

Challenges for structural fire protection strategies for modern construction

By Alastair Temple and Tom Parker

Modular construction offers a solution to the UK housing problem. It is fast to build and can be mass produced in a quality controlled environment.

Where is it used?

- Residential
 - Student halls
 - Institutional residential (sheltered housing)
 - Flats
- Hotels
- Healthcare
- Education (Schools)

- How much do these rely upon their structural fire performance?

Risk Profile

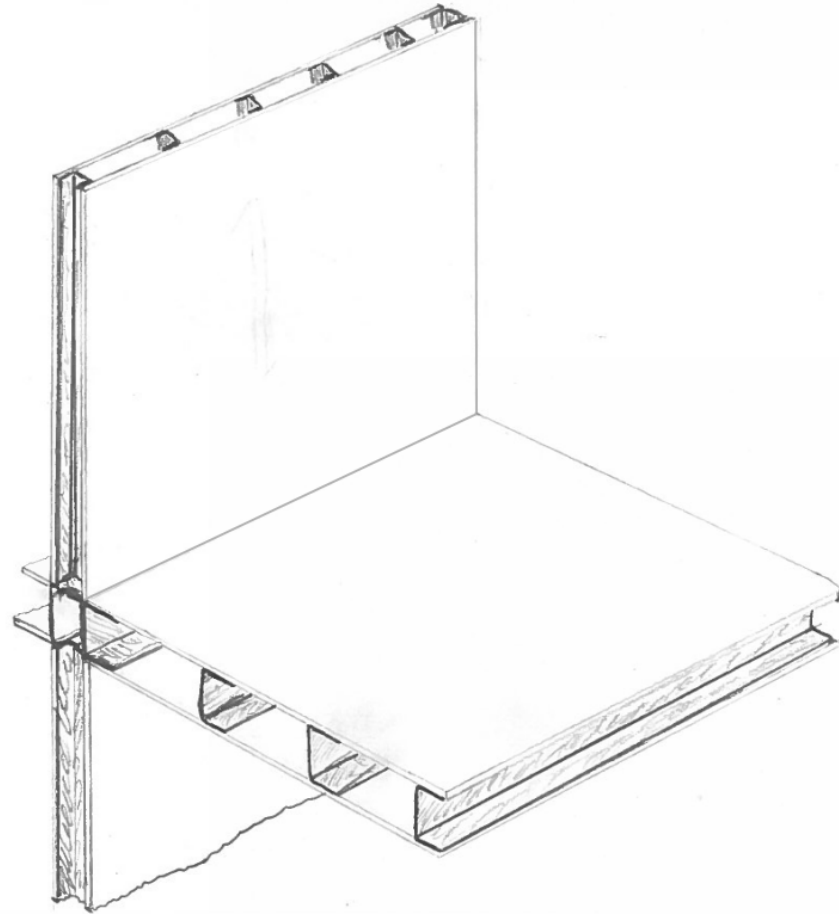
Category	Loadbearing Element	Separating Element
Low Rise	Must survive the early stages of a fire, but complete failure is acceptable.	The reliance placed on separating elements is likely to be negligible with no real fire resistance required.
Medium Rise	Overall stability must be maintained for the burnout of a reasonably expected fire.	The protection given to primary access and egress routes needs to be maintained to enable escape and search and rescue.
High Rise	Overall and local stability must be maintained for the burnout of reasonable, worst-case fire.	Egress and access routes must be protected and compartmentation maintained for the burnout of a reasonable, worst-case fire.
Remain in Place	Overall and local stability must be maintained for the burnout of any credible fire.	Egress and access routes must be protected and compartmentation maintained for the burnout of any credible fire.

Risk Profile

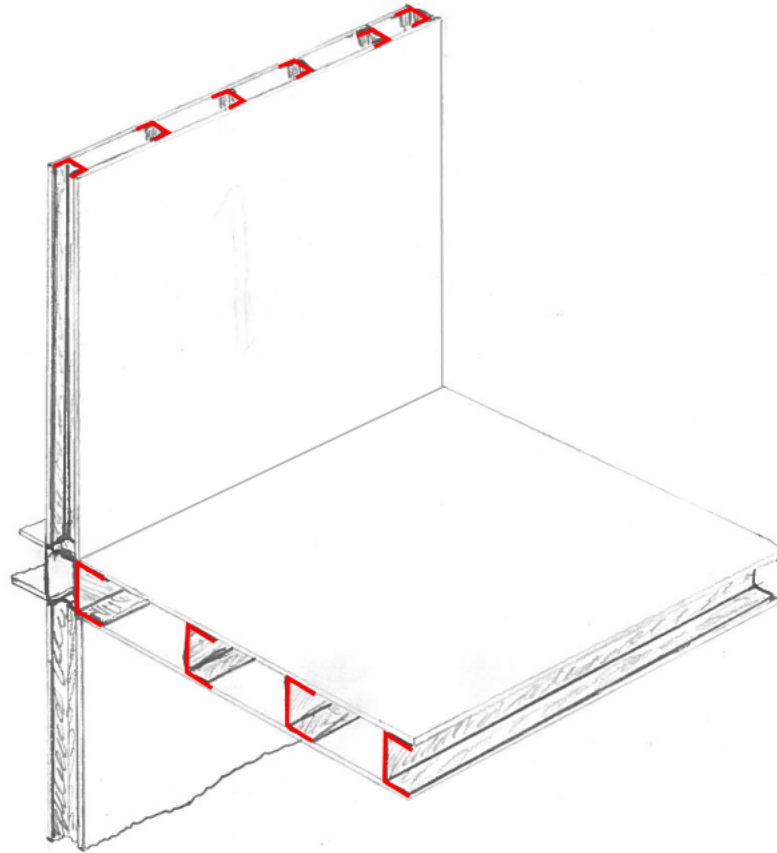
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How do these systems work?

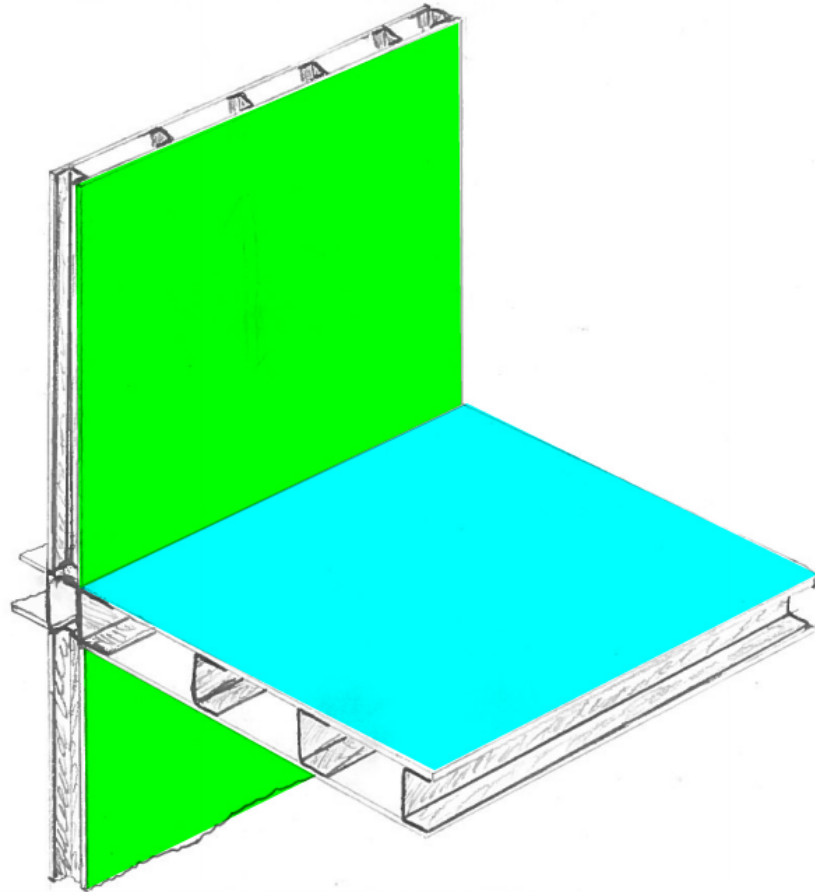
Type 1 – Lightweight Steel



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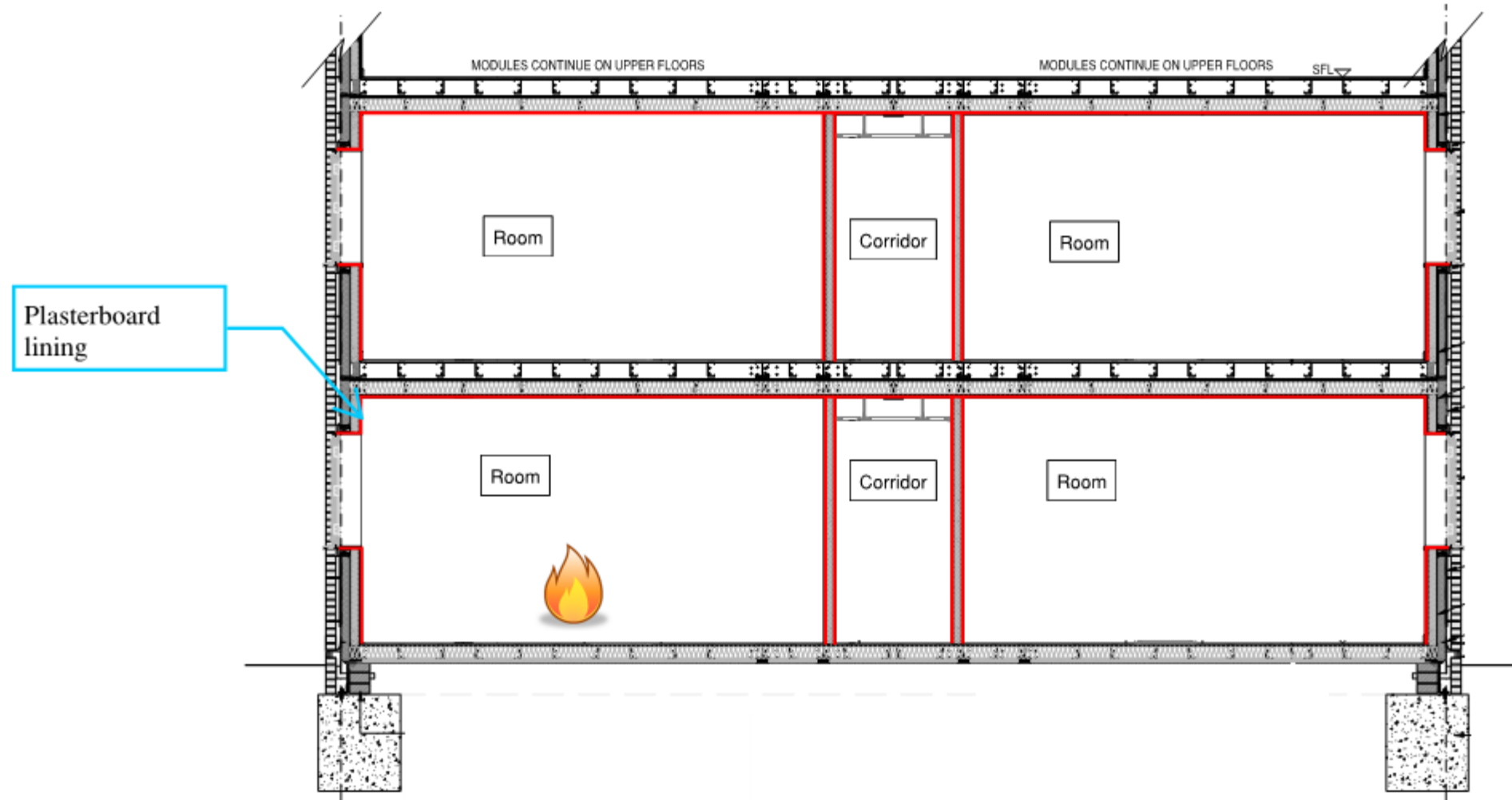
Type 1 – Lightweight Steel



Type 2 – Lightweight Steel



How is structural protection provided?



Performance Requirements (Fire)

Performance Requirements

- **Unseen spread of fire and smoke**

- Requirement B3 (4)

- *“The building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited”*

- **Compartmentation**

- Requirement B3 (3)

- *“Where reasonably necessary to inhibit the spread of fire within the building, measures shall be taken, to an extent appropriate to the size and intended use of the building, comprising either or both of the following*

- (a) *Sub-division of the building with fire resisting construction”*

- **Structural fire protection**

- Requirement B3 (1) of the Building Regulations 2010 states.

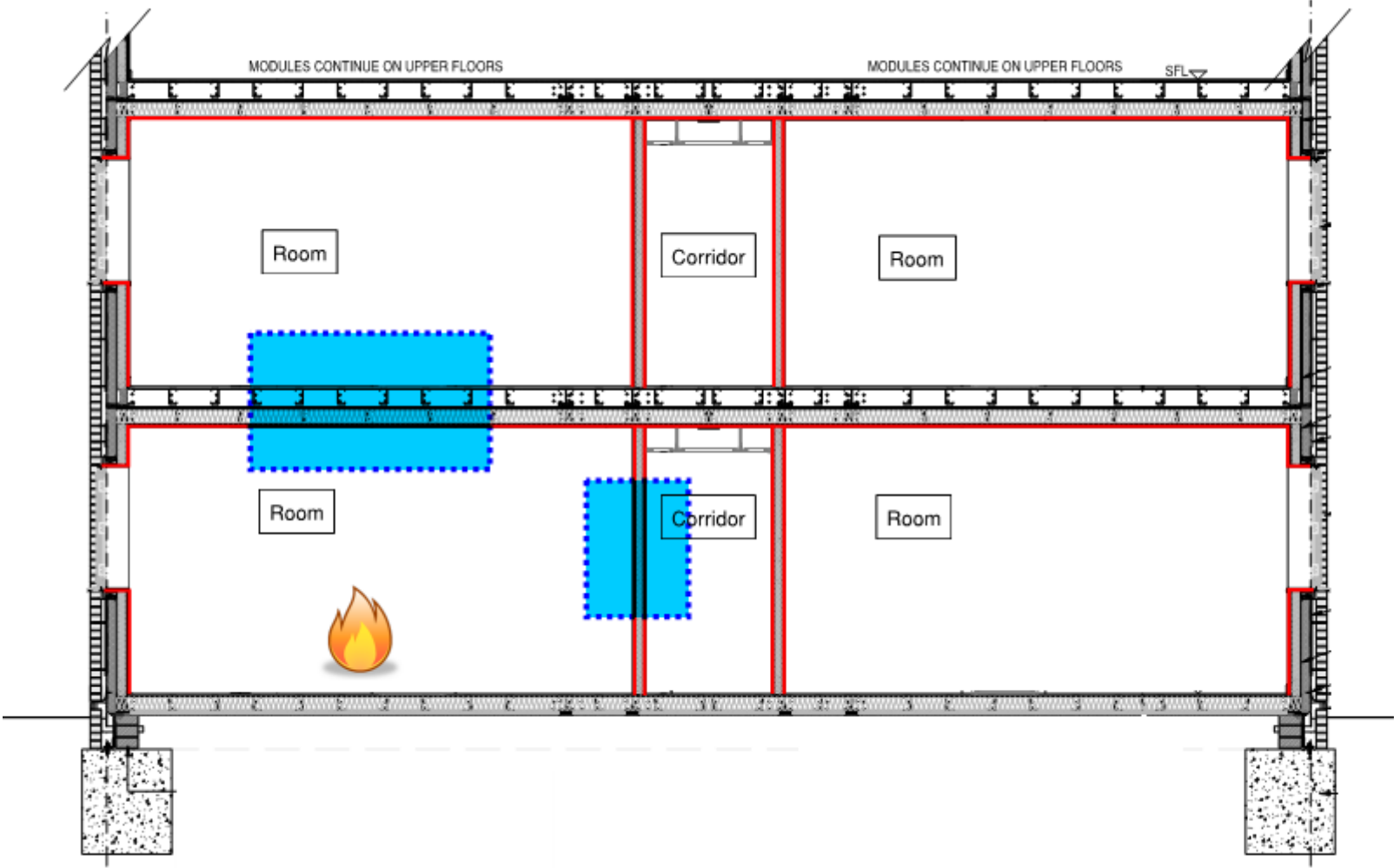
- *“The building shall be designed and constructed so that in the event of a fire, its stability shall be maintained for a reasonable period”*

Risks in Design

Key Risks

- Testing individual elements only,
- Heavy reliance on detailing around junctions with no testing of these potential weak points.
- Fires affecting the structure from above.
- Weaknesses around external walls –
 - Often filled with combustible insulation
 - Cavity barriers only around edges

Testing



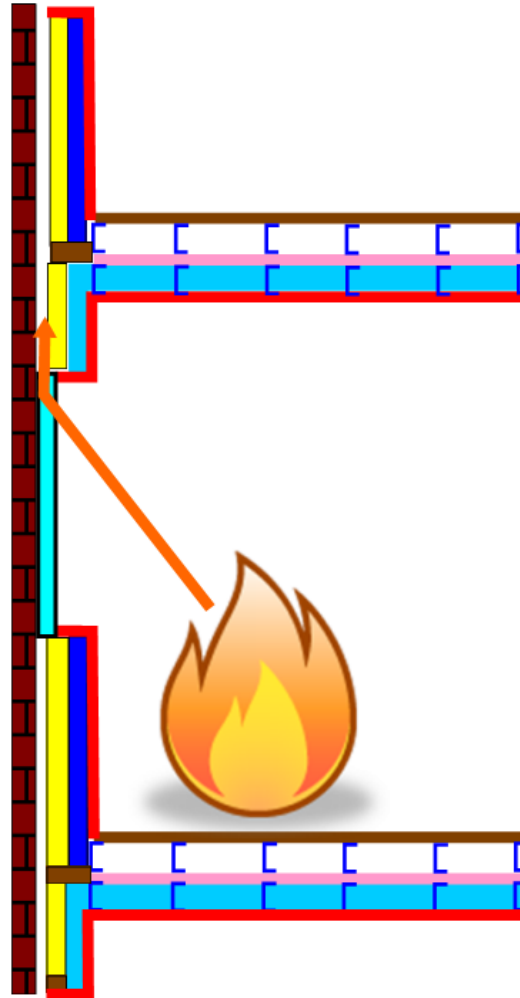
Full-frame behaviour



Approving authorities statement on fires originating in walls

“AD B Vol 2 Table A1 item 1 requires 60 minutes fire resistance to a structural frame, beam or column on exposed faces of the elements. The structural elements within the cavity are not exposed as they are encased in a combustible PIR insulation.”

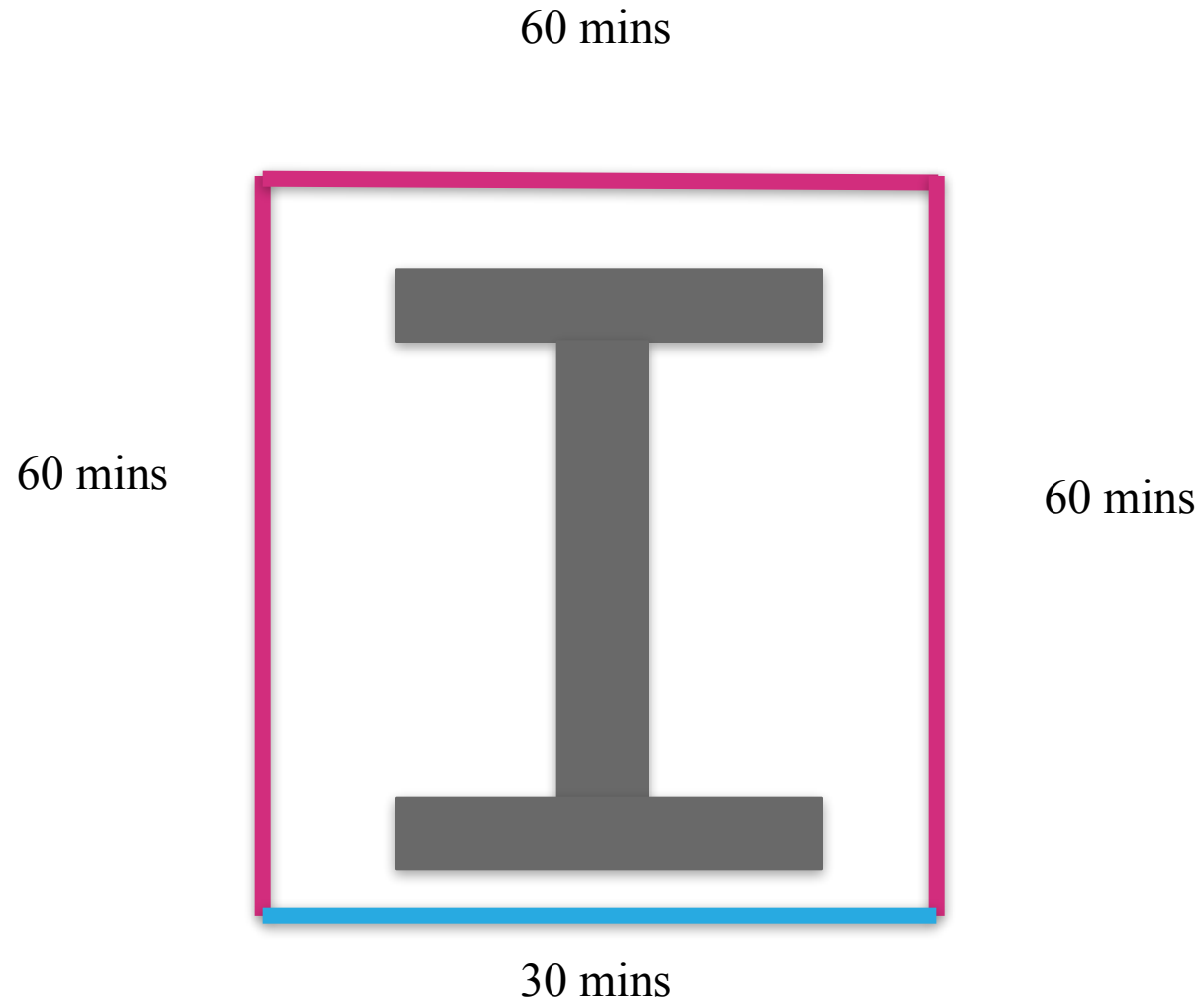
Fire break out through openings in external wall



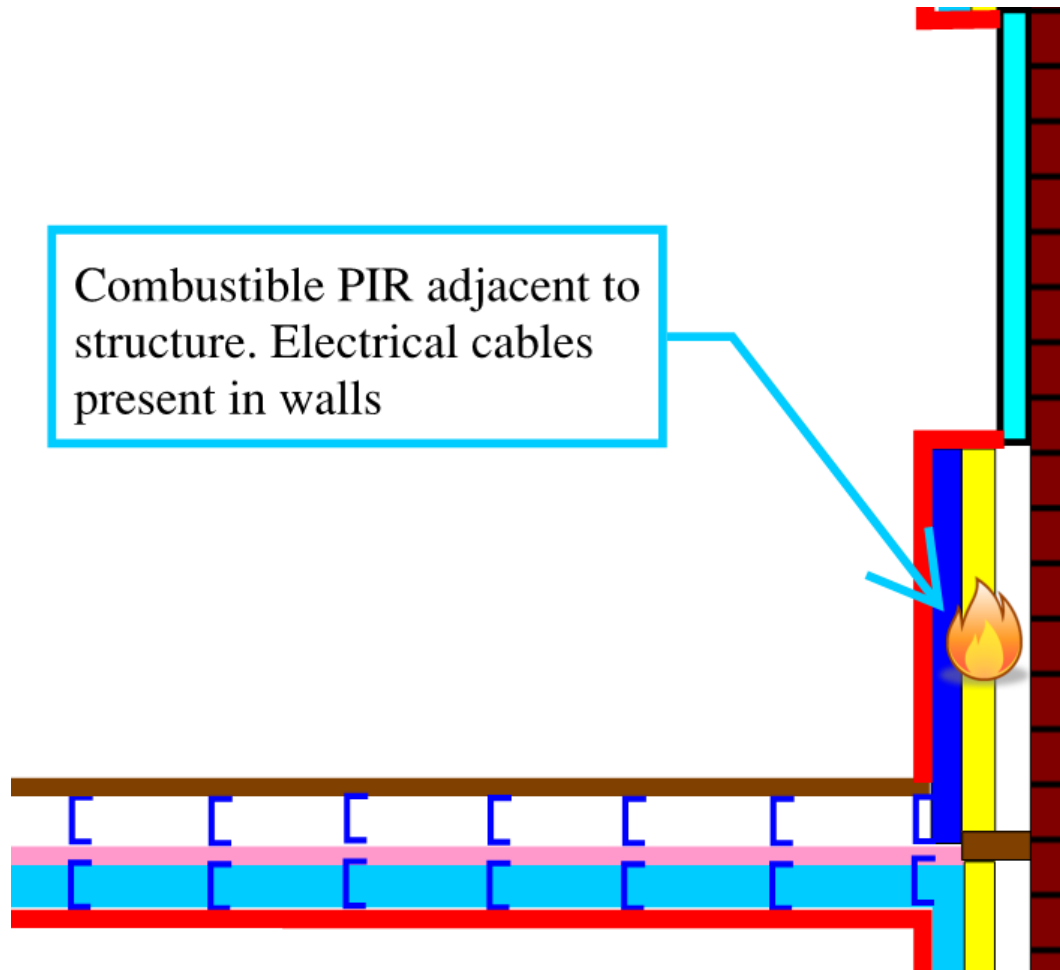
Weaknesses at openings in external wall

- Cavity barrier rated to 30 minutes insulation in accordance with ADB Table A2
- Structural protection required in practice is 60 minutes
- Confusion between the two elements

Weaknesses at openings in external wall



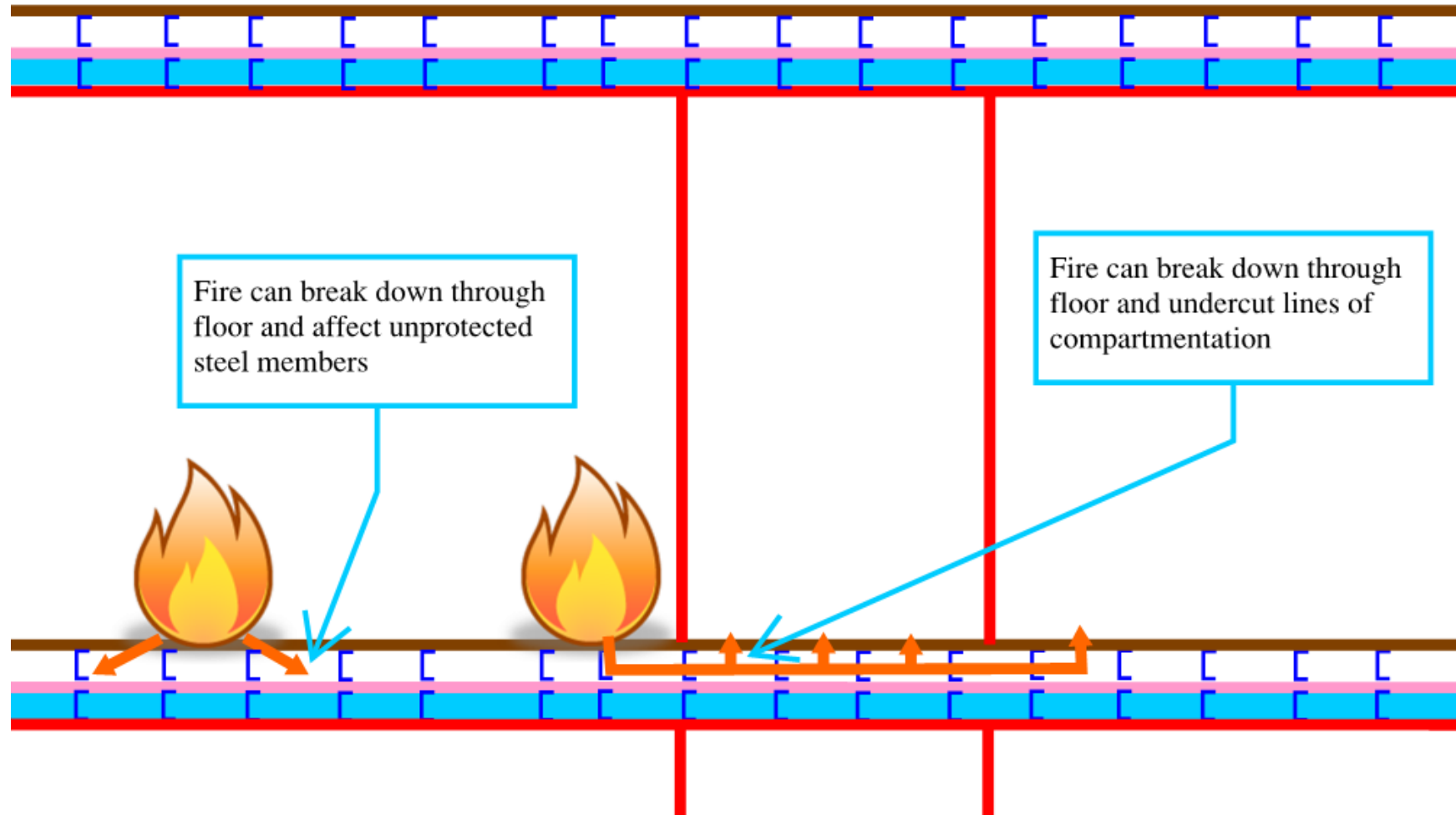
Fire originating in external wall



Possible ignition Sources:

- External electrical lighting cables
- Data cables
- Power socket cables
- Are these sufficient to ignite PIR?

Fire break out through floor/ undercutting compartmentation



Floor tests

- No British Standard for floor fire resistance
- ADB Table A2 states structure need to be tested from all exposed sides to BS 476-20
- Traditional building structure is protected from burn down by concrete slab or timber frames with joists sized sufficiently to withstand charring

Risks in construction/use

Risks in construction

- Rely on entire inner leaf to be fully integral
- No consideration of manufacturing defects or flexibility for onsite construction issues
- Creates very large onus on ongoing management to ensure future works to any internal wall are fire stopped

Moving forward

Future direction

- Design for manufacture



Improving design and delivery?

- Intumescent paint for steel joists?
- Thoughts and suggestions welcome!