Effective Passive Roof Fire Venting

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In large area single storey buildings, a small fire may produce enough smoke and hot gases to quickly fill the building. This can conceal the origin of the fire before the arrival of the Fire Service. Fire-fighting is then more difficult and dangerous, since the fire must be located within the building and the extent of smoke and heat may be sufficiently severe to cause the Fire Service to retreat and conduct an external fire attack. External attacks are often ineffective as fire hose streams rarely reach the seat of the fire to extinguish it and this only results in more water damage, contaminated run-off and the likely loss of the building and its contents. The temperatures of the hot layer trapped beneath the roof may also be high enough to cause distortion or failure of unprotected roof construction or ignite flammable roof materials.

Currently the New Zealand Building Act (2004) does not require building owners to consider owner's property protection. Consequently, most industrial buildings have been constructed in the expectation that insurers will cover the fire loss.

To assist Fire Service operations in large buildings, the Building Code Compliance Document C/AS1 (2001) places a limit on the maximum compartment floor area in unsprinklered buildings (typically 1500 m^2). This is designed to limit the total fire load in each fire compartment. However subdividing large industrial buildings is often undesirable for functional reasons. No subdivision of the building is required according to C/AS1, if at least 15% of the roof area (distributed evenly throughout the firecell) is designed for 'effective fire venting'. Subsequently the roof fire venting option is a popular one.

The purpose of roof venting is:

- to allow for the efficient removal of smoke and heat from the building allowing better access for the Fire Service to locate and control the fire, and
- to reduce the overall severity of the fire on the building structure via the removal of heat from the building. (The FRR provided to some structural elements (that require an S rating) can be reduced by up to around 50%, according to C/AS1 requirements, if roof venting for fire is provided.)

A passive fire venting system relies on heating by hot gases to form an opening in the roof, with the buoyancy of hot fire products providing the driving force for removal of the hot gases. Advantages of such a system include: simplicity, effectiveness in a wide range of fire conditions and independence from any available power supply that may be disrupted during a fire.

Furthermore previous experimental work has been performed at the Building Research Establishment in the UK during the 1960's, investigating roof sheeting materials for passive roof venting, including some material testing (e.g. for PVC). The results of these previous investigations indicated that passive roof venting can be a valuable system in limiting fire spread and maintaining conditions for the seat of the fire to be located more easily. However, limited 'large-scale' and 'full-scale' testing has been performed and a limited number of potentially appropriate roofing materials have been tested in this way.

Unfortunately, there is no detailed specification or standard currently referenced in the New Zealand Compliance Document to ensure that fire venting is 'effective'. The current performance and effectiveness of these systems is therefore questionable.

There is also the question of the location or distribution of the panels over the area of the roof. An even distribution across the roof area is appropriate for flat or very shallow roofs, but venting in steep roofs would be more effective if located near the apex.

The use and appropriate size of smoke reservoirs are also not currently addressed for effective fire venting.
Mechanically operated smoke and heat venting systems for fire are established technology overseas and various codes and standards do exist (e.g. AS 2665, AS 2428, NFPA 204, UL 793 and UBC Standard

15–7) that may be suitable as performance standards in New Zealand. Passive systems such as dedicated units utilising drop-out panels are less common, however these venting systems are also subject to international standards testing and performance criteria. New Zealand is the only country that uses roofing materials with no demonstrated level of fire-venting performance for fire venting purposes.

Detailed guidance on how to assess the effectiveness of roof venting systems leading to appropriate specifications for them is therefore needed.

Conclusions

- New Zealand is the only country that uses passive fire venting that does not incorporate a dedicated frame or unit, or have a demonstrated level of performance.
- The current requirements and definitions in C/AS1 are lacking for effective fire venting. This has enabled the use of a range of materials, of which the passive fire venting performance is not known.
- A passive fire venting system utilising material properties and installation of unprotected roof sheeting has cost and installation advantages over dedicated fire venting units, and if designed appropriately could potentially be effective for venting fire (and subsequently be competitive with currently established dedicated fire venting systems). However, appropriate performance criteria and design are essential.

Two important issues emerge:

1. ensuring effective fire venting for future building stock designed in accordance with the appropriate regulatory definitions and requirements, and
2. ensuring current building stock with proven ineffective fire venting (depending on the future definition and performance criteria) is appropriately prepared for a fire event or alternative fire-fighting measures are available in the event of fire.

Current Research Work

BRANZ has recently completed Stage I of a research project to investigate effective passive roof venting of fires. The project is fully funded by Building Research. BRANZ is about to start Stage II of this project, focusing primarily on the first issue raised above, as well as determining the full extent of the problem underlying the second point. The approach is to use both experimental and modelling work to determine:

1. a formal definition for “effective fire venting”, including performance criteria

2. whether passive buoyancy-driven venting utilising roof sheeting provides “effective fire venting”, and, if so,

3. the appropriate test methods and criteria to qualify as “effective fire venting”.

The intended use of the results of this research is to form a technical basis for recommendations that will be presented to the Department of Building and Housing.

Details of Stage I of this BRANZ research is available at:
http://www.branz.co.nz/branzltd/bookshop/info.php?ask=free&idnum=1628