C02

Technical performance

Technical performance and principles of system design

This section provides guidance on the technical performance and principles of system design. Reference is made to relevant regulatory requirements and International Standard Organisation (ISO), European (EN) and British (BS) standards. It considers the various aspects of performance, both from a building theory and practical perspective

Technical performance and principles of system design

Introduction

Fire (▶ Refer to C02. S01. P16)

Fire performance includes fire resistance, fire protection and reaction to fire, which are relevant for compartmentation, structural steelwork and surface spread of flame respectively. The assessment of systems in accordance with both British Standard (BS) and European Standard (EN) fire testing criterion is acceptable for compliance with Building Regulations. However, it is important to recognise the impact of selecting EN over BS assessed systems. EN fire testing standards are more onerous and therefore a higher level of fire engineering is often required when compared to equivalent BS compliant specifications.

Building acoustics (▶ Refer to C02. S01. P21)

Building acoustics includes both sound insulation (airborne and impact) and sound absorption. A key design aspect is how the drylined building element interacts with the associated structure. If this is ignored, the performance of the element can be completely nullified. The key factors that are covered include gap sealing, why it is preferable to take the partition through to the structural soffit, and why it is important to design out flanking sound transmission.

Robustness (▶ Refer to C02. S01. P37)

Consideration needs to be given to the robustness of drylining systems, particularly if required to resist crowd pressure, impacts and abrasions and wind loading. The stiffness of a partition is critical to this and is therefore considered when determining the recommended maximum height.

Service installations (▶ Refer to C02. S01. P41)

Drylining elements need to be fully compatible with building services such as electrical, plumbing, heating and ventilation etc. This means that service installation should be fully assessed at the design stage to ensure that the layout of the services is compatible with the ceiling module or location of stud work. Furthermore, the weight of fixtures and fittings must be considered at the design stage to ensure that the appropriate system with correct detailing is specified.

Thermal insulation and condensation (▶ Refer to C02. S01. P49)

Thermal comfort within a building is primarily dictated by the constructed elements ability to provide thermal insulation and maintain air-tightness combined with the heating and ventilation strategy adopted.

It is also important that appropriate vapour control measures are applied to manage the risk of condensation that can lead to poor occupancy health and building durability.

Good air quality and fabric energy efficiency assist in optimising the performance of the building.

Sustainability (▶ Refer to C02. S01. P57)

Commitment to sustainability and minimising impacts on valuable natural resources is fundamental to our policies and is recognised in many ways, for example, the achievement of *ISO 14001* and *BES 6001* third party certification. Use of our products and systems not only gives sustainable assurances but can also assist designers in meeting specific criteria within a number of different environmental and sustainability standards and schemes e.g. BREEAM, LEED and the Irish Green Building Council's Home Performance Index (HPI) system.

Notably, our lightweight products and systems are highly suitable for low impact alterations to buildings, in particular gypsum is a natural product and may be fully recycled. Gypframe metal components may also be reused or recycled and similarly Isover mineral wool insulation may be reused.

Technical performance and principles of system design

Fire

Legislation, guidance and insurance

Building Regulations - Fire Safety

Technical Guidance Document B (RoI) and Technical Booklet E (NI) are among the series of approved documents that provide practical guidance on meeting the fire safety requirements of Building Regulations.

The documents classify the use of a building into purpose groups and specify minimum periods of fire resistance to be achieved by the building elements. The periods of fire resistance vary according to the classification and the size of building. The greater the fire hazard a building presents, then the greater the period of fire resistance required to protect the elements within the building. The materials used to form the internal surfaces of the building are also controlled to reduce the risk of fire growth and internal fire spread.

Healthcare buildings

Hospitals and healthcare environments by their very nature contain people who are at risk from fire. Health Technical Memorandum (HTM) 05 series UK documents may also be useful in the fire safety design of healthcare facilities. These documents provide guidance on the standards of fire safety expected in healthcare facilities and include recommendations on internal fire spread, elements of structure, compartmentation, fire hazard areas, hospital streets, penetrations, protected shafts, ceiling membranes, cavity barriers and fire-stopping.

Educational buildings

The design of fire safety in schools is covered by TGD 021 from the Department of Education & Skills (RoI) and Building Bulletin 100 UK may also be useful.

Fire protection for structural steel in buildings, ASFP Yellow Book

Publication prepared by the members of the Association for Specialist Fire Protection (ASFP). Presenting the theory behind, and methods for, fire protection of structural steelwork to comply with Building Regulations. It provides a comprehensive guide to proprietary materials and systems, all of which are manufactured, marketed or applied on site by members of ASFP.

Principles of fire performance

Fire growth

The choice of materials for walls and ceilings can significantly affect the spread of fire and its rate of growth through a building, even though they are not likely to be the materials first ignited. The specification of linings is particularly important in circulation spaces where surfaces may offer the main means by which fire spreads, and where rapid spread is most likely to prevent occupants from escaping.

Two properties of lining materials that influence fire spread are:

- The rate of flame spread over the surface when it is subject to intense radiant heating
- The rate at which the lining material gives off heat when burning

Compartmentation

The spread of fire within a building can be restricted by sub-dividing it into compartments separated from one another by walls and/or floors of designated fire resisting construction.

The two key objectives are:

- To prevent rapid fire spread, which could trap occupants within the building
- To reduce the chance of fires becoming large, which is more dangerous – not only to occupants and fire service personnel, but also to people in the vicinity of the building

The appropriate degree of sub-division depends on:

- The use and fire loading of the building, which affects the potential for fires and their severity, as well as the ease of evacuation
- The height to the floor of the top storey in the building, and the maximum distance from a route of safe passage, which is an indication of the ease of evacuation and the ability of the fire service to intervene effectively

Technical performance and principles of system design

Fire (continued)

Structural fire precautions

Premature failure of the structure can be prevented by fire protecting loadbearing elements.

The purpose in providing the structure with fire resistance is:

- To minimise the risk to the occupants, some of whom may have to remain in the building for some time (particularly if the building is a large one), while evacuation proceeds
- To reduce the risk to fire fighters engaged on search and rescue operations
- To reduce the danger to people in the vicinity of the building who may be hurt by falling debris, or because of the impact of the collapsing structure on other buildings

Fire limit state

In structural design terms, fire is considered to be an accidental limit state, i.e. an accidental occurrence, and one for which the structure must not collapse. Loads and their factors of safety used in design at the fire limit state reflect the low probability of occurrence.

Typically, structural members that are designed to be fully stressed under normal conditions would be subject to a load ratio of 0.5 to 0.6 under fire conditions. Within this book, loadbearing floors and partitions are quoted with respect to a stated load ratio. Many constructions have been tested at a conservative load ratio of 1.0 (100%) despite the fire state being an accidental load.

Structural behaviour of timber in fire

Although it is combustible, the charring that occurs around timber when it is exposed to fire helps to slow down its rate of degradation and maintain its structural capacity. Timber has a low thermal expansion coefficient, which minimises the possibility of protective layers and charred materials becoming displaced. It also has a low thermal conductivity, which means that undamaged timber immediately below the charred layer retains its strength. Generally, it may be assumed that timber will char at a constant rate when subjected to the standard heating conditions of the test furnace. The rate of reduction in the size of structural timber can be taken as 15mm to 25mm (depending on species) in 30 minutes for each face exposed; different rates apply where all faces are exposed. The undamaged timber can be assessed for structural stability using standard design guides in conjunction with stress modification factors.

For partitions tested with high load ratios it should be noted that when the timber is exposed to fire, the exposed face will shrink causing differential thermal movement. This can be important for axially loaded sections, as it introduces a degree of eccentricity, which may cause a loss of loadbearing capacity.

Structural behaviour of steel in fire

Steel generally begins to lose strength at temperatures above 300°C and eventually melts at about 1500°C. Importantly for design, the greatest rate of strength loss is in the range of 400°C to 600°C.

Using fire design codes such as the Structural Eurocodes EC3-1.2 and EC4-1.2 (designated *BS EN 1993-1-2: 2005* and *BS EN 1994-1-2: 2005*), the load on the structure at the time of the fire can be calculated by treating it as an accidental limit state. If used, this will allow designers to specify to the fire protection contractor a limiting or failure temperature for a given structural section. The fire protection contractor will then be able to use the required thickness of material to ensure that the steel section does not exceed this temperature within the fire resistance period. This process could be simplified by the designer specifying a maximum steel temperature, based on the worst case, for all beams or columns on one floor level.

Buildings that are not primarily used for storage, e.g. offices, residential units, schools and hospitals, have a high percentage of non-permanent loads. For this type of building, the structural Eurocode *BS EN 1991-1-1: 2002* assumes that a proportion of the design load will not be present at the time of the fire. Other types of buildings, such as warehouses and libraries, are primarily used for storage, so a high percentage of the load is permanent. The codes allow for no reduction in design load for the fire condition.

The fire testing standards effectively base the failure criteria for loadbearing elements on strength. However, beams should be designed at the fire state limit as well at in the cold state limit.

Columns are frequently designed so that a single length will be two or three storeys high. The lowest storey will be loaded; the highest and the upper storey will be lightly loaded. In buildings with a degree of non-permanent load (in terms of duration and magnitude), the load ratio of the structural members is unlikely to be greater than 0.6. In storage buildings, where the majority of load is permanent, the load ratio would normally be higher, but is unlikely to be greater than 0.65.

In C03. S01. P67 – Steelwork encasement systems, the thicknesses of protection required are specified for design temperatures of 550°C, unless otherwise stated. It is the responsibility of the design engineer, using design codes such as *BS EN 1993-1-2: 2005*, to specify the appropriate limiting steel temperatures.

The loss of strength of cold-formed steel at elevated temperatures exceeds that of hot-rolled steel by between 10% and 20%. Expert advice should be sought in determining the strength reduction factor at the limiting temperature.

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Fire (continued)

Why gypsum is so effective in fire

Our plasters, plasterboards and specialist boards provide good fire protection due to the unique behaviour of gypsum in fire. When gypsum-protected building elements are exposed to fire, dehydration by heat (calcination) occurs at the exposed surface and proceeds gradually through the gypsum layer.

Calcined gypsum on the exposed faces adheres tenaciously to uncalcined material, retarding further calcination which slows as the thickness of calcined material increases. While this continues, materials adjacent to the unexposed side will not exceed 100°C, below the temperature at which most materials will ignite, and far below the critical temperatures for structural components. Once the gypsum layer is fully calcined, the residue acts as an insulating layer while it remains intact.

Gypsum products are excellent performers in terms of reaction to fire, as the endothermic hydration reaction requires energy to be taken from the fire, so gypsum is a negative calorific contributor.

Fire resistance test standards

Building Regulations and supporting documentation require elements of structure and other building elements to provide minimum periods of fire resistance, expressed in minutes, which are generally based on the occupancy and size of the building.

Fire resistance is defined in 'the ability of an element of building construction to withstand exposure to a standard temperature / time and pressure regime without loss of its fire separating function or loadbearing function or both for a given time' (*BS 476: Part 20: 1987*).

The fire separating function of a construction is defined as the integrity and insulation performance.

- **Integrity** is the ability of a separating element to resist collapse, the occurrence of holes, gaps or cracks through which flames and hot gases could pass and sustained flaming on the unexposed face.
- **Insulation** is the ability of a separating element to restrict the temperature rise of the unexposed face to below specified levels.
- **Loadbearing function** is the ability of the loadbearing element to support its test load without deflecting beyond specified limits.

Conformance with Building Regulations can be demonstrated with test reports showing the system has been tested for the imperforate system in accordance with European (EN) or British (BS) fire resistance test standards, however, for service penetrations or other junctions, please check with the Gyproc technical department where such details are required to meet the European Norm.

EN fire resistance test standards

The Construction Products Regulation (CPR) within European legislation is designed to enable free trade across Europe in construction products. To enable free trade, harmonised test standards for technical performance are required. The area of technical performance most affected by this requirement is fire performance.

Fire resistance methods used across Europe were similar but the severity of furnaces varied due to factors such as different fuel sources and furnace geometry. To improve consistency between different furnaces, plate thermometers were introduced to measure the heat flux to which samples are exposed. The use of plate thermometers means the EN fire resistance test can be more severe, especially during the first 30 minutes of exposure when compared with BS fire resistance tests.

EN fire resistance test standard also imposes strict rules governing the use of tests to cover specific end use scenarios (field of application). This restricted field of application has most effect on partitions that are built with heights above 4m, as they may need to have enhanced levels of fire protection.

To claim up to 3m, the partition has to be tested at a height of 3m in the fire resistance test. To claim up to 4m, the partition has to pass the test with a partition test height of 3m and not deflect laterally by more than 100mm during the test.

To claim above 4m, the partition has to undergo an engineering appraisal where the thermal bow and strength loss of the steel studs are taken into account. This means that the same partition may have different quoted heights at different fire resistance durations. The only alternative to using an engineering appraisal is to conduct a test at the height under consideration.

We have conducted an extensive series of EN fire resistance tests on partitions with heights up to 6m. Data from these tests are used within the performance tables. Insulation materials, such as glass and stone mineral wool, can affect the fire resistance of a partition. These materials can provide additional insulation / integrity performance but can also increase the thermal bow of the partition and therefore reduce the partition height that can be claimed. Consequently, within the performance tables, there are instances where the partition height is reduced when a quilt is included within the cavity of the partition. It cannot be assumed that adding a quilt to a partition specification will not impact on its fire resistance.

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Fire (continued)

EN fire resistance and its application to Gyproc systems

The EN fire resistance periods claimed for systems in this document are evaluated in accordance with the relevant EN fire resistance test standards.

BS EN 1364-1: 2015
Specifies a method for determining the fire resistance of non-loadbearing walls.

BS EN 1365-1: 2012
Specifies a method for determining the fire resistance of loadbearing walls.

BS EN 1365-2: 2014
Specifies a method for determining the fire resistance of loadbearing floors and roofs.

BS EN 1364-2: 1999
Specifies a method for determining the fire resistance of non-loadbearing ceilings.

BS EN 13381-4: 2013
Test methods for determining the contribution to the fire resistance of structural members: Applied protection to steel members.

ENV 13381-2: 2014
Test methods for determining the contribution to the fire resistance of structural members. Vertical protective membranes.

BS fire resistance test standards

As both EN and BS fire resistance standards are acceptable for showing compliance with Building Regulations, this book shows tables for systems tested in accordance with both EN and BS standards.

Unlike the EN test standards the BS test standards do not impose restrictions with respect to maximum partition height. Within the *BS 476: Part 22* testing regime, the partition height in the fire state is not considered, and if a partition passes the fire test at 3m it is deemed to be suitable in fire resistance terms for any possible heights. Under the BS system, the cold state height would be the maximum height claimed regardless of the fire duration required.

BS fire resistance and its application to Gyproc systems

The BS fire resistance periods claimed for systems in this document are evaluated in accordance with the relevant BS fire resistance test standards.

BS 476: Part 20: 1987
Describes the general procedures and equipment required to determine the fire resistance of elements of construction.

BS 476: Part 21: 1987
Describes the specific equipment and procedures for determining the fire resistance of loadbearing elements.

BS 476: Part 22: 1987
Describes the procedures for determining the fire resistance of non-loadbearing elements.

BS 476: Part 23: 1987
Describes the specific equipment and procedures for determining the contribution made by components to the fire resistance of structures.

Reaction to fire test standards

Reaction to fire is the measurement of how a product will contribute to the development and spread of a fire.

The choice of materials for walls and ceilings can be of critical importance when designing a building especially in spaces which occupants will use when escaping from a potential fire.

EN reaction to fire

The European Classification System (Euroclass), devised for the classification of ‘reaction to fire’, has been introduced as part of the ongoing harmonisation of European standards. Reaction to fire has traditionally been assessed using at least 30 different national standards across Europe. The Euroclass system includes tests designed to better evaluate the reaction of building products to fire.

The Euroclass system predicts the performance of building materials in a real fire more accurately than the British Standard classification system.

The Euroclass test methodology is built around the Single Burning Item (SBI) test method (BS EN 13823: 2010+A1:2014), which is an intermediate scale test to evaluate the rate of fire growth from a waste paper basket fire positioned in the corner of a room.

Other tests used in the classification system are the non-combustibility test (*BS EN ISO 1182: 2010*), heat of combustion test (*BS EN ISO 1716: 2010*) and direct flame impingement test (*BS EN ISO 11925-2: 2010*).

The overall reaction to fire performance of a construction product or building element is presented in a classification report in accordance with *BS EN 13501-1: 2007*. This report uses the results from the relevant test methods and determines the Euroclass category rating for the product.

Gypsum products are intrinsically fire safe products and generally fall into the higher Euroclass classifications. Plasterboard is subject to a ‘classification without further test’ decision. This means that any type of plasterboard can be classified as A2, so long as the paper grammage of the

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Fire (continued)

liner does not exceed 220g/m² and the core of the board is classified as A1 (non-combustible). Any plasterboard product with a paper liner in excess of this grammage is required to be tested.

All our plasterboard products manufactured in accordance with *BS EN 520: 2004* are designated Euroclass A2. All our Glasroc products manufactured in accordance with *BS EN 15283-1: 2008* are designated Euroclass A1.

BS reaction to fire

The British Standard classification system determines the reaction to fire performance of a product based upon the performance in the fire tests *BS 476 Parts 4, 6, 7, and 11*. These fire test methods are material tests and measure the characteristics of the surface of the material, whereas the EN tests are measurements of the performance of the construction product in an arrangement representative of end use.

To help provide maximum fire safety in buildings, certain building elements need to be constructed of non-combustible materials. A building material is designated as non-combustible if it satisfies performance criteria when tested in accordance with:

BS 476: Part 4: 1970 (1984) Non-combustibility test for materials.

BS 476: Part 11: 1982 (1988) Method for assessing the heat emission from building materials.

Glasroc boards are designated as non-combustible materials. Some construction products can be described as materials of limited combustibility provided they satisfy the following requirements:

(a) Any non-combustible material (listed in Technical Guidance Document B, section A18 (RoI) or Technical Booklet E, section 1.9 (NI)).

(b) Any material of density 300kg/m³ or more, which does not flame or cause a 20°C temperature rise when tested to *BS 476: Part 11 under national classes.*

(c) Any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick. Where a flame spread rating is specified, these materials must also meet the appropriate test requirements under National classes.

d) a material classed as A2-s3,d2 per BS 13501-1 under European classification.

Gyproc plasterboards are all designated materials of limited combustibility or greater.

Surface spread of flame

Flame spread over wall and ceiling surfaces is controlled by providing materials that are either non-combustible or materials of limited combustibility. Combustible materials (or certain materials of limited combustibility that are composite products) when tested to the standard below, are classified Class 1, 2, 3 or 4. Class 1 provides the greatest resistance to surface spread of flame:

BS 476: Part 7: 1997 Surface spread of flame tests for materials.

The exposed surfaces of our plasterboards and specialist boards are all designated Class 1.

Fire propagation

Investigations concerned with the growth of fires in buildings show that the surface spread of flame test does not measure all the properties that are relevant for placing combustible materials in the proper order of hazard. Such considerations led to the test which is described in *BS 476: Part 6: 1989 Method of test for fire propagation for products*. This test takes into account the amount and rate of heat evolved by a specimen whilst subjected to a specified heating regime in a small furnace. The standard describes the method of calculating the results to obtain indices of performance, which help to determine the suitability of combustible wall and ceiling lining materials when used in areas requiring maximum safety.

Class 0

In addition to the degree to which combustible materials used as wall and ceiling linings can contribute to the spread of flame over their surfaces, consideration must also be given to the amount and rate of heat evolved by these materials when used in areas requiring maximum safety. Building Regulations, by means of associated documentation, make provisions that wall and ceiling surfaces must be Class 0 in circulation spaces (which are often escape routes) and in other specific situations.

In Technical Guidance Document B (RoI) or Technical Booklet E (NI), a Class 0 material is defined as either:

(a) composed throughout of materials of limited combustibility (this term includes non-combustible materials)
or
(b) a Class 1 material that has a fire propagation index (I) of not more than 12 and a sub-index (i1) of not more than 6.

Materials of limited combustibility are those achieving an EN reaction to fire classification of A2-s3, d2 or greater.

For further information, please refer to Technical Guidance Document B (RoI) or Technical Booklet E (NI). The exposed plasterboard surfaces of Gyproc specialist boards are designated Class 0 in accordance with current building regulations.

Although Class 0 is the highest performance classification for lining materials, it is not a classification identified in any harmonised test or standard.

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Building acoustics

Principles of building acoustics

Building acoustics is the science of controlling noise in buildings, including the minimisation of noise transmission from one space to another, and the control of noise levels and characteristics within a space.

Noise can be defined as sound that is undesirable, but it can be subjective and depends on the reactions of the individual. When a noise is troublesome, it can reduce comfort and efficiency. If a person is subjected to noise for long periods, it can result in physical discomfort or mental distress. Within homes, a noisy neighbour can be one of the main problems experienced in attached housing. It's estimated that up to 300,000 people in Ireland have had their lives disturbed by noisy neighbours.

The best defence against noise is to ensure that proper precautions are taken at the design stage and during construction of the building. The correct acoustic climate must be provided in each space, and noise transmission levels should be compatible with the building's usage. Retrofitted remedial measures taken after occupation can be expensive and inconvenient.

The term 'building acoustics' covers both sound insulation and sound absorption.

Sound insulation

Sound insulation is the term describing the reduction of sound that passes between two spaces separated by a dividing element.

In transmitting between two spaces, the sound energy may pass through the dividing element (direct transmission) and through the surrounding structure (indirect or flanking transmission). When designing for optimum sound insulation, it's important to consider both methods of transmission. The walls or floors, which flank the dividing element, constitute the main paths for flanking transmission, but this can also occur at windows, doorways, heating or ventilation ducts, for example.

The acoustic environment of the room and/or the building, and the ability to reduce or eliminate air paths in the vicinity of the sound reducing element, these include doorsets, glazing, suspended ceiling cavities, ductwork, etc. will have a significant effect on its performance. For these reasons it is unlikely that figures quoted from laboratory test conditions will be achieved in practice. When the background noise is low, consideration may have to be given to a superior standard of sound insulation performance in conjunction with the adjoining flanking conditions.

In any existing sound insulation problem, it is essential to identify the weakest parts of the composite construction.

The Building Regulation requirements regarding the sound insulation of walls and partitions only relate to the transmission of airborne sounds. These include speech, musical instruments, loudspeakers and other sounds that originate in the air. In most cases, floors must also resist the transmission of impact sounds, such as heavy footsteps and the movement of furniture.

Indirect paths (flanking transmission)

Flanking sound is defined as sound from a source room that is not transmitted via the separating building element. It is transmitted indirectly via paths such as windows, external walls and internal corridors. Refer to figure 1.

It is imperative that flanking transmission is considered at the design stage and construction detailing is specified so as to eliminate or at least to minimise any downgrading of the acoustic performance. The sound insulation values quoted in system performance tables are laboratory values and the practicalities of construction will mean that acoustic performances measured in the laboratory will be difficult to achieve on site.

One of the main reasons for this difference is the loss of acoustic performance via flanking transmission paths. Good detailing at the design stage will minimise this effect and optimise the overall levels of acoustic privacy achieved.

If designing for residential units, design advice on flanking details must be followed to maximise the possibility of achieving the specified acoustic performance. It is imperative that the design advice is followed, otherwise site sound insulation values may not meet the minimum standards required by Building Regulations and expensive remedial treatment will be required.

Small openings such as gaps, cracks or holes will conduct airborne sounds and can significantly reduce the sound insulation of a construction. For optimum sound insulation a construction must be airtight. Within masonry construction, most gaps can be sealed at the finishing stage using Gyproc Airtite Quiet, Gyproc plaster or Gyproc jointing compounds. At the base of the partition, gaps will occur, particularly when boards are lifted tight to the ceiling. Small gaps or air paths can be sealed with Gyproc Sealant.

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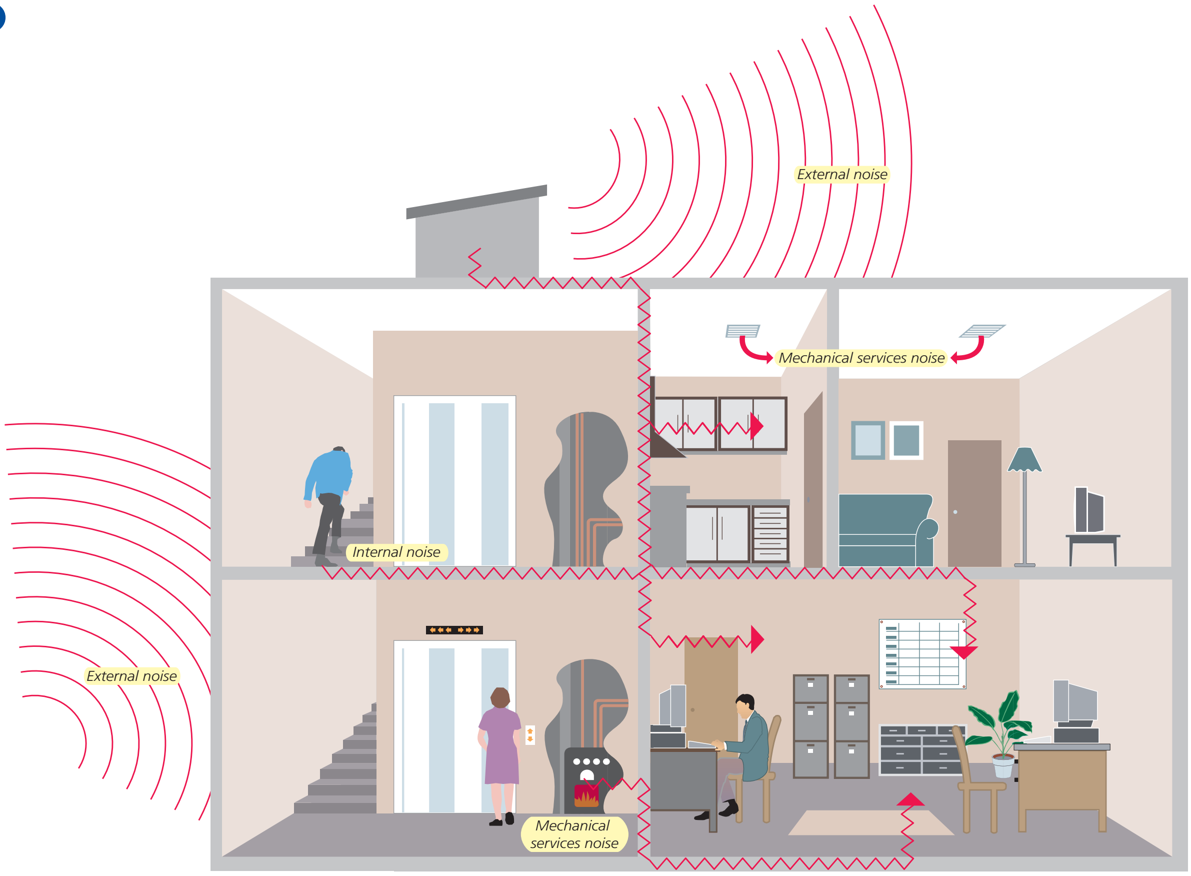
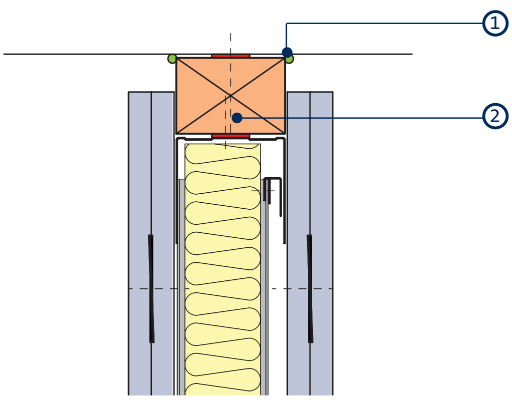
Building acoustics (continued)

1



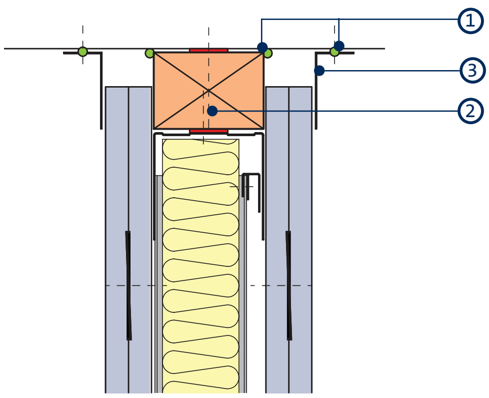
Common flanking paths

2



Deflection head A (subject to fire performance)

3



Deflection head B (subject to fire performance)

1 Gyproc Sealant for optimum sound insulation

2 50mm timber head plate equivalent to channel width forming fire-stop

3 Gypframe GA4 Steel Angle to minimise loss of sound insulation performance due to air leakage

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Building acoustics (continued)

Acoustic performance of deflection head details

Deflection heads, by definition, must be able to move and, therefore, achieving an airtight seal is very difficult without incorporating sophisticated components and techniques. Air leakage at the partition heads will have a detrimental effect on acoustic performance of any partition.

The approach shown in figure 2 could, for example, result in a loss of around 4dB to 5dB due to air leakage, in addition to any performance lost due to flanking transmission.

Where acoustic performance is a key consideration, steps can be taken to minimise this loss of performance. Figure 3 shows the generally accepted method of achieving this and, provided that care is taken to ensure a tight fit between the cloaking angle and lining board surface, the loss in performance can be reduced.

Other factors, such as flanking transmission through the structural soffit, can significantly affect the overall level of sound insulation. Therefore, other measures may need to be taken.

- A suspended ceiling installed on both sides of the partition may provide a similar cloaking effect to that of steel angles
- CasoLine MF incorporating imperforate plasterboard can deliver a similar reduction in air leakage at the partition head. A tight fit between the ceiling perimeter and the surface of the partition lining board is important, although mechanically fixed perimeters are not essential

Ceilings with recessed light fittings may be less effective and if these cannot be sealed in some way, the installation of cloaking angles at the partition head should be considered. A suspended ceiling may also reduce the level of sound flanking transmission via the soffit.

Where perforated ceilings are used, e.g. Gyptone, the angles as shown in figure 3 are recommended. However, if the distance between the ceiling and the deflection head is greater than 200mm, and the ceiling plenum contains Isover insulation (minimum 25mm), the angles may not be required.

Partition to structural steelwork junctions

When designing the layout of rooms requiring separation by sound insulating walls abutting structural steelwork, consideration should be given to the potential loss of sound insulation performance through the steelwork.

Figures 4 to 7 are example details relating to a typical scenario where a partition is specified against a requirement of R_w 50dB. Although these details refer to structural steel column abutments, similar principles apply when abutting structural steel beams. We recommend that these details are checked by an Acoustic Consultant, in particular the performance via the flanking structure.

Sound by-passing a partition via the void above a suspended ceiling

This is a common source of sound transmission, particularly where the ceiling is absorbent to sound. Sound can easily travel through a perforated tile, or lightweight suspended ceiling, and over the top of a partition where it abuts the underside of the suspended ceiling. Where sound insulation is important, partitions should, wherever possible, continue through the ceiling to the structural soffit, and be sealed at the perimeter junctions. Gyproc plasterboard suspended ceilings offer better insulation where partitions must stop at ceiling level to provide a continuous plenum. In this instance, a cavity barrier can be incorporated above the ceiling line.

Figures 8 to 11 show the stages of sound insulation improvement for typical ceiling/high performance partition junctions. The best result is achieved by running the partition through to the structural soffit.

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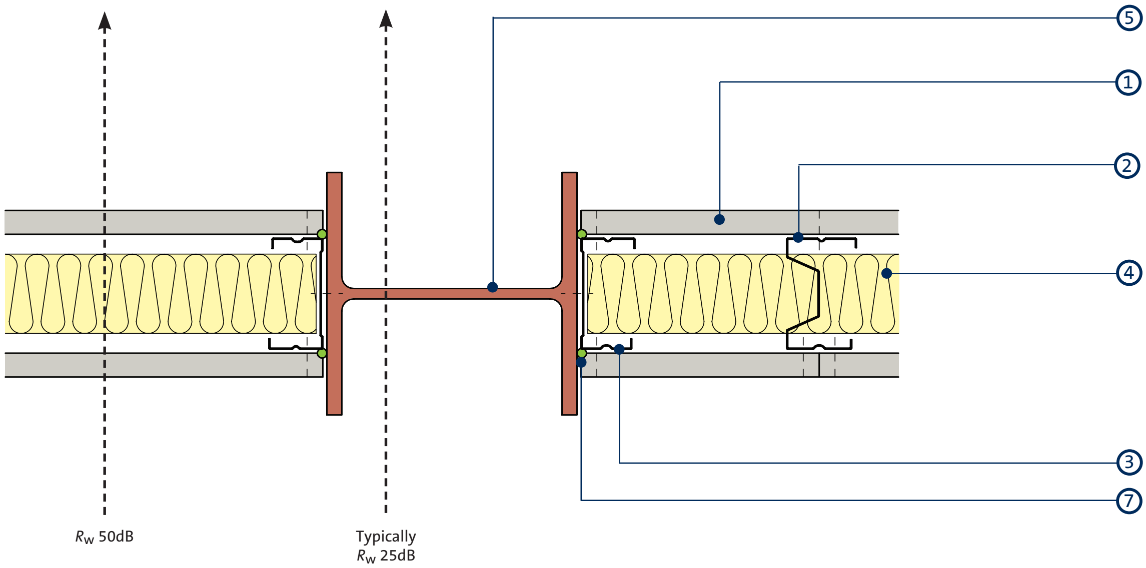
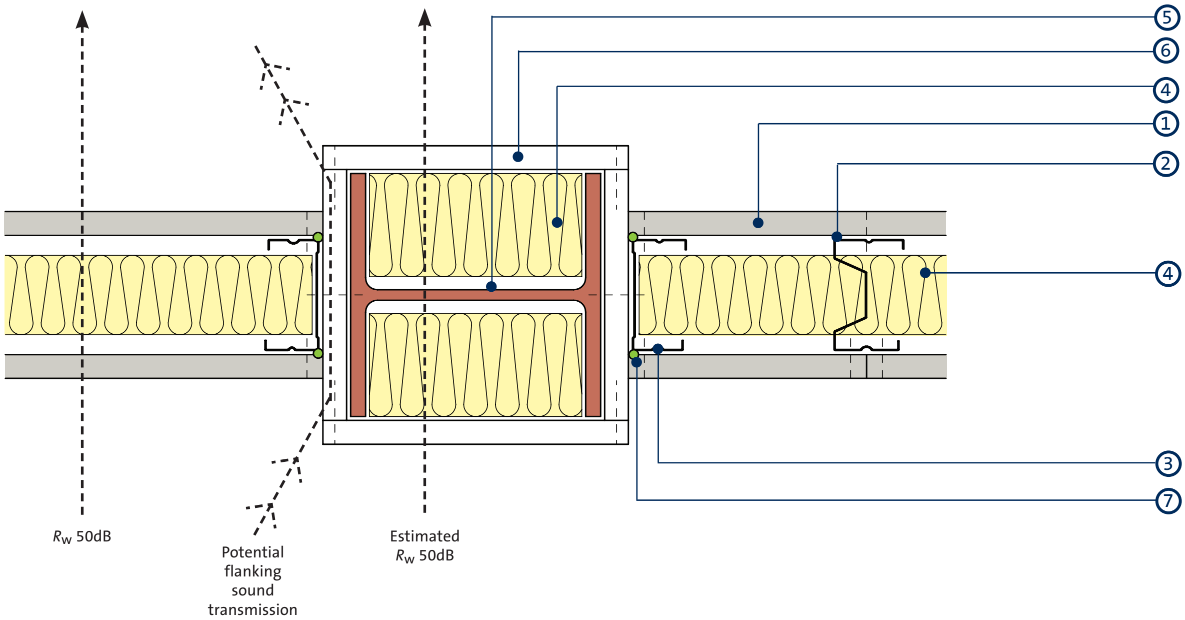
Building acoustics (continued)

4



Exposed / painted steel column

5



Encased steel column

1 Gyproc DuraLine
2 Gypframe AcouStud
3 Gypframe 'C' Stud
4 Isover acoustic insulation
5 Structural steel
6 Glasroc F FIRECASE
7 Gyproc Sealant

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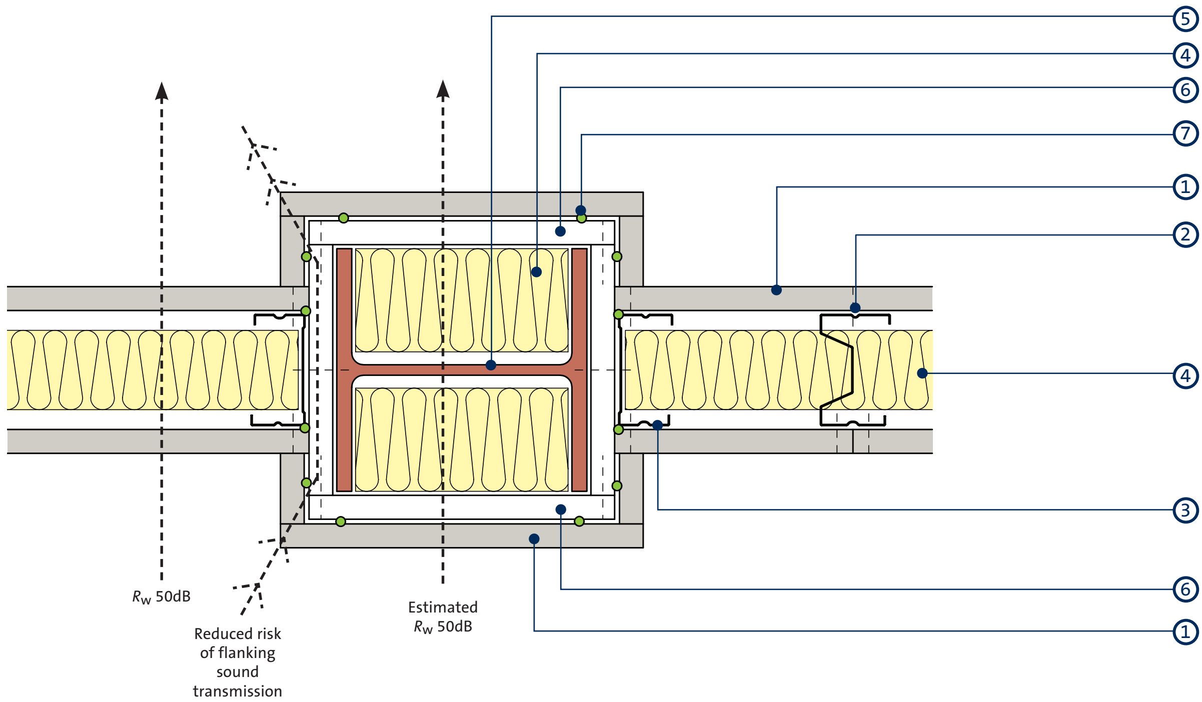
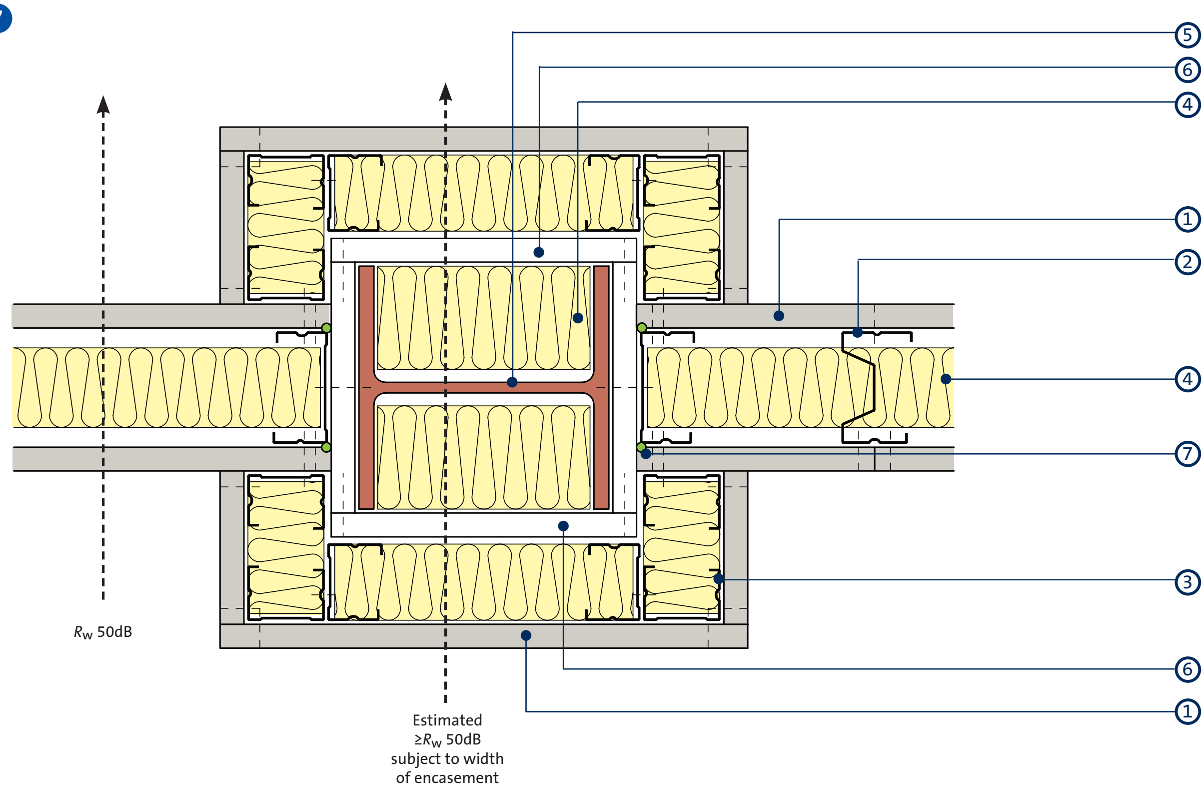
Building acoustics (continued)

6



Encased steel column with additional plasterboard lining

7



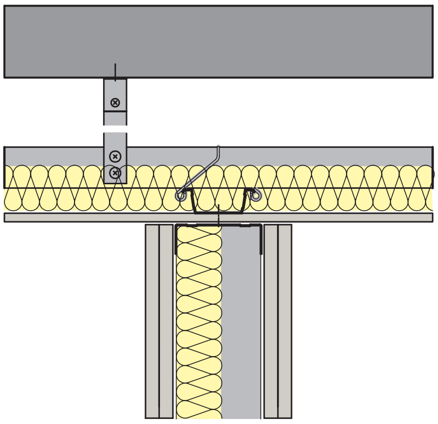
Encased steel column with additional framing, insulation and plasterboard lining

1 Gyproc DuraLine
2 Gypframe AcouStud
3 Gypframe 'C' Stud
4 Isover acoustic insulation
5 Structural steel
6 Glasroc F FIRECASE
7 Gyproc Sealant

Technical performance and principles of system design

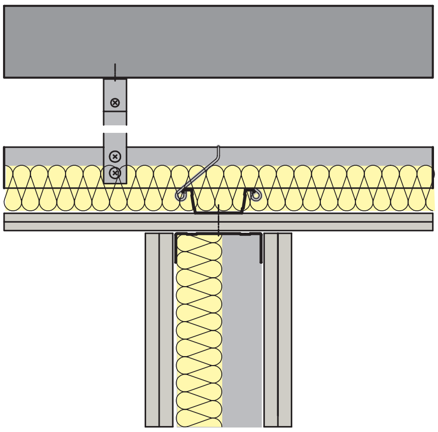
Building acoustics (continued)

8



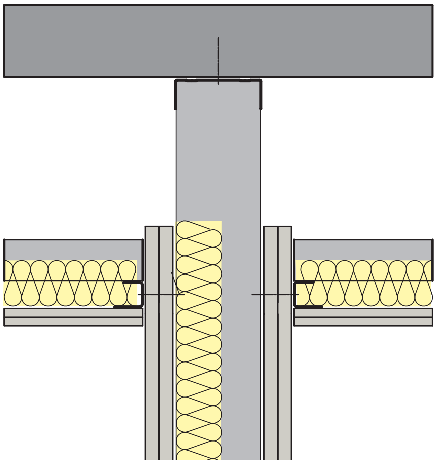
Concealed grid – lined with a single layer of plasterboard and overlaid with insulation = 48dB

9



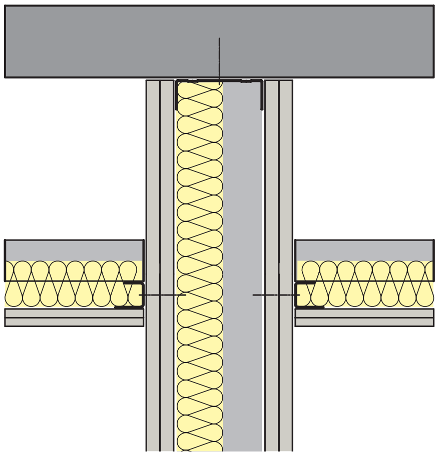
Concealed grid – lined with a double layer of plasterboard and overlaid with insulation = 49dB

10



Concealed grid lined with a double layer of plasterboard within each room and overlaid with insulation = 56dB

11



Partition lining continued to the soffit enabling the full potential of the partition to be achieved = 58dB

Composite construction

A common mistake made when designing a building is to specify a high performance element and then incorporate a lower performing element within it; for example, a door within a partition.

Where the difference between insulation is relatively small (7dB or less), there needs to be a comparatively large area of the lower insulation element before the overall sound insulation is significantly affected. However, where there is a greater difference in sound insulation performance between the two elements, this would normally result in a greater reduction of overall sound insulation performance.

Table 1 shows the acoustic effect various door types have within a partition system. For example; if a poor performance door is included within a partition, it does not matter if the wall achieves 35dB or 50dB sound insulation, as the net performance will never be greater than 27dB. The lowest performing element will always dominate the overall performance.

Table 1 – The effect various door types have within a partition system

Door construction	Mean sound insulation of partition alone (dB)					
	25	**30**	**35**	**40**	**45**	**50**
	Mean sound insulation of partition with doorways accounting for 7% of area (dB)					
Poor performance door with large gaps around the edge	23	25	27	27	27	27
Light door with edge sealing	24	28	30	32	32	32
Heavy door with edge sealing	25	29	33	35	37	37
Double doors with a sound lock	25	30	35	40	44	49

Acoustic privacy

Two main factors affect the level of acoustic privacy achieved when designing a building:

– The sound insulation performance of the structure separating the two spaces
– The ambient background noise present within the receiving room

The ambient background noise level can be a useful tool when designing buildings, as it is possible to mask speech from an adjacent space and hence provide enhanced speech confidentiality, for example a Doctor's consultancy room next to a waiting room. There are a number of commercially available systems to achieve this. It is, however, more common to treat the problem by specifying appropriate levels of sound insulation. A guide to sound insulation levels is given in table 2.

Table 2 – Guide to sound insulation levels for speech privacy

Sound insulation between rooms R_w [1]	Speech privacy
25dB	Normal speech can be overheard
30dB	Loud speech can be heard clearly
35dB	Loud speech can be distinguished under normal conditions
40dB	Loud speech can be heard but not distinguished
45dB	Loud speech can be heard faintly but not distinguished
> 50dB	Loud speech can only be heard with great difficulty

[1] Refer to page 29 for explanations of R_w.

For healthcare and educational environments, acoustic privacy issues are covered in more detail within Health Technical Memorandum (HTM) 05 series and TGD 021-5 from the Department of Education

When designing for residential buildings, the standards of sound insulation given in table 2 are not adequate. Reference should be made to the requirements of Technical Guidance Document E (RoI) or Technical Booklet G (NI).

Ambient noise levels

Along with acoustic privacy, the acceptable level of sound within a room should be assessed. Factors that affect the ambient noise level of a space are:

– The level of external noise
– The level of sound insulation designed into the surrounding structure
– The amount and type of sound absorbing surfaces within the room
– The noise generated by building services

Where control of ambient noise is critical, advice should be sought from an Acoustic Consultant.

For each room there might be a range of levels that are considered acceptable. The designer should select a level appropriate for the particular circumstances.

For this purpose there are a number of methods, including the Noise Rating (NR) system.

The NR system quantifies the level of noise present within a space, taking into account break-in of noise from the adjacent areas, and also the background noise present within the space from ventilation or other building services. Table 3 gives the recommended maximum noise within different activity spaces, using the NR system criteria.

Technical performance and principles of system design

Building acoustics (continued)

Table 3 – Recommended maximum noise rating for various types of room function

Situation	NR [1] criteria (dB)
Sound studios	15
Concert halls, large theatres, opera houses	20
Large auditoria, large conference rooms, TV studios, hospital wards, private bedrooms, music practice rooms	25
Libraries, hotel rooms, courtrooms, churches, cinemas, medium-sized conference rooms	30
Classrooms, small conference rooms, open-plan offices, restaurants, public rooms, operating theatres, nightclubs	35
Sports halls, swimming pools, cafeteria, large shops circulation areas	40
Workshops, commercial kitchens, factory interiors	45

[1] Refer to 'Ambient noise levels' section on the previous page for explanations of NR.

BS 8233:2014 gives guidance on sound insulation and noise reduction in buildings. The standard includes a matrix that can be used to determine the sound insulation requirement of separating partitions once the noise activity, noise sensitivity and privacy requirements for each room and space are established. An example matrix, which can be adapted according to the specific building use, is given in table 4. Each room may be both a source and a receiving room. Where adjacent rooms have different uses, the worst case sound insulation should be specified.

Table 4 – Example on-site sound insulation matrix ($D_{nT,w}$ dB)

Privacy	Activity noise of source room	Noise sensitivity of receiving rooms		
		Low sensitivity	Medium sensitivity	Sensitive
Confidential	Very high	47	52	57[2]
	High	47	47	52
	Typical	47	47	47
	Low	42	42	47
Moderate	Very high	47	52	57[2]
	High	37	42	47
	Typical	37	37	42
	Low	No rating	No rating	37
Not private	Very high	47	52	57[2]
	High	37	42	47
	Typical	No rating	37	42
	Low	No rating	No rating	37

[2] $D_{nT,w}$ 55dB or greater is difficult to obtain on-site and room adjacencies requiring these levels should be avoided wherever practical. Refer to page 29 for explanations of $D_{nT,w}$.

Sound absorption

Sound absorption is the term given to the loss of sound energy on interaction with a surface. Sound absorbent surfaces are used to provide the correct acoustic environment within a room or space. The choice of material will be influenced by its acoustic efficiency, appearance, durability and fire protection.

By converting some of the sound energy into heat, sound absorbing materials will also help sound insulation because less noise will be transmitted to other rooms. However, this reduction in noise is very small when compared with the potential reduction due to sound insulation. Sound absorption is therefore never a substitute for adequate sound insulation.

Reverberant energy

Reverberation is the persistence of sound in a particular space after the original sound is removed. A reverberation, or reverb, is created when a sound is produced in an enclosed space causing a large number of echoes to build up and then slowly decay as the sound is absorbed by the walls, ceilings, floor and air. The length of this sound decay is known as reverberation time and can be controlled using sound absorbing materials. The appropriate reverberation time for a space will be dependent on the size and function of the space. Examples of typical reverberation times are given in table 5.

Table 5 – Typical reverberation times

Type of room / activity	Reverberation time (mid frequency)
Swimming pool	<2.0 seconds
Dance studio	<1.2 seconds
Large lecture theatre	<1.0 seconds
Small lecture room	<0.8 seconds
Primary school playroom	<0.6 seconds
Classroom for hearing impaired	<0.4 seconds

Speech clarity

Speech clarity (intelligibility) is now recognised as essential in helping pupils in an educational environment to achieve their full potential.

Research has shown that pupils who cannot understand clearly what the teacher is saying have a tendency to 'switch off' – limiting their own educational opportunities and creating additional stress for teachers. In a typical classroom with the teacher at one end, sound reaches the pupils both directly from the teacher and via reflections from the ceiling, walls and floor. Refer to figure 12.

Pupils at the front will generally be able to understand what the teacher is saying, whilst pupils at the back and sides of the room receive a mixture of both direct speech and reflected sound, making it difficult to identify the teacher's words.

Reverberation time alone cannot be relied upon to deliver a suitable environment for good speech intelligibility. In any situation where speech communication is critical, e.g. conference room, lecture theatre or classroom, it is necessary to design the space appropriately using a mixture of sound reflective and sound absorbing surfaces.

Technical performance and principles of system design

Building acoustics (continued)

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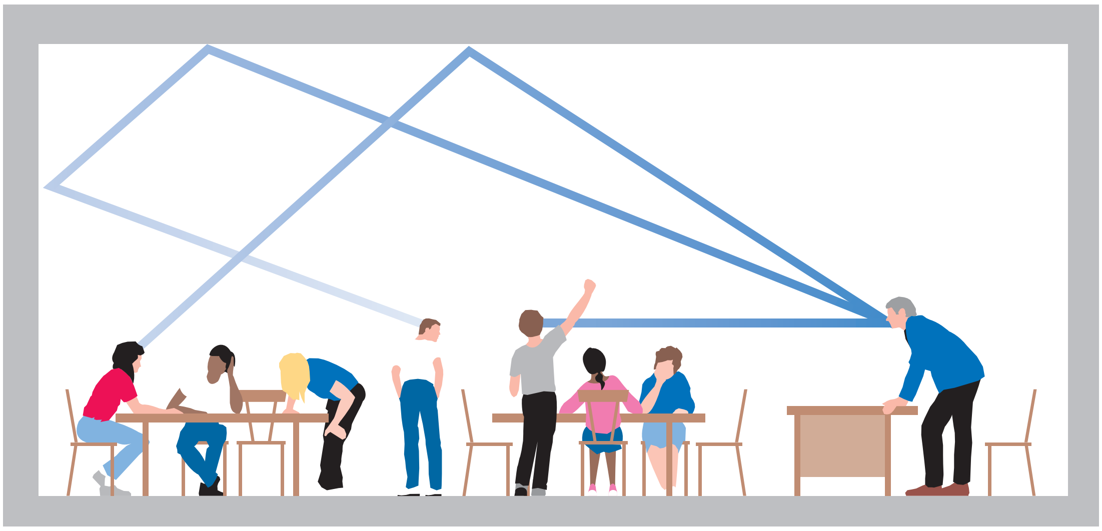


Sound transmission in a typical classroom

Rating methods

Sound insulation rating methods

The sound insulation rating methods that follow are defined in: *BS EN ISO 717: Part 1: 2013 (airborne)* and *BS EN ISO 717: Part 2: 2013 (impact)*.

R_w

This single figure rating method is used for laboratory airborne sound insulation tests. The figure indicates the amount of sound energy being stopped by a separating building element when tested in isolation in the absence of any flanking paths.

$D_{nT,w}$

This single figure rating method gives the airborne sound insulation performance between two adjacent rooms within a building as measured on site. The result achieved is affected not only by the separating element, but also by the surrounding structure and junction details.

C_{tr}

The C_{tr} adaptation term is a correction that can be added to either the R_w (laboratory) or $D_{nT,w}$ (site) airborne rating.

The term has been adopted within Building Regulations Technical Booklet G (NI). The C_{tr} term is used because it targets the low frequency performance of a building element and in particular the performance achieved in the 100 – 315 Hz frequency range. This term was originally developed to describe how a building element would perform if subject to excessive low frequency sound sources, such as traffic and railway noise. Performance tables in this book present relevant sound insulation values both in R_w terms but also in the C_{tr} adapted form. This rating is expressed as $R_w + C_{tr}$ and allows the Acoustic Consultant to critically compare performances. The rating method mainly considers low frequency performance, and has not been universally welcomed due to the difficulties in measuring low frequency performance.

Consequently, within separating constructions, Gyproc can offer enhanced specifications that meet the low frequency performance of the C_{tr} rating whilst also offering good mid and high frequency sound insulation.

$L_{n,w}$

This single figure rating method is used for laboratory impact sound insulation tests on separating floors. The figure indicates the amount of sound energy being transmitted through the floor tested in isolation, in the absence of any flanking paths. With impact sound insulation, the lower the figure the better the performance.

$L'_{nT,w}$

This single figure rating method gives the impact sound insulation performance for floors. The figure indicates the sound insulation performance between two adjacent rooms within a building as measured on site. The result achieved is affected not only by the separating floor but also by the surrounding structure, e.g. flanking walls and associated junction details.

Technical performance and principles of system design

Building acoustics (continued)

$D_{n,c,w}$ (as defined in *BS EN ISO 717-1:1997*)
This single figure laboratory rating method is used for evaluating the airborne sound insulation performance of suspended ceilings. Laboratory tests simulate the room-to-room performance of the suspended ceiling when a partition is built up to the underside of the ceiling with sound transmitted via the plenum.

Sound absorption rating methods

The following ratings are calculated in accordance with *BS EN ISO 11654: 1997*.

Sound absorption coefficient, α_s
Individual sound absorption figures quoted in one-third octave frequency bands are used within advanced modelling techniques to accurately predict the acoustic characteristics of a space. The coefficient ranges from 0 (total reflection) through to 1 (total absorption).

Practical sound absorption coefficient, α_P
A convenient octave-based expression of the sound absorption coefficient; commonly used by Acoustic Consultants when performing calculations of reverberation times within a building space.

Sound absorption rating, α_w
A single figure rating used to describe the performance of a material. The single figure rating can have a modifier added to indicate if the spectral shape is dominated by a particular frequency range

- L – absorption is predominantly in the low frequency region
- M – absorption is predominantly in the mid frequency region
- H – absorption is predominantly in the high frequency region

The absence of a letter following the rating indicates that the absorber has no distinct area of sound absorption and has an essentially flat spectral shape.

Noise Reduction Coefficient, NRC

Whilst the sound absorption performance of a ceiling system can be expressed as an NRC, this does not always accurately reflect the product performance. An NRC value is the arithmetic mean of the absorption coefficients across a limited frequency range; this means that it will hide extremes in performance. For instance, a ceiling tile may be a very efficient absorber at high frequencies but very poor at low frequencies, and the NRC value will not reflect this. To optimise the room acoustics the more accurate sound absorption rating, α_w, should be used.

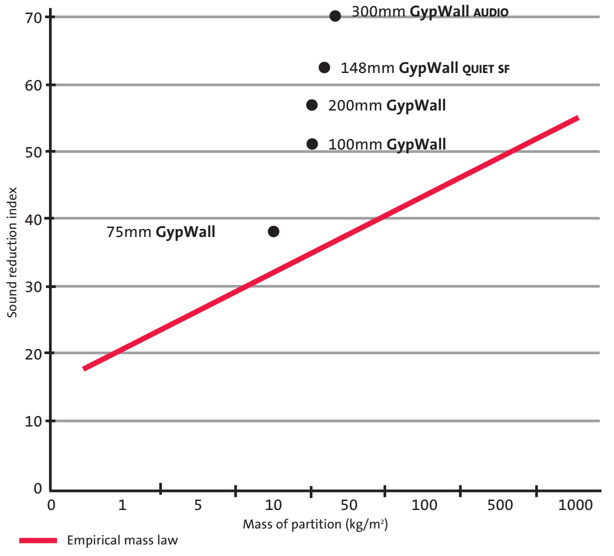
Principles of lightweight construction

Typically the average sound insulation of a material forming a solid partition is governed by its mass; the heavier the material, the greater its resistance to sound transmission. To increase the sound insulation of a solid partition by approximately 4dB, the mass must be doubled. This is known as the empirical mass law.

For example; a 100mm solid block wall of average mass 100kg/m² will have an approximate R_w value of 40dB, whereas a 200mm solid wall of the same material would have an R_w value of 44dB.

Increasing mass is a very inefficient way of achieving sound insulation and one of the advantages of using lightweight cavity partitions and walls is that better than predicted sound reduction values can be achieved. This is why this construction is commonly used in auditoria, e.g. **GypWall AUDIO**. Lightweight systems versus the mass law shows how lightweight systems consistently exceed mass law predictions. This demonstrates that adding mass is not always the best method to satisfy acoustic design requirements and that, lightweight systems, if correctly designed, can provide very effective acoustic solutions. Refer to figure 13.

13



Lightweight systems versus the mass law

Acoustic performance is commonly expressed as a decibel (dB) value. The logarithmic scale of decibels provides a simple way to cover a large range of values and show them as a convenient number. Unfortunately the decibel scale can create confusion especially when comparing alternative systems as the difference in acoustic performance can appear to be quite small. In reality an increase of 6dB is equivalent to a doubling of the acoustic performance of the system.

Technical performance and principles of system design

Building acoustics (continued)

A simple stud partition, for example, can have an R_w rating of 6dB better than predicted by the mass law. In this case, the maximum sound insulation obtainable will be governed by the transmission of energy through the stud frame. The use of other frame types, or configurations, can result in even better insulation. If Gyproc plasterboard or Gyproc specialist boards are fixed to a timber stud frame using a flexible mounting system, such as Gypframe RB1 Resilient Bar, or a more flexible frame is used, for example, Gypframe studs and channels, sound transmission through the framing is minimised and performance significantly better than the mass law prediction can be achieved.

The use of two completely separate stud frames can produce even better results. In this case, the maximum energy transmission is through the cavity between the plasterboard linings. The air in the cavity can be considered as a spring connecting the linings, which allows the passage of energy. The spring will have some inherent damping, which can be significantly increased by the introduction of a sound absorbing material, such as mineral wool, positioned in the cavity. The increased damping of the air-spring results in a reduced coupling between the plasterboard linings and a consequent decrease in sound transmission. Air-spring coupling becomes less significant as the cavity width increases. In practice, cavities should be as wide as possible to insulate against low frequency sounds.

Two important effects; resonance and coincidence, occur in partitions and walls. These are governed by physical properties such as density, thickness and bending stiffness, and can result in a reduction in sound insulation at certain frequencies.

In lightweight cavity constructions, resonance and coincidence effects can be decreased by the use of two or more board layers. A simple way of increasing the sound insulation performance of a single layer metal stud partition is to add an additional layer of plasterboard to one, or both, sides. This will increase the sound insulation performance by approximately 6dB or 10dB respectively.

Acoustic benefits of applying Gyproc Finish Plasters to certain GypWall partition systems

Applying 2mm Gyproc Finish Plasters to both sides of certain **GypWall** partitions has a positive effect on the sound insulation performance. This is effective on partitions that are limited by their high frequency performance (coincidence region).

The application of Gyproc Finish Plasters also adds mass to the partition which has a positive effect on the mid-frequency of the spectrum.

Figure 14 shows an example of a partition that will be positively affected by skim finish using Gyproc Finish Plasters.

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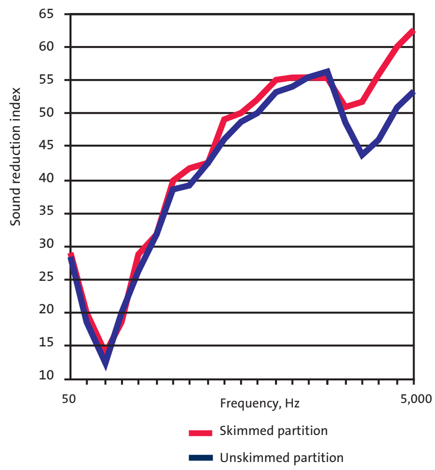

Acoustic benefits of applying Gyproc Finish Plasters to certain **GypWall** partitions

Table 6 – TGD E: Sound Insulation Requirements (RoI)

Separating construction	Airborne sound insulation $D_{nT,w}$dB	Impact sound insulation $L'_{nT,w}$dB
Walls	53 (min)	-
Floors (including stairs with separating function)	53 (min)	58 (max)

Table 6a – TB G: Sound Insulation Requirements (NI)

Separating construction	Airborne sound insulation $D_{nT,w}+C_w$dB	Impact sound insulation $L'_{nT,w}$dB
New dwellings		
Walls	43/45 (dwellings only)	-
Flors and stairs	45	62
Dwellings formed by material change of use		
Walls	43	-
Floors and stairs	43	64

Technical performance and principles of system design

Building acoustics (continued)

Refer to system sections within 'Partitions' where systems positively affected by the application of Gyproc Finish Plasters are shown. Systems with additional performance will show two acoustic figures in the tables – Sound insulation performance for partitions finished using jointing or plaster skim and sound insulation performance for partitions with a 2mm skim finish of Gyproc Finish Plasters.

Legislation and guidance

Building Regulations – Residential Buildings

Building Regulations Technical Guidance Document E (RoI) or Technical Booklet G (NI) gives guidance on how to provide reasonable standards of sound insulation in dwellings and other residential buildings. They cover both new-build and refurbishment or conversion, and include minimum standards of performance.

Complying with the regulations

In Ireland, housebuilders and residential developers can demonstrate compliance of separating walls and floors for new-build houses and apartments using manufacturers' proprietary systems or Building Regulations Example / Guidance and verifying by Pre-Completion Testing

Robust Details (Northern Ireland)

To avoid Pre-Completion Testing for new-build houses and flats the Home Builders Federation (HBF) developed a series of Robust Details. These forms of construction have been designed and site tested to ensure that they deliver a standard of sound insulation on site to meet the minimum requirements of TB G. The Building Regulations have been amended to allow Robust Details to be used as an alternative to Pre-Completion Testing.

If you are following the Robust Detail route, you must register each plot, with the details you intend to use, and pay a fee. You will then be given a registration certificate to hand to your building control authority before work starts. Robust Details Ltd administers the scheme.

If you are building to the Irish Green Building Council's Home Quality Rating Tool, Robust Details may entitle you to additional credits under the Health and Wellbeing category – check the Robust Details Handbook for the most up-to-date details.

Sound Absorption

Section 5.2.2 of TGD E (2014) and Section 7 of TB G (2012) cover reverberation noise in the common internal parts of buildings containing flats or rooms for residential purposes. The regulations state that "the common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable".

The regulations give two methods of calculating the amount of absorption required in any communal areas. The two methods are referred to as 'Method A' and 'Method B'.

AD E specifies sound absorption in terms of a class of absorber. There are five classes (A through to E) with Class A signifying the products with the highest level of sound absorption. However, to comply with method A, only class C or D is required. The values ascribed to the different classes are given in table 7.

Table 7 – Absorption class

Sound absorption class	α_w
A	0.90, 0.95, 1.00
B	0.80, 0.85
C	0.60, 0.65, 0.70, 0.75
D	0.30, 0.35, 0.40, 0.45, 0.50, 0.55
E	0.15, 0.20, 0.25
Unclassified	0.00, 0.05, 0.10

For more information, refer to Building Regulations; Section 5.2.2 of TGD E (2014) and Section 7 of TB G (2012): Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes.

Example constructions

These are constructions developed to repeatedly achieve required design performance levels, if built correctly with correctly designed flanking details. Use of these constructions does not guarantee regulatory performance levels will be achieved, and the onus is therefore on the housebuilder to demonstrate compliance by Post-Completion Testing on site.

Other constructions

These include manufacturers' proprietary solutions and new, or innovative, constructions not considered to be 'Example Constructions'. Again, the onus is on the housebuilder to demonstrate compliance by Post-Completion Testing.

Post-Completion Testing

Post-Completion Testing is carried out when the building is complete, with doors, access hatches and windows fitted.

If a test fails due to the construction of the separating floor or associated flanking elements, other untested

Technical performance and principles of system design

Building acoustics (continued)

rooms may be affected. This will result in additional testing requirements. It may be prudent to seek specialist advice to identify and remedy any problems.

Acoustic design of schools

Each room or other space in a school building shall be designed and constructed in such a way that it has the acoustic conditions and the insulation against disturbance by noise appropriate to its intended use.

To satisfy this requirement, it is recommended that buildings comply with the guidance TGD 021-5 Acoustic Performance of Schools from the Department of Education in RoI and Building Bulletin 93 (BB93) Acoustic design of schools, a design guide for Northern Ireland.

BB93 was written by the Department for Children, Schools and Families (DCSF), formerly the Department for Education and Skills (DfES), and provides a regulatory framework for the acoustic design of schools; including sound insulation between spaces, ambient noise levels and optimum reverberation times for various spaces within educational buildings.

For more information refer to our **Education Sector Guide**, available from the Gyproc Technical Department.

Health and Technical Memorandum HTM 08-01 Acoustics – Healthcare Buildings

Good acoustic design is fundamental to the quality of healthcare buildings. The control of unwanted noise improves patient privacy, dignity and sleep patterns; all key conditions for healing. Good acoustic design also increases the morale and comfort of healthcare professionals.

HTM 08-01 covers the acoustic design criteria that are important for healthcare premises and contains a method of determining the level of sound insulation required between adjacent spaces in a healthcare environment. The document also gives recommended reverberation times for various types of space.

Hotels and Hospitality: Acoustic Standards

The Fáilte Ireland Guest House Classification Scheme requires that bedrooms, the toilets and bathrooms serving them, and the corridors off which they shall open shall be separated from each other by walls or partitions, floors and ceilings and having an acoustic attenuation of 50 dB.

BS 8233 advises a figure of 43 dB DnT,w + Ctr , (i.e. a site tested result factoring in additional low frequencies) but also 60 dB DnT,w between Bedrooms and other common areas, excluding corridors.

BS 8233 – Sound insulation and noise reduction for buildings

BS 8233 provides guidance on acoustic ratings appropriate to a variety of different building types. It is applicable to the design of new buildings, or refurbished buildings undergoing a change of use. It deals with control of noise from outside the building, noise from plant and services within it, and room acoustics for non-critical situations.

A full revision of the standard, launched in 2014, includes changes which reflect:

- Legislative framework revision since publication of the 1999 edition
- Revisions to Building Regulations
- The publication of specialist documents for specific sectors, such as healthcare and education
- A reappraisal of the tabular content with respect to setting targets for various classes of living space in the light of research findings
- The need to transfer some of the more detailed information from the main text to annexes
- Requirements for offices

Designing for on-site performance in Northern Ireland

Achieving a $D_{nT,w}$ + C_{tr} performance on site

The C_{tr} rating method puts increased emphasis on the low frequency region of the spectrum. For lightweight construction this means a significant change in some of the design principles. For partitions, the cavity should be as large as possible and double layers of plasterboard should be used.

For masonry walls lined with lightweight panels, cavities with a depth of less than 60mm should be avoided. Two linings, with small, identical sized cavities either side of a solid masonry wall, should not be specified. These cavities can interact and cause a significant downgrade in the critical low frequency zone. If a small cavity is required, one side only should be lined with a double layer of plasterboard. Optimum performance is achieved by lining one side only and having a cavity depth of at least 85mm.

▶ Refer to C02. S01. P41 for more information on service voids.

Technical performance and principles of system design

Building acoustics (continued)

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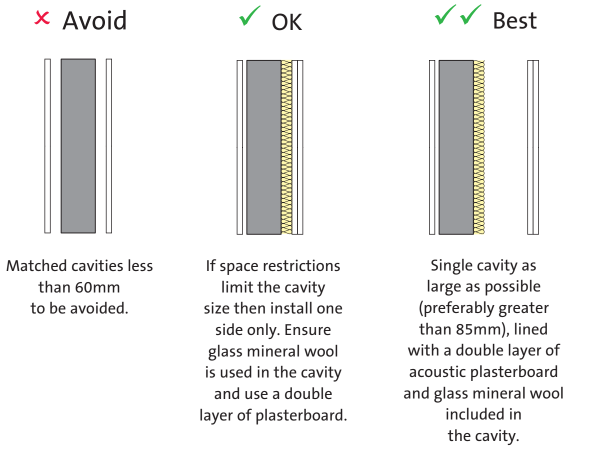


Optimum design of panel linings for C_{tr}

To increase the sound insulation of new or existing masonry walls, **GypLyner** wall lining systems can be used in conjunction with Isover acoustic insulation and Gyproc plasterboard. The cavity depth of the **GypLyner** lining should be as large as possible, and small, identical sized cavities to either side of the wall should be avoided.

For lightweight separating floors, partially de-coupling the plasterboard ceiling from the floor structure, using Gypframe RB1 Resilient Bars, helps to achieve the required performance. Floating floor treatments, for example timber battens, should have a cavity depth of at least 70mm to avoid low frequency resonance effects in the critical low frequency zone. Performance can be further enhanced by specifying Gyproc Plank within the walking surface.

Floating floor and resilient bar ceiling systems should be tested in a UKAS laboratory to ensure good low frequency performance.

A method of determining the achievable site $D_{nT,w} + C_{tr}$ performance is to refer to a laboratory $R_w + C_{tr}$ rating. Depending on the wall specification, a minimum drop of 4dB is typical when comparing $R_w + C_{tr}$ and $D_{nT,w} + C_{tr}$. However, we recommend that a safety margin of + 9dB should be used to reduce the risk of failure to comply with Building Regulations. This assumes all flanking paths are appropriately detailed, ideal site lay-out exists and a high quality of workmanship is applied.
For purpose-built dwelling houses and flats requiring $D_{nT,w} + C_{tr}$ 45dB for separating walls, separating floors and stairs, we recommend specifications capable of achieving $R_w + C_{tr}$ 54dB.

For purpose-built rooms for residential purposes requiring $D_{nT,w} + C_{tr}$ 43dB for separating walls, and $D_{nT,w} + C_{tr}$ 45dB for separating floors and stairs, we recommend specifications capable of achieving $R_w + C_{tr}$ 52dB for separating walls, and $R_w + C_{tr}$ 54dB for separating floors and stairs.

For dwelling houses, flats and rooms for residential purposes formed by material change of use requiring $D_{nT,w} + C_{tr}$ 43dB for separating walls, separating floors and stairs, we recommend the use of specifications that are capable of achieving $R_w + C_{tr}$ 52dB.

Achieving a $D_{nT,w}$ performance on site

Similar to the principles of achieving a $D_{nT,w} + C_{tr}$ performance on site, a realistic safety margin should be incorporated when designing to meet a $D_{nT,w}$ requirement, to reduce the risk of failure. We recommend a safety margin of + 7dB when comparing site performance, $D_{nT,w}$ to laboratory performance, R_w.

For example, to comply with Scottish Technical Handbook Section 5 in Scotland for a requirement of $D_{nT,w}$ 56dB, a system capable of achieving R_w 63dB under laboratory conditions should be specified.

Achieving a $L'_{nT,w}$ performance on site

A minimum reduction of 5dB is typical when comparing site performance, $L'_{nT,w}$, to laboratory performance, $L_{n,w}$. However, when designing separating floors to reduce the risk of impact sound flanking transmission, in particular timber joist, the walking surface should be de-coupled from the joists, for example using **GypFloor SILENT** or a batten floating floor system. This is in addition to the de-coupling of the ceiling, using **CasoLine MF** ceiling or Gypframe RB1 Resilient Bar, for example.

Therefore, in some cases the safety margin in the laboratory for timber joist separating floors is likely to be in the region of + 10dB, rather than the typical minimum + 5dB for concrete floors.

The key points for consideration when designing to meet any acoustic performance requirement are below:

- Inappropriate detailing of flanking conditions can greatly reduce the level of performance of the system from that achieved in the laboratory. Refer to figures 4-7 for more information
- For separating wall and floor constructions to be fully effective, care must be taken to correctly detail the junctions between the separating wall or floor and associated elements such as external walls, other separating elements and penetrations or door openings, etc.
- If junctions are incorrectly detailed then the acoustic performance will be limited and Building Regulations requirements will not be achieved in practice
- Pre-Completion Testing exposes poor flanking details and inadequate separating wall and floor specifications. Good flanking detailing and specifications that provide a reasonable margin of safety on site are therefore essential.

Technical performance and principles of system design

Building acoustics (continued)

Examples of practical solutions

Gypframe AcouStuds

Gypframe AcouStuds are metal stud sections optimised to give enhanced sound insulation performance. These unique shaped studs are used for increased acoustic performance. Gypframe AcouStuds can be used to upgrade the acoustic performance of 70mm, 92mm and 146mm wall systems.

Figure 16 shows the performance improvement possible using acoustic stud technology compared with a standard 'C' stud of the same cavity dimension.

GypWall STAGGERED

GypWall STAGGERED features staggered studs that are located within a head and base channel by means of retaining clips. This arrangement means there is limited connection through the framework to the plasterboard face on the opposite side of the partition. The system design enables a higher level of sound insulation to be achieved with modest cavity sizes.

Figure 17 shows the improvements possible using a staggered stud arrangement compared to a standard **GypWall** 'C' stud partition with the same partition cavity size.

GypWall QUIET SF

GypWall QUIET SF utilises Gypframe RB1 Resilient Bars to partially de-couple the plasterboard linings from the partition stud frame, leading to enhanced levels of sound insulation.

Figure 18 shows the improvements possible when including Gypframe RB1 Resilient Bar on one or both sides of a standard Gypframe 70mm 'C' Stud partition.

GypWall AUDIO and GypWall QUIET IWL

The most acoustically effective wall designs are twin frame walls. Minimal or no bridging between the plasterboard linings and the increased cavity size allows optimum performance from the wall.

Figure 19 shows the difference achievable by using a twin framed wall approach as opposed to a standard **GypWall** 'C' stud partition. The plasterboard linings and insulation are the same for both partitions and the key difference is the overall partition thickness – typically 211mm for the standard partition and 300mm for the twin framed option. With this type of design, further improvements in performance can be achieved by increasing the cavity size and/or increasing the board specification.

Gypframe RB1 Resilient Bar (ceilings)

Gypframe RB1 Resilient Bar is an engineered metal component used predominantly with lightweight separating floors to de-couple the ceiling from the floor structure and thereby improve the airborne sound insulation performance of the separating floor.

The value of this component is recognised in Robust Details, where all lightweight floor solutions feature resilient bars to partially de-couple the ceiling from the floor structure.

Figure 20 shows the substantial performance improvements achievable for airborne sound insulation when Gypframe RB1 Resilient Bar is utilised instead of a directly fixed ceiling.

Floating floor treatment

Floating floor treatments are used with both lightweight and concrete separating floors to de-couple the walking surface from the floor structure and thereby improve both the airborne and impact sound insulation performance of a separating floor.

The value of this technique is recognised in Robust Details, and is currently featured in a number of separating floor solutions.

Sound insulating dry linings

In designing for sound insulation, care should be taken to ensure that flanking transmission via the associated structure does not downgrade the performance of the partition or wall to a level below that required in use. This applies especially when a lightweight partition or wall is constructed in a masonry building. Care should therefore be taken to ensure the associated structure is able to achieve the level of sound insulation required.

The performance of sound resisting floors of timber joist or lightweight concrete construction, supported on or flanked by conventionally finished masonry walls, can be adversely affected by flanking transmission in the walls. This effect can be significantly reduced by the application of a **GypLyner** wall lining system, to the flanking walls.

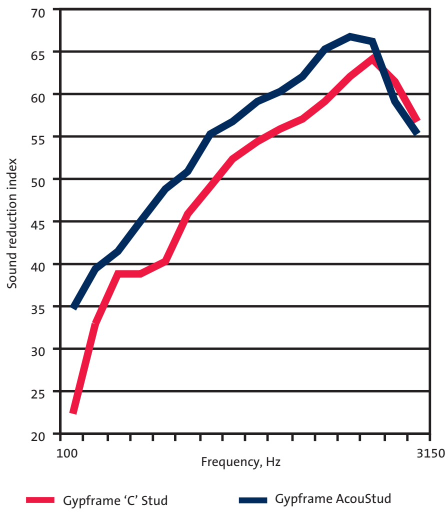
Lining treatments can also be beneficial in refurbishment work when applied to flanking walls of new or existing sound resisting walls.

▶ Refer to C07. S01. P429 – Linings introduction.

Technical performance and principles of system design

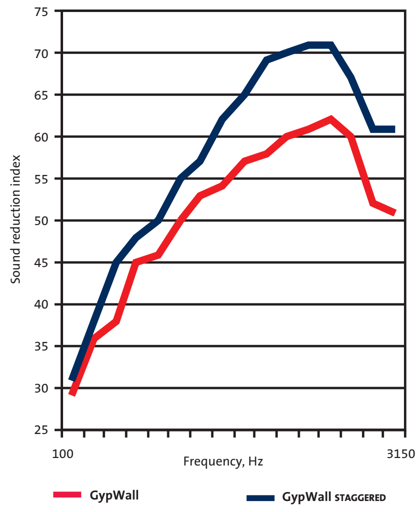
Building acoustics (continued)

16



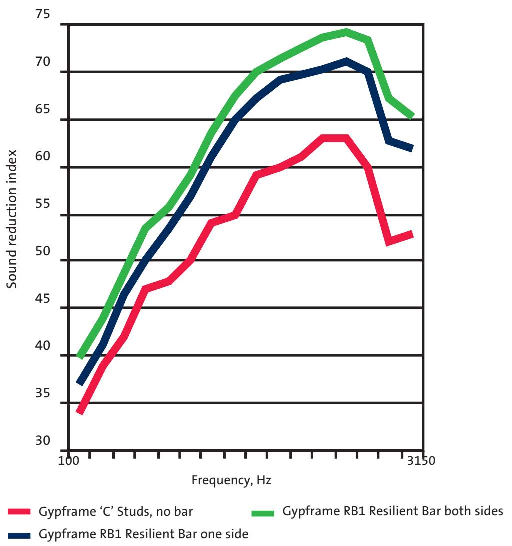
Acoustic benefits of Gypframe AcouStuds

17



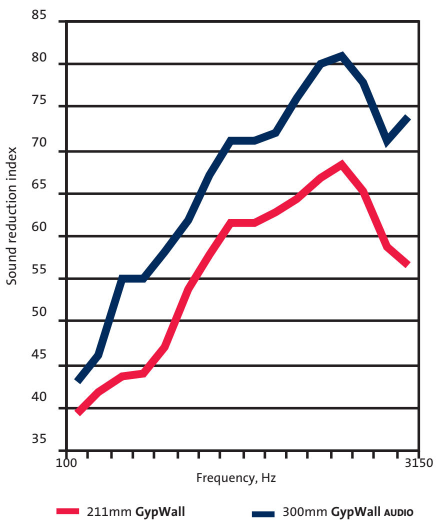
Acoustic benefits of staggered studs

18



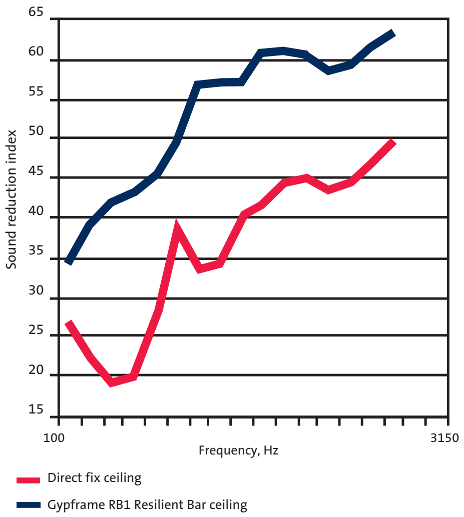
Acoustic benefits of resilient bars (partition)

19



Acoustic benefits of twin stud framework

20



Airborne sound insulation benefit of resilient bars (ceiling)

Technical performance and principles of system design

Robustness

Legislation and guidance

BS 5234: 1992 – Partition (including matching linings)

BS 5234 comprises two parts – *Part 1 code of practice for the design and installation*, and *Part 2 Specification for performance requirements for strength and robustness including methods of test* in relation to end-use categories. The standard covers performance aspects such as stiffness, crowd pressure, impact resistance, anchorages and door slamming resistance.

BS 6399-1: Part 1:1996 – Loading for buildings: – Code of practice for dead and imposed loads

This code of practice gives dead and minimum recommended imposed loads for use in designing buildings. Whilst our GypWall partition systems are non-loadbearing, they are able to provide resistance to levels of horizontal uniformly distributed loads (UDL) applied at a height of 1.1m as detailed within this standard for parapets, barriers and balustrades, etc. Refer to examples in table 8.

BS EN 13964: 2014 – Suspended ceiling – Requirements and test methods

Includes performance requirements for ceiling tiles and suspended ceiling grid systems (concealed and exposed). The standard covers issues such as the load span performance of grids.

Principles of robust design

Partition Duty Ratings

All our partition systems have a Duty Rating established in accordance with all the full requirements of *BS 5234*. This rating relates to the strength and robustness characteristics of the partition system against specific end-use applications. Table 9 gives details of the four duty categories.

A series of tests are used to assess the resistance to damage, both aesthetic and structural, from a range of impacts and load applications.

The tests are conducted at the maximum height for the partition system. *BS 5234* itself does not have a method for establishing an acceptable maximum height, and the partition height must be established using a separate method. It is suggested within *BS 5234* that the crowd pressure test may be suitable for evaluating heights up to 4200mm, but we would strongly advise against using this inconsistent approach and would never rely solely on *BS 5234* for evaluating heights, especially above 4200mm.

Table 8 – *BS 6399-1 – Loading for buildings: – Code of practice for dead and imposed loads*

Gyproc GypWall partitions comprising double layer 12.5mm Gyproc plasterboard or specialist board each side						
Gypframe AcouStuds at 600mm centres	146 AS 50	146 AS 50	92 AS 50	92 AS 50	70 AS 50	70 AS 50
Gypframe Deep Flange Floor & Ceiling Channel	148 EDC 80	148 EDC 80	94 EDC 70	94 EDC 70	72 EDC 80	72 EDC 80
Partition height	7.8m	6m	5.8m	4.9m	4.7m	3.1m
Maximum horizontal UDL as per BS 6399-1, applied at a height of 1.1m	1.5 kN/m	3 kN/m	0.74 kN/m	1.5 kN/m	0.74 kN/m	1.5 kN/m

Table 9 – *BS 5234* Duty Ratings

Partition Duty Rating	Category	Examples
Light	Adjacent space only accessible to persons with high incentive to exercise care. Small chance of accident occurring or misuse.	Domestic accommodation
Medium	Adjacent space moderately used, primarily by persons with some incentive to exercise care. Some chance of accident occurring or misuse.	Office accommodation
Heavy	Adjacent space frequently used by the public and others with little incentive to exercise care. Chance of accident occurring or misuse.	Public circulation areas, industrial areas
Severe	Adjacent space intensively used by the public and others with little incentive to exercise care. Prone to vandalism and abnormally rough use.	Major circulation areas, heavy industrial areas

Technical performance and principles of system design

Robustness (continued)

Tests within *BS 5234* include:

- Partition stiffness
- Resistance to damage from a small hard body impactor
- Resistance to damage from a large soft body impactor
- Resistance to perforation from a small hard body impactor
- Resistance to structural damage from a large soft body impactor
- Resistance to damage from door slamming

BS 5234 does not identify specific points of contact on a partition that should be impacted. However, we understand that there are limiting points in terms of impact resistance. These are then subjected to the impact tests to ensure that the most onerous situation is assessed.

Optional tests are also detailed within the standard, but these are not used in the partition grading. These include:

- Resistance to damage from a crowd pressure load
- Lightweight anchorages pull down
- Lightweight anchorages pull out
- Heavyweight anchorages wall cupboard
- Heavyweight anchorages wash basin

▶ Refer to Service installations within this section, for more information on fixing to drywall systems.

Important design considerations

To achieve Heavy Duty Rating or Severe Duty Rating, the door detail needs to be reinforced otherwise the door opening will undergo too much deflection and damage during the onerous door slamming test.

Important information

To claim a partition Duty Rating, all tests must achieve the designated performance level. It is not possible, for example, for a partition lined with a single layer of Gyproc WallBoard (12.5mm) to achieve a Duty Rating better than medium, because of the board's performance in the hard body perforation test. In the majority of cases, the type of board used will determine the maximum partition Duty Rating. Table 10 shows the maximum rating available based on a single layer board lining. In all cases, a double layer lining achieves Severe Duty Rating.

Table 10 – Board type required to achieve a given Duty Rating (single layer) solutions

Board type	Maximum rating
Gyproc WallBoard 12.5mm	Medium
Gyproc WallBoard 15mm	Medium
Gyproc SoundBloc 12.5mm	Medium
Gyproc SoundBloc 15mm	Medium
Gyproc FireLine 12.5mm	Medium
Glasroc H TILEBACKER 12.5mm	Medium
Gyproc FireLine 15mm	Heavy
Gyproc SoundBloc 15mm	Heavy[1]
Glasroc F MULTIBOARD 10mm	Heavy
Gyproc Habito 12.5mm	Severe
Glasroc F MULTIBOARD 12.5mm	Severe
Gyproc DuraLine 15mm	Severe
Rigidur 12.5mm / 15mm	Severe

[1] Minimum Gypframe 70mm Stud for Heavy Duty Rating.

The level of deflection and strength performance required to achieve Light Duty Rating within *BS 5234* is, in our opinion, unsuitable for any application. We do not offer any systems with a rating less than Medium Duty Rating.

Maximum partition heights

As stated previously, *BS 5234: Part 2* does not contain a consistent methodology for establishing the performance of a partition in terms of height. To date the UK and Ireland has adopted a methodology, which is based on the level of lateral deflection under a given uniformly distributed load (UDL). The criterion is that the maximum lateral deflection of the partition should not exceed L/240 (where L is the partition height) when the partition is uniformly loaded to 200Pa.

We utilise a UKAS accredited test laboratory to evaluate partition system heights against this performance criteria. The test evidence comes from a full-scale test procedure where the test specimen is subjected to a UDL and the induced lateral deflection recorded. From this procedure, it is possible to establish the maximum height for a range of partition systems.

When cutting Gypframe studs to suit the partition height, it is not good practice to cut the stud through the location of a service cut-out.

Technical performance and principles of system design

Robustness (continued)

Assessing acoustic performance of GypWall with reduced stud centres

Reducing the centres of the metal studs within **GypWall** partition systems can have a detrimental effect on the sound insulation performance of the system. We have estimated the performance reductions for **GypWall**:

- When there is no insulation within the partition cavity and studs are closed down to 400mm centres, this results in an estimated 2dB loss in *Rw* compared to studs at 600mm centres with no insulation
- When there is no insulation within the partition cavity and studs are closed down to 300mm centres, this results in an estimated 3dB loss in *Rw* compared to studs at 600mm centres with no insulation
- When there is a minimum 25mm Isover Acoustic Roll within the partition cavity and studs are closed down to 400mm centres, this results in no loss in *Rw* compared to studs at 600mm centres with 25mm Isover Acoustic Roll
- When there is a minimum 25mm Isover Acoustic Roll within the partition cavity and studs are closed down to 300mm centres, this results in an estimated 2dB loss in *Rw* compared to studs at 600mm centres with 25mm Isover Acoustic Roll

Where Gyproc Finish Plasters are specified to obtain a 1 or 2 dB uplift, this will be negated when closing down stud centres or changing stud profile.

If the partition system is also performing a fire compartmentation function to EN standards, the partition height in the fire state also needs to be established for the required duration. It should not be assumed that the cold state height is still valid in the fire state.

Movement

Deflection of upper floor and roof slabs can cause appreciable stress in partitions. Where such deflection is likely to occur, the partition to structural soffit junction detail must be designed to accommodate movement, whilst still complying with any fire or acoustic performance requirements. Typical deflection head details for fire-rated **GypWall** partition systems are given in the relevant partition and wall system sections within this book. Additional attention to detailing will be required to optimise sound insulation performance. The detail included in **GypWall STAGGERED** shows a good practice solution incorporating steel angles, either side of the head and sealed to the structure. Refer to figures 2 and 3 earlier in this section for more information.

Where linings (partitions, wall linings and ceilings) cross a movement joint in a structural wall, floor or roof slab, they should be provided with a movement joint at the same point, and be capable of the same range of movement as the wall, floor or roof joint. Gyproc Control Joint provides a suitable solution for movement up to 7mm. Gyproc Control Joint may also be required to relieve stresses induced by extreme environmental conditions. For example, consideration could be given to installing control joints at 10m centres in linings that are subjected to either extreme or variable temperatures.

▶ Refer to C07. S05. P477 detail 7 and 8 – Control joint detail.

Environmental conditions

Temperature

Gyproc plasterboards, Glasroc F specialist boards and Gyproc plasters should not be used where the temperature will exceed 49°C. Prolonged exposure to high temperature, and/or multiple exposure for short periods, results in the gradual continued calcination of the gypsum and loss of its inherent properties. Gyproc plasterboards, Glasroc F specialist boards and Gyproc plasters (once fully dried) can be subjected to freezing conditions without risk of damage.

Moisture

Our products should not be used in continuously damp conditions or in buildings that are not weather tight. However, our Gyproc moisture resistant grade plasterboards and Glasroc F specialist boards are suitable for use in intermittently damp conditions or sheltered external situations in conjunction with an appropriate decorative finish. This should take the form of ceramic tiling or other suitable moisture impervious coating by others. Glasroc H TILEBACKER can be used as a tiling substrate in high moisture applications.

Relative humidity (RH)

In moderate humidity situations, i.e. 40% to 70% RH, no special precautions need to be taken when using Gyproc plasterboards, other than those necessary to prevent interstitial condensation. However, whenever the building's heating system is turned off a rapid increase in the relative humidity can occur as the building cools down. This could lead to the occurrence of potentially harmful surface condensation. Precautions to avoid this problem should be taken, e.g. by continuing to run the ventilation system after the heating is turned off.

Low humidity does not affect the plasterboards, but may lead to distortion of timber framing members as they dry to below their usual moisture content. Intermittently high relative humidity, i.e. above 70% RH, requires special treatment to the face of the plasterboards, and only moisture resistant grade plasterboards or Glasroc F specialist boards should be used. Suitable surface treatments include ceramic tiling and water vapour resistant paint systems. Gyproc plasterboards are not considered suitable in continuously high humidity conditions. Certain Gyproc ceiling products are suitable for use in environments above 70% RH.

Technical performance and principles of system design

Robustness (continued)

Special environments – swimming pools and similar environments

Ceiling lining

Our products and systems are regularly specified for ceilings in and around swimming pool halls and similar areas. With regard to ceiling specifications attention to detail is critical. The following guidance should be considered:

- The boards to be used should be moisture resistant grade or Glasroc F specialist boards. They should be screw-fixed to a framed system at their recommended centres
- The surface of the board should be finished using our recommended methods, and they must be set and dry before applying decoration. Gyproc Finish Plasters are not recommended for this type of environment
- The decoration should take the form of a suitable moisture impervious finish supplied by other manufacturers
- Penetrations in the ceiling linings and perimeters should be avoided where possible. All service penetrations must be sealed using a moisture resistant sealant (even though the recommended plasterboards are moisture resistant it is unwise to allow moisture to gain access to the core of the board)
- The air in the pool area should be conditioned such that condensation will not form on the surface of the boards
- In situations where there is a risk of condensation occurring within the ceiling cavity, it must be mechanically ventilated or the decorative finish must be impervious to water vapour. This will minimise the risk of condensation forming on 'cold' surfaces in the cavity, which could then come in to contact with the unprotected back face of the plasterboard lining
- It is good practice to protect the cut ends of Gypframe metal components using suitable material to prevent corrosion
- Ensure that the Gypframe metal frame is totally encapsulated by suitable Gyproc board and waterproof finishing system (by others).

Wall lining

Offering enhanced levels of moisture resistance performance, Glasroc H TILEBACKER is suitable as a tiling substrate in high moisture environments including domestic shower enclosures and bathrooms, commercial kitchens and changing areas.

Gyproc moisture resistant grade boards and Glasroc F specialist boards are not suitable to be used in those areas, but can be considered for use in adjacent areas of wall lining and in most domestic situations. Attention to detail is critical and, in addition to the guidance given above for ceiling linings, the following additional guidance should be considered:

- The lining boards must be lifted clear from any floor where free water is possible and a suitable skirting detail must be employed which will not allow water penetration
- In extreme moisture environments, Glasroc H TILEBACKER must be used in conjunction with a tanking system
- Important guidance is given within *BS 5385-1: 2009* and *BS 5385-4: 2009*, within which gypsum plasterboard and gypsum plaster are deemed unsuitable backgrounds for tiling in 'frequently wetted' areas. These areas include communal showers and pool halls

Ceilings

EN 13964: 2014 includes class definition relating to exposure conditions and maximum deflection. The standard **CasoLine MF** ceiling layout is capable of complying with deflection Class 2 and exposure Class A, however the system can be modified to meet Classes 1 and B. Contact the Gyproc Technical Department for further guidance.

Technical performance and principles of system design

Service installations

Service installations

Services within partitions and lining cavities

The installation of electrical services must always be carried out strictly in accordance with the National Rules for Electrical Installations, Fourth Edition ET101:2008 (RoI) and *BS 7671 Requirements for electrical installations. IET Wiring Regulations (NI).*

Services can be incorporated within all our partition and lining systems. As shown in figure 21 and figure 22, Gypframe studs either have cut-outs or push-outs to accommodate routing of electrical services and other small services. Grommets or isolating strips should be installed in the cut-out to prevent abrasion of the cables.

Gypframe channels do not generally have cut-outs and so, if required, they need to be cut on-site, paying attention to Health & Safety guidance. Grommets or isolating strips should be installed in these cut-outs to prevent abrasion of the cables. However, Gypframe GWR3 Floor & Ceiling Channel has half-round cut-outs at regular centres. Refer to figure 23. These cut-outs are designed to prevent abrasion of electrical cables where they pass through the metal framework, therefore grommets are not required.

When installing electrical services within a partition, this might result in the concealed cable being less than 50mm from the surface of the partition, particularly if the partition is less than 100mm thick. Whilst it may be apparent that electrical services are contained within a partition cavity due the appearance of electrical sockets / switches on the partition surface, this might not be obvious from the reverse side. Therefore, before carrying out work, e.g. drilling into the surface, the reverse side of the partition must always be checked to determine the location of any concealed cables. It is good practice to maintain a clear zone. Where the location of electrical outlets cannot be determined from the reverse side, then the cable must either be mechanically protected or run at least 50mm from the surface of the wall or partition on the reverse side. Refer to figure 24 and figure 25.

Where heating pipes, particularly micro-bore systems, are to be located within the **GypWall** system, it is recommended that only one pipe is passed through each aperture in the metal framework. If this cannot be accommodated for whatever reason, it may be necessary to incorporate proprietary pipe restraining clips, or other means of keeping the pipes apart, to prevent vibration noise.

If a lining system, such as **DriLyner**, does not have sufficient depth to accommodate the service then the background should be 'chased out' to the appropriate depth considering maximum allowable tolerances. Pipes or conduits should be fixed in position before work commences.

Please see National Housing Building Council (NHBC) Standards 8.1 and Building Research Establishment (BRE) Thermal Insulation: avoiding risks (BR262)'.

Thermal insulation covering or around cables has the effect of reducing the current carrying capacity and so the cable may need to be de-rated and increased in size.

▶ **Refer to National Rules for Electrical Installations, Fourth Edition ET101:2008, BS 7671 and SR 54: Code of Practice: Methodology for the energy efficient retrofit of existing dwellings.**

To maintain an airtight construction, the perimeter of any penetration through the lining should be sealed as necessary at the time the services are being installed.

Hot and cold water pipes should be installed strictly in accordance with manufacturers instruction.

In the case of gas service pipes behind drylined walls, *BS 6891* states that the pipe should be encased in building material, which could take the form of Gyproc plaster. Alternatively, apply a continuous band of Gyproc Plasterboard Compound or timber battens either side of the pipe to receive a plasterboard lining.

Service penetrations and fixing into drywall systems

Switch boxes and socket outlets can be supported on brackets formed from Gypframe 99FC50 Fixing Channel or cut and bent channels fixed horizontally between the studs. Alternatively, services can be fixed to the face of the partition, using a Gypframe Service Support Plate, which carries 18mm plywood within the cavity of the partition as shown in figure 26.

In fire-rated walls, the fire-stopping design is dependent on the period of fire resistance. Where acoustic performance is not a specific requirement, refer to figure 27 and figure 28.

Fixing electrical socket boxes into our partitions and walls can affect the technical performance e.g. fire, acoustic, air leakage, but careful detailing can minimise this. Robust Details offer specific guidance on the installation of socket boxes in separating walls, particularly with regard to the avoidance of back-to-back services. Refer to figure 29.

There are a number of putty pad products available on the market from a range of manufacturers and whilst we have no objection to the use of putty pads (by others) within drylining systems, all performance substantiation has to be provided by the fire-stopping manufacturer as is the case for any fire-stopping material. Refer to figure 30, for example.

The Robust Details pattern book also offers *the* alternative of a 'sacrificial' lining in front of a separating wall to create a zone for service installation. These service zones remove the need for service penetration of the actual Robust Detail separating wall construction, which in turn removes the

Technical performance and principles of system design

Service installations (continued)

risk of a loss in acoustic performance as a result of service penetrations. Refer to figure 31.

This method is increasingly migrating to projects where Pre-Completion Testing is being used, as best practice. However, it can lead to a downgrading of the $D_{nT,w} + C_{tr}$ performance of the base wall due to the introduction of additional cavities within the overall construction. Robust Detail walls are designed to exceed the building regulations so the slight potential downgrade in performance caused by the 'sacrificial' lining would not lead to system failure.

Where Pre-Completion Testing is required however, depending on the system specified, there may not be this level of 'safety margin', particularly at lower frequencies. Therefore, where additional 'sacrificial' service installation zone linings have been specified in non-Robust Details systems the most appropriate solution to ensure no reduction in the acoustic performance of the base partition is a 70mm cavity with 50mm Isover Acoustic Roll and a single layer 15mm Gyproc SoundBloc board lining installed on one or both sides of the base partition construction. Refer to figure 32, for example.

The plasterboard should always be neatly cut and Gyproc Sealant should be applied where optimum acoustic performance is required.

In wall linings and ceilings, access for services may be required for routine maintenance, inspection, upgrading or repair. This can be achieved by installing Gyproc Profilex Access Panels. Services should be routed through the lowest acoustic performing wall where possible. Penetrations of fire-resistant constructions for services need careful consideration to ensure that the integrity of the element is not impaired, and also that the services themselves do not act as the mechanism for fire spread. It is important to use only those services and their installations that have been shown by a fire test to be able to maintain the integrity of the construction. By designing service zones, through which all services pass, the number of individual service penetrations can be minimised. Service zones can be sealed after installation of the services using a tested and substantiated fire-stopping system.

In most situations, the services will be installed by contractors other than the drylining contractor. It is important, therefore, that all relevant contractors are advised as to where and how their service penetrations should be made and maintained. The necessity to independently support services will depend on their size and weight and the drylining specification.
There is a wide variety of fixing devices suitable for securing fixtures and fittings to our systems. Generally, the choice of individual fixing devices will depend on the type of system and the loading requirements. This section gives recommendations on the selection of generic devices and proprietary fixings. Tables 11, 12 and 13 give example fixing devices and typical applications in drywall systems to meet the specific load criteria for single fixtures. It is important to ensure that the drylining system specified is capable of supporting the loads, particularly if installing multiple fixtures. Furthermore, it may be necessary to incorporate several fixings per fixture to ensure the weight is distributed across the drylining system rather than a point load, particularly for medium to heavy fixtures.

The guidance given is primarily concerned with fixtures at the time of installation. For subsequent installation, especially for heavier fixtures, the identification of studs and noggings within the lining / partition system will be required in order to attach the fixtures at these points.

Duct / damper penetration through drywall systems

Fire and smoke resisting dampers can be installed in our systems. Dampers prevent fire and smoke from passing from one fire compartment to another through heating, ventilation and air conditioning systems. 'An Industry Guide to the Design for the Installation of Fire and Smoke Resisting Dampers' is available from the Association of Specialist Fire Protection (ASFP) or as a download from asfp.org.uk. This document refers the designer to the principles of construction, and in particular to tested constructions, or to constructions assessed for performance in fire by a suitably qualified person.

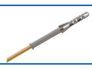
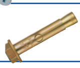
Figure 33, figure 34 and figure 35 show a method of preparing openings for installing dampers up to a maximum weight of 57kg within our systems. As the performance of the complete assembly will depend on a number of elements, the actual details of the opening need to be determined in conjunction with the fire-stopping and damper manufacturers.

Technical performance and principles of system design

Service installations (continued)

Table 11 – Example fixing devices and typical safe working loads on partitions and wall linings

System	Lightweight fixtures up to 3kg (e.g. socket)	Lightweight to medium fixtures up to 4 – 8kg (e.g. small mirror)	Medium weight fixtures 9 – 20kg (e.g. shelf)	Medium to heavy fixtures 21 – 50kg (e.g. cupboard)	Heavy fixtures 51 – 100kg (e.g. basin)
ShaftWall and **GypWall** systems[1] **GypLyner IWL**	A	B or C	D, E or I	G, H or I	K
Timber stud	A	B or C	K or D	K	K
DriLyner	A	B	F	L	L
GypLyner wall lining	A	B or C	D or E	K	K

Reference	Detail	Description	Typical SWL[2] (typical failure load)
A		5mm woodscrew into Gyproc plasterboard	3kg (12kg)
B		Steel picture hook and masonry nail into Gyproc plasterboard	4kg (16kg)
C		Metal self-drive into single layer Gyproc plasterboard	6kg (24kg)
		Metal self-drive into double layer Gyproc plasterboard	8kg (32kg)
D		Steel expanding cavity fixing, e.g. M5 x 40, into Gyproc plasterboard (board thicknesses up to 12.5mm)	12kg (48kg)
		Steel expanding cavity fixing, e.g. M5 x 65, into plasterboard (board thicknesses from 15mm to 28mm)	18kg (72kg)
E		Gyproc Drywall Screw fixed through Gyproc plasterboard into 0.5mm Gypframe metal stud / Gypframe 99 FC 50 Fixing Channel	19kg (76kg)
F		Heavy duty plastic plug fixed through Gyproc plasterboard into masonry with 55mm minimum penetration	20kg (140kg)
G		Gyproc Jack-Point Screws fixed through Gyproc plasterboard into minimum 0.9mm Gypframe metal stud	30kg (120kg)
H		No.12 self-tapping screws fixed through Gyproc plasterboard into minimum 0.9mm Gypframe metal stud	50kg (200kg)
I		Steel expanding metal cavity fixing, e.g. M4 x 40, through Gyproc plasterboard into 0.9mm Gypframe metal stud (board thicknesses up to 12.5mm)	40kg (160kg)
		Steel expanding metal cavity fixing, e.g. M4 x 65, through Gyproc plasterboard into 0.9mm Gypframe metal stud (board thicknesses from 15mm to 28mm)	50kg (200kg)
		Steel expanding metal cavity fixing, e.g. M5 x 65, fixing through Gyproc plasterboard into plywood supported by Gypframe Service Support Plate	50kg (200kg)
J		8mm steel frame fixing fixed through Gyproc plasterboard into masonry with minimum 55mm penetration	60kg (240kg)
K		No.12 self-tapping screw fixed through Gyproc plasterboard into timber sub-frame	120kg (480kg)
L		M8 steel bolt / anchor fixed through Gyproc plasterboard into masonry with minimum 55mm penetration	130kg (520kg)

[1] For **GypWall QUIET SF**, ensure that the fixings do not bridge the Gypframe RB1 Resilient Bars, otherwise the acoustic performance will be compromised.
[2] Safe Working Load (SWL) – a safety factor of 4 (steel fixings) and 7 (plastic fixings) has been used.

For technical assistance on above fixings please contact the fixings manufacturer. The suitability of the fixing must be confirmed by the building designer / fixing manufacturer.

Reference can also be made to the Construction Fixing Association (CFA) guidance note 'Fixing For Plasterboard', which can be accessed at fixingscfa.co.uk

The information within table 11 does not take into consideration any additional forces that may be applied whether it be accidental, abusive or otherwise. The example fixing devices, typical safe working loads and typical failure loads given in table 11 relate to the installation of single fixtures. It is important to ensure that the drylining system specified is capable of supporting the loads, particularly if installing multiple fixtures. Furthermore, it may be necessary to incorporate several fixings per fixture to ensure the weight is distributed across the drylining system rather than a point load, particularly for medium to heavy fixtures.

Technical performance and principles of system design

Service installations (continued)

Table 12 – Example fixing devices and typical safe working loads on partitions incorporating Rigidur (GypWall EXTREME)

Reference	Detail	Description	Typical SWL[1] (typical failure load)
B		Steel picture hook and masonry nail into 12.5mm Rigidur	17kg (68kg)
		Steel picture hook and masonry nail into 15mm Rigidur	18kg (72kg)
F		Fischer PD nylon plug and screw into 12.5mm or 15mm Rigidur	20kg (140kg)
A		No. 10 woodscrew into 12.5mm or 15mm Rigidur	15kg (60kg)
I		Fischer HM8 x 55 steel cavity fixing into 15mm Rigidur	49kg (196kg)
M		Fischer KD6 steel cavity fixing into 12.5mm Rigidur	58kg (232kg)
		Fischer KD6 steel cavity fixing into 15mm Rigidur	74kg (296kg)

[1] Safe Working Load (SWL) – a safety factor of 4 (steel fixings) and 7 (plastic fixings) has been used.

For technical assistance on above fixings please contact the fixings manufacturer. The suitability of the fixing must be confirmed by the building designer / fixing manufacturer.

The information within table 12 does not take into consideration any additional forces that may be applied, whether it be accidental, abusive or otherwise. The example fixing devices, typical safe working loads and typical failure loads given in table 12 relate to the installation of single fixtures. It is important to ensure that the drylining system specified is capable of supporting the loads, particularly if installing multiple fixtures. Furthermore, it may be necessary to incorporate several fixings per fixture to ensure the weight is distributed across the drylining system rather than a point load, particularly for medium to heavy fixtures.

Table 13 – Example fixing devices and typical safe working loads on partitions incorporating Habito (GypWall SUPERIOR)

Reference	Detail	Description	Typical SWL[1] (typical failure load)
A		5mm Woodscrew into 12.5mm Gyproc Habito	15kg (60kg)
A		5mm Woodscrew into 2 x 12.5mm Gyproc Habito	34kg (136kg)
N		Steel expanding cavity fixing - M5/12 Cavity Anchor into 12.5mm Gyproc Habito	37kg (148kg)
O		Steel expanding cavity fixing - M5/25 Cavity Anchor into 12.5mm Gyproc Habito	47kg (188kg)
O		Steel expanding cavity fixing - M5/25 Cavity Anchor into 2 x 12.5mm Gyproc Habito	81kg (324kg)
P		M4 Spring Toggle into 12.5mm Gyproc Habito	42kg (168kg)
P		M4 Spring Toggle into 2 x 12.5mm Gyproc Habito	53kg (212kg)

[1] Safe Working Load (SWL) – a safety factor of 4 (steel fixings) has been used.

For technical assistance on above fixings please contact the fixings manufacturer. The suitability of the fixing must be confirmed by the building designer / fixing manufacturer.

The information within table 13 does not take into consideration any additional forces that may be applied, whether it be accidental, abusive or otherwise. The example fixing devices, typical safe working loads and typical failure loads given in table 13 relate to the installation of single fixtures. It is important to ensure that the drylining system specified is capable of supporting the loads, particularly if installing multiple fixtures. Furthermore, it may be necessary to incorporate several fixings per fixture to ensure the weight is distributed across the drylining system rather than a point load, particularly for medium to heavy fixtures.

Technical performance and principles of system design

Service installations (continued)

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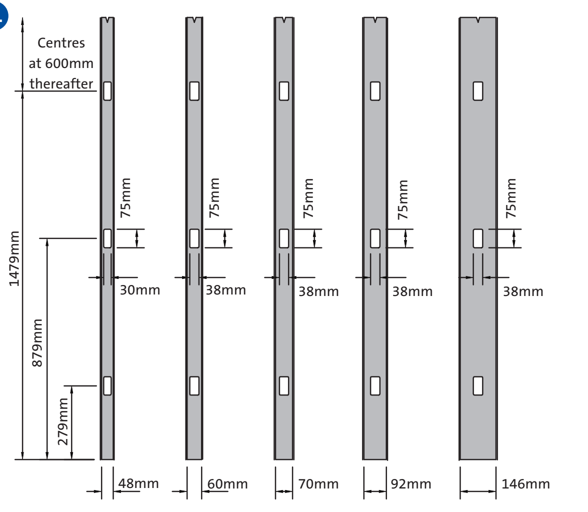

Gypframe studs service cut-out details – Gypframe 'C' and Gypframe 'I' Studs

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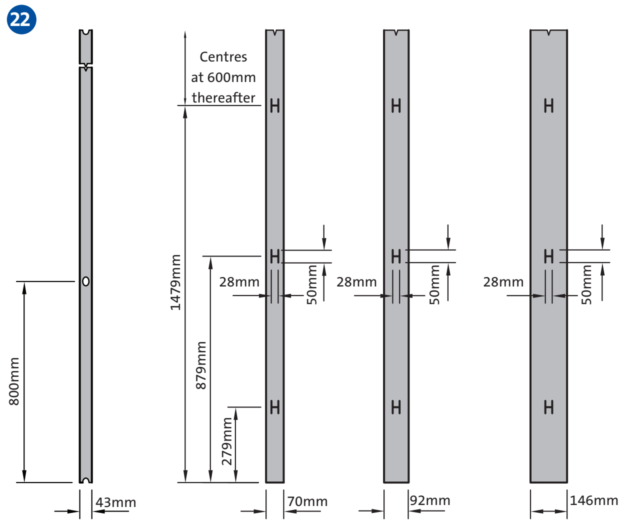

Gypframe studs service push-out details – Gypframe AcouStuds

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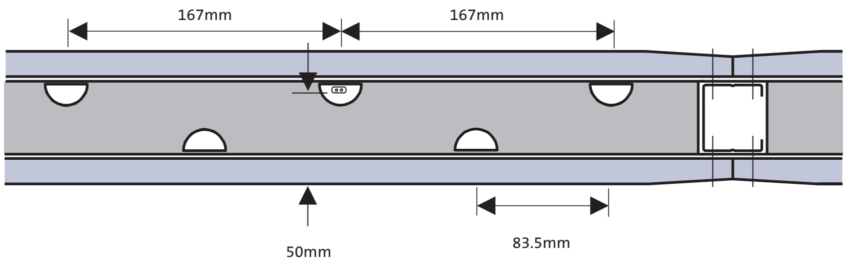

Cross-nogging cut-outs

Technical performance and principles of system design

Service installations (continued)

Figures

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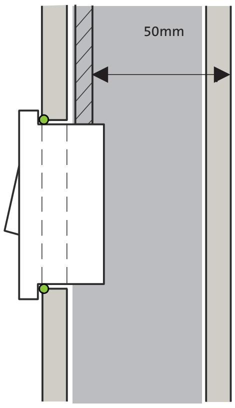

Minimum distance of cabling

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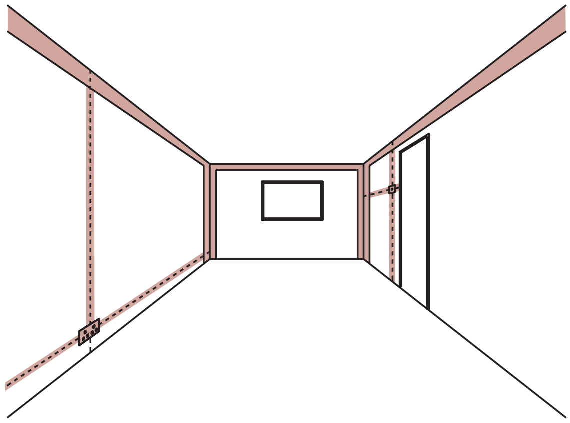
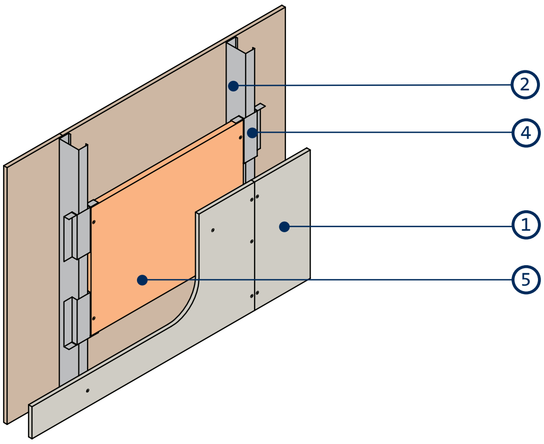


Standard zones of cabling

26



General arrangement of service support plates showing studs at 600mm centres

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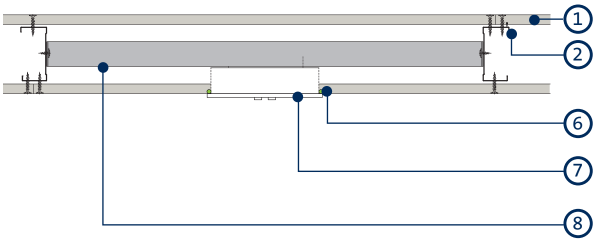

Socket box installation – up to 60 minutes fire resistance

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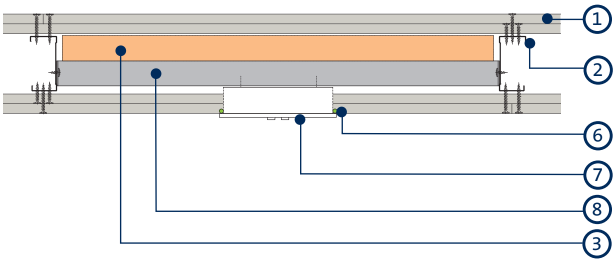

Socket box installation – up to 120 minutes fire resistance

1 Gyproc plasterboard or Gyproc specialist board
2 Gypframe 'C' Stud
3 Stone mineral wool (minimum 80kg/m³) backing to socket box
4 Gypframe Service Support Plate
5 18mm plywood
6 Gyproc Sealant at switch box perimeter for improved acoustics
7 Electrical socket with metal back box fitted tight into plasterboard
8 Gypframe Folded Edge Standard Floor & Ceiling Channel receiving fixing of socket box – channel legs tabbed, bent and fixed to metal studs with Gyproc Wafer Head Drywall Screws

NB If Gypframe Service Support Plates are being installed and not immediately boarded, secure plates with a Gyproc Wafer Head Drywall Screw or Gyproc Wafer Head Jack-Point Screw.

Technical performance and principles of system design

Service installations (continued)

Figures

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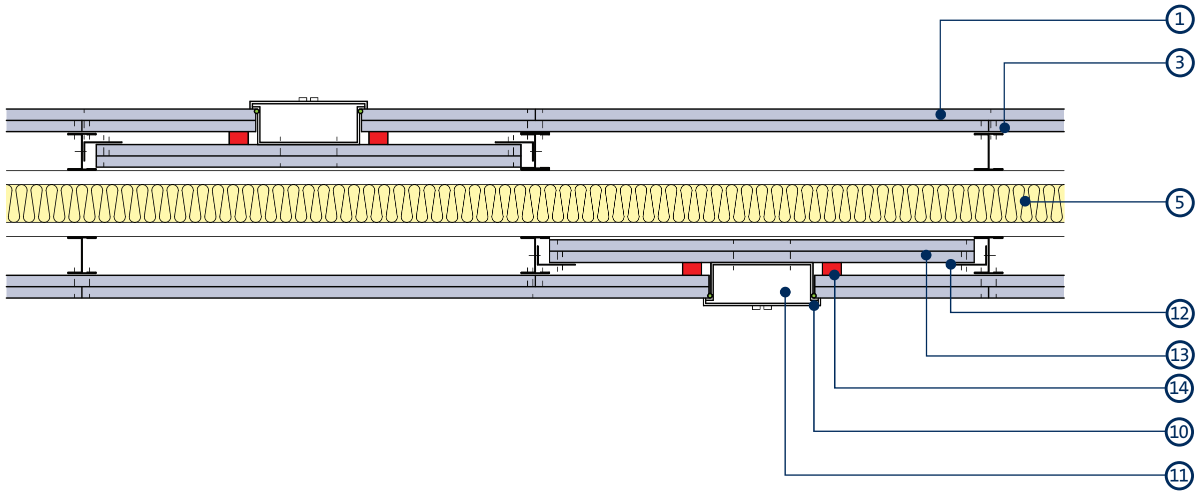

Electrical socket box with plasterboard baffle in **GypWall QUIET IWL**

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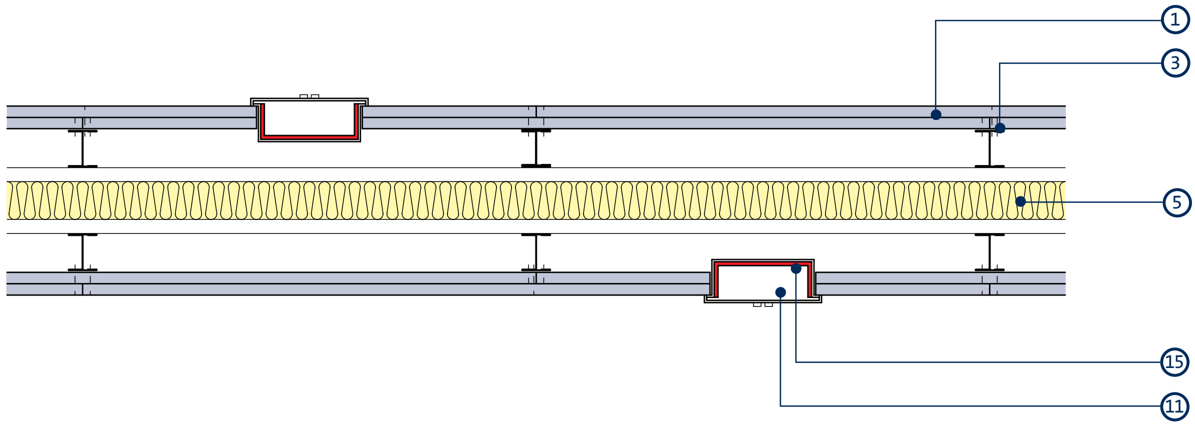

Electrical socket box with putty pad in **GypWall QUIET IWL**

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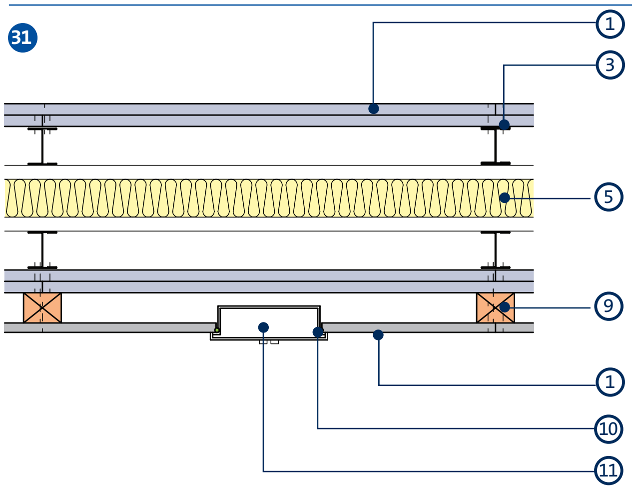

Robust Details sacrificial lining where a slight performance downgrade is not detrimental to the system

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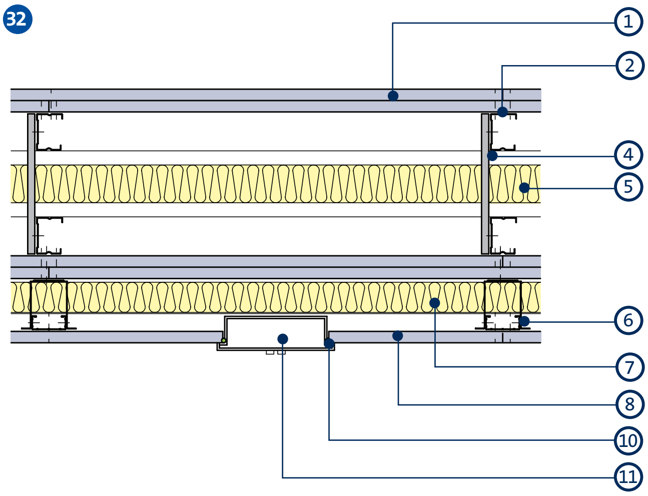

Electrical socket box in sacrificial lining to **GypWall QUIET**

1 Gyproc plasterboard
2 Gypframe 'C' Stud
3 Gypframe 'I' Stud
4 Gypframe 99 FC 50 Fixing Channel
5 Isover acoustic insulation
6 **GypLyner** with minimum 70mm cavity
7 50mm Isover Acoustic Roll
8 15mm Gyproc SoundBloc
9 Timber batten
10 Gyproc Sealant
11 Electrical socket box
12 Gypframe GA4 Steel Angle
13 150mm high Gyproc plasterboard baffle to match partition lining
14 Fire-resistant seal where required
15 Putty pad (by others) in accordance with manufacturer's instructions

Technical performance and principles of system design

Service installations (continued)

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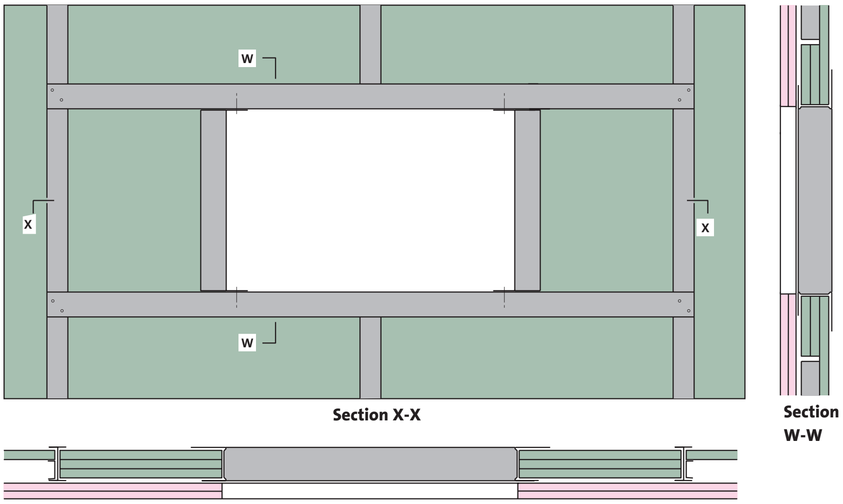

Opening bridging studs for duct / damper penetration within **ShaftWall**

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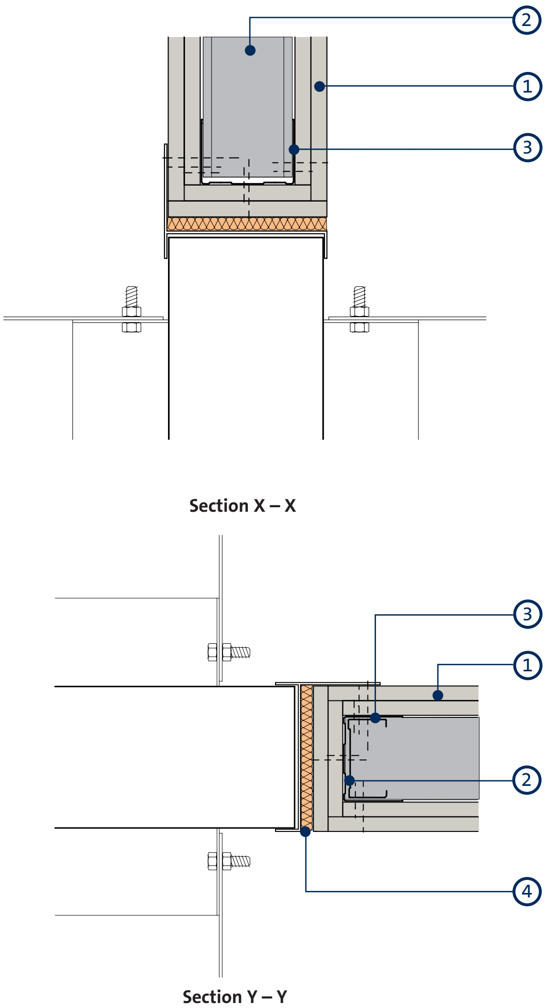

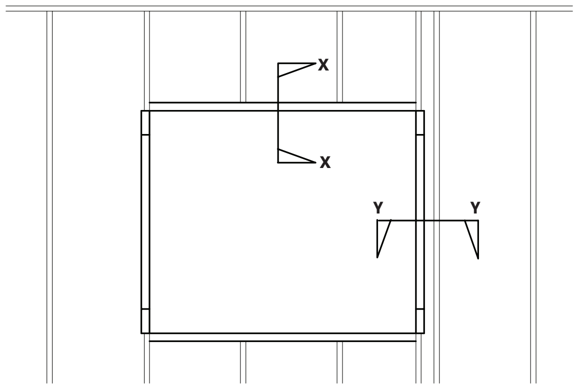

Typical opening for service penetrations in fire-rated partitions

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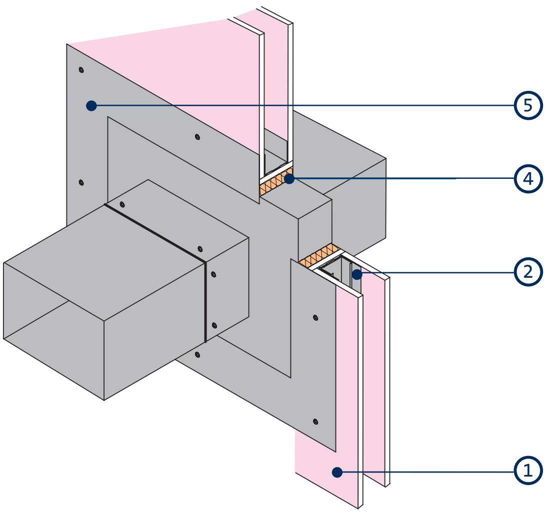

Fire rated construction in which the damper is supported by the partition (isometric view)

1 Gyproc plasterboard or Glasroc F specialist board
2 Gypframe 'C' Stud
3 Gypframe Floor & Ceiling Channel
4 Penetration seal as tested by damper manufacturer or proprietary alternative, confirmed as compatible by system designer / specifier (plasterboard lining around opening may not be required)
5 Damper (by others). Weight of damper should not exceed 57kg. Size damper should not exceed 1400 x 1200mm

Technical performance and principles of system design

Thermal insulation and condensation

Legislation and guidance documents

Building Regulations – Thermal insulation

Minimum energy efficiency requirements in Ireland are set out in Building Regulation documents below:

Republic of Ireland

- TGD L – 2011 : Conservation of Fuel and Energy – Dwellings
- TGD L – 2008 : Conservation of Fuel and Energy – Buildings other than dwellings

Northern Ireland

- TB F1 – 2012 : Conservation of fuel and power in dwellings
- TB F2 – 2012 : Conservation of fuel and power in buildings other than dwellings

Compliance is based on both the carbon dioxide performance and the fabric energy efficiency of the dwelling. Compliance targets are given through the use of Dwelling Energy Assessment procedure (DEAP) in RoI and Standard Assessment Procedure (SAP calculation) in NI and although compliance cannot be demonstrated by the elemental U-value method, U-values are important requirements within the calculation. Limiting fabric parameter U-values are given but U-values better than these are likely to be required and the regulations include model U-values within a concurrent notional dwelling specification. Air permeability / airtightness is also a requirement within the SAP calculation. Refer to table 14a.

Compliance with the non-domestic regulations is based upon the carbon dioxide performance. Compliance targets are given through the use of the Simplified Building Energy Model (SBEM) and although compliance cannot be demonstrated by the elemental U-value method, U-values are important requirements within the SBEM calculation. Limiting fabric parameter U-values are given but U-values better than these are likely to be required and the regulations include model U-values within a concurrent notional building specification. Air permeability is also a requirement within the SBEM calculation. Refer to table 14b.

Conservation of fuel and power in existing dwellings and in existing buildings other than dwellings are based on fabric energy efficiency and carbon dioxide performance with the need to meet U-values targets. Where an existing element forms part of the thermal envelope it must have a certain thermal value. This is known as the 'threshold' value. If the existing value of the element equals or is better than the threshold, no thermal renovation will be required. If it is worse than the threshold value then thermal renovation to achieve the required U-values has to be carried out. Refer to tables 15a and 15b.

Building Regulations – Condensation

In the Republic of Ireland the requirements are set out in Building Regulations Technical Guidance Document 'F'-Ventilation and 'L-Conservation of Fuel and Energy. In Northern Ireland the requirements are set out in Building Regulations Technical Booklet 'C' – site preparation and resistance to contaminants and moisture, 'K' – Ventilation and 'F1&2' Conservation of fuel and power. The walls, floors and roof of the building shall adequately protect the building and people who use the building from harmful effects caused by interstitial and surface condensation. To provide resistance to surface condensation and mould growth, guidance is also given to ensure that in simple terms the minimum internal surface temperature is not more than 25% below roof temperature.

Table 14a

New dwellings	Republic of Ireland (TGD L Dwellings)		Northern Ireland (TB F1)	
	U-value (W/m²K)		U-value (W/m²K)	
	Limiting fabric parameters	Example dwelling specification	Area weighted average	Maximum at any point
Wall	0.21	0.13	0.3	0.7
Floor	0.21 (0.15 if Underfloor heating)	0.14	0.25	0.7
Roof	0.16	0.11	0.2	0.35
Party Wall	n/a	n/a	0.2	0.7

Table 14b

New buildings other than dwellings	Republic of Ireland (TGD L Buildings other than Dwellings)	Northern Ireland (TB F2)
	U-value (W/m²K)	U-value (W/m²K)
	Average elemental U-values	Area weighted average
Wall	0.27	0.35
Floor	0.25	0.25
Party Wall	-	0.2
Pitched roof, insulation at ceiling level	0.16	0.25
Pitched roof, insulation at rafter level	0.2	-
Flat roof or roof with integral insulation	0.22	0.2

Technical performance and principles of system design

Thermal insulation and condensation (continued)

Table 15a

Existing dwellings	**Republic of Ireland (TGD L Dwellings)** U-value (W/m²K)		**Northern Ireland (TB F1)** U-value (W/m²K)	
	Material alterations or material change of use	Average Elemental U-value - individual element or section of element	New thermal elements (including replacements for existing elements and non-exempt Conservatories & Porches)	Upgrading retained thermal elements
Wall	0.35 (0.55 Cavity Walls)	0.6	0.28	0.30 (0.55 Cavity insulation)
Floor	0.45 (0.25 Other exposed)	0.6	0.22	0.25
Pitched roof, insulation at ceiling level	0.16	0.35	0.16	0.16
Pitched roof, insulation at rafter level	0.25	0.35	0.18	0.18
Flat roof or roof with integral insulation	0.25	0.35	0.18	0.18

Table 15b

Existing buildings other than dwellings	**Republic of Ireland (TGD L Buildings other than dwellings)** U-value (W/m²K)	**Northern Ireland (TB F2)** U-value (W/m²K)	
	Material Alterations to, or Material Changes of Use of, Existing Buildings	New thermal elements (including replacements for existing elements)	Upgrading retained thermal elements
Wall	0.6	0.28	0.30 (0.55 Cavity insulation)
Floor	0.6	0.22	0.25
Pitched roof, insulation at ceiling level	0.35	0.16	0.16
Pitched roof, insulation at rafter level	0.35	0.18	0.18
Flat roof or roof with integral insulation	0.35	0.18	0.18

Guidance documents referenced in national building regulations

Acceptable (RoI) or Accredited (NI) Construction Details
Published by Local Government, these are intended to assist the construction industry to comply with the performance standards published in the guidance documents. These are focused on issues concerning insulation continuity and airtightness, providing theoretical information and large scale indicative drawings. It can be accessed via the websites www.planningportal.gov.uk (NI) or www.environ.ie/housing/building-standards/tgd-part-l-conservation-fuel-and-energy/technical-guidance-document-l-2 (RoI)

BR443 U-value conventions
Published by the Building Research Establishment (BRE), it provides calculation methods for the determination of U-values of building elements and includes common issues, together with data on typical constructions and the thermal conductivity of materials.

BR262 Thermal insulation avoiding risks
Published by the BRE,it highlights risks, causes and solutions of thermal design. The guidance supports the Building Regulations and represents the recommendations on good design and construction practice associated with thermal standards.

BS EN 12524: 2000 Building material and products - Hygrothermal properties - Tabulated design values
This gives design data in tabular form for heat and moisture transfer calculations, for thermally homogeneous materials and products commonly used in building construction. It also gives data to enable calculations and conversion of design thermal values for various environmental conditions.

BS EN ISO 13788: 2012 Hygrothermal performance of building components and building elements. Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation method
This deals with the critical surface humidity likely to lead to problems such as mould growth on the internal surfaces of buildings and interstitial condensation within a building component. It also deals with estimation of the time taken for a component, between high vapour resistance layers, to dry, after wetting from any source, and the risk of interstitial condensation occurring elsewhere in the component during the drying process.

BS EN ISO 6946: 2007 Building components and building elements. Thermal resistance and thermal transmittance - Calculation method
This gives the method of calculation of the thermal resistance and thermal transmittance of building components and building elements, excluding doors, windows and other glazed units; components that involve heat transfer to the ground; and components through which air is designed to permeate. The calculation method is based on the appropriate design thermal conductivities or design thermal resistances of the materials and products involved.

BS 5250: 2011 Code of practice for control of condensation in buildings
This describes the causes and effects of surface and interstitial condensation in buildings, and gives recommendations for their control.

BS 9250: 2007 Code of practice for design of the airtightness of ceilings in pitched roofs
This describes methods that can be used to meet the “well sealed ceiling” requirements defined in BS 5250 for cold and warm pitched roofs and provides robust design details for the construction of more airtight ceilings and for the control of air movement into pitched roofs.

Technical performance and principles of system design

Thermal insulation and condensation (continued)

The provision of thermal insulation

Reducing heat loss

Any building with an internal temperature higher than the external temperature will lose heat. Thermal insulation reduces this heat loss and therefore helps to conserve energy and reduce heating costs. To comply with Building Regulations, levels of thermal performance are required for the external walls, roof and floors of almost all building types. Adequate insulation must also be provided for hot water heating services, pipes, warm air ducts and hot water storage vessels.

Savings are maximised where insulation is supported by other measures such as automatic controls, which govern the operation and output of heating systems and the temperature of stored water.

In addition to providing high levels of thermal performance in newly constructed buildings, insulation products and systems are also incorporated into existing buildings where the energy efficiency of the building may be inadequate. This will apply equally to both non-domestic buildings and to the existing housing stock. The scale of inefficiency for the latter has been highlighted by various Government surveys and subsequent corrective measures. When specifying the insulation system for a particular building it is important to take into account both the heating regime and the pattern of usage of the building.

Infrequently heated buildings

If a building is only infrequently heated, thermal insulation materials should be located as near as possible to the internal surface of exposed building elements to provide a quick thermal response to heating input. This is essential in such conditions to reduce internal surface condensation during the warm-up period, when the maximum amount of water vapour is often produced. It will also ensure that comfortable room temperatures are quickly achieved.

Regularly heated buildings

Heating regimes may be of a regular nature, with relatively equal periods of heating activity and non-activity, as may occur in housing during winter months. In this situation, traditional forms of high mass construction, such as externally insulated solid leaf walls or to a lesser extent double leaf cavity walls, can effectively exploit the ‘heat store’ concept when thermal insulation is positioned within the cavity. Note however that this is more applicable in our climate to non-domestic buildings because residential construction neither gains from extreme external temperatures or high internal heat outputs. These may be present in office buildings for example due to the number of staff or other high internal gains from server rooms or kitchens. Extreme air temperature fluctuations within the building can be subdued as heat stored in components within the insulation ‘envelope’ is dissipated back into the building. Further benefits can be derived from the reduced size and complexity of space heating equipment necessary to maintain room temperatures.

Airtightness

Airtightness describes the air leakage characteristics of a building. This determines the uncontrolled background ventilation or leakage rate of a building.

Airtightness is expressed in terms of a whole building leakage rate at an artificially induced pressure (usually 50Pa). The lower the air leakage rate, the greater the airtightness. For example, within TGD L (RoI domestic) an upper limit on air permeability of 7m³/hour/m² and within TB F1 (NI) 10m³/hour/m² is required. In practice, most designs will need to be significantly better than this.

Improving a building’s airtightness is crucial to improving the energy performance of a building.

Although air leakage can occur directly, the majority of leaks occur indirectly. Air leakage paths are often complicated and therefore air leakage can be difficult to trace and seal effectively. However, the following is a list of some example air leakage paths:

- Cracks, gaps and joints in the structure
- Timber floors
- Joist penetrations of external walls
- Windows, doors, roof windows and AOVs
- Loft hatches
  - Tubular rooflights
- Skirting boards
- Chimney and flues
- Service entries, ducts and electrical components
  - Light fittings
  - Ventilators, and extraction outlets
- Areas of un-plastered walls

To improve airtightness when using a plasterboard internal drylining system, e.g. **DriLyner**, continuous ribbons of adhesive should be applied around the perimeter of the wall and around openings / penetrations to seal airpaths. Gyproc Airtite Quiet can be used on most external masonry walls to seal air paths. This may also improve the airtightness before a drylining system is applied to the wall, alternatively Gyproc Hard Coat combined with our finish plaster may be used as an airtight solid plastered wall finish.

Terminology

Thermal conductivity (λ)

This is a measure of a material’s ability to transmit heat, and is expressed as heat flow in watts per metre thickness of material for a temperature gradient of one degree Kelvin (K). It is expressed as W/mK.

Generally, dense materials have high thermal conductivity and are inefficient thermal insulants. Lightweight materials

Technical performance and principles of system design

Thermal insulation and condensation (continued)

have low conductivity and can be efficient thermal insulants. The lower the λ value of a material, the better its insulating efficiency.

Thermal resistance (R)

This is the measure of the resistance to the passage of heat offered by the thickness of a material and is expressed as m²K/W. The thermal resistance of a material is obtained by the following calculation:

$$R = \frac{t}{\lambda}$$

Where t = thickness in (m) and λ = thermal conductivity (W/mK)

Thermal transmittance (U-value)

This is a property of the whole construction, including air spaces, and is a measure of its ability to transmit heat under steady state conditions. It is calculated by taking the reciprocal of the sum of all the individual thermal resistances, taking into consideration any thermal bridging, and is expressed as W/m²K. The lower the U-value of the element the better its thermal insulation.

For the purpose of calculating U-values, thermal resistances for the inside and outside surfaces of a building element, and for any cavities within it, have to be taken into account. This is in addition to thermal resistances directly relating to the actual thickness of materials.

The R-values of inside surfaces, outside surfaces and of any cavities will vary according to the surface emissivity. Emissivity should be taken as high for all normal building materials other than polished or metal surfaces, such as aluminium foil, which are regarded as low.

U-value calculations are used as a common basis for comparing different constructions or for meeting a stated figure. When calculating the U-value of some constructions the effect of components that repeatedly bridge the insulation layer, such as mortar joints in lightweight blockwork, studs in timber and metal framed walls, wall ties, and roof joists, should be taken into account. The U-value is calculated through the thermal bridge and combined with the U-value through the insulation in proportion to its face area, often resulting in a higher U-value (i.e. lower performance) for the element. More insulation may be needed to compensate for the presence of thermal bridges and return the U-value to a specified level. This can also be achieved by changing to a more efficient insulant. The additional heat loss for non-repeating thermal bridges, such as details at window and door openings, is determined separately.

Thermal mass / heat sink

Thermal mass (also discussed under 'regularly heated buildings above'), describes a material's capacity to absorb, store and release heat. For example, water and concrete have a high capacity to store heat and are referred to as 'high thermal mass' materials. Insulation foam, by contrast, has very little heat storage capacity and is referred to as having 'low thermal mass'. Gyproc plasterboards and Rigidur are effective in contributing towards the thermal mass effect. Thermal mass design, for example in school buildings, is a means of ensuring overheating is kept under control.

This principle is included with the SBEM and SAP or DEAP procedure within which it is expressed as a Kappa (κ) value in calculating the thermal mass parameter to characterise the thermal mass of the building. As an example within SAP, the heat capacity κ of a single layer plasterboard partition is given as 9 kJ/m²K.

Condensation control in buildings

Harmful effects of condensation

Condensation can be one of the worst problems that designers, owners or occupants of buildings experience.

Dampness and mould growth caused by surface condensation can not only be distressing to the occupants of a building, but can eventually lead to health risk to the occupants and or damage in the building itself.

The thermal insulation and ventilation requirements of Building Regulations aim to reduce the risk of condensation and mould growth occurring in new buildings. However, designers should take care to eliminate all problems caused by condensation, particularly in refurbishment projects on existing buildings, where situations exist that are not directly covered by the regulations.

Reducing the risk

Due to changes in building design, occupancy patterns and increased thermal requirements, all buildings, particularly houses, are more sensitive to condensation now than in previous years. Homes tend to be heated intermittently and moisture-producing activities are concentrated into relatively short periods of time.

Thermal insulation correctly positioned within specific building elements, combined with adequate heating and the necessary water vapour control and ventilation, where appropriate, should ensure trouble-free design.

How condensation occurs

At any given temperature, air is capable of containing a specific maximum amount of water in vapour form. The warmer the air, the greater the amount of water vapour it can contain. Conversely, the lower the temperature, the smaller the amount. Water vapour in air exerts a pressure, called the vapour pressure. Any differential in vapour pressure causes vapour to diffuse from high to low pressure areas.

Warm air inside a building usually also contains more moisture than external air, due either to the occupants' activities or resulting from the evaporation of residual moisture in new construction. This creates a pressure differential across structural elements. Water vapour in the internal air, being at a higher pressure, tends to diffuse through the structure towards the colder, lower pressure exterior.

Technical performance and principles of system design

Thermal insulation and condensation (continued)

If moisture-laden air comes into contact with a cold surface it will cool. As it cools, the amount of water it can hold in vapour form reduces until, at a specific temperature called the dew point, it becomes saturated. Water is then deposited in the form of condensation.

Surface condensation

Surface condensation occurs when air containing water vapour comes into contact with highly vapour resistant surfaces, which are at, or below, the dew point temperature.

Refer to figure 36 – 'Surface condensation'. It usually shows itself as beads of water, damp patches, and, where the condition persists, mould growth.

Surface condensation can be in localised zones in a particular building element caused by the presence of 'cold bridges', such as mortar joints in walls, which can be colder than the rest of the wall structure.

In addition, warm moist air will diffuse through a building into colder rooms, such as poorly heated bedrooms and stairwells. This is one reason why surface condensation does not always occur in the room where water vapour is produced.

Interstitial condensation

Warm moist air will also diffuse through building elements to reach colder, lower pressure conditions outside. If the building materials have low water vapour resistance it is possible for condensation to occur within the building element. This will occur on the first cold surface, at or below dew point temperature, which is encountered by the moisture vapour on its passage through the structure. As an example, for double skin masonry walls, the position for condensation to form is on the inner face of the outer leaf whether or not insulation is included in the cavity. Refer to figure 37 – 'Interstitial condensation'.

There is no evidence to suggest that interstitial condensation will occur within the core of building materials under general building and climatic conditions. For other types of building structure vapour control layers can help to eliminate the risk of interstitial condensation. It is recommended that the risk of harmful condensation be assessed using an appropriate calculation procedure, for example as described in I.S. EN IS0 13788: 2002 and/or I.S. EN 15026: 2007. Refer to table 17 for typical hygrothermal properties.

Designing to reduce condensation risk

Thermal insulation

Thermal insulation helps to reduce the risk of surface condensation by maintaining surfaces above the dew point temperature subject to adequate heating being provided.

In buildings that are heated infrequently, the thermal insulation should be located as near as possible to the internal surface of building elements to provide rapid thermal response. These surfaces will then be less prone to surface condensation during the warm-up period, which is often when the maximum amount of water vapour is produced. Where the greater part of the insulation is located to the internal surface, strategies must be employed to ensure interstitial condensation does not occur behind the insulation. Please contact our technical department for further advice in these scenarios.

Where the insulation is being 'topped up' with internal insulation, this is far less of a concern, e.g. where adding internal insulation to a cavity wall This will also reduce the thermal bridge effects in a building, e.g. at lintels and reveals and at the gable wall below an attic.

For most constructions the use of vapour permeable insulation, in combination with other building materials of low vapour resistance, will allow the structure to breathe naturally. In this instance, the likely occurrence of interstitial condensation can be managed but must be considered in the context of the complete wall as a 'system' including external render and use of the building/room.

Thermal bridging, particularly at junctions, abutments and openings can occur and therefore good detailing is essential. This is now a critical issue in the context of new buildings based on imminent mandatory standards for nearly Zero Energy Buildings (nZEB). Information on Psi (φ) values (linear thermal transmission) relating to thermal bridging details is contained within SAP, and within Accredited Construction Details (ACDs) which are available to view at www.planningportal.gov.uk (NI) or www.environ.ie/housing/building-standards/tgd-part-l-conservation-fuel-and-energy/technical-guidance-document-l-2 (RoI).

Note that providing a simple calculation of the 'y factor', essentially the average u-value for all thermal bridges in the building can reduce the costs and need for alternative efficiency measures including renewable energy solutions.

Heating

Adequate heating helps to keep the temperature of the internal surfaces above the dew point. Ideally, an air temperature above 10°C should be maintained in all parts of the building.

Ventilation

Ventilation removes the water vapour produced within a building to the outside air. Adequate ventilation, including the provision of small controllable slot ventilators in windows, electrical extractor fans controlled by humidistats in bathrooms and kitchens, and cooker hoods extracted to the outside air, will help to reduce harmful condensation and mould growth. Ideally, ventilation should control the internal air to between 40% and 70% relative humidity (RH) for human occupation.

Condensation can occur in roof spaces of slated or tiled pitched roofs of dwellings and in timber joisted flat roofs with insulated ceilings, unless adequate ventilation is provided. Precautions should be taken, in particular the provision of adequate cross-ventilation of the roof spaces to the outside. The main requirements for ventilation in buildings are given in BS 5250 and referenced in national building regulations, TGD F (RoI) and TB K (NI). Note that

Technical performance and principles of system design

Thermal insulation and condensation (continued)

in accordance with BS 5250, pitched roofs may not require active ventilation where a low resistance (LR) underlay is used in combination with a permeable roof finish such as natural slates or concrete tiles. Please contact our the Gyproc Technical Department for further information.

Vapour control layer

A vapour control layer, usually in the form of a membrane, is used to substantially reduce the transfer of water vapour through a building element in which it is incorporated. Refer to table 16 for a few example wall and roof constructions. A vapour control layer, positioned on the warm side of the thermal insulation within a building element, helps to reduce the risk of interstitial condensation occurring within that element. However, other precautions may also be necessary, either in combination with, or as alternatives to, a vapour control layer. These include the use of ventilated cavities and the provision of materials of low vapour resistance, particularly on the colder side of the construction.

Vapour control layers should be as airtight as possible. Holes and penetrations for services should be cut neatly and suitably sealed, or localised condensation may still occur. It is recommended that the risk of harmful interstitial condensation is assessed using the calculation procedure given in I.S. EN IS0 13788: 2002 and/or I.S. EN 15026: 2007.

Existing masonry walls

The Isover Optima system incorporating Gyproc plasterboard, metal framing, Metac insulation and Optima clips is agrément certified by the NSAI and BBA for internal insulation of a range of masonry wall types. Suitability and the level of insulation in the system depends on the exposure and porosity of the external leaf as well as internal humidity. High risk areas include porous unrendered solid brick walls and where intermediate floors are built into the wall. Please contact the Gyproc Technical Department for further information.

New masonry walls

Full fill or partial fill cavity
Positioning Isover CWS 32 or 36 Batt insulation within the cavity, either full fill or partial fill, can maintain the internal surface of the wall above dew point temperature. Therefore a water vapour resistant treatment to the surface of internal plaster finishes is not always necessary because any interstitial condensation will occur on the inner surface of the outer leaf. Gyproc plasters, or Gyproc WallBoard, fixed in the DriLyner or GypLyner systems, form suitable linings. Gyproc WallBoard **DUPLEX** can be specified in conjunction with the (mechanically fixed) DriLyner **MF** or GypLyner systems, however exposed blockwork is typically highly porous and should first be sealed with a parge coat layer of plaster such as Gyproc Airtite Quiet. For higher levels of airtightness and moisture management we recommend Isover Vario KM duplex be used (taped and sealed) behind our non-duplex boards.

Timber / steel frame walls

To reduce the risk of interstitial condensation occurring on the inner surface of the sheathing, a vapour control layer is required as part of the internal lining, refer to NHBC (Technical Standards for domestic applications) at nhbc.co.uk. Isover timber frame insulation is positioned within the stud cavity and Gyproc **DUPLEX** grade plasterboards can be used as the internal face lining or Isover Vario KM Duplex membrane and an alternative Gyproc plasterboard. The dew point will then fall within the outer cavity or external cladding.

Where the insulation does not meet the U-value requirement alone, a drylining system using a thermal laminate could be considered which will provide both thermal performance and a vapour control layer however, system designers and installers must ensure that fire performance of the system is fully validated by appropriate fire test evidence where required. Note that in order to mitigate risks of interstitial condensation, a maximum of one third the total resistance of insulation in the construction may be provided to the inside of the vapour control layer. This is commonly referred to as the ‘one third rule’.

Pitched roofs

Horizontal insulated ceilings, e.g. cold loft space
Positioning a vapour control membrane at ceiling level should reduce the amount of water vapour migrating into the roof space. In practice, however, a continuous barrier is unlikely to be achieved because of the difficulty of sealing leaks through loft access hatches, electrical wiring drops, pipe penetrations and cracks. Gaps in the ceiling can be much more significant for heat losses and water vapour transfer from convection / migration than diffusion through the ceiling itself. Appropriate cross-ventilation of the roof space is necessary.

Insulation, e.g. Isover Spacesaver range, is located on top of and between the ceiling joists and Gyproc plasterboard fixed to the underside. Gyproc **DUPLEX** grade plasterboards can be used as the ceiling lining if a vapour control layer is required. The amount of ventilation is set out in TGD F (RoI) and TB K (NI). An alternative compliance method is set out in BS 5250 and depends on the permeability of roof finish and airtightness of ceiling below.For a pitched roof (>15° pitch), generally a minimum 50mm clear cavity well vented space above the insulation to the external air is required with the equivalent of a continuous 10mm gap in the eaves/soffit at the perimeter. With a low resistance roof underlay (<0.4 MNs/g) and a well sealed ceiling below, this may be reduced to a 3mm gap or equivalent. For well-sealed ceilings, it is recommended to use Isover Vario membranes, taped and sealed.

Sloping insulated ceilings, e.g. warm room-in-the-roof
Isover Metac insulation is located between the rafters and a minimum 50mm ventilation zone above the insulation is typically required. However, per BS 5250 if the roof finish is air permeable or the tiling batten / counter batten cavity is vented and a low resistance underlay is used, the 50mm vented zone may not be required. This will also improve the wind-tightness of the assembly.

Technical performance and principles of system design

Thermal insulation and condensation (continued)

Warm construction

In warm roof construction, the thermal insulation (by others) is located on top of a high performance vapour control layer over the roof decking. The construction is referred to as a warm roof because in winter, with adequate heating, the temperature of the vapour control layer, and of the materials below it, is maintained close to that of the internal air. Specific requirements in BS5250 set out that ceilings under warm pitched roofs must be 'well sealed' in order to minimize the transfer of water vapour by air movement, diffusion and convection. In addition, recent building science has shown that a warm roof must provide either no insulation above the rafters (so that solar gains on a dark colour slate/tile roof may keep the top of the rafters warm) or a minimum of 50mm rigid insulation be provided (which will block out solar gain to the rafters but maintain sufficient temperatures below.)

Flat roofs (<15° pitch)

Cold construction

In a cold roof construction, the thermal insulation, e.g. Isover Metac, is located directly above the ceiling. Most of the structure is on the unheated side of the insulation and is therefore vulnerable to the risk ofinterstitial condensation. To reduce this risk, cross-ventilation must be provided above the insulation to disperse water vapour to the outside. Generally a minimum 50mm clear cavity well vented to the external air is required. Flat roofs will require 25mm fresh air gap or equivalent at each end of the cavity. An effective vapour control layer should be provided at ceiling level and perforations for pipes, electrical wiring drops, etc., should be sealed. Refer to figure 38 – 'Timber flat roof, cold type'. Gyproc **DUPLEX** grade plasterboards can be used as the internal face ceiling lining.

Table 16 – Recommendations for the use of vapour control layers to reduce the risk of interstitial condensation in some example external wall and roof constructions in dwellings

Element	Type of external wall	Vapour control layer required?	Comments
External walls	Timber or metal frame (brick outer leaf)	Yes	Low vapour resistance sheathing board and breather membrane.
	Brick / insulated cavity / block Gyproc plasterboard lining or plaster	No	Consider vapour control layer in adverse conditions
	Solid masonry	Yes	Please contact Technical Department for further information.
Roofs	Cold pitched roof, tiles or slates on battens on membrane over loft space	Recommended	Especially important with higher levels of insulation
	Ceiling and insulation horizontal	Recommended	Ventilated in accordance with *BS 5250* and Approved Document F. Consider vapour control layer in adverse conditions.
	Warm pitched roof, tiles or slates on battens on membrane Ceiling and insulation inclined	Yes	Ventilated in accordance with BS 5250 and TGD F / TB K. Minimum 50mm ventilation zone above insulation (unless permeable or ventilated tiling battens/counter batten cavity over breathable membrane used)
	Cold flat roof Insulation at ceiling level (horizontal)	Yes	Ventilated in accordance with BS 5250 and TGD F / TB K. Minimum 50mm ventilation zone above insulation and 10mm continuous gap at eaves

Where a vapour control layer is used, it must be airtight, e.g. holes and penetrations for services etc., cut neatly and suitably sealed.

Table 17 – Hygrothermal properties

Material	Specific heat capacity, Cp [1] J/(kgK)	Water vapour resistance factor, dry [1] μ	Equivalent water vapour resistivity [2] MNs/gm	Typical vapour resistance MNs/g
Gypsum plasterboard	1000	10	50	0.63 (12.5mm thickness)
Gypsum plaster	1000	10	50	0.65 (13mm thickness)
Mineral wool	1030	1	5	0.25 (50mm thickness)
Expanded polystyrene	1450	60	300	15.0 (50mm thickness)
Extruded polystyrene	1450	150	750	37.5 (50mm thickness)
Phenolic foam	1400	50	250	12.5 (50mm thickness)
Polyisocyanurate foam	1400	60	300	15.0 (50mm thickness)
Vapour Control layer in DUPLEX grade Gyproc plasterboard	-	-	-	60

[1] Taken from *BS EN 12524 Building materials and products - Hygrothermal properties - Tabulated design values.*
[2] Using conversion factor as per *BS 5250 Code of practice for control of condensation in buildings.*

Technical performance and principles of system design

Thermal insulation and condensation (continued)

Figures

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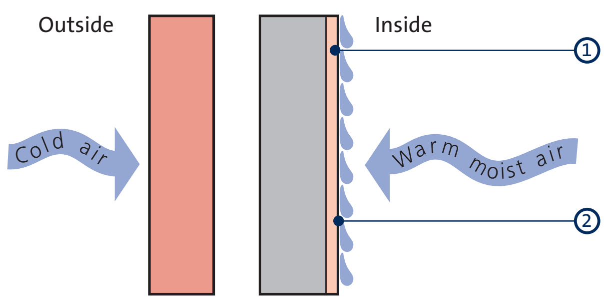
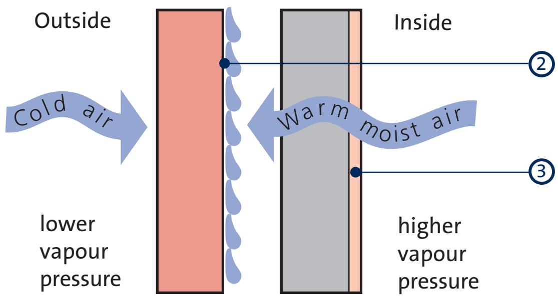


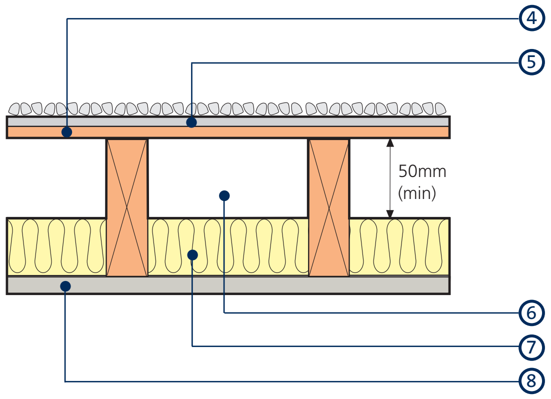
Surface condensation

37



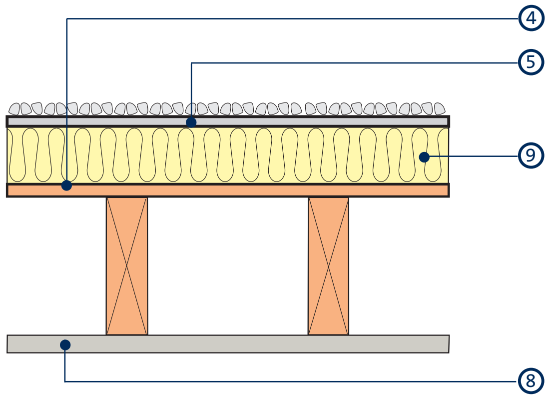
Interstitial condensation

38



Timber flat roof, cold type

39



Timber flat roof, warm type

1 High vapour resistance surface
2 Surface at or below the dewpoint
3 Low vapour resistance surface
4 Timber roof decking
5 Built-up felt (or similar) with solar reflective finish
6 Cross-ventilated roof cavities
7 Isover acoustic insulation
8 12.5mm Gyproc WallBoard DUPLEX
9 Insulation (by others)

Technical performance and principles of system design

Sustainability

Sustainability

Our mission is to develop innovative products and services that help customers build better spaces to live, work and play. In every kind of building – from home to work, from the local supermarket to the local hospital – we help to create partitions, provide comfort, protect against fire and insulate against sound.

With over 80 years' experience in plaster, plasterboard and ceiling solutions, we have a multitude of high performance products and systems.

You'll find our plaster, plasterboard, metal and ceiling solutions in almost every kind of building in the country. Builders, tradesmen and specifiers choose our products because they offer the best acoustic, thermal insulation and fire protection performance.

Standards and legislation

There are many building standards and environmental assessment methods that apply to our industry such as:

- Building Regulations
- The BRE Environmental Assessment Method (BREEAM)
- Irish Green Building Council Home Performance Index (HPI)
- Leadership in Energy and Environmental Design (LEED)
- Green Guide Ratings

Construction Products Regulations

From 1st July 2013, under the Construction Products Regulation 2011 (CPR), it has been mandatory for manufacturers to draw up a declaration of performance (DoP) and apply CE marking to any of their construction products, which are covered by a harmonised European standard (hEN) or conforms to a European Technical Assessment (ETA), when they are placed on the market. A construction product is any product or 'kit' which is produced and placed on the market for use in a permanent manner in construction works, and the performance of which has an effect on the performance of the construction works.

The CPR builds upon the previous legislation and aims to break down technical barriers to trade in construction products within the European Economic Area (EEA).

To achieve this, the CPR provides for four main elements:

1 A system of harmonised technical specifications
- Defines EEA-wide methods of assessing and declaring all the performance characteristics
- Must meet seven basic requirements for construction works. These cover:
  - Mechanical resistance and stability
  - Safety in case of fire
  - Hygiene, health and environment
  - Safety and accessibility in use
  - Protection against noise
  - Energy economy and heat retention
  - Sustainable use of natural resources

2 An agreed system of conformity assessment for each product family

3 A framework of notified bodies

4 CE marking of products

CE marking

CE marking enables a product to be placed legally on the market in any Member State. However, this does not necessarily mean that the product will be suitable for all end uses in all Member States.

CE marking indicates that a product is consistent with its Declaration of Performance (DoP) as made by the manufacturer. The declaration varies according to the particular harmonised technical specification covering the product. As such, decision makers (e.g. designers and specifiers) should understand the relevant performance requirements for the product.

Declarations of Performance (DoP)

By making a DoP the manufacturer, importer or distributor is assuming legal responsibility for the conformity of the construction product with its declared performance. The information to be contained in them is detailed in Annex ZA of a hEN or in a section of the ETA. DoPs must be supplied either in paper form or by electronic means which includes permission to make them available on a website.

Together with the technical specification, the DoP should give all the information needed by specifiers and regulators to judge whether the product meets all relevant regulations in the Member State upon whose market it is to be placed.

Where applicable, the DoP should be accompanied by information on the content of hazardous substances in the construction product to improve the possibilities for sustainable construction and to facilitate the development of environment-friendly products.

Copies of DoPs are available on our website: gyproc.ie

Technical performance and principles of system design

Sustainability (continued)

Certifications

ISO 14001:2004 – Environmental Management Systems: Requirements with guidance for use

ISO 14001 specifies the requirements for an environmental management system (EMS). It applies to those environmental aspects which the organization has control over and which it can be expected to have an influence. The standard applies to management systems which a site or organisation might employ, but does not directly relate to products. It is not a product certification system or label. The standard itself does not state specific environmental performance criteria; this is down to the site or organisation to do.

As part of our drive to continuously improve our performance, we have invested significant resource in developing environmental management systems certified to *ISO 14001:2004*.

In 2004, we achieved *ISO 14001:2004* certification across the whole of our manufacturing, mining and support functions in Ireland. This certification emphasises the stringent environmental standards maintained across the business and enables us to support customers through the delivery of sustainable construction products as advocated by BREEAM and the BRE Green Guide.

A copy of the certificate is available on our website: gyproc.ie

ISO 9001:2008 – Quality Management Systems: Requirements

ISO 9001 is an internationally recognised and well established quality framework, currently used by more than 897,000 organizations in 170 countries worldwide, and sets the standard for quality management systems.

We have been certified to *IS0 9001* across the whole business since 2003. The business has continuous assessment visits every 6 months, and the latest certificate was reissued under the revised *ISO 9001:2008* in January 2016.

The scope of the *ISO 9001:2008* Certificate is the same as the *ISO 14001* certificate. A copy of the certificate is available on our website: gyproc.ie

OHSAS 18001:2007 – Occupational Health and Safety Management Systems: Requirements

OHSAS 18001:2007 is an internationally recognised assessment specification for occupational Health and Safety management systems. It was developed by a selection of leading trade bodies, international standards and certification bodies to address a gap where no third-party certifiable international standard exists.

Health and Safety is our core value. Our aim is to always be injury-free. We passionately believe that our employees, and other stakeholders, should go home in the same condition as they arrived. We set the target of zero accidents at work for employees, visitors and contractors.

Our culture is one where safety is everyone's responsibility. Our people are encouraged to lead from within, through a programme of employee engagement and safety awareness, which includes functional safety committees, safety initiative worker groups and leadership groups. The business uses tools such as SUSA (Safe and Unsafe Acts) discussions and SMAT (Safety Management Audit Tool) to highlight safety concerns and correct them.

Keeping employees fit, happy and healthy is crucial for us. Our in-house occupational health team provide periodic health surveillance and on-going assessments with lifestyle guidance.

As part of our drive to continuously improve our performance, we have invested significant resource in developing our safety management systems and certifying them to *OHSAS 18001:2007*

Copies of our certificates are available on our website: gyproc.ie

ISO 50001:2011 – Energy Management System

ISO 50001 is based on the management system model of continual improvement also used for other well-known standards such as *ISO 9001* or *ISO 14001*. This makes it easier for organisations to integrate energy management into their overall efforts to improve quality and environmental management.

ISO 50001:2011 provides a framework of requirements for organisations to:

- Develop a policy for more efficient use of energy
- Fix targets and objectives to meet the policy
- Use data to better understand and make decisions about energy use
- Measure the results
- Review how well the policy works
- Continually improve energy management

We have been carefully managing our energy consumption for a number of years, using the well-established tools and techniques familiar to our business. As a result of this our management systems have been certified to *ISO 50001: 2011*. This international standard is about implementing and maintaining systems and processes to manage our energy consumption.
One of the key elements in any work we do is training and awareness of our employees. In particular when it comes

Technical performance and principles of system design

Sustainability (continued)

to energy, understanding reduction opportunities enables our employees to minimise the energy that we use. We use various communications, teams and courses to deliver this message.

As far as we are concerned, energy management should not be seen as special, or anything out of the ordinary, it is an integral part of what we do every day. Gaining certification of our established energy management systems will ensure an integrated approach to reducing the overall impact of our manufacturing process.

BES 6001 – Certified responsible sourcing

For Environmental Assessment Tools such as BREEAM it is becoming increasingly important for the building industry to be able to demonstrate responsible sourcing, and supply chain management.

Currently Chain of Custody and Responsible Sourcing is synonymous within the timber market, where there are internationally recognised standards and schemes.

Saint-Gobain have, through the Construction Products Association, been involved with the BRE since 2007 with work to develop a Responsible Sourcing Standard.

The standard, *BES 6001*, describes a framework for the organisational governance, supply chain management and environmental and social aspects that must be addressed in order to ensure the responsible sourcing of construction products.

Independent, third party assessment and certification against the requirements of *BES 6001* then give the organisation the ability to prove that an effective system for ensuring responsible sourcing exists and add credibility to any claims made.

Certification to *BES 6001* can contribute to points and credits under BREEAM. An 'Excellent' rating results in products being classified as Tier Two under Mat 03 in BREEAM 2011, providing 3.5 of a maximum 4 points and making it easier for customers to achieve a higher number of points towards credits at no additional cost.

Copies of the BRE standard are available from the BRE's Green Book Live website: greenbooklive.com

We recognise the importance of independently verified Responsible Sourcing Certification to provide assurance to our customers that they are sourcing materials responsibly and sustainably.

UK manufactured Gyproc plasterboards, Glasroc specialist boards, Hard Coat plaster, Gypframe metal and Gyproc Cove have all been awarded 'Excellent', the highest possible rating to *BES 6001*.

Products not manufactured by Gyproc

As previously stated, the ISO and OHSAS standards are not product certifications. They certify the management systems of companies within the supply chain. All products that are merchandised (i.e. bought in and not manufactured by us) and all processes conducted by us, i.e. purchasing and logistics management, are covered by our certifications as listed in Table 18.

Technical performance and principles of system design

Sustainability (continued)

Table 18 – Gyproc products and certifications at a glance

Product Group	ISO 9001	ISO 14001	OHSAS 18001	BES 6001	ISO 50001
Gyproc standard performance plasterboards	✓	✓	✓	-	✓
Gyproc acoustic performance plasterboards	✓	✓	✓	-	✓
Gyproc fire performance plasterboards	✓	✓	✓	-	✓
Gyproc impact performance plasterboards	✓	✓	✓	-	✓
Gyproc moisture resistant plasterboards	✓	✓	✓	-	✓
Gyproc thermal performance plasterboards	✓	✓	✓	✓	✓
Gyproc fixings	-	-	-	-	✓
Gyproc decorative products – Cove / Cornice	✓	✓	✓	✓	✓
Gyproc decorative products – Styletrims	-	-	-	-	✓
Gyproc beads	-	-	-	-	✓
Gyproc accessories	✓	✓	-	-	✓
Gyproc accessories – Tape	-	-	-	-	-
Gyproc accessories – Sealant	-	-	-	-	-
Gyproc accessories – Control Joint	-	-	-	-	✓
Gyproc accessories – FireStrip	-	-	-	-	-
Gypframe studs	✓	✓	-	✓	✓
Gypframe channels	✓	✓	-	✓	✓
Gypframe steel angles	✓	✓	-	✓	✓
Gypframe specialist profiles	✓	✓	-	✓	✓
Gypframe clip, brackets & accessories	✓	✓	-	✓	✓
Rigitone tiles	✓	-	-	-	-
Gyptone boards – QUATTRO	-	-	-	-	-
Gyptone boards – SIXTO	✓	-	-	-	-
Gyptone Tiles and Planks	-	-	-	-	-
Gyprex	✓	✓	-	✓	-
Gyproc beads for solid plastering	-	-	-	-	✓
Gyproc plaster bonding agents	✓	-	-	-	-
Gyproc Hard Coat plaster	✓	✓	✓	✓	✓
Gyproc undercoat plasters	✓	✓	✓	-	✓
Gyproc finish coat plasters	✓	✓	✓	-	✓
Glasroc F fire protection boards	✓	✓	✓	✓	✓

Table 19 – Gyproc's raw materials

Type	Description
Natural/Mined gypsum	The main raw material for most types of plaster and plasterboard is natural gypsum from our own mines. Gypsum mining is well established on a professional and environmentally sound basis as recycling optimises the use of limited natural resources and extends the life of mineral reserves. Our mines are certified to *ISO 14001:2004* and *ISO 9001:2008*. Our objective is to maintain 20 year reserve life for the Company and we have a rolling programme of investment to maintain this level of gypsum reserves.
DSG – Desulphogypsum	The main raw material for our UK manufactured plaster and plasterboard products is a recycled gypsum by-product formed during the 'desulphurisation' of flue gases at fossil fuel fired power stations (Drax and Ratcliffe on Soar, for example). This is known as DSG (desulphogypsum) or FGD (Flue Gas Desulphogypsum).
Recycled Plasterboard Off-Cuts	We are the only manufacturer in Ireland to offer a plasterboard off-cut recycling service. We will provide a Gyproc waste movement document to prove your plasterboard off-cuts are 100% recycled back into our plasterboard manufacturing process. For more information on this service please contact our Plasterboard Recycling Service (PRS) team at PRS.customerservice@saint-gobain.com or call +353 (0)1 6298444.
Plasterboard liner	The liner used to sandwich gypsum to make plasterboard is made from various grades of paper, all of which is 100% post-consumer recycled material.

Technical performance and principles of system design

Sustainability (continued)

Recycled content of our products

All recycled content figures are indicative, and give a fair statement of the normal situation but there is a certain amount of variation depending on demand for products and availability of feedstock at any given time. For the most up to date information please contact the Plasterboard Recycling Service (PRS) team:
Email: PRS.customerservice@saint-gobain.com
Tel: +353 (0) 1 6298444

Table 20 – Gyproc products and recycled content at a glance

Product group	Percentage post consumer	Percentage post industrial	Manufactured w/in 500 miles?	Contains raw materials extracted w/in 500 miles?	Material is recyclable?
Gyproc plasterboards	5.00%[1]	0.00%	Y	Y	100%
Gyproc fixings	25.00%	35.00%	N	N	100%
Gyproc beads	55.00%	0.00%	N	N	Y
Gyproc accessories	0.00%	0.00%	Y	Y	Y
Gypframe studs	55.00%	0.00%	Y	N	100%
Gypframe channels	55.00%	0.00%	Y	N	100%
Gypframe steel angles	55.00%	0.00%	Y	N	100%
Gypframe specialist profiles	55.00%	0.00%	Y	N	100%
Gypframe clip, brackets & accessories	55.00%	0.00%	Y	N	100%
Rigitone tiles	3.50%	84.00%	N	Y	100%
Gyptone boards	0.00%	75.00%	N	Y	100%
Gyptone Tiles and Planks	0.00%	75.00%	N	Y	100%
Gyprex	4.14%	95.86%	Y	Y	100%
Gyproc beads for solid plastering	55.00%	0.00%	Y	N	Y
Gyproc Finish Coat plasters	0.00%	0.00%	Y	Y	100%
Gyproc Undercoat plasters	0.00%	0.00%	Y	Y	100%
Gyproc Hard Coat plasters	0.00%	0.00%	Y	Y	100%
Glasroc F fire protection boards	1.30%	97.90%	Y	Y	100%
Glasroc F MULTIBOARD	0.00%	94.80%	Y	Y	100%
Rigidur	16.00%	20.00%	N	Y	100%
Glasroc H TILEBACKER	0.00%	94.10%	Y	Y	100%

Explanatory Notes

Post-consumer recycled content: Portion of material or product which derives from discarded consumer waste that has been recovered for use as a raw material.
Post-industrial recycled content: Portion of material or product which derives from recovered industrial and manufacturing processes.
Manufacture location: If If site is within the Republic of Ireland, this is typically an automatic YES. Note requirements for LEED v.4 have a 160km limit. Please verify your project location with the Gyproc Technical Department.
Extraction location: This is relative to the manufacture location, and is based on the majority of raw materials.

[1]Standard plasterboard

NB Some raw materials are imported; % addition rates fluctuate in accordance with availability and quality requirements.
Metal recycled content is an average overall recycled content as received from the supplier.

Technical performance and principles of system design

Sustainability (continued)

Indoor air quality

The current BREEAM schemes do not include plasterboard as a product category; there is no specific requirement to provide VOC content data. However, it can be relevant for post-construction testing requirements, as clients/specifiers may request this information from us. The standards used widely in Europe to evaluate VOC levels in plasterboard products are *EN 13419* and *ISO 16000*.

Table 21 – Summary of indoor air quality parameters

Product	VOCs	CFC & HCFC	GWP [1]	Comment
Gyproc plasterboard	-	Zero	Zero	Based upon indicative testing of a sample of plasterboard products, Gyproc plasterboard is estimated not to contain a VOC content or formaldehyde content which exceeds the requirements of European voluntary labelling schemes connected with indoor air quality.
Rigidur gypsum fibre boards	≤ 10 mg/m³	Zero	Zero	Emission test in compliance with the requirements following the testing scheme of the AgBB-version 2008 regarding all *DIN EN ISO 16000-9/-11* existing test points are met.
Gyproc Thermal laminate plasterboard	-	Zero	<5	
Gyproc plaster	-	Zero	Zero	None of the ingredients contained in the Gyproc range of undercoat and finishing plaster contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
ThistleBond-it	<5 g/l	Zero	Zero	
GypPrime	<3 g/l	Zero	Zero	
Gyproc Joint Filler	-	Zero	Zero	None of the ingredients contained in the Gyproc range of jointing materials contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc Joint Cement	-	Zero	Zero	None of the ingredients contained in the Gyproc range of jointing materials contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc Ready Mix Joint Cement	-	Zero	Zero	None of the ingredients contained in the Gyproc range of jointing materials contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc Airtite Quiet	-	Zero	Zero	None of the ingredients contained in the Gyproc Airtite Quiet contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc Plasterboard Compound	-	Zero	Zero	None of the ingredients contained in the Gyproc range of jointing materials contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc Easi-Fill	-	Zero	Zero	Some of the ingredients for the product are known to contain trace elements of VOCs which are below the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc Sealant	153.4 g/l	Zero	Zero	Gyproc Sealant contains VOCs. The 600ml cartridge contain 92.1 grams.
Gyproc Drywall Primer	<1g/l	Zero	Zero	-
Gyptone ceiling tiles	<1000µg/m³	Zero	Zero	Tested to *EN 13419-1 EN 13419-3* and *ISO16000-3*.
Gyprex SATINSPAR	-	Zero	Zero	None of the main components used in the manufacture of Gyprex SATINSPAR contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gyproc FireStrip	-	Zero	Zero	None of the main components used in the manufacture of Gyproc FireStrip contain VOCs or formaldehyde which exceeds the requirements of European voluntary labelling schemes connected to indoor air quality.
Gypframe	-	Zero	Zero	We currently do not have specific certification on the VOC content of our Gypframe product range. As far as we are aware our Gypframe products do not contain VOCs. The need for information on VOC content within BREEAM generally relates to surface finish products such as wall coverings and paints etc. and wood based products, and not the underlying drylining product / system.

[1] Global Warming Potential

Assess for further locally supplied products

Sustainability (continued)

Life Cycle Assessment (LCA)

Across the construction industry there are many claims made regarding the environmental performance of products, and as such, it can be hard for specifiers to get a genuine picture of how sustainable a solution really is. LCA (Life Cycle Assessment) considers the entire life cycle of a product solution throughout its lifetime. As part of the assessment, a comprehensive range of factors are considered, including the potential environmental effects of raw materials, the manufacturing process, logistics, installation, performance in use and finally the product at the end of its life.

An Environmental Product Declaration (EPD) is a verified document that reports on the environmental data of products based on an LCA, as well as other relevant information in accordance with international standards such as *ISO 14025:2006 Type III Environmental Declarations* and *BS EN 15804: 2012 Sustainability of Construction Works. Environmental product declaration core rates for the product category of construction products.* Information such as raw material use, energy use and efficiency, content of materials and chemical substances, emissions to air, soil and water and waste generation can be viewed in an EPD.

The EPD results also enable us to understand at which stage our products have the greatest impact on the environment. We can therefore make better informed decisions on processes involved in the production of current and new products, as well as taking steps to minimise the environmental impact of our products across their lifecycle.

EPD also provide clear evidence for environmental building certification schemes, meeting credit requirements in BREEAM, for example.

Generic LCA have been carried out in the past for plasterboard products – including, one carried out by the Building Research Establishment (BRE), on which the current Green Guide rankings are based and another was conducted by Waste and Resources Action Programme (WRAP) and is available to download from their website: wrap.org.uk

Professor Geoffrey Hammond and Craig Jones from the Department of Mechanical Engineering at the University of Bath have developed an 'Inventory of Carbon & Energy' (ICE) – a database for embodied energy and carbon emissions associated with a wide range of materials. This can be found online at: www.circularecology.com/embodied-energy-and-carbon-footprint-database.html

We want to make the selection of sustainable solutions simpler for our customers. In order to do this we have begun developing Life Cycle Assessments (LCA) for our product ranges. The independently verified EPD, which are the result of the Life Cycle Assessment (LCA) process, are designed to give users information on the environmental performance of our products across numerous impact categories.

Our current completed EPDs are for:

- Gyproc Finish Plaster
- Gyproc Hard Coat
- 12.5mm WallBoard
- 12.5mm FireLine
- 6mm Glasroc F MULTIBOARD
- 15mm Glasroc F FIRECASE
- 12.5mm Glasroc H TILEBACKER
- 12.5mm Gyptone Big Activ'Air®
- 10mm Gyptone Ceiling Tiles Activ'Air®
- Gypframe Metal Components

This is just the beginning of the journey. We are developing further EPD for our solutions and these will be rolled out in due course. All current EPD can be found on our website gyproc.ie

Our sister company Rigips, located in Germany have had assessments carried out on our Rigidur product. The EPD for this product can be found on the Rigips website rigips.de/download/Environmental_Product_Declaration_Rigidur.pdf

Useful links

Gyproc – sustainability
www.gyproc.ie/about-gyproc/sustainability
www.gyproc.ie/resources

Building Regulations
www.environ.ie/housing/building-standards/building-standards
www.buildingcontrol-ni.com/regulations/technical-booklets

BREEAM
breeam.org

Irish Green Building Council Home Performance Index
www.igbc.ie/certification/home-quality-rating/

Green Guide
bre.co.uk/greenguide

LEED
usgbc.org/leed