



CONSTRUCTION GUIDELINES FOR COLD-FORMED STEEL ROOF TRUSSES

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PREFACE

The construction of cold-formed steel roof trusses has been widely used in Malaysia promoted under the implementation of Industrialized Building System (IBS) championed by Construction Industry Development Board (CIDB).

The objective of this Construction Guidelines is to provide Guidelines for good construction practice in delivering the prefabricated cold-formed steel roof truss. Whereas, Specification is written to provide a basis for and to ensure establish minimum design, material application and quality assurance in delivering this product.

Both documents compliment the JKR's SPECIFICATION PRE FABRICATED COLD FORMED STEEL ROOF TRUSSES and also fill the knowledge gaps in cold-formed steel industry at Malaysia. These documents were written for all prefabricated cold-formed steel roof trusses for, but not limited to residential; agricultural; institutional; commercial or buildings for temporary purpose. It can be adopted and used by developers, building professionals and members in this cold-formed steel industry.

I am in debt to the technical committee members and reviewers for their contributions and support to these two documents. We trust that these two documents will be widely adopted as the Specification for the Prefabricated Cold-formed Steel Roof Truss and Industry's guideline.

Mei Chee Chiang
President

**CONSTRUCTION GUIDELINES FOR
PREFABRICATED COLD FORMED STEEL ROOF TRUSSES**

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1.0 DEFINITIONS

1.1 MyCSI

Malaysia Cold-formed Steel Institute

1.2 System Provider (SP)

A supplier of a proprietary roofing system, who is a corporate member of MyCSI, employing Quality Assurance procedures in the design, detailing, connection, manufacture bracing and erection criteria for the structural roofing system provided. The System Provider shall guarantee the due performance of the entire roof truss system.

1.3 Superintending Officer (SO)

The highest commanding officer as defined in the Contract.

1.4 Contractor

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

1.5 Fabricator

A licensed supplier of an approved System Provider, who assembles the structural and assembly details, which include the truss to truss details, bracing, tie-down, erection, lifting instructions in addition to producing and installing the roofing system in a manner approved by the System Provider.

1.6 Installer

Trained personnel appointed by the System Provider or fabricator to assemble, erect and install the System Provider's proprietary roofing system.

1.7 Professional Engineer (PE)

An appointed Professional Engineer by System Provider, who has a valid registration with the Board of Engineers, Malaysia (BEM) and is allowed to practice in the registered field.

1.8 Construction Drawing

Drawing or set of drawings approved by the Professional Engineer representing the design principle and parameter. The drawings hold adequate information to produce fabrication drawings, and shall also contain adequate information on work to be done in the construction of all or a portion of the building structure.

1.9 Fabrication Drawing

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

1.10 Warranty

The warranty provided by the System Provider for their design, supply and installation of the proprietary cold formed steel framing system. Joint warranty where fabricator and system provider is to provide a system warranty shall be subject to terms & conditions in the supply.

2.0 MANUFACTURING

2.1 Manufacturing Capability (TBA as per MyCSI Constitution)

2.1.1 Production Premise

The SP shall conduct manufacturing activities at production premises with appropriate licenses or permits issued by relevant Local Authority. The address of the premises appeared on the Local Authority licenses or permits shall be the same with the address stated in the application documents approved by SO.

2.1.2 Machinery

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

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

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

2.2 Production Quality Control

2.2.1 Material

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

The SP shall retain all documents including mill certificates, SIRIM or other approved testing laboratory test results and in-house test results for a period equivalent to the project warranty period with a copy retained by the SO.

2.2.2 Material Storage

Raw materials shall be stored on raised supports, protected from weather and covered with waterproof covering. The SP shall also ensure adequate air circulation and ventilation are available and no deterioration or damage occurs before and during the manufacturing process.

2.2.3 Production Process

The SP shall submit to the SO the Quality Assurance Documents together with the Quality Control Plan relevant to the production process. The SP shall maintain all documents generated as a result of implementing the Quality Control Plan at all time for inspection. Quality Reports shall be produced as and when required by the SO.

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

3.0 TRUSS FABRICATION

Unless otherwise approved by the SO, roof trusses shall be assembled and fabricated at the factory or on-site.

3.1 On-Site Fabrication

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

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

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

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

3.2 Site Measurement

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

3.3 Identification of Completed Trusses

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

3.4 Splicing

Unless expressly provided for in the design, no splicing of members shall be allowed in the truss. All splices detail shall be supported with design calculations.

4.0 TRUSS HANDLING AND INSTALLATION

4.1 Handling

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

4.2 Installation

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

4.3 Installation Tolerances

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

4.3.1 Verticality

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

- a) Span/200
- b) 50mm
- c) H/50

4.3.2 Straightness

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

- a) Span/200
- b) 50 mm

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

4.3.3 Position

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

4.3.4 Squareness

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

- a) Span/200
- b) 25 mm

4.4 Bolted Connection

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

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

4.5 Anchoring of Trusses to Supporting Structure

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

4.6 Roof Frame Bracing

4.6.1 Permanent bracing shall be applied to ensure that all the elements on roof frame act together as an integral structure that is stable under specified loading conditions. All bracings used to provide initial stability during installation shall remain and not be removed.

4.6.2 Lateral Restraint

Roof battens/ purlins whenever considered to provide lateral restraints shall be so arranged that on any truss line, not more than one third of the roof battens/ purlins are spliced and that no two splices are adjacent.

Particular attention is drawn to the need to provide lateral restrains on the bottom chord of trusses that are not directly braced by the ceiling frame. In areas where battens are not bound on both sides by diagonal bracing, battens shall be continuous.

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

All lateral restrains shall be braced back to rigid points on the main structure through the use of diagonal ties or bracing laid according to the fabrication drawings. The minimum working load for the steel brace shall be as shown in Table 1.0.

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

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

Table 1.0: Minimum Basic Working Load for Steel Brace

(JKR-20601-0186-11, pg.22)

4.6.3 Top Chord Bracing

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

If lapping of steel braces are required, it shall be positioned and fastened to the truss. The total number of steel brace layers at any location of the self-drilling screw at a lap position shall not be more than three (3) layers, with a maximum total thickness of 3.2 mm.

In addition to the battens, the top chords shall be braced with diagonal steel braces. All steel braces shall be fixed to the top chord of each truss it crosses or the tie battens as the case may be anchored to the support structure.

Where roof frame are built-up with saddle back or cap trusses, the horizontal top chords of lower trusses shall also be braced according to the design requirements as stated in the fabrication drawings. Where the top chords are tied by continuous lateral battens, the battens shall be

adequately fixed at all crossings of the top chords. Unless otherwise provided, all steel battens shall be fastened with minimum two (2) nos. of fasteners.

4.6.4 Bottom Chord Bracing

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

3.6.8 Web Bracing

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

4.7 Member Stiffener

Steel stiffeners for truss members shall only be spliced at positions, as specified by the PE.

4.8 Multiple Trusses

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

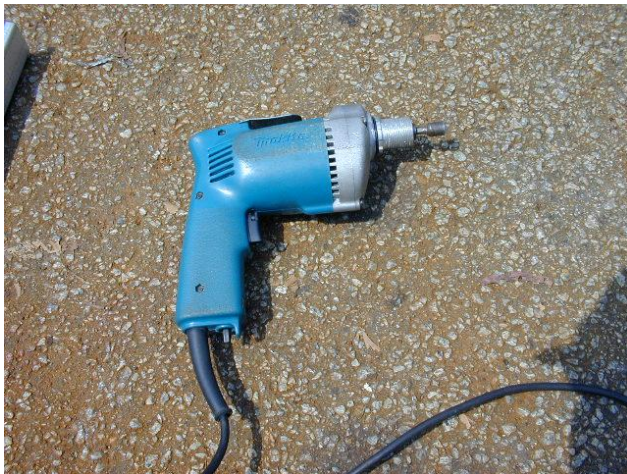
5.0 ALTERATION TO TRUSSES

- 5.1 No element of the roof trusses, roof frames or roof ancillary members shall be cut or notched or removed or otherwise altered from its original state without prior written approval of the SP.
- 5.2 Where defects exceeding the limits or permitted tolerances are detected, rectification works shall be carried out based on the recommendations made by the PE and to the approval of the SO.

6.0 FABRICATION METHODS



Use metal blades (cold cutting) rather than carborundum discs/angle grinders to cut members and to remove flanges as they produce fewer damaging hot metal particles, leaving fewer burrs on the cut sheet.



Use drill gun with a torque limiter control to prevent over tightening of fasteners.



Hand shearer for cutting small areas.



Create a truss template. This template will form the base of similar trusses in the project. This method will ensure that subsequent trusses have the same configuration and slope.



Assemble subsequent trusses over the truss template. Truss members are arranged before they are fastened together.



Use inverted stools to align truss members.



The web members are fastened to the bottom chord using a drill gun and screws.



Similarly, the apex joint is fastened with a drill gun and screws.



A drill gun is used to fasten the web and bottom chord members together.



If required, web members are boxed up for added stiffening.



Trusses are built by stacking over previously assembled trusses to follow the template outline.



Once the trusses are assembled, the trusses are moved from the template stack to the storing area ready to be installed onto roof beams or transported.



At least two points of attachment are recommended for lifting the truss bundle.



Truss bundle is being lifted to the top of the roof beam for installation.



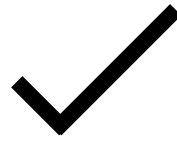
Trusses are being temporary propped to allow the trusses supports to be fixed into place.



Trusses are installed at the gable end first and worked towards the other gable end.

7.0 ROOF TILES PLACEMENT

Where concrete roof tiles are used as roof covering material, the tiles shall be stacked no higher than 10 tiles at 600 mm spacing from center to center.



The CORRECT way of installing concrete roof tiles

Loaded concrete roof tile pallets shall not be placed on top of finished roof battens and trusses during installation of concrete roof tiles.

REFERENCES

1. JKR 20601-0186-11 SPECIFICATION PRE-FABRICATED COLD FORMED STEEL ROOF TRUSSES (JKR, MALAYSIA)
2. SMARTRUSS HANDBOOK LYSAGHT STEEL BUILDING PRODUCTS SDN. BHD., 2002
3. UBBL 1984 UNIFORM BUILDING BY LAWS 1984- LAWS OF MALAYSIA
4. SIRIM STANDARD AND INDUSTRIAL RESEARCH INSTITUTE OF MALAYSIA

Malaysian Standards

- MS 740:1981 SPECIFICATION FOR HOT-DIP GALVANIZED COATINGS ON IRON AND STEEL ARTICLES
- MS 1553 WIND LOADING (MALAYSIA)

Australian Standards

- AS 1170.2:2011 SAA LOADING CODE PART 2 – DEAD AND LIVE LOADS
- AS 1397:2011 STEEL SHEET AND STRIP HOT DIP ZINC COATED or ALUMINIUM / ZINC COATED
- AS3623:1993 DOMESTIC METAL FRAMING (AUSTRALIA)

British Standards

- BS5950-5:1998 CODE OF PRACTICE for DESIGN OF COLD FORMED THIN GAUGE SECTIONS (U.K.)
- BS 6399-2:1997 CODE OF PRACTICE FOR WIND LOADS. (U.K.)

ACKNOWLEDGEMENTS

The contents used in this document refer to the JKR Specification Pre-fabricated Cold Formed Steel Roof Trusses, JKR 20601-0186-11 as a source and referral. The relevant recommendations from the various references stated above are also adopted. Sincere thanks to the MyCSI committee members and the international panel of reviewers for all their contributions, invaluable comments and inputs to the document.

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