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HIGH UPLIFT POINTS IN SHALLOW ROOFS

Modern architectural trends favour very shallow low pitched roofs.

Their increasing popularity coupled with lightweight steel roofing materials result in a generation of higher than normal uplift reactions at the supports of primary roof trusses which presents a challenge to the detailer.

A common method of achieving such flat roofs is to situate a parallel chord girder truss along the apex to support half trusses on each side, like ribs from a spine.

The fixing of these standard half trusses to the wall frame is not usually difficult to achieve but the tying down of the primary girder truss can be quite a task as uplift reactions at its supports often exceed the capacity of standard hold down connectors.

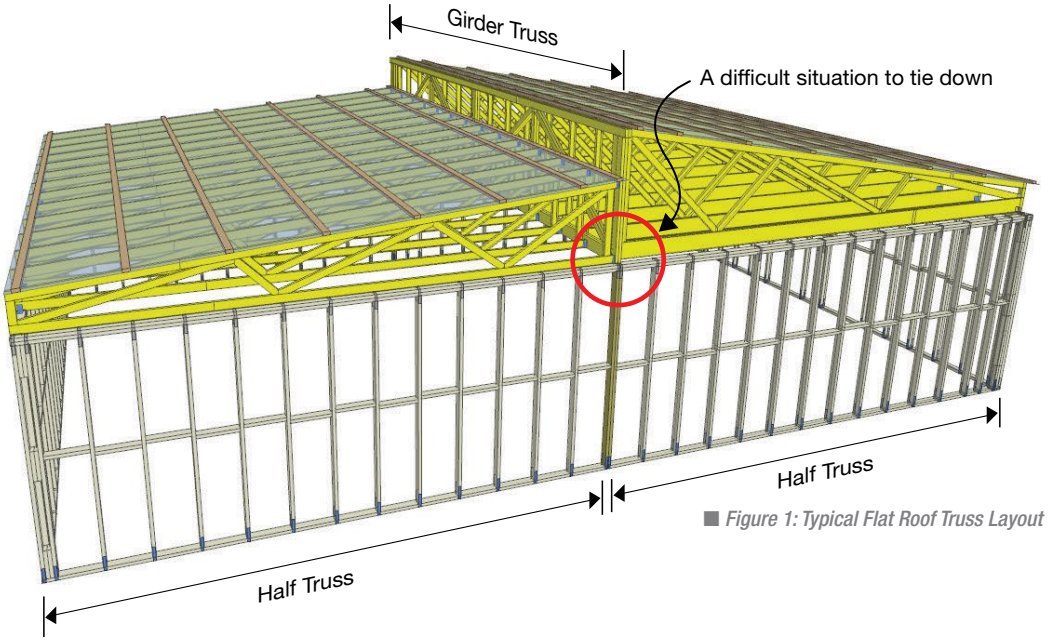

Figure 1: Typical Flat Roof Truss Layout

Take the 8mx12m roof layout shown in Figure 1 as an example. At a low N2 wind classification, the uplift generated at each bearing of the 8m girder truss carrying 6m half trusses on both sides is approximately 17kN.

If the classification is raised to a moderate N3, the uplift nearly doubles to about 30kN at each support point.

Putting that into perspective, since 10kN is the approximate weight of a small car, a connection with a strength equivalent to the weight of three small cars would be needed to hold down that girder truss to the wall frame at each end!

With uplift forces of such magnitudes, a detailer has to exercise additional considerations to safely transfer the uplift forces down to the foundations.

These include a careful analysis of each point along the load path the uplift forces take before it reaches the foundation: firstly a suitable connection between the girder truss and wall frame, secondly the sizing and connections of wall frame components, and finally the calculation of anchor bolts to transfer tension forces from the wall frame to the slab.

There must be good coordination between the detailer and the slab designer to agree on the locations where all significant forces are to be anchored at ground level so that these points in the foundation are adequately reinforced to resist such high uplift.

I have seen too many instances where the slab and wall frame designers made no allowances for these girder trusses, causing any number of problems for the detailer trying to design an adequate hold down, such as the following:

- An inability to use a standard connector wrapped over the top of the parallel chord girder truss due to excessive height.
- Clashing with hangers supporting half trusses in the restricted space making the tiedown more difficult.
- A wall opening directly underneath the girder truss complicating the load path and creating multiple more connections possibly needing the frames to be retrofitted with plate ties or wall straps.
- Resolving double brick wall frames where the top plate tiedown straps do not extend an adequate number of courses down the brickwork for the high uplift force from the girder truss.
- Offset wall frames between the upper and lower storeys complicating the load path of the uplift forces and making the retrofitting of ties between the two levels more difficult.
- Near finished wall cladding inhibiting access for the installation of additional studs, plate ties and anchor bolts.
- Construction setbacks and additional costs incurred due to an inability to resolve the hold down issue quickly and inexpensively.

It is easy to see that all of the problems above could have been avoided if adequate planning had taken place during the building design stage through communication between architect and truss detailer so that a truss layout is known from the start by the foundation and wall designers to account for the load flow path in their component designs.

Good communication and coordination are very cost effective ways of preventing costly fixes and delays in construction and ensuring successful projects. TTN