REQUIREMENTS OF COMPARTMENTATION: FIRE RESISTANCE

A SYSTEM APPROACH TO SIGN OFF AND SAFETY

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TECHNICAL ACADEMY

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FIRE RESISTANCE: BUILDING REGULATIONS

Internal fire spread – Linings

34. To inhibit the spread of fire within a building the internal linings shall—

(a) offer adequate resistance to the spread of flame over their surfaces; and

(b) where they are located in a circulation space, have a low rate of heat release or a low rate of fire growth when ignited.

Internal fire spread – Structure

35.—(1) A building shall be so designed and constructed that, in the event of a fire, its stability will be retained for a reasonable period.

(2) A wall common to two or more buildings shall be so designed and constructed that it provides adequate resistance to the spread of fire between those buildings and for the purposes of this paragraph a dwellinghouse in a terrace and a semi-detached dwellinghouse shall be considered as a separate building.

(3) To inhibit the spread of fire within it, a building shall be adequately sub-divided with fire-resisting construction.

(4) A building shall be so designed and constructed that the spread of fire (and in particular smoke) within concealed spaces in its structure and fabric is adequately inhibited.

BUILDING REGULATIONS

Table 4.1 Specific provisions of test for fire resistance of elements of structure and other components of a building

Part of building		Minimum provisions when tested to the relevant part of BS 476 (minutes)[11]			Minimum provisions when tested to the relevant European standard (minutes)[10][11]	Method of exposure
		Loadbearing capacity[1]	Integrity	Insulation		
1	Structural frame, beam or column	See Table 4.2	Not applicable	Not applicable	R see Table 4.2	Exposed faces
2	Loadbearing wall (which is not also a wall described in any of the following items)	See Table 4.2	Not applicable	Not applicable	R see Table 4.2	Each side separately
3	Floors –					
	(a) in upper storey of two storey dwellinghouse (but not over a garage)	30[2]	15[2]	15[2]	REI 30[7]	From underside
	(b) between a shop and flat above	60 or see Table 4.2 (whichever is greater)	60 or see Table 4.2 (whichever is greater)	60 or see Table 4.2 (whichever is greater)	REI 60 or see Table 4.2 (whichever is greater)	
	(c) any other floor	See Table 4.2	See Table 4.2	See Table 4.2	REI see Table 4.2	

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BUILDING REGULATIONS

Table 4.2 Minimum periods of fire resistance

Purpose group of building	Minimum period (minutes) for elements of structure and other components of the building forming part of					
	Basement storey* including floor over		Ground or upper storey			
	Depth (m) of basement		Height (m) of top floor above ground in building or separated part of building[1]			
	More than 10	Not more than 10	Not more than 5	More than 5 not more than 18	More than 18 not more than 30	More than 30
1 Residential (dwellings) –						
(a) flats	90	60	30*	60[2]/**	90**	120**
(b) **and (c)** dwellinghouses	Not relevant	30*	30*	60@	Not relevant	Not relevant
2 Residential –						
(a) institutional	90	60	30*##	60	90	120#
(b) other residential	90	60	30*	60	90	120#
3 Office –						
not sprinklered	90	60	30*	60	90	Not permitted
sprinklered[3]	60	60	30*	30*	60	120#
4 Shop and commercial –						
not sprinklered	90	60	60	60	90	Not permitted
sprinklered[3]	60	60	30*	60	60	120#

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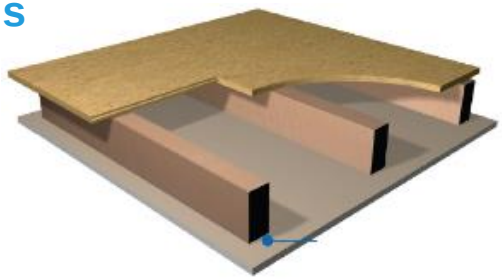
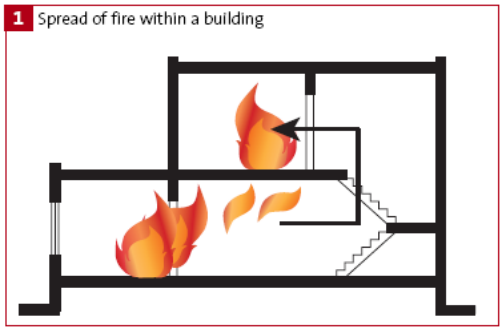
PLASTERBOARDS IN BUILDINGS

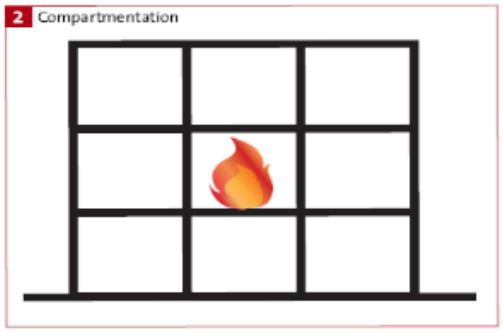
Extensive use for internal fit outs

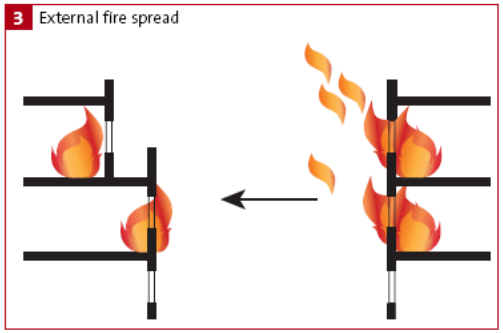
Wall Linings & Partitions

Floors & Ceilings



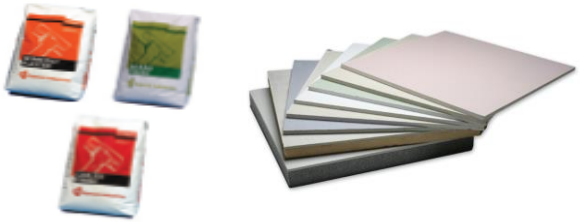


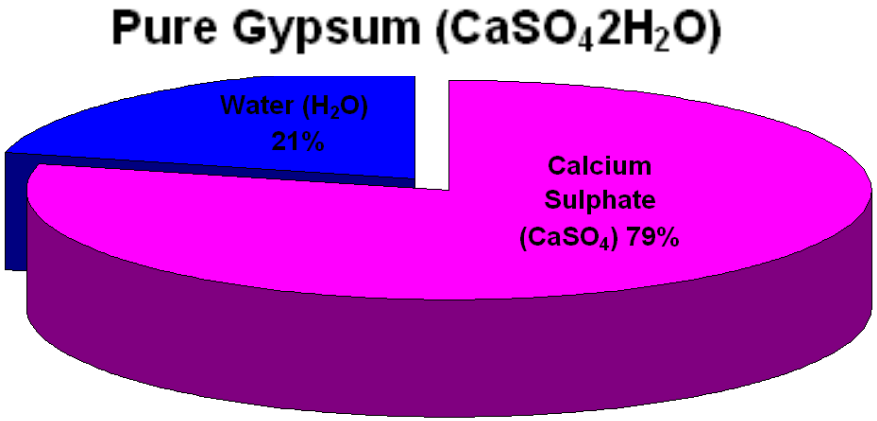




GYPSUM - CHEMICAL PROTECTION

Gypsum plasters and boards provide good fire protection in buildings due to the unique behaviour of gypsum when exposed to fire.





Pure gypsum ($CaSO_4 2H_2O$)

- 21% chemically combined water ($2H_2O$)
- 79% calcium sulphate ($CaSO_4$)
- Inert below a temperature of 1200°C.

When exposed to fire, the chemically combined water absorbs the heat and is gradually released in the form of moisture vapour

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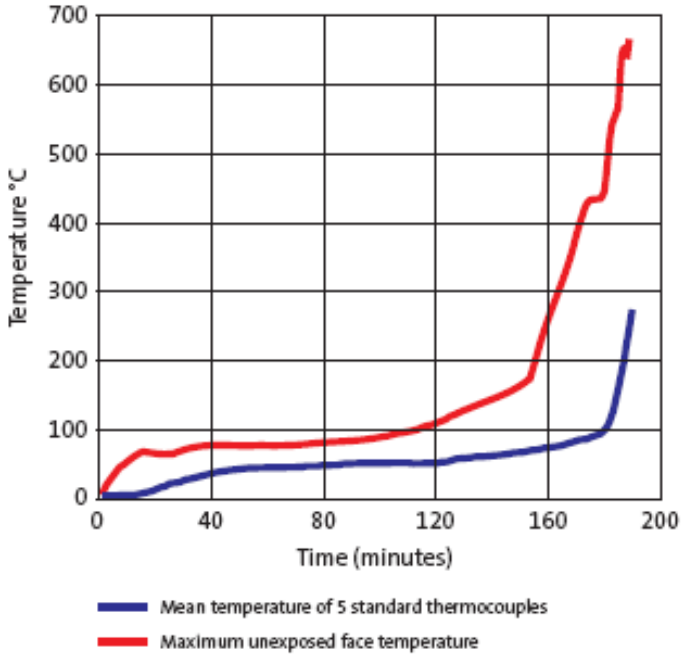
GYPSUM - CALCINATION PROCESS

The process of dehydrating gypsum by heat is known as '**calcination**'. This commences at the surface exposed to the fire and proceeds gradually through the gypsum layer.



Calcined gypsum formed on the exposed faces serves to retard the calcination process

Calcination becomes progressively slower as the thickness of the calcined material increases.

REACTION TO FIRE

The Construction Products Regulation (CPR), has harmonised Reaction to Fire standards with the **Euroclass system**.

All CE marked Gyproc plasterboards are now rated against this standard

National classification	Category
Non-combustible	A1
Material of limited combustibility	A2
Class 0	B
Class 1	C
Class 3	D
	E
	F

→ Paperless faced plasterboards

→ Paper lined plasterboards

PLASTERBOARDS

No plasterboard by itself offers a fire resistance

30 mins
60 mins
90 mins

Thicknesses
- 6mm
- 9.5mm
- 12.5mm
- 15mm
- 19mm

Manufactured in accordance with EN520

FIRE RESISTANCE

FLAMES
&
HEAT

FIRE INTEGRITY

FIRE INSULATION

LOADBEARING

Fire resistance testing

Testing the full system

Photo 1. View of the unexposed face at 30 minutes.

Undertaken in accredited laboratories

Building Regulations

Table 4.1 Specific provisions of test for fire resistance of elements of structure and other components of a building

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(c) any other floor	See Table 4.2	See Table 4.2	See Table 4.2	REI see Table 4.2	

Fire resistance standards

Two systems co-existing within current regulation documents

Both standards require minimum levels of performance in…….

Loadbearing performance	(R)	– to maintain levels of structural
Fire **integrity** gases	(E)	– to prevent the spread of flame & hot
Fire **insulation**	(I)	– to prevent the spread of excessive heat

BS 476: Part 20: 1987 - Elements of construction.

BS 476: Part 21: 1987 - Loadbearing elements.

BS 476: Part 22: 1987 - Non-loadbearing elements.

BS 476: Part 23: 1987 - Components of Structures.

EN 1364-1: 2015 - Non-loadbearing walls (*1999*)
EN 1364-2: 1999 - Non-loadbearing ceilings

EN 1365-1: 2012 - Loadbearing walls (*1999*)
EN 1365-2: 2014 - Loadbearing floors and roofs (*2000*)

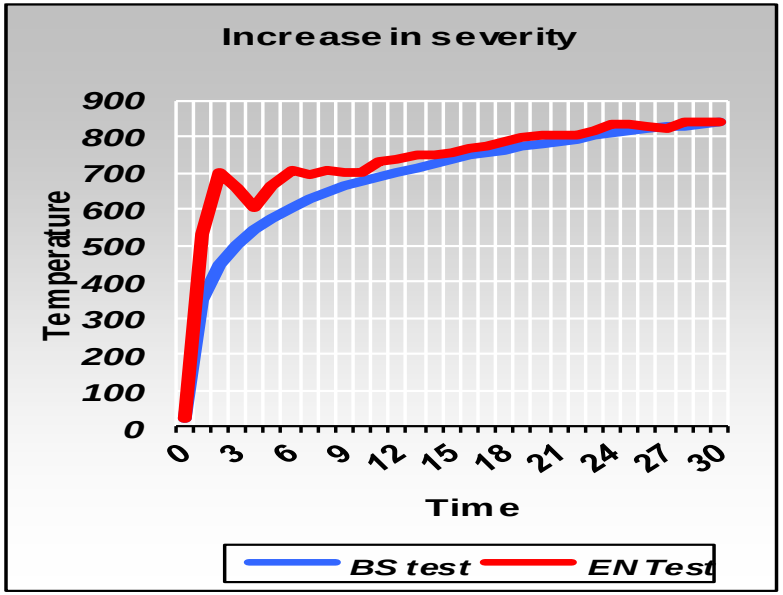
EN 13381-2: 2014 - Vertical protective membranes (*2002*)
EN 13381-4: 2013 - Protection to steel members (*2002*)

EN Fire resistance testing

Key differences in testing to BS

Severity of testing & application

- EN fire testing methodology sets out to eliminate variances in furnace severity
  - Fuel sources
  - Furnace geometry
- Use of plate thermometers to measure the heat flux
- More **onerous conditions in early stages** of a test.
- Stricter 'Field of Application' rules
  - Hot state heights



COMPARISON OF TEST RESULTS

EN vs BS achievements

60 minute systems

Report Number BTC 12637F

A FIRE RESISTANCE TEST ON A BRITISH GYPSUM GYPWALL PARTITION CLAD WITH A SINGLE LAYER OF 15mm GYPROC FIRELINE BOARD CONDUCTED IN ACCORDANCE WITH BS 476: PART 22:1987: CLAUSE 5.

Integrity	113 minutes
Insulation	69 minutes

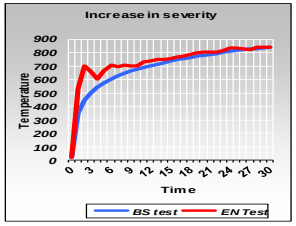
Report Number BTC 11831F

A FIRE RESISTANCE TEST, ON A GYPROC GYPWALL PARTITION INCORPORATING GYPFRAME 48S50 METAL STUDS CLAD WITH A SINGLE LAYER OF 15mm GYPROC FIRELINE BOARD, CONDUCTED IN ACCORDANCE WITH BS EN 1364-1: 1999.

Integrity -Sustained flaming.	68 minutes
Integrity -25mm diameter gap gauge.	67 minutes
Integrity -6mm x 150mm gap gauge.	65 minutes
Integrity -Cotton pad.	63 minutes
Insulation	60 minutes

What would the impact if each system tested 1 minute less?

60 mins (BS) vs 30 mins (EN)



Gyproc White Book

BS & EN Fire resistances

GypWall performance (continued)

70mm Gypframe 'C' Studs - double layer board linings

Table 7a — Solutions to satisfy the requirements of *BS EN 1364-1: 1999*

For details of when to specify fire resistance using EN ▶ Refer to C02. S01. P18

EN

① Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. Linings as in table.

② Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. 25mm Isover Acoustic Roll in the cavity. Linings as in table.

③ Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. 50mm Isover Acoustic Roll in the cavity. Linings as in table.

▶ Refer to GypWall ROBUST and GypWall EXTREME sections for single layer Severe Duty solutions

Detail	Partition thickness mm	Board type	Lining thickness mm	Max height[1] mm	Sound insulation R_w dB Any[2] finish	Sound insulation R_w dB Skim[2] only	Duty rating	Approx. weight kg/m²	System reference Any[2] finish	System reference Skim[2] only
30 minutes fire resistance EN										
①	122	Gyproc WallBoard	2 x 12.5	4600	45	-	Severe	35	A206015	-
①	122	Outer layer Glasroc H FIRECASE + Inner layer Gyproc WallBoard	1 x 12.5 + 1 x 12.5	4600	45	-	Severe	39	H206015	-
②	122	Gyproc WallBoard	2 x 12.5	4600	49	-	Severe	35	A206047	-
60 minutes fire resistance EN										
①	122	Gyproc SoundBloc	2 x 12.5	4600	49	-	Severe	43	A206166	-
③	122	Gyproc WallBoard	2 x 12.5	4600	50	-	Severe	35	A206142	-
③	122	Outer layer Glasroc H FIRECASE + Inner layer Gyproc WallBoard	1 x 12.5 + 1 x 12.5	4600	50	-	Severe	39	H206142	-
②	122	Gyproc SoundBloc	2 x 12.5	4600	52	-	Severe	43	A206198	-

GypWall performance (continued)

70mm Gypframe 'C' Studs - double layer board linings

Table 7b — Solutions to satisfy the requirements of *BS 476: Part 22: 1987*

For details of when to specify fire resistance using BS ▶ Refer to C02. S01. P18

BS

① Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. Linings as in table.

② Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. 25mm Isover Acoustic Roll in the cavity. Linings as in table.

③ Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. 50mm Isover Acoustic Roll in the cavity. Linings as in table.

▶ Refer to GypWall ROBUST and GypWall EXTREME sections for single layer Severe Duty solutions

Detail	Partition thickness mm	Board type	Lining thickness mm	Max height[1] mm	Sound insulation R_w dB Any[2] finish	Sound insulation R_w dB Skim[2] only	Duty rating	Approx. weight kg/m²	System reference Any[2] finish	System reference Skim[2] only
60 minutes fire resistance BS										
①	122	Gyproc WallBoard	2 x 12.5	4600	45	-	Severe	35	A206015	-
①	122	Outer layer Glasroc H FIRECASE + Inner layer Gyproc WallBoard	1 x 12.5 + 1 x 12.5	4600	45	-	Severe	39	H206015	-
①	122	Gyproc SoundBloc	2 x 12.5	4600	49	-	Severe	43	A206166	-
②	122	Gyproc WallBoard	2 x 12.5	4600	49	-	Severe	35	A206047	-
122		Outer layer Glasroc H FIRECASE + Inner layer Gyproc WallBoard	1 x 12.5 + 1 x 12.5	4600	49	-	Severe	39	H206047	-
122		Outer layer Glasroc H FIRECASE + Inner layer Gyproc WallBoard	2 x 12.5	4600	50	-	Severe	36	A206142	-
			1 x 12.5 + 1 x 12.5	4600	50	-	Severe	39	H206142	-

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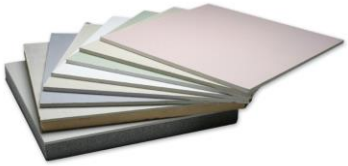
SYSTEM BASED SOLUTIONS



PLASTERBOARDS

+

FRAMING

+

FIXINGS

+

FINISHING

Certification
+ Installation
+
Detailing

SYSTEM BASED SOLUTIONS

FIXING PLASTERBOARDS

CORRECT SCREW TYPE TO SUIT FRAMING

Minimum penetration

- 10mm Metal
- 25mm Timber

Maximum centres

- 300mm (200mm at external corners)
- Correspond with vertical studs (all layers)
- Around perimeter of each board (outer layers only)

BASIC REQUIREMENTS

INSTALLING PLASTERBOARDS

STAGGERING OF BOARD JOINTS

- Vertical joints on either side of partition
- Between layers on same side

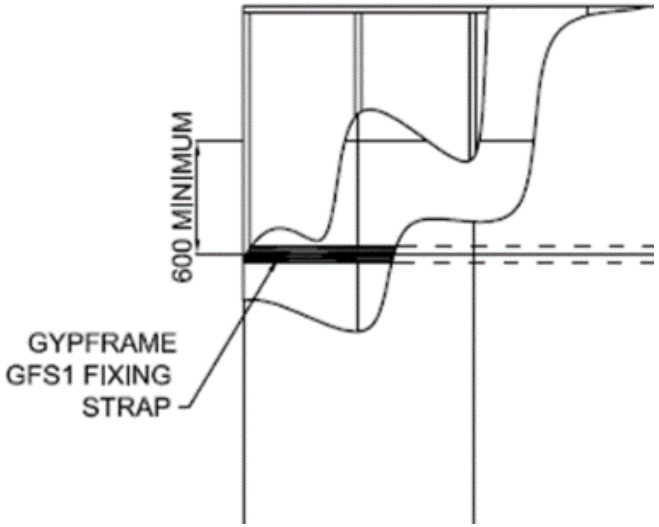
BACKING OF INTERMEDIATE JOINTS

- Vertical alignment on studs
- Horizontal backing (outer layer)

• Timber noggings

• GFS1 Flat Strap

No remedial fix



BACKING JOINTS WITH FIXING STRAP

TAPING & JOINTING

REQUIRED FOR FIRE RESISTANCE SUBSTANTIATION OF ALL SYSTEMS

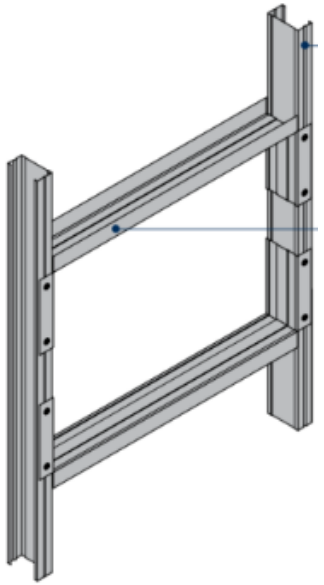
- All **outer layer** vertical and horizontal joints
- Gyproc **Paper Joint Tape**
- Suitable **Gyproc Joint Filler**

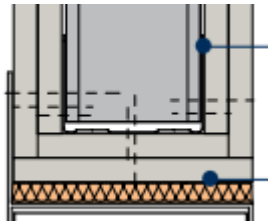
TAPE & JOINTING

FRAMING AROUND OPENINGS

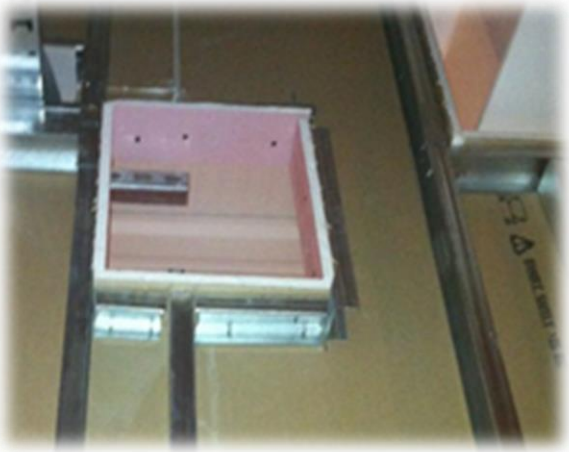
FLOOR & CEILING CHANNELS REQUIRED TO SPAN OPENING DISTANCE

- Internal lining of the opening (recommended)
- Line opening with the same specification of plasterboard as on face linings
- Ensures fire integrity of system is maintained regardless of additional insulation specification





SERVICE OPENINGS



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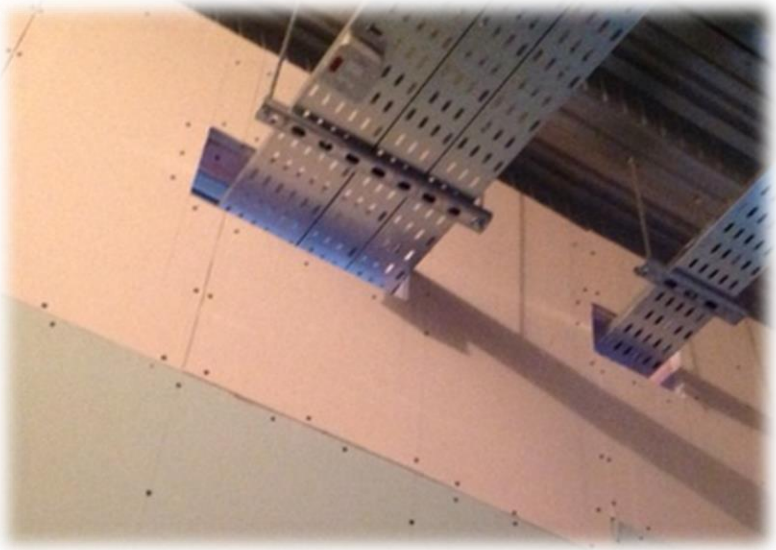
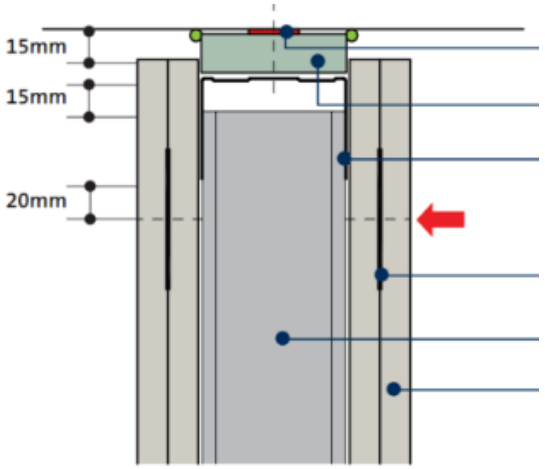


FIRE STOPPING OPENINGS

DEFLECTION HEAD DETAILING

REQUIRED TO ACCOMMODATE STRUCTURAL MOVEMENT



4 key principles

- Introduction of dropped soffit section
- Inclusion of Gyproc FireStrip
- Use of DC (Deep) or EDC (Extra Deep) Channels
- Components cut short to accommodate movement

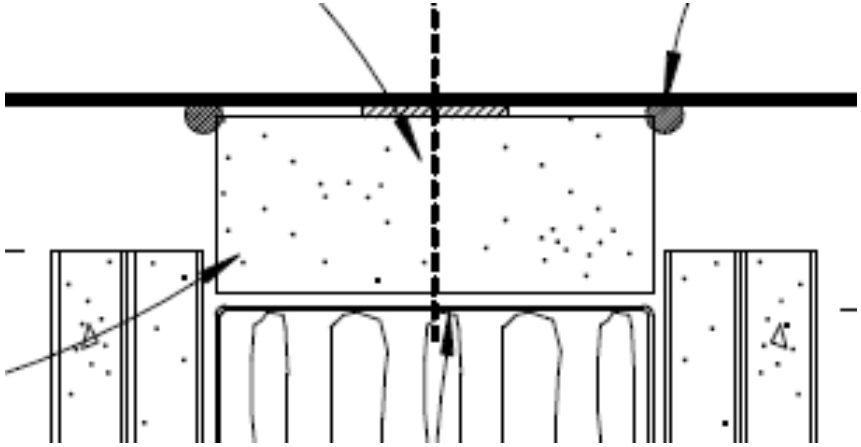
DEFLECTION HEADS

PERMISSIBLE DROPPED SOFFIT MATERIALS

Maximum 2 layers

- FireLine
- DuraLine
- CoreBoard
- MultiBoard
- FireCase F
- Timber (minimum depth dimensions 38mm)

Up to 60 minutes only except for 146mm stud systems

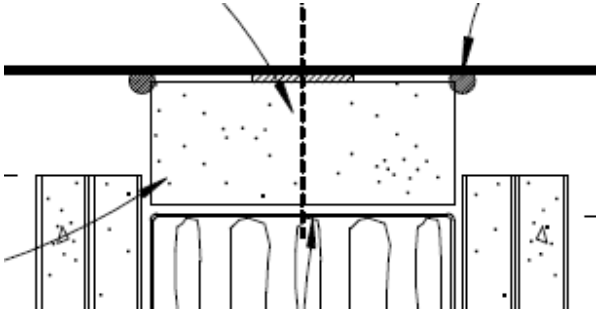


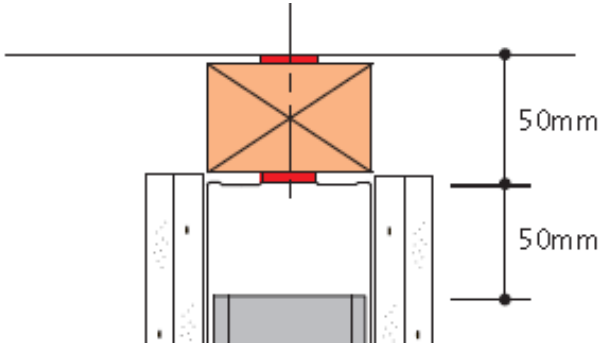
DEFLECTION HEADS

INSTALLATION

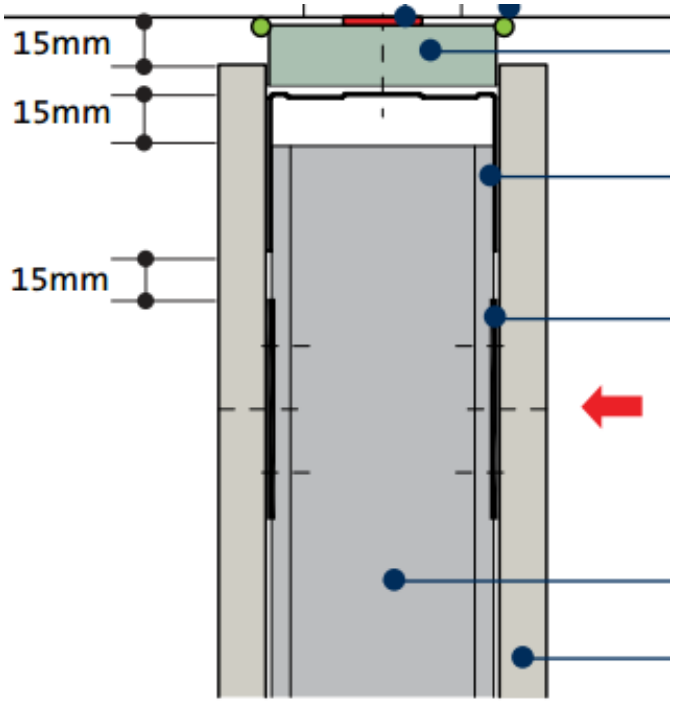
Dropped soffit materials

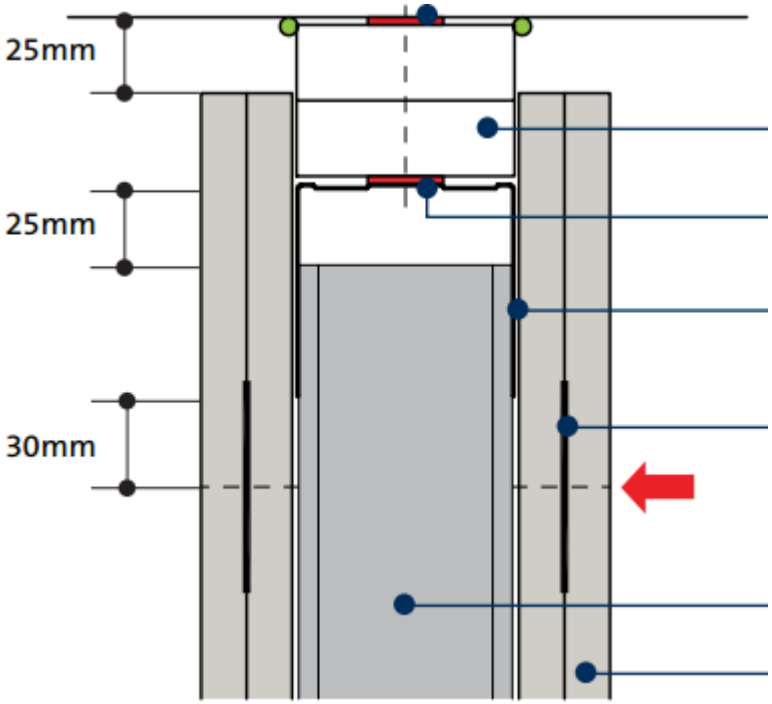
- Approx. 5mm deeper than deflection requirement
- Inclusion of secondary section of Gyproc FireStrip if boards finish level
- Best practice – Overlap between boards and dropped soffit





DEFLECTION HEADS





DEFLECTION HEADS

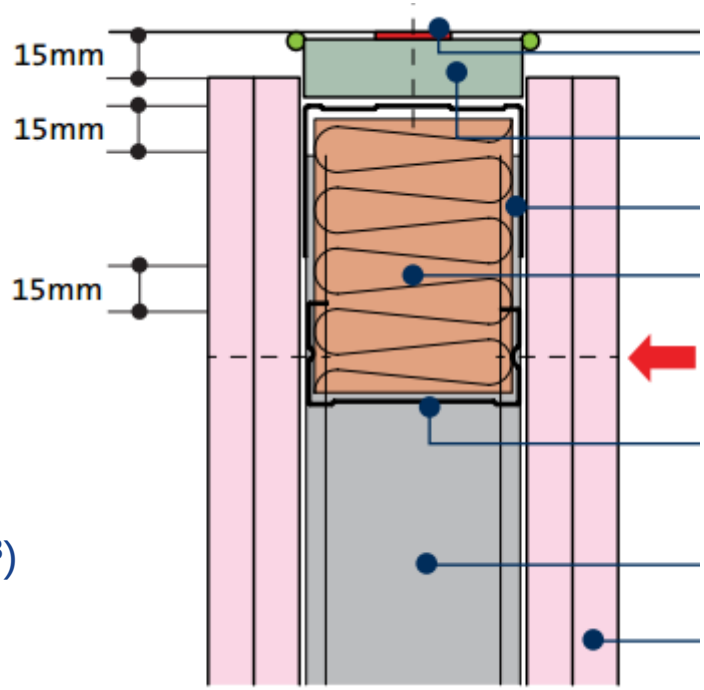
INCREASED FIRE RESISTANCES

Up to 60 minute requirements without additional material

90 minutes + require additional insulation and support

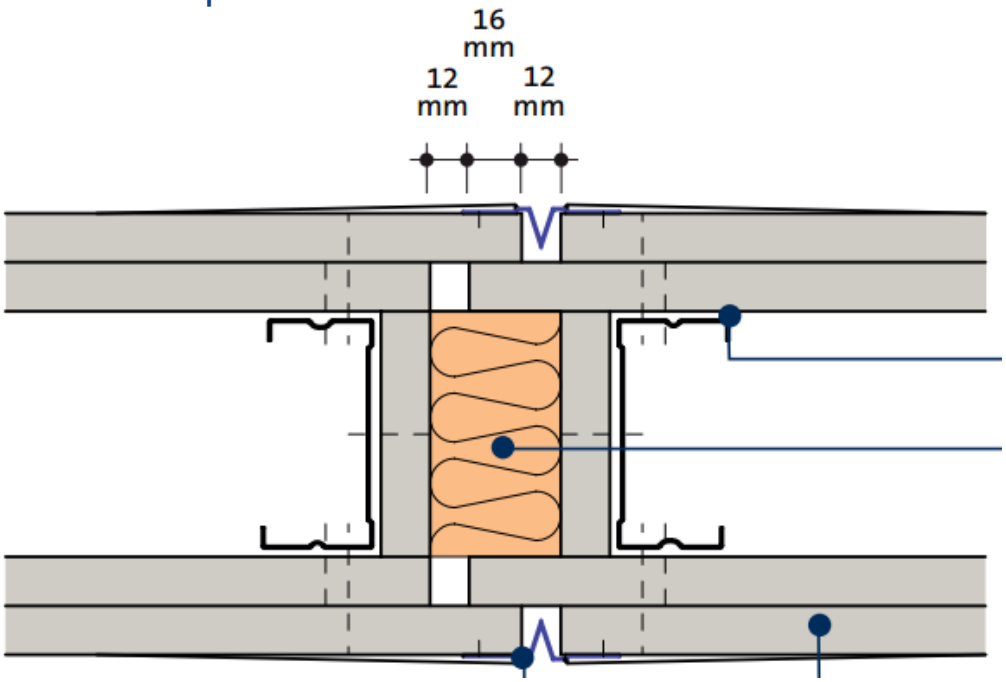
- Insulation – Stone mineral wool (minimum 33kg/m^3)
- Support provided by Stud or Channel nogging

Eliminates requirement for GFS1 Flat Strap



CONTROL JOINT DETAILS

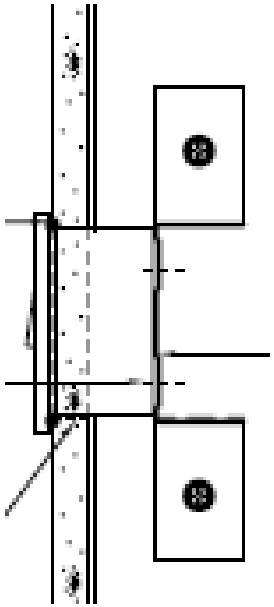
• Coincide with structural movement joints
or
• Long and continuous partitions

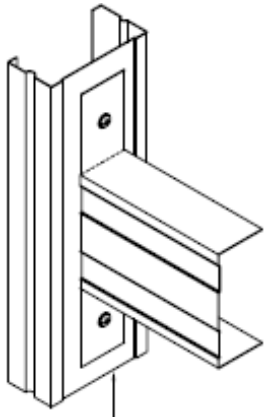


SOCKET BOX DETAILS

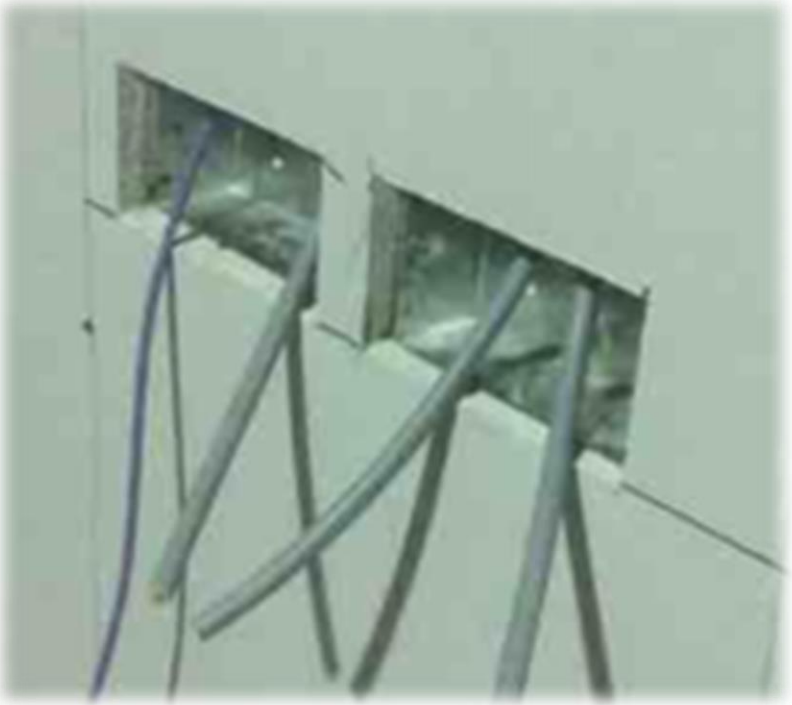
DETAILING UP TO 60 MINUTES

- No requirement for additional insulation
- Plasterboard cut neat around opening
- Metal backed box to engage with back of plasterboard (5mm minimum recommended)
- Stud nogging or timber to support socket box
- Gyproc Sealant applied around perimeter





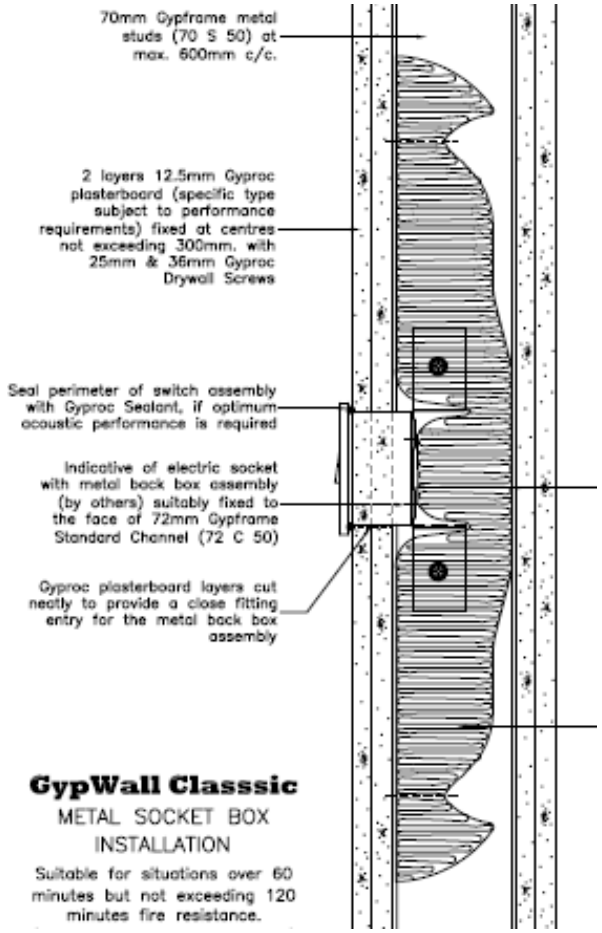
SOCKET BOX DETAILS



SOCKET BOX DETAILS

DETAILING OVER 60 MINUTES

Fire stopping insulation required

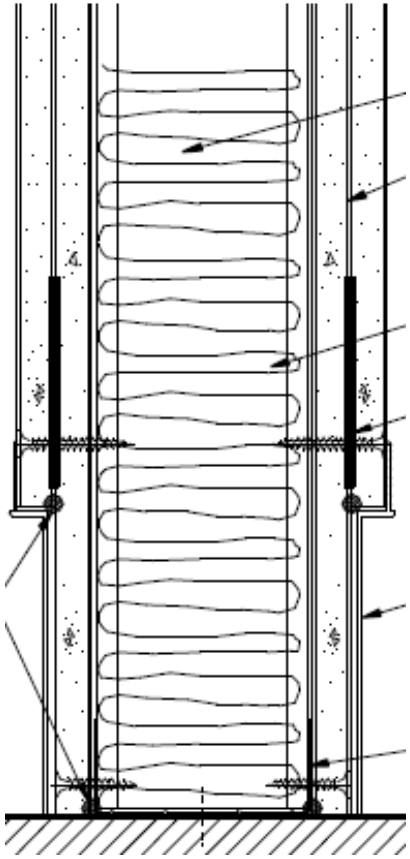


RECESSED SKIRTING

REMOVAL OF LAYER OF PLASTERBOARD WILL AFFECT SYSTEMS FIRE RESISTANCE

Options

- Use of sacrificial layer
- Upgrade inner layer of plasterboard
- Use of fire stopping by others



SHAFTWALL

SYSTEM REQUIREMENTS

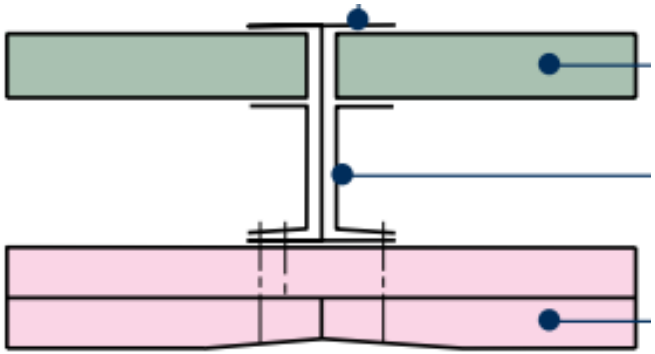
System installed entirely from one side only

- Offers fire resistance in both directions (not symmetrical)

‘I’ Studs at 600mm centres

‘J’ or EDC Channels should be used at head

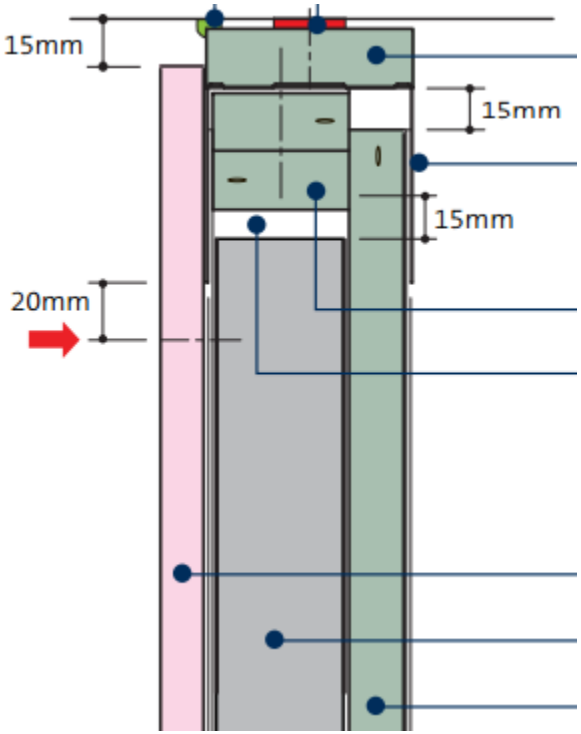
Retaining channels continuous

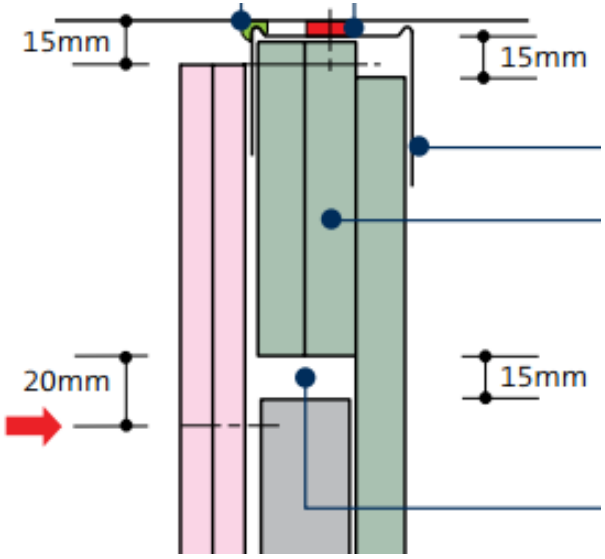


HEAD DETAILING

Standard details include allowance for 15mm downwards deflection

Additional fire-stops inside the channels required



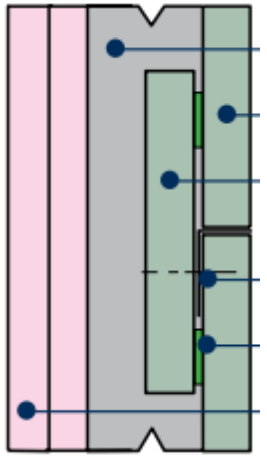


HORIZONTAL JOINTS IN COREBOARD

CoreBoard sections required to back horizontal joints

Gypframe GA3 Angle to provide grounds for screw fixings

Gypframe Sealant to bond and seal CoreBoard patress section.



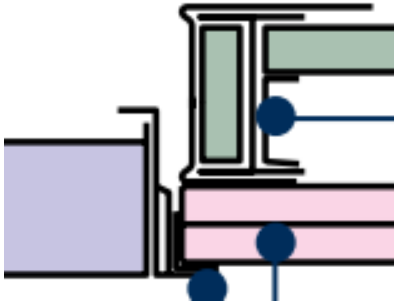
SHAFTWALL

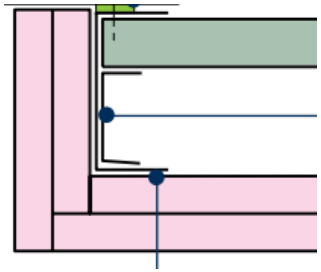
FRAMED OPENINGS

Require additional CoreBoard inside adjacent framing

Trapped within sleeved Floor & Ceiling Channel

Not required if facing boards returned around edges





Allowable variances

Test evidence as the reference test

Fire test rules allow certain changes to be made in the field of application

- Increasing the stud size
- Increasing the thickness of components
- Decreasing the stud centres
- Decreasing the fixing centres
- Increasing the number of vertical joints of the type tested
- Increasing the number of horizontal joints of the type tested

FIRE AND STRUCTURAL STEEL

BEHAVIOUR OF STEEL IN FIRE

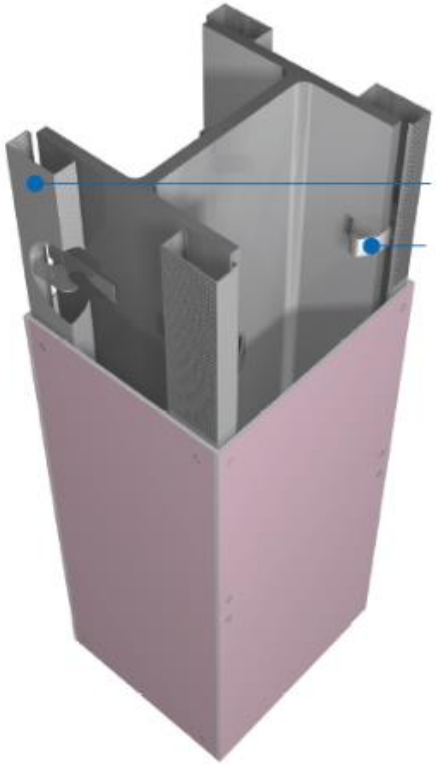
- Steel lose strength at temperatures above 300^{o}C
- Steel melts at about 1500^{o}C
- Loaded steel will lose it's **design margin of safety** at approximately **550^{o}C**
- Virtually all structural steel fire protection is designed to the **550^{o}C limiting temperature threshold**

STRUCTURAL STEEL SECTION FACTORS

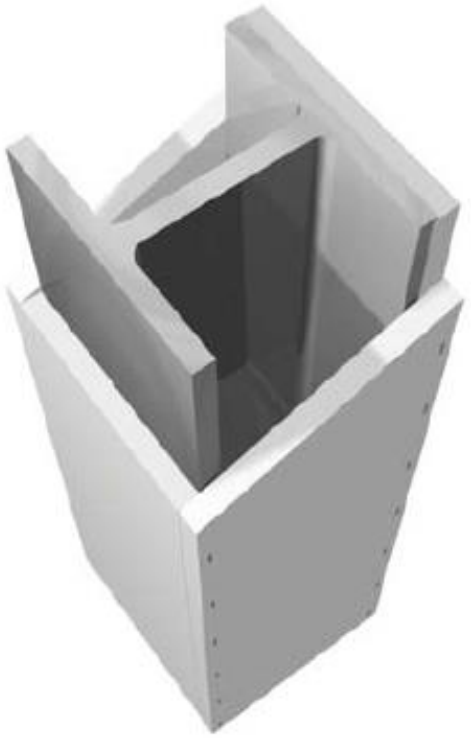
- Structural steel available in many profiles and weights
- The relationship (A) divided by (V) is called the '**Section Factor (m^{-1})**'

ENCASEMENT SYSTEMS

FRAMED



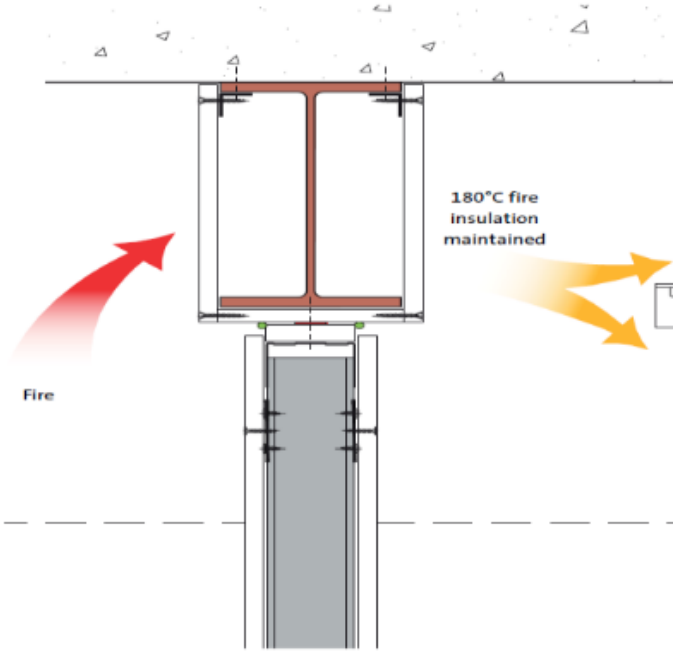
FRAMELESS



FIRE RESISTANCE & STRUCTURAL PROTECTION

BEWARE THE DIFFERENT CRITERIA

- Structural steel within the cavity of a partition
- Structural steel at the head of a partition



SUMMARY

UNDERSTAND THE PERFORMANCE CRITERIA REQUIRED

TAKE A SYSTEM APPROACH

USE OF APPROVED SYSTEMS

APPLICATION OF APPROVED DETAILS

SUPERVISION / INSPECTION / SIGN OFF

THANK YOU FOR YOUR ATTENTION

FOR FURTHER INFORMATION

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