING LOADS AND CHARACTERISTIC STRENGTH

British standards

BS 1449 --PART 2 SPECIFICATION FOR STAINLESS AND HEAT RESISTING STEEL PLATE, SHEET AND STRIP

BS 4604 --PART 1 SPECIFICATION FOR THE USE OF HIGH STRENGTH FRICTION GRIP BOLTS IN STRUCTURAL STEELWORK. METRIC SERIES – GENERAL GRADE

(SAA: STANDARDS ASSOCIATION OF AUSTRALIA)
(BS: BRITISH STANDARDS)

1. UBBL 1984 -- UNIFORM BUILDING BY-LAWS 1984 -LAWS OF MALAYSIA
2. MGR -- THE MALAYSIAN GRADING RULES FOR SAWN HARDWOOD TIMBERS
3. MTIB -- MALAYSIAN TIMBER INDUSTRIAL BOARD
4. SIRIM – STANDARDS AND INDUSTRIAL RESEARCH INSTITUTE OF MALAYSIA