Experimental studies of the contribution of cladding material to external fire spread

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1. Introduction

- *Tall buildings are classically based on the fundamental principles of compartmentalisation and structural integrity.*
- *Code-based fire safety strategies are then based on the assumption that external fire spread must not occur.*
- *There has been a large growth in new external cladding systems to meet industry drivers, this rapid growth has led to the use of products that do not abide by the no vertical fire spread principle.*
- *This is not an isolated issue but is present in thousands of existing buildings all over the world.*
- *There are no current tools for Fire Safety Engineers to evaluate the risk of external fire spread in existing tall buildings.*

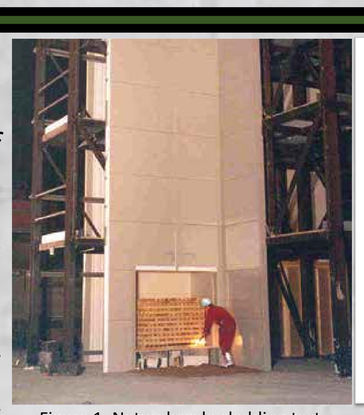


Figure 1. Natural-scale cladding test

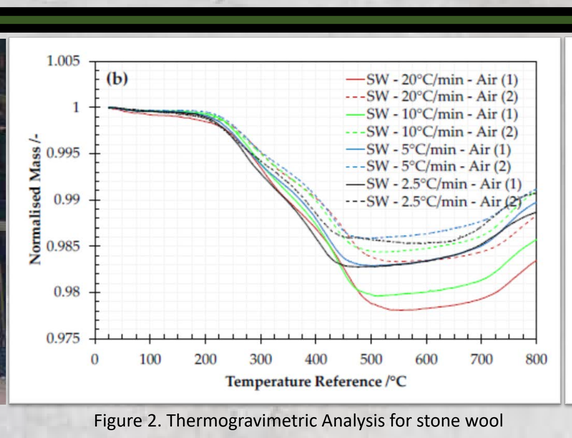


Figure 2. Thermogravimetric Analysis for stone wool

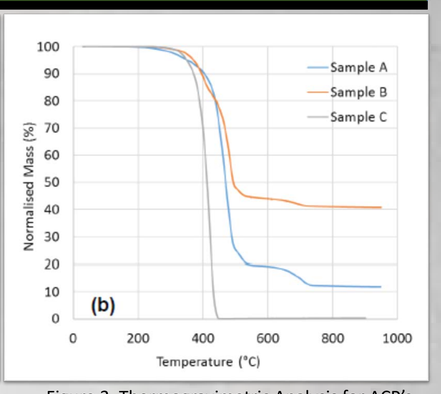


Figure 3. Thermogravimetric Analysis for ACP's

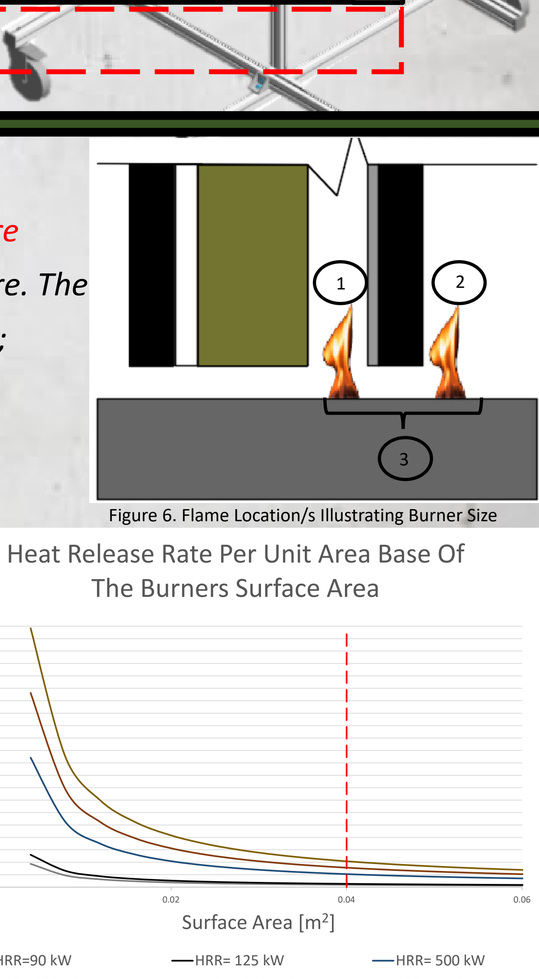
2. Current Research

- *Natural-scale external façade test used to analyse the external fire performance of applied and supported cladding systems.*
- *Material-scale and flammability methods applied to multiple cladding materials (aluminium composite panel cores and insulation materials), which have been developed at The University of Queensland.*

3. The Test Apparatus

- **Insulation**
  - Stone wool (SW)
  - Rigid polyisocyanurate (PIR)
  - Rigid phenolic foam (PF)
- **Air-gap Cavity**
  - Non-ventilated
  - Ventilated
- **Aluminium Composite Panel**
  - Fire resistant (FR)
  - Polyethylene (PE)
- **Fire Scenario**

Geometry and Material Properties

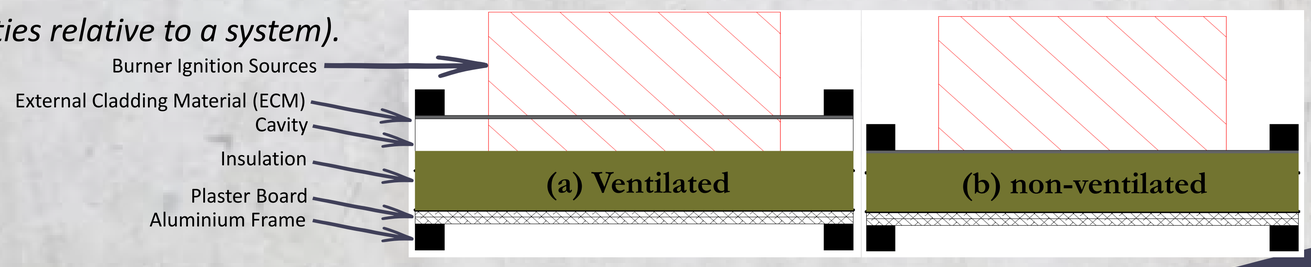


4. Objectives

1. *Explore the interaction between a non-ventilated and ventilated façade system (material and geometry), in relationship to external flame spread.*
2. *Studying the flame spread velocity and the heat release rate (HRR) growth within of the system as the fire grows from an initial ignition source to a fully-developed fire.*
3. *Understanding the performance of external cladding systems under fire conditions.*

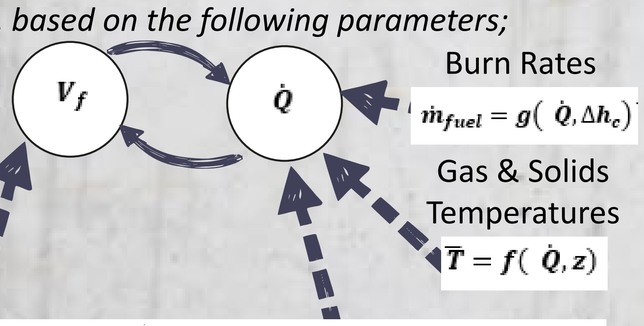
<u>With the ultimate goal being;</u>

1. *Guidelines to identify the risk of external fire spread for existing tall buildings containing cladding materials.*
2. *Creating a tool that fire engineers can use to assess the risk of fire spread in tall buildings (in terms of velocities relative to a system).*



5. Methodology

Design and construct a medium scale test rig used to identify the interaction between cladding materials and geometry, and the potential fire spread rate of these systems.
Four parameters will be assessed: (1) cladding material, (2) insulation material,(3) size of air cavity in façade system, and (4) fire scenario. Flame spread velocity and the heat release rate (HRR) growth will be accessed from ignition to fully developed, based on the following parameters;



Flame length
Heat flux

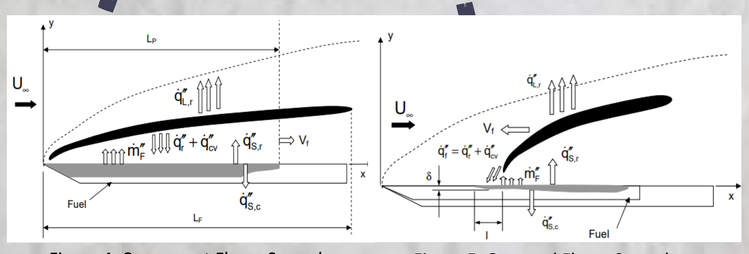


Figure 4. Concurrent Flame Spread

Figure 5. Opposed Flame Spread

6. Preliminary Results

The preliminary results have been obtained for the Fire Scenario using fluid dynamics simulator (FDS) software. The model is designed to simulate the following scenarios;

1. *Fire burning inside the Rainscreen cavity,*
2. *Fire burning on the Rainscreen outer face, and*
3. *A combination of 1 and 2.*

Figure 6. Flame Location/s Illustrating Burner Size

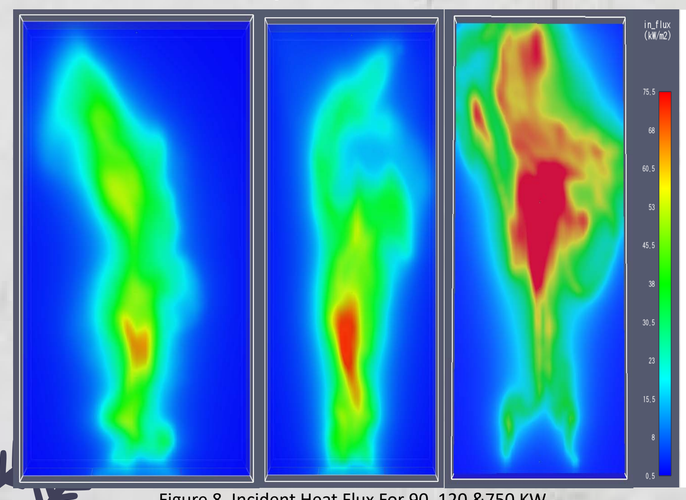


Figure 8. Incident Heat Flux For 90, 120 &750 KW

Figure 7. HRRPUA For Different Fire Scenario

7. Current progress

- *The frame has been purchased and is in transit, therefore the mock-up façade frame will be fully constructed in the coming weeks.*
- *Several manufacturers have been contacted about acquiring their products.*
- *Testing methodology has commenced, this includes sampling devices and location, along with constructing a failure criteria of the test.*

References;

- *BRE, BRE Global Client Report. 2017.*
- *Ogilvie, J., Fire Performance of ACP Façade Systems. 2017, The University of Queensland: Brisbane Australia.*
- Hidalgo-Medina, "Performance-based Methodology for the Fire Safe Design of Insulation Materials in Energy Efficient Buildings (Ph.D. thesis)," The University of Edinburgh.

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