How new technology is stopping fire in its tracks

After spotting an existing weakness in fire prevention methods, **Geir Jensen**, Technical Director at COWI Fire International, has spent the last twenty years researching and developing new ways to stop the spread of fire.

Inventor and professional engineer Geir Jensen has a passion for devising practical solutions to problems. Through collaborations with scientists and the exploitation of opportunities as and when they arise, Jensen has recently brought to fruition an idea first envisioned 20 years ago. From idea to reality, the story of Jensen's invention is an inspiring example of how far you can get with limited resources, as long as you have sufficient vision and ambition.

CONFLICTING INTERESTS

The challenge of designing buildings to withstand fire is an ongoing issue for the construction industry. In many cases, buildings, in particular their exterior construction, also need to be ventilated to prevent rot and fungus. However, in practical construction, ventilation and fire resistance are contradictory requirements: to ventilate a building you need gaps through which air can freely pass, but these gaps present a major area of weakness in the fire resistance of a building.

This conundrum has for a long time been a major challenge to both research scientists and the construction industry. The question of how to make ventilation gaps fire resistant has, until recently, been deemed too difficult and so generally ignored. Instead, research has focused on the parts of buildings that lend themselves more favourably to fire-resistance measures. As a result, a lot of time and money has been invested in installing fire-resistance techologies in buildings which remain vulnerable to fire (due to the presence of unprotected openings like vents and gaps). In addition, there is a lack of standardised testing in this area, making it difficult for those requiring fire-resistance measures to make informed decisions.

FILLING THE GAP

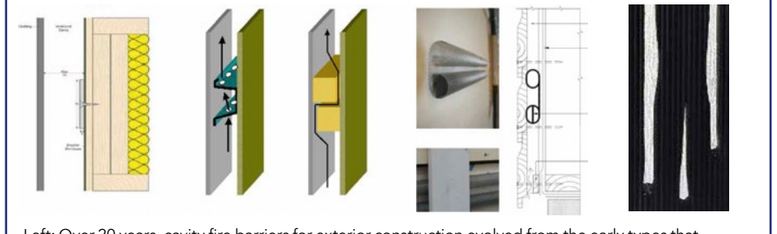
There currently exists a range of methods for making ventilation gaps fire resistant. Intumescent materials that expand on exposure to flames and hot smoke gases create a seal against the spread of fire. However, these take a few minutes to fully seal, so still allow fire to spread in the critical early stages. An alternative technology, flame arresters, uses the principle of a quenching distance to prevent combustion. However, they have a very short working duration of a few milliseconds up to a few seconds.

Evidently, even a combination of these two technologies would leave a significant time gap during which fire could spread through a building. Fascinated by this challenge, Jensen has spent the last 20 years designing and refining an invention which is set to revolutionise the world of fire resistance.

FROM IDEA TO REALITY

The story of Jensen's invention begins in 1994, when he observed the construction of the Eidsvoll 1814, the constitutional building of Norway. The building contained many vertical ventilation shafts and Jensen was struck by the potential fire threat posed by these shafts and the lack of methods to prevent fires

> **Geir Jensen's research and inventions are paving the way for a new mode of thinking about fire resistance**



Left: Over 20 years, cavity fire barriers for exterior construction evolved from the early types that performed only after being sealed by fire (flame and embers could penetate for the first few minutes). Middle: Perforated or labyrinth-type flame arrestors would block fire for the first five minutes, not after, and ventilated less efficiently. Right: The result is well ventilating malleable barriers for gaps or cracks of any size or form. These stand up to embers and direct flame as well as sustained fire, instantly at zero hours and for hours. (Coloured drawings by B Østman et al)

spreading. This single observation prompted Jensen's interest and research in this area and sparked a thought which has since proven to be revolutionary in this field.

Motivated by a request for research from authorities and academia, in 1998 Jensen conducted a review of available mechanisms to prevent fire spreading through vents. This review gave him the idea of combining current technologies with new thinking to develop a unique and more effective method. Jensen's new technology, Firebreather, combines flame arresters and intumescent materials with a third component that acts as a heat sink. The heat sink material efficiently lowers the smoke gas temperature to below the ignition temperature of fuels, stemming the initial transfer of flames until the intumescent material becomes effective. This way, fire cannot penetrate at any time from the exact moment the fire exposure starts (zero hours) up to several hours later. This is key – all products are assessed on a time scale but it begins five minutes after ignition; that seemingly small window of the first five minutes is a crucial period when flames and embers could still be passing through other products.

Over the next few years, Norwegian government funding allowed for prototype development. Prototype testing in 2002 proved highly successful, providing both immense satisfaction and the motivation to progress the design. Between 2002 and 2004 Jensen worked on refining his design and manufacturing an eave vent. 2004 marked a significant milestone in progress, as the invention was published as a poster paper at the annual Interflam conference.

Although faced at times with a lack of interest and resistance from industry competitors, Jensen persevered with his vision. In the subsequent years, he filed patent applications, created building guides and handbooks, and addressed the lack of test standards. In a review of vented fire barriers in 2013, Jensen brought to light the lack of appropriate, comprehensive tests. In his review, Jensen states that most current tests do not adequately simulate likely fire scenarios, such as sudden flame. The conclusion to his report suggests re-developing an existing full-scale test to include exposure from zero hours by direct flame impingement.

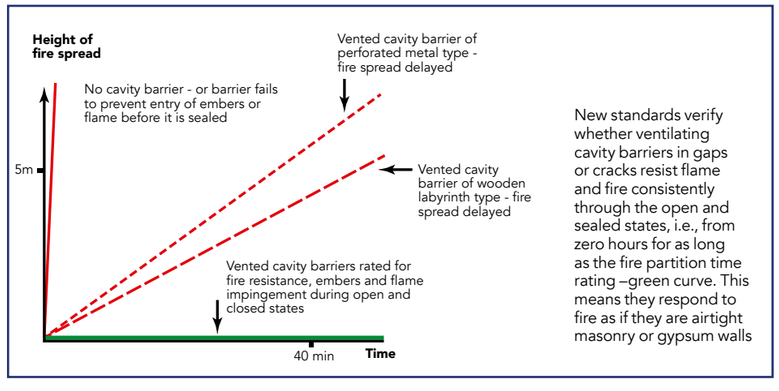
Based on the success of his previous design, Jensen is currently developing a linear malleable vent to seal irregular gaps and cracks. The vent can easily be installed by hand and is a fully reversible design, allowing it to be installed and removed without leaving a trace. This feature makes it particularly appealing for use in heritage buildings. With a patent application in progress, Jensen's inventions are continuing to change long standing views on fire protection methods.

Flame contact ignites combustibles in just one to three seconds. New test methods had to be designed in the USA and Europe in order to test whether vents instantly block flame attacks while they are still fully open

In terms of fire, a few seconds can make all the difference and, ultimately, by providing instant and lasting protection, Jensen's inventions buy the time to reduce damage and loss

PREVENTION IS KEY

Clearly, Geir Jensen's research and inventions are paving the way for a new mode of thinking about fire resistance. His vision, ambition and perseverance have resulted in unique new methods to stop fire from spreading through vents. These effective, affordable and easy-to-install technologies protect not only the structure itself, but also prevent the fire spreading to neighbouring buildings. In terms of fire, a few seconds can make all the difference and, ultimately, by providing instant and lasting protection, Jensen's inventions are buying the time to reduce damage and loss.



Q&A

Your patented technology combines the commonly used principles of intumescence and quenching diameter with a heat sink material. How does the heat sink work to prevent the spread of fire?

The function of the heat sink is to delay heating of the unexposed side while the vent is still in the open state. Temperature must be kept below the ignition threshold of the gas emitted by the fire source.

What fire scenarios should prevention methods be tested for?

Until this invention, no ventilation fire dampers or air transfer grilles or other vented construction parts had been tested for fire resistance during the first five minutes after fire ignition. That was because, conventionally, fire resistance elements of buildings are inherently homogenous and airtight, so if an object resisted fire at five minutes it could be assumed it would have done so for the previous five minutes as well, so no need to test that initial period. In addition, the fire test furnaces require some minutes to run correctly and have been used as an excuse to not register failures at zero to five minutes.

Fire dampers have always been tested as open from the start and they could not prevent fire spread during the first minutes before they closed. All fire dampers would therefore fail if tested from 'zero hours'. So, the industry has continued to test dampers as if they were solid objects, i.e., failures are registered from five minutes onwards only.

This delay in the testing is also partly due to the idea that fires take some time to build up in rooms so usually do not penetrate that early. This is valid for most indoor fires, though there are exemptions. For exterior fires, however, wind-driven embers and flames abound and penetrate vents in seconds without warning. All parties are agreed that conventional vents were not acceptable. Before my invention, attempts were made to close off vents manually if a fire was getting near, or use vents of metal sheet labyrinths to block flame, mesh to block embers etc. This new technology simplified all this.

What effect has your research had on testing and standards in this field?

My research and the ensuing technology has proven that "open state fire resistance" is technically feasible. Therefore, it was decided in North America to dedicate a new test method for direct flame impingement of open state elements (vented construction) during the zero- to five-minute period. This became the ASTM E2912 Standard. The test method for vents exposed to wildfire adopted that method, ASTM E2886. In Europe CEN decided to add a similar method to both new prEN 1364-5 and prEN 1364-6 Standards. In France a guide has been issued that explains how to apply open state fire resistance vents in facades (my technology) and refers to ASTM 2912 (*Bois construction et propagation du feu par les façades En application de l'Instruction Technique 249 01/02/2017*).

You have been working on hypoxic (low oxygen) air technology for fire prevention. What are the limitations of this method?

A constant low-oxygen indoor climate that is fire preventative but occupiable is a very simple and clean method. Except, the more that the low oxygen air leaks out and must be replaced, the more energy is required to refill. So, leaky rooms are ruled out. Low oxygen for occupation does not work for combustibles with very low ignition thresholds, as then the oxygen content in the room becomes so low it is uninhabitable.

What are your aspirations for 2017 and beyond?

To see national codes require open state fire resistant ventilation where applicable, world-wide. Also, to see progress of my ideas on water mist and sprinklers for fire protection.

Detail

RESEARCH OBJECTIVES

Geir Jensen's research focuses on preventing the spread of fires through the design and manufacture of specialised air vents for use in the construction industry.

FUNDING

Innovation Norway

COLLABORATORS

- Turid Buvik, Innovation Norway
- Amal Tamim, COWI Gulf (now at Arencon, Canada)
- Phil Grimwood, Cambridge Fire Research (now Technical Director of Dixon International Group)

BIO

Geir Jensen is a Technical Director of Fire Protection at multi-disciplinary consulting group COWI. He is also an inventor and is particularly interested in designing fire resistant solutions for the construction industry.

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