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3 activities hubs
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Construction products
Building distribution

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ISOVER
weber
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SAINT-GOBAIN

A sound effect on people
STRUCTURAL FIRE PROTECTION

Broad or narrow definition?

STRUCTURAL FIRE PROTECTION MEASURES

- **Fire Prevention**
  - Design & Layout
  - Material Selection

- **Active Fire Protection**
  - Alarms
  - Sprinklers

- **Passive Fire Protection**
  - Compartmentalisation
  - Protection of structural elements

Narrow definition
The **minimum** standards of passive fire measures required within buildings other than dwellings are currently set out in the Building Regulations (2006), *Technical Guidance Document Part B: Fire Safety*

- Categorises buildings into purpose groups based on building size and use.
- Reduce the risk of fire growth and internal fire spread.
- Defines minimum periods of fire resistance.
- Controls the materials used to form the internal surfaces of the building.
Appendix A
Performance of Materials and Structures

For buildings designed in accordance with the Eurocodes, the performance specified must be achieved when tested in accordance with the European test methods.

For existing buildings the performance may be achieved by reference to the test methods set out in BS 476.
Introduction

1.0.1 The safety of a structure depends on the successful combination of design and execution…

The use of the Eurocodes referenced in this document is a practical guidance on meeting the Requirements of Part A.
EVERYTHING HAS CHANGED
BUT NOTHING IS DIFFERENT...
PLASTERBOARDS - INTERNAL FIT-OUTS

WALLS LININGS & PARTITIONS

FLOORS / CEILINGS

ENCASEMENT OF STRUCTURAL STEEL

1. Spread of fire within a building
2. Compartmentation
3. External fire spread
PLASTERBOARDS AND PASSIVE FIRE SYSTEMS

Reliant upon the appropriate selection of materials, constructions and design.

PASSIVE FIRE PROTECTION
- Containment of fire
- Preventing or slowing the spread of fire
- Maintaining the building structure
- Providing safe passage of escape / refuge

ACHIEVING PASSIVE PROTECTION
- Surface spread of flame → Products
- Fire resistances → Systems
- Fire protection to structural steel → Products or Systems
Gypsum plasters and boards provide good fire protection in buildings due to the unique behaviour of gypsum when exposed to fire.

Pure gypsum ($\text{CaSO}_42\text{H}_2\text{O}$)

- 21% chemically combined water ($2\text{H}_2\text{O}$)
- 79% calcium sulphate ($\text{CaSO}_4$)
- 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.
FIRE CURVES
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.
REATION TO FIRE - EUROCLASS

Euroclass rating - *EN 13501-1 Fire classification of construction products and building elements - Part 1*

Based on Single Burning Item (SBI) test method (BS EN 13823:2010+A1:2014)
Also includes tests relating to
- Non-combustibility (BS EN ISO 1182:2010)
- Heat of combustion test (BS EN ISO 1716:2010)
- Direct flame impingement test (BS EN ISO 11925-2:2010)

Three characteristics measured
- Reaction to fire – A1, A2, B, C, D, E, F
- Smoke Development – S1, S2, S3
- Burning Droplets – D0, D1, D2
## REACTION TO FIRE - FLAMMABILITY OF MATERIALS

### SURFACE SPREAD OF FLAME

<table>
<thead>
<tr>
<th>National classification</th>
<th>Category</th>
<th>Safety level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-combustible</td>
<td>A1</td>
<td></td>
</tr>
<tr>
<td>Material of limited combustibility</td>
<td>A2</td>
<td></td>
</tr>
<tr>
<td>Class 0</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Class 1</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Class 3</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Class 4</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Class 5</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

Plasterboards:
- **CE Marking – CPR**
- **EN 520**
- **DOP’s** (Declaration of performance)

Most rooms and circulation spaces

Bathrooms, toilets & shower rooms
PLASTERBOARDS

Manufactured in accordance with EN520

Gyproc WallBoard  Gyproc FireLine  Gyproc SoundBloc  Gyproc CoreBoard

Gyproc Plank  Gyproc Duroplast  Glasroc H tilebacker  Glasroc F Firecase

No plasterboard by itself offers a fire resistance

Manufactured in accordance with EN520

6mm  9.5mm  12.5mm  15mm  19mm

30 mins  60 mins  90 mins
FIRE RESISTANCE: SYSTEMS

- Components vs Systems
- BS or EN fire test substantiation?
Plasterboards used on a ceiling will be subject to more onerous fire conditions.
CHARACTERISTICS OF FIRE - DUCTS

Level of equivalent fire protection for vertical ducts will generally be greater than for horizontal ducts.

### FLAMES & HEAT

<table>
<thead>
<tr>
<th>Duct orientation</th>
<th>Fire class</th>
<th>EI15</th>
<th>EI30</th>
<th>EI60</th>
<th>EI90</th>
<th>EI120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td></td>
<td>30</td>
<td>40</td>
<td>60 (70)</td>
<td>70 (80)</td>
<td>80 (90)</td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td>40</td>
<td>50</td>
<td>80</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>
PLASTERBOARD INSTALLATION

Plasterboards need to be supported

Plasterboards need to be fixed
PLASTERBOARD INSTALLATION

Plasterboards need to be sealed

Contribution from other materials
Timber is a combustible material but….

When it burns the outer surfaces char
- Outer charred surfaces help to protect the inner core
- Slowing down the rate of degradation (15-25mm in 30 mins)

Timber has a low thermal expansion coefficient
- Minimises the possibilities of the outer charred layers being displaced

Timber has a low thermal conductivity
- Undamaged timber below the charred layer retains its strength
SYSTEM BASED SOLUTIONS

PLASTERBOARDS

+ FRAMING

+ FIXINGS

+ FINISHING

Certification

+ Installation

+ Detailing
FIRE RESISTANCE STANDARDS

**British Standards (BS)**


**European Standards (EN)**

- EN 1364-1: 2015 - Non-loadbearing walls (1999)
- EN 1364-2: 1999 - Non-loadbearing ceilings
- EN 1365-1: 2012 - Loadbearing walls (1999)
FIRE TESTS

Photo 1. View of the unexposed face at 30 minutes.
Claimed system performances typically in increments of 30 minutes

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

<table>
<thead>
<tr>
<th>Loadbearing Capacity:</th>
<th>37 minutes (Unable to support load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity:</td>
<td>37 minutes (By virtue of loadbearing capacity failure)</td>
</tr>
<tr>
<td>Insulation:</td>
<td>37 minutes (By virtue of loadbearing capacity failure)</td>
</tr>
</tbody>
</table>
FIRE RESISTANCE: BS VS EN

SEVERITY OF TESTING & APPLICATION

- EN fire testing methodology eliminates variances in furnace severity
  - Fuel sources
  - Furnace geometry

- EN fire testing uses plate thermometers to measure the heat flux

- EN fire testing subjects components and systems to more onerous conditions at the early stages of a test.

- EN fire test application is subject to stricter ‘Field of Application’ rules
  - Hot state heights

![Graph showing increase in severity between BS test and EN test over time][1]

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[1]: Image of a graph comparing the increase in severity between BS test and EN test over time, with a legend indicating "BS test" and "EN Test."
### Example Comparison of Test Results

#### 60 minute systems

<table>
<thead>
<tr>
<th>Test</th>
<th>Integrity</th>
<th>Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS test</td>
<td>113 minutes</td>
<td>69 minutes</td>
</tr>
<tr>
<td>EN Test</td>
<td>68 minutes</td>
<td>63 minutes</td>
</tr>
</tbody>
</table>

- **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

*No failure (test discontinued)*
FIELD OF DIRECT APPLICATION

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability.

(i) Decrease in height from 3000mm.

(ii) Increase in thickness of the wall (Minimum thickness 105mm).

(iii) Increase in thickness of component materials (minimum timber stud size 75mm x 38mm).

(iv) Decrease in linear dimensions of boards ($\leq 2400$mm long x $\leq 1200$mm wide Gyproc WallBoard).

(v) Decrease in stud spacing from 600mm.

(vi) Decrease in distance of fixing centres from 300mm.

(vii) Decrease in the applied load.

(viii) Increase in the partition width from 3000mm.
**FIELD OF DIRECT APPLICATION**

**Extension of Width**

The width of an identical construction may be increased as the specimen was tested at nominally 3000mm wide with one vertical edge without restraint.

**Extension of Height**

The height of constructions tested at a minimum of 3000mm, maybe increased to 4000mm at the following fire resistance periods as the lateral deflection was below 100mm.

<table>
<thead>
<tr>
<th>30 minutes</th>
<th>60 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100mm, :: 4000mm</td>
<td>&lt;100mm, :: 4000mm</td>
</tr>
</tbody>
</table>
GYPROC PLASTERBOARD LININGS ON EXAMPLE TIMBER FRAME CONSTRUCTION*

* This construction is specific to the relevant test evidence including loading, insulation and counter battens. Designers must ensure the tested system is consistent with the built construction.

Alternatives must be based on complete & relevant fire test evidence.
METAL STUD INTERNAL WALLS (NON-LOADBEARING)

Based on 70mm Gypframe ‘C’ Studs

- 30 minutes – 1 x 12.5mm WallBoard – Max height 3600mm
- 60 minutes – 2 x 12.5mm WallBoard – Max height 4600mm
- 90 minutes – 2 x 15mm WallBoard – Max height 4900mm

Limitations on height of tested samples
BASIC INSTALLATION REQUIREMENTS

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
BASIC REQUIREMENTS

TAPPING & 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
SERVICE OPENINGS

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
SERVICE OPENINGS
FIRE STOPPING OPENINGS
DEFLECTION HEADS

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

![Diagram of control joint details](image-url)
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

- Not suitable for back to back scenarios
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
ADDING IN THE DETAIL

IMPERFORATE SYSTEMS

- System performances are generally claimed as unpenetrated systems
- Detailing should be appropriate to maintain system performance requirements
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
SHAFTWALL

HEAD DETAILING

Standard details include allowance for 15mm downwards deflection

Additional fire-stops inside the channels required
SHAFTWALL

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
PLASTERBOARD ON CEILINGS

ROLE OF OTHER MATERIALS

SUPPORTING FRAMING

- Concrete
- Steel framing
- Solid timber joists of minimum dimensions
- Engineered / Web joists
- Suspended framing
PLASTERBOARD ON CEILINGS

ROLE OF OTHER MATERIALS

FLOORING SURFACE

- Minimum thickness
  - 18mm or 21mm T&G in most cases
- Plain edged vs Closed joints
- BRE 208 – T&G Equivalence
- 2 layers of flooring with staggered joints

- Need for insulation where no floor exists
- Insulation of correct type
Plain-edged floor boarding, or tongued and grooved boarding with significant shrinkage, contributes little to the overall performance of a floor and therefore the period of fire resistance of the floor is effectively the collapse time of the ceiling membrane. Tongued and grooved boarding with closed joints can contribute additional time to integrity and insulation. The addition of a hardboard or plywood surface enables a plain-edged boarded floor (or sub-standard t & g floor) to be considered as a good fitting t & g floor construction for the purposes of its maximum contribution to integrity and insulation.
PLASTERBOARD ON CEILINGS

CORRECT SCREW TYPE TO SUIT FRAMING

Minimum penetration

- 10mm Metal
- 25mm Timber

Maximum centres

- 230mm to all framing elements
- 150mm at board ends on suspended systems
PLASTERBOARD ON CEILINGS

TYPICAL SINGLE LAYER APPLICATION – STAGGERED JONTS
PLASTERBOARD ON CEILINGS

TYPICAL DOUBLE LAYER APPLICATION – STAGGERED LAYER

noggings may be required to support long edges of board of outer layer
NOGGINGS MAY BE REQUIRED

- Installed between primary joists
- To align with outer layer of plasterboards
- Located to align with transverse edges of plasterboards
- Minimum 38mm x 38mm timbers
FIRE AND STRUCTURAL STEEL

BEHAVIOUR OF STEEL IN FIRE

- Steel lose strength at temperatures above 300°C
- Steel melts at about 1500°C
- Loaded steel will lose its design margin of safety at approximately 550°C
- Virtually all structural steel fire protection is designed to the 550°C limiting temperature threshold
FIRE ASSESSMENT OF STRUCTURAL STEEL

STRUCTURAL STEEL SECTION FACTORS

• Structural steel available in many profiles and weights

• The rate at which steel sections heat up and hence lose strength is dependant on:
  - the surface area of steel exposed to the fire (A)
  - the amount of steel contained within the section (V)

• The relationship (A) divided by (V) is called the ‘Section Factor (m⁻¹)’
  - Also referred to as the exposed heated perimeter (Hp) divided by cross-sectional area (A)
FIRE ASSESSMENT OF STRUCTURAL STEEL

CALCULATING FIRE PROTECTION REQUIREMENTS

• Fire protection is determined by
  - The ‘Section Factor’ of the steelwork
  - The length of time fire protection is required
• Number of exposed sides is also considered
• Differences exist between ‘boxed’ and ‘profiled’ section factors

• Boarded encasements assessed using 3 or 4 sided boxed section factor (m⁻¹) of the steel
ENCASEMENT SYSTEMS

FRAMED

FRAMELESS
STRUCTURAL STEEL PROTECTION

ASSESSMENT

- Based on test evidence relating to the ‘section factor’ of structural steel sections
- Fire protection to EN standards may require greater levels of lining/coating

**EN 13381-4**

**BS 476: Part 20**
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

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