



Fire resistance of timber frame wall constructions

Executive Summary

Timber frame constructions are a popular design solution in a number of European countries. Thanks to its superior thermal performance, PU (PIR/PUR) offers a maximum of flexibility to designers with a view to keeping building envelope elements thin whilst reaching very low energy demand levels.

Recent fire resistance tests conducted by Exova Warrington Fire (UK) [1] according to EN 1365-1 demonstrated that timber frame wall constructions using PIR insulation boards can achieve the same level of fire safety as similar wall build-ups using A1 rated glass fibre insulation.

The tests provided further evidence that the fire performance of a building structure does

not predominantly depend on the Euroclass of insulation products but is determined by its design and the combination of materials used to construct it.



Figure 1: Timber frame building

Project background

PU is popular for on- and off-site panel construction as its rigid nature allows it to be held into the timber frame panels easily while being moved or transported from factory to site. The closed cell nature of the product also means that if exposed to inclement weather during transportation the moisture can simply be wiped off the low emissivity foil facings before the dry-lining is added and the wall construction is completed. PU's low thermal conductivity means the demanding U-values of today's markets can be met without increasing the

timber stud depth dimensions.

The PU industry is committed to providing solutions to the market which combine an outstanding environmental and cost performance with a high level of fire safety. The goal of the project was therefore to provide evidence that timber frame constructions using PIR can provide the same level of fire resistance as similar constructions using glass mineral fibre achieving Euroclass A1 [2].

The applicable harmonised European test method is described in EN 1365-1 "Fire resistance tests for load-bearing elements (Walls)".

Fire resistance tests are required if part of a building is a structural element.

Structural safety in fires is defined in terms of specified distances and times within which collapse of the structural element e.g. the wall construction- is prevented. The objective of fire resistant requirements is to protect the occupants of the building during their evacuation [3].

Fire Resistance can be explained as the ability of the structural element or system to sustain its structural duty whilst being exposed to temperatures relating to a developed fire.

The three main properties that are measured in European fire resistance test EN 1365-1 are

- **R** = Load Bearing ability
- **E** = Integrity
- **I** = Insulation

Fire resistance is related to the building structure rather than individual components thus the complete assembly is tested which accurately reflects the 'end use' construction with joints, fixings and ancillary materials.

Project Set-up

To fairly assess the products in end-use, it was decided to compare two closed panel timber frame systems with identical build-ups, one using PIR boards and the other one glass fibre. The differences in the thickness of the insulation layer are due to the fact that the required U-value can be

reached with a far thinner PIR insulation layer thanks to its very low thermal conductivity (see [table 1](#)).

The build-ups were loaded and constructed with guidance from the UKTFA (UK timber frame association).

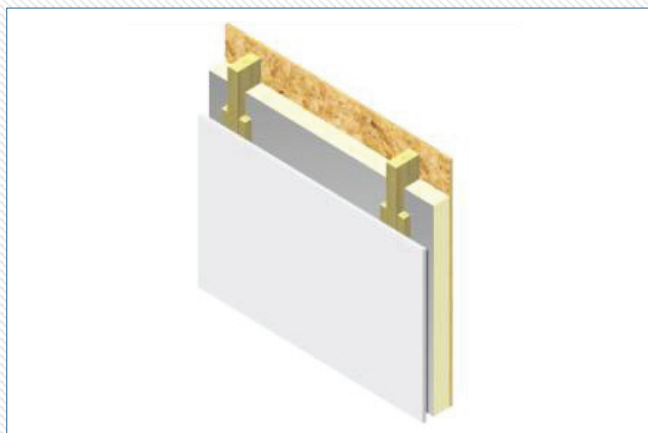


Figure 2: PIR construction

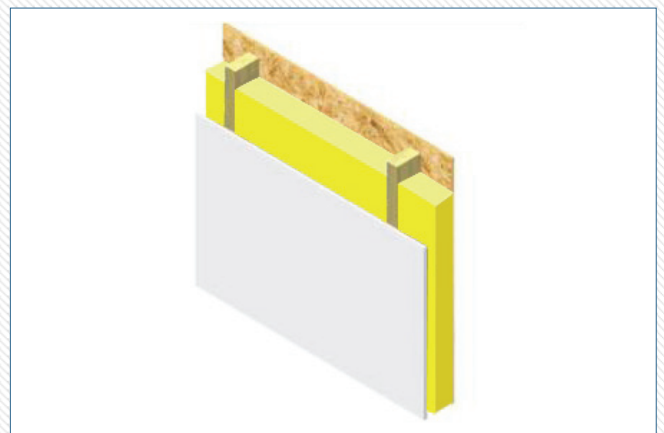


Figure 3: Glass fibre construction

Case code	PIR construction	Glass fibre construction
Internal Exposed (to fire) Face	12.5 mm Standard Gypsum wallboard	
Ancillary materials/fixings	C16 Grade softwood 140x38mm studs (at 600 mm ctrs), head-binder and soleplate	
Unexposed Face	Sheathing 11 mm OSB (Orientated Strand Board)	
Insulation solution	Insulation between studs	
Load	11 kN per metre	
U value of the construction	0.27W/m²K (when used with a 102.5mm facing brick)	
Insulation product used	PIR board <ul style="list-style-type: none"> • foil facing • Euroclass D,s2,d0 • Thermal conductivity: 0.022W/(m·K) 	Glass fibre <ul style="list-style-type: none"> • no facing • Euroclass A1 • Thermal conductivity: 0.035W/(m·K)
Required thickness of the insulation layer	80 mm	140 mm

Table 1: Details of the construction used for the tests

Test results

The tests were conducted by the UKAS accredited fire test laboratory Exova

Warrington Fire according EN 1365-1 and led to the following results:

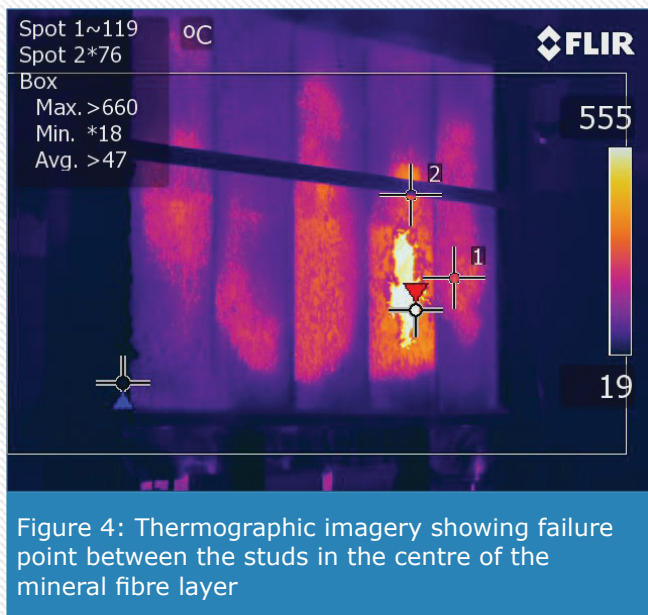
Case code	PIR construction	Glass fibre construction
Load-bearing capacity	39 minutes	32 minutes
Integrity Performance		
<ul style="list-style-type: none"> • Sustained flaming 	38 minutes	31 minutes
<ul style="list-style-type: none"> • Gap gauge 	38 minutes	32 minutes
<ul style="list-style-type: none"> • Cotton pad 	38 minutes	31 minutes
Insulation Performance	38 minutes	31 minutes



Figure 2: PIR test 306703 failing at 38 minutes



Figure 3: Mineral fibre test 306702 failing at 32 minutes



Conclusions

The following conclusions can be drawn from the tests:

- Both build-ups meet the minimum legal requirement in the UK of a 30 minutes fire resistance (REI30) for this type of construction.
- The resistance to fire performance of the PU solution is similar, or even slightly better, than that of the glass fibre construction for this specific build-up. Moreover, the required U-value is achieved with a 60% thinner PU insulation layer than that of glass fibre.
- While these results cannot be simply extended to all PU timber frame constructions, they clearly show that the use of PU solutions can provide a similar level of resistance to fire as solutions using A1 rated mineral fibre insulation.
- The fire performance of a building structure does not preliminary depend on the Euroclass of insulation products but is determined by its design and the combination of materials used to construct it.

References

- [1] Exova Warrington Fire for PU Europe: [Fire Resistance of timber frame wall constructions \(glass fibre build-up, WF report no 306702\)](#) and Exova Warrington Fire for PU Europe: [Fire Resistance of timber frame wall constructions \(PIR build-up, WF report no 306703\)](#)
- [2] For more details on reaction to fire classification (euroclasses) refer to the [PU Europe Fire Handbook](#), section "European Fire Standards and National Legislation"
- [3] For more details on resistance to fire test methods refer to the [PU Europe Fire Handbook](#), section "European Fire Standards and National Legislation"

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