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STRUCTURAL CEILING DIAPHRAGMS

All structures need to be adequately braced to resist applied forces, and it is commonly understood that roof trusses and wall frames require bracing.

But what are we actually bracing for and how are these forces transferred from the roof to the walls?

There are two main types of force that require bracing.

Lateral (or raking) forces are usually the first to come to mind and are caused by wind loads on the structure (Fig 1).

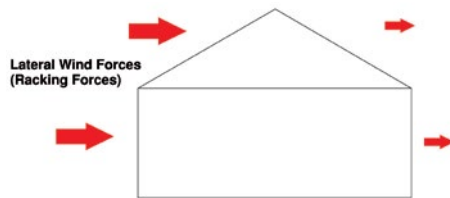


Fig 1 Lateral Wind Forces

The second type of force, which is not quite so obvious, is the force created in certain elements of the structure when resisting other loads.

For example, a long slender member in compression will have a tendency to buckle unless it is stabilised by lateral restraints, such as roof battens on truss chords and noggings on studs (Fig 2).

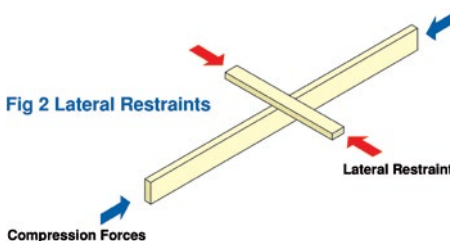


Fig 2 Lateral Restraints

The forces applied to the lateral restraints will then need to be securely braced back through the structure.

Bottom chords of trusses experiencing wind uplift also have these compression loads and will require lateral restraint in accordance with the truss design and therefore will also need to be braced back to the sides of the structure.

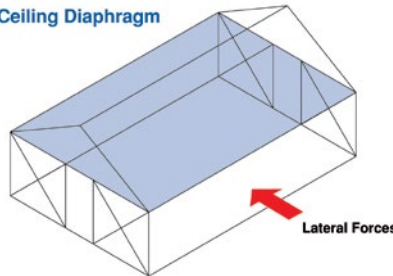
In timber framed residential construction, the structure and the

bracing are typically designed in accordance with AS1684.

One of the basic assumptions of AS1684 is that lateral forces can be transferred horizontally through the ceiling as a "structural diaphragm" and into the bracing walls.

In order for the ceiling system to transfer lateral forces as the structural diaphragm, there must be adequate fixings to the truss bottom chords (Fig 3).

Fig 3 Ceiling Diaphragm



Battened ceilings or ceilings fixed direct to the bottom chords are both considered to have sufficient connectivity to transfer these forces through the ceiling material.

For a battened ceiling to be considered a structural diaphragm, the battens themselves must be securely fixed to the truss bottom chord.

Furring channels connected to the trusses by clips are becoming more common on residential structures, but the clips and/or their fixings to the battens are not considered to be adequate to transfer the lateral forces.

Additional bracing systems will be required in these cases.

Circumstances that require this extra consideration may include:

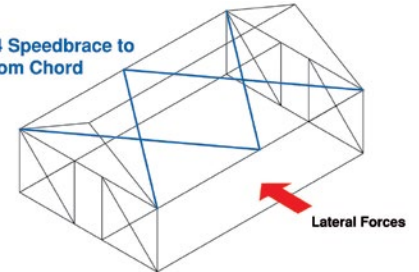
- Exposed trusses
- Suspended ceilings
- Clipped furring channels
- Bracing wall positioning that exceeds the location and distribution requirements of AS1684

This extra bracing can include the additional bottom chord ties in accordance with the truss design as well as additional diagonal bracing.

The diagonal bracing could be SpeedBrace fixed (Fig 4) to the truss

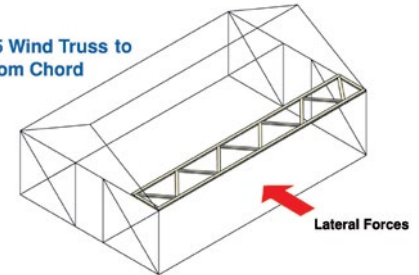
bottom chord and the supporting structure in accordance with AS4440.

Fig 4 Speedbrace to Bottom Chord



Another way of providing the extra bracing could be a system of wind trusses (Fig 5) designed as specified by the project engineer and fixed in accordance with those details (Ref GN Guidelines 144 by Sunil Narsey).

Fig 5 Wind Truss to Bottom Chord



The connection of the ceiling system or alternate structural diaphragm to the bracing walls also needs to be adequate for the correct transfer of the forces.

For a ceiling system above an internal bracing wall, shear blocks or propriety products that allow vertical movement of the truss would be required (eg BraceWall Brackets).

The design of any additional bracing system should provide clear details of all connections.

The transfer of lateral forces through structural diaphragms, whether via the ceiling or any alternate additional bracing systems, is an integral part of the stability of every structure.

When alternate systems are required it is important that it is clearly documented who is responsible for the design, and that the details of the design, including all necessary fixing, are complied with in construction.