Experimental Study on the Fire Behaviour of Rainscreen Façade Mock-ups

Towards small scale testing for façade system optimization

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Introduction

The reaction to fire classification process for external wall and façade systems is resource demanding. This is due to the high costs of large scale tests and the lack of standards harmonization between the EU countries. Hence, there is a need for façade system producers to optimize their solutions before performing large scale fire tests.

Difficulties of correlating the overall large scale façade fire performance with the small scale tests had been identified[1]. The design of small scale tests should be further improved to better represent possible worst case scenario during the large scale tests. Such testing would also help to identify the critical system parameters (e.g. system detailing, fire stops, ventilation cavity) affecting the reaction to fire behaviour.

This study presents two tests with rainscreen façade mock-ups using the Single Burning Item (EN 13823) test method.

The flame spread mechanisms

A commonly suggested 'worst case' building exterior fire spread scenario involves flames emerging from windows of the room of fire origin after flashover. At this point the flames will interact with the building exterior envelope and the envelope may contribute to the fire spread up to the building levels above.

The rainscreen system consists of building thermal insulation mounted to the exterior wall and a cladding system . The flames can thus interact with the outside cladding or it may break into the air cavity between the insulation and the cladding system.

It is observed that the flames, emerging through cavities within the building envelope can extend up to 10 times the original flame height [1].

The tests presented in this study were designed to represent two discussed fire spread scenarios.

Testing

Two tests were performed to assess different fire exposure scenarios: external flame exposure to the cladding system and the flames within the air cavity. The specimens consisted of phenolic foam insulation K15 (Kingspan), wood studs and class A2 cladding material system. The tests were performed at Efectis Netherlands in February 2016.

Scenario 1: flames outside the cavity

Scenario 2: flames inside the cavity

Fig.1: before testing scenario 1

Fig.2: after testing scenario 1

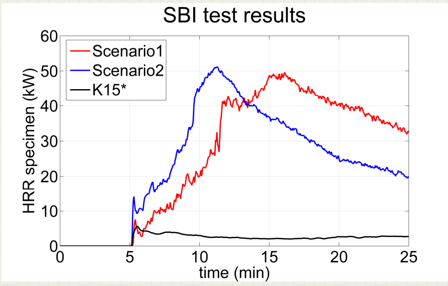

Fig 3: HRR graphs of tested scenarios

* Tests performed a year earlier with K15 insulation, but different thickness.

Fig.4: before testing scenario 2

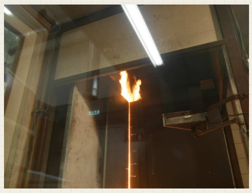

Fig.5: during the test of scenario 2

Results

The tests allowed assessing the difference between the reaction to fire behaviour of rainscreen system in two scenarios.

These indicative tests suggest that the largest contributor to the fuel load is wood used in studs. However, hot gases entrapped inside the cavity may also be a factor increasing the total heat release from the insulation material.

The maximum HRR and the total heat release is approximately the same in both scenarios. The time to reach the peak HRR is shorter and the initial HRR peak is higher in scenario 2 (flames inside the cavity). This indicates faster flame spread in scenario 2.

The observed flame heights for the set-up 1 are much higher than during the set-up 2 tests indicating the flame extension in the gap between the insulation and the cladding materials.

Future Work

The future work includes further investigation of the cavity width and how it affects the reaction to fire behaviour of the constructions. The previous work on parallel wall systems has identified the cavity width as one of the main factors influencing the flame heights and heat fluxes to the surfaces [2,3]. A proposed test method is presented in figure 6 and in general it is a slight modification of the previous work. The application of this investigation goes beyond the rainscreen facade systems and would be useful for understanding any system involving cavities.

Further development of representative mock-up scale tests for assessing the complete full scale system fire behaviour would also provide the basis for modelling. There already exist simple empirically based methods for calculating small scale test HRR behaviour based on the material test results.

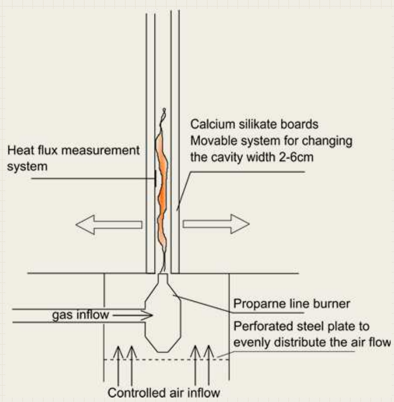

Fig.6: suggested test set-up for studying flame characteristics in cavities

The FIRETOOLS project

The project FIRETOOLS investigates modelling approaches of reaction to fire and fire resistance performance of commonlly used building systems. The main approach of the project is building links between material behaviour at different physical scales. The main partners of the project are the Danish Institute of Fire and Security Technology and Lund University. In addition a number of industrial partners are involved and contributing to the project.

References

[1] Colwell, S. Licking the building envelope?, Fire Safety Engineering (March 2008)

[2]Foley, M., Drysdale D.D., Heat transfer from flames between vertical parallel walls, Fire Safety Journal 24 (1995) 53-73

[3]Ingason, H., Two dimensional rack storage fires, Proceedings of 4th International Symposium of Fire Safety Science (1994)

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