TIMBER QUEENSLAND
We build Queensland

TECHNICAL DATA SHEET
ISSUED BY TIMBER QUEENSLAND

CEILING DIAPHRAGM ACTION AND LATERAL LOAD TRANSFER IN NAIL PLATED TIMBER ROOF TRUSS SYSTEMS

37

RECOMMENDED PRACTICE // DECEMBER 2019

Horizontal wind actions on buildings creates lateral loads on the structure. These loads are transferred to the foundation or sub-level diaphragms through a systematic interaction between the roof truss system and bracing elements placed vertically in wall frames. Sheet ceiling lining, such as plasterboard, that is rigidly attached to the bottom chords of roof truss systems is typically used as a diaphragm to transfer these racking loads to bracing walls in residential structures of Class 1 and 10. AS 1684 Parts 2 and 3 provide 'deemed to comply' solutions in this regard. These solutions may also be applicable for some similar 'light' timber framed commercial buildings of Class 2 to 9.

CEILING DIAPHRAGM ACTION

Lateral load transfer can be successfully achieved where a **functional and adequate ceiling diaphragm** is provided.

A **functional ceiling diaphragm** is conventionally created by providing screw/nail fixed lining directly to bottom chords of roof trusses. In cases where ceiling battens are being used; the battens are screw/nail fixed to bottom chords of trusses and the ceiling is subsequently screw/nail installed to ceiling battens.

The **Adequacy of ceiling diaphragm** depends on the depth of the diaphragm. AS 1684.2 and AS 1684.3 achieve this through recommendations in section 8.3.6.6 and 8.3.6.7. Shallow ceiling diaphragms, though rigidly fixed to bottom chords of trusses, may not function adequately as can be seen in Figure 1.

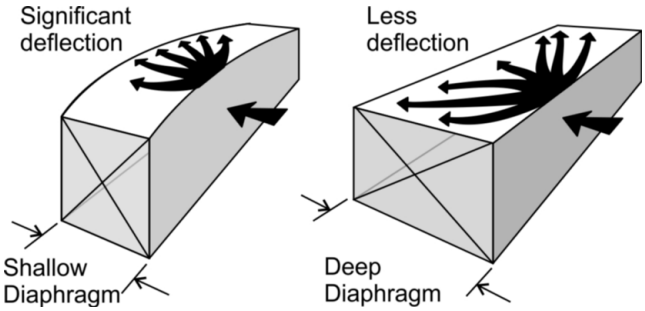


Figure 1. Diaphragm Action

The ceiling diaphragm:

1. Provides restraint to the bottom chords of roof trusses under compression occurring from wind uplift
2. Works as a mechanism to transfer lateral wind loads to wall bracing elements/bracing walls.

WHERE FUNCTIONAL CEILING DIAPHRAGMS ARE NOT INSTALLED

In the case of clip on furring channels or suspended grid ceilings, or where no ceilings are present, the diaphragm action is not available from the ceiling linings.

While structural ties to bottom chords of trusses with strap bracing to bottom chords may be used to laterally restrain the bottom chords of roof trusses, alternate mechanisms like wind beams and wind trusses must be designed to transfer lateral wind loads to bracing walls.

Successful load transfer can be achieved if:

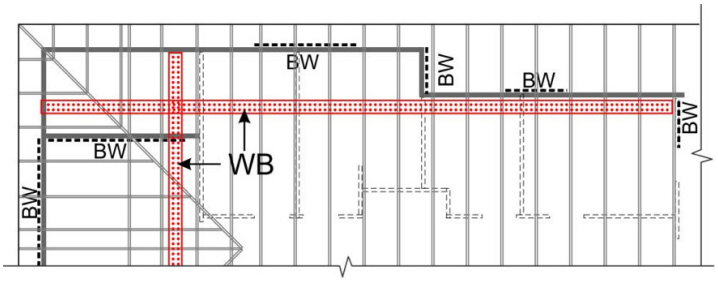
1. The roof truss system is adequately braced and stable. Refer to AS 4440 for more details;
2. Wind Beams or Wind Trusses are adequately connected to bracing elements;
3. Wall bracing elements are adequately connected to the lower level floor diaphragm. The lower level floor diaphragm must be adequate and functional and must be adequately connected to sub level wall bracing elements.

This system is replicated for each sub-level with assessment required towards adequacy of each lower level diaphragm.

ALTERNATIVE MECHANISMS TO TRANSFER LATERAL LOADS

Various alternate mechanisms for transfer of lateral loads to bracing walls in the absence of a ceiling diaphragm are listed below:

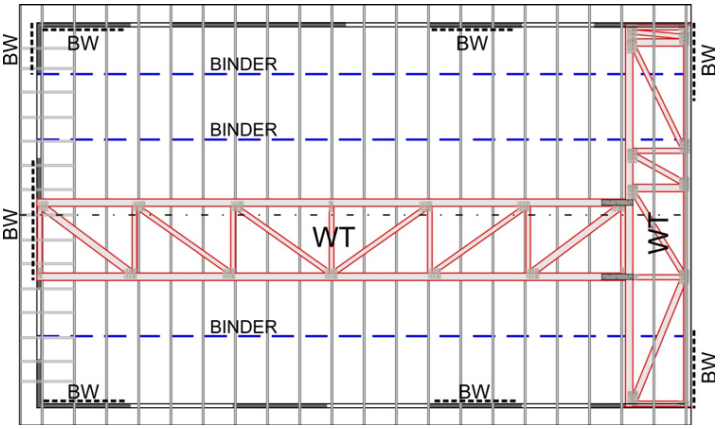
1. **Wind Beams** can be provided at suitable locations to span across nominated bracing walls under the roof trusses. If detailed adequately; wind beams may be concealed in the roof truss space. Beams must be designed for lateral load action and **all beam to roof truss and beam to shear/bracing wall connections must be specified.** Refer Figure 2.



Notes:
1. WB = Wind Beams
2. BW = Bracing wall
3. Wind Beams may be fixed to upper or lower side of truss bottom chords

Figure 2 – Typical Example of Wind Beams

2. Wind Trusses are used where Wind Beams are not feasible. Wind Trusses may be installed concealed in the roof system or under the roof system. Wind Trusses must be designed for lateral load action and **all wind truss to roof truss and wind truss to shear/ bracing wall connections must be specified**. Refer Figure 3.

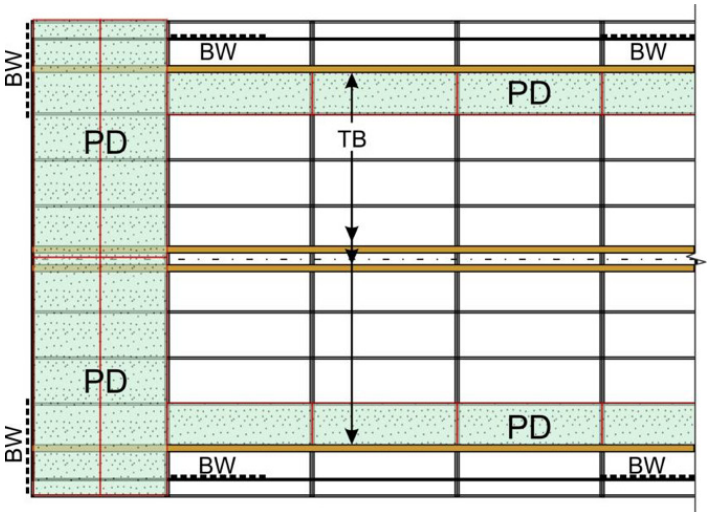


Notes:
1. WT = Wind Truss
2. BW = Bracing wall
3. Wind Truss may be fixed to upper or lower side of truss bottom chords

Figure 3 – Typical Example of Wind Trusses

Example of a Wind Truss Installation

3. Plywood sheeting under roof lining [sheet metal or concrete tiles] is sometimes used as diaphragm to roof trusses. All plywood to roof truss and bracing wall connections must be specified by a structural engineer. Nailing pattern for plywood, plywood splicing and blocking details, design of chords in diaphragms and any required chord splicing details must also be specified by design engineers. Refer to EWPAA Structural Plywood and LVL Design Guide for design of plywood diaphragms. Refer Figure 4.

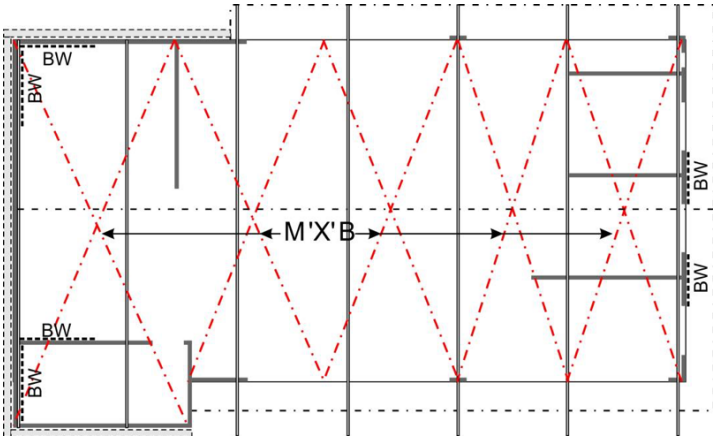


Notes:
1. PD = Plywood diaphragm
2. BW = Bracing wall
3. TB = Timber battens (these may be of significant size)
4. Plywood diaphragm may be fixed to upper or lower side of truss bottom chords

Figure 4 – Typical Example of Plywood/OSB Diaphragms

Example of OSB Diaphragm Installation

4. In-situ X-Bracing systems using steel straps is sometimes recommended for low wind rated structures. All connections of bracing straps to strutting elements and the connection of strutting elements to wall frames must be designed and specified by a structural engineer. It is difficult to estimate the overall deflection of such systems owing to slip at joints. Refer Figure 5.



Notes:
1. M'X'B = Z275 (min) metal strap 'X' bracing
2. BW = Bracing walls

Figure 5 – Typical Example of Steel Strap X Bracing System

Example of metal strap 'X' bracing Installation over Bottom Chords

SUMMARY

Lateral load transfer can be successfully achieved where a **functional and adequate ceiling diaphragm** is not provided, by using a number of optional engineer designed systems in lieu of conventional sheeted ceiling diaphragms.

ACKNOWLEDGEMENTS

The support and assistance of QBCC, MiteK, Multinail and Pryda in preparation of this Data Sheet is gratefully acknowledged.

SAFE WORKING

Working with timber produces dust particles. Protection of the eyes, nose and mouth when sanding, sawing and planing is highly recommended. Refer to tool manufacturers for safe working recommendations for particular items of equipment.

DISPOSAL OF OFFCUTS AND WASTE

For any treated timber, do not burn offcuts or sawdust. Preservative treated offcuts and sawdust should be disposed of by approved local authority methods.

TIMBER QUEENSLAND
We build Queensland

Timber Queensland Limited
ACN 092 686 756 | ABN 50 092 686 756

30 Boothby Street, Kedron
Brisbane Queensland 4031

Phone (07) 3358 7900
PO Box 231, Kedron Qld 4031
admin@timberqueensland.com.au
www.timberqueensland.com.au