GUIDE TO THE USE OF AS 1684

Distribution of Racking Forces via Diaphragms and Bracing Walls

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(The Code clause and table references given below apply to AS 1684 Part 2 and Part 3 unless specifically noted)

Background

AS 1684 Section 8 requires permanent bracing to be provided to enable the roof, wall and floor framework to resist horizontal forces applied to the building (racking forces). Appropriate connection is also to be provided to transfer these forces through the framework and sub-floor structure to the building's foundation (ground).

Where required, bracing within the building will normally occur in vertical planes and be incorporated in walls or sub-floor supports and be distributed evenly throughout.

Where buildings are more than one storey in height, wall bracing will be required to be designed for each storey.

Bracing Methodology

Wind produces horizontal loads on buildings that must be transmitted through the structure to the foundation. In a conventionally constructed house these loads are transmitted to the ground by a complex interaction between the walls, ceiling/roof structure and floor structure. See Figure 1

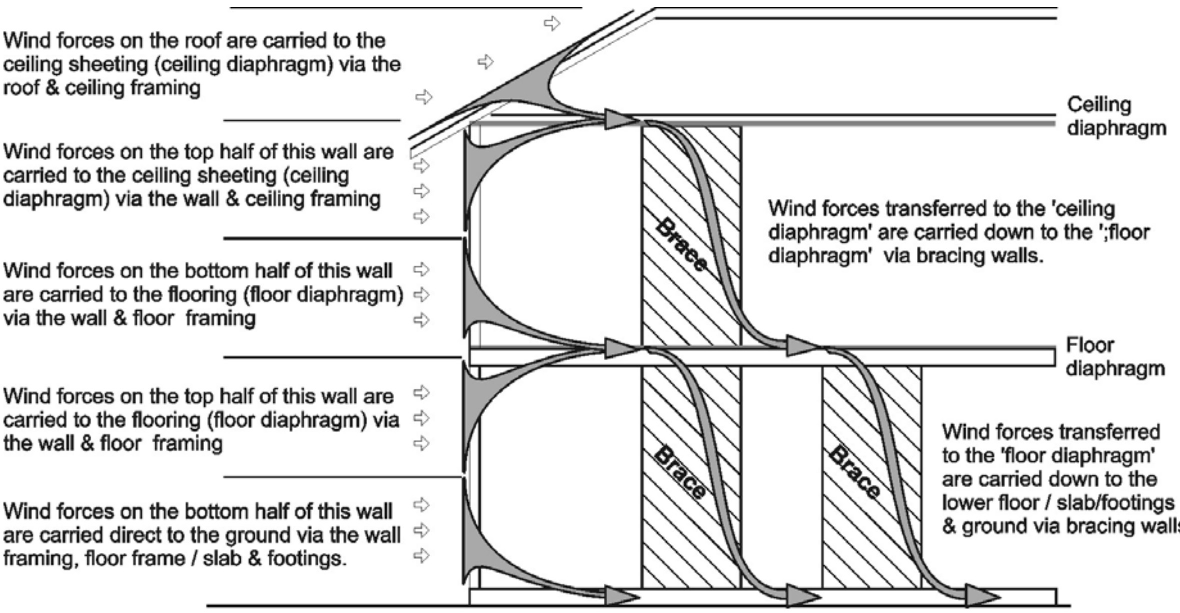

Figure 1 Horizontal Wind Forces (Racking Forces)

The ceiling and floor form large horizontal diaphragms which play an important role in distributing horizontal wind forces to bracing walls. Most walls also rely on support from the ceiling or floor diaphragm to prevent them blowing over. See Figure 2. The wind forces are transmitted to the ceiling diaphragm from the walls and also the roof. They are then transferred through the ceiling diaphragm to the bracing walls that transmit them to the floor structure, footings and then into the ground.

The role that the ceiling plays in the overall structural integrity of a house is very important. For the ceiling diaphragm to work properly, the ceiling sheeting must have direct fixing to the roof/ceiling framing.

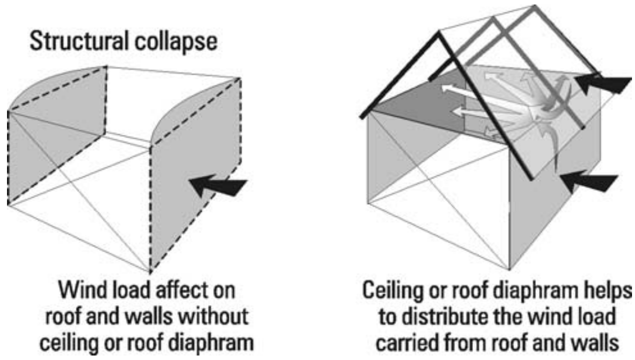

Figure 2 Horizontal Diaphragms

Ceiling battens, if used, must be fixed solidly to the roof/ceiling framing. If the ceiling is to be a suspended system or the battens are not fixed solidly to the roof framing, such as a metal furring channel fixed with a clip system, then alternate methods of distributing the loads must be found. This normally will require engineering advice.

Another factor that will affect the ability of the ceiling diaphragm to distribute the wind loads is the depth of the ceiling diaphragm. A shallow diaphragm will not distribute the wind loads over a great distance whereas a deeper diaphragm will transfer loads further. See Figure 3. For this reason the spacing of bracing walls in AS1684 is limited. For Single or Upper Storey, the spacing of bracing walls in N1 and N2 wind classifications is limited to 9000 mm maximum and in all other wind classifications, it is limited by the diaphragm depth and the roof pitch as per Clause 8.3.6.7. It should be noted that the higher the wind speed, the closer the spacing of bracing walls for the same roof pitch and ceiling diaphragm depth.

The final link in the chain is to transfer horizontal racking forces to the floor frame, slab and foundations by connecting the bracing walls to the horizontal diaphragms both at their tops and at their bottoms. Refer to Guide Note 5 for advice

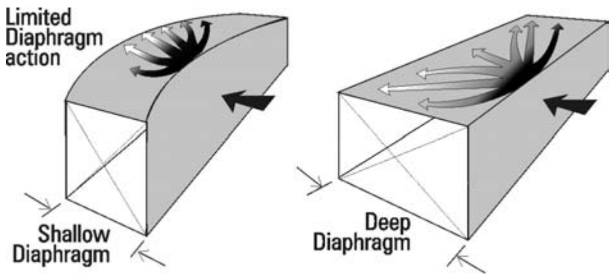

Figure 3 Effect of Ceiling/Floor Diaphragm Depth

Raked Ceiling Diaphragms

AS 1684 Figure 8.1, Note 2, infers that ceiling diaphragms can be installed on the rake, as would be typical in cathedral or exposed raftered roof construction. See Figure 4.
The code does not specify what the maximum roof slope for raked ceiling diaphragms is as it only refers to 'near horizontal' diaphragms.

Raked ceiling diaphragms have however been permitted and have been used successfully in Australia for many years (including cyclonic areas) for roof slopes up to 35°.

As the Code is limited to a roof slope up to 35°, Clause 1.6.7, it is recommended that this limit is also applicable to raked ceiling diaphragms.

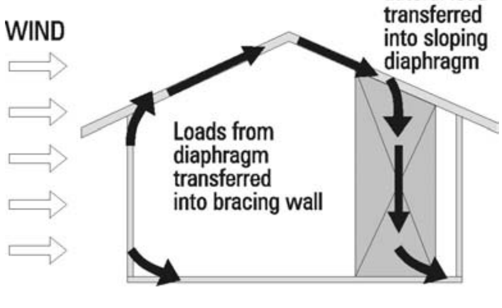

Figure 4 Raked Diaphragms

Holes in Diaphragms

The ability of diaphragms to distribute horizontal racking forces is not considered to be affected by:-

- Small holes through the diaphragm (eg manholes) with a length or depth up to 10% of the length or depth of the diaphragm.
- Discontinuity of ceiling lining or flooring at junctions of internal walls or partitions.

Diaphragms may also contain 'holes' that result from inclusion of stairwells or atriums providing the resulting discontinuity in the diaphragm is allowed for.

This can be achieved by determining the minimum net depth of the diaphragm, and using this depth for determination of the maximum spacing of bracing walls as per Clause 8.3.6.7 at either side of the opening.

Note: The spacing of bracing walls under the section/s of diaphragm that are full depth is still determined using the full depth of the diaphragm.

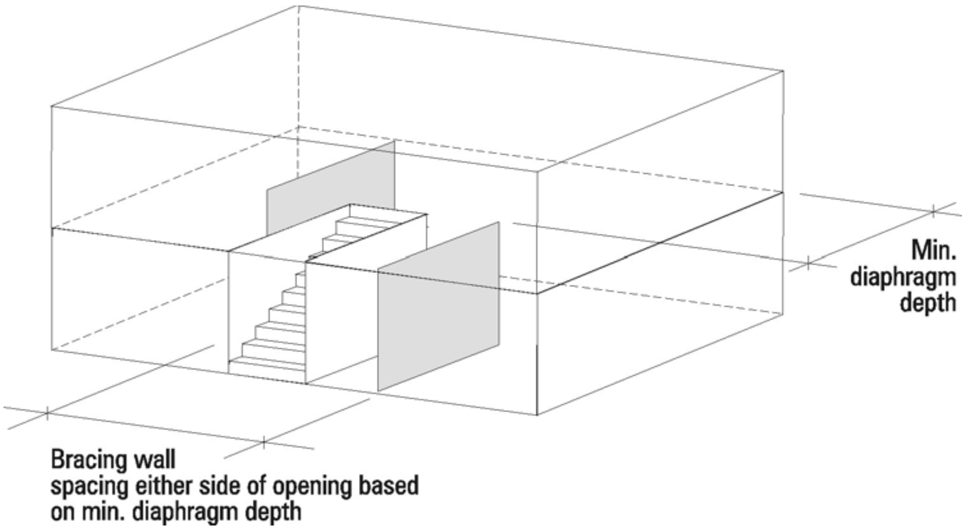

Figure 5 Holes in Diaphragms

Cantilevered Diaphragms

If a horizontal diaphragm is considered to be simply, a very deep horizontal beam, it is logical that it could cantilever in a similar manner to any other beam.

It is therefore recommended that diaphragms without discontinuities be permitted to cantilever up to 1/3rd of their allowable spans (maximum bracing wall spacing) provided the non cantilevered section is at least 3 times the cantilever. See Figure 6.

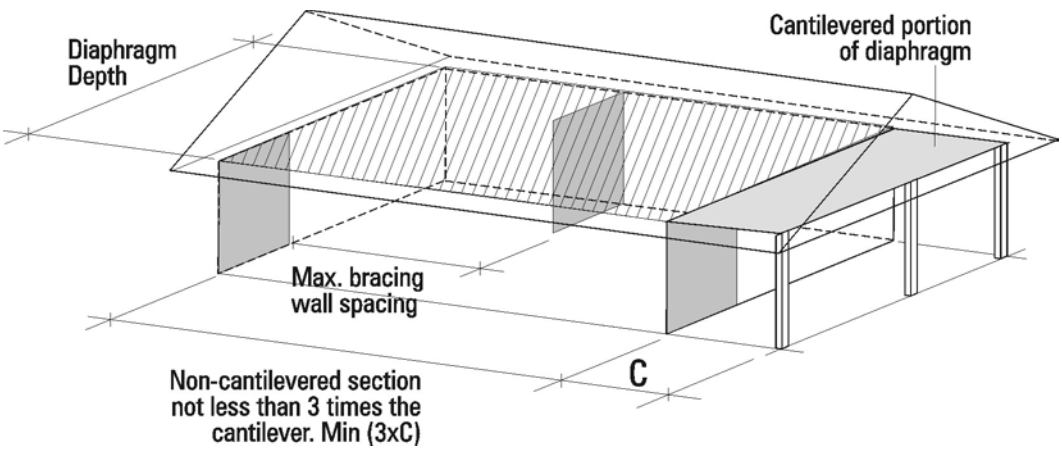

Figure 6 Cantilevered Diaphragms

Technical Advice

Further technical information and assistance is available from the following Timber Advisory Services.

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