Autobuild News
GANG-NAIL® Guide Lines
BUILDING ON INNOVATION
NO. 2

THE CATCH WITH CATHEDRAL CEILINGS

by John Tadich,
technical services manager,
Gang-Nail Australia

With the advent of more powerful computer programs for the design of timber trusses, more complex and more challenging projects are being undertaken by truss fabricators.

This is good as it is expanding the market for our industry.

However, from time to time, we are pushing the engineering limits of what we can reasonably expect of our truss programs.

A typical example of this is the design of buildings with cathedral ceilings using either scissored trusses or trusses supported on their extended overhangs.

All of the truss programs provided by nail plate suppliers will design these types of trusses readily and provide a solution based on design assumptions made by each company.

Unfortunately, unlike other truss types, the design of top chord supported trusses and scissor trusses depends on the method of fixing and the design of the supporting structure in a way which is very different to any other type of truss.

The rigidity of both fixings and the ability of supporting structure to restrain horizontal loads will have a substantial effect on the design of the truss.

We all know that when we load a truss we can expect to get a small amount of deflection. This is why we camber trusses.

However, with trusses that have vaulted bottom chords, we not only have vertical movements, we also have a potential horizontal movement.

The greater the pitch of the bottom chord, the greater the potential for horizontal movement.

This is why the design of buildings with cathedral ceilings is difficult. As truss designers we basically have two choices.

We either have to design the connection between the truss and the building to accommodate this horizontal movement or we design the building and the connections between truss and structure to restrain it.

If we choose to restrain the horizontal movement, ie in engineering terms we use hinged supports, we get the most economical truss design but we can create a nightmare of problems for the designer of the supporting structure.

The magnitude of the loads that need to be restrained can be very large and if the structure is not properly designed can cause considerable damage to the supporting wall.

To design the structure for these horizontal loads is beyond the ability of any of the computer programs available to Australian fabricators, therefore, if this assumption is made in the truss design, then a separate analysis and design of the structure is required by a qualified structural engineer.

A costly and time consuming task.

However the consequence of not doing this is even more costly, as walls can be pushed out of plumb, brickwork cracked, etc.

This on-site rectification work is usually very difficult and extensive, which usually leads to costly and time consuming litigation.

So it is essential that detailers understand what assumptions have been made by their computer programs and to pass this information on to their clients.

The other design assumption of allowing horizontal movement also has its problems, sliding connections at the support needs to be designed along with a ceiling detail which will allow the movement to take place.

This is not as easy as it may seem as the friction between the truss and supporting walls can be enough to cause large horizontal forces to develop causing the same problems as the previous method.

Well, what is the best way to resolve these problems?

I believe it is to engineer the truss or roof to reduce the vertical movement to a minimum and by doing so reducing the horizontal movement.

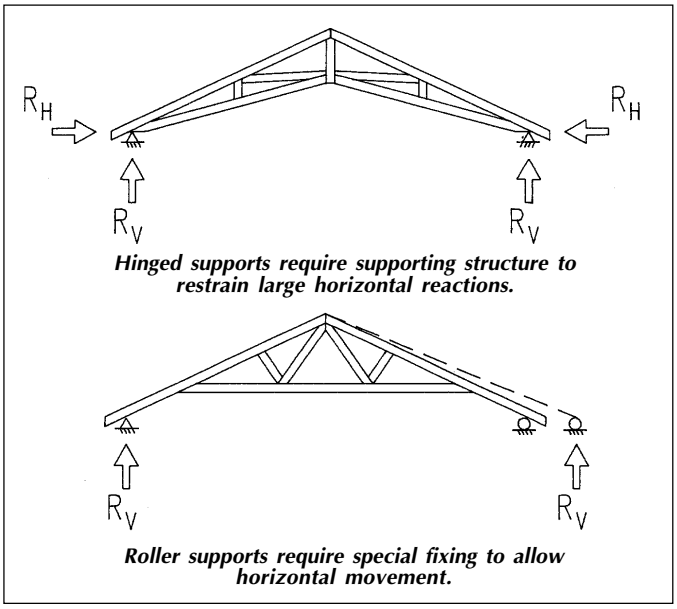
This can be done by:

1. Increasing truss stiffness, that is increase chord sizes. As a guide for brick veneer walls horizontal movement should be limited to wall height/600 or 8 mm. For solid brick or glazed wall even less horizontal movement can be tolerated. Conversely greater movement may be tolerated with timber framed walls with flexible cladding.

2. By using internal walls for support or by designing the roof with a stiff parallel girder truss as the ridge if the floor plan permits.

Although this, from the overall project point of view, is the most convenient and cost effective solution, it does mean that there is additional cost built into the trusses.

So if you are in a competitive situation, it is important to discuss the options with your client.



Hinged supports require supporting structure to restrain large horizontal reactions.

Roller supports require special fixing to allow horizontal movement.