CIS 5: 2018
QUALITY ASSURANCE FOR PREFABRICATED TIMBER ROOF TRUSS SYSTEMS

Description: quality assurance, prefabricated timber truss systems, roof trusses, truss specifications, fabrication tolerances, installation tolerances, toothed metal plate connectors

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QUALITY ASSURANCE FOR PREFABRICATED TIMBER ROOF TRUSS SYSTEMS
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COMMITTEE REPRESENTATION

This Construction Industry Standard (CIS) was developed and reviewed by the Construction Industry Development Board Malaysia with the assistance of the Technical Committee, which comprises representatives from the following organisations:

Board of Engineers Malaysia (BEM)
Forest Research Institute Malaysia (FRIM)
Institution of Engineers, Malaysia
Jabatan Kerja Raya (JKR)
Malaysian Timber Industry Board (MTIB)
Malaysia Wood Industry Association
Multinail Asia Sdn. Bhd.
MiTek Asia Sdn. Bhd.
Pertubuhan Arkitek Malaysia (PAM)
Persatuan Pengusaha Kayu Kayan dan Perabot Bumiputera Malaysia (PEKA)
Universiti Sains Malaysia (USM)
Universiti Teknologi MARA (UiTM)
PREFACE

This construction industry standard was first developed in 2004 and is revised as a quality assurance for prefabricated timber roof truss with the assistance of the Construction Industry Development Board (CIDB), which acted as a moderator and facilitator for the technical committee throughout the revision process of the standard.

The main objective for the development of the quality assurance is to establish a detailed and systematic framework to:

a) Ensure the quality of prefabricated timber trusses supplied to project sites are consistent with the standard set for the product

b) Establish a common standard of acceptance for all relevant parties involved in the construction of roof that uses such trusses (including project consultants and authorities)

c) Set minimum specifications to be used by connecting plates manufacturers and truss fabricators

d) Identify relevant parties with the necessary expertise for each of the specific areas for conducting the internal and external audits for the processes concerned.

Compliance with this document does not in itself confer immunity from legal obligations.
SECTION 1: GENERAL

1.1 Scope

This Quality Assurance System covers the main elements of the prefabricated timber truss that encompasses:

i. Stage 1- Truss Design Process

ii. Stage 2 - Truss Fabrication Process

iii. Stage 3 - Site Installation Process

The relationship between each of these processes is illustrated in flow chart FC 1. Total System Quality Check. Some aspects are checked more than once as the product moves through the production chain. For instance, checks for defects in timber used for trusses, which exceeds the timber grading allowances, are carried out at Stage 2 and Stage 3.

1.2 Normative References

The referenced documents in this text constitute provisions of this Quality Assurance System. For dated references, where there are subsequent amendments to, or, revisions of, none of these publications apply. For undated references, the current edition of the publication is referred to and applied.

i. MS 360 Specification for Treatment of Timber with Copper/Chrome/Arsenic Wood Preservatives

ii. MS 544-1 Code of Practice for Structural Use of Timber: Part 1: General

iii. MS 544-2 Code of Practice for Structural Use of Timber: Part 2: Permissible Stress Design of Solid Timber

iv. MS 544 Part 6 Code of Practice for Structural Use of Timber: Part 6: Workmanship, Inspection and Maintenance (First revision)

v. MS 1714 Specification for Visual Strength Grading of Tropical Hardwood Timber

vi. ANSI/TPI 1 National Design Standard for Metal Plate Connected Wood Truss Construction

viii. AS 1720.1 Timber Structures Part 1 - Design Methods

x. JIS G 3302: 1987 Hot-dip Zinc-coated Steel Sheet and Strip

xi. JKR 20601-0190-12 Specification for Prefabricated Timber Roof Trusses
1.3 Terms and Definitions

For the purpose of this quality assurance system, the following terms and definitions apply.

i. **Truss system designer (SD)**
   
   A Professional Engineer who is responsible for the design of the specified roof truss system or systems, and producing the required engineering design drawings based on the relevant standards approved by the supervising authority.

ii. **Supervising authority (SA)**

   The authority responsible for ensuring that the contract work is done and completed, as specified in the contract within the stipulated period according to the accepted standards.

iii. **Supervising officer (SO)**

   A person who is responsible for ensuring that the contract work is done and completed, as specified in the contract within the stipulated period according to the accepted standards.

iv. **Truss system provider (SP)**

   A supplier of a proprietary roof truss system, registered with MTIB.

v. **Truss system fabricator**

   A manufacturer capable of fabricating and producing proprietary roof truss systems using equipment and tools approved by an established truss system provider.

vi. **Truss system installer**

   The contractor appointed by the System Provider or fabricator to assemble, erect and install the specified proprietary roof truss system on site.

vii. **Accredited laboratory**

   Laboratory accredited under the Malaysian Laboratory Accreditation Scheme (SAMM), or equivalent, which is approved by the Supervising Authority and System Provider.

viii. **Main contractor**

   A contractor defined in the main contract of work, who undertakes the obligation for the completion and delivery of work, as specified in the contract.

ix. **Professional engineer (PE)**

   Trained professional engineer who is registered with the Board of Engineers Malaysia (BEM) and is a current practitioner (having an active Practicing Certificate) in the registered field.
x. **Project consultant engineer (CE)**

A third-party professional engineer who is responsible in checking the structural drawings and all related engineering works, as specified in the work contract. In this quality assurance documentation, the Consultant Engineer is referred to as a consultant.

xi. **Construction drawing**

PE-approved drawing that represents the design principles and parameters, containing adequate information to produce fabrication drawings, and shall also contain adequate information on works to be done in the construction of all or a portion of the building structure.

xii. **Fabrication drawing**

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

xiii. **As-built drawing**

A revised set of drawings submitted by SP to the contractor showing the dimensions, geometry and location of all elements of the work to be completed under the contract.

xiv. **Certified treated timber**

Timber treated in accordance with MS 544 - Part 10, or any other equivalent standards, accompanied by a treatment certificate or charge sheet, approved by MTIB.

xv. **Pre-fabricated trusses**

Truss fabricated in a controlled setting on assembly line in an off-site facility, then delivered and installed on site.

xvi. **Certified pre-fabricated timber roof truss**

Roof truss fabricated in compliance with this Quality Assurance System by fabricators registered with MTIB that is approved by an established truss System Provider, who is also registered with MTIB.
SECTION 2: TRUSS DESIGN PROCESS

2.1 General

Prefabricated timber trusses are designed by either the System Provider or the truss designers of the System Provider’s truss fabricator using proprietary computer software developed by the individual System Provider. The software shall comply with the Codes of Practices stated below:

i. AS 1720.1 Timber Structures Code Part 1 - Design Methods; or

ii. ANSI/TPI 1 National Design Standard for Metal Plate Connected Wood Truss Construction; or

iii. MS 544 Code of Practice for Structural Use of Timbers
   Part 1: General
   Part 2: Permissible stress design of solid timber
   Part 5: Timber Joints
   Part 8: Design, fabrication and installation of prefabricated timber roof trusses using toothed metal plate connectors
   Part 9: Fire resistance of timber structures
   Part 10: Preservative treatment of structural timbers
   Part 11: Recommendations for the calculation basis for span tables

Independent engineering consultants may undertake the design of these trusses, but shall ensure that the correct design values for the connectors at the joints are utilised. These design values may be obtained from the System Provider. The manufacturer and product codes of the connectors shall be indicated on the design drawings and shall not be substituted without a complete redesign for connectors from another manufacturer.
This section consists of the information required:

i. To commence the truss design process

ii. To be shown on the truss design drawings upon completion of the truss design process

Truss designs are checked for compliance with the drawings supplied to the Truss Fabricator either by the Main Contractor, or Supervising Authority. Any deviations or inability to meet with any of the requirements of the supplied drawings shall be informed by the SD to the Truss Fabricator for approval or resolution by the Main Contractor or SO.

2.2 Documentation or Records

2.2.1 Information required before commencement of the design process

To commence the design process, information required from the Main Contractor and Supervising Authority includes the following:

i. Architectural drawings (comprising of roof plans, floor plans, elevations, sections, roof and ceiling materials, positions of water tanks and other services, other details, etc.)

ii. Structural drawings (comprising of beam layout plans, top of beam levels)

iii. Mechanical and electrical services drawings (indicating positions of fan coil units, air-conditioning ducting, hot water and chiller pipes, firefighting pipes, etc., which are to be supported by the roof trusses)

iv. Loads of the various elements of the mechanical and electrical services

v. Ceiling levels or areas of sloping ceiling

vi. Any special requirements (e.g. decorative features to be incorporated into truss structural members, matching of adjacent existing roofs, etc.)

vii. The general truss limitation should be referred to related standards and specification, e.g. MS 544:2015 Part 8 and JKR 20601-0190-12-cl 2.2

2.2.2 Discrepancies or deviations from drawings supplied

Discrepancies in architectural and structural drawings or inability to conform to the requirements of the drawings provided shall be handled in the following manner:

• The affected areas or details shall be highlighted to the Truss Fabricator, and thereon, brought to the attention of the Main Contractor and Supervising Authority for resolution; or

• Any proposed changes or modifications to the details of the affected areas shall be highlighted to the Truss Fabricator to be approved by the Main Contractor and Supervising Authority.
2.2.3 Information to be provided on truss design drawings

The truss design drawings shall include the following information:

i. Loading data
   a) Dead loads
   b) Wind loads
   c) Water tank loads or capacities
   d) Mechanical and electrical service loads (where applicable)

ii. Timber design data
   a) Strength group and grade
   b) Joint group
   c) Moisture condition

iii. General truss design criteria
   a) Design wind speed
   b) Eaves height from ground level
   c) Truss spacing
   d) Top chord restraint centres (tile batten and purlin centres)
   e) Bottom chord restraint centres (ceiling batten and tie centres)
   f) Roof pitch

iv. Roof layout plan details
   a) Individual truss and rafter position
   b) Marking or identification of each truss or rafter
   c) Eaves overhang dimension
   d) Building dimensions

v. Bracing layouts (where applicable)
   a) Top chord plane
   b) Bottom chord plane
   c) Horizontal top chord plane

vi. Position of water tanks

vii. Position of other services (if relevant)

viii. Connection details, such as
   a) Hold-down on the supports
   b) Truss to truss connections
   c) Rafter to truss connections
   d) Under purlin connections

Discrepancies in drawings supplied or any inability to conform to the drawings supplied that have not been resolved by the Main Contractor and Supervising Authority with the Truss Fabricator shall be noted on the design drawings together with any assumptions made to form the affected areas.
In addition, for each individual truss, the following information shall be included:

i. Truss profile with panel lengths, span and height indicated

ii. Timber component member sizes

iii. Camber

iv. Connector type, size, positioning and orientation

v. Web tie bracing (where relevant)

vi. Stiffener position and detail (where relevant)

All truss design drawings shall have a reference number that may be nominated by either the System Provider or the Truss Fabricator for identification, record filing and retrieval purposes.

The records shall be retained for a period equivalent to the project warranty period or 5 years, whichever is longer by the Truss Fabricator with a copy retained by the System Provider.

2.3 Checking Parameters

All designs done are checked for:

i. Conformance with the architectural and structural drawings supplied to the Truss Fabricator by the Main Contractor

ii. Correct design criteria

iii. Adequacy of truss designs, bracing and connection requirements

iv. Detailing and presentation of information and details (Checklist used: CL1. Checklist for Truss Design and Detail)

2.4 Checking Personnel

The following parties shall check designs done by the System Provider:

i. Professional Engineer

ii. Main Contractor

iii. Supervising Authority or Project Consultant Engineer
The following parties shall check designs done by the Truss Fabricator:

i. System Provider

ii. Professional Engineer

iii. Main Contractor

iv. Supervising Authority or Project Consultant Engineer

After checking, the Professional Engineer shall endorse at least two sets of the drawings for submission to Supervising Authority or Project Consultant Engineer for their approval.

The Professional Engineer shall be experienced and competent in truss design systems.

The System Provider shall issue a design warranty letter for the design checked to the Truss Fabricator for submission to the Main Contractor or Supervising Authority.

2.5 Frequency of Checks

For design drawings done by System Provider, the drawings shall be checked for every project by the Main Contractor and Supervising Authority.

For design drawings done by Truss Fabricator, the drawings shall be checked for every project by System Provider, Main Contractor and Supervising Authority.

2.6 Acceptance Criteria

The truss designs are accepted if deemed to conform with the design codes of practice stated above; the supplied architectural and structural drawings, the design criteria, adequacy of the truss, bracing and connection details conform to recognised standards.

Instructions by the Main Contractor to the Fabricator to commence truss fabrication shall be taken as all necessary approvals are given and all proposed changes, modifications or assumptions taken to form the truss are accepted by the relevant authorities or parties.

2.7 Verification of Truss Design Drawings

All truss design drawings shall be endorsed by the checking Professional Engineer.

2.8 Responsibilities of the Main Contractor

The Main Contractor shall be responsible for any changes or amendments to the architectural or structural details that are not reflected in the drawings that are supplied to the Truss Fabricator at the truss design stage. This shall also include changes to mechanical and electrical service loading details.
SECTION 3. TRUSS FABRICATION PROCESS

3.1 General

This section covers timber processing and the assembly or fabrication of the cut timber components and connectors into trusses in the Truss Fabricator’s factory premises.

Jigs are used to hold or clamp the various cut timber components in position with the fixing of the toothed metal plate connectors at the truss joints, carried out by using hydraulic presses.

This section is divided into the following subsections:

i. Fabrication equipment

ii. Timber

iii. Assembly of truss components or fabrication process

iv. Storage

NOTE:
Site measurement by the Truss Fabricator of the supporting building structure is recommended prior to cutting truss components (refer to Section 4.1 and Checklist CL 3. Checklist of documentation for site measurement).

3.2 Documentation or Records

The records shall be retained for a period equivalent to the project warranty period or 7 years, whichever is longer by the Truss Fabricator, with a copy retained by the Truss Designer.

3.2.1 Fabrication equipment

(Checklist used: Form CL2. Checklist for Truss Fabrication Equipment)

3.2.2 Timber

The Truss Fabricator shall utilise the checklist for each project undertaken by the Truss Fabricator. The checklist shall be maintained for inspection by the System Provider, Main Contractor and Supervising Authority. For certification, MTIB shall verify the checklist.

For each batch of timber, the following records shall be furnished by the fabricator with the minimum information as listed below and retained:

i. Grading summary by MTIB-registered or STIDC-registered timber grader
   a) Batch identification number
   b) Nominal timber sizes and quantity
   c) Type of species or strength group
   d) Visual grade
   e) Name of grader and MTIB or STIDC registration number
ii. Preservative vacuum pressure-treatment certificate and charge sheet
   a) Batch identification number
   b) Nominal timber sizes and quantity
   c) Name of treatment plant
   d) Date of treatment
   e) Type of chemical used and chemical manufacturer’s name
   f) Treatment chemical retention or treatment charge

Test results of treated timber samples that were sent to chemical suppliers’ test laboratories by
Truss Fabricators for the purpose of monitoring the performance of the treatment plants (both
in-house or external facilities) shall also be filed with relevant timber batches for audit purposes.

All grading summaries and treatment certificates or charge sheets shall be filed in a manner
that allows easy retrieval and identification of relevant timber batches for inspection or audit
purposes.

(Checklist used: Form CL4. Checklist for Timber and Trusses at Truss Plant)

3.2.3 Assembly of truss components or fabrication process

The Truss fabricator shall utilise the checklist for each project undertaken by the Truss Fabricator.
Checklists shall be maintained for inspection by the System Provider, Main Contractor and
Supervising Authority.

(Checklist used: Form CL4. Checklist for Timber and Trusses at Truss Plant)

3.2.4 Storage

(Checklist used: For CL4. Checklist for Timber and Trusses at Truss Plant)

3.3 Checking Parameters

3.3.1 Fabrication equipment

The sawing equipment is checked for:

i. General condition of the saw assembly

ii. Alignment of saw bench

iii. Cut squareness

iv. Accuracy of angles cut

The hydraulic pressing equipment is checked for:

i. Condition of the hydraulic system (leakage at hoses or valves, hydraulic system pressure
   and condition of hydraulic oil)

ii. Condition of electrical controls

iii. Condition of jig frame and boxes (for portal gantry or A-frame systems)

(Refer to Flow Charts FC2.1. and FC2.2.: Truss Plant Equipment Maintenance Process)
3.3.2 Timber

The grading summary of the timber batch to be used shall be checked for conformance with the truss design criteria indicated on the design drawings:

i. Visual grade

ii. Species or strength group

The preservative vacuum pressure-treatment certificate or charge sheet shall be checked to ensure it corresponds to the treatment the timber batch is stated to be used:

i. The vacuum-pressure process

ii. Copper-chrome-arsenic based chemicals or other approved wood preservatives

iii. Retention of the preservative chemical corresponding with the current version of MS 360 requirements or other relevant Codes of Practice for the stated use of the timber.

Test results of treated timber samples sent by the Truss Fabricator to monitor the performance of the treatment facilities (both in-house and external facilities) shall be reviewed. Any corrective action taken will be noted.

NOTE:
The checks on the cross-sectional dimensions and allowable timber defects of the timber used for truss fabrication at the Truss Fabricator’s factory shall be carried out during the checks on fabricated trusses (Refer Section 3.6.2).

3.3.3 Assembly of truss components

The parameters required to be checked include the following:

i. Truss geometry (check on overall dimensions, e.g. span, height, panel lengths)

ii. Timber member sizes (cross-section dimensions conform with design drawing requirements)

iii. Timber defects (not exceeding the limits specified for the grade of timber used)

iv. Joint timber tolerances
   a) Variation in timber thickness between any 2 abutting adjacent members
   b) Gap between the ends of any 2 adjacent members

v. Connector type and size

vi. Joint connector tolerances
   a) Embedment of connector teeth
   b) Placement

vii. Connector orientation

viii. Teeth rollover

ix. Damaged connector or joint

x. Missing connector
3.3.4 Storage

The completed trusses, that are stored in the Fabricator's yard while awaiting delivery to the site, are checked for the following parameters:

i. Bundling off ground

ii. Stacking in a flat position with supporting blocks under panel points

iii. Marking or identification of individual trusses stacked

If the completed trusses are to be stored in the yard for more than two (2) weeks, then these trusses should be protected from the elements in a manner that provide adequate ventilation to the trusses. If tarpaulins or other similar materials are used, the ends should be left open for ventilation.

3.4 Checking Format

3.4.1 Fabrication equipment

Audit of the equipment shall be carried out by the System Provider or its representative.

3.4.2 Timber

The System Provider shall review the following documentation:

i. Timber grade, species or strength group and size
   a) Details on the grading summary by MTIB- or STIDC-registered timber grader to conform accordingly
   b) With the truss design requirements for visual grade, species or strength group
   c) Timber cross-section dimensions

ii. Timber treatment
   a) Details on the treatment certificate issued to the treatment plant by MTIB are reviewed by the System Provider for the correct treatment charge used

3.4.3 Assembly of truss components

For randomly selected batches, the System Provider shall check the trusses for conformance with the truss design drawings and the tolerances specified by the System Provider for fabrication are met in accordance with the parameters stated above.

3.4.4 Storage

Completed trusses in the factory shall be inspected by the System Provider to check whether they are stacked and stored in accordance with the System Provider’s recommended practices.
3.5 Frequency of Checks

The Truss Fabricator shall carry out the truss fabrication quality control process at least once every two (2) years and retain the records for the System Provider’s audits.

The System Provider shall conduct audits of the Truss Fabricator’s manufacturing facilities at least once a year, or upon the Truss Fabricator’s request, or if deficiencies are discovered in the previous audit and verified by MTIB.

3.5.1 Fabrication equipment

Checks for all sawing and pressing equipment shall be carried out annually.

3.5.2 Assembly of truss components

During the System Provider’s audit, a truss fabrication batch is randomly selected for checking at the above frequency. Ten (10) random trusses are picked from the batch and checked for the parameters stated in 3.4.2.

Sampling may be repeated as stated under the Acceptance Criteria.

3.5.3 Storage

The System Provider shall conduct its audit at the frequency stated in Section 3.5.2.

3.6 Acceptance Criteria

3.6.1 Fabrication equipment

Equipment shall be in good general order with the saw benches aligned, and for the presses, minimal leakage along the hydraulic hoses and valves.

Sawing tolerances shall not exceed the following:

i. ± 2 degrees off-vertical for timber thickness for cut squareness (refer to note below)

ii. ± 1 degree for accuracy of angles cut

NOTE:

The cutting shall not result in the joint gaps exceeding the limits specified in 3.6.2.4 d for all member thicknesses.

For the hydraulic presses, the hydraulic pressure shall be able to be maintained when clamping on a piece of timber and held for 2 seconds.

3.6.2 Assembly of truss components

For each batch of trusses inspected, the following documents shall be made available:

i. Grading summary by a MTIB- or STIDC-registered timber grader, stating the timber grade and species or timber strength group

ii. Treatment certificate from MTIB or STIDC or FRIM or TRTTC, which shall bear the name of the chemical supplier, type of chemical, treatment charge used and thereater
3.6.2.1 For timber grade and species or strength group

The grade and species or strength group in the grading summary shall comply with the truss design criteria.

Samples may be required to be sent for testing by an independent party (as defined in Section 3.7.2 below) for confirmation if the relevant certificates are not available.

For 10 trusses selected, if more than 5% of the timber components are found to have defects exceeding the limits specified by the current version of MS 544: Part 2 or MS 1714, or, the cross-section size is less than the design specified size, a further 10 trusses from the same batch shall be selected at random for further checking. If no more than 5% non-permissible defects are found in the second sampling, the batch shall be deemed to meet the specifications with the defective pieces replaced or strengthened.

If more than 5% of components have non-permissible defects in the second 10 trusses, then the entire batch shall be checked for compliance.

3.6.2.2 For timber treatment

All roof timbers shall be treated to a charge of not less than 5.6 kg/m³ (0.35 lb/ft³) for CCA preservatives to achieve the necessary salt retention for non-durable timber and sapwood of durable species. For other approved preservative chemicals, the relevant Codes of Practice should be referred to.

If the charge is less than 5.6 kg/m³, the timber batch shall either be rejected or sent through the treatment process again in order to satisfy the acceptance criteria. For species that require treatment, the minimum preservative penetration depth for timber is 6 mm (MS 360).

If no treatment certificate is available for the timber batch, then that batch shall not be utilised for fabrication.

3.6.2.3 For timber sizes

At the time of fabrication, the cross-section dimensions shall not be less than the specified design sizes.

NOTE:

i. Sizes referred to in design drawings are at the time of truss fabrication. Upon drying out, green timber shall undergo shrinkage in dimensions. This Quality Assurance shall adopt an average of 3% as the magnitude of shrinkage for species commonly used in truss fabrication (refer to Annex F).

ii. Note that there is an increase in timber strength as the timber dries (refer to Table 1. Wet grade stresses of timber, Table 2. Dry grade stresses of timber and Table 4. Wet and dry grade stresses for various groups of timber of MS 544: Part 2).
3.6.2.4 For assembly and fabrication process

Trusses fabricated are deemed acceptable if:

i. Their overall geometry conforms with the design truss profiles (taking into account of adjustments for variations in building dimensions based on site measurements taken)

ii. Timber member sizes are of at least specified in the design drawings (refer to 3.6.2.3 “Note” on timber shrinkage)

iii. Timber defects do not exceed sizes specified in the current version of MS 544: Part 2 or MS 1714 for visual grading (refer to Annex E)

iv. Joint timber tolerances do not exceed the limits below:
   a) Variation in timber thickness between any two (2) abutting adjacent members is 2mm or less
   b) The average gap between the ends of any two (2) abutting adjacent members is 2mm or less;

v. Connector type and size is not less than specified in the design drawings:
   a) Connectors that project outside the edges of the timber are allowed if designed for and their placement do not deviate by more than the tolerances specified;

vi. Tolerances for the connectors at the truss joint do not exceed the limits below:
   a) Gap between the underside of the connector to the timber surface is 1.5mm or less
   b) Embedment of the connector plate is not more than 0.5mm
   c) Mispositioning of connector by not more than 6mm for connector dimension of less than 150mm (in the direction of the dimension), and 12mm for connector dimension of 150mm or more (in the direction of the dimension)

vii. Orientation of connector to conform with System Provider specifications and standards, and truss design drawings

viii. Number of teeth rolled-over or flattened shall not exceed 10% of available teeth

ix. No detectable damage to the connectors or joint

x. No missing connectors at the joint

The System Provider shall then undertake an engineering assessment to determine what steps are required, if any, to rectify any trusses that do not meet the above acceptance criteria.

Any trusses, in the opinion of the System Provider, that cannot be rectified shall be rejected and disposed by the Truss Fabricator.
3.6.3 Storage

The completed trusses shall be stored in the following manner in accordance with the requirements of the System Provider:

i. Bundles are off the ground and not in direct contact with the ground

ii. Stacked in a flat position with supporting blocks under panel points

iii. Individual trusses stacked are marked or identified clearly

3.7 Verification and Testing Authority

3.7.1 Fabrication equipment

MTIB shall verify the documentation for the maintenance of the fabrication equipment.

3.7.2 Timber

(Refer to Annex C - Flow Chart FC 4. (a) to (c): Stage for Timber Verification)

Where further verification is required, tests shall be carried out at any of the following organisations:

i. For timber grade verification
   a) Malaysian Timber Industry Board
   b) Sarawak Timber Industry Development Corporation

ii. For timber species verification
   a) Malaysian Timber Industry Board
   b) Forest Research Institute Malaysia
   c) Sarawak Timber Industry Development Corporation
   d) Timber Research and Technical Training Centre

iii. For timber treatment verification
   a) Malaysian Timber Industry Board
   b) Forest Research Institute Malaysia
   c) Timber Research and Technical Training Centre
   d) Laboratories registered under SAMM

3.8 Rectification of Trusses in Factory

Checked trusses that do not meet the fabrication specifications or are damaged in the Fabricator’s factory may be rectified provided:

i. The System Provider and/or Professional Engineer engaged by Truss Fabricator agrees that the said trusses can be rectified, and

ii. Rectification details are provided by the System Provider and/or Professional Engineer engaged by Truss Fabricator, or

iii. Rectification details are approved by the System Provider and/or Professional Engineer engaged by Truss Fabricator in writing
SECTION 4. SITE INSTALLATION PROCESS

4.1 General

This section covers the area of truss installation on the site, where materials and workmanship are checked against the details of the design drawings and recommended installation tolerances.

Site measurements are recommended to be taken prior to fabrication of the trusses to allow for site construction deviations or tolerances of the supporting structure.

However, it remains the responsibility of the Main Contractor to advise the Truss Fabricator of any changes or amendments to the architectural or structural details (including mechanical and electrical services) that are not reflected in the drawings supplied to the Truss Fabricator at design stage.

4.2 Documentation or Records

The checklist is generally used when the truss installation works are either completed or close to completion.

NOTE:
The use of checklist Form CL 3. Checklist of Documentation for Site Measurement will highlight or minimise any discrepancies between the design criteria or details and the actual site situation.

A CL5 checklist shall be used for each individual stand-alone building or for a block of units with a similar roof design. Block identification shall be indicated on the relevant checklist.

The records shall be retained for a period equivalent to the project warranty period or 5 years, whichever is longer by the fabricator with a copy retained by the System Provider.

(Checklist used: Form CL5. Checklist for Truss Installation)

4.3 Checking Parameters

The parameters required to be checked for both materials used and workmanship for the installation of:

i. Wall-plates along beams used for truss support

ii. Trusses and rafters

iii. Erection tolerances

iv. Bracing

v. Other framing components

vi. Presence of service loads

vii. Tile battening (if applicable)

viii. Purlins (if applicable)

ix. Fascia board
4.4 Checking Format

A joint-site inspection, coordinated by the main contractor, shall be carried out upon completion of roof truss installation (prior to ceiling installation) by:

i. Truss Fabricator’s site coordinator or supervisor

ii. System Provider’s technical personnel or its authorised representative

iii. Main Contractor’s representative

iv. Professional Engineer who endorsed the truss design drawings or his/her authorised representative

The Consultant or Supervising Authority’s personnel shall be informed of the joint inspection and invited to witness the inspection.

All trusses shall be visually checked for obvious misalignment and incorrect spacing.

To verify that the spacings and alignments of the installed trusses are within design tolerance, a number of trusses shall be chosen randomly for these measurement checks based on the following criteria:

i. 10% of all installed trusses

ii. A maximum of ten (10) numbers of trusses, whichever is lower

If the total number of trusses is less than 10, then all the installed trusses in the roof shall be checked.

If the requirements of the checking parameters are not met, a further number of trusses are selected based on the above criteria for additional inspection. In the event that nonconformance are detected in the second sampling, all the roof trusses shall be checked.

All detected nonconformances shall then be rectified in accordance with 5.8.

Inspection of the roof or roof elements in other stages of installation shall be at the discretion of the parties involved.

4.5 Frequency of Checks

Joint inspections shall be carried out at least once for every project.
4.6 Acceptance Criteria

Workmanship shall conform with the details in the truss design drawing - System Provider's Installation Guide, the current versions of MS 544: Part 6 and System Provider’s requirements.

Timber defects shall not exceed the timber grading requirements as defined by the current version of MS 544: Part 2 and MS 1714 for the specified grade.

Acceptable installation tolerances shall be as tabulated in Table 1.

Table 1. Roof Truss Installation Tolerances

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Acceptance tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position or truss spacing</td>
<td>+50 mm or 5% of the spacing whichever is higher</td>
</tr>
<tr>
<td>Vertical misalignment or out-of-plane</td>
<td>height/50 or maximum 50 mm</td>
</tr>
<tr>
<td>Horizontal misalignment or straightness</td>
<td>span/200 or maximum 50 mm</td>
</tr>
</tbody>
</table>

All measurements on site of timber member sizes shall allow for:

i.  Any specified dimensional undersize allowed (as stated on the truss design drawings)

ii. Dimensional shrinkage

The measured sizes at site for timber ancillaries shall not be less than the value calculated using the following formula.

\[ T \geq X - Y - Z \]

where,

- \( T \) is the measured timber size (mm)
- \( X \) is the specified size on truss design drawings (mm)
- \( Y \) is the specified allowable undersize (mm)
- \( Z \) is the shrinkage equal to 3% of each dimension (mm)

NOTE:
This 3% value is taken as an average shrinkage value. The specific shrinkage value for each particular species is given in Annex F. If the species is not listed, a shrinkage value of 3% could be adopted or guidance is to be sought from FRIM.

All metal bracing (speed-brace or strap brace) shall be installed tight without any sagging between supports or nailing points, not to exceed the value of the distance between supports divided by 500.

4.7 Verification of Truss Design Drawings

The installed trusses shall be inspected by the Professional Engineer who endorsed the truss design drawings or his authorised representative.
4.8 Rectification of Trusses on Site

Checked trusses that are damaged on site may be rectified, provided:

i. The System Provider agrees that the said trusses can be rectified

ii. Rectification details are provided by the System Provider

iii. Rectification details are approved by the System Provider in writing.

The rectification details shall be approved by the Professional Engineer with a copy submitted to the Main Contractor.

SECTION 5. QUALITY ASSURANCE AUDIT TEAM

5.1 System Provider (SP)

Each System Provider shall form an audit and inspection team under the supervision of an engineer for implementing and maintaining the Quality Assurance System.

Members of the team shall be experienced or are trained in at least one or more of the process areas under the scope of this Quality Assurance System and are to audit or inspect these process areas only.

Factory inspections are to be carried out on a random basis, provided production is scheduled for the nominated day.

Site installation inspections are carried out as soon as practicable, prior to handing over of the works by the Truss Fabricator.

This team shall liaise with any other third party involved in auditing of this Quality Assurance System (refer to Annex B - Summary of Documentation and Inspections).

5.2 Truss Fabricator

Each fabricator shall identify their personnel who shall have quality assurance responsibilities of their operations.

The suggested personnel shall be:

i. General Manager : overall executive responsibility

ii. Technical Manager or Designer : design and detailing

iii. Factory Manager or Supervisor : production and distribution

iv. Technical Manager or Supervisor : site installation
5.3 **Fabricator Human Resources**

The technical competency of the personnel involved in the following process areas shall be audited annually by the System Provider:

i. Design and detailing
ii. Production and distribution
iii. Site installation
ANNEX A
(normative)

STEEL IN CONNECTOR MANUFACTURING

A1 General

This section is to confirm that the steel supplied for the manufacture of toothed metal plate connectors meets the specifications required to ensure the design values of the connectors are met.

Toothed metal plates are used as connectors in the fabrication of the prefabricated timber truss systems. These connectors are manufactured from light gauge galvanized steel having teeth punched out in one direction and bent perpendicular to the base of the plate. The galvanized steel is supplied to the System Providers or manufacturers of the toothed metal plates in the form of coils.

A2 Documentation or records

The steel supplier’s Mill Test Certificate is to accompany each shipment.

The minimum information required on the certificates shall include the following:

i. Suppliers' name
ii. Coil number or shipment number
iii. Date of shipment
iv. Coil thickness and width
v. Steel mechanical properties (tensile strength, yield strength and elongation)
vi. Galvanizing coating mass or galvanizing standard used

All mill test certificates shall be filed based on the coil number/shipment number or the date of shipment and retrieved, if necessary, for inspection or audit purposes.

The records shall be retained for a minimum period of five years by the System Provider.

A3 Checking parameters

The following properties of the steel coils shall be tested and confirmed by an accredited laboratory as specified in A7 of this Annex:

i. Mechanical properties
   a) Ultimate steel tensile strength
   b) Minimum steel yield strength
   c) Elongation

ii. Anti-corrosion coating

iii. Galvanizing coating mass

iv. Coil thickness
A4 Checking format

The Mill Test Certificate(s) of all coil shipments received shall be checked for conformance with the acceptance standard for the parameters stated by the System Provider.

In addition, samples selected from the coils at random shall be sent to an accredited test laboratory to verify that the minimum mechanical properties and galvanizing coating masses are achieved.

A5 Frequency of checks

The System Provider shall check the Mill Test Certificate for every shipment received.

One sample from a coil selected at random shall be sent. In addition, at a minimum frequency of once every six months, one sample from a coil selected at random, shall be sent to an accredited test laboratory.

A6 Acceptance criteria

Criteria for acceptance shall be based on the following standards or other approved equivalent standards:

i. Steel mechanical properties
   a) AS 1397: 2011 Table 2.2 - Mechanical Property Requirements for Structural Grades and Table 2.3 - Mechanical Property Requirements for Formability/Grades, or
   b) JIS G 3302 Table 7.8 - Yield Point, Tensile Strength, Elongation and Non-aging (cold-rolled base metal used)

ii. Galvanizing coating mass
   a) AS 1397: 2011 Table 3.1 - Coating Mass Requirements, or
   b) JIS G 3302 Table 2 - Minimum coating mass on both surfaces for sheets or coils having same coating mass on both surfaces

Properties of some of the steel grades commonly used by the System Provider in Malaysia are summarised as follows:
### Table A1. Steel Mechanical Properties

<table>
<thead>
<tr>
<th>Standard Used</th>
<th>AS 1397</th>
<th>AS 1397</th>
<th>JIS G 3302</th>
<th>JIS G 3302</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade of Steel</td>
<td>G2</td>
<td>G300</td>
<td>SGCC</td>
<td>SGC400</td>
</tr>
<tr>
<td>Ultimate Tensile Strength, MPa</td>
<td>340 min.</td>
<td>340 min.</td>
<td>330 min.</td>
<td>400 min.</td>
</tr>
<tr>
<td>Minimum Yield Strength, MPa</td>
<td>270 min.</td>
<td>300 min.</td>
<td>250 min.</td>
<td>295 min.</td>
</tr>
<tr>
<td>Elongation on 50 mm test length</td>
<td>30% min.</td>
<td>20% min.</td>
<td>30% min.*</td>
<td>18% min.*</td>
</tr>
<tr>
<td>80 mm test length</td>
<td>27% min.</td>
<td>18% min.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
* Test length not indicated

### Table A2. Galvanizing Coating Mass (Hot-dipped zinc-coated)

<table>
<thead>
<tr>
<th>Standard Used</th>
<th>AS 1397</th>
<th>JIS G 3302</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating Class</td>
<td>Z275</td>
<td>Z27</td>
</tr>
<tr>
<td>Single Spot</td>
<td>250</td>
<td>234</td>
</tr>
<tr>
<td>(both surfaces), g/m2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triple Spot</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>(both surfaces), g/m2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table A3. Coil Thickness

<table>
<thead>
<tr>
<th>Nominal Thickness (mm)</th>
<th>Minimum Coated Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>0.95</td>
</tr>
<tr>
<td>1.2</td>
<td>1.15</td>
</tr>
<tr>
<td>1.6</td>
<td>1.55</td>
</tr>
<tr>
<td>1.9</td>
<td>1.85</td>
</tr>
<tr>
<td>2.0</td>
<td>1.95</td>
</tr>
</tbody>
</table>

### A7 Testing authority

The external tests shall be carried out by an independent test laboratory accredited under SAMM.
<table>
<thead>
<tr>
<th>Process Area</th>
<th>Documentation</th>
<th>By Whom</th>
<th>Frequency</th>
<th>Documentation Reviewed/Checked by</th>
<th>Frequency</th>
<th>Documentation Verification Testing</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CONNECTORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Steel strength</td>
<td>Mill certificate</td>
<td>Steel supplier</td>
<td>Every shipment</td>
<td>Mill certificate</td>
<td>SP</td>
<td>Every shipment</td>
<td>Certificates</td>
</tr>
<tr>
<td>b) Galvanizing coating</td>
<td>Mill certificate</td>
<td>Steel supplier</td>
<td>Every shipment</td>
<td>Mill certificate</td>
<td>SP</td>
<td>Every shipment</td>
<td>Certificates</td>
</tr>
<tr>
<td>c) Material thickness</td>
<td>Mill certificate</td>
<td>Steel supplier</td>
<td>Every shipment</td>
<td>Mill certificate</td>
<td>SP</td>
<td>Every shipment</td>
<td>Certificates</td>
</tr>
<tr>
<td>2. TRUSS DESIGN PROCESS</td>
<td>Design drawings</td>
<td>SP</td>
<td>Every project</td>
<td>Truss design drawings</td>
<td>Main Con, PE and JKR/Consultant</td>
<td>Every project</td>
<td>Truss design drawings</td>
</tr>
<tr>
<td>a) By SP design office; or</td>
<td>Design drawings</td>
<td>Fabricator</td>
<td>Every project</td>
<td>Truss design drawings</td>
<td>SP, Main Con, PE and JKR/Consultant</td>
<td>Every project</td>
<td>Truss design drawings</td>
</tr>
<tr>
<td>b) By Fabricator</td>
<td>Check list CL1</td>
<td>Fabricator</td>
<td>Every project</td>
<td>Checklist CL1</td>
<td>SP and PE</td>
<td>Every project</td>
<td>Checklist CL1</td>
</tr>
<tr>
<td>3. TRUSS FABRICATION PROCESS</td>
<td>Internal maintenance records</td>
<td>Fabricator</td>
<td>-</td>
<td>Checklist CL2</td>
<td>-</td>
<td>Annually*</td>
<td>-</td>
</tr>
<tr>
<td>a) Fabrication equipment</td>
<td>Grading summary</td>
<td>Registered timber grader</td>
<td>Every batch</td>
<td>Checklist CL4</td>
<td>SP</td>
<td>Min. once per project</td>
<td>Certificate</td>
</tr>
<tr>
<td>b) Timber - grade - species &amp; strength group - Treatment Assembly of truss component</td>
<td>Grading summary</td>
<td>Registered timber grader</td>
<td>Every batch</td>
<td>Checklist CL4</td>
<td>SP</td>
<td>Min. once per project</td>
<td>Certificate</td>
</tr>
<tr>
<td>c) Treatment certificate &amp; Charge sheets</td>
<td>Treatment plant</td>
<td>Every batch</td>
<td>Checklist CL4</td>
<td>SP</td>
<td>Min. once per project</td>
<td>Certificate</td>
<td>MTIB/STIDC FRIM/TRTTC or SAMM-accredited laboratory</td>
</tr>
<tr>
<td>d) Storage</td>
<td>Checklist CL4</td>
<td>Fabricator</td>
<td>Every batch</td>
<td>Checklist CL5</td>
<td>SP</td>
<td>Min. once per project</td>
<td>-</td>
</tr>
<tr>
<td>4. SITE INSTALLATION PROCESS</td>
<td>Checklist CL5</td>
<td>Fabricator</td>
<td>Every project</td>
<td>Checklist CL5</td>
<td>SP, Main Con, PE and JKR/Consultant</td>
<td>Every project</td>
<td>Checklist CL5</td>
</tr>
</tbody>
</table>

NOTES:
SP - System Provider; PE - Professional Engineer; STIDC - Sarawak Timber Industry Development Corporation; MTIB - Malaysia Timber Industry Board; Main con. - Main contractor; SMM - Skim Akreditasi Makmal Malaysia; TRTTC - Timber Research and Technical Training Centre; FRIM - Forest Research Institute Malaysia. (* if non-conformance is detected, the auditor may recommend an increase in the frequency of audits).
ANNEX C  
(normative)  

PROCESS FLOW CHARTS  

FC1. Total System Quality Check  
FC2.1. Truss Plant Equipment Maintenance Process  
FC2.2. Truss Plant Equipment Maintenance Process (continued)  
FC3. Timber Selection Check on Truss Plant  
FC4. Stages of Timber Flow - Fabricator with Licensed Timber Grader:  
   a) Truss Fabricator/Sawmill with a licensed timber grader  
   b) Truss Fabricator with treatment facilities  
   c) Truss Fabricator without treatment facilities
FC 1. TOTAL SYSTEM QUALITY CHECK

START → TRUSS DESIGN → TIMBER CHECK

TIMBER COMPLY TO DESIGN & SPECIFICATION → SP PRODUCTION TAKE ACTION

CONNECTOR QUALITY IS OK → TRUSS PLANT EQUIPMENT CHECK

ALL EQUIPMENT CONDITION IS OK → TRUSS HANDLING IS OK

FABRICATOR'S RESPONSIBILITY TO COMPLY

TRUSS INSTALLATION CHECK

TRUSS INSTALLATION ACCORDING TO DRAWINGS → SP ADVICE RECTIFICATION

QAS COMPLIED → END

NOTE:
SP - SYSTEM PROVIDER
PE - PROFESSIONAL ENGINEER
FC 2.1. TRUSS PLANT EQUIPMENT MAINTENANCE PROCESS

START

CUTTING EQUIPMENT CHECK

SAW BENCH CHECK

NO

TO MAKE GOOD

SAW PHYSICAL CONDITION

NO

TO MAKE GOOD

SAW ANGLE CALIBRATION

NO

TO CALIBRATE

YES

PRESSING EQUIPMENT CHECK

HYDRAULIC OIL/FILTER CONDITION

NOT OK

TO CLEAN/REPLACE

OK

HYDRAULIC HOSES & VALVES CONDITION

NOT OK

TO CLEAN/REPLACE

OK

HYDRAULIC PRESSURE IS RIGHT

NO

ADJUSTMENT TO RIGHT PRESSURE

YES

CONTROL BUTTONS ARE WORKING

NO

TO REPAIR/REPLACE

YES

TO FC 2.2 PORTAL OR ‘A’ FRAME

TO FC 2.2 BENCH PRESS
PORTAL OR 'A' FRAME BRAKE SYSTEM IS WORKING

JIG TABLE & FLO BOXES ON FLAT LEVEL

REPAIR AND PUT TO THE CORRECT LEVEL

ADJUST TO RIGHT BRAKE PRESSURE

HYDRAULIC HOSES & VALVES CONDITION

CALIBRATE TO RIGHT PRESSURE

HYDRAULIC OIL/FILTER CONDITION

TO CLEAN/REPLACE

END

FROM FC 2.1

BENCH PRESS EQUIPMENT CHECK

TO REPAIR/REPLACE

HYDRAULIC PRESSURE IS RIGHT

OK

FROM FC 2.1

TO REPAIR/REPLACE

FC 2.2 TRUSS PLANT EQUIPMENT MAINTENANCE PROCESS (continued)
FC 3. TIMBER SELECTION CHECK IN TRUSS PLANT

START

TIMBER CHECK

CERTIFIED TREATED TIMBER CHECK

YES

STRENGTH GROUP & GRADE COMPLY TO DESIGN

NO

REJECT

TIMBER DEFECT CHECK

TIMBER DEFECTS WITHIN TOLERANCE

NO

REJECT

YES

TIMBER SIZE

CHECK

TREATMENT DONE TO SPECIFICATION

NO

FABRICATOR TO CARRY OUT REETREATMENT

YES

REJECT

FABRICATOR TO RESAW

TIMBER SIZES COMPLY TO DESIGN

REJECT

STRENGTH GROUP & GRADE COMPLY TO DESIGN

NO

REJECT

YES

TIMBER READY FOR FABRICATION

END
Treated Timber Certification

Prefabricated Timber Roof Truss Certification

NOTE:
For Fabricator without treatment plant, the in-coming timber in the fabricator’s factory shall be certified treated timber

For Fabricator without a licensed timber grader, arrangement can be made with MTIB or STIDC for timber grading services
ANNEX D
(Informative)

CHECKLISTS

CL1. Checklist for Truss Design & Detail
CL2. Checklist for Truss Fabricating Equipment
CL3. Checklist for Documentation for Site Measurement
CL4. Checklist for Timber and Trusses at Truss Plant
CL5. Checklist for Truss Installation
CHECKLIST FOR TRUSS DESIGN & DETAILS

Date: ______________________________________________________________

Fabricator Name: ______________________________________________________________

Project Title: ______________________________________________________________

______________________________

______________________________

______________________________

Job No.: _________________________           Designer: _______________________

A. RESULT OF TRUSS DESIGN & DETAILS CHECK

The design was assessed on the following criteria:

1.0  Availability of Architectural, Structural and M&E drawings  Y / N

2.0  Design according to all loading specified  Y / N

3.0  Truss design parameters are clearly stated   Y / N

4.0  Truss design is properly engineered in accordance with recognised standard   Y / N

5.0  Drawing details are well presented    Y / N

Fabricator: _________________________   Company Stamp:

Signature: _________________________

Date: _________________________

System Provider _________________________  Company Stamp:

Signature: _________________________

Date: _________________________

Professional Engineer: _________________________  Company Stamp:

Signature: _________________________

Date: _________________________
**General notes:**
This checklist is to be checked against the roof truss design and details done by the fabricators. Design and detail information that complies with the checks should be marked ‘✓’. Otherwise, mark ‘X’ in the appropriate box provided.

<table>
<thead>
<tr>
<th>1.0</th>
<th>DRAWING REQUIRED</th>
<th>FILLED BY DESIGNER</th>
<th>CHECKED BY SYSTEM PROVIDER</th>
<th>CHECKED BY P. ENGINEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Architectural:</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>(a) Roof plan</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Elevation</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Sections</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Floor plan</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(e) Details</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(f) Others</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Structural</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>(a) Roof beam layout</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Service Load</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>(a) Air-con unit &amp; ducting system</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Water tank</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>(c) Fire fighting system</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Others</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
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<tr>
<td>2.0</td>
<td>LOADING CRITERIA</td>
<td>[ ]</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>ROOFING SELF WEIGHT</td>
<td>___kN/m²</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>CEILING SELF WEIGHT</td>
<td>___kN/m²</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>ROOF LIVE LOAD</td>
<td>___kN/m²</td>
<td>[ ]</td>
<td></td>
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<tr>
<td>2.4</td>
<td>DESIGN WIND SPEED</td>
<td>___m/s</td>
<td>[ ]</td>
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<td>2.5</td>
<td>Service load</td>
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<td></td>
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<tr>
<td></td>
<td>(a) Air-con unit &amp; ducting system</td>
<td>___</td>
<td>[ ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Water tank</td>
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<td>(e) Service load</td>
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<td>(f) On-site splicing</td>
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<td>(g) Truss hold-down</td>
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<td>(e) Hold-downs</td>
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</tbody>
</table>

Professional Engineers

[Signature]

[Signature]
CHECKLIST FOR TRUSS FABRICATING EQUIPMENT

Fabricator Name: ______________________________________________________________

Factory Location: _______________________________ Tel: __________________________

Fax: __________________________

Factory Manager: __________________________

Equipment QC Officer: __________________________

Date of Inspection by System Provider: _________________________________

System Provider’s Representative: _________________________________

Date of Last Inspection: _________________________________

A. RESULT OF TRUSS FABRICATING EQUIPMENT INSPECTION

This inspection of truss fabricating equipment was conducted on ___________ and the findings are:-

a) Equipment was maintained in good condition according to System Provider’s requirement     Yes / No

b) Maintenance records available      Yes / No

If ‘No’,
c) The comments of the findings AND/OR recommended rectifications are :

1. _________________________________________________________________________

2. _________________________________________________________________________

Checked in the presence of :

Fabricator Rep: _________________  Company Stamp:

Signature: _________________

Date: _________________

Checked by :

System Provider: _________________  Company Stamp:

Signature: _________________

Date: _________________
General notes:
This checklist is to be checked against the truss fabricating equipment at licensed fabricator’s truss plant. Equipment that complies with the checks should be marked ‘✓’. Otherwise, mark ‘✗’ in the appropriate box provided.

1.0 SAW – TIMBER CUTTING

1.1 Condition of saw bench

a) Are the saw benches aligned with the centre point of the two saws? 

b) Is the measurement taken from Adjustable Saw Stop bench accurate? (Tolerance ± 2mm)

1.2 Condition of saw

a) Does the saw-column stand straight vertically?

b) Does the saw cut through the same reference point for any angle setting?

1.3 Saw Angle calibration

Is the saw calibrated correctly at the angles below?

i) 90 degree ± 1 degree

ii) 45 degree ± 1 degree

2.0 PRESSING EQUIPMENT (PORTAL GANTRY or A-FRAME) AND JIGS

2.1 Condition of Pressing Equipment

a) Hydraulic hoses and valves condition.

b) Is the hydraulic pressure of ‘G’ Clamp working satisfactorily to fully embed connector plate to the timber to meet the requirement? (Clamp a piece of 2" thickness timber on the Flow-Box)

c) Are the control buttons below in good condition?

i) ‘Up’ button of ‘G’ Clamp

ii) Down button of ‘G’ Clamp
iii) ‘Forward’ button
iv) ‘Backward’ button
v) ‘Start & Stop’ button
d) Is the brake system of the portal gantry or A-frame in good condition?
e) When was the last time hydraulic oil and oil filter checked?
   Date:

2.2 Condition of Jig table and boxes.
   a) Is the Jig table and boxes on flat level?

3.0 BENCH PRESS

3.1 Condition of Bench Press.
   a) Is the hydraulic pressure working satisfactorily to fully embed connector plate to the timber to meet the requirement?
      (Clamp a piece of 2” thickness timber on the table)
   b) Hydraulic hoses and valve condition.
   c) When was the last time hydraulic oil and oil filter checked?
      Date:

4.0 COMMENTS

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
CHECKLIST FOR DOCUMENTATION FOR SITE MEASUREMENT

Date: _____________________     Project Name: _________________________________________
_________________________________________________________________________________
Fabricator: _________________________ Contact Person: _____________________________
Site Personnel: _________________________  Tel./Fax No.:_________________________________

1. ROOF TRUSS DESIGN DRAWINGS

Are the following details available to site prior to site measurement?
- Truss Layout plans for all roof levels      Y/N
- Bracing Layouts (top chord/bottom chord/horizontal top chord)   Y/N
- Individual truss details        Y/N
- Fixing details                     Y/N

Remarks: __________________________________________________________________

2. SITE PERSONNEL TO CHECK

Do the following site conditions correspond to roof truss design?
(NB: Truss fabricator may not be informed of revisions to architectural/structural
drawings and details)

- Roofing material/ceiling material      Y/N
- Roof shape and dimensions            Y/N
- Position of RC beams for truss support Y/N
- Support beam levels                  Y/N
- Location and size of water tanks      Y/N
- M & E loading (eg air-con ducts, etc) catered for by truss design Y/N

Remarks: __________________________________________________________________

3. AMENDMENTS OF ARCHITECTURAL/STRUCTURAL DETAILS
If amendment or discrepancy is found:

Amendment date:  _____________________  Revision No. _____________________
Amended by:       _____________________
Truss fabricator informed on   __________________     (Person : __________________)
(NB: Truss fabricator to be provided with revisions to architectural/structural drawings
and details.)

Checked by:

Fabricator Site Personnel:_______________ Signature: _________________
Date:_____________________

Fabricator: _________________________ Contact Person: _____________________________
Site Personnel: _________________________  Tel./Fax No.:_________________________________
CHECKLIST FOR TIMBER AND TRUSSES AT TRUSS PLANT

Fabricator Name: _______________________________ Tel: _______________________________
                      _______________________________ Fax: _______________________________

Factory Location: _______________________________

Project Title: ______________________________________________________________
               ______________________________________________________________
               ______________________________________________________________

Block Checked: ______________________  Job No.: _______________________

Factory Manager: _______________________

Quality Control Officer for
Timber Selection & Sorting: ______________________  Timber Sizing: ______________________
Truss Assembly & Pressing: ______________________  Timber Treatment: ______________________

Date of Inspection: _______________________

Fabricator’s Representative (Name & Signature):______________________________

A. RESULT OF TIMBER AND TRUSSES INSPECTION AT TRUSS PLANT

This inspection on timber, timber preservative treatment and truss fabrication at the truss plant was
commenced on _________________ and were found to:

a) Conform to manufacturing specifications of the System Provider. Yes/No

If ‘No’,
b) The findings and rectifications or actions required are:

1. ______________________________________________________

2. ______________________________________________________

Verified by MTIB: ______________________  Company Stamp :

Signature: _______________________

Date: _______________________

40
General note:
This checklist is used to check trusses fabricated at a licensed fabricator’s truss plant.

1.0 TIMBER PRESERVATIVE TREATMENT

Instructions:
1) If checked parameter complies with the specifications, mark ‘✓’. Otherwise mark ‘X’ in the appropriate box provided. Comments to be noted in the Section 6.0 ‘REMARKS’ if appropriate.

1.1 Is timber treatment done within the plant?

1.2 If answer to above is ‘NO’.
   - Are treatment certificates provided by the supplier and done to specification? (Treatment Certificate)

1.3 If treatment is done within the plant.
   - Is treatment certificate provided by the fabricator and treatment done to specification? (Treatment Certificate)

GENERAL INSTRUCTIONS FOR SECTIONS 2.0, 3.0 AND 4.0:

i) Ten (10) trusses shall be randomly selected and individually checked against the truss design drawings (Refer to Truss Design Drawings) for the parameters stated in Sections 2.0, 3.0 and 4.0 below.

ii) Use separate page CL.4/4 for each individual truss selected to record results for Section 3.0 Truss Geometry and Section 4.0 Truss Quality Jointing Inspection checks.

iii) For non-conformances, state the action or rectification needed.

2.0 TIMBER SIZE, GRADE, DEFECTS AND BOW INSPECTION

Instructions:
1.0 For each truss, check for defects in timber exceeding the limits stated in the MS1714 in terms of “Splits, Knots, Sloping grain, Borer holes, Bow etc.”

2.0 For each truss, randomly pick a minimum of one timber component for each cross-section size and record its measurement.

2.1 What type of timber grading method used to grade timber?

Visual Grading [ ] Machine Grading [ ]

(Refer Attachment 3: Grading Summary)

2.2 Check on the selected timber component(s) of each individual truss selected for the criteria in the following table.
Table 1: Measured Sizes and Presence of Defects

<table>
<thead>
<tr>
<th>TRUSS</th>
<th>CROSS-SECTION SIZE (mm x mm)</th>
<th>DEFECTS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
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</table>

NOTE:
In the cross-section column states the various required nett design timber sizes for the selected trusses. Refer to Annex E and MS 1714 for defects identification.

3.0 TRUSS GEOMETRY

Instructions:
i) For each truss, sketch the overall truss profile on Pg CL4/4 and check the overall span and height against the fabrication drawings.

4.0 TRUSS JOINTING QUALITY INSPECTION

Instructions:
i) For both faces of each joint for each selected truss, record the connector sizes, positioning and jointing quality in Pg CL4/4 of 4.

4.1 Inspect jointing quality of finished truss.

5.0 MARKING & STACKING OF FINISHED TRUSSES

5.1 Are finished trusses clearly and correctly marked? □

5.2 Stacking of finished trusses:
   a) Are trusses bundled off the ground? (To avoid the trusses from being saturated specifically after raining) □
   b) Are trusses stacked correctly and supported sufficiently to avoid sagging? □

6.0 REMARKS (if any)

___________________________________________________________________________
___________________________________________________________________________
For Section 3.0: TRUSS GEOMETRY

<table>
<thead>
<tr>
<th>TRUSS PROFILE, MEMBER, AND JOINT NOS.</th>
<th>DATA</th>
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<tr>
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<td>TRUSS NO.</td>
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<td>CHORD NO.</td>
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<td>WEBS NO.</td>
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<td>PROJECT:</td>
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REMARKS: _________________________________________________________________
______________________________________________________________________

For Section 4.0: TRUSS JOINTING QUALITY INSPECTION
(Check both faces of truss joints)

<table>
<thead>
<tr>
<th>NO</th>
<th>JOINTS NOS.</th>
<th>PLATE SIZES</th>
<th>PLATE PLACEMENT</th>
<th>PLATE PRESSING</th>
<th>TIMBER THICKNESS</th>
<th>JOINT TIGHTNESS</th>
<th>JOINT TYPE</th>
<th>REMARKS</th>
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</table>
CHECKLIST FOR TRUSS INSTALLATION

Fabricator Name: ___________________________________________________________________

Project Title: _______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

Block Checked: ________________________Job No.: _____________________________________
Installer: __________________________________________________________________________

The final inspection is carried out in the presence of:
• System Provider:  ______________________________________________________________
• Fabricator:  ______________________________________________________________
• Professional Engineer:  _____________________________________________________________
• Main Contractor’s Rep  ______________________________________________________________
• Consultant Engineer or S.O. Reps/JKR: ________________________________________________

Date of Inspection: ________________

A. RESULT OF TRUSS INSTALLATION INSPECTION

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>OK</th>
<th>NOT OK</th>
<th>OK</th>
<th>NOT OK</th>
<th>Remarks</th>
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<tr>
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<tr>
<td>2</td>
<td>Trusses And Rafters</td>
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<tr>
<td>3</td>
<td>Bracing</td>
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If any remedial work needs to be carried out, the proposed rectification is:

1. _______________________________________________________

2. _______________________________________________________

3. _______________________________________________________

4. _______________________________________________________ 

Approved By P.E.(Name): ________________________ Company Stamp

Signature: __________________________      Date: _______________
General Instructions:

i) Use checklist in conjunction with truss layout and full set of truss designs (Refer to Design Drawings).

ii) Where brackets [ ] are provided, mark ✓ if acceptable, mark X if rectification is required.

iii) On truss layout plan, identify location of defect by putting a cross “X” where it occurs, and describe defect by writing item number, e.g. 1.2(c) means starter bar not bent properly.

1. **WALL-PLATES** (extra care for roofs subject to high wind loading)

   Specified size : _____________________ Grade specified : _____________________

<table>
<thead>
<tr>
<th>No.</th>
<th>Location (or grid line)</th>
<th>Measured Size</th>
<th>Non-permissible Defects (Y/N)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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1.1 Materials:

   a) No non-permissible timber defect between starter bar and truss [ ]

   b) Size of starter bar/anchor bolt matches the specifications [ ]

1.2 Workmanship:

   a) Gaps between the wall plate and beam at truss/rafter positions packed [ ]

   b) No knots at starter bar/anchor bolt positions [ ]

   c) Anchor bars bent sharply and secured at the ends [ ]

   d) If applicable, washers provided for anchor bolts [ ]

   e) If applicable, anchor bolts tightened [ ]

   f) All wall plates anchored at a minimum of 2 locations, or wall-plate with one anchor joined to next piece with steel brace or timber block [ ]

   g) Wall-plate not notched for roofs subject to high wind loading [ ]

2. **TRUSSES AND RAFTERS**

2.1 Materials:

   a) Timber - defects within permissible limits* -

      i) Knots [ ]

      ii) Wane [ ]

      iii) Checks and shakes (splits) [ ]

      iv) Fractures [ ]

   * Refer to MS 544 Part 2 or Malaysian Grading Rules for Standard Structural or better grade

   b) Truss joints-

      i) Damage to connectors [ ]

      ii) Missing connectors [ ]
2.2 Workmanship:
All trusses visually checked for obvious misalignment and incorrect spacing. Yes / No

a) Spacing of trusses and rafters
(Specified truss spacing: __________ mm)

b) Vertical alignment (misalignment < height/50 or max. 50mm) [  ]

c) Horizontal alignment (misalignment < span/200 or max. 50mm) [  ]

Measurement of Vertical and Horizontal Misalignment

<table>
<thead>
<tr>
<th>Truss Mark:</th>
<th>Truss Span:</th>
<th>Max. Truss Ht:</th>
<th>Vertical alignment tolerance (max. ht/50 or 50 mm whichever is less):</th>
<th>Horizontal alignment tolerance (span/200 or 50mm, whichever is less):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Alignment at Position</td>
<td>Horizontal Alignment at Position</td>
<td>Remarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td>V2</td>
<td>V3</td>
<td>H1</td>
<td>H2</td>
</tr>
<tr>
<td>1</td>
<td></td>
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</tbody>
</table>
d) Internal supports provided at correct locations as designed [ ]
e) Gap between trusses and internal beams not used for support [ ]
f) Trusses spaced to allow location of service loads, e.g. water tank [ ]
g) Mid-web ties-
i) Positioned at mid-web [ ]
ii) Nailed at all junctions [ ]
iii) Diagonals fixed at the correct angle [ ]
iv) Diagonals nailed at all junctions [ ]

MID-WEB TIE - MWT (Specified Sizes: _________________________)

<table>
<thead>
<tr>
<th>No.</th>
<th>Bracing Type*</th>
<th>Measured Size</th>
<th>Non-permissible Defects (Y/N)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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</tbody>
</table>

* For abbreviations used for various bracing types, refer to Section 3 Bracing

h) Chord and web stiffeners
   i) Continuous length [ ]
   ii) Nailing centres to detail [ ]
   iii) Web stiffeners form T-sections [ ]

i) Truss and rafter are anchoring to wallplate
   i) Type of connector [ ]
   ii) No. of connectors at each support [ ]
   iii) Are the connectors correctly installed (if applicable) [ ]
   iv) Nos. of nails driven in [ ]
   v) Nail type [ ]

j) Truss to truss connection
   i) Trusses to girders as detailed [ ]
   ii) Saddles to trusses as detailed [ ]
   iii) Cap trusses to support trusses as detailed [ ]

k) Rafters to truss fixing as detailed [ ]
3. **BRACING**

Specified Sizes: _______________________________________________

<table>
<thead>
<tr>
<th>No.</th>
<th>Bracing Type*</th>
<th>Measured Size</th>
<th>Non-permissible Defects (Y/N)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

*Abbreviations used for bracing types:*
- Top Chord Bracing - tcb
- Bottom Chord Tie - bct
- Bottom Chord Bracing - bcb
- Diagonal brace - db

3.1 Materials of correct size and type [ ]

3.2 Workmanship (timber bracing)
   a) Diagonal bracing provided for positional stability [ ]
   b) Bracing nailed at all junctions [ ]
   c) Bracing spliced according to specifications [ ]
   d) Bracing finished at wall plate according to specifications [ ]
   e) Bracing detail at cantilever [ ]
   f) Bracing angles [ ]
   g) Bracing lay-out [ ]
   h) For multilevel trusses, horizontal top chords of supporting trusses laterally tied and braced [ ]

3.3 Workmanship (steel brace)
   a) Bracing layout and position [ ]
   b) End fixing detail at heel [ ]
   c) End fixing at apex [ ]
   d) Bracing splicing detail [ ]
   e) Bracing tightness [ ]
   f) Nail type and size [ ]

4. **OTHER FRAMING COMPONENTS**

4.1 Walling plate
   a) Material [ ]
   b) Fixing detail [ ]

4.2 Under-purlins
   a) Material [ ]
   b) Fixing detail [ ]
5. SERVICE LOADS

5.1 Type of service loads
   a) Water tanks [ ]
   b) Solar heaters [ ]
   c) Air-conditioning ducting [ ]
   d) Others - __________________ [ ]

5.2 Support structure for service loads if specified in truss drawing [ ]

6. TILE BATTENING (if applicable)
   Max. batten spacing : _________________
   Specified size : _______________________ Grade specified :_____________________

<table>
<thead>
<tr>
<th>No.</th>
<th>Measured Size</th>
<th>Spacing +</th>
<th>Non-permissible Defects (Y/N)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

NOTE:
+ As measured from the centre of the batten to the centre of the next batten up the slope

6.1 Material of correct size and type [ ]

6.2 Workmanship
   a) Spacing of batten for eave tile according to Client’s/Manufacturer’s details [ ]
   b) For trusses without fascia board, eaves batten are higher [ ]
   b) Spacing of intermediate battens according to Client’s/Manufacturer’s details [ ]
   d) Spacing of top batten for ridge tile according to Client’s/Manufacturer’s details [ ]
   e) All battens nailed at junctions [ ]
   f) Battens for metal tiles fixed with batten anchors in high buildings [ ]
   g) Battening is continuous at saddle truss areas [ ]
7. **PURLINS (if applicable)**

Max. purlin spacing : _________________
Specified size : _________________  Grade specified : _________________

<table>
<thead>
<tr>
<th>No.</th>
<th>Measured Size</th>
<th>Spacing +</th>
<th>Non-permissible Defects (Y/N)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**NOTE:**
+ As measured from the centre of the purlin to the centre of the next purlin up the slope

7.1 Material of correct size and type [ ]

7.2 Workmanship
   a) Top purlin spaced to suit fixing of ridge piece [ ]
   b) Intermediate purlins spaced-
      i) Within Manufacturer’s limit [ ]
      ii) To suit multiple sheets [ ]
      iii) To allow for end laps of multiple sheets [ ]
   c) Purlins fixed with purlin anchors according to detail [ ]
   d) Orientation of purlins according to design detail [ ]

8. **TIMBER FASCIA BOARD**

Specified size (by fabricator) : _________________

<table>
<thead>
<tr>
<th>No.</th>
<th>Location (or grid line)</th>
<th>Measured Size</th>
<th>Non-permissible Defects (Y/N)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

8.1 Material of correct size and type [ ]

8.2 Workmanship
   a) For concrete/clay tile roofs, fascia board positioned above batten line for eaves tile [ ]
   b) Fascia board spliced at the correct positions [ ]
   c) Horizontal alignment of fascia board [ ]
   d) Edge of eaves tile is in line with axis of storm gutter [ ]
9. **SKETCHES** (note any damage caused by other sub-contractors):

<table>
<thead>
<tr>
<th>I.</th>
<th>II.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III.</th>
<th>IV.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEX E
(normative)

MS 544: PART 2: 2001 CODE OF PRACTICE FOR STRUCTURAL USE OF TIMBER
PART 2 : PERMISSIBLE STRESS DESIGN OF SOLID TIMBER

Appendix C. Grading of Malaysian structural timbers
Appendix E

GRADING OF MALAYSIAN STRUCTURAL TIMBERS

E1. Grade

The timber should be graded, by assessing the characteristics covered by Clauses E1 to E11 inclusive on each piece, in the size and condition in which it is used, in the following grades:

a) select structural;

b) standard structural; and

c) common building

The grades are multipurpose grades, i.e. applicable to all structural timbers whether used as bending members, or in endwise compression. In the case of timber used as beams, the recommended working stresses (as given in Clause 6 Design considerations of MS 544: Part 1) will apply no matter which way up the members intended for resawing to shorter lengths.

The standard structural grade should be specified for normal purposes.

The select structural grade is intended for special purposes, particularly when the strength/weight ratio of the timber is to be a maximum, for example in towers for transmission lines and trusses of very long span.

The common building grade is intended for wooden members used in less important parts of building frames, which are not usually designed by means of engineering calculations.

E2. OPEN SHAKES, SURFACE CHECKS AND END CHECKS

E2.1 Measurement

The size of an open shake or surface check should be taken as its depth projected onto a surface at right angles to the face on which it occurs. The projected depths of all checks occurring within the middle half of the face should be added together to assess the magnitude of the total defect.

A feeler gauge of 0.13 mm thickness should be used in measuring the size of an open shake or surface check.

E2.2 Grading limits

To qualify for a particular grade, a member should not have shaken or checks whose size, expressed as a fraction of the width of the face at right angles to the one on which the defects occur, exceeds the maximum value given in Table E1.
Table E1. Maximum Size of Shakes and Checks

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum Permissible Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>1/6 thickness</td>
</tr>
<tr>
<td>Standard</td>
<td>1/3 thickness</td>
</tr>
<tr>
<td>Common</td>
<td>1/2 thickness</td>
</tr>
</tbody>
</table>

**E3. Slope of Grain**

**E3.1 Measurement**

The slope of grain should be measured over a distance sufficiently great to determine the general slope, disregarding slight local deviations (round small knots, etc.). The minimum distance over which the slope of grain is measured should not ordinarily be less than the distance over which a deviation of 25 mm is permitted, e.g. a slope of 1 in 15 should be measured over a distance of not less than 375mm if possible. A cranked scribe with a freely swiveling handle should be used. The slope of grain shall be measured on the face or edge where it is most severe (see E12).

**E3.2 Grading limits**

To qualify for a particular grade, a member should not have a slope of grain steeper than the value given in Table E2.

Table E2. Maximum Slope of Grain

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum Slope of Grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>1 in 16</td>
</tr>
<tr>
<td>Standard</td>
<td>1 in 10.7</td>
</tr>
<tr>
<td>Common</td>
<td>1 in 8</td>
</tr>
</tbody>
</table>

**E4. Spiral Grain**

Where spiral grain occurs, the slope of grain should be determined by measuring the worst slope of grain on the faces and edges and taking the square root of the sum of the square of the slopes. For example if these slopes are 1 in 18 and 1 in 12, the combined slope is:

\[
\sqrt{\left(\frac{1}{18}\right)^2 + \left(\frac{1}{12}\right)^2} = \frac{1}{10}
\]

or a slope of 1 in 10

**NOTE:**

This procedure is intended to apply where it is deemed necessary to measure the slope of grain in most cases, it will be sufficient for the grader to use his judgement in rejecting timber containing spiral grain to an undesirable extent.
E5. Wane

E5.1 Measurement

The amount of wane on any surface should be the sum of the wane at the two arises, and should be expressed as a fraction of the width of the surface on which it occurs (see Figure E1).

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum Amount of Wane, Expressed as a Fraction of the Width of the Surface on Which It Occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>1/8</td>
</tr>
<tr>
<td>Standard</td>
<td>1/6</td>
</tr>
<tr>
<td>Common</td>
<td>1/4</td>
</tr>
</tbody>
</table>

Table E3. Maximum Amount of Wane

E5.2 Grading limits

To qualify for a particular grade, a member shall not have waned whose total width, expressed as a fraction of the surface on which it occurs, exceeds the amount given in Table E3.

E6. Borer Holes and Pin Holes

E6.1 Measurement

The size of a borer hole shall be taken as the maximum diameter of its visible cross section, no matter where it occurs. Where only a portion of the cross section is visible, the maximum dimension of that portion should be measured.

E6.2 Grading limits

To qualify for a particular grade, a member shall not have holes that exceed the amount given in Table E4. However, scattered pinholes and small occasional wormholes are permissible in all grades.
Amount of wane on the face of the member to be specified by the ratio:
\[
\frac{v_1}{d} \quad \text{or} \quad \frac{v_2 + v_3}{d}
\]
Amount of wane on the edge of the member to be specified by the ratio:
\[
\frac{K_1}{b} \quad \text{or} \quad \frac{K_2 + K_3}{b}
\]

Figure E1. Extent of Wane

Table E4. Maximum Amount of Pin, Shot and Borer Holes

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum Amount of Holes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pin &lt; 1.6mm</td>
</tr>
<tr>
<td>Select</td>
<td>16 in 100cm²</td>
</tr>
<tr>
<td>Standard</td>
<td>32 in 100cm²</td>
</tr>
<tr>
<td>Common</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

E7. Sapwood

Sapwood, though not a structural defect, is liable to attack by fungi and termites if not treated, whether or not the timber is a naturally durable species. Therefore, where durability is the main consideration, the timber with sapwood, even of a naturally durable species, should be treated. If not, the sapwood shall be limited so as not to exceed the amount given in Table E3, expressed as a fraction of the width of the surface on which it occurs.
E8. Stain

Stain, provided the timber is free from decay, is not a structural defect and shall be acceptable.

E9. Curvature

E9.1 Measurement

The extent of curvature is determined by measuring the maximum deviation from a tightly stretched string or wire, expressed as a ratio of the length of the timber.

E9.2 Grading limits

To qualify for a particular grade, a member shall not have curvature whose deviation exceeds the amount given in Table E5.

**Table E5. Maximum Amount of Curvature**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum Slope of Grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>5 mm in 3 m</td>
</tr>
<tr>
<td>Standard</td>
<td>10 mm in 3 m</td>
</tr>
<tr>
<td>Common</td>
<td>15 mm in 3 m</td>
</tr>
</tbody>
</table>
Table E6. Permissible Deviations in Curvature

<table>
<thead>
<tr>
<th>Length of Timber, m</th>
<th>Permissible Deviations (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Select Grade (5mm in 3m)</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
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<td>13</td>
</tr>
</tbody>
</table>

Table C6 shows permissible deviations in curvature for some common lengths.

E10. Knots

E10.1 Measurement

The size of a knot shall be taken as the maximum diameter of its visible cross section, no matter where it occurs. Where the knot can be seen in longitudinal section as well as in cross section, the longitudinal section should be ignored.

Where two or more knots occur in the same cross section, each knot should be measured as just described and the sum of these measurements taken as a diameter of an equivalent single knot.

E10.2 Grading limits

To qualify for a particular grade, a member shall not have knots whose sizes exceed the maximum values given in Tables C7 and C8.

E11. Other Defects

All pieces showing fungal decay, brittleheart or other abnormal defects affecting strength shall be excluded from all grades, except in pieces of standard structural and common building grades that have unsound or hollow knots which contain fungal decay. In such cases the permissible size of unsound knots for the respective grades are as shown in Table 8.

Table E7. Maximum Width of Permissible Sound Knots

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum Width of Knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>⅛ dimension of face, to maximum of 38mm in diameter. 1 per 1mm in length</td>
</tr>
<tr>
<td>Standard</td>
<td>¼ dimension of face, to maximum of 75mm in diameter. 1 per 1mm in length</td>
</tr>
<tr>
<td>Common</td>
<td>⅓ dimension of face, to maximum of 100mm in diameter. 1 per 1mm in length</td>
</tr>
</tbody>
</table>
Table E 8. Maximum Width of Permissible Unsound Knots

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum width of knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select</td>
<td>None</td>
</tr>
<tr>
<td>Standard</td>
<td>(\frac{1}{4}) dimension of face, to maximum of 50mm in diameter. 1 per 2.4mm in length</td>
</tr>
<tr>
<td>Common</td>
<td>(\frac{1}{4}) dimension of face, to maximum of 75mm in diameter. 1 per 1mm in length</td>
</tr>
</tbody>
</table>

E12. **Guided to the Determination of Slope of Grain**

To ascertain the slope of the grain in timber it is necessary to study both the quartered and flatsawn faces of the member.

If seasoning checks are present, these will indicate the slope of the grain.

Slope of grain can be more accurately determined by means of a scribe, as shown in Figure E3 comprising a cranked rod with a swivel handle and a needle, similar to a gramophone needle, at the tip, set at a slight trailing angle. The needle is pressed into the wood and the scribe is drawn along with a steady action in the apparent dissection of the grain, which is indicated more precisely as the needle forms a groove. If the pressure on the needles is insufficient, it may be dragged across the grain: on the other hand, a steady action is impossible if the pressure is excessive and the needle penetrates too far into the wood.

If the action is correcting the needle follows the grain even when the direction of pull of the scribe is slightly out of line. This may be used to check that the scribe does follow the grain by scribing another groove in close proximity on each side of the original one with the direction of pull diverging slightly outwards in each case when, if the grooves are following the grain, they will be parallel to each other.

The inclination of grain on a face is measured as shown in Figures E4 and E5, in which AB is the line indicating grain direction, AC is a line drawn parallel to the edge of the member, BC is of length one unit (any convenient unit may be used) and is at right angles to AC. Grain inclination is expressed as ‘one in x’ where x is the length of AC measured in terms of BC.

The slope of grain should be measured on two adjacent faces, and from the values obtained the true inclination of the grains to the longitudinal axis of the member should be determined in accordance with E4.
Figure E3. Swivel-handed Scribe for the Determination of Slope of Grain in the Wood

Figure E4. Use of Scribe

Figure E5. Measurement of Slope Grain
**ANNEX F**  
(normative)

**MS544: 1978  TABLE A1. CLASSIFICATION OF TIMBERS INTO SHRINKAGE GROUPS**

Table A1. Classification of Timbers into Shrinkage Groups  
(based on average tangential shrinkage from green to 19% moisture content)

<table>
<thead>
<tr>
<th>Group 1 0.5–1.5% inclusive</th>
<th>Group 2 Over 1.5–2.5%</th>
<th>Group 3 Over 2.5–3.5%</th>
<th>Group 4 Over 3.5–5%</th>
<th>Group 5 Over 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHENGAL* (Balanocarpus heimi - King)</td>
<td>BINTANGOR* (Calopityllum inophyllum) (C.kunstleri) (C.curcitsii)</td>
<td>BALAU* (Shorea laevis Ridl.) (S. maxwelliana King) (S. glauca - King)</td>
<td>GERONGGANG* (Cratoxylon spp.)</td>
<td>KERUING* (Dipterocarpus Gramdoflorus)</td>
</tr>
<tr>
<td>DAMAR MINYAK* (Agathis alba)</td>
<td>GIAM* (Hopea helferi (Dyer, Brandis) (H. nutans - Ridl.)</td>
<td>BALAU, RED* (Shorea guiso (Bianco) Bl.) (S. kunstleri - King) (S. ochroploia)</td>
<td>KAPUR* (Dryobalanops aromatica - Gaertn.) (D. oblongifolia)</td>
<td>MERANTI BAKAU* (Shorea rugosa var. uliginosa)</td>
</tr>
<tr>
<td>KUNGKUR* (Pithecellobium confertum)</td>
<td>MACHANG* (Mangifera longipes) (M. indica) (M. foetida Lour.)</td>
<td>MEDANG* (Litsea megacapa) (L. firma)</td>
<td>MEMPENING (Quercus lamponga)</td>
<td></td>
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<tr>
<td>MEMPISANG* (Cathaycalyx maingayi)</td>
<td>MEMPISANG* (Shoreabacteolata Dyer)</td>
<td>DURIAN* (Dario oxleyanus)</td>
<td>MEMPISANG* (Mezzittia leptopoda Oliv.)</td>
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<tr>
<td>MERANTI, DARK RED* (Shoreabacteolata Dyer)</td>
<td>MERANTI, DARK RED* (Canarium rufum) (Santiria laevigata - Bl.)</td>
<td>KEDONGONG* (Cynometra inaequifolia A. Gray)</td>
<td>MERANTI, DARK RED* (Shorea platyclados)</td>
<td></td>
</tr>
<tr>
<td>KEKATONG* (Cynometra inaequifolia A. Gray)</td>
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*Timbers that appear in the Malaysian Grading Rules
<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5–1.5% inclusive</td>
<td>Over 1.5–2.5%</td>
<td>Over 2.5–3.5%</td>
<td>Over 3.5–5%</td>
<td>Over 5%</td>
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<tr>
<td>MEDANG* (Dehaasia nigrescens)</td>
<td>MERANTI, LIGHT RED* (Shorea hemsleyana King)</td>
<td>KEMPAS* (Koompassia malaccensis Maing.)</td>
<td>MERANTI, LIGHT RED* (Shorea parvifolia Dyer)</td>
<td>MERANTI, LIGHT RED* (Shorea parvifolia Dyer)</td>
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<tr>
<td>MERANTI, WHITE* (Shorea talura)</td>
<td>MERANTI, WHITE* (Shorea bracteolata Dyer)</td>
<td>KULIM* (Scorodocarpus borneensis - Becc.)</td>
<td>MERANTI, LIGHT RED* (Shorea leprosula Miq.)</td>
<td>MERANTI, LIGHT RED* (Shorea leprosula Miq.)</td>
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<tr>
<td>MERBAU* (Intsia palembanica Baker)</td>
<td>MERAWAN* (Hopea sulcata)</td>
<td>MELUNAK* (Pentace triptera - Mast)</td>
<td>(Shorea acuminata - Dyer)</td>
<td>(Shorea acuminata - Dyer)</td>
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<td>MERPAUH* (Swintonia schwenkii) (S. spicifera Hook.f.) (S.penangiana)</td>
<td>PERUOK* (Lophopetalum reflexum)</td>
<td>MENGKULANG* (Heritiera javanica Bl.)</td>
<td>MERSAWA* (Anisopectera spp.)</td>
<td>(H. simplicifolia Mast.)</td>
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<td>RENGAS* (Melanorrhoea torquata)</td>
<td>(L. Maingayi Ridl.) (L. floribundum) (L. subovatumKing)</td>
<td>(L. sempervirens)</td>
<td>NYALAS* (Parastemon urophyllum)</td>
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<td>SEPETIR* (Sindora coriacea Prain)</td>
<td>PULAI* (Alstonia angustiloba)</td>
<td>MERANTI, DARK RED* (Shorea pauciflora King)</td>
<td>SIMPOH* (Dillenia grandifolia)</td>
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<tr>
<td>SESENDOK* (Endospermum malaccense Muell. - Arg.)</td>
<td>TABAN MERAH (Palaquinumgutta)</td>
<td>MERANTI, WHITE* (Shorea hypochra Hance)</td>
<td>TERAP* (Parartocarpus triandra)</td>
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<tr>
<td>TUJALANG* (Koompassia excelsa - Taub.)</td>
<td>TEMBUSU* (Fragraea fragransRoxb.)</td>
<td>MERANTI, YELLOW* (Shorea resinanigra Foxw.)</td>
<td>TERENTANG* (Campnosperma Macophylla)</td>
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<td></td>
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<td>MERAWAN* (Hopea nervosa King)</td>
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<td></td>
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<td>MERTAS (Ctenolophon parvifolius)</td>
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<td>MINYAK BEROK (Xanthophyllum verrucosum)</td>
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<td>PENARAHAN* (Myristica gigantea) (M.maingayi)</td>
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<td></td>
<td></td>
<td>PENAGA (Mesua ferrea)</td>
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<td></td>
<td>RAMIN (MELAWIS)* (Gonystylus bancanus (Miq.) Baill.)</td>
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<td>RESAK* (Vatica cuspidata (Ridl.) Sym.)</td>
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<td></td>
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<td>TERAP* (Artocarpus Scortechini Hook.f.)</td>
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<td></td>
<td></td>
<td>TERENTANG* (Campnosperma Auriculata Hook.f.)</td>
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*Timbers that appear in the Malayan Grading Rules
ANNEX G
(informative)

TERMS APPLYING TO PREFABRICATED TIMBER ROOF TRUSSES

Figure G1. Terms Applying to Prefabricated Timber Trusses

Figure G2. Terms Applying to Roof Truss System
Some Examples of Truss Fabrication Defects Involving the Toothed Metal Plate (Nail Plate) Connectors

Terms applied to a roof truss system
Figure H1. Toothed Metal Plate Connectors

a) Gap between the underside of connector to the timber surface

b) Embedment of the connector plate into the timber

Figure H2. Embedment of Connector Plate

a) Proper positioning of connector plate
b) Mispositioning of connector plate across the width of timber

c) Mispositioning of connector plate along the length of timber

**Figure H3. Positioning of Toothed Metal Plate Connectors**

*NOTE:*
Mispositioning of connector by not more than 6mm for connector dimension of less than 150mm (in the direction of the dimension), and, 12mm for connector dimension of 150mm or more (in the direction of the dimension).

**Figure H4. Side View of a Butt Joint: Acceptable Placement of Nail Plates**

*(teeth are not bent or flattened)*
Figure H5. Side View of a Butt Joint: Teeth Roll or Roll-over (teeth bent or flattened)

Figure H6. Vertical Gaps
Figure H7. Horizontal Gap in Built-up Structural Members

Top view of nail plates at the edge and end jointed components

Gap

End joint

Edge joint

Figure H8. Mismatch Timbers

Side view of the nail plates at butt joint

Thickness mismatch

Nail platxe

a) Case 1

Side view of the nail plates at butt joint

Thickness mismatch

b) Case 2

Figure H8. Mismatch Timbers
REFERENCES


AKNOWLEDGMENT

This Malaysian Construction Industry Standard is a revision of the CIS 5:2004. The committee involved in the revision consists of the following representatives:

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