



APPROPRIATE FIRE TESTING & STRUCTURAL FIRE
DESIGN COMPETENCY FOR MODERN METHODS OF
CONSTRUCTION

PRESENTED BY

DECLAN WALLACE

EVOLUTION INNOVATION CEO



Modular



Modular



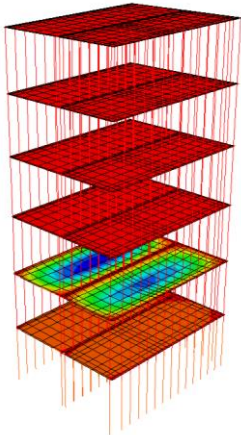
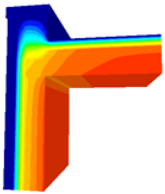
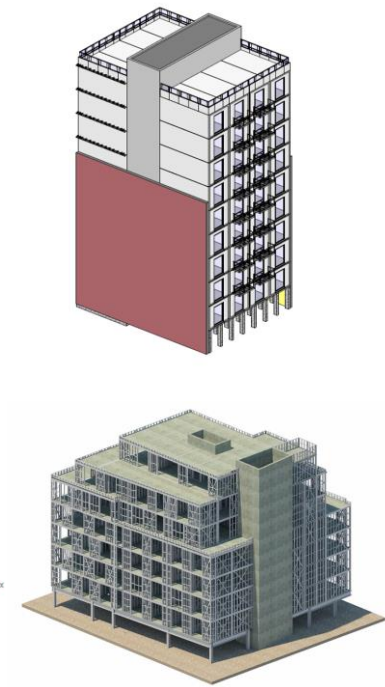
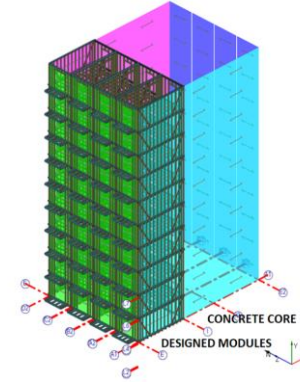
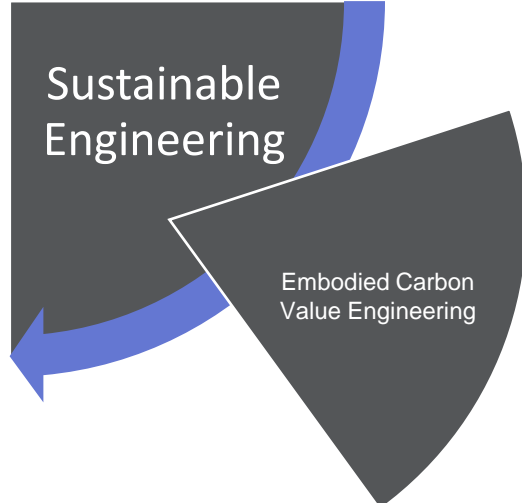
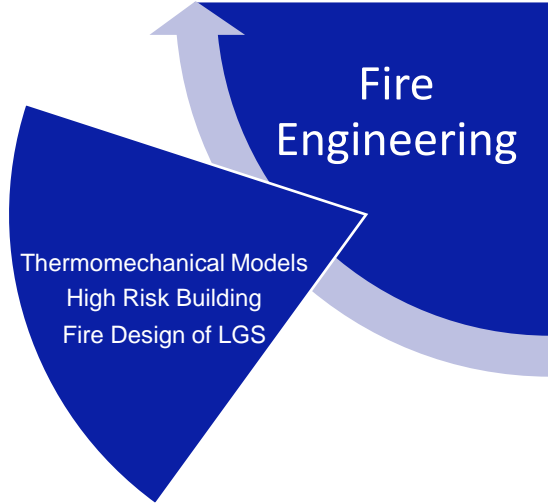
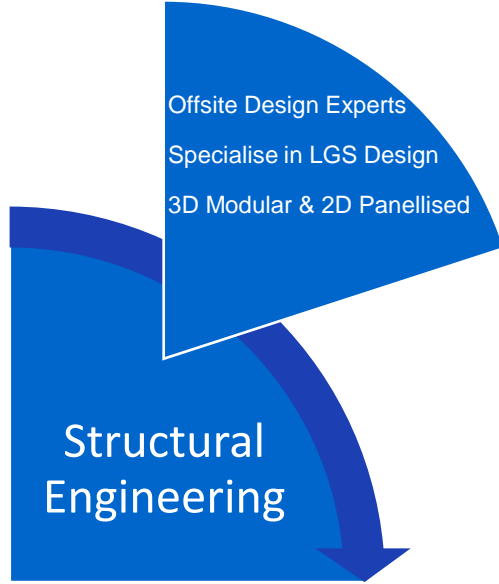
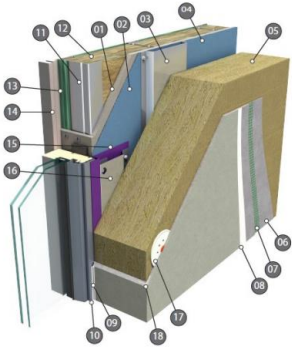
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We are world experts in Modular and Panellised Offsite Construction



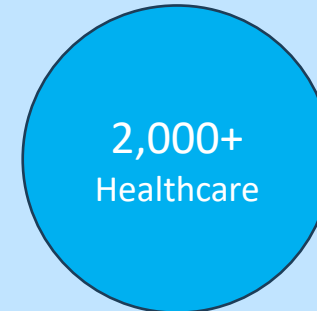
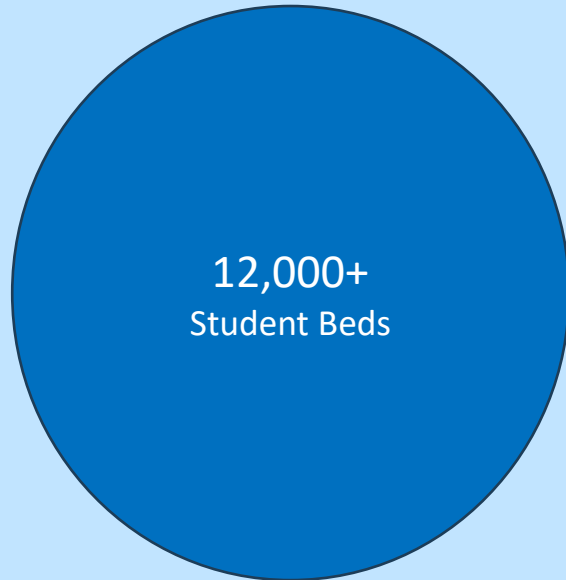
Panellised

EVOLUTION SERVICES



EVOLUTION'S MMC TRACK RECORD IN IRELAND AND UK

PROVIDING OUR SERVICES TO A VARIETY OF SECTORS

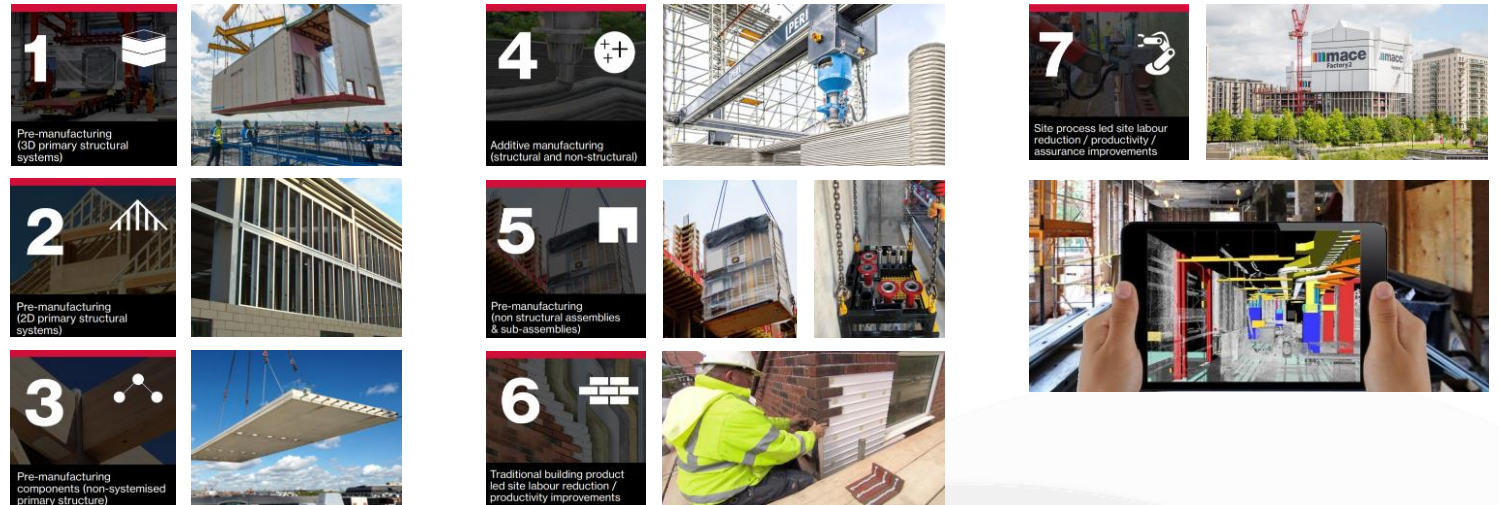


Central to the Development and Certification of more than 20 Building Systems and Construction Products



MMC and MMC CATEGORIES

- MMC now central to future housing targets
- Critical due to current skilled labour shortages
- MMC is a part of the future of the building industry, here to stay
- MMC must be designed competently and safely from a fire perspective
- MMC categorised as per the adjacent illustration

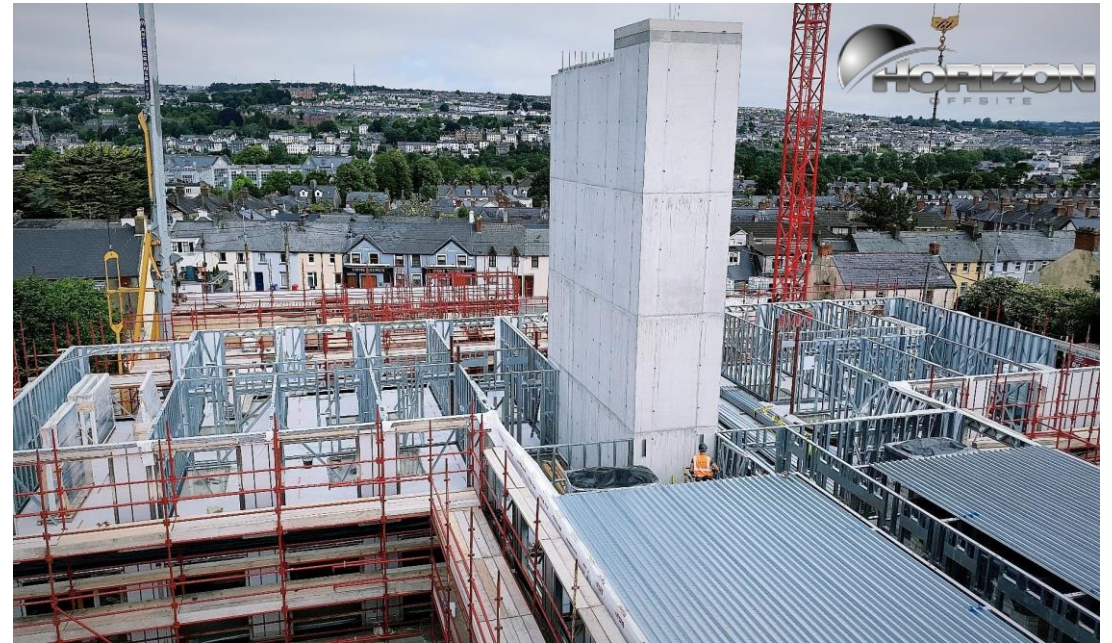


MODERN METHODS OF CONSTRUCTION DEFINITIONS

CATEGORY 1

PRE-MANUFACTURING 3D PRIMARY STRUCTURAL SYSTEMS

1

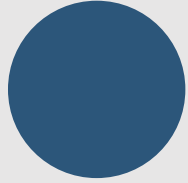


2

CATEGORY 2

PRE-MANUFACTURING 2D STRUCTURAL SYSTEMS

COMPLIANCE – WHY AND HOW?

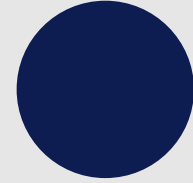


DRIVERS OF COMPLIANCE

Building Regulations
Building Control legislation
Standards and Codes of Practice
Grenfell and the Hackitt Review

Building a Safer Future

Independent Review of Building
Regulations and Fire Safety:
Final Report

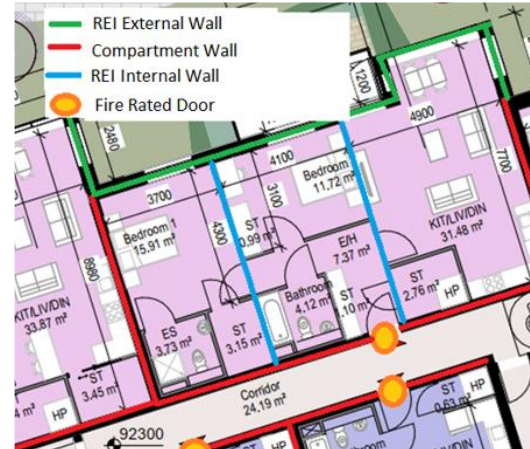


DEMONSTRATING COMPLIANCE

Offsite systems and the
importance of appropriate
System Specific testing.
Has the offsite product got the
system specific testing?

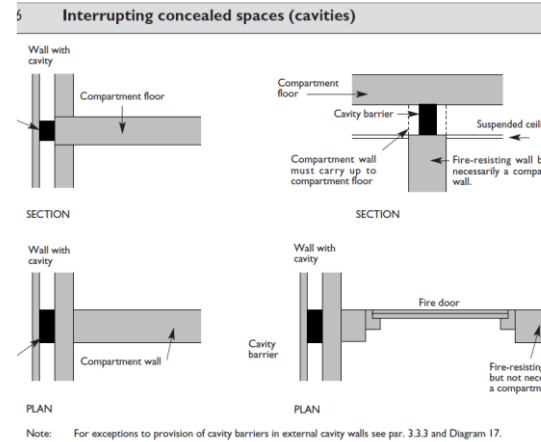
Three very important, industry-critical issues regarding MMC compliance recently raised.

CROSS 1 Exposure to fire on 2 sides of wall



Internal loadbearing LGS walls could be exposed to fire on both sides simultaneously and should therefore provide the required loadbearing fire resistance for such exposure

CROSS 2 Cavities in Modular



For volumetric modular construction, in the form of permanent stacked modular buildings - concerned that the existence of extensive cavities within the compartments, combined with the lack of appropriate care when connecting the modules could lead to the concealed spread of fire and smoke, noting some recent fire events.

NFCC MMC Policy Position Statement



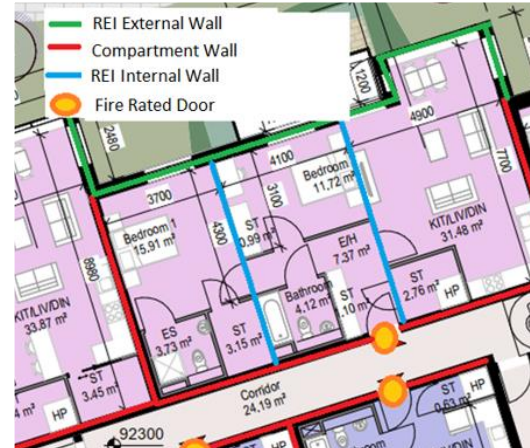
Concerns expressed in statement re

- 3D Modular (Volumetric) construction - Category 1 of the MMC Definitions Framework (3D primary structural systems); and
- the use of engineered mass timber products e.g., Cross-Laminated Timber (CLT); Glue-Laminated Timber (Glulam).

Evolution have been key players in addressing these concerns.

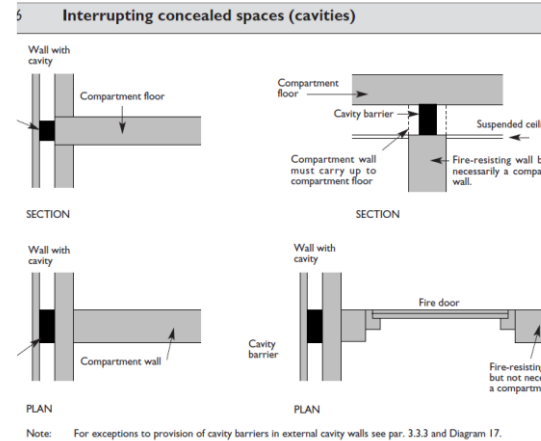
Going to look at CROSS 1 in detail today.

CROSS 1 Exposure to fire on 2 sides of wall



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NATIONAL FIRE CHIEFS COUNCIL

MMC POLICY POSITION STATEMENT

- Particular concerns around the use of 3D modular MMC:
 - In High Rise Buildings
 - Buildings housing vulnerable people
 - Buildings with a “stay-put” or an evacuation with a designed delay
- NFCC also state that significant cultural change in the system must take place to improve competency across the sector, including MMC.



NFCC
National Fire
Chiefs Council

The professional voice of the UK Fire & Rescue Service

Modern Methods of Construction Policy Position Statement

The National Fire Chiefs Council (NFCC) support the Government's ambition to build homes quickly and sustainably, reducing the environmental impact wherever possible, and recognise the role that Modern Methods of Construction (MMC) can play in achieving this. However, meeting housing supply should not be prioritised at the expense of safety, and we have concerns that there remains a lack of understanding about the performance of MMC which presents significant uncertainty in the built environment.

The UK construction sector is a strategically significant part of the UK economy. The sector has been struggling to meet growing residential demand, with supply and demand imbalances contributing to unaffordability, tenure shortages and homelessness. NFCC understands that the Department for Levelling Up, Housing and Communities (DLUHC) is very supportive of MMC and see MMC as central to the delivery of ambitious housing targets and the Affordable Homes Programme.

Government has also started to introduce housing and construction policies that address or relate to sustainability targets. A focus on sustainable building approaches has shown an increased interest in MMC and in the use of materials such as timber as well as the incorporation of features such as living walls and roofs. There should not be a conflict between sustainability, improved building standards and fire safety.

Whilst we hold concerns and support proper scrutiny of all building and construction that use MMC, we hold particular concern around the following methods, particularly when in use for high-rise buildings, buildings that are housing vulnerable people, and buildings with a 'stay put' or an evacuation with designed delay:

- 3D Modular (Volumetric) construction - Category 1 of the MMC Definitions Framework (3D primary structural systems); and
- the use of engineered mass timber products e.g., Cross-Laminated Timber (CLT); Glue-Laminate Timber (Glulam).

Whilst we welcome the current reform of building safety, significant cultural change in the system must take place to improve competency levels across the sector and ensure that MMC is promoted and used in a manner which provides safe buildings for all.

Recommendations

- Government should provide clarity on the applicability or otherwise of Approved Document B to MMC considering factors such as construction type, use, height, size, and complexity of the building.
- Government should incorporate and address MMC within secondary legislation and supporting documents.

NATIONAL FIRE CHIEFS COUNCIL

MMC POLICY POSITION STATEMENT

- Recommendations include that Gov. should do the following:
- Provide clarity on the applicability or otherwise of Approved Document B to MMC considering factors such as construction type, use, height, size, and complexity of the building.
- Incorporate and address MMC within secondary legislation and supporting documents.
- Ensure that structural and fire engineers are included on its MMC taskforce and that the remit of the group is widened to focus on safety and promoting better understanding of the performance of MMC.
- Ensure that MMC builds are underpinned by research and whole system testing, by developing a large-scale testing protocol.
- Ensure that research is independent and supported by large scale test data.
- Define the competency requirements for practitioners who work on MMC buildings, including industry and regulators.
- Elevate the status of the Building regulations and fire safety procedural guidance to an Approved Document and ensure via this process, information is provided to FRSs on construction methodology they need to know to intervene in a fire event effectively and safely.
- **“Working together to improve standards”**



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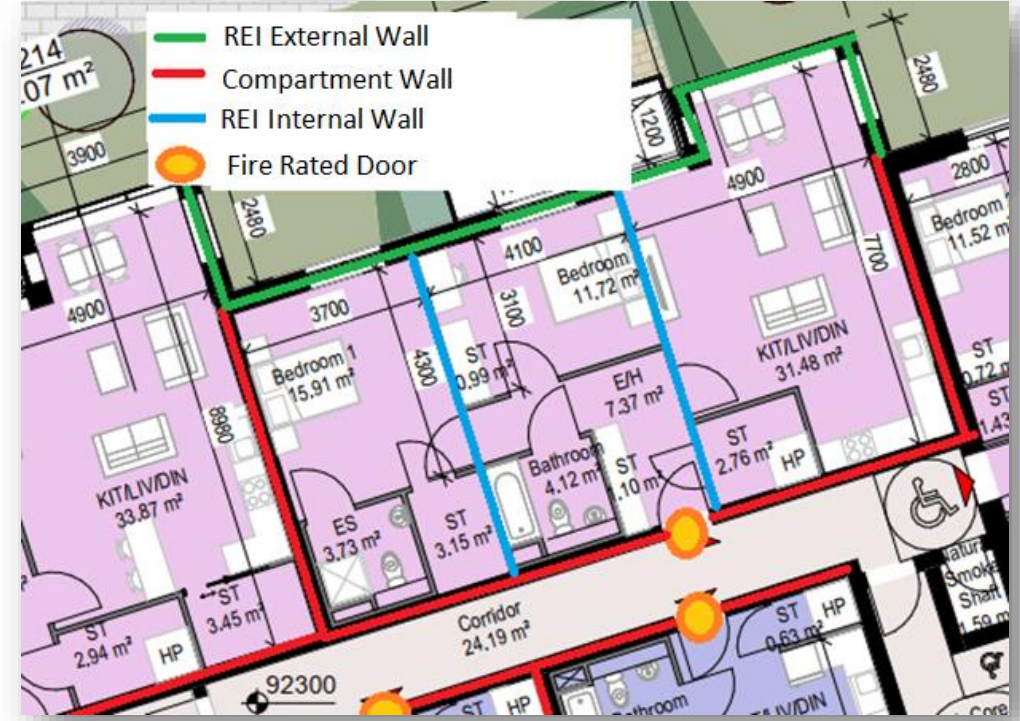
REPORT PUBLISHED RAISING CONCERNS

- In June 2022, a report was published by Cross (collaborative reporting for safer structures), an influential industry body in the UK
- The following is an excerpt from the report:

Internal loadbearing walls could be exposed to fire on both sides simultaneously and should therefore provide the required loadbearing fire resistance for such exposure

- The suggestion was that this condition may lead to premature structural failure

This issue has been directed at steel frame walls even though it affects all constructions



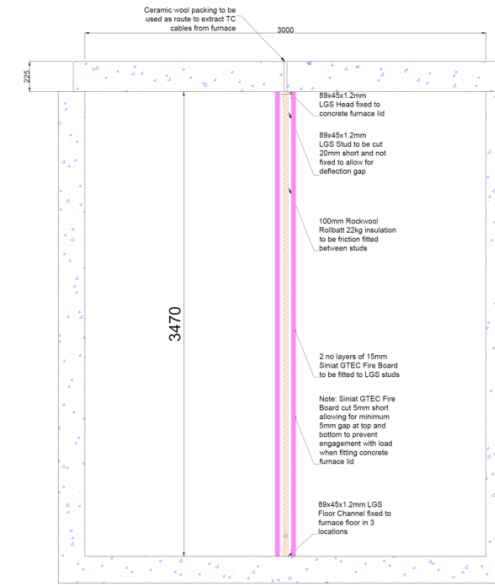
Implications

- / The report suggested an issue with structural failure of internal load-bearing walls.
- / The implications of the Cross report were very serious.
- / Fire authorities began to refuse to issue Fire Safety Certificates for buildings.
- / This led to developers/contractors/building professionals excluding LGS as a solution for mid-rise buildings.
- / If not resolved, the impact on the LGS industry would be disastrous, sales would plummet.
- / It was imperative that a solution be found quickly.



Challenges

- / We were asked to prove wall stability with fire from both sides.
- / However, no standard for fire testing a wall from both sides exist.
- / Obviously, demonstrating compliance when exposed to fire from both sides simultaneously is a much more onerous task than when exposed to fire from one side only.
- / Thinking outside the box.
 - / Evolusion went above and beyond by designing a unique test method to cater for this unprecedented challenge.
- / This was only the start - we then had to work with the fire authorities, Regulatory bodies, and other stakeholders.



Section B-B Through Furnace Including Wall Elevation



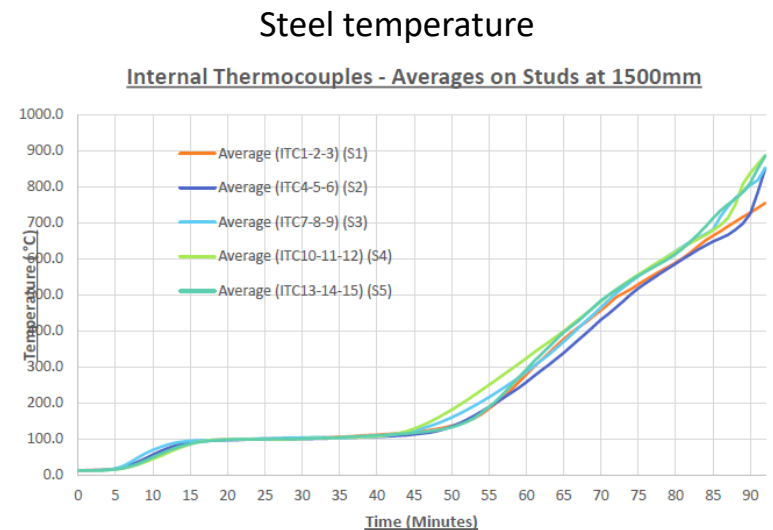
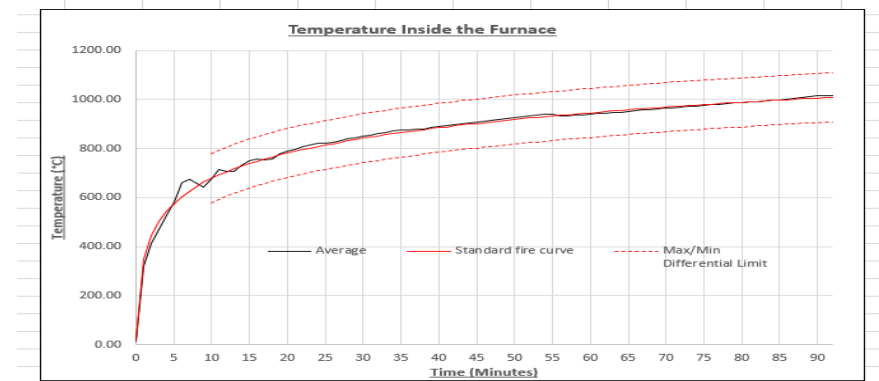
Execution

- / Our product development and structural engineering teams analysed the problem from first principles.
- / Because of the unique nature of the test, no test rigs exist for this type of test.
- / We worked with the test lab in Belfast to design a wall panel that could be built within the existing **FLOOR** test rig without affecting the fire curve.
- / This was a worldwide first.



Findings and Solution

- / The test was successful as we managed to follow the ISO fire curve perfectly.
 - / The standard single-sided detail incorporates 2 x 12.5mm Siniat GTEC fire boards.
 - / By enhancing to 2 x 15mm Siniat GTEC fire boards we were able to keep the steel within the maximum temperature range for more than 60 minutes exposure.
-
- **CROSS 1 Problem Solved**
 - / This demonstrated that we had a simple, low-cost solution which addressed the concerns raised in the Cross report.



Fire Safety Cert Strategies for LGS Buildings

Addressing Cross Report

01

Contain Fire

- No Change to Fire strategy
- Internal load bearing walls exposed to fire from each side separately

Examples of application:

- Co-Living
- Hotels
- Student Accommodations



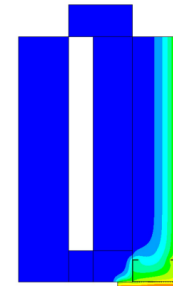
02

Indicative Fire Testing and FE Design for 2 Sided Fire Exposure

- No Change to Fire strategy
- Internal load bearing walls exposed to fire from exposed sides simultaneously

Examples of application:

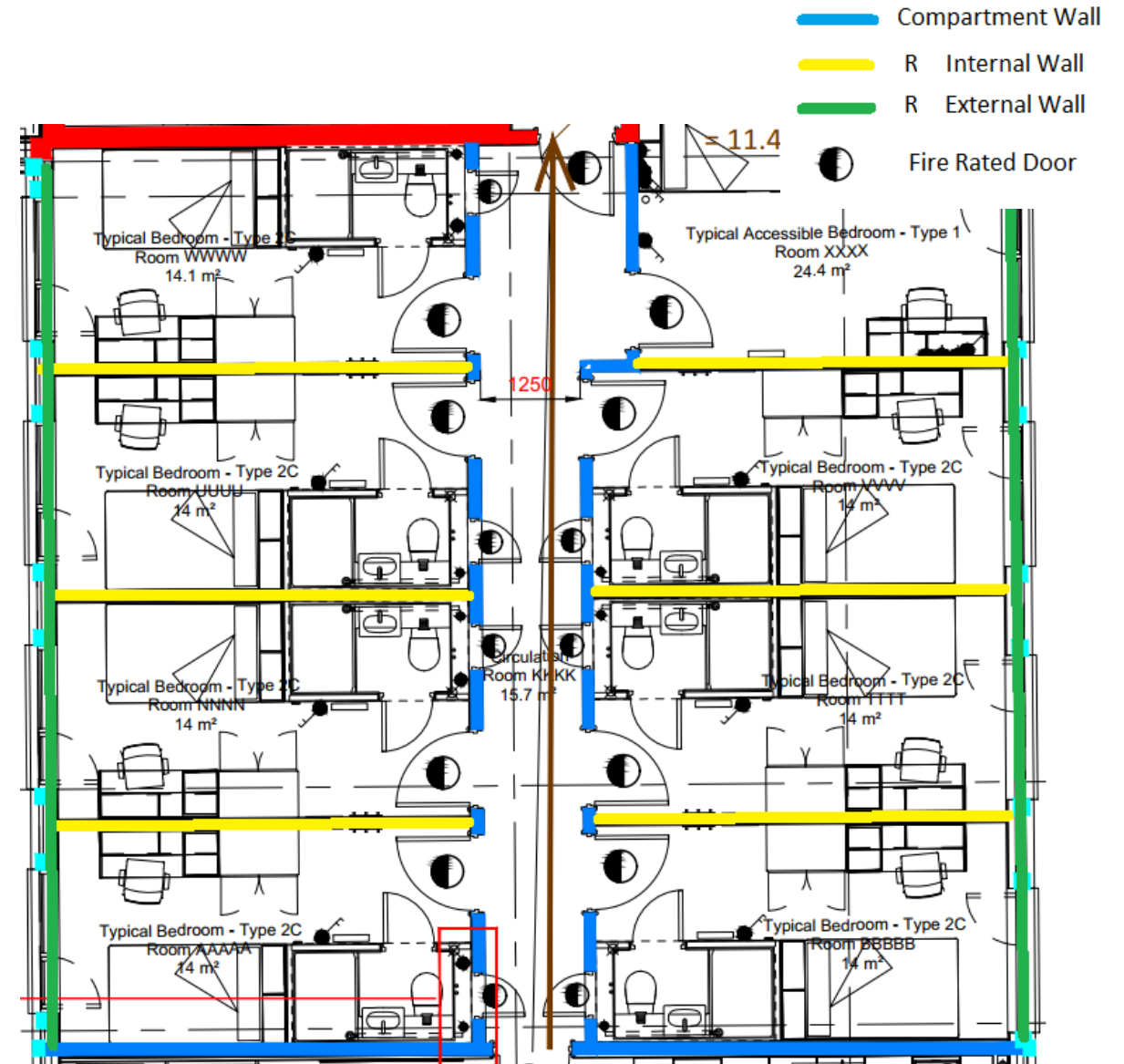
- Apartments
- Other Building types



01 Contain Fire

Contain Fire to Keep Fire Exposure From One Side

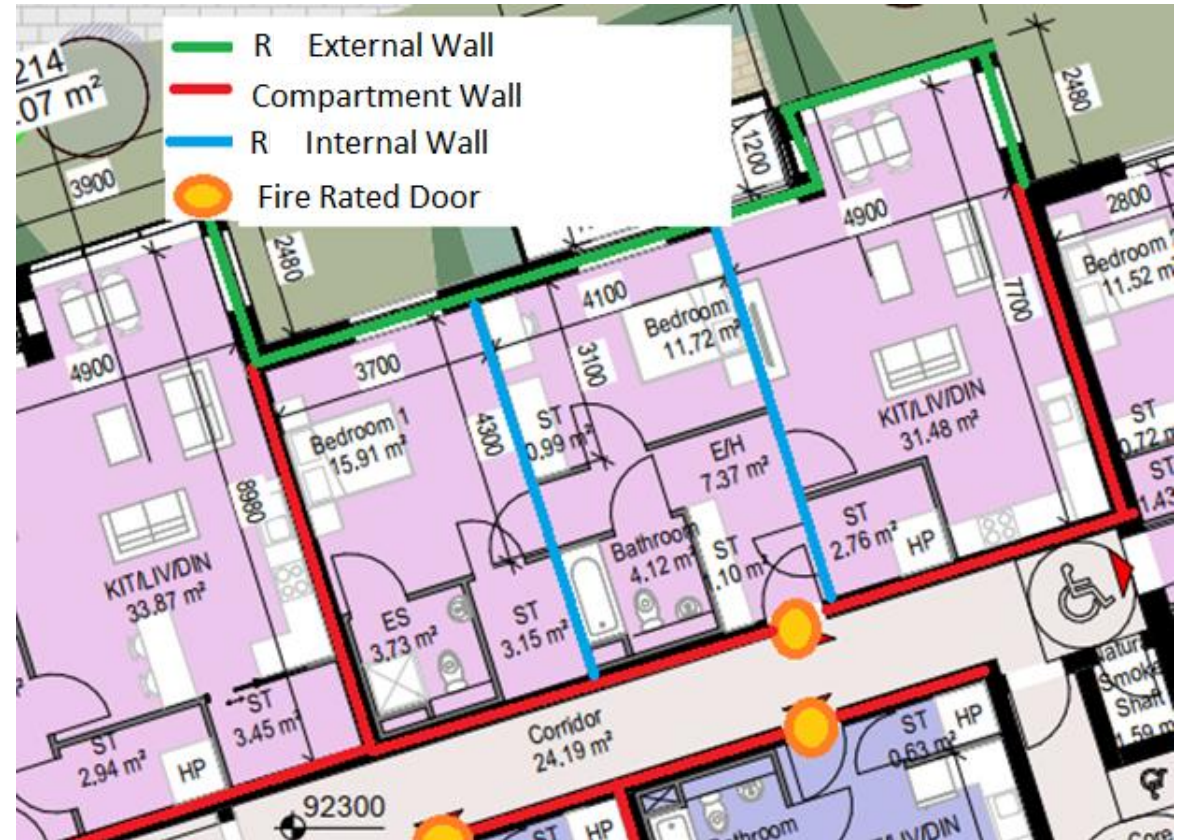
- Prevent simultaneous fire from both sides by using additional “fire resistant” walls and doors including firestopping where required. i.e. Fire on one side is inhibited from occurring on the other side simultaneously.
- The structural engineer and the fire consultant need to coordinate works to identify the fire resistance requirements of the structural elements (walls).



02 Indicative Fire Testing and FE Design for 2-Sided Fire Exposure

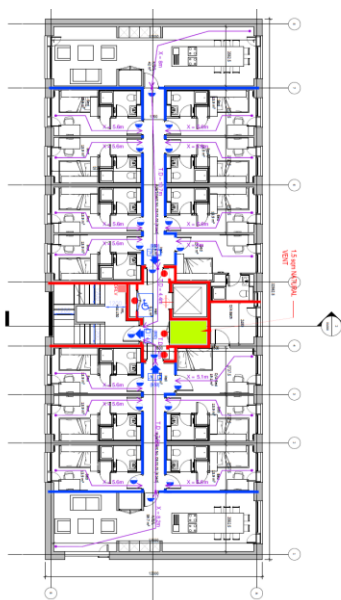
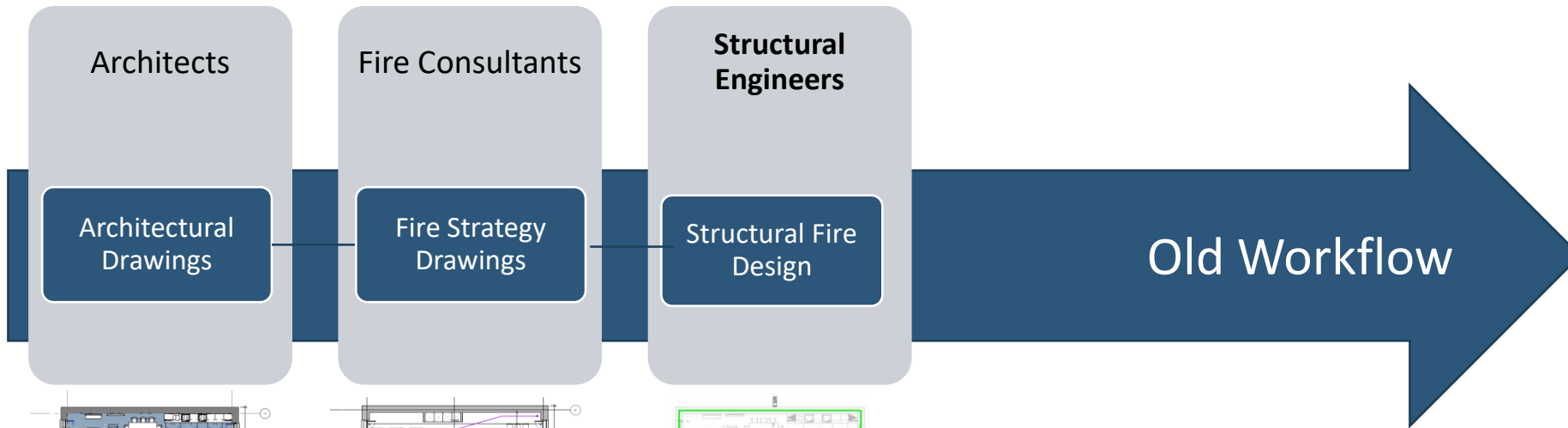
Assess and Design Load Bearing Walls Exposed to Fire From Both Sides

- Where 01 is not feasible Finite Element Analysis linked to available fire testing defines the enhancements required for internal load bearing walls (ex. Additional board, thicker steel gauge, etc.)
- Design based on:
 - Fire test data from the specific system
 - Heat Transfer Models validated against fire test data and assessed by **third party experts**
 - Structural fire design based on the heat transfer model



Old Design Workflow

Fire Consultants and Structural Engineers do not collaborate

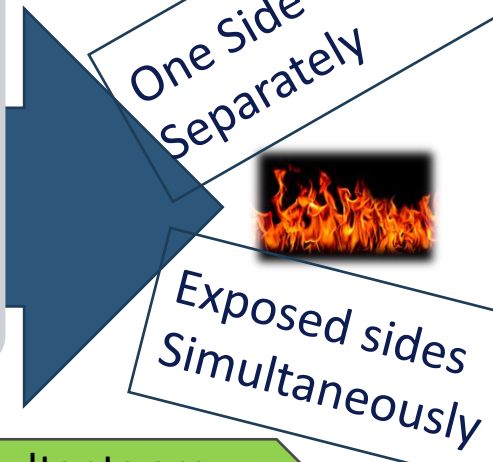
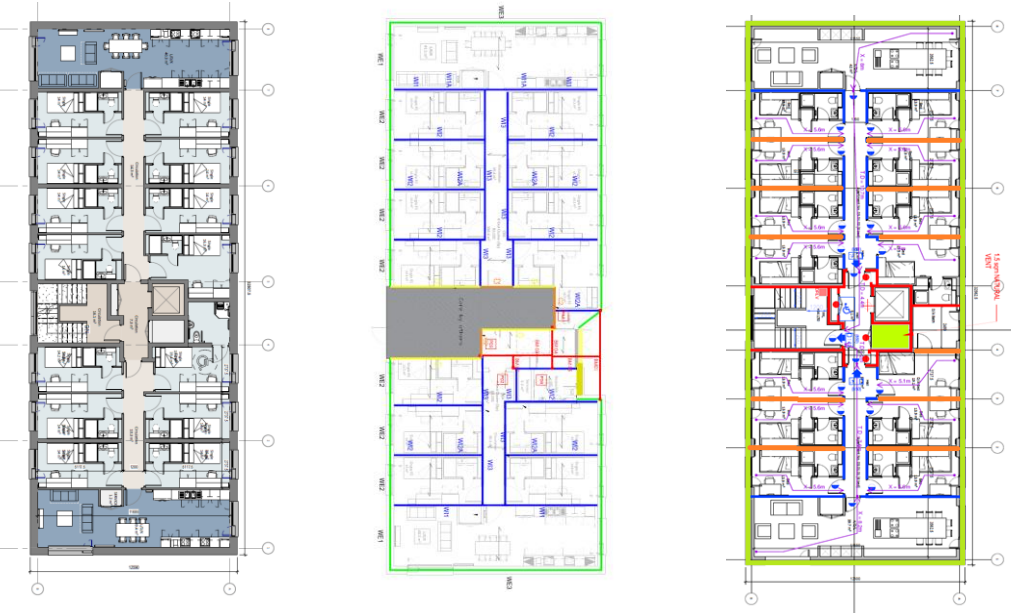
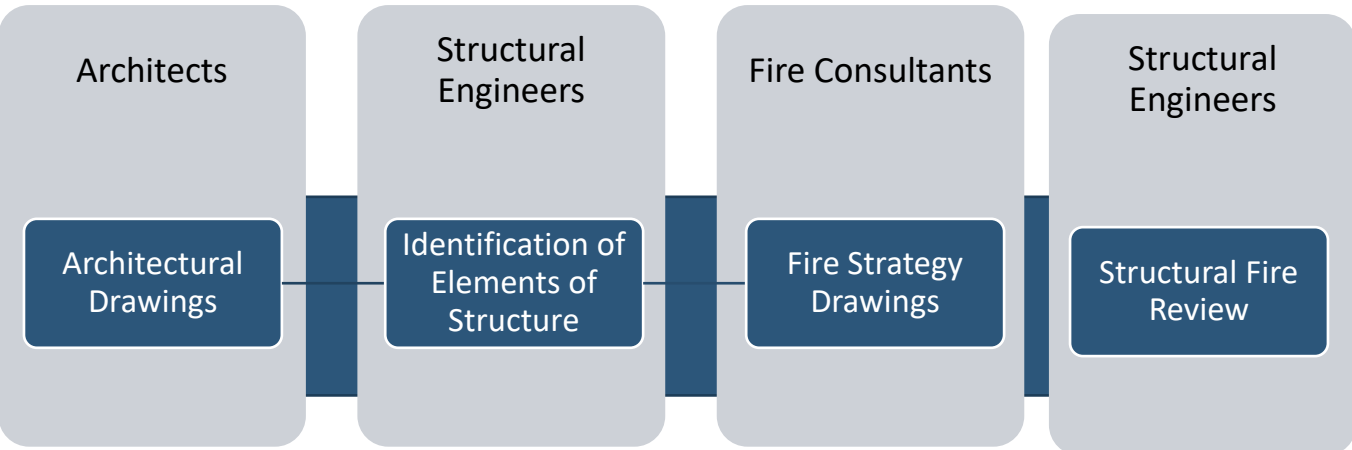


Fire consultants are not provided with structural drawings

Structural engineers are not provided with minimum periods of fire resistance for elements of structure

New Design Workflow

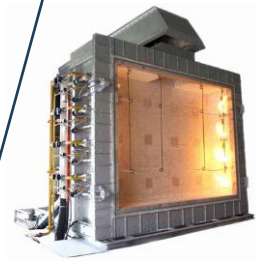
Internal load bearing walls exposed to fire



Structural Engineers

Fire Resistance Verification of Elements of Structure *

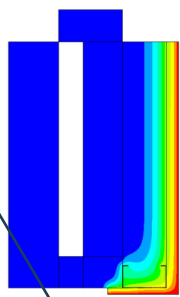
*Based on Fire Tests



Structural Fire Experts

Fire Resistance Assessment of Elements of Structure **

**Based on Heat Transfer Models calibrated with Fire tests and third party verified



Fire consultants are provided with structural drawings

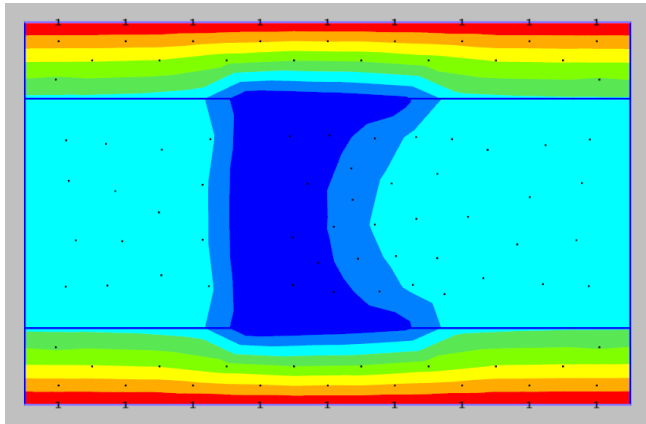
Structural engineers are provided with minimum periods of fire resistance for elements of structure

Heat Transfer Models

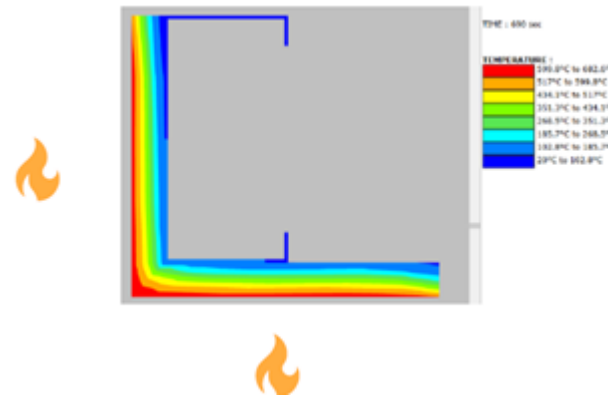
Heat Transfer modelling can only be relied upon when calibrated to determine the board properties from a benchmark fire test.

- Once bespoke properties are calculated this allows various iterations and junctions to be modeled for compliance.

2 Side exposed wall

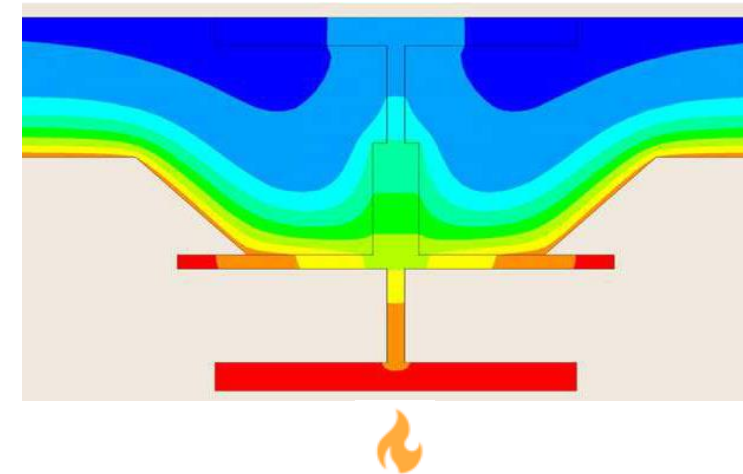


2 Side exposed jamb stud

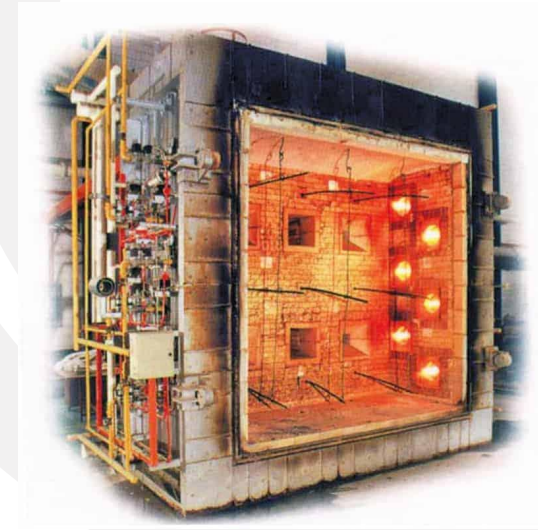


Footer

Partially Embedded Steel Beam



1. Review existing 60min Internal Fire Test data as a benchmark
2. Calibrate Fire Test with fire modelling software (Safir)
3. Then apply Fire both sides
4. Review model and structurally verify adequacy of Stud
5. Sense Check against CROSS Test with 2x15mm boards



Our approach has been peer reviewed by

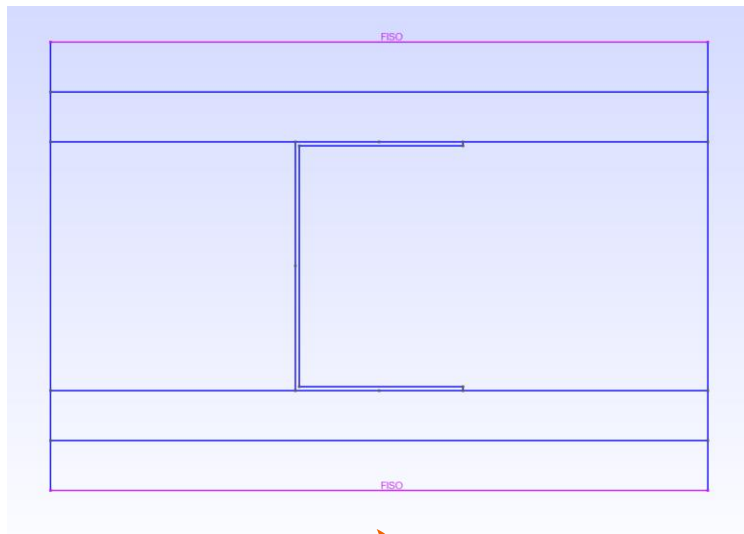
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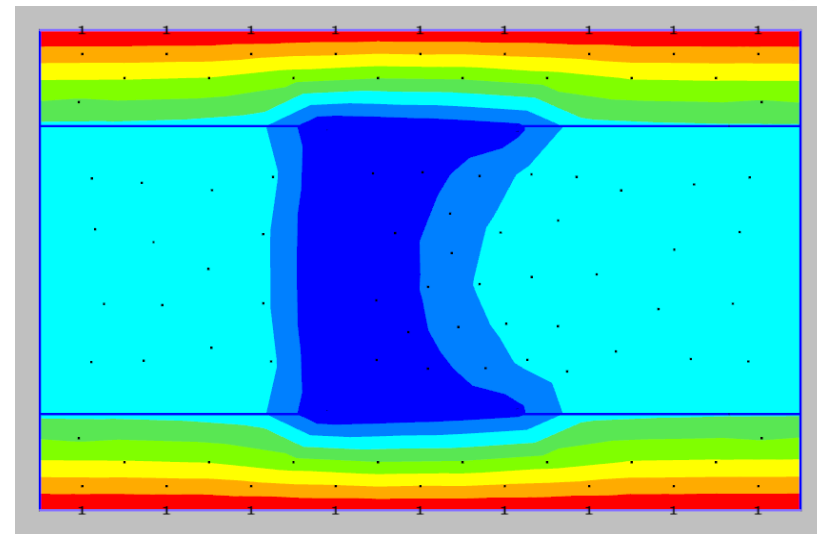
PROJECT SPECIFIC QUERY

- CROSS Report. If a non-compartment Internal load bearing wall is subjected to fire on both sides, will it achieve structural integrity for the desired fire period

Apply ISO fire curve to both sides



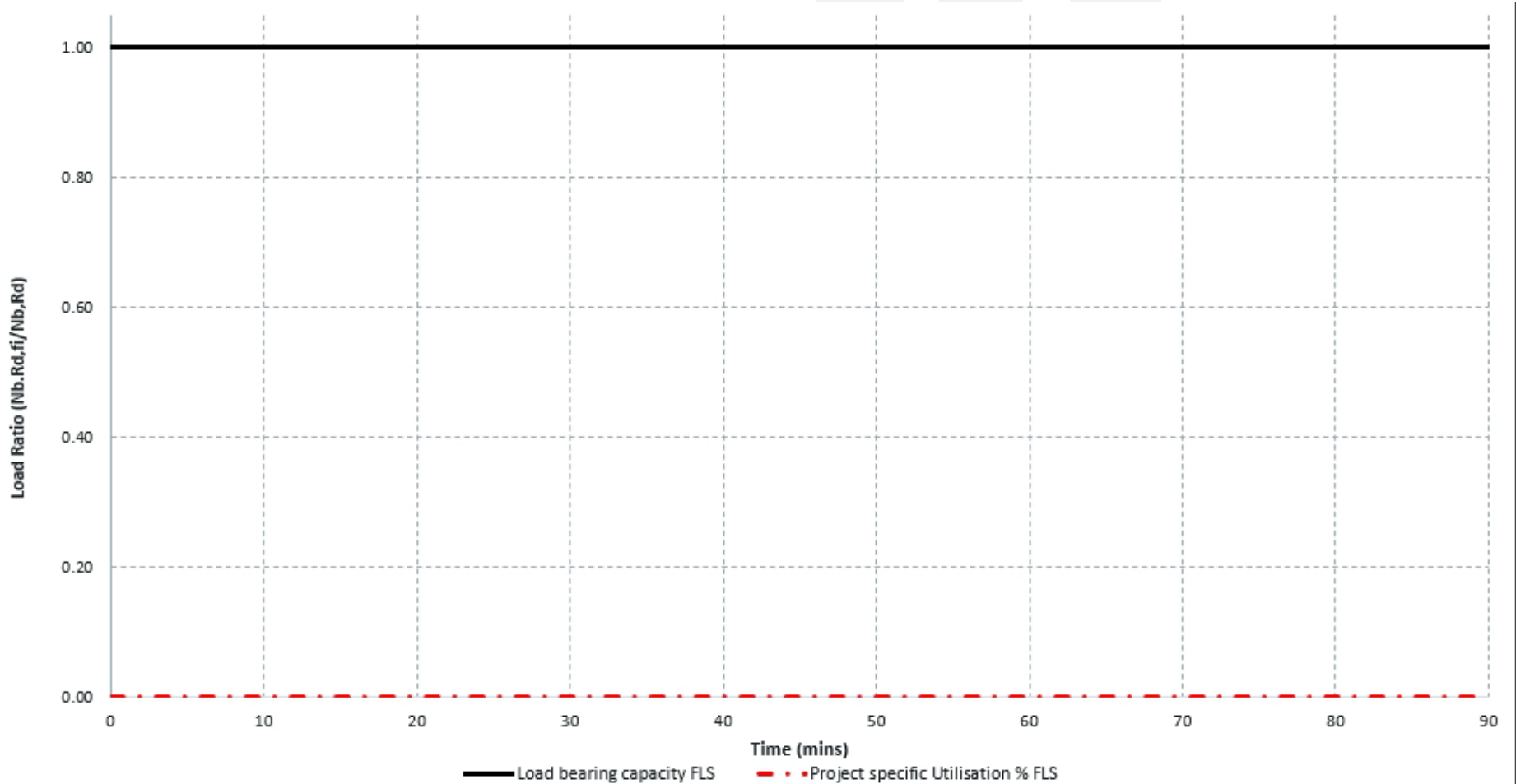
Review time temperature results



STRUCTURALLY VERIFY ADEQUACY OF STUD

Calibrated Safir Results	
Time	Steel Temp
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	

SCI P424 (A.1)



Failure Time = #N/A mins

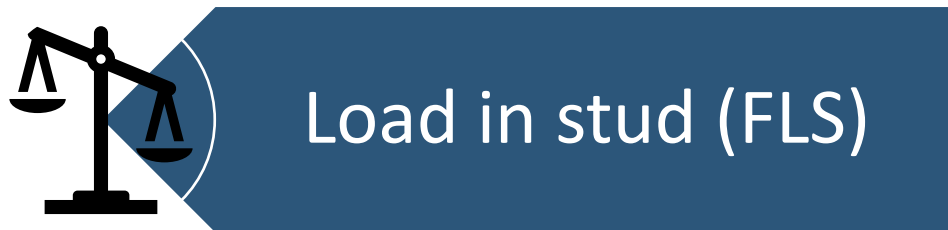


DRIVING FACTORS

- All 3 factors are interlinked and need to be checked holistically



As the temperature increases with time the strength of the steel reduces. Dependent on Board effectiveness and insulation



How hard the stud is working in a fire situation?
 $FLS = 1.0DL + 0.5LL$ (in a test or project specific)



What is the normal capacity of the section in question (height, gauge of steel, noggins, section size etc.)



FIRE RESISTANCE TESTING OF CAT 1 AND CAT 2 STRUCTURES

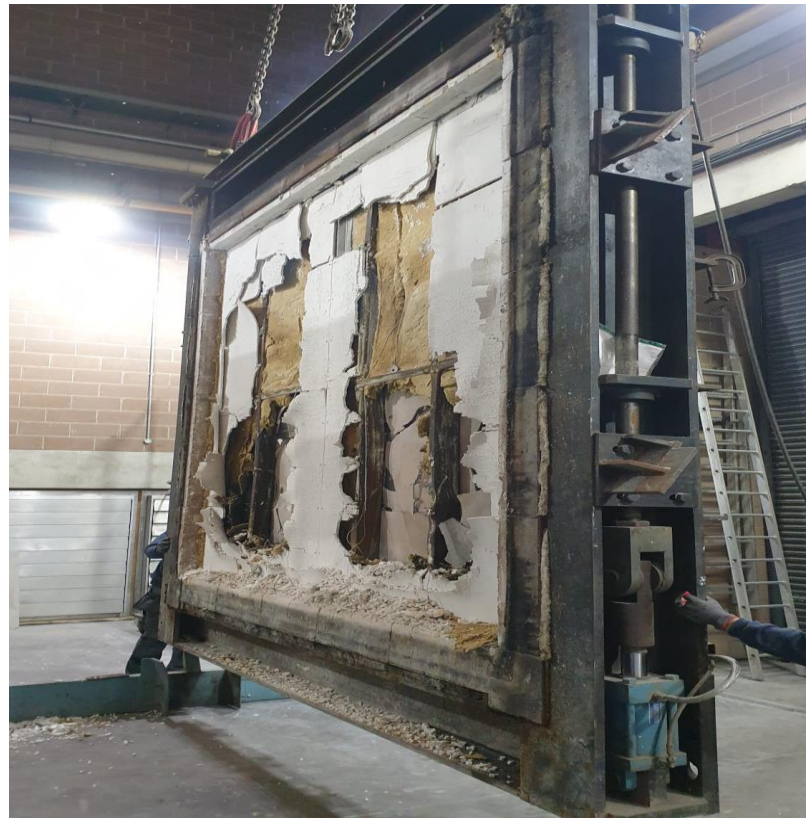


Typically Stages in a Loaded Fire Test Continued

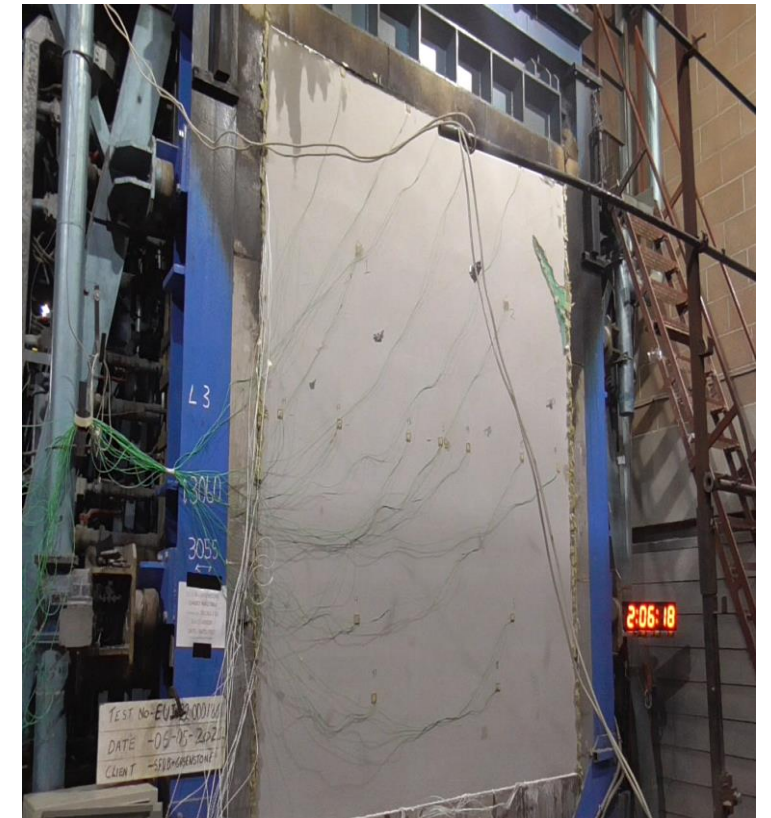
- During Test



- Exposed Face After Test

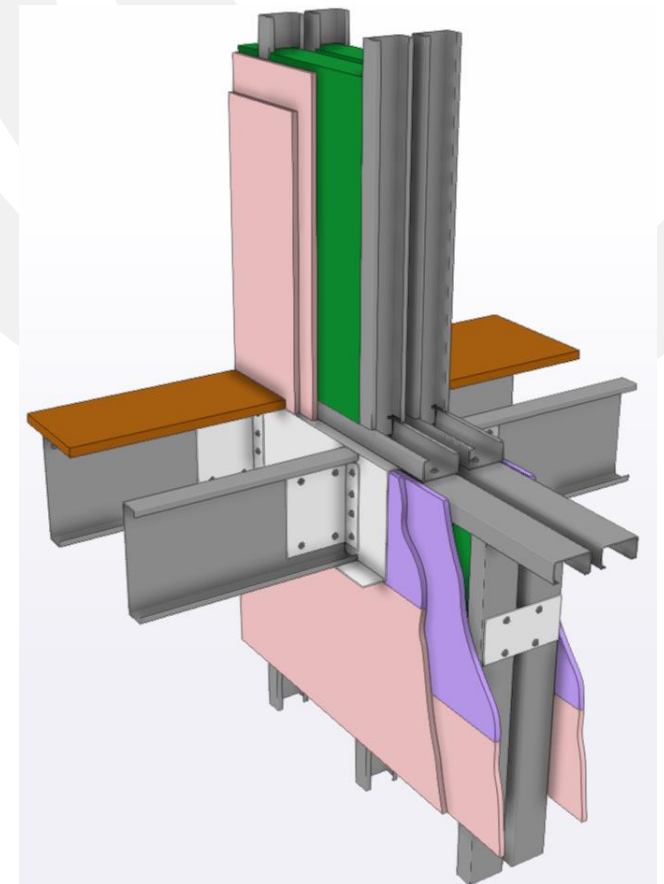
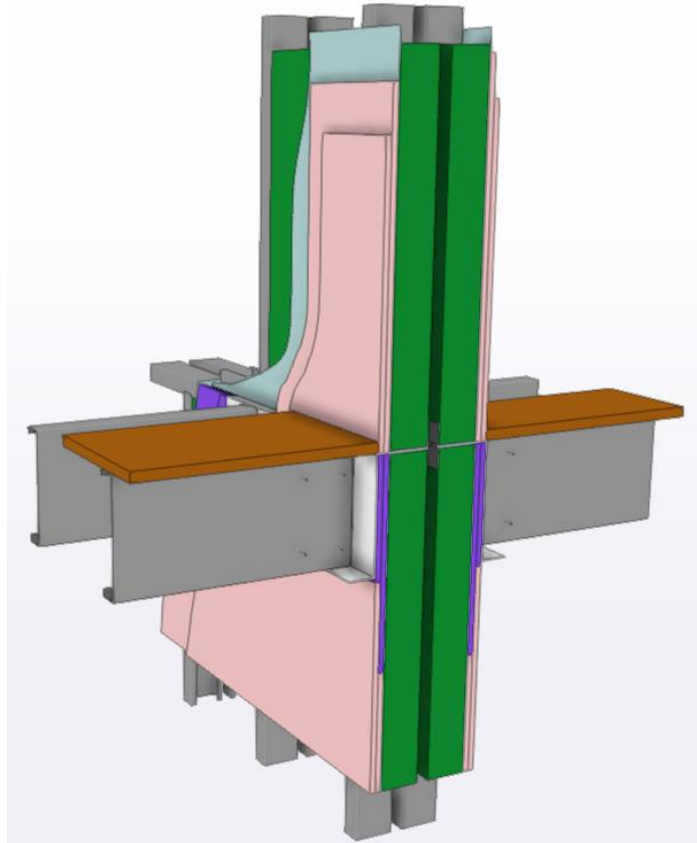


- Unexposed Face After Test



INTERACTIVE TESTING - SEPARATING WALL & FLOOR

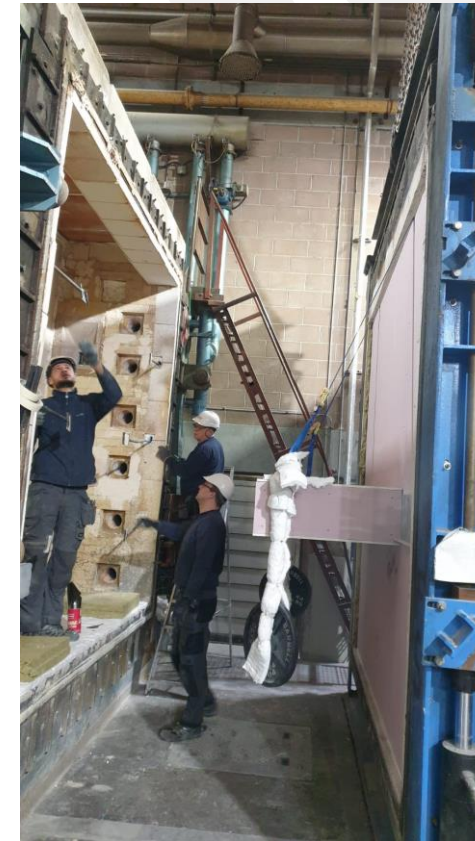
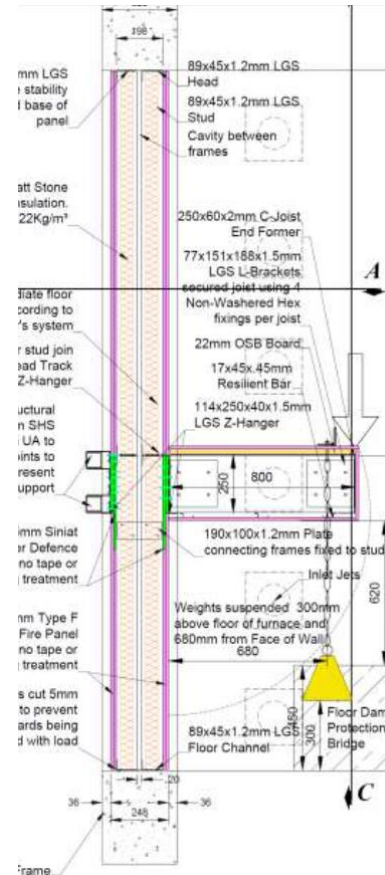
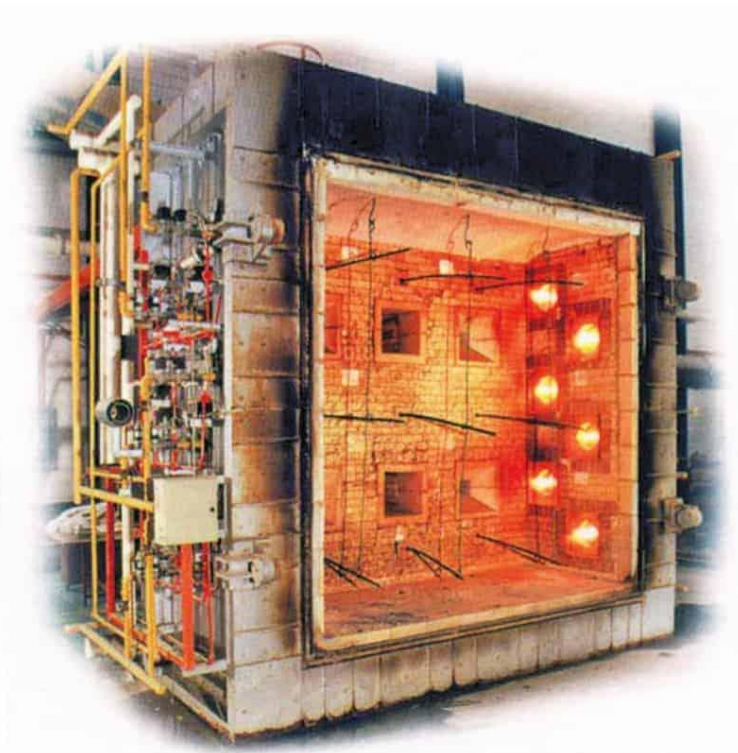
3.2.5.5 Separating walls - Compartment walls that are common to two or more buildings (separating walls) should run the full height of the building in a **continuous vertical plane** and should be constructed of non-combustible (see Appendix A, Table A8) materials. Adjoining buildings should only be separated by walls, not floors. A compartment wall being used to divide a building into separate occupancies or uses would not be subject to this provision.



INTERACTIVE WALL FLOOR

EN 1365 - 1

Fire Test Specimen



Full Scale Fire Testing

LPCB®

Loss Prevention Standard

LPS 1501: Issue 1.1

Fire test and performance requirements for innovative methods of building construction

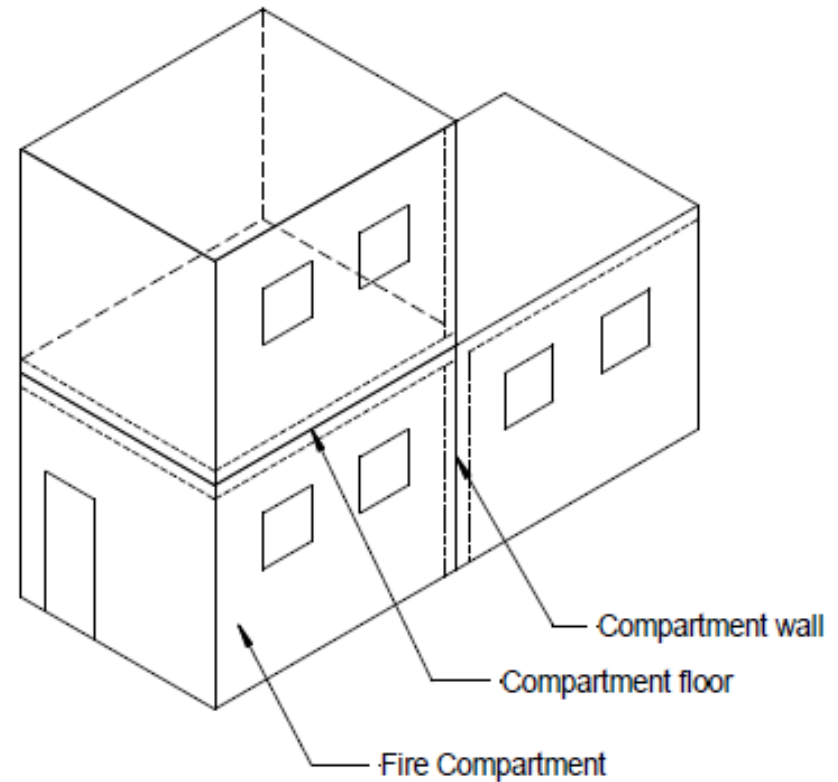


Figure 1 Basic arrangement of test building

PURPOSE OF THE FULL-SCALE FIRE TEST

- The purpose of the full-scale fire test is to identify potential modes of failure that cannot be predicted from the results of standard fire tests on individual elements and to consider the system response when subject to a realistic fire scenario.

Full Scale Fire Test

2-hour full scale natural fire test

Vision Modular external wall is fully non-combustible



Conclusions

There needs to be an understanding of how structures behave in fire and how to treat them in all structural forms.

Fire design needs to involve more than one kind of specialist.

Fire Brigade should know what MMC they are facing before they enter the building.

Industry full scale testing should be carried out but due to its expense it should be supported by government.

You will see a greater move to interactive and system fire testing but there are no harmonized standards for this.

Thermomechanical and Calibrated Heat Transfer modelling will be critical for future structural fire design in HRB.

On site QC for Firestopping needs to be in line with the quality in the factory of MMC.

There still needs to be a place for desktop assessments once they are undertaken with the required knowledge and competence.

Meet with local Fire officer and Building Control at Design stage to answer any questions that they may have. Avoid 7-day notice applications when using MMC.



THANK YOU



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