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WIND PRESSURES INTERNAL/EXTERNAL

When Tropical Cyclone Yasi gave North Queensland a battering in February this year, it made me think again about wind pressures.

Could normally low internal wind pressures have turned into high external pressures as to have caused some of the damage seen?

It may sound confusing but the short answer is "Yes".

Let me clarify with this simplified explanation. Internal wind pressures are exerted on the underside of ceilings and overhangs to "push" the roof up.

On the other hand, external wind pressures are applied on the top of roofs to "suck" it up.

The total wind pressure is a combination of the two.

(Naturally, uplift wind pressures can also be reversed into a downdraft but for simplicity, that will be left out of discussion here.)

The pressure on different surfaces of a building varies according to their exposure and orientation to the wind direction and this is measured by a "pressure coefficient".

In an enclosed house, the external pressure coefficients on the outer surfaces of walls and roofs (commonly between 0.6 and 0.9) are much higher than the internal pressure coefficients on the inner surfaces of walls and ceilings (typically around 0.2).

But in cyclonic regions, debris often flies around at breakneck speeds breaking windows, smashing roller doors and lifting roofs in extreme cases. (See Photos 1 & 2)

Photo 1: Pierced tree trunk during Cyclone Larry.

When that occurs, it is no longer a fully enclosed house and the inner surfaces suddenly become just as exposed as outer surfaces, causing internal pressure coefficients to escalate accordingly.

That is why the Standards recommend using an internal pressure coefficient of 0.7 in cyclonic regions unless windows are protected by timber shutters and roller doors are cyclone proof.

What about the eaves under roof overhangs, external cantilevered ceilings or underside of open patios, verandahs and carports (e.g. Photo 3) that are always exposed to the wind, even in non-cyclonic regions?

Well, in these situations, the Standards treat cyclonic and non-cyclonic regions equally.

It stipulates that the pressure under eaves and exposed ceilings attached to the side of a house shall be taken as equal to those applied to the adjacent wall surfaces.

Under general circumstances, this means that the pressure coefficient on the underside of eaves should be 0.8.

For this reason, it is important for a truss detailer to define which underside sections of a truss forms part of the open area because its internal pressure coefficient should rise from 0.2 to 0.8, a fourfold difference in pressure.

With the example in Photo 3, the total wind pressure on the top and bottom of the carport trusses is nearly twice that of the roof inside the house simply because the underside is outside the building enclosure.

The situation is slightly different in a freestanding carport where there are no walls on any side and estimating pressure coefficient is more complex.

Nevertheless, the coefficient is usually less than that of a carport attached to the side of a house and so a designer can conservatively adopt 0.8 as the internal pressure coefficient unless an engineer is consulted.

Thankfully, a competent truss design software package will accurately work out all necessary wind pressure coefficients on every side of a truss provided the user properly defines the internal or external ceiling zones that are open or enclosed within the walls of the house. If uncertain, talk to your truss engineer.

For further information on wind coefficients, refer to GN Guideline No. 45.

Photo 2: Smashed roller door during Cyclone Yasi.

Photo 3: Exposed carport ceilings attract higher wind pressures.