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Ministry of Housing, Communities and Local Government Interim Report

Fire Performance of Cladding Materials Research – Experimental methodology and performance criteria

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1 Introduction

This Interim report is delivered as part of the Ministry of Housing, Communities and Local Government (MHCLG) project titled “Fire performance of cladding materials research”, MHCLG Contract reference CCZZ17A36.

The aim of this project is:

- To investigate the burning behaviour of selected types of **non-ACM (non-Aluminium Composite Material)** cladding products using physical testing at bench/intermediate scale in a laboratory setting to identify materials/products of potential concern so that MHCLG can consider the risk of their contributing to external fire spread when used as part of a system and ensure that its guidance is adequate.

The specific objectives are:

- To improve the understanding of the burning behaviour for selected cladding materials/products samples
- To improve the understanding of implications on safety levels within the buildings in which the selected cladding materials/products are installed
- To identify cladding materials/products that require further investigation.

The project has been broken down into Tasks, as follows:

- Task 1 Start up
- Task 2 Establish a Project Steering Group
- Task 3 Literature search
- Task 4 Agree the types of cladding materials/products to be assessed
- Task 5 Agree test methodology and performance criteria
- Task 6 Testing
- Task 7 Assessment
- Task 8 Publishable report.

This technical report contains a description of the proposed experimental methodology and the performance criteria to be used for assessment as part of the experimental phase of the project and forms the principal output for Task 5, Agree test methodology and performance criteria.

The information within this report was developed with the participation of the Project Steering Group who have provided input to the Project team.

2 Experimental methodology

2.1 Introduction

Following the first Project Steering Group meeting held at BRE Watford on 12th April 2018, a request for information was sent on behalf of the Project team to Project Steering Group members based on three specific questions covering three of the Project tasks. These were:

- **Question 1** relating to the literature review – Do you have any relevant information that you would like to make the project team aware of? Please give details, references and/or provide reports.
- **Question 2** relating to the type of products to be selected for experimental work – What are the materials/products currently being used as elements within a cladding system which you believe may give cause for concern in relation to fire performance? Please supply as much of the following information as possible:
    - Trade name and generic description of product.
    - Extent and use in cladding systems within England (and UK).
    - Reason why product is causing concern.
- **Question 3** relating to the methodology for the experimental work – At this stage, do you have any views or comments on what you would like to see in the methodology for the experimental work – please remember that this project is only considering elemental performance in fire of products, it is not considering system performance.

The methodology set out in this report is based on responses received via Project Steering Group members to Question 3 and discussions with MHCLG. This report includes a summary of the responses received together with a comment from the Project team as to how each of these will be addressed.

At the first Project Steering Group meeting, MHCLG clarified that the focus of the project was on non-ACM materials/products forming the external face of the cladding system. The experimental phase of the project, phase 2, will evaluate and characterise such materials/products in relation to ignitability, flame spread and heat release to evaluate whether the outer cladding panel presents a specific risk in relation to fire performance when considered in isolation in a similar manner to that presented by (non-fire rated) ACM panels (for which the ACM panel in isolation supported rapid self-propagating spread of fire).

2.2 Responses received

Table 1 summarises the responses received from the Project Steering Group members together with a comment from the Project team as to how each of these will be addressed.

Note to Table 1

1. For confidentiality reasons, no reference is made to the source of the information and any references to specific products or trade names have been removed.
2. Whilst some of the issues proposed are outside of the scope of the current project, all proposals have been captured so that they can be passed to MHCLG for their consideration and possible action at a later stage.

View/comment	Project team response
Approach should include experimental assessment of surface spread of flame and heat release	Surface spread of flame and heat release will form part of the experimental assessment.
Burning droplets and solid debris	Observation of burning droplets and falling debris will form part of the experimental assessment.
Performance of cavity barriers	Outside the scope of this project
Assessment of thermal properties (thermal conductivity, specific heat capacity and density)	Outside the scope of this project. Where possible, manufacturer's data will be collected and collated for the materials to be experimentally assessed.
Assessment of mechanical properties (coefficient of thermal expansion, elastic and shear moduli, yield and ultimate strengths)	Outside the scope of this project. Where possible, manufacturer's data will be collected and collated for the materials to be experimentally assessed.
Mechanical failure (delamination, adhesive degeneration, connection performance degeneration)	Mechanical failure will form part of the experimental assessment.
Change of phase properties (liquification, pyrolysis)	Change of phase (melting, evolution of gases, and formation of burning droplets) will form part of the experimental assessment.
Ignition properties (auto ignition temperature, piloted ignition)	Ignition will form part of the experimental assessment.
Burning properties, rate of heat release	Heat release rate will form part of the experimental assessment.
Rate of fire spread as a function of applied heat flux	Rate of fire spread will be recorded, subject to initial incident heat flux from fuel source. Rate of fire spread will form part of the experimental assessment.
Toxic gas generation	This is outside the scope of this project at this stage.
Open state cavity barriers	This is outside the scope of this project at this stage.
Drawbacks with small-scale testing. Concern that results will not be useful. Further consideration to be given to design of the experimental base.	The intention of this phase of the project is to identify materials/products currently being used as elements within a cladding system which may give cause for concern in relation to fire performance of a cladding system. It is not intended to be the single source of data or information upon which to base a life safety assessment of a cladding system.

View/comment	Project team response
Confusion over terminology. Testing should reflect worst case scenario.	The intention is that this experimental study will develop a representative worst case thermal exposure to the material/product being assessed i.e. post flashover compartment fire.
Consideration of need for large-scale testing	Proposed experimental programme will identify materials/products which should be considered further including for large-scale testing.
Effect of environmental factors (wind and aging) to be taken into account	Testing is routinely carried out in a laboratory to ensure that the results are repeatable (within the laboratory) and reproducible (between different laboratories). The influence of external environmental factors tend to be random and uncontrollable and so cannot be used to carry out systematic routine evaluations. Once a methodology is established, then it is possible to carry out further investigations into the impact of applied wind loads and ambient temperature variations if required. The impact of aging on different materials would need to be considered as part of a durability assessment and would require the application and/or development of an agreed standardised methodology. These factors are currently outside the scope of this project.
Tests to be realistic	Every effort will be made to ensure experiments reflect thermal exposure representative of a post flashover compartment fire within the constraints of the project.
Source materials/products without manufacturer's knowledge	Sourcing of materials/products to be discussed with MHCLG.
Concerns regarding objectives	The objective is to explore the elemental performance of single materials/products at a medium scale.
Issues over balconies and projections, vulnerability of corners and edges inclusion of uPVC window opening	This is outside the scope of this project at this stage.
Agreement required over representative temperatures	Performance/assessment criteria (temperatures and heat flux) to be representative of post flashover compartment fires and agreed with MHCLG.
Test upper and lower bound thickness	Where required, a range of thicknesses will be assessed.

View/comment	Project team response
Test should incorporate a ventilated cavity	Experiments will incorporate an air gap behind the exposed panel to allow flame spread on both the exposed and unexposed surfaces
Samples should be tested with and without gaps	Standard joints will be incorporated within the experimental assembly depending on the actual dimensions of the materials/products to be experimentally assessed.
Performance of compression cavity barrier/fire stops that are compromised by penetrations	This is outside the scope of this project at this stage.
Vulnerability of ventilated metal rainscreens on aluminium railing systems	This is outside the scope of this project at this stage.
Relevance of product testing in isolation	The intention of this phase of the project is to identify materials/products currently being used as elements within a cladding system which may give cause for concern in relation to fire performance of a cladding system. It is not intended to be the single source of data or information upon which to base a life safety assessment of a cladding system.
Ensure heat source used to evaluate performance is deemed credible	Heat source will relate to the expected level of heat flux from a post flashover compartment fire.
Scale of the sample panels in proportion to the heat source is adequate to enable the progression of the fire to be clearly measured	The scale will be sufficient to allow for characterisation of fire spread.
Enable testing to destruction where required	Experimental work will take place in the BRE Burn Hall laboratory where safety of the building will not adversely impact the experimental procedure i.e. the experiments will be allowed to progress to enable the collection of as much useful data as possible.
Use existing classification as means of selection	Published reaction to fire classifications will be collected and collated as part of the project.

Table 1 – Views/comments received and Project team response

2.3 Proposed experimental methodology

An experimental methodology has been proposed in consultation with MHCLG and based on responses received from the Project Steering Group.

The proposed approach is based on the following principles:

- The proposed methodology should be able to evaluate the fire performance of the selected materials/products to establish if they are likely to give cause for concern if used in a cladding system.
- The proposed methodology will focus on individual materials/product behaviour rather than system performance.
- The proposed methodology has been designed specifically to consider the potential contribution of external cladding panels in isolation from other system components.
- The performance, and therefore the level of risk, will be assessed in relation to the fire performance characteristics of materials/products known to constitute an unacceptable risk of fire spread via the external cladding panels[1].
- The assessment will be based on the contribution of the specific materials/products to flame spread, heat release and incident heat flux as well as the maintenance of stability and integrity.
- The imposed heat flux to the surface of the materials/products will be representative of that expected from a fully developed post-flashover compartment fire scenario.
- The proposed methodology will be characterised using a non-combustible substrate to ensure a repeatable thermal impact.
- The samples will be supported on a steel frame to allow for rapid assembly/disassembly to minimise the time required for installation and maximise the number of experiments to be conducted.

Figure 1 shows the proposed steel frame assembly with the base frame and supporting framework of mild steel angles used to fix the samples in position. The precise method of fixing will depend on the characteristics of the specific materials/products to be assessed. In general, the panels will be fixed back to the mild steel angles based on the fixing information supplied by manufacturers.

Prior to undertaking any experimental studies of the materials/products, a series of calibration/characterisation burns will be undertaken using a non combustible calcium silicate board to ensure a consistent behaviour from the fire source in relation to specific locations remote from it and at additional locations offset from the centre line. During the calibration/characterisation process, the heat flux at various heights above the centre line of the fire source will be measured. The temperature on the face of the board will be measured at a number of locations. The heat release rate and flame heights from the fire source will be measured.

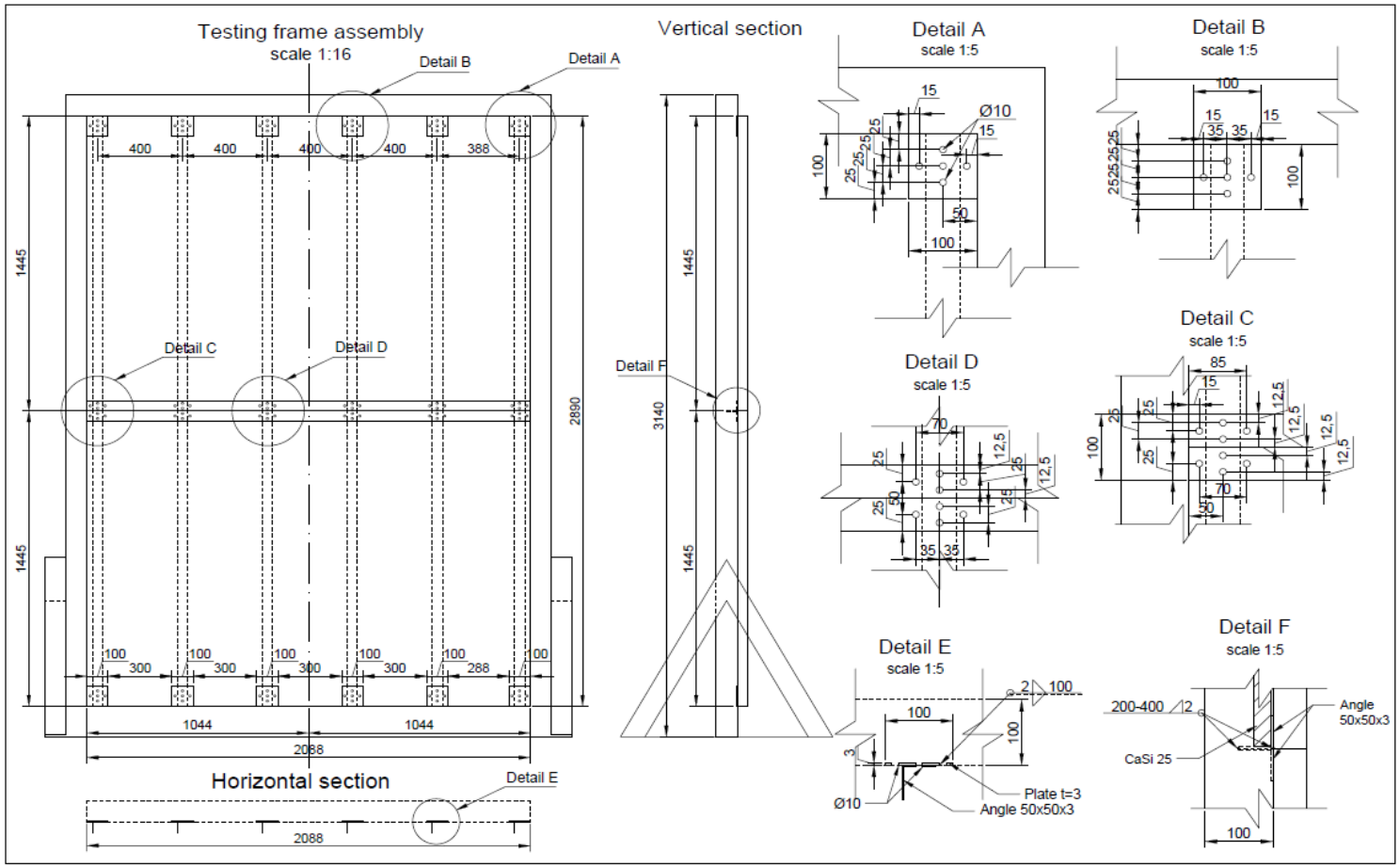

Figure 1 - Proposed experimental frame assembly

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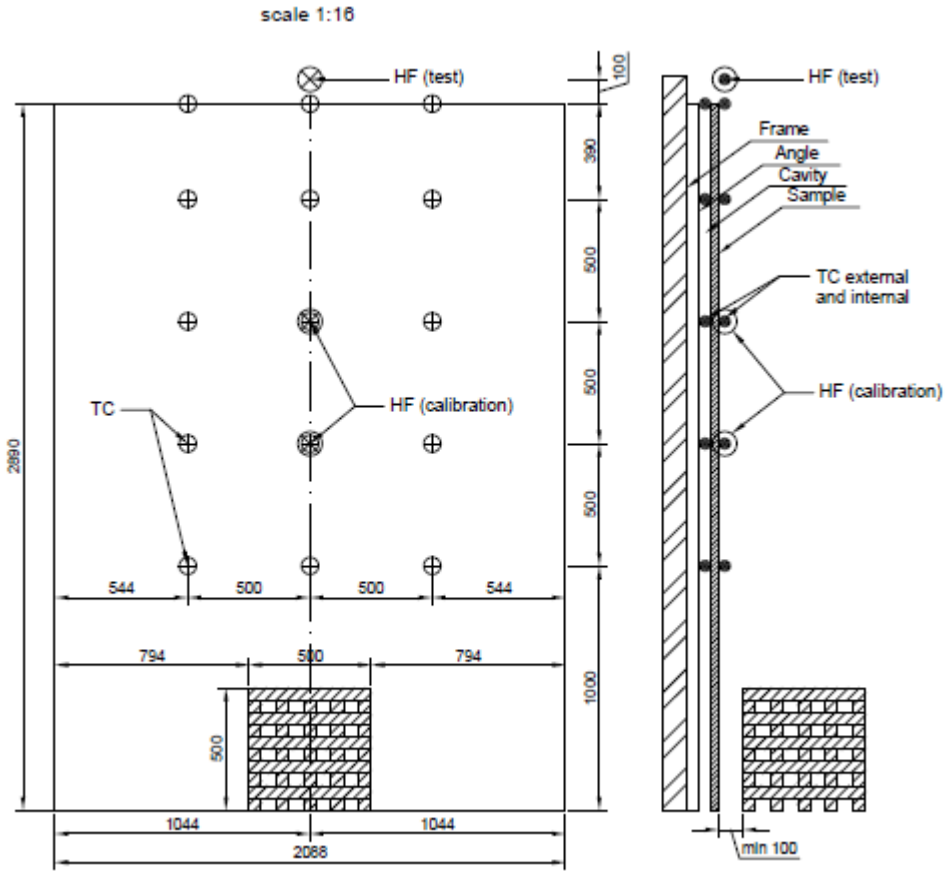
Figure 2 shows the proposed experimental set up in terms of sample size, instrumentation required (both for calibration and the experimental programme).



Key

HF = heat flux

TC = thermocouple

Figure 2 - Proposed instrumentation for experiments and calibration/characterisation

Based on a consideration of the calibration/characterisation requirements for alternative heat sources set out in Annex B of BS 8414[1, 2], the incident heat flux 1.5m above the ground level (1m above the top of the crib) should be in the range 45 – 75 kW/m².

Some initial indicative modelling has been undertaken using the FDS (Fire Dynamics Simulator) CFD (Computational Fluid Dynamics) computer model[2, 3, 4] , based on an initial crib size of 50 sticks of nominal dimensions of 50mm x 50mm x 500mm with a substrate of calcium silicate board. Initial indications suggest that a fire source with a heat output of between 400kW and 500kW will result in an incident heat flux at a position of 1m above the crib on the centre line of the crib in line with the required range.

Further modelling work will be conducted and the final choice of the fire load will be based on the initial calibration/characterisation of the system results using a propane burner and additional heat flux meters.

2.4 Performance criteria

The performance of each of the materials/products to be assessed will be measured in accordance with the following criteria shown in Table 2.

Performance criterion	Means of measurement
Heat flux	Measured value (in kW/m²) on centre line of crib 3m from ground level
Maximum temperature	Measured value (in °C) on centre line of crib 3m from ground level
Heat Release Rate (and peak Heat Release)	Measured value (in kW) from calorimetry
Surface spread of flame (vertical and horizontal)	Visual observation and measured temperature
Burning droplets and falling debris	Visual observation
Delamination	Visual observation
Burn through (loss of integrity)	Visual observation
Cavity temperature	Measured value (in °C) on centre line of sample

Table 2 – Performance criteria and means of measurement

3 Future work

The next stage of the project will be to agree with MHCLG the experimental methodology and measurement criteria for phase 2 of the Project.

4 Acknowledgements

The authors would like to thank other members of the Project team including the University of Edinburgh and Lund University and also the Project Steering Group members who provided input to the methodology for the proposed experimental work.

5 References

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Report Ends