KNAUF

SYSTEMS+

Plasterboard Systems Philippines

2024

Build on us.

CONTENTS

PREFACE

Knauf started when the brothers and mining engineers Alfons and Karl Knauf secured the mining rights for the gypsum deposits in the municipality of Schengen.

Today, Knauf has grown into a global industry leader spanning 90 countries, multiple brands, and with more than 41,500 employees worldwide across Europe, the USA, South America, Russia, Asia, Africa, and Australia.

In 2016, Knauf Gypsum Philippines was established, quickly rising as the leading manufacturer and supplier of high-quality lightweight construction materials, with a focus on gypsum products.

Our core products include:

- Gypsum Boards: Ideal for interior walls and ceilings.
- Jointing Compounds: Designed to finish and protect gypsum board joints.
- Ceiling Tiles: Perfect for suspended ceilings.
- Upcoming Products: We are expanding our offerings to include more materials that meet diverse project requirements.

Through our people and state-of-the-art manufacturing plants, we produce high-performing solutions that include drywall systems, plasters, and insulating materials. Our products cater to standard needs as well as specialized applications, such as fire resistance, moisture resistance, and acoustic insulation.

For more information about Knauf and our innovative solutions, please visit www.knauf.com/en-PH/.

SECTION A

GENERAL INFORMATION

PRELIMINARIES

Introduction

This manual is intended for use by building designers, builders, certifiers, and plastering contractors dealing with fire-rated and acoustic construction. It provides fire rating, acoustic and structural performance data, and installation specifications for a wide range of Knauf building systems, including lightweight wall and ceiling systems.

In addition to the systems listed in this publication, Knauf offers many other system configurations to suit specific project requirements.

Scope

This manual lists a wide range of Knauf fire-rated and acoustic wall systems that can achieve up to 120 minutes of FRL and STC 55 acoustic rating.

Certification

Fire Resistance

Fire testing and assessment have been done for ASTM E119: Standard Test Methods for Fire Tests of Building Construction and Materials

- Research Engineering Development Façade Consultants Limited, Hong Kong
- Intertek Testing Services Shenzen Ltd, Guangzou, China

Acoustic Ratings

All acoustic ratings provided in this publication are either laboratory tested results or opinions provided by Knauf APAC Research & Development and are covered by the stated Opinion Reference in each table. These opinions are based on acoustic tests of similar systems (laboratory and/or site tests) as well as theoretical models, and are produced by experienced acousticians who are members of the Australian Acoustical Society.

Structural

The design tables, material properties, and installation details for metal frames of the wall and ceiling systems in this manual use Rondo Framing systems.

Fire, acoustic, and structural test reports and opinions can be made available on request from Knauf.

Notes:

- Various system certifications are valid only when the relevant systems are constructed in accordance with Knauf specifications and using the stated materials and components. Fastening should be of the same type and at centers no greater than detailed for particular systems.
- While Knauf systems are certified to achieve the stated fire resistance and acoustic ratings, it is the responsibility of the relevant project consultant to ensure that the selected systems satisfy project requirements.
- Acoustic ratings provided in this publication are the expected laboratory test results based on the opinion of acoustical experts. Laboratory measurements are conducted under strict and near ideal conditions. On-site performance is generally lower due to flanking effects.

PRELIMINARIES

Standards

The following Standards are referenced in this publication:

- National Building Code of the Philippines
- Fire Code of the Philippines
- AS/NZS 4600:1996 - Cold Formed Steel Structures
- AS/NZS 1397:2011 - Steel Sheet and Strip
- AS/NZS 1170:2002 - Structural Design Actions
  Part 0: General Principles;
  Part 1: Permanent, Imposed and Other Actions;
  Part 2: Wind Actions;
  Part 4: Earthquake Loads.
- AS 2331.3.1:2001 - Neutral Salt Spray Test
- AS/NZS 2589-1:1997 - Gypsum Linings in Residential and Light Commercial Construction – Application and Finish
- AS/NZS 3566.2:2002 - Self-drilling Screws for the Building and Construction Industries – Corrosion Resistance Requirements
- AS/NZS 1170.2 Structural Design Actions — Wind Actions
  AS 1170.4 Structural Design Actions — Earthquake Actions
- AS 1397 Steel Sheet and Strip — Hot Dipped, Zinc Coated or Aluminium/Zinc Coated
- ASTM C1396 - Standard Specification for Gypsum Board
- ASTM C645 - Standard Specification for Nonstructural Steel Framing Members
- ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
- ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C
- ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board
- ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
- ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials
- ASTM E90 - Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- ASTM C1658 - Standard Specification for Glass Mat Gypsum Boards
- ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- ASTM D5116 - Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products
- BS 5234-2 - Partitions Specification for Performance Requirements for Strength and Robustness Including Methods of Test

Abbreviations

The following abbreviations are used throughout this manual:

TABLE A1: ABBREVIATIONS

ABBREVIATION	DESCRIPTION
AAAC	The Association of Australasian Acoustical Consultants
ASTM	American Standard of Testing Materials
BS	British Standards
BMT	Base Metal Thickness
ctrs	Centers
Max	Maximum
NBC	National Building Code of the Philippines
LB	Load Bearing
Min	Minimum
NLB	Non-Load Bearing
Nom	Nominal
NA	Not Applicable
NSCP	National Structural Code of the Philippines
p	Page
pbd	Plasterboard
UNO	Unless Noted Otherwise

PRELIMINARIES

Performance Indicators

The following performance indicators are mentioned in various parts of this manual:

TABLE A2: PERFORMANCE INDICATORS

INDICATOR	DESCRIPTION
Fire Resistance Properties	
FRL	Fire Resistance Level
RISF	Resistance to Incipient Spread of Fire
Acoustic Properties	
α_w	Weighted Sound Absorption Coefficient
CAC	Ceiling Attenuation Class
$D_{nc,w}$	Weighted Suspended Ceiling Normalized Level Difference (laboratory performance)
$D_{nT,w}$	Weighted Standardized Sound Level Difference (field performance)
$D_{nT,w} + C_{tr}$	Weighted Standardized Sound Level Difference with Spectrum Adaptation Term (field performance)
IIC	Impact Insulation Class (laboratory performance)
L_{Aeq}	Equivalent A-weighted Sound Pressure Level
$L_{Amax,\ avg}$	Average A-weighted Maximum Sound Pressure Level
$L_{n,w}$	Weighted Normalized Impact Sound Pressure Level (laboratory performance)
$L'_{nT,w}$	Weighted Standardized Impact Sound Pressure Level (field performance)
NRC	Noise Reduction Coefficient
STC	Sound Transmission Class
ASTC	Apparent Sound Transmission Class
$ASTC_{60}$	Reverberation Time
Other	
LR	Light Reflectance

For a full description of various performance indicators, refer to the relevant parts of the General Information section.

Plasterboard Properties

Moisture Effects

The hygrometric coefficient of linear expansion of plasterboard is 7.2 x 10^{-6} mm/(mm% RH) over the range of 5% to 90% relative humidity.

As exposure to moisture may affect the performance of plasterboard linings, it is recommended that plasterboard be installed in well-ventilated areas protected from moisture or any liquid penetration.

Building designers should be aware that some types of bulk insulation tend to absorb and retain moisture against the face of plasterboard.

Moisture & Mould Resistance

Although plasterboard is not a waterproof material, Knauf offers a number of lining products classified as moisture-resistant per ASTM C1396. These products include:

- MoistureShield™
- MultiShield™

Glass Mat Liner panels, which are classified as mold-resistant (achieved no mold growth with a rating of 0 when tested in accordance with ASTM G21 and the highest score of 10 when tested in accordance with ASTM D3273). Glass mat liner panels comply with ASTM C1658 Standard Specification for Glass Mat Gypsum Panels.

Notes:

Most of the plasterboard linings used in this manual are locally produced at the Knauf Gypsum Philippines manufacturing plant in Calaca, Batangas.

MATERIALS

Plasterboard

Knauf offers a wide range of plasterboard products to suit various applications:

TABLE A3: KNAUF PLASTERBOARD AND OTHER LINING PANELS

PRODUCT NAME	THICKNESS mm	COUNTER CHECK WEIGHT kg/m2	APPLICATIONS
STANDARDSHIELD	9 12 16	5.3 7.6 10.0	Wall and ceiling linings
SPANSHIELD	10	6.8	Lightweight ceiling linings
MOISTURESHIELD	9 13 16	6.8 9.2 11.25	Wet area wall and ceiling linings
DENSESHIELD	13 16	12.1 14.9	Impact resistant linings
FIRESHIELD	13 16	12.0 14.8	Fire-resistant linings
MULTISHIELD	13 16	12.2 14.9	Fire-resistant linings in tiled wet areas
ECHOSTOP	12	10.0	Sound absorption within a room
GLAS-MAT LINER MOLD TOUGH	25	20.5	Shaft enclosures & separating walls

Notes:

Product availability should be checked with Knauf, as some products may only be available on order and/or in minimum order quantities.

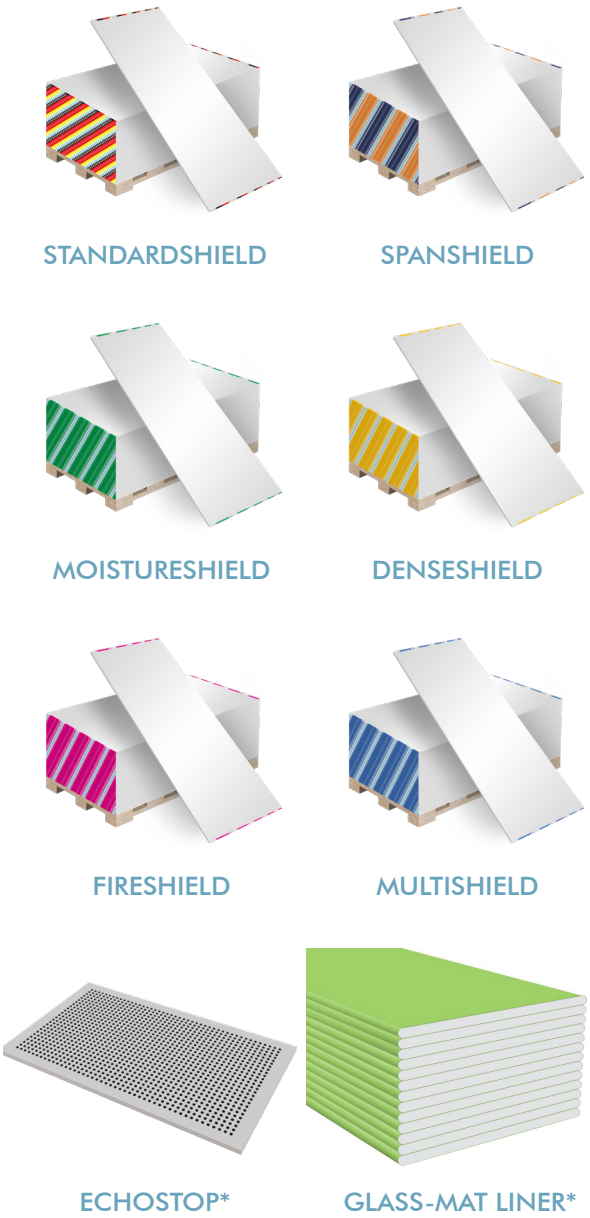


Figure A1: Plasterboard and Glass Mat Linings

Notes:

*Currently imported products

MATERIALS

Metal Components

Steel Stud Walls

Knauf steel stud wall systems use Rondo-lipped C-studs, wall tracks, and deflection head tracks, as listed in the Steel Stud Walls section.

The Knauf Shaftwall system uses Rondo CH-Studs and other components as listed in Steel Stud Walls section.

Suspended Ceilings

Knauf suspended ceilings utilize the Rondo KEY-LOCK® Suspended Ceiling System.

Fasteners

The following fasteners are suitable for fixing of plasterboard linings:

TABLE A4a: PLASTERBOARD SCREWS[1]

SCREW TYPE		APPLICATION
S		Steel BMT* up to 0.75mm
W		Timber only
D		Steel BMT* 0.80 - 2.00mm
L		Gypsum board laminating

* BMT – Base Metal Thickness.

TABLE A4b: PLASTERBOARD TO PLASTERBOARD FASTENERS

NUMBER OF LAYERS OF PLASTERBOARD x THICKNESS		TYPE L[10] SCREWS FOR FIXING PLASTERBOARD A TO B
PLASTERBOARD A	PLASTERBOARD B	
1 x 13mm	13mm	10-8 x 32mm
1 x 16mm	16mm	0-8 x 38mm
1 x 16mm	2 x 16mm	6-8 x 50mm

MATERIALS

TABLE A5: PLASTERBOARD TO FRAME FASTENERS

PLASTERBOARD THICKNESS mm	TIMBER FRAME				STEEL FRAME
	KNAUF SMOOTH SHANK GOLD PASSIVATED NAILS[9]	KNAUF ANNULAR RING SHANK NAILS[9] AND UNI-NAILS[9]	GALVANISED NAILS[9] (2.8mm DIA UNO)	TYPE W SCREWS[2]	TYPE S[3] AND TYPE D[4] SCREWS
1 x 10	40 softwood 30 hardwood	30	40 softwood 30 hardwood	6-9 x 25W wall 6-9 x 32W ceiling	6-18 x 25[7] D, S
1 x 13	40 softwood 30 hardwood	30	40 softwood 30 hardwood	6-9 x 32W	6-18 x 25[7] D, S
1 x 16	50	-	50 softwood 30 hardwood	6-9 x 40W	6-18 x 30D, S
1 x 25	-		-	-	6-18 x 40 D, S
2 x 10	50		50	6-9 x 40W	6-18 x 30D, S
2 x 13	65		50	6-9 x 50W	6-18 x 40D, S
13 x 16	65			6-9 x 50W	6-18 x 40D, S
2 x 16	65			6-9 x 60W	6-18 x 45D, S
3 x 13	-		75 x 3.75	8-8 x 60W	7-16 x 50S
3 x 16	-	-	75 x 3.75	8-8 x 75W	8-15 x 60S

Notes:

1. Screws to be Class 3 or Class 4 as appropriate for the corrosion conditions in wet areas and protected external applications.
2. "W" is a needlepoint, bugle-head-type W gypsum screw for fixing to hardwood and softwood framing. In some instances, double-start thread screws are permissible.
3. "S" is a needlepoint, bugle-head type S gypsum screw for fixing to steel gauges of up to 0.75mm BMT.
4. "D" is a drill point, bugle head type D gypsum screw for fixing to steel gauges 0.80 to 2.00mm BMT.
5. "L" is a needle point, bugle head type L gypsum screw for fixing plasterboard to plasterboard.
6. Screw designation given as (minimum screw gauge) — (threads per inch +1) x (minimum screw length).
7. For ease of construction with framing steel gauges of less than 0.8mm BMT, use a minimum screw length of 30 mm.
8. Correct screw length is critical when fastening to a resilient furring channel to avoid acoustic bridging.
9. For wall systems only. Tables are to be read in conjunction with plasterboard installation details.
10. Screws are recommended to comply with ASTM C1002.
11. Screws shall be of sufficient length so that the threaded portion shall penetrate not less than 9mm into the framing members and plasterboard thickness.

MATERIALS

Jointing Tapes

Jointing tapes are used to provide reinforcement to plasterboard joints and angles.

Paper tape is recommended by Knauf for jointing of gypsum wall and ceiling linings due to its high strength and suitability for all jointing compounds and applications.

Knauf Brand paper tape is a high-strength special cross-fiber paper tape possessing exceptional wet strength and resisting stretching, wrinkling, and tearing.

Knauf Brand jointing tape is available in 75m x 50mm wide rolls.

Jointing Compounds

Knauf offers a wide range of setting and air-drying jointing compounds suitable for a variety of application methods and requirements. A jointing system may consist of one or both types of compounds in combination with jointing tape. Knauf jointing compounds and paper tape comply with *ASTM C474: Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction.*

Figure A15 shows the recommended level of finish based on the final decoration.

Visit www.knauf.com/en-PH/ for the full range of Knauf jointing compounds.

Sealants & Waterproofing Membranes

Fire and smoke sealant is recommended for sealing perimeter gaps and penetrations in Knauf fire-rated and acoustic systems.

A suitable flexible waterproof sealant must be used to seal the sheet ends of moisture-resistant plasterboard to other surfaces, such as preformed shower bases, baths, and plumbing fixtures (see Wet Areas section of this manual at page A17).

PREMIUM JOINTING

PREMIUM PREMIX

PAPER TAPE

Figure A2: Jointing Compound and Paper Tape

DESIGN

Structural

Building elements must be checked for structural adequacy under dead, live, wind, and other applicable loads as a good design practice and as required by the NBC and other Philippine construction standards.

Wall design must allow for:

- Expected vertical deflection due to building movement
- Thermal expansion during fire service
- The support, including lateral support of any door or access panel frames, supported external cladding, internal lining, dampers, shelves, cupboards, attachments, or other loadings required to be supported by the wall or wall embedded frame.
- Any loadings due to internal or external pressure differentials
- Vertical loads

Head Clearance

Almost all structures will deflect during service. Designers should be aware of the expected deflections of the building structure as they affect partitions. These deflections may be due to both dead and live loads. Non-load-bearing partitions are not designed to take any axial loading due to building deflection.

In fire-rated steel stud walls, thermal expansion of studs of up to 5 mm/m should be expected during fire service. Stud shortening due to thermal bowing may reduce the expansion, especially in thinner walls.

Designers should make do allowance for expected vertical deflections and stud thermal expansion in considering deflection head requirements and, where necessary, refer to Knauf for further information. Standard partition head details should accommodate normal service deflections.

Plasterboard as Structural Bracing

Knauf does not recommend the use of plasterboard linings to brace the roof structure or individual roof truss chords.

Knauf does not recommend the use of plasterboard for dedicated bracing of walls.

Maximum Wall Heights

Wall heights for non-load-bearing steel stud walls must not exceed the maximum heights specified in the Steel Stud Walls section.

Maximum heights for non-load-bearing steel stud walls have been provided for 0.25 kPa lateral serviceability pressure and are based on L/240 deflection criteria. L/360 or L/480 deflection limit is recommended for drywall where the final finishes are brittle, such as tiles. For other design pressure max heights, contact Knauf.

Load Bearing Walls

A load-bearing wall is intended to resist vertical forces in addition to its own weight.

Shelf Loading

Walls, including fire-rated walls, that carry shelf loadings must be designed accordingly. Refer to Rondo for permissible shelf loadings on steel stud walls. The following static loads can be supported directly by the following Knauf linings using an applicable cavity anchor:

TABLE A6: MAXIMUM LOADS ON GYPSUM BOARDS

PLASTERBOARD THICKNESS	MAXIMUM POINT LOAD PARALLEL TO THE BOARD
10mm	9kgf
13mm	12kgf
16mm	15kgf

* Loads should be attached to the boards using applicable cavity anchor.

DESIGN

Fire Resistance

Fire Resistance Level (FRL)

Fire rating requirements as required by the Fire Code of the Philippines and NBC are specified in terms of the Fire Resistance Level (FRL). The FRL specifies the performance, in minutes, for each of the following design criteria when specimens are fire tested to the requirements of the ASTM E119 *Standard Test Methods for Fire Tests of Building Construction and Materials*.

In addition, the surface burning of interior finishes of building materials is required by the Fire Code to prevent the spread of fire.

Structural Adequacy*

The specimen can no longer carry its load (self-weight and superimposed loads). This criterion is intended for load-bearing partitions and ceilings.

Integrity

Cracks or openings develop that allow the passage of flames or hot gases.

Insulation

For example, a wall system under fire test that carries its load for 120 minutes and maintains its integrity and insulation for 120 minutes is given a FRL of 120/120/120, i.e., 120 minutes of structural adequacy, 120 minutes of integrity, and 120 minutes of insulation.

Systems that achieve a particular FRL as example can be used to satisfy the requirements of a lesser FRL. A 2-hour FRL system can be used for a 1-hour FRL requirement.

Support

Any structure required to support a fire-rated system must have a fire-resistant structural adequacy level like or better than that of the system. This includes vertical support for ceilings and walls and lateral support for the top of walls, which may be provided from both sides. Refer to the Philippine Fire Code for specific requirements.

Portal Frame Behavior

In portal frames affected by the fire, the rafters often push outward on the column members until the ridge sinks and then pull the columns inward. Should drywall be used to provide a fire separation within a portal-framed building, the above mode of failure needs to be recognized by the designer.

As mentioned above, load-bearing elements may need to be incorporated within, or adjacent to, the partition to maintain support for the roof structure during a fire event.

Direction of Attack by Fire

In most cases, the direction of attack by fire is assumed to be from both sides of the partition. In some cases, such as the exterior walls of a building, the rating may be required from one side only.

For conventional fire-rated plasterboard ceiling systems, the direction of attack by fire is always from below, while for spanning ceilings, it can also be from both sides or from above.

Maximum Heights

The maximum wall heights should be considered when selecting the appropriate wall system. The maximum wall height of the system will vary according to the fire resistance performance. If a partition is required to provide fire resistance, the constructed height must not exceed the fire state height. It should not be assumed that the cold state maximum height is also valid for the maximum fire state height.

Fire Hazard Properties

Wall and ceiling lining materials in certain types of buildings must comply with the Fire Hazard Properties requirements of the NBC and Philippine Fire Code.

Knauf gypsum lining products can be classified as Class A Interior Finish (least hazardous) materials, it has a flame spread index less than 25 when tested in accordance with ASTM E84.

DESIGN

Combustibility

Knauf gypsum lining products can achieve the requirements of ASTM E136. The Standard requires that the material should neither ignite nor flame during the test, and the temperature shouldn't rise more than the prescribed temperature anytime during the test.

Gas Reticulation in Fire-Rated Walls

Oxygen or combustible fluid reticulation systems should not be located within fire-rated walls unless designed, fire-tested, and constructed to suit this application.

Penetrations

Penetrations in a fire-rated system must be treated strictly in accordance with relevant test reports and approved installation details to maintain the system's fire resistance level. Where components by others are specified in Knauf fire-rated penetration details (i.e., dampers, GPO's, fire collars, etc.), such components must be installed in accordance with the manufacturer's specifications. It is the responsibility of the component manufacturer to ensure that the fire rating performance of the system is not affected.

Jointing

Knauf Premium Jointing or Premium Premix and paper tape may be used to finish the board joints and screw heads of gypsum-fire-rated partitions or ceilings.

DESIGN

Acoustics

Sound Transmission Class (STC)

Certain construction segments, like hospitals, hotel and casinos, have adopted the STC as a measure of sound insulation for building elements measured at standard one-third octave band frequencies. STC ratings could be necessary for assemblies in certain types of projects to meet the requirements of *ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, LEED, ANSI/ASA S12.60 Guidelines for Schools, FGI Guidelines for Healthcare Facilities, and the International Green Construction Code*. A partition with a high STC rating isolates sounds better than a partition with a low STC rating (an increase of 10 points in STC rating indicates a doubling in perceived performance).

STC ratings are obtained from tests carried out in certified laboratories under controlled conditions following ASTM E90: *Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements* or professional opinion from Knauf APAC R&D inferred from laboratory tests.

Any structure required to support a fire-rated system must have a fire-resistant structural adequacy level like or better than that of the system. This includes vertical support for ceilings and walls and lateral support for the top of walls, which may be provided from both sides. Refer to the Philippine Fire Code for specific requirements.

Provided below are examples of STC levels for some Knauf wall systems:

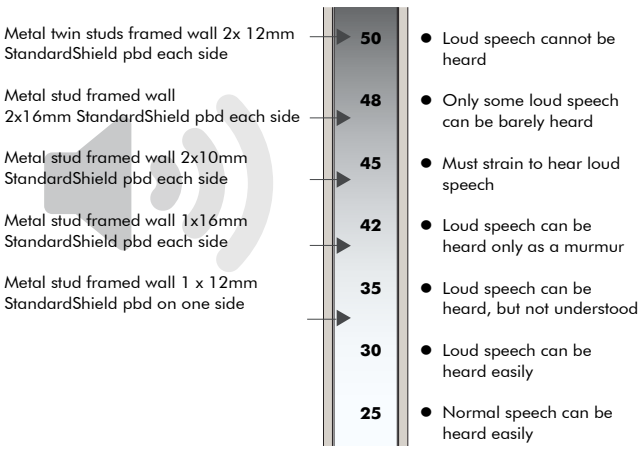


Figure A3: Noise Levels

Outdoor-Indoor Transmission Class (OITC)

The STC alone is not a good indicator of how well the partition isolates low-frequency (bass) sounds. OITC better measures the low-frequency performance of wall, floor, and ceiling partitions below the 100 Hz one-third octave. Studies have shown that data in the 80 Hz one-third octave band are necessary to obtain acceptable correlations for transportation sound sources.

OITC is a single-number index, which provides a more reliable indicator of the ability of the partition to isolate noise containing low-frequency components. The higher the OITC value for a wall or ceiling partition, the better the sound insulation performance, particularly at low frequencies. This makes OITC more applicable for exterior establishments, especially those that are near airports, train lines, and the like.

OITC is computed using ASTM 1332: *Standard Classification for Rating Outdoor-Indoor Sound Attenuation*.

Differences Between Laboratory and Field Acoustic Performance

The on-site rating measurement of transmission loss, ASTC (Apparent Sound Transmission Class), is technically slightly different from the laboratory STC assessment. When identical partitions are tested on site, it is often found that the site rating, ASTC, is lower than the STC (laboratory performance). This reduction in performance can be due to:

- Incorrect installation procedures
- Flanking paths (i.e., noise passing through adjacent parts of the building)
- Non-ideal measurement conditions. For instance, small room sizes may affect accurate measurements at frequencies.

Typically, a 5-8dB difference between the laboratory performance and field performance can be expected due to any one or combination of the factors mentioned above.

DESIGN

Sound Insulation Rating of Services

It is good practice for ducts, soil and waste pipes, and water supply pipes that serve or pass through more than one SOU (separate operational unit), including those located in a party wall or floor cavity, to be acoustically separated from habitable and non-habitable rooms. In addition to the airborne rating, it is also good practice to install water supply pipes in the cavity of discontinuous construction.

To achieve the sound insulation requirements, one of the options for soil and waste pipe treatment includes acoustic lagging of the pipes, which typically comprises loaded vinyl isolated from the pipe with foam or fiberglass. It is important that the lagging and pipe are not in contact with ceilings, walls, or supports, and the pipe mounts and supports are not in contact with the surrounding bulkheads or risers.

Over-partition Noise Rating

Sound can easily travel through an exposed grid or flush suspended ceiling and over the top of a partition where it abuts the underside of a suspended ceiling. This is a common source of sound transmission, particularly where the ceiling is porous to sound.

In this case, the sound rating of the ceiling element is stated as the CAC (Ceiling Attenuation Class).

The Ceiling Attenuation Class is a measure for rating the efficiency of a ceiling system to decrease airborne sound transmission between adjacent closed spaces that share a common air plenum. Where sound insulation is important, partitions should, wherever possible, continue through the ceiling to the structural soffit and be sealed at their perimeter.

ASTM E1414 *(Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum)* is used to measure the CAC of a ceiling system and is classified in accordance with ASTM E1264 *(Standard Classification for Acoustical Ceiling Products)*.

Figure A4: Sound Transfer Over Partition

Sound Absorption Rating

The reverberation time is a critical element in determining the acoustic quality of a space. The reverberation time is determined by several factors, but the most important is the amount of acoustic absorption in the space. The overall acoustic absorption is determined by the area of the absorptive material and the absorption coefficient of the material.

The Noise Reduction Coefficient (NRC) is a measure of how well a material stops sound from being reflected, as measured in accordance with ASTM C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. The absorption coefficient varies as a function of frequency, and the sound absorption of a material is usually expressed as a single- or double-digit decimal number rating. The closer the NRC rating is to 1, the better the sound absorption.

Construction Changes and Substitutions

Changes in construction and substitution of different materials can increase or decrease the acoustical isolation of wall and floor/ceiling systems and may result in the acoustical isolation falling below the specification. The following comments apply to wall systems, unless otherwise noted:

Studs

- Substituting a denser material, for example, timber studs, in place of steel studs generally results in a significant decrease in sound insulation.

DESIGN

- In single-stud walls lined on both sides, increasing the thickness of steel studs from 0.50 BMT or 0.55 BMT to 0.75 BMT or 1.15 BMT will generally decrease sound insulation.
- Increasing the partition cavity will increase sound insulation.
- Decreasing the stud spacing will decrease the sound insulation.

Plasterboard

Substituting with lighter plasterboard will usually result in a decrease in STC of around 1-2 dB for most systems.

Insulation

- Thinner insulation may decrease sound insulation.
- Thicker insulation may increase sound insulation.
- Higher-density insulation will generally increase the acoustic performance of a system, but polyester insulation needs to be approximately 40% denser than glass wool to provide a similar level of acoustic performance.

Fixings

- Using more screws or nails than specified may reduce sound insulation.
- Using cornice adhesive or other methods of laminating plasterboard other than nailing or screw fixing will reduce the sound insulation.

Perimeter Acoustical Sealing

It should be noted that as the sound insulation requirement of a partition increases, the control of flanking paths becomes more critical. Consequently, the perimeter sealing requirements for a low sound rating wall, such as STC = 30 dB, are much lower than for a high sound rating wall, such as STC = 60 db. It cannot be overemphasized that for high-performance walls, the sealing of each face must be virtually airtight.

For a sealant to be effective at controlling noise passing through gaps, it must have the following properties:

- Good flexibility, elastic set
- Low hardness
- Excellent adhesion, usually to concrete, timber, plaster, and galvanized steel
- Minimal shrinkage (less than 5%)
- Density greater than 800kg/m^3
- Fire-rated (where required)

All the above properties must be maintained over the useful life of the building.

Some silicone sealants and some acrylic latex sealants are examples of suitable sealants. Reference should be made to the sealant manufacturer to ensure the type or grade of sealant is suitable for the purpose.

Notes:

The use of expanding foam sealants is not acceptable.

Noise Flanking

Noise flanking can significantly reduce the perceived isolation of a wall, floor, or ceiling system and should therefore be given careful consideration.

Typical flanking paths for a wall include:

- Through ceilings and via the ceiling cavity above
- Through floors and via the floor crawl space below
- Through glazing and windows
- Through light switches, or GPO's, located in the wall
- Through gaps, cracks, holes, or other penetrations or services (continuous pipes, ducts, etc.)
- Through shared building elements such as floorboards, floor joists, continuous plasterboard walls, continuous plasterboard ceilings, and even continuous concrete walls and floors
- Through the perimeter joints between the wall and the floor, or the wall and the ceiling (or underside of the floor slab), or wall junctions
- Via adjacent walls or facade walls.

Typical flanking paths for a floor/ceiling system include:

- Through windows
- Through light fittings or air conditioning fixtures in the ceiling
- Through shared building elements, such as external walls
- Through any sound leaks
- Through the perimeter joints between the floor and walls, or between the ceiling and wall.

See figure A5.

DESIGN

Acoustic Performance on Site

Acoustic performance ratings stated in this manual are based on tested laboratory results or the expected laboratory results based on the opinions of independent acoustical consultants.

To reproduce the stated performance in the field, attention to detail in the design and construction of the partition or ceiling and its associated structure is of prime importance. Even the most basic principles, if ignored, can significantly downgrade sound insulation performance.

Knauf cannot guarantee that the site-tested acoustic performance of the systems will achieve the laboratory test results or the expected laboratory performance (opinion). Generally, there is a margin of 5-8 dB between the laboratory-tested values and the equivalent site-tested values for airborne sound transmission loss, and different types of systems are likely to have different variances between laboratory and site-tested values. However, with careful attention during the erection of the wall or ceiling, correct installation to specification, and proper caulking or sealing, the difference between the laboratory or estimated laboratory value and the site measured value should be minimized.

Apart from installation procedures, workmanship, and caulking, the following factors can also affect the acoustic performance on site:

Doors

Hollow core and even solid doors generally provide unsatisfactory sound insulation between rooms. Doors can also provide direct air leaks between rooms, thus having a detrimental effect on the overall sound insulation of the partition in which they are inserted. The higher the insulation of the partition, the worse the effect of the doors.

Where sound insulation is important, specialized heavyweight doors or, preferably, two doors separated by an absorbent-lined airspace or lobby should be used.

Because air leakage largely determines the sound insulation of a single door, consideration must be given to providing airtight seals between the door and the frame and at the threshold. The joints between the door frame and partition structure should also be sealed. If required, the door seal must be compatible with the fire resistance of the door.

Lightweight Panels Above Doors

These are often incorporated for aesthetic reasons; however, the performance of a partition with high sound insulation can be considerably downgraded by lightweight panels.

Air Paths through Gaps, Cracks, or Holes

Gaps, cracks, or openings, however small, readily conduct airborne sounds and can considerably reduce the sound insulation of a construction.

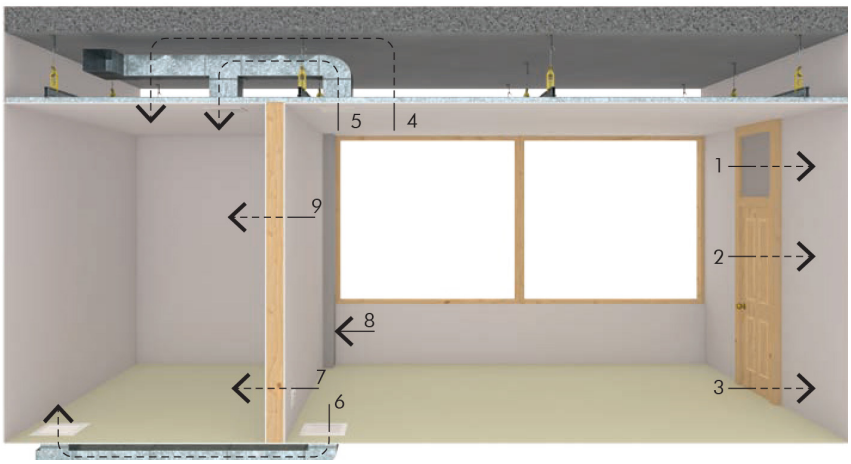


Figure A5: Sound Flanking Paths

Diagram Key

1. Lightweight panels above doors
2. Doors
3. Air leaks through gaps, cracks, or holes
4. Sound transmission via suspended ceilings or partitions
5. A common ventilation system without sound-absorbing treatment
6. Common floor duct
7. Electrical outlets and service pipes
8. Lightweight mullions or mullion/ partition closers
9. Partition performance

DESIGN

Appliances

In cases where sound insulation is important, noise-producing fixtures or appliances such as water closets, cisterns, water storage tanks, dishwashers, washing machines, and pumps should be repositioned or isolated from the structure with resilient mountings and flexible service leads and connections.

Where fittings are duplicated on opposite sides of partitions, such as back-to-back baths or unit shower cubicles, the partition wall should be continuous between the fittings; otherwise, a path for direct sound transmission will exist.

Electrical Outlets and Service Pipe Penetrations

Penetrations in separating walls should be avoided. This includes recessed fittings or ducts such as skirting heating, electrical or telephone wiring trunking, light fittings, intercommunication systems and alarms, and medical and laboratory gas outlets.

Plumbing connections between fittings or appliances on opposite sides of a partition offer a path for the transmission of sound and should be sealed. If possible, introduce discontinuity in the pipe work between fittings, such as a flexible connection within or on the face of a partition.

The acoustic performance may be downgraded where penetrations or services exist within the wall unless extreme care is taken at the detailing and construction stages. This is especially likely with acoustical bridging caused by plumbing or electrical services or by structural members, including flooring.

Where penetrations are not avoidable in separating walls, electrical outlets, switch boxes, and similar penetrations should not be placed back-to-back. Seal the backs and sides of boxes and the perimeter of all penetrations with acoustic sealant. Preferably, sound-rated electrical outlets and switches should be used, or outlets and switches should be surface mounted on sound-rated walls.

It is recommended to offset electrical outlets from each other in timber or steel-framed walls by not less than 300mm.

Penetrations in Linings Separating Soil and Waste Pipes

The acoustic ratings for unlagged soil and waste pipes are provided in the Multi-Residential section. The effect of penetrations differs between unlagged, lagged and clad pipes. Lagging and cladding have the benefit of reducing the noise emitted from the pipe itself.

Refer to the lagging manufacturer's data for acoustic ratings of lagged soil and waste pipes.

DESIGN

Wet Areas

A wet area is generally defined as an area within a building supplied with water from a water supply system. This includes bathrooms, showers, laundries, and sanitary compartments. Knauf moisture-resistant gypsum boards, like MoistureShield and MultiShield, are suitable for partition application on wet areas and tiles can be directly applied. Fastener spacing should be adjusted based on the tile load as shown on Table A7.

Contact Knauf for high moisture-exposure applications such as group shower rooms, etc.

TABLE A7: FASTENER SPACING IN TILED AREAS

Wall Tiles Weight (including tile adhesive)	Max Fastener Spacing	
	Field of Board	Sheet Ends
No greater than 12kg/m²	200mm	150mm
>12kg/m² and up to 32kg/m²	100mm	100mm

Waterproofing of Joints and Junctions Within Wet Areas

It is good practice that building elements in wet areas must be waterproofed or water-resistant, depending on the location within a wet area. Wet area membranes are deemed to be waterproof materials when used as part of a waterproofing system. Wet areas that are recommended for waterproofing are listed below.

Shower Areas (enclosed and unenclosed)

- Wall junctions within shower areas
- Wall/floor junctions within and outside of shower areas
- Penetrations in shower areas

Areas Adjacent to Baths

- Wall junctions above inserted baths and spas
- Shelf areas around inserted baths and spas
- Tap and spout penetrations where they occur on horizontal surfaces around inserted baths and spas.
- Where a shower is above a bath or spa, use the requirements for a shower.

A bond breaker must be installed at all wall/floor, hob/wall junctions, and movement joints where the waterproofing membrane is bonded to the substrate. Always refer to the manufacturer's waterproofing recommendations before applying waterproof membranes.

Waterproofing of Wet Areas

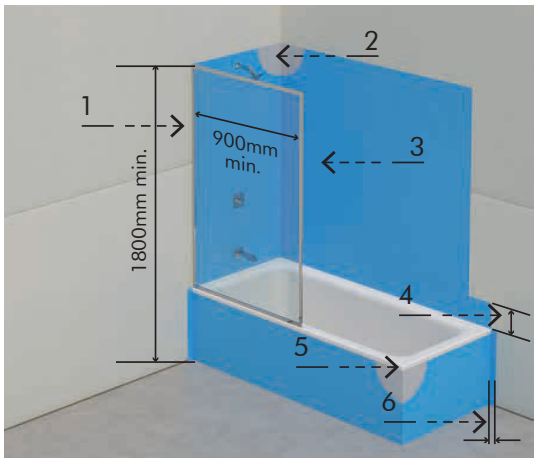


Figure A6: Waterproofing of enclosed shower over bath

1. The shower panel is sealed at all junctions.
2. Water-resistant lining
3. Waterproofing membrane
4. 150mm minimum waterproofing
5. Water-resistant lining
6. 40mm minimum waterproofing

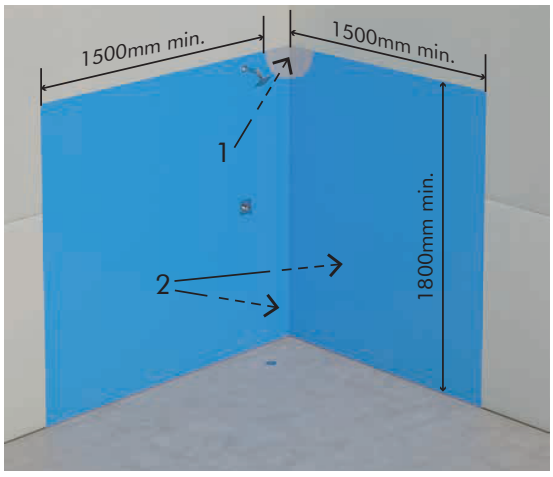


Figure A7: Waterproofing of unenclosed shower

1. The shower panel is sealed at all junctions.
2. Waterproofing membrane

DESIGN

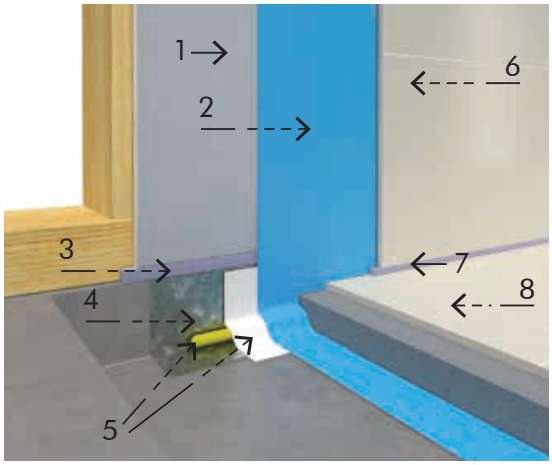


Figure A8: Set-down shower base and wall junction

1. Water-resistant lining
2. A waterproof membrane is applied to the wall face and floor.
3. Wet Area Sealant
4. Optional flashing
5. Backing rod and bond breaker tape
6. Ceramic tiles on approved tile adhesive
7. Flexible sealant relief joint – 6mm nom
8. Floor tiles on a mortar bed

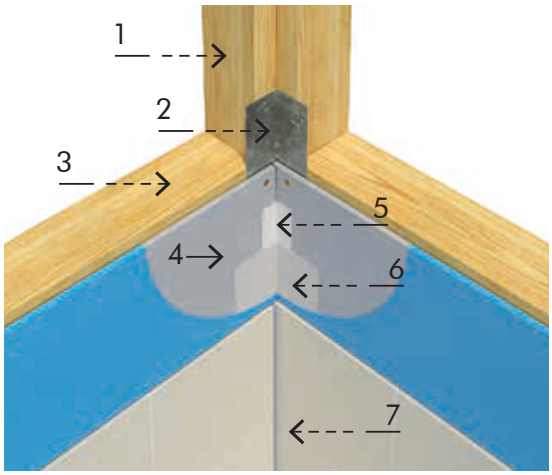


Figure A9: Internal Corner

1. Stud
2. Corner support angle
3. Nogging
4. Water-resistant lining
5. Paper Jointing Tape
6. Setting Type Compound
7. Ceramic tiles on approved tile adhesive

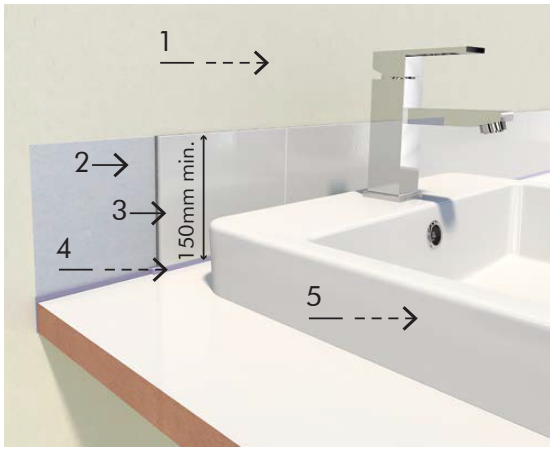


Figure A10: Vanity unit and wall junction

1. Wall lining
2. Water-resistant lining 150mm minimum above lip
3. Ceramic tiles on approved tile adhesive
4. Nom. 6mm flexible sealant relief joint
5. Vanity basin

Figure A11: Seal Sheet Edges Over Baths, Shower Bases, and Laundry Tubs

Figure A12: Seal Floor and Wall Junctions

DESIGN

Joints and junctions within wet areas must be waterproofed prior to installation of tiling or other approved surface materials.

The cut edges of gypsum linings at wall-floor junctions, preformed shower bases, and over-the-bath lip must be protected by sealing with sealant.

Jointing in Wet Areas

Knauf water-resistant gypsum linings in wet areas must be jointed using Knauf setting-type compounds and paper tape (refer to the Jointing section for application details).

Ceilings over Wet Areas

Knauf moisture-resistant gypsum boards, like MoistureShield and MultiShield, can be used in wet area ceilings. It is recommended that ceiling paint in wet areas be impervious to moisture for added protection as necessary.

DESIGN

Thermal Insulation

Although plasterboard itself does not provide high thermal resistance, the R-values of framed plasterboard systems can be significantly increased by incorporating bulk or reflective cavity insulation.

Design Considerations

Condensation

Condensation occurs when warm and humid air encounters cold surfaces. Condensation on internal building surfaces is more likely to occur where there are large temperature fluctuations and the moisture content inside a house (often generated in a bathroom, laundry room, or kitchen) is high.

Repeat or prolonged condensation may lead to nail popping, sagging ceiling linings, rotting, mold growth, joint and corner cracking, and deterioration of internal air quality. If left untreated, condensation may result in structural damage to the building and health concerns for the building occupants.

The following precautions can help minimize internal condensation:

- Keep air spaces well-ventilated to promote moisture dissipation, especially in the roof and sub-floor spaces.
- In rooms such as bathrooms, kitchens, and laundries, exhaust moisture-laden air to the outside of the building and not into the roof or ceiling space.
- Use vapor barriers in conjunction with insulation around the building envelope. Place a vapor barrier on the warm side of the insulation.
- Use thermal breaks on steel framing members.

Devices Generating Heat

Knauf does not recommend the use of radiant heating systems that continuously subject plasterboard ceilings to temperatures more than 40°C. Prolonged exposure to temperatures higher than 40°C may cause changes in the chemical composition of the gypsum core and loss of plasterboard integrity over time.

Notes:

Knauf does not advise the use of plasterboard as a wall lining behind and around fireplaces unless protected in accordance with prevailing Philippine construction codes.

Control and Movement Joints

One of the purpose of control joints is to accommodate hygrometric (moisture-caused) and/or thermally caused changes in plasterboard dimensions. Control joints are required in unbroken plasterboard walls and ceilings at no greater than 12-meter centers in both directions or as recommended by the structural engineer.

Movement joints are required in walls and/or ceilings to accommodate movements in the building structure (i.e., due to shrinkage, settlement, wind, or seismic forces) and include construction and expansion joints and joints at changes in substrate materials.
Control joints in non-fire-rated systems can be formed by fitting Rondo P35 control joints or plastic expansion beads that leave a neat and flexible joint.

Control joints in plasterboard walls and ceilings must coincide with control or movement joints in the superstructure.

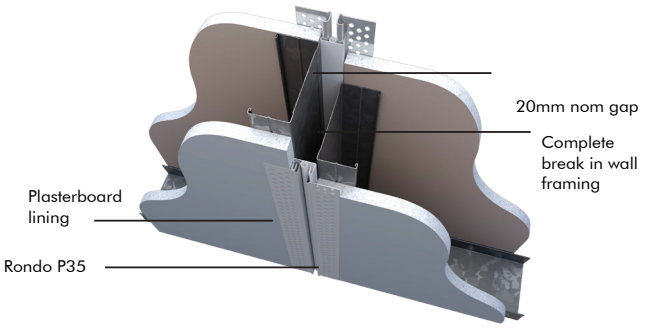


Figure A13: Control Joint in Non-Fire-Rated System

Jointing

Compounds used for finishing plasterboard joints in fire-rated systems may be any plaster or vinyl-based compounds supplied by Knauf that are normally used for this purpose.

Knauf jointing compounds have been shown by tests not to self-ignite at temperatures below 200°C and thus are suitable for use in fire-rated systems.

DESIGN

Impact Resistance

Impacts on walls come in three basic forms: soft body, abrasive, and hard body. Each of these can affect the partition in different ways and consequently affect the choice of the drywall system.

BS 5234 Pt 2 is used to grade the partition according to the level of activity in adjacent spaces and the degree of care likely to be exercised by people in the area.

TABLE A8: PARTITION GRADES BY CATEGORY OF DUTY

GRADE	CATEGORY OF DUTY	EXAMPLES
Light duty (LD)	Adjacent space is only accessible to persons with a high incentive to exercise care. There is a small chance of an accident occurring or of misuse.	Domestic accommodation
Medium duty (MD)	Adjacent space is moderately used primarily by persons with some incentive to exercise care. There is some chance of accidents occurring and of misuse.	Office accommodation
Heavy duty (HD)	Adjacent space is frequently used by the public and others with little incentive to exercise care. Chances of accidents occurring and of misuse.	Public circulation areas, Industrial areas
Severe duty (SD)	Adjacent space is 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

Soft Body Impact

Soft body impact is the type of impact one would associate with people hitting walls with their shoulder or hip.

Up to the point of breaking the lining, soft body impacts rarely leave any visible marks on the face of the wall, unlike hard body and abrasive impacts. Where required, Knauf systems comply with the soft-body impact resistance requirements.

Notes:

Knauf partitions SB.60.1c and SB.120.1c can achieve severe duty and heavy duty rating, respectively. See page C19 and C24.

Figure A14: Large Soft Body Impact Testing

Hard Body Impact

These impacts result in dents, gouges, and sometimes penetration of the wall lining. Examples of hard body impacts would include kicks and hits with trolleys, furniture, or hospital beds.

A static test measuring resistance to indentation of wall linings is done to measure the depth of indentation on the surface of the plasterboard. Knauf impact-resistant systems can meet a severe duty rating.

Partition Stiffness

The test is to establish the ability of the partition to withstand people or ladders leaning against it without causing unacceptable cracking or movement. To simulate this, the partition is subjected to a static horizontal load at a set height, and the maximum deflection and residual deflection are measured, recording surface or structural damage.

Door Slam

The test simulates that the partition is subjected to an impact from the test specimen door leaf slamming, transmitted through the door frame and to the partition. There should not be any significant deformation on the door frame or damage to the partition.

DESIGN

Design Options

The following design options can be incorporated into Knauf wall systems if required:

Overall Width of Partition

Twin and staggered stud walls, often used to form a service duct, can be varied in width to suit the building design. Note that reducing the width may adversely affect the acoustic properties of the partitions.

Frame

Other factors remaining the same, steel stud depth and gauge greater than that specified may be used without adversely affecting the fire resistance of the wall system (note that changes in stud size or gauge may affect the system acoustic rating).

Frame Spacing

Unless noted otherwise, all plasterboard supporting framework must be spaced at no greater than 610mm on centers.

Stud Substitution

Rondo steel studs have been used in the development of Knauf acoustic and fire-rated systems.

Limiting heights and spans listed are for Rondo studs only. Other stud sections should not be used unless it can be shown that they are at least equal to Rondo studs in all of the relevant performance characteristics.

Structural and fire properties of unlipped C-studs can vary significantly from those of lipped studs, therefore unlipped C-studs must not be used without the independent assessment by a qualified Engineer.

Cavity Structures

Ballistic or forcible entry protective items may be included within walls. In the case of fire-rated walls, adequate allowance must be made for expansion relief at the perimeter of ballistic/protective steel sheets. Security mesh may be incorporated within steel framed fire-rated walls to Knauf details.

Board Orientation

In wall systems the sheets of plasterboard may be oriented with the bound edges horizontal, vertical or, in the case of multilayer systems, both horizontally and vertically oriented layers. This option may be useful in achieving the best outcome in the prevailing lighting conditions.

Beams and Columns

Wall support beams, walls under beams, structural frames and columns within walls may be incorporated as per standard Knauf details.

Fastener

Size and spacing screws at lesser centers than specified may be used without adversely affecting the fire resistance level of a partition or ceiling (note that acoustic performance of the system may be affected).

Attachments, Shelf Loading Capacity

In general, items may be attached through a fire-rated lining to the wall frame providing that:

- The frame is designed and constructed to take the loading from the attachments.
- The attachments have a self ignition temperature of greater than the fire-rated partition.

Electrical conduits may be attached to steel stud partitions by means of clipping to screw fixed pressed metal sections without detrimentally affecting the FRL of the partition provided that:

- The conduits are self supporting and do not impose any axial load on the partition.
- The clips used to restrain the conduits are manufactured from a material having a melting point greater than or equal the metal studs.

Refer to Knauf for attachment options for non-load bearing walls. For load bearing steel stud walls, framing and fastenings are to be designed by an appropriately qualified Structural Engineer and shall comply with ASTM C645

DESIGN

Penetrations

Access hatch, duct, GPO, lighting recesses, tapsets, pipes, and cable penetrations in fire-rated walls and ceilings are to be constructed to fire tested or assessed details.

The incorporation of services and penetrations must not adversely affect the structural capacity of the framing members or the acoustic properties of the wall system.

Lighting Recesses and Service Chases

Where items such as lights, plumbing, heating or electrical services are fitted within or pass up through a fire-rated wall, the recess/chase must first be framed out then the top, bottom, sides, and back are to be lined using the same thickness and number of linings as on the penetrated face of the wall.

All corners between plasterboard linings are to be formed herringbone style, backed by a stud, metal stud track or angle of equal or greater than 0.7mm BMT and any cable penetrations are to be sealed with an approved fire-grade sealant. Refer to the relevant details in the Junctions and Penetrations section.

Notes:

- The acoustic isolation capacity of walls is likely to suffer where chases and/or lighting recesses are provided within the wall or ceiling.
- Lighting or other heat producing items should not be included within walls where there is any likelihood that, through continuous, extensive use, temperatures in the plasterboard surrounding the fitting remain above 40°C for a prolonged period of time.

Access Panels

Rondo access panels up to 600mm square may be constructed within non-load bearing fire-rated walls with a FRL of up to –/120/120. Prefabricated non-fire-rated and fire-rated access panels are also available.

Ducts, Dampers and Grilles

Where items such as ducts, dampers and grilles pass through a fire-rated wall, the penetration systems should comply with Philippine Fire Code requirements. The aperture must first be framed out allowing for lining and sealing of the aperture and expansion of the penetrating item during fire service where required. A useful rule of thumb for the amount of expansion to be allowed for is 10mm + 1% of the side under consideration. Some dampers are built to absorb their thermal expansion within their outside dimensions (refer to damper manufacturer's specifications).

The wall frame may need to be strengthened locally to account for any crippling of studs causing redistribution of loadings into the adjacent full height studs (i.e.. these studs may be required to be boxed or require additional structural steel.

The aperture should be lined using the same thickness and number of linings as on the face of the wall. The sealing/mounting system around the penetrating item is to be as tested or assessed for that particular item.

DESIGN

Appearance

Levels of Finish

The term 'Level of Finish' applies to plasterboard linings prior to decoration.

Level 4 is the recommended level of finish for plasterboard linings, unless specified otherwise.

It is essential that the level of finish is determined at the design stage since each level has specific requirements for substrate tolerances and plasterboard installation, jointing and finishing. The desired level of finish may not be achieved unless all of these requirements are met through various stages of construction.

Levels of finish recommended for various lighting conditions and surface decorations are shown in Figure A15.

For the full description of levels of finish and guidelines on assessment of finished surfaces refer to ASTM C840. A summary of various levels of finish is provided below.

Level 3

This level of finish is used in areas that do not require decoration or where finish is not important (for example, above ceiling level or inside service shafts and the like).

All joints and interior angles shall have tape embedded in two coats of joint compound. Fastener heads and accessories shall be covered with two separate coats of joint compound.

Butt joints and recessed joints in walls and ceilings can be on framing members.

Level 4

This is the default and generally accepted level of plasterboard finish. All joints and interior angles must have tape embedded in the jointing compound and two separate coats of joint compound applied over all joints, angles, fastener heads and accessories.
Wall butt joints can be on framing members. If wall butt joints are between framing menbers, any butt joints longer than 400mm and less than 2m above the floor must be back-blocked.

For better ceiling aesthetics, ceiling butt joints must be between framing members. All ceiling butt joints must be back-blocked. Ceiling recessed joints must be back-blocked in any area containing three or more recessed joints.

If Level 4 surface is to be exposed to critical light, it should be covered with textured finishes or wall coverings. Smooth textured finishes and flat/matt or low sheen paints can be used when Level 4 finish is illuminated by non-critical lighting. Flat paints in this situation tend to conceal joints better.

Weight, texture and sheen level of wall coverings and finishes should be carefully evaluated and joints should be adequately concealed if wall-covering material is lightweight, glossy or lightly patterned.

Notes:

- In critical lighting conditions, surface variations may still be apparent in a Level 4 surface finish.
- Gloss, semi-gloss or deep tone paints are not recommended for Level 4 finish, as they accentuate surface variations.

Level 5

Level 5 finish should be used where gloss or semi-gloss paints are specified or where lining surfaces will be exposed to critical lighting conditions.

Level 5 finish is characterised by a parity of surface texture and porosity. All joints and interior angles must have tape embedded in the jointing compound and a minimum of two separate coats of jointing compound applied over all joints, angles, fastener heads, and accessories.

Butt joints in walls and ceilings must be between framing members and back-blocked. Recessed joints in the ceilings must be back-blocked.

The work is finished with proprietary surface preparations or skim coating to remove differential surface textures and porosity. A suitable paint or plaster material is sprayed, rolled or troweled over the defined area. The surface texture must be random and monolithic, concealing joints and fixing points.

DESIGN

Notes:

- If Level 5 finish is desired for a decorated plasterboard surface, this must be specified at the design stage.
- Level 5 finish is difficult to achieve and always requires the cooperation of the framer, plasterer, and painter in establishing suitable work practices that deliver the agreed painted finish for the given project.
- Some minor surface variations may still be visible in Level 5 finish, however, these will be minimised.
- The surface of the defined area may require sanding to be suitable for decoration.

Framing Tolerances

Refer to the Table A9 for maximum allowable framing tolerances for various levels of finish.

Influences

There are many factors in modern building design that influence the overall appearance of a wall or ceiling. Modern features such as lower unbroken ceiling areas across adjoining rooms, large open living areas, and importantly, larger windows with greater use of natural light from skylights and mirrored walls etc. often create conditions in which it is difficult to achieve the desired level of finish.

Consumers are often not aware of the difficulties involved in achieving their expectations, particularly when some design conditions highlight rather than camouflage surface conditions. It is therefore very important that the consumer's expected standard of finish matches the level of finish the tradesperson is capable of achieving given the particular design features of the project.

Glancing Light

Glancing light is the light that shines across the surface of a wall or ceiling rather than directly on it. When considering the type of finish required it is important to understand how the overall appearance is likely to be affected by glancing light in a particular situation.

Refer Knauf publication Guide to Lighting and Decoration of Plasterboard for guidance on good lighting and decoration practices.

Gloss/Sheen Paints

Full gloss paint finish is not recommended on plasterboard walls or ceilings. When semi-gloss paint is to be used in large open rooms or vast areas with uncurtained windows, the highest level of finish (Level 5) is essential.

Where gloss or impervious sheen paint finishes are desired for purely functional reasons e.g., kitchens, bathrooms etc., some loss of appearance should be accepted.

Paint Discoloration

Whilst a plasterboard installation may conform to the standards, discoloration of the joints may occur due to effects of condensation, mold growth, contaminated paint or other factors.

The risk of paint discoloration can be reduced through good design practices, and the use of quality products and workmanship.

Notes:

The following are the other levels of finish as per ASTM C840

- Level 0 - Have no taping, finishing or corner beads. This is to be used in temporary construction or whenever the final finish is yet to be determined.
- Level 1 - Have all joints and interior angles are taped and embedded in one coat of jointing compound. Frequently used in areas that are concealed or not, normally, open to public view.
- Level 2 - Requires all joints, interior angles, fastener heads, and accessories are covered with a coat of jointing compound. Tool marks and ridges are still acceptable on this level of finish. Generally used on garages, warehouse storage, or similar areas where surface appearance is not a priority.

DESIGN

TABLE A9: LEVELS OF FINISH REQUIREMENTS SUMMARY

LEVEL OF FINISH	ALLOWABLE BUTT JOINTS LOCATION		CEILING BUTT JOINTS BACK-BLOCKING	CEILING RECESSED JOINTS BACK-BLOCKING		FRAMING TOLERANCES* (MM)		JOINTING SYSTEM
	Walls	**Ceilings**		**Less Than 3 Recessed Joints in a Room**	**3 or More Recessed Joints in a Room**	**90% of Area**	**Remaining Area**	
3	On or between framing members	On or between framing members	Optional	Optional	Optional	4	5	Tape Coat + 2nd Coat
4	On or between framing members	Between framing members only	Must	Optional	Must**	4	5	Tape Coat + 2nd Coat + Finishing Coat
5	Between framing members only	Between framing members only	Must	Must	Must	3	4	Tape Coat + 2nd Coat + Finishing Coat + Skim Coat over whole face

* Maximum deviation at any point of the bearing surface of the finished framing prior to installation of plasterboard linings, when measured with 1.8m straight edge (refer AS/NZS 2589).
** Level 4 ceilings supported by a ceiling suspension system in accordance with AS/NZS 2785 do not require back-blocking of recessed joints provided there is not rigid connection between ceiling and wall.

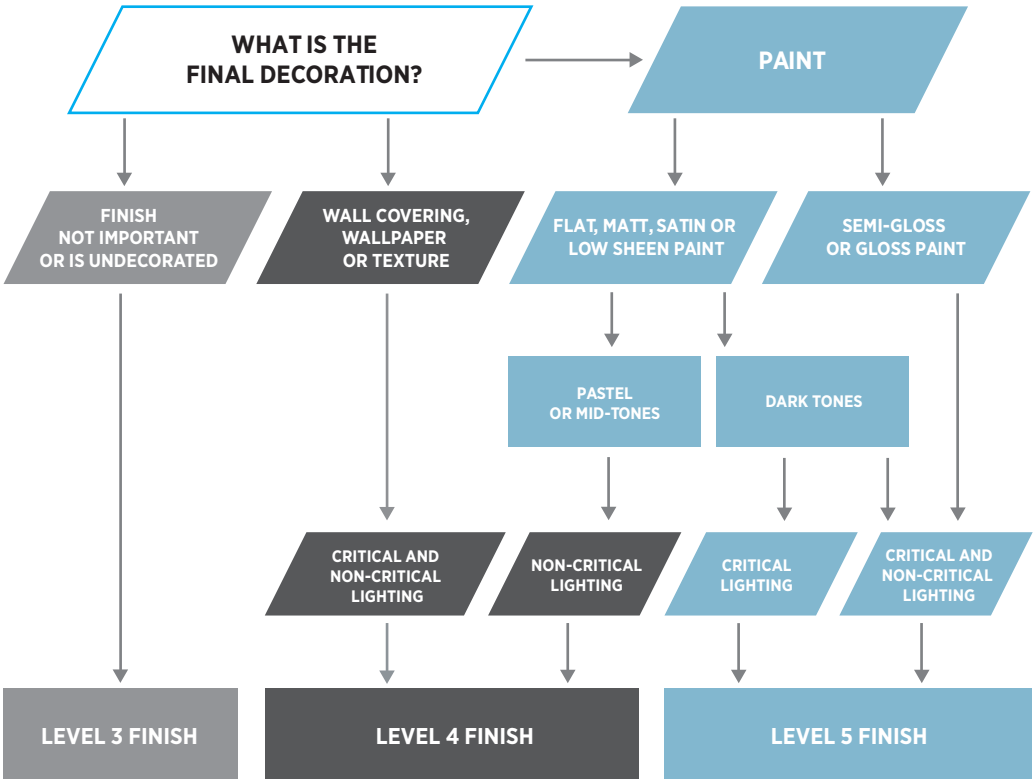


Figure A15: Levels of Finish

USER GUIDE

System Identification

Knauf has developed a user friendly system naming convention based on system type and fire rating. System names uniquely identify each system by incorporating the following information:

- System Type designation
- Non-load bearing fire rating (or load bearing fire rating if this isthe only one applicable) for fire-rated systems
- System variation

Knauf system types and corresponding designations are shown in Table A10. Lining Configurations and Lining Types are designated by numbers or letters depending on the system. Shown below are some examples of Knauf system names:

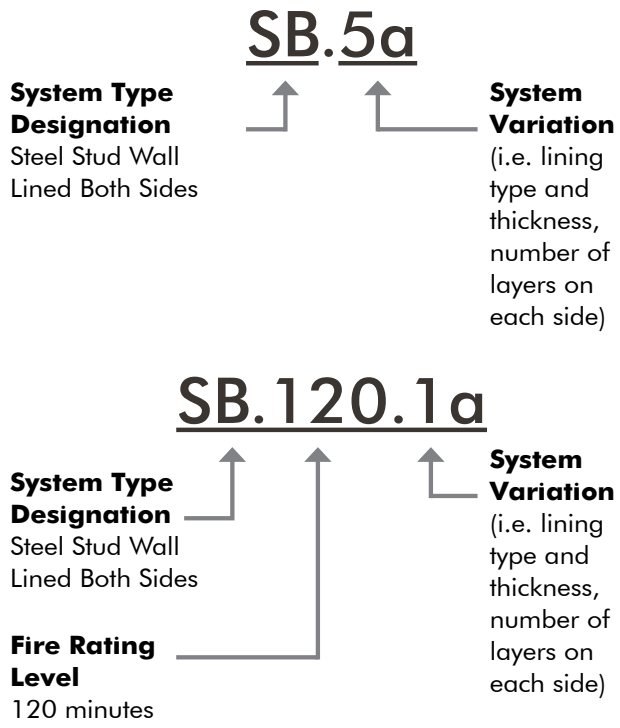


Figure A16: System Identification

TABLE A10: SYSTEM TYPE DESIGNATION

SYSTEM TYPE	SYSTEM TYPE DESIGNATION
Steel Stud Walls	
Lined One Side	SO
Lined Both Sides	SB
Quiet Stud	SQ
Staggered Stud	SS
Twin Stud	TS
External Walls	
Exterior Wall (Aquapanel)	EWA
Fireclad	FC
Masonry Upgrade	
Acoustic Upgrades - Internal Walls	MWI
Acoustic Upgrades - Lifts & Stair Lifts	MWS
Fire Upgrades	MW
Ceilings	
Ceilings under Roof	CR
Ceiling Under Concrete Floors	CC
Spanning Ceilings - C Stud	CS
Spanning Ceilings - CH Studs	CH
Over Partition	OP
Specialty Systems	
Shaftwall	SH
Ventshaft	VS
Protection - Steel Column	PSC
Protection - Concrete Column	PCC
Protection - Steel Beam	PSB
Fire Tunnels	FT

USER GUIDE

System Sections Overview

All System sections follow a common format, starting with the Introduction, followed by System Tables.

An Introduction provides a brief outline of various types of systems contained in the section, grouping information under the following headings:

- Description
- Design Options
- Materials
- Design Considerations
- Installation

Introductions to Steel Stud Walls sections also contain general plasterboard fixing drawings.

System tables pages have been arranged in a logical order reflecting a typical system selection process.

While system table format varies depending on the type of system, all system table pages contain key information required for system selection and specification. System table pages also incorporate a number of visual cues and other common features and information to assist in system selection:

Lined Both Sides (2)

SB.120.1

(3) Fire Resistance Level 120 Minutes

FRL Basis-R21K06-3B (13)

(12)

ACOUSTIC RATINGS BASIS: AU_RTA Opinions TK778-01502 (Knauf r11) (6) Based on studs @ 600mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM Wall Width mm	103	116	128	144	203
			Stud Size mm	51	64	76	92	150
			INSULATION 60kg/m³	(9) RW(RW+Ctr)				
58.120.1a (7)	2 x 15mm FIRESHIELD	2 x 15mm FIRESHIELD	50mm THK Mineral Wool	53	54	54	55	56
SB.120.1b	2x 13mm MULTISHIELD	2x 13mm MULTISHIE (10)	50mm THK Mineral Wool	53	54	54	55	56
58.120.1c	2 x 13mm DENSESHIELD	2 x 13mm DENSESHIELD	50mm THK Mineral Wool	53	54	(8)	55	56
SB.120.1d	2 x 13mm FIRESHIELD	2 x 13mm MULTISHIELD	50mm THK Mineral Wool	53	54	54	55	56
58.120.1e	2 x 13mm FIRESHIELD	2x13mm DENSESHIELD	50mm THK Mineral Wool	53	54	54	55	56
SB.120.1f	2 x 13mm FIRESHIELD	1x 13mm FIRESHIELD+ 1 x 13mm MULTISHIELD	50mm THK Mineral Wool	53	54	54	55	56
SB.120.1g	2 x 13mm FIRESHIELD	1x 13mm FIRESHIELD + 1x 13mm DENSESHIELD	50mm THK Mineral Wool	53	54	54	55	56

1

C Steel Stud Walls

SYSTEM DESCRIPTION

Side 1: 2x13mm fire-resistant pbd

Framing: Steel studs

Insulation: Refer to the table

Side 2: 2x13mm fire-resistant pbd

5

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS							SERVICEABILITY PRESSURE 0.25 kPa				
Studs Spacing mm		**406**					**610**				
Studs Size mm		**51**	**64**	**76**	**92**	**150**	**51**	**64**	**76**	**92**	**150**
BASE METAL THICKNESS mm	0.5	3510 d	4020 d	NA	NA	NA	11	3720 d	NA	NA	NA
	0.55	NA	NA	4530 d	5330 d	NA	NA	NA	4130 d	4940 d	NA
	0.75	3680 d	4530 d	5450 d	6050 d	7340 2d	3320 d	4220 d	5020 d	5500 d	6990 h
	1.15	NA	4810 d	5720 d	6380 d	7970 2h	NA	4430 d	5220 d	5750 d	7450 h

System Page Features

1. Colour coded page tabs and table headers corresponding to the Section colour code.
2. Description of the System Type at the top of the page.
3. Prominently displayed System Types and Fire Resistance Levels(where applicable).
4. System thumbnails showing basic system configuration.
5. Brief description of a system under a particular System Type.
6. Table containing the following system information as applicable.
7. System identification and corresponding lining types/configurations under a particular System Type.
8. STC ratings with and without insulation.
9. Insulation description.
10. Water-resistant linings indicated in blue font.
11. Maximum Height/Width/Span tables where and as applicable (height limiting factors included for Steel Stud Walls).
12. Acoustic opinion reference.
13. FRL basis.

USER GUIDE

System Selection

System Selection Example

Select non load bearing steel stud wall system that satisfies the following performance requirements:

Fire rating: FRL = 120 from both sides
Acoustic rating: STC = 55
Impact resistance: Moderate impact resistance on one side only
Height: 4100mm
Design pressure: 0.25kPa
Allowable Wall Thickness: less than 150mm
Application Area : wet area on both sides

Lined Both Sides

STEP 2

SB.120.1

Fire Resistance Level 120 Minutes

FRL Basis-R21K06-3B

ACOUSTIC RATINGS BASIS: AU_RTA Opinions TK778-01502 (Knauf r11)

Based on studs @ 600mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM Wall Width mm	103	116	128	144	203
			Stud Size mm	51	64	76	92	150
			INSULATION 60kg/m³	RW(RW+Ctr)				
58.120.1a	2 x 15mm FIRESHIELD	2 x 15mm FIRESHIELD	50mm THK Mineral Wool	53	54	54	55	56
SB.120.1b	2x 13mm MULTISHIELD	2x 13mm MULTISHIELD	50mm THK Mineral Wool	53	54	54	55	56
58.120.1c	2 x 13mm DENSESHIELD	2 x 13mm DENSESHIELD	50mm THK Mineral Wool	53				56
SB.120.1d	2 x 13mm FIRESHIELD	2 x 13mm MULTISHIELD	50mm THK Mineral Wool	53	54	54	55	56
58.120.1e	2 x 13mm FIRESHIELD	2x13mm DENSESHIELD	50mm THK Mineral Wool	53	54	54	55	56
SB.120.1f	2 x 13mm FIRESHIELD	1x 13mm FIRESHIELD+ 1 x 13mm MULTISHIELD	50mm THK Mineral Wool	53	54	54	55	56
SB.120.1g	2 x 13mm FIRESHIELD	1x 13mm FIRESHIELD + 1x 13mm DENSESHIELD	50mm THK Mineral Wool	53	54	54	55	56

STEP 4

STEP 3

STEP 1

SYSTEM DESCRIPTION

Side 1:	2x13mm fire-resistant pbd
Framing:	Steel studs
Insulation:	Refer to the table
Side 2:	2x13mm fire-resistant pbd

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS							SERVICEABILITY PRESSURE 0.25 kPa				
Studs Spacing mm		**406**					**610**				
Studs Size mm		**51**	**64**	**76**	**92**	**150**	**51**	**64**	**76**	**92**	**150**
BASE METAL THICKNESS mm	0.5	3510 d	4020 d	NA	NA	NA	NA	3720 d	NA	NA	NA
	0.55	NA	NA	4530 d	5330 d	NA	NA	NA	4130 d	4940 d	NA
	0.75	3680 d	4530 d	5450 d	6050 d	7340 2d	3320 d	4220 d	5020 d	5500 d	6990 h
	1.15	NA	4810 d	5720 d	6380 d	7970 2h	NA	4430 d	5220 d	5750 d	7450 h

STEP 5

STEP 1: Identify the relevant section and system type

- Locate Steel Stud Walls section by referring to section name (Steel Stud Walls), section designation letter (C), page numbers (C10, C11, etc.) and/or color coded page tabs and table headers (Purple).
- Locate walls Lined Both Sides by referring to the system type at the top of the page (Lined Both Sides).

STEP 2: Identify systems achieving required fire resistance level

- Locate system SB.120.1 by referring to fire identifier within system designation (120).
- Verify system fire rating by referring to the Fire Resistance Level box below 120 minutes.

STEP 3: Identify systems achieving required acoustic ratings allowable wall thickness

- Identify systems SB.120.1a to SB.120.1g by referring to STC acoustic ratings

STEP 4: Select system with linings satisfying any additional performance criteria

- Select system SB.120.1b with MultiShield plasterboard on both sides (moderate impact resistance on one side only and moisture resistance on both sides).

STEP 5: Select the most economical stud/insulation combination satisfying structural requirements.

- Select 92mm stud 0.55mm Base Metal Thickness @ 610mm (max height 4940mm limited by deflection).

USER GUIDE

System Specification

Minimum Specification

It is recommended that the following minimum information is included as appropriate when specifying Knauf systems:

- System name
- System description
- Linings configuration, type and fixing
  - Substrate type, size and arrangement
  - Insulation type, thickness and location
  - Other components contributing to the performance of the system.
- Fire Resistance Level and direction
- Acoustic rating

Recommended Supplemental Information

The following information is optional in order to ensure a full and unambiguous system specification:

- Overall width/depth
- Maximum height/length/span
- Design pressure/vertical/shelf loads
- Design deflection
- Number, location and size of noggings and fixing plates
- Requirement for special heads
- Additional furring channels
- The required level of finish
- The presence within the system of other items (e.g. protective steel mesh or sheet)

System Specification Example

Provided below is the system specification based on the system selection example above:

Minimum Specification

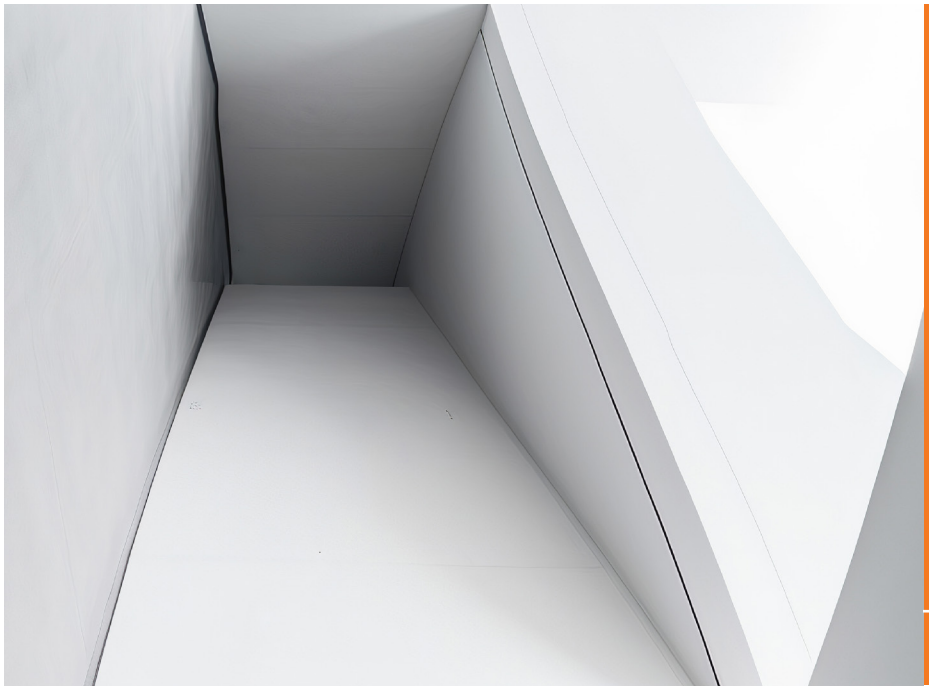
- Knauf system SB__.__
- Lining Side 1: __x__mm _____ plasterboard
- Lining Side 2: __x__mm _____ plasterboard
- __mm Rondo C-studs 0.__mm Base Metal Thickness @ __mm
- __mm glasswool insulation __kg/m3 density, density†
- FRL "x" minutes (non-load bearing)
- STC =__.

† Provide full insulation description rather than abbreviated designation.

Supplemental Information

- Nom wall width __mm
- Maximum height __mm
- Design pressure 0.25kPa
- Design deflection L/240
- One row of noggings at mid-height*
- Level 4 finish UNO.

* At least one mid height row of noggings is required in all wall 4400mm and higher (refer to Table C4 of the Steel Stud Walls section).



SECTION B

ACOUSTIC REQUIREMENTS | 07/23

ACOUSTIC REQUIREMENTS

INTRODUCTION

The following tables provide the sound insulation requirement for various building types and applications. These tables are extracts from various guidelines developed by the Association of Australian Acoustical Consultants (AAAC). The full guidelines can be found in aaac.org.au.

Even though the stated requirements relate to Australian building regulations, adopting the same for the Philippines on building projects is worthy of consideration.

On-site sound insulation ratings for wall partitions are expressed in D_w or D_{nTw} + Ctr which are ISO-based. The equivalent ASTM-based rating for D_w & D_{nTw} is the Noise Isolation Class (NIC) and Normalized Noise Isolation Class (NNIC), respectively.

The Ctr is the spectrum adaptation term which is used to account for the low frequency noise - typically the biggest problem with sound insulation. Ctr is always a negative number, so the D_{nTw} + Ctr will always be less than the D_{nTw} value alone.

Unfortunately, ASTM does not have an equivalent to the Ctr. The Ctr is typically in the range of -5 to -12, so as rough guide one could adapt a (conservative) average of -10 which could be added to the stated D_{nTw} rating to provide a comparable NNIC, or an Apparent Sound Transmission Class (ASTC) performance even though it differs through the implementation of reverberation time and absorption.

i.e.
(D_{nTw} + Ctr) + 10dB = comparable NNIC/ ASTC

e.g.
(D_{nTw} + Ctr) 45 + 10 dB = NNIC/ ASTC 55

MULTI-RESIDENTIAL BUILDINGS

Extract from AAAC Guidelines

TABLE B1: INDICATIVE SOUND INSULATION PERFORMANCE OF THE VARIOUS STAR RATINGS IN RESPECT TO CONTROLLING TYPICAL DOMESTIC NOISE

TYPE OF NOISE SOURCE	SOUND INSULATION EXPRESSED AS DnT,w +Ctr		
	45*	50	55
	4 STAR	5 STAR	6 STAR
Normal Speech	Not Audible	Not Audible	Not Audible
Raised Speech	Just Audible	Not Audible	Not Audible
Dinner Party/Laughter	Just Audible	Not Audible	Not Audible
Shouting	Audible	Just Audible	Not Audible
Small Television/Small Entertainment System	Audible	Just Audible	Not Audible
Large Television/Large Hi-fi Music System	Clearly Audible	Audible	Just Audible
DVD With Surround Sound	Clearly Audible	Audible	Audible
Digital Television With Surround Sound	Clearly Audible	Audible	Audible

*Min NCC requirement.

TABLE B2: MINIMUM IN-SITU ACOUSTIC PERFORMANCE OF SEPARATING WALLS AND FLOORS, DnT,w +Ctr

INTERTENANCY ACTIVITIES	4 STAR	5 STAR	6 STAR
(A) AIRBORNE SOUND INSULATION FOR WALLS AND FLOORS			
Between Separate Tenancies DnT,w + Ctr ≥	45*	50	55
Between a Lobby/Corridor & Bedroom DnT,w + Ctr ≥	40	45	50
Between a Lobby/Corridor & Living Area DnT,w + Ctr ≥	40	40	45
(B) Corridor, Foyer to Living Space Via Door(s) DnT,w ≥	30	35	40
(C) IMPACT ISOLATION OF FLOORS			
Between Tenancies LnT,w ≤	50	45	40
Between All Other Spaces & Tenancies LnT,w ≤	50	45	40
(D) IMPACT ISOLATION OF WALLS			
Between Tenancies	Yes	Yes	Yes
Between Common Areas & Tenancies	No	Yes	Yes

*Min NCC requirement.

COMMERICAL BUILDINGS

Extract from AAAC Guidelines

TABLE B3: ACCEPTABLE D_w VALUES DEPENDING ON A ROOMS'S NOISE LEVEL AND THE TOLERANCE IN THE ADJACENT SPACE

NOISE TOLERANCE IN RECEIVING ROOM	SOURCE ROOM ACTIVITY NOISE			
	LOW	AVERAGE	HIGH	VERY HIGH
High	30	35	40	45
Medium	35	40	45	50
Low	40	45	50	55
Very Low	45	50	55	60

For guidance on expected noise source levels and tolerance for various room occupancies refer to the table B4.

TABLE B4: ROOM NOISE SOURCE LEVELS AND TOLERANCE

TYPE OF OCCUPANCY/ACTIVITY	SOURCE ACTIVITY LEVEL	NOISE TOLERANCE
Board and Conference Rooms	High	Very Low
Cafeterias	Very High	High
Call Centers	Average - High	Low - Medium
Computer (Server) Rooms	High	Medium - High
Corridors and Lobbies	Average	High
Design Offices	Average	Low
Drafting Offices	Average	Low
General Office Areas	Average	Medium
Private Offices	Low	Low
Public Spaces	Average	High
Reception Areas	Average	Medium
Rest Rooms and Tea Rooms	High	High
Toilets	Average	High
Undercover Car Parks	Very High	High

COMMERICAL BUILDINGS
Extract from AAAC Guidelines

TABLE B5: PERFORMANCE REQUIREMENTS BETWEEN SEPARATE TENANCIES WHERE SPACE USE IS UNKNOWN

WEIGHTED LEVEL DIFFERENCE (D_w)				
POOR	AVERAGE	GOOD	VERY GOOD	EXCELLENT
35	40	45	50	55

TABLE B5: Provides acoustic quality as it relates to the quality of the development and where the use of the spaces either side of a common wall is unknown. The AAAC Guideline suggests a minimum Rw 50 (Dw 45) between tenancies.

TABLE B6: PERFORMANCE REQUIREMENTS WITHIN THE SAME TENANCY WHERE SPACE USE IS YET TO BE DEFINED

WEIGHTED LEVEL DIFFERENCE (D_w)				
POOR	AVERAGE	GOOD	VERY GOOD	EXCELLENT
30	35	40	45	50

TABLE B6: Provides acoustic quality as it relates to the quality of the development and where the use of spaces on each side of the wall is yet to be defined, otherwise table B3 can be used.

For office areas where walls do not extend full height, the ceiling selected will also become critical.

EDUCATIONAL FACILITIES

Extract from AAAC Guidelines

TABLE B7: AIRBORNE AND IMPACT SOUND INSULATION REQUIREMENTS

ROOM	SOUND INSULATION		
	SOURCE ROOM IMPACT GENERATION	SOURCE ROOM ACTIVITY AIRBORNE NOISE GENERATION	RECEIVING SPACE NOISE TOLERANCE
Atria (for circulation, not teaching)	Medium	Average	High
Art / craft studios	Medium	Average	Medium
Assembly halls up to 250 seats	High	Very High	Low
Assembly halls over 250 seats	High	Very High	Low
Audio-visual areas	Low	High	Low
Cafeterias	High	Very High	High
Computer rooms – Teaching	Low	Average	Medium
Computer rooms – Laboratories	Low	Average	Medium
Conference room	Low	High	Very Low
Corridors and lobbies	Medium	Average	High
Drama Studios	Medium	High	Low
Dance Studios	High	Very High	Medium
Engineering workshops – Teaching	High	High	High
Engineering workshops – Non-teaching	High	High	High
Weight training / fitness room	High	High	Medium
Gymnasia	High	Very High	Medium
Interview / counselling rooms	Low	Low	Medium
Laboratories – Teaching	Low	Average	Medium
Laboratories – Working	Low	Average	Medium
Lecture rooms – up to 50 seats	Low	Average	Medium
Lecture theatres – without speech reinforcement and >50 seats	Low	Average	Low
Lecture theatres – with speech reinforcement	Low	High	Medium
Libraries – General areas	Medium	Average	Medium
Libraries – Reading areas	Low	Low	Low
Manual arts workshops	Medium	Average	Medium
Medical rooms (First aid)	Low	Low	Medium
Music practice rooms	Low	Very high	Low
Music studios	Low	Very high	Very Low
Nursery school – Play rooms	Medium	Average	Medium
Nursery school - Quiet rooms	Low	Low	Low
Office areas	Low	Average	Medium
Professional and administrative offices	Low	Average	Medium
Teaching spaces – Open plan	Low	Average	Low
Teaching spaces – Primary schools	Low	Average	Low
Teaching spaces – Secondary schools	Low	Average	Low
Teaching spaces – Hearing impaired	Low	Average	Low
Staff common rooms	Low	Low	Medium
Staff studies / collegiate	Low	Low	Low
Toilet / change / showers	Medium	Average	High
Swimming pools	Medium	High	High
Plant rooms	Low	High	High

EDUCATIONAL FACILITIES
Extract from AAAC Guidelines

TABLE B8: SOUND INSULATION RATINGS FOR INTERFACES WITHOUT PASS DOORS (D_w)

NOISE TOLERANCE IN RECEIVING ROOM	ACTIVITY NOISE IN SOURCE ROOM			
	LOW	AVERAGE	HIGH	VERY HIGH
High	30	35	40	45
Medium	35	40	45	50
Low	40	45	50	55
Very Low	45	50	55	60

NOTE: Where doors are proposed between spaces, consideration must be given to the placement and performance requirements of the door since ratings for doors with no acoustic treatment are not likely to exceed D_w 20 dB, while standard solid-core doors with full perimeter acoustic seals could achieve a rating up to D_w 30 dB.

TABLE B9: IMPACT ISOLATION RATINGS FOR FLOOR/CEILING BETWEEN VERTICALLY SEPARATED SPACES (L'_{nTw})

		IMPACT GENERATION IN SOURCE ROOM		
		LOW	MEDIUM	HIGH
NOISE TOLERANCE IN RECEIVING ROOM	High	70	65	60
	Medium	65	60	55
	Low	60	55	50*
	Very Low	55	50*	45*

*Where high-impact-generating activities are to be located above spaces with low noise tolerance, consideration should be given to the relocating of one of the spaces. Specialist advice should be sought where very high-impact activities, such as gymnasia, are to occur above a sensitive space.

HEALTH CARE BUILDINGS
Extract from AAAC Guidelines

TABLE B10: RECOMMENDED ACOUSTIC SEPARATION REQUIREMENTS (D_w)

USAGE	INDICATIVE ACOUSTIC SEPARATION		USAGE	INDICATIVE ACOUSTIC SEPARATION	
	ADJACENT*	CORRIDOR**		ADJACENT*	CORRIDOR**
Single bed ward (including Mental Health, Parent Accommodation)	40	25			
Multiple bed ward	40	25	Corridors and lobby spaces	-	-
Ward ensuites	40, Discont.	15	Cafeterias/ dining	40	15
Consulting, examination, interview, counselling/ bereavement	40	25	Family and parents' lounges	40	20
Treatment, procedures, surgeries	40	25	Toilets, amenities	40	15
Morgue presentation areas	45	25	Waiting rooms and Reception areas	40	-
Birthing room/delivery suites	45	25	Multi-faith, chapel, Lecture theatres, cinemas, multipurpose rooms	Specialist design input required	
Laboratories	40	20	Radio broadcast, interview or audio editing	Specialist design input required	
Clean utility/Dirty utility/ drug storage or preparation	35	15	Outdoor seating or activity areas	-	-
Speech and language therapy	40	25	STAFF AREAS		
Audiology/audiometry	As per AS1269.4	-	Enclosed nurse stations	35	-
Dental clinics	45	25	Boardroom/conference	45	25
Rehabilitation areas	40	25	Private offices	35	20
Hydrotherapy	45	25	Executive offices	40	25
General intensive care wards	45	25	Cellular offices (2-4 desks)	35	20
Neonatal or paediatric ICUs (NICU/PICU)	45	30	UTILITY ROOMS		
Pharmacy offices	35	20	Amenities, locker rooms	40	-
Kitchens, sterilisation and service areas	40	-	Morgue - Grossing stations, observation areas	55, Discont.	-
Operating theatres	40	25	INFRASTRUCTURE		
			Engineering, Workshops	55, Discont.	-
			Plantrooms, generators	55, Discont.	-

NOTE:
* Minimum values to nearby noise-sensitive enclosed rooms where no common door exists – where interconnecting doors are proposed, these criteria are very difficult to achieve without effective spatial planning. Discontinuous walls as defined by the National Construction Code are recommended for impact or wall attached noise sources.
** To circulation corridor, where the intermediate partition is a solid wall with an operable door or air lock. Subtract 5 dB for listening areas with a visual connection (easily visible to the occupants of the space). Note that walls without a door onto a corridor would fall into the "Adjacent" category.

SECTION C

STEEL STUD WALLS | 07/23

STEEL STUD WALLS

INTRODUCTION

Description

Knauf Steel Stud Wall systems consist of single twin or multiple layers of plasterboard, screw-fixed to one or both sides of light-gauge Rondo C-stud or QUIET STUD® framing.

Design Options

Steel stud wall systems outlined in this manual provide designers and builders with a wide range of options to suit project-specific requirements in regard to fire rating, acoustic isolation, water resistance, and robustness. A large number of hybrid systems have been included, providing cost-effective solutions when robustness and/or water resistance requirements differ on each side of the wall.

The following types of Steel Stud Wall Systems are outlined in this manual:

- Lined One Side
- Lined Both Sides
- Twin Stud

Materials

Plasterboard Linings

- 12mm/ 16mm StandardShield
- 10mm SpanShield
- 13mm/ 16mm MoistureShield
- 13mm/16mm FireShield
- 13mm/16mm MultiShield
- 13mm/16mm DenseShield
- 25mm Glas Mat Liner

Steel Framing

Knauf steel stud wall systems utilise Rondo framing as outlined below:

Lipped C-studs

Lipped C-studs are available in a number of sizes and Base Metal Thicknesses (BMT):

TABLE C1: RONDO LIPPED C–STUDS

STUD SIZE mm	BASE METAL THICKNESS (BMT) mm			
	0.50	0.55	0.75	1.15
51	•		•	
64	•		•	•
76		•	•	•
92		•	•	•
150			•	•

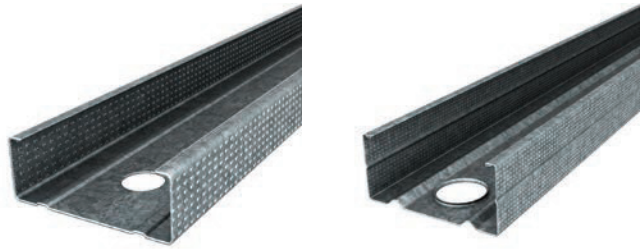


Figure C1: Rondo Lipped C–studs

Quiet Stud®

Rondo QUIET STUD is available in 92mm size and 0.55mm BMT (lead times apply).

Figure C2: Rondo QUIET STUD®

INTRODUCTION

Wall Tracks

Rondo Wall Tracks are available in the following sizes and Base Metal Thicknesses:

TABLE C2: RONDO WALL TRACKS

STUD SIZE mm	BASE METAL THICKNESS (BMT) mm		
	0.50	0.75	1.15
51	•	•	•
64	•	•	•
76		•	•
92		•	•

You may contact Knauf for further information on available sizes.

Figure C3: Wall Track

Deflection Head Tracks

Deflection head tracks are available in the following sizes and base metal thicknesses:

TABLE C3: RONDO DEFLECTION HEAD TRACKS

STUD SIZE mm	BASE METAL THICKNESS (BMT) mm			
	0.50	0.55	0.75	1.15
51			•	
64			•	•
76			•	•
92			•	•
150			•	•

Figure C4: Deflection Head Tracks

Screws

For screw types suitable for various lining configurations and steel stud BMT's, refer to the tables A4 & A5 in General Information — Materials.

Design Considerations

Maximum Heights

Wall heights for non-load-bearing walls must be within the maximum heights as set out in the maximum wall height tables for various systems.

Maximum heights for non-load-bearing steel-framed walls have been provided for 0.25 kPa lateral serviceability pressures and are based on L/240 deflection criteria.

Please refer to pages A9 and A10 for more information on maximum wall heights.

Notes to Maximum Height Tables

General

- Table C4 shows the minimum required number of noggings based on the maximum wall height.
- The minimum yield stress of steel sections is 270 MPa.
- Deflection limit is L/240 to a maximum of 30mm
- Wall heights tabled are for single-piece Rondo-lipped C–studs at maximum centers are shown. Stud splicing is heavily discouraged in fire-rated applications.
- Wall heights tabled are for non–load bearing walls and account for self weight and lateral pressures stated.
- Shelf loading is not considered for the tabulated maximum wall heights. Refer to Rondo for maximum heights with shelf loadings.
- Tabulated heights are for internal walls only. Contact Knauf if partitions are subject to external pressures.
- All plasterboards are to be manufactured by Knauf.
- Walls are to be constructed to Knauf standard C–Stud fire-rated or screw-fixed non-fire-rated wall details as appropriate.

TABLE C4: MINIMUM NUMBER OF NOGGINGS

WALL HEIGHT	LINING CONDITION	NUMBER OF NOGGINGS
0 to 4.4	LINED BOTH SIDES	0
4.4+ to 8.8		1
0 to 3	LINED ON ONE SIDE ONLY	1
3+ to 6		2
6+ to 8		3
8+		4

INTRODUCTION

Installation

Knauf steel stud wall systems must be assembled strictly in accordance with the details and specifications outlined in this manual in order to achieve the stated fire resistance levels and acoustic ratings.

Notes:

Where proprietary products have been tested in Knauf systems by other manufacturers, reference should be made to the product manufacturer's specifications for details of tested designs and related standards.

Installation and Fastening Sequence

Unlike rigid timber framing, light-gauge steel studs are prone to flexing and twisting when driving fasteners to secure plasterboard sheets.

The first plasterboard sheet installed at a joint should be fixed to the open side of a stud flange. Additional sheets are then installed in the direction toward the closed side of the stud web.

When installing the first side, screw–fasten the plasterboard sheets to studs at the edges only, as illustrated in Figure C5 (positions 1 and 2). Then, on the second side, fasten the edge (position 3), followed by intermediate studs (position 4). Return to the first side and fasten sheets to previously unattached studs (position 5).

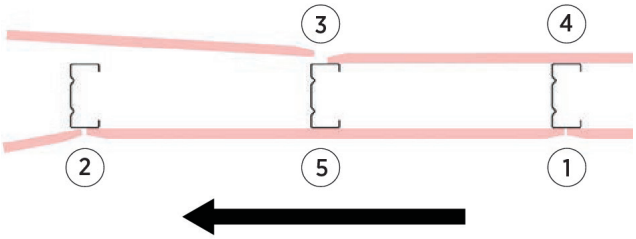


Figure C5: Correct Fastening Sequence

The correct direction of sheet installation is in the direction from the open side of the stud to the closed side of the stud web (Figure C5). The first sheet installed at a joint is screwed to the flange on the open side of the stud. The flange will initially deflect, then straighten as the screw pulls tight. Ensure that the stud is adequately supported to avoid twisting, and fully screw this sheet to the stud before continuing.

The next sheet is now screwed to the flange at the closed side of the stud. The deflection on this part of the flange is very small, and the previously installed sheet helps keep the assembly rigid during the installation of the second sheet.

If fixed correctly, the result is a flat joint with no lipping. The correct installation sequence is illustrated in Figure C6 below:

Fix plasterboard sheets in the direction of the open side of the stud to the closed side of the stud:

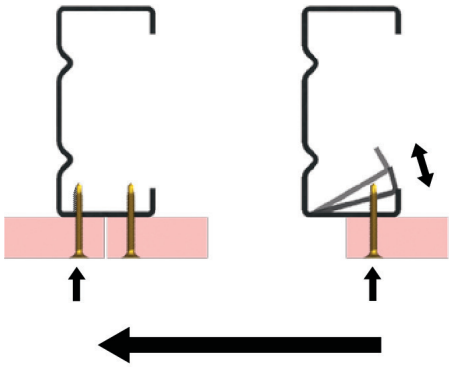


Figure C6: Correct Fastening Sequence Detail

Laying Out

- Accurately mark wall layouts.
- Always check individual measurements against overall site dimensions.
- Align the top and bottom tracks accurately according to the plan layout. Attach at ceiling and floor to structural elements.
- Use suitable fasteners for anchoring top and bottom tracks. Locate fasteners at 50mm from each end and spaced at maximum 600mm centers along each track.

Framing Installation

- For studs in fire-rated walls up to 3000mm high, cut studs nom15mm short of the floor-to-ceiling height to allow a 15mm expansion gap at top.
- For studs in walls higher than 3000mm, allow 5mm gap per 1000mm of height for expansion. Allowance should be made for possible deflection of the floor or roof structure over walls.
- Studs may be boxed together to provide greater frame strength. Studs are usually boxed to frame door and other openings and to support heavy fixtures on the partition.
- Studs in fire-rated partitions are not to be fastened to top and bottom tracks except boxed studs at fire door openings, which should be pop riveted to the tracks. When framing openings, secure both flanges of boxed studs to the tracks using pop rivets (refer to Junctions and Penetrations Section, Figure E3).
- In addition to the noggings specified in the maximum heights notes, noggings are required as headers above doorways, for reinforcement behind fixture attachments, and where special circumstances require additional stiffening of the frame. (Noggings are formed from lengths of steel track, approximately 100mm longer than the stud spacing. Cut the track flanges at approximately 45 degrees and bend the track ends at right angles to fit between the studs. Position and fasten with a stud crimper or with pop rivets for fire door application.)

Plasterboard Application

- Plasterboard linings can be installed vertically or horizontally in fire-rated and non-fire-rated wall systems. Refer Figures C9–C13 for optional plasterboard configurations in steel stud wall systems.
- If no deflection requirement exists, cut plasterboard sheets to provide a 10mm maximum gap at the floor and ceiling (refer to the Junctions and Penetrations section for typical head and base details).
- Center abutting vertical sheet edges on stud flanges.
- Fasten plasterboard sheets to steel framing with appropriate screws as outlined in the General Information section. Place screws 10mm–16mm from sheet ends and edges UNO. Do not fasten plasterboard to top and bottom tracks of fire-rated systems. Sheets should be installed by advancing in the direction of the stud web (refer to Figures C5 and C6).
- Offset or stagger plasterboard joints on opposite sides in adjacent layers, as shown in Figures C5.
- For general screw spacings, refer to Figures C9 to C11.

Jointing and Finishing

- Finish all joints, internal and external corners in the face layers with the appropriate Knauf jointing system. Joints and junctions in inner layers of multiple-layer systems are not required to be stopped.
- Paper tape must be used in fire-rated and wet area systems.
- Stop exposed fasteners on face layers.
- Do NOT strip paper liners as, this may decrease nail pull capacity of the plasterboard

Caulking

Caulk perimeter gaps and penetrations in fire-rated and acoustic sealant refer to the (refer details in the Junctions and Penetrations section).

Decorating

Apply paint or other decorative finishes as required. Refer to Figure A15 for recommendations on the decoration of plasterboard.

INTRODUCTION

Wall Construction Notes

- Steel stud wall systems are non-load-bearing unless noted otherwise.
- Wall systems should not be used where conditions of constant excessive moisture or humidity is prevalent. i.e., in excess of 80% relative humidity.
- Movement joints in plasterboard are required at building construction joint locations. Control joints in plasterboard are required at not more than 12 meter maximum centers, and at change in substrate material.
- Fire-rated penetrations must be installed and caulked in accordance with the details provided in this manual and fire-stopping manufacturer's recommendation. Components by others must be installed in accordance with the manufacturer's specifications and test reports.
- Fire-rated systems must be assembled strictly in accordance with relevant test reports, opinions, approved system details and specifications.
- Steel studs in fire-rated partitions are not to be fastened to top and bottom tracks except boxed studs facing fire door openings, in which case the boxed studs are pop-riveted to the tracks.
- Steel wall framing must be constructed to Rondo specifications and spaced at 610mm maximum on centers unless noted otherwise.
- Components must not be used if fractured or damaged.
- Butt joints to be backed by a stud, nogging, or metal flat strap for fire-rated systems.

INTRODUCTION

Shaftwall™

Description

Shaftwall systems utilize a 25mm GLASS-MAT LINER MOLD TOUGH friction fit between Rondo CH-Studs and FIRESHIELD plasterboard screw fixed on one side of the wall.

Most shaftwall systems outlined in this manual can be fully constructed from one side and can be used for the enclosure of service shafts or where construction is limited on one side only.

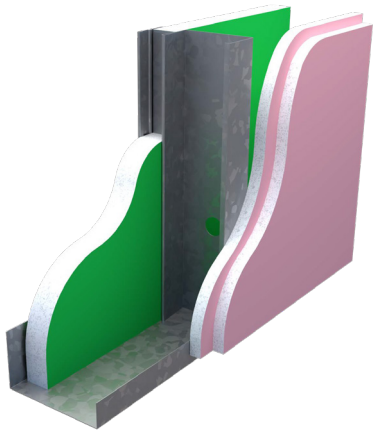


Figure C7: Shaftwall

Design Options

Shaftwall systems are available with various configurations of fire resistant plasterboard linings, achieving fire-resistance levels up to 120 minutes from both sides and acoustic ratings up to STC 53.

A number of stud sizes and thicknesses are available, allowing the construction of some Shaftwall systems greater than 3m (refer to the Shaftwall Maximum Wall Heights table).

Materials

Plasterboard and Glass Mat Linings

- 25mm GLASS-MAT LINER MOLD TOUGH
- 16mm MultiShield plasterboard
- 16mm FireShield plasterboard
- 16mm DenseShield plasterboard

Steel Sections

The following Rondo steel sections are utilised in Shaftwall systems:

TABLE C5: RONDO SHAFTWALL COMPONENTS

SECTION TYPE & SIZE	SECTION SIZE	BASE METAL THICKNESS
CH-stud	64mm and 102mm	0.55mm and 0.90mm
E-stud	64mm and 102mm	0.55mm and 0.90mm
J-track	64mm and 102mm	0.80mm
Deflection track	64mm and 102mm	0.80mm

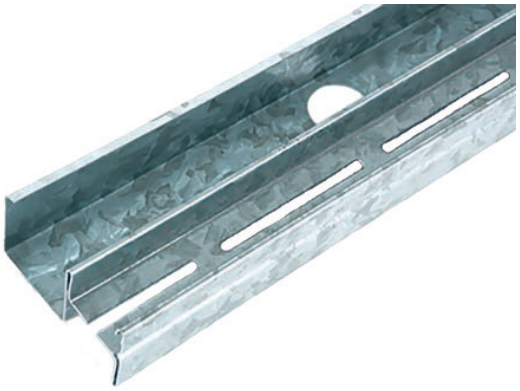


Figure C8: CH-Stud

Screws

Refer to General Information — Materials section for plasterboard screw types.

Caulking

Fire and acoustic selant per selant manufacturer recommendation.

INTRODUCTION

Notes to Shaftwall Height Tables:

- Minimum yield stress of steel sections is 270MPa.
- Deflection limit is height/240 to a maximum of 20mm for CH-studs.
- Wall heights tabled are for single-length studs at the maximum centers shown.
- Wall heights tabled are not for axial loads but include self-weight and lateral pressures stated.
- Wall heights tabled are not applicable to steel-lipped C-studs.
- Shelf loading is not permitted for tabulated maximum wall heights. Refer to Rondo for maximum heights with shelf loadings.
- Tabulated heights are for internal walls only.
- All plasterboard is to be manufactured by Knauf Gypsum Philippines, Inc.
- Walls are to be constructed with FireShield, MultiShield, or DenseShield plasterboard to Knauf standards and Glass Mat Liner fire-rated wall details as appropriate.
- Framing components and connections must be suitably designed by the project structural engineer in accordance with the NSCP for earthquake action or seismic applications..

INTRODUCTION

Plasterboard Installation – Non–Fire-Rated Walls

MIN JOINT OFFSETS (mm)		
LINING LAYER	VERT JOINTS	HORZ JOINTS
Inner/single layers on opposite sides or Adjacent layers on same side	One stud spacing (300mm min..)	300

MAX SCREW SPACING (mm)			
LINING LAYER	INTERMEDIATE STUDS	VERTICAL EDGES	INT/EXT CORNERS & AROUND OPENINGS
Outer/ single layer	300	200 (stagger screws in abutting sheets)	200

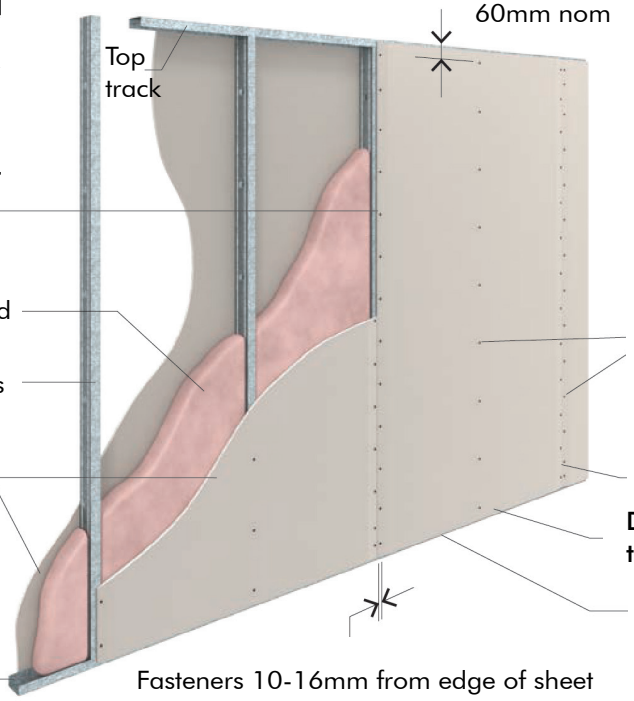


Figure C9: Non–Fire-Rated Steel Stud – Vertical Fixing – Single Layer (fully screw fixed)

MIN JOINT OFFSETS (mm)		
LINING LAYER	VERT JOINTS	HORZ JOINTS
Inner/single layers on opposite sides or Adjacent layers on same side	One stud spacing (300mm min..)	300

MAX SCREW SPACING (mm)			
LINING LAYER	INTERMEDIATE STUDS	VERTICAL EDGES	INT/EXT CORNERS & AROUND OPENINGS
Outer/ single layer	300	200 (stagger screws in abutting sheets)	200
Inner layers	600	600	600

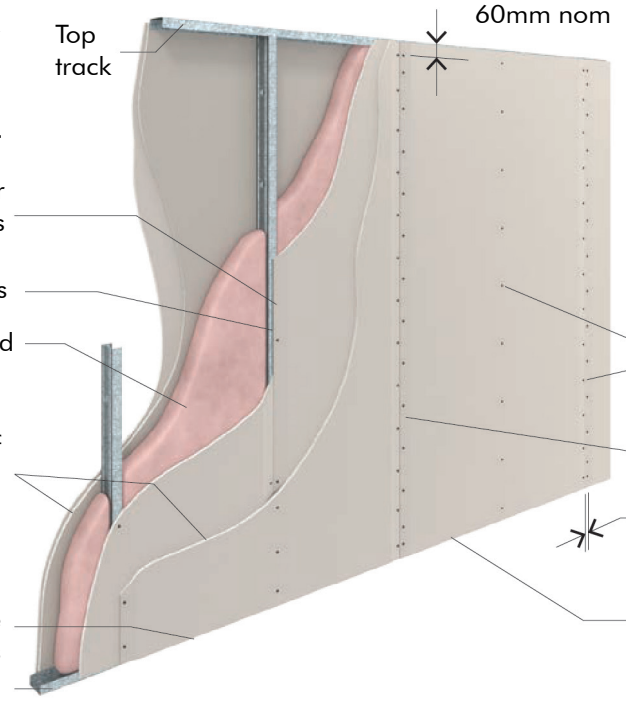
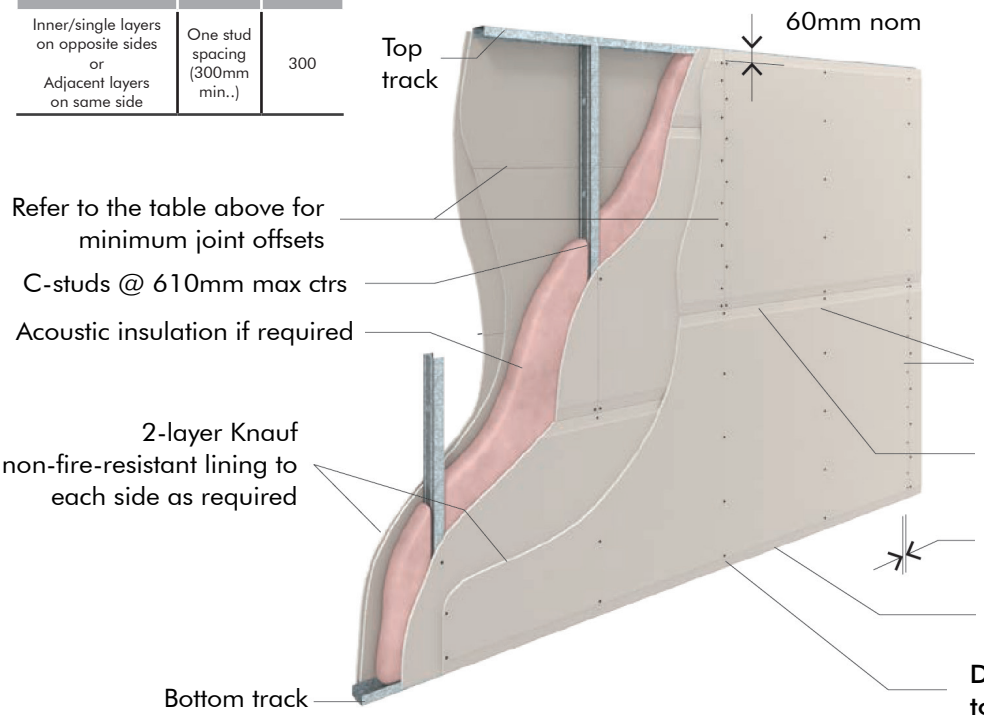


Figure C10: Non–Fire-Rated Steel Stud – Vertical Fixing – Double Layer

INTRODUCTION

MIN JOINT OFFSETS (mm)		
LINING LAYER	VERT JOINTS	HORZ JOINTS
Inner/single layers on opposite sides or Adjacent layers on same side	One stud spacing (300mm min..)	300



MAX SCREW SPACING (mm)			
LINING LAYER	INTERMEDIATE STUDS	VERTICAL EDGES	INT/EXT CORNERS & AROUND OPENINGS
Outer/ single layer	300	200 (stagger screws in abutting sheets)	200
Inner layers	600	600	600

Refer to the table above for maximum fastener spacings. Refer to General Information - Materials for screw details

Tape and set joints to external layers only

Fasteners 10–16mm from edge of the sheet

Refer to the head and base details for gap requirements

Do not fasten the plasterboard to top and bottom tracks.

Figure C11: Non–Fire-Rated Steel Stud – Horizontal Fixing – Double Layer

Notes:

- For Level 5 finish, butt joints must fall between framing members and be back-blocked.
- The same parameters apply for horizontal fixing in a single layer.

Plasterboard Installation – Fire-Rated Walls

MIN JOINT OFFSETS (mm)		
LINING LAYER	VERT JOINTS	HORZ JOINTS
Inner/single layers on opposite sides or Adjacent layers on same side	One stud spacing (300mm min..)	300

MAX SCREW SPACING (mm)			
LINING LAYER	INTERMEDIATE STUDS	VERTICAL EDGES	INT/EXT CORNERS & AROUND OPENINGS
Outer/ single layer	300	200 (stagger screws in abutting sheets)	200
Inner layers	300	200	200

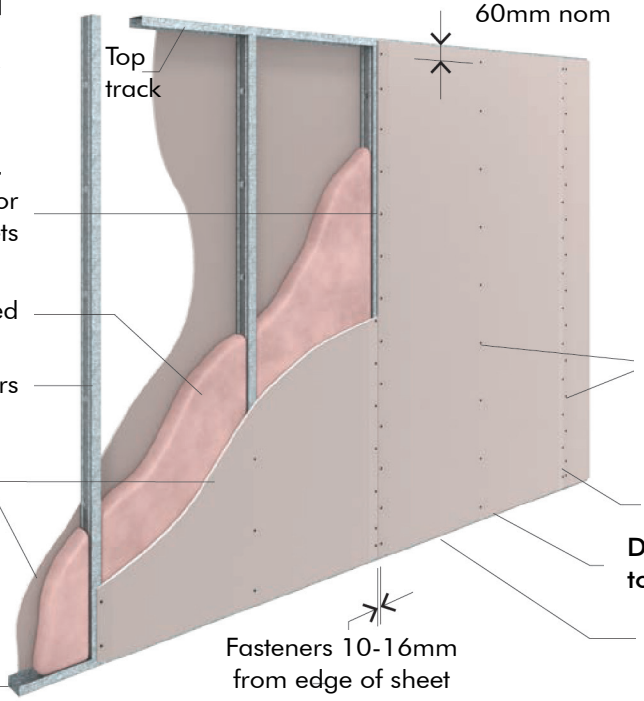


Figure C12: Fire-Rated Steel Stud – Vertical Fixing – Single Layer

MIN JOINT OFFSETS (mm)		
LINING LAYER	VERT JOINTS	HORZ JOINTS
Inner/single layers on opposite sides or Adjacent layers on same side	One stud spacing (300mm min..)	300

MAX SCREW SPACING (mm)			
LINING LAYER	INTERMEDIATE STUDS	VERTICAL EDGES	INT/EXT CORNERS & AROUND OPENINGS
Outer/ single layer	300	200 (stagger screws in abutting sheets)	200
Inner layers	300	200	200

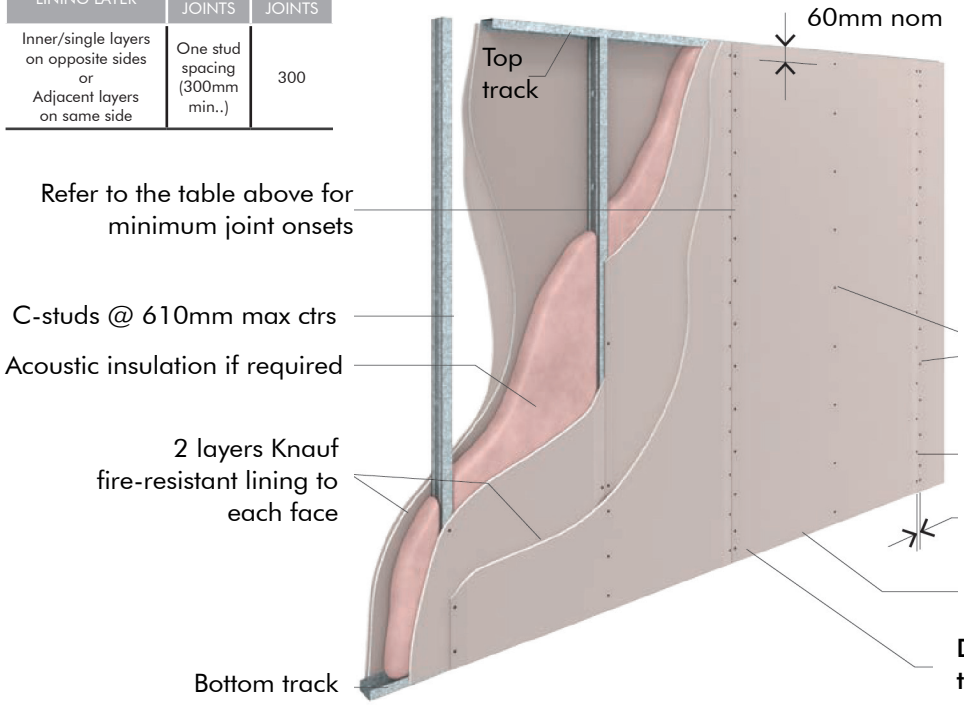


Figure C13: Fire-Rated Steel Stud – Vertical Fixing – Multiple Layer

LINED ONE SIDE

SO.1

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 1x10mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	10+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.1a	1x10mm SPANSHIELD	N/A	Nil	27

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3070	NA	NA	NA	2320	2720	NA	NA	NA
	0.55	NA	NA	3640	4210	NA	NA	NA	3200	3610	NA
	0.75	2970	3540	4070	4700	6740	2600	3130	3580	4130	5330
	1.15	NA	4020	4620	5360	7650	NA	3530	4050	4690	6810

SO.2

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 1x12mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	12+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.2a	1x12mm STANDARDSHIELD	N/A	Nil	27

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3070	NA	NA	NA	2320	2720	NA	NA	NA
	0.55	NA	NA	3740	4210	NA	NA	NA	3240	3610	NA
	0.75	2970	3660	4320	4800	6740	2600	3250	3820	4180	5370
	1.15	NA	4090	4620	5360	7650	NA	3580	4050	4690	6810

LINED ONE SIDE

SO.3

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 1x13mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	13+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.3a	1x13mm FIRESHIELD	NA	Nil	29
SO.3b	1x13mm MOISTURESHIELD	NA	Nil	27
SO.3c	1x13mm MULTISHIELD	NA	Nil	29
SO.3d	1x13mm DENSESHIELD	NA	Nil	29

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3070	NA	NA	NA	2320	2720	NA	NA	NA
	0.55	NA	NA	3740	4210	NA	NA	NA	3240	3610	NA
	0.75	2970	3660	4320	4800	6740	2600	3250	3820	4180	5370
	1.15	NA	4090	4620	5360	7650	NA	3580	4050	4690	6810

SO.4

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 1x16mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	16+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.4a	1x16mm STANDARDSHIELD	NA	Nil	29
SO.4b	1x16mm FIRESHIELD	NA	Nil	30
SO.4c	1x16mm MOISTURESHIELD	NA	Nil	29
SO.4d	1x16mm MULTISHIELD	NA	Nil	30
SO.4e	1x16mm DENSESHIELD	NA	Nil	30

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3140	NA	NA	NA	2320	2750	NA	NA	NA
	0.55	NA	NA	3760	4210	NA	NA	NA	3250	3610	NA
	0.75	2970	3700	4380	4820	6740	2600	3280	3870	4200	5370
	1.15	NA	4100	4620	5360	7650	NA	3590	4050	4690	6810

LINED ONE SIDE

SO.5

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 2x10mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	20+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.5a	2x10mm SPANSHIELD	N/A	Nil	33

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3070	NA	NA	NA	2320	2720	NA	NA	NA
	0.55	NA	NA	3640	4210	NA	NA	NA	3200	3610	NA
	0.75	2970	3540	4070	4700	6740	2600	3130	3580	4130	5330
	1.15	NA	4020	4620	5360	7650	NA	3530	4050	4690	6810

SO.6

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 2x12mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	24+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.6a	2x12mm STANDARDSHIELD	N/A	Nil	33

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3070	NA	NA	NA	2320	2720	NA	NA	NA
	0.55	NA	NA	3740	4210	NA	NA	NA	3240	3610	NA
	0.75	2970	3660	4320	4800	6740	2600	3250	3820	4180	5370
	1.15	NA	4090	4620	5360	7650	NA	3580	4050	4690	6810

LINED ONE SIDE

SO.7

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 2x13mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	26+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.7a	2x13mm FIRESHIELD	NA	Nil	35
SO.7b	2x13mm MOISTURESHIELD	NA	Nil	34
SO.7c	2x13mm MULTISHIELD	NA	Nil	35
SO.7d	2x13mm DENSESHIELD	NA	Nil	35

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3070	NA	NA	NA	2320	2720	NA	NA	NA
	0.55	NA	NA	3740	4210	NA	NA	NA	3240	3610	NA
	0.75	2970	3660	4320	4800	6740	2600	3250	3820	4180	5370
	1.15	NA	4090	4620	5360	7650	NA	3580	4050	4690	6810

SO.8

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 2x16mm PBD

Framing: Steel studs

Insulation: Refer to the table

Side 2: Nil

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	32+ STUDS
			STUD SIZE mm	ANY STUDS
			INSULATION	STC
SO.8a	2x16mm STANDARDSHIELD	NA	Nil	34
SO.8b	2x16mm FIRESHIELD	NA	Nil	36
SO.8c	2x16mm MOISTURESHIELD	NA	Nil	35
SO.8d	2x16mm MULTISHIELD	NA	Nil	36
SO.8e	2x16mm DENSESHIELD	NA	Nil	36

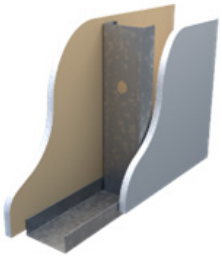
MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)					610 (NOGGED)				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	2630	3140	NA	NA	NA	2320	2750	NA	NA	NA
	0.55	NA	NA	3760	4210	NA	NA	NA	3250	3610	NA
	0.75	2970	3700	4380	4820	6740	2600	3280	3870	4200	5370
	1.15	NA	4100	4620	5360	7650	NA	3590	4050	4690	6810

LINED BOTH SIDES

SB.1a

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	1x10mm PBD
Framing:	Steel studs
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x10mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

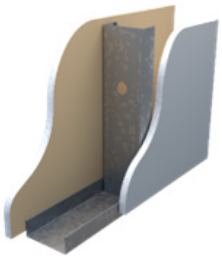
SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	71	84	96	112	170
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.1a	1x10mm SPANSHIELD	1x10mm SPANSHIELD	Nil	33	34	34	35	36
			50mm THK	41	42	42	43	43

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3130	3690	NA	NA	NA	2770	3330	NA	NA	NA
	0.55	NA	NA	4160	4990	NA	NA	NA	3700	4540	NA
	0.75	3320	4280	4930	5460	7340	2910	3930	4430	4830	6550
	1.15	NA	4590	5240	5840	7970	NA	4170	4650	5110	7220

SB.1b

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	1x12mm PBD
Framing:	Steel studs
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x12mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	75	88	100	116	174
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.1b	1x12mm STANDARDSHIELD	1x12mm STANDARDSHIELD	Nil	34	35	35	36	36
			50mm THK	42	43	43	44	44

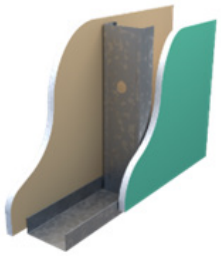
MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

LINED BOTH SIDES

SB.2

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 1x13mm PBD

Framing: Steel studs

Insulation: 60kg/m³ Mineral Wool

Side 2: 1x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

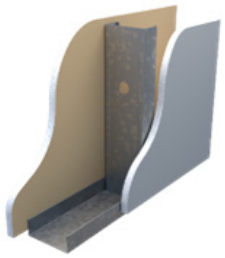
SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	77	90	102	118	176
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.2a	1x13mm MOISTURESHIELD	1x13mm MOISTURESHIELD	Nil	35	36	36	37	37
			50mm THK	43	44	44	45	45

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

SB.3

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 1x16mm PBD

Framing: Steel studs

Insulation: 60kg/m³ Mineral Wool

Side 2: 1x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	83	96	108	124	182
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.3a	1x16mm STANDARDSHIELD	1x16mm STANDARDSHIELD	Nil	37	38	39	39	40
			50mm THK	43	44	45	45	46
SB.3b	1x16mm MOISTURESHIELD	1x16mm MOISTURESHIELD	Nil	41	43	43	44	45
			50mm THK	48	48	49	50	51

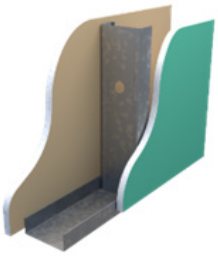
MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

LINED BOTH SIDES

SB.4

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	1x12mm PBD
Framing:	Steel studs
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	76	89	101	117	175
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.4a	1x12mm STANDARDSHIELD	1x13mm MOISTURESHIELD	Nil	35	36	36	37	37
			50mm THK	43	44	44	45	45
SB.4b*	1x12mm STANDARDSHIELD	1x13mm DENSESHIELD	Nil	36	37	37	38	38
			50mm THK	44	45	45	46	46

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

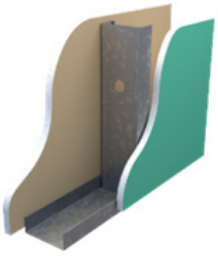
STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

Notes:

SB.4b can achieve Heavy Duty (HD) rating by substituting 13mm DenseShield on Lining Sine 1. This applies to partitions using 76mm stud or higher and spaced at ,maximum, 610mm on centers.

SB.5

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	1x12mm PBD
Framing:	Steel studs
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	79	92	104	120	178
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.5a	1x12mm STANDARDSHIELD	1x16mm MOISTURESHIELD	Nil	37	38	39	39	40
			50mm THK	43	44	45	45	46
SB.5b*	1x12mm STANDARDSHIELD	1x16mm DENSESHIELD	Nil	38	39	40	40	41
			50mm THK	44	45	46	46	47

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

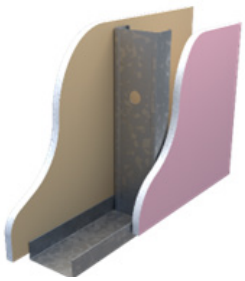
STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

LINED BOTH SIDES

SB.60.1

FIRE RESISTANCE LEVEL
60 MINUTES

FRL Basis-R21026-2A



SYSTEM DESCRIPTION

Side 1: 1x16mm PBD

Framing: Steel studs

Insulation: 60kg/m^3 Mineral Wool

Side 2: 1x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	83	96	108	124	182
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.60.1a	1 x 16mm FIRESHIELD	1 x 16mm FIRESHIELD	Nil	39	40	41	42	43
			50mm THK	46	47	48	48	49
SB.60.1b	1 x 16mm MULTISHIELD	1 x 16mm MULTISHIELD	Nil	39	40	41	42	43
			50mm THK	46	47	48	48	49
SB.60.1c*	1 x 16mm DENSESHIELD	1 x 16mm DENSESHIELD	Nil	39	40	41	42	43
			50mm THK	46	47	48	48	49
SB.60.1d	1 x 16mm FIRESHIELD	1x16mm MULTISHIELD	Nil	39	40	41	42	43
			50mm THK	46	47	48	48	49
SB.60.1e	1 x 16mm FIRESHIELD	1 x 16mm DENSESHIELD	Nil	39	40	41	42	43
			50mm THK	46	47	48	48	49

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

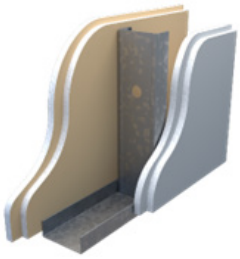
Notes:

SB.60.1c can achieve Severe Duty (SD) rating by using 76mm stud or higher when spaced at 610 mm on centers, maximum.

LINED BOTH SIDES

SB.6a

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 2x10mm PBD

Framing: Steel studs

Insulation: 60kg/m^3 Mineral Wool

Side 2: 2x10mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

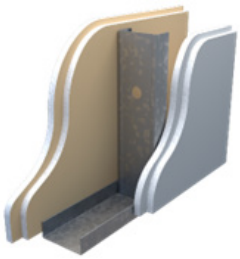
SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	91	104	116	132	190
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.6a	2 x 10mm SPANSHIELD	2 x 10mm SPANSHIELD	Nil	41	42	42	43	44
			50mm THK	46	48	49	49	50

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3130	3690	NA	NA	NA	2770	3330	NA	NA	NA
	0.55	NA	NA	4160	4990	NA	NA	NA	3700	4540	NA
	0.75	3320	4280	4930	5460	7340	2910	3930	4430	4830	6550
	1.15	NA	4590	5240	5840	7970	NA	4170	4650	5110	7220

SB.6b

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 2x12mm PBD

Framing: Steel studs

Insulation: 60kg/m^3 Mineral Wool

Side 2: 2x12mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	99	112	124	140	198
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.6b	2 x 12mm STANDARDSHIELD	2 x 12mm STANDARDSHIELD	Nil	42	43	43	44	45
			50mm THK	47	49	50	50	51

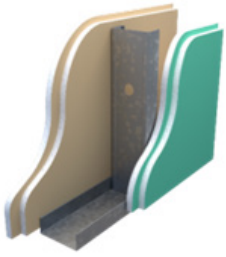
MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

LINED BOTH SIDES

SB.7

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 2x13mm PBD

Framing: Steel studs

Insulation: 60kg/m^3 Mineral Wool

Side 2: 2x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

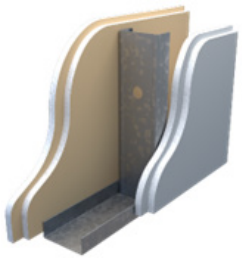
SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	103	116	128	144	202
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.7a	2 x 13mm MOISTURESHIELD	2x 13mm MOISTURESHIELD	Nil	42	43	43	44	45
			50mm THK	48	50	51	51	52

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

SB.8

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 2x16mm PBD

Framing: Steel studs

Insulation: 60kg/m^3 Mineral Wool

Side 2: 2x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	115	128	140	156	214
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.8a	2x16mm STANDARDSHIELD	2x16mm STANDARDSHIELD	Nil	43	45	46	47	48
			50mm THK	48	50	51	52	53
SB.8b	2 x 16mm MOISTURESHIELD	2 x 16mm MOISTURESHIELD	Nil	44	46	47	48	49
			50mm THK	50	51	52	53	54

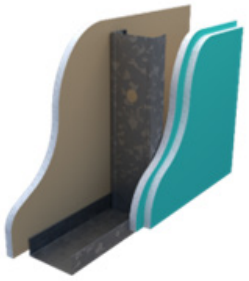
MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

LINED BOTH SIDES

SB.9

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 1x12mm PBD

Framing: Steel studs

Insulation: 60kg/m³ Mineral Wool

Side 2: 2x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

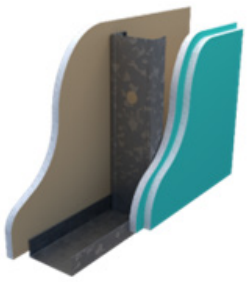
SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	89	102	114	130	188
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.8a	1 x 12mm STANDARDSHIELD	2 x 13mm MOISTURESHIELD	Nil	38	39	40	41	42
			50mm THK	43	45	46	47	48
SB.8b	1 x 12mm STANDARDSHIELD	2 x 13mm DENSESHIELD	Nil	40	41	42	43	44
			50mm THK	46	48	48	49	50

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

SB.10

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 1x12mm PBD

Framing: Steel studs

Insulation: 60kg/m³ Mineral Wool

Side 2: 2x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	95	108	120	136	194
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.10a	1 x 12mm STANDARDSHIELD	2 x 16mm MOISTURESHIELD	Nil	39	40	41	42	43
			50mm THK	45	46	47	48	49
SB.10b	1 x 12mm STANDARDSHIELD	2 x 16mm DENSESHIELD	Nil	42	44	44	45	46
			50mm THK	49	50	50	51	52

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

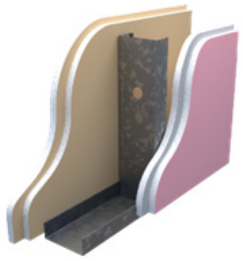
STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

LINED BOTH SIDES

SB.60.2

FIRE RESISTANCE LEVEL
60 MINUTES

FRL Basis-R21626-2A



SYSTEM DESCRIPTION

Side 1:	1x12mm PBD + 1x16mm PBD
Framing:	Steel studs
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x12mm PBD + 1x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	107	120	132	148	206
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.60.2a	1 x 16mm FIRESHIELD + 1 x 12mm STANDARSHIELD	1 x 16mm FIRESHIELD + 1 x 12mm STANDARSHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

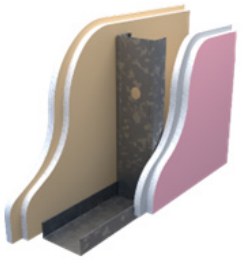
STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

LINED BOTH SIDES

SB.120.1

FIRE RESISTANCE LEVEL 120 MINUTES

FRL Basis-R21K06-38



SYSTEM DESCRIPTION

Side 1: 2x13mm PBD

Framing: Steel studs

Insulation: 60kg/m³ Mineral Wool

Side 2: 2x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	103	116	128	144	202
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.120.1a	2 x 13mm FIRESHIELD	2 x 13mm FIRESHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55
SB.120.1b	2 x 13mm MULTISHIELD	2x 13mm MULTISHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55
SB.120.1c*	2 x 13mm DENSESHIELD	2 x 13mm DENSESHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55
SB.120.1d	2 x 13mm FIRESHIELD	2 x 13mm MULTISHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55
SB.120.1e	2 x 13mm FIRESHIELD	2 x 13mm DENSESHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55
SB.120.1f	2 x 13mm FIRESHIELD	1 x 13mm FIRESHIELD + 1 x 13mm MULTISHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55
SB.120.1g	2 x 13mm FIRESHIELD	1 x 13mm FIRESHIELD + 1 x 13mm DENSESHIELD	Nil	44	46	47	48	49
			50mm THK	50	52	53	54	55

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3510	4020	NA	NA	NA	3200	3720	NA	NA	NA
	0.55	NA	NA	4530	5330	NA	NA	NA	4130	4940	NA
	0.75	3680	4530	5450	6050	7610	3320	4220	5020	5500	6990
	1.15	NA	4810	5720	6380	8190	NA	4430	5220	5750	7540

Notes:

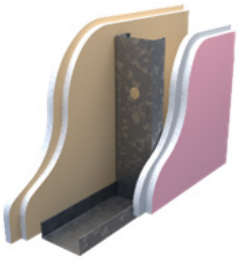
SB.120.1c can achieve Heavy Duty (HD) rating by using 76mm stud or higher when spaced at 610mm, maximum, on centers.

LINED BOTH SIDES

SB.120.2

FIRE RESISTANCE LEVEL
120 MINUTES

FRL Basis-R21K06-38



SYSTEM DESCRIPTION

Side 1: 2x16mm PBD

Framing: Steel studs

Insulation: 60kg/m³ Mineral Wool

Side 2: 2x16mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	NOM WALL WIDTH mm	115	128	140	156	214
			STUD SIZE mm	51	64	76	92	150
			INSULATION	STC				
SB.120.2a	2 x 16mm FIRESHIELD	2 x 16mm FIRESHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56
SB.120.2b	2 x 16mm MULTISHIELD	2x 16mm MULTISHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56
SB.120.2c*	2 x 16mm DENSESHIELD	2 x 16mm DENSESHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56
SB.120.2d	2 x 16mm FIRESHIELD	2 x 16mm MULTISHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56
SB.120.2e	2 x 16mm FIRESHIELD	2 x 16mm DENSESHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56
SB.120.2f	2 x 16mm FIRESHIELD	1 x 16mm FIRESHIELD + 1 x 16mm MULTISHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56
SB.120.2g	2 x 16mm FIRESHIELD	1 x 16mm FIRESHIELD + 1 x 16mm DENSESHIELD	Nil	45	47	48	49	50
			50mm THK	51	53	54	55	56

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406					610				
Studs Size mm		51	64	76	92	150	51	64	76	92	150
BASE METAL THICKNESS mm	0.5	3620	4220	NA	NA	NA	3380	3910	NA	NA	NA
	0.55	NA	NA	4700	5560	NA	NA	NA	4300	5180	NA
	0.75	3750	4710	5710	6280	7750	3520	4350	5250	5710	7190
	1.15	NA	4950	5950	6580	8300	NA	4520	5420	5920	7650

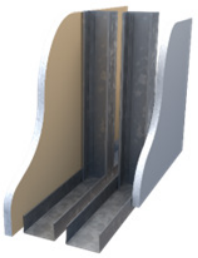
Notes:

SB.120.2c can achieve Severe Duty (SD) rating by using 76mm stud or higher when spaced at 610mm, maximum, on centers.

TWIN STUDS

TS.1A

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	1x12mm PBD
Framing:	Twin Steel Stud
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x12mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

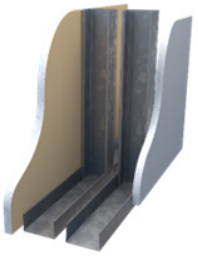
SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN. WALL WIDTH mm		202	226	258	374
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.1a	1 x 12mm STANDARDSHIELD	1 x 12mm STANDARDSHIELD	Nil		41	42	43	45
			50mm THK	ONE SIDE	51	51	52	52
				BOTH SIDES	54	54	55	55

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3740	4210	NA	NA	3240	3610	NA
	0.75	3660	4320	4800	6740	3250	3820	4180	5370
	1.15	4090	4620	5360	7650	3580	4050	4690	6810

TS.1B

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	1x10mm PBD
Framing:	Twin Steel Stud
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x10mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN. WALL WIDTH mm		198	222	254	370
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.1b	1 x 10mm SPANSHIELD	1 x 10mm SPANDSHIELD	Nil		41	42	42	44
			50mm THK Mineral Wool	ONE SIDE	48	49	50	50
				BOTH SIDES	51	52	53	53

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3640	4210	NA	NA	3200	3610	NA
	0.75	3540	4070	4700	6740	3130	3580	4130	5330
	1.15	4020	4620	5360	7650	3530	4050	4690	6810

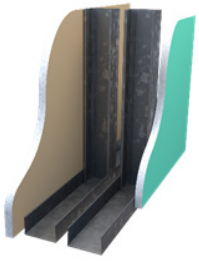
Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are unbridged.
- Bridging the twin studs generally decreases the STC but improves the maximum wall height. Contact Knauf for specific project design requirements.

TWIN STUDS

TS.2

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 1x13mm PBD

Framing: Twin Steel Stud

Insulation: 60kg/m^3 Mineral Wool

Side 2: 1x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN. WALL WIDTH mm		204	228	260	376
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.2a	1 x 13mm MOISTURESHIELD	1 x 13mm MOISTURESHIELD	Nil		43	44	45	47
			50mm THK Mineral Wool	ONE SIDE	53	54	54	55
				BOTH SIDES	56	57	57	58
TS.2b	1 x 13mm DENSESHIELD	1 x 13mm DENSESHIELD	Nil		46	46	47	50
			50mm THK Mineral Wool	ONE SIDE	56	56	57	57
				BOTH SIDES	59	59	60	60

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3740	4210	NA	NA	3240	3610	NA
	0.75	3660	4320	4800	6740	3250	3820	4180	5370
	1.15	4090	4620	5360	7650	3580	4050	4690	6810

Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are unbridged.
- Bridging the twin studs generally decreases the STC but improves the maximum wall height. Contact Knauf for specific project design requirements.

TWIN STUDS

TS.3

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1:	1x16mm MR PBD
Framing:	Twin Steel Stud
Insulation:	60kg/m³ Mineral Wool
Side 2:	1x16mm non MR PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		210	234	266	382
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.3a	1 x 16mm MOISTURESHIELD	1 x 16mm MOISTURESHIELD	Nil		45	45	46	49
			50mm THK Mineral Wool	ONE SIDE	55	55	56	56
				BOTH SIDES	58	58	59	59

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3140	NA	NA	NA	2750	NA	NA	NA
	0.55	NA	3760	4210	NA	NA	3250	3610	NA
	0.75	3700	4380	4820	6740	3250	3870	4200	5370
	1.15	4100	4620	5360	7650	3590	4050	4690	6810

Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are Unbridged.
- Bridging the twin studs generally decreases the STC but improves the maximum wall height. Contact Knauf for specific project design requirements.

TWIN STUDS

TS.4

NON-FIRE-RATED

SYSTEM DESCRIPTION

Side 1: 1x12mm PBD

Framing: Twin Steel Stud

Insulation: 60kg/m³ Mineral Wool

Side 2: PBD thickness per table

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		LINING THICKNESS+ 50mm + STUD WIDTH			
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.4a	1 x 12mm STANDARDSHIELD	1 x 13mm MOISTURESHIELD	Nil		42	43	44	46
			50mm THK Mineral Wool	ONE SIDE	52	52	53	53
				BOTH SIDES	55	55	56	56
TS.4b	1 x 12mm STANDARDSHIELD	1 x 16mm MOISTURESHIELD	Nil		44	45	46	48
			50mm THK Mineral Wool	ONE SIDE	54	55	55	56
				BOTH SIDES	57	58	58	59
TS.4c	1 x 12mm STANDARDSHIELD	1 x 13mm DENSESHIELD	Nil		44	45	46	48
			50mm THK Mineral Wool	ONE SIDE	54	55	55	56
				BOTH SIDES	57	58	58	59
TS.4d	1 x 12mm STANDARDSHIELD	1 x 16mm DENSESHIELD	Nil		45	46	47	49
			50mm THK Mineral Wool	ONE SIDE	55	56	56	57
				BOTH SIDES	58	59	59	60

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3740	4210	NA	NA	3240	3610	NA
	0.75	3660	4320	4800	6740	3250	3820	4180	5370
	1.15	4090	4620	5360	7650	3580	4050	4690	6810

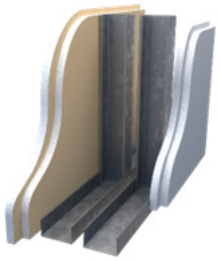
Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are Unbridged.
- Bridging the twin studs generally decreases the STC but improves the maximum wall height. Contact Knauf for specific project design requirements.

TWIN STUDS

TS.5A

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	2x12mm PBD
Framing:	Twin Steel Stud
Insulation:	60kg/m³ Mineral Wool
Side 2:	2x12mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		226	250	282	398
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.5a	2 x 12mm STANDARDSHIELD	2 x 12mm STANDARDSHIELD	Nil		50	51	52	55
			50mm THK Mineral Wool	ONE SIDE	57	58	58	58
				BOTH SIDES	60	61	61	61

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3740	4210	NA	NA	3240	3610	NA
	0.75	3660	4320	4800	6740	3250	3820	4180	5370
	1.15	4090	4620	5360	7650	3580	4050	4690	6810

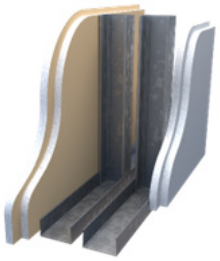
Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are Unbridged.
- Bridging the twin studs generally decreases the STC but improves the maximum wall height. Contact Knauf for specific project design requirements.

TWIN STUDS

TS.5B

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 2x10mm PBD

Framing: Twin Steel Stud

Insulation: 60kg/m³ Mineral Wool

Side 2: 2x10mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

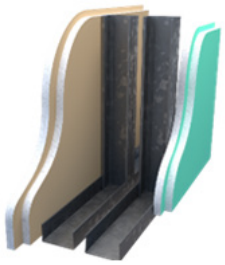
SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		218	242	274	390
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.5b	2 X 10mm SPANSHIELD	2 X 10mm SPANSHIELD	Nil		49	49	50	53
			50mm THK Mineral Wool	ONE SIDE	56	57	57	58
				BOTH SIDES	59	60	60	61

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3640	4210	NA	NA	3200	3610	NA
	0.75	3540	4070	4700	6740	3130	3580	4130	5330
	1.15	4020	4620	5360	7650	3530	4050	4690	6810

TS.6

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 2x13mm PBD

Framing: Twin Steel Stud

Insulation: 60kg/m³ Mineral Wool

Side 2: 2x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		230	254	286	402
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.6	2 x 13mm MOISTURESHIELD	2 x 13mm MOISTURESHIELD	Nil		53	54	55	57
			50mm THK Mineral Wool	ONE SIDE	59	60	60	61
				BOTH SIDES	62	63	63	64

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3740	4210	NA	NA	3240	3610	NA
	0.75	3660	4320	4800	6740	3250	3820	4180	5370
	1.15	4090	4620	5360	7650	3580	4050	4690	6810

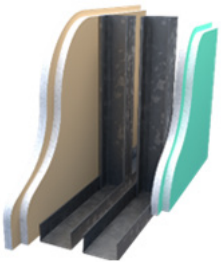
Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are Unbridged.
- Bridging the twin studs generally decreases the STC but improves the maximum wall height. Contact Knauf for specific project design requirements.

TWIN STUDS

TS.7

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1:	2x16mm MR PBD
Framing:	Twin Steel Stud
Insulation:	60kg/m³ Mineral Wool
Side 2:	2x16mm MR PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		242	266	298	414
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.7	2 x 16mm MOISTURESHIELD	2 x 16mm MOISTURESHIELD	Nil		54	55	56	58
			50mm THK Mineral Wool	ONE SIDE	60	61	61	62
				BOTH SIDES	63	64	64	65

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3140	NA	NA	NA	2750	NA	NA	NA
	0.55	NA	3760	4210	NA	NA	3250	3610	NA
	0.75	3700	4380	4820	6740	3280	3870	4180	5370
	1.15	4100	4620	5360	7650	3590	4050	4690	6810

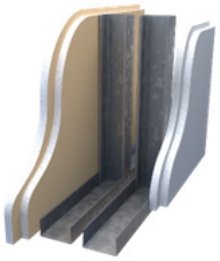
Notes:

- The STC and maximum wall heights shown for the Twin Studs System shown on the table are unbroken.
- Bridging the twin-studs generally decreases the STC but improves the maximum wall height. Contact Knauf for project-specific design requirements.

TWIN STUDS

TS.8

NON-FIRE-RATED



SYSTEM DESCRIPTION

Side 1: 1x12mm PBD

Framing: Twin Steel Stud

Insulation: 60kg/m^3 Mineral Wool

Side 2: 2x13mm PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm		216	240	272	388
			STUD SIZE mm		64	76	92	150
			INSULATION		STC			
TS.5a	1 x 12mm STANDARDSHIELD	2 x 13mm MOISTURESHIELD	Nil		47	48	49	51
			50mm THK Mineral Wool	ONE SIDE	56	57	57	58
				BOTH SIDES	59	60	60	61
TS.5a	1 x 12mm STANDARDSHIELD	2 x 13mm DENSESHIELD	Nil		49	50	51	53
			50mm THK Mineral Wool	ONE SIDE	58	59	59	60
				BOTH SIDES	61	52	62	63

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS — SERVICEABILITY PRESSURE: 0.25 kPa

STUDS SPACING mm		406 (NOGGED)				610 (NOGGED)			
Studs Size mm		64	76	92	150	64	76	92	150
BASE METAL THICKNESS mm	0.5	3070	NA	NA	NA	2720	NA	NA	NA
	0.55	NA	3740	4210	NA	NA	3240	3610	NA
	0.75	3660	4320	4700	6740	3250	3820	4180	5370
	1.15	4090	4620	5360	7650	3580	4050	4690	6810

Notes:

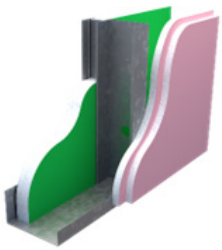
- The STC and maximum wall heights shown for the Twin Studs System shown on the table are unbroken.
- Bridging the twin-studs generally decreases the STC but improves the maximum wall height. Contact Knauf for project-specific design requirements.

SHAFT WALL

SH.120.1

FIRE RESISTANCE LEVEL
120 MINUTES

FRL BASIS
230130009SHF-002



SYSTEM DESCRIPTION

Side 1:	1x25mm Glass-Mat Liner
Framing:	CH-Studs
Insulation:	60kg/m^3 Mineral Wool
Side 2:	2x16mm FR PBD

ACOUSTIC RATINGS — Based on studs @ 610mm ctrs and thinnest available stud gauge

SYSTEM	LINING SIDE 1	LINING SIDE 2	MIN WALL WIDTH mm	96	134
			STUD SIZE mm	64	102
			INSULATION	STC	
SH.120.1a	1 x 25mm GLASS-MAT LINER	2 x 16mm FIRESHIELD	Nil	45	52
			50mm THK Mineral Wool	47	53
SH.120.1a	1 x 25mm GLASS-MAT LINER	2 x 16mm MULTISHIELD	Nil	45	52
			50mm THK Mineral Wool	47	53
SH.120.1a	1 x 25mm GLASS-MAT LINER	2 x 16mm DENSESHIELD	Nil	45	52
			50mm THK Mineral Wool	47	53

MAX WALL HEIGHTS NON-LOAD-BEARING WALLS		SERVICEABILITY PRESSURE: 0.25 kPa	
STUDS SPACING mm		**600**	
Studs Size mm		**64**	**102**
BASE METAL THICKNESS mm	0.55	3730	3730
	0.9	4380	5510

SECTION D

CEILINGS

INTRODUCTION

CONVENTIONAL CEILINGS

Description

Knauf conventional ceilings comprise single or multiple-layer plasterboard linings attached to the underside of the floor or roof structure above.

Design Options

Fire-Rated Ceilings

Fire-rated ceiling systems are available with fire resistance levels up to 120 minutes per ASTM E119.

Ceilings under Concrete Floors

Acoustic ratings for ceilings under concrete floors are provided for 150mm and 200mm slab thicknesses and the following floor coverings.

Attachment Options

Ceiling attachment options vary depending on the structure above, and include:

- Direct fixed
- Furred
- Furred with acoustic mounts
- Suspended
- Suspended with acoustic mounts

Design Considerations

- Knauf ceiling systems are not designed to support the weight of construction or maintenance personnel, additional plants, or storage of goods.
- The ceiling can be constructed to a pitch of up to 70 degrees from the horizontal.
- Ceiling systems can incorporate the following approved features: access panels, bulkheads, light and luminaire fittings, plumbing pipe penetrations, power cable penetrations, loaded penetrations, control joints, protection for steel and timber beams, changes in ceiling slope direction, and a variety of perimeter details.
- The use of false ceilings may eliminate the need for penetrations in fire-rated ceilings. Refer to Knauf for the acoustic rating of fire-rated ceiling systems with false ceilings.
- Suspension grids must be installed in accordance with Rondo and Knauf specifications.

Note:

- Extra suspension components must be provided to support light fittings, bulkheads, and other fixtures. It improves the maximum wall height. Contact Knauf for project-specific design requirements.

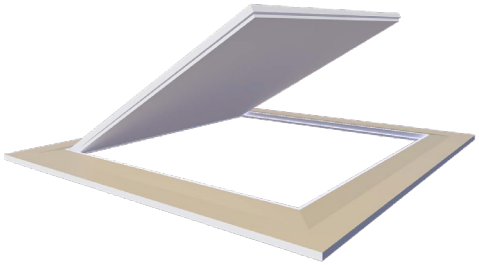


Figure D1: Knauf Standard Access Panel

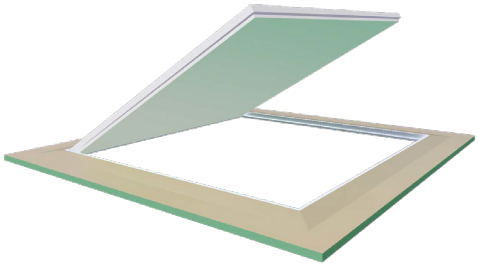


Figure D2: Knauf Moisture Resistant Access Panel

INTRODUCTION

Materials

The following materials and components are utilized in Knauf conventional ceiling systems listed in this manual are:

Ceiling Linings

- 10mm SpanShield
- 9/12mm StandardShield
- 9/13mm MoistureShield
- 13/16mm FireShield
- 13mm/16mm MultiShield

Furring Channels and Fixing Clips

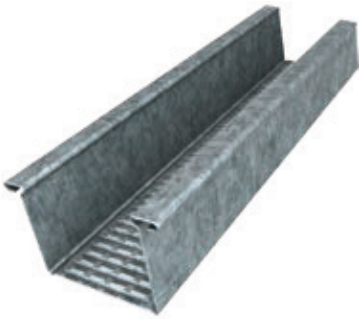


Figure D3: Rondo 129 Furring Channel

Figure D4:
Rondo 237 Fixing Clip

Figure D5:
Rondo STWC Sound Isolation Mount

Figure D6:
Embelton Ceiling Isolation Hanger LB Bracket (Blue Dot Rubber Element)

Figure D7:
Embelton Ceiling Isolation Hanger HB Bracket (White Dot Rubber Element)

Suspended Ceiling Systems

- Rondo KEY-LOCK® Concealed Suspended Ceiling System

Furred and Suspended Systems

- Ensure that furring channels or suspended grid are installed on a true and level plane.
- Plasterboard supporting members must be spaced at a maximum of 610mm on centers for 12mm and above thick plasterboards and a maximum of 406mm on centers for 9mm-thick plasterboards.
- Fire-rated ceiling systems may require closer spacing of supporting members. Contact Knauf for guidance.
- Furring channels should be taken to and provided within 100mm of the ceiling perimeter (minimum of 15mm end clearance is required at walls.)
- Allow for an expansion gap at the rate of 3mm per 1 meter run in abutting furring channels and the top cross rails in fire-rated systems.
- Rondo KEY-LOCK concealed suspended ceiling system must be instanced in accordance with Rondo specifications.

Penetrations

Penetrations in a fire-rated system must be treated strictly in accordance with relevant test reports and approved installation details in order to maintain the system's fire resistance level.

Where components by others are specified in Knauf fire-rated penetration details (i.e., dampers, GPOs, fire collars, etc.), such components must be installed in accordance with the manufacturer's specifications. It is the responsibility of the component manufacturer to ensure that the fire rating performance of the system is not affected.

INTRODUCTION

Movement and Control Joints

- Control joints in internal ceilings should be spaced at 12 meter maximum intervals in both directions. Control joints in external ceilings should be spaced at 6-meter maximum intervals in both directions.
- Control joints must be provided over movement joints in the substrate or structural elements and at every change of lining or substrate material.
- Refer to the Junctions and Penetrations section for control joint details in fire-rated ceilings.
- Control joints in non-fire-rated ceilings can be formed by fitting Rondo P35 control joints or plastic expansion beads.
- In multi-layer, non-fire-rated systems, control joints can be provided in the face layer only.

Plasterboard Fixing

Fire-Rated Ceilings

- Plasterboard linings in fire-rated plasterboard ceilings must be installed using screw fixing only. Adhesives are not permitted.
- Apply plasterboard sheets with recessed edges at right angles to framing members (e.g. furring channel).
- In single-layer systems, place butt joints on the framing or midway between the framing members and back block, as shown in the Junctions and Penetrations section.
- Screw-fix the first (uppermost) layer sheets at 300mm max centers in the field of the board and at 200mm max centers along the board ends and edges. Stagger edge screw fixings in adjacent sheets.
- Screw fix additional plasterboard layers in the same manner as the first layer, but with all joints in adjacent layers staggered to at least 200mm. If butt joints in additional layers fall between the framing members, screw the laminate sheet ends to the previous layer with appropriate laminating screws at 200mm max centers (refer to General Information Materials Screws.)

Jointing and Finishing

- Stop and finish the face-layer plasterboard joints per the approved level of finish. Level 4 is the recommended level of finish. See page A26.
- Plasterboard joints in the inner layers of multi-layer fire-rated and non-fire-rated systems are not required to be stopped.

Note:

Paper jointing tape must be used in fire-rated systems.

INTRODUCTION

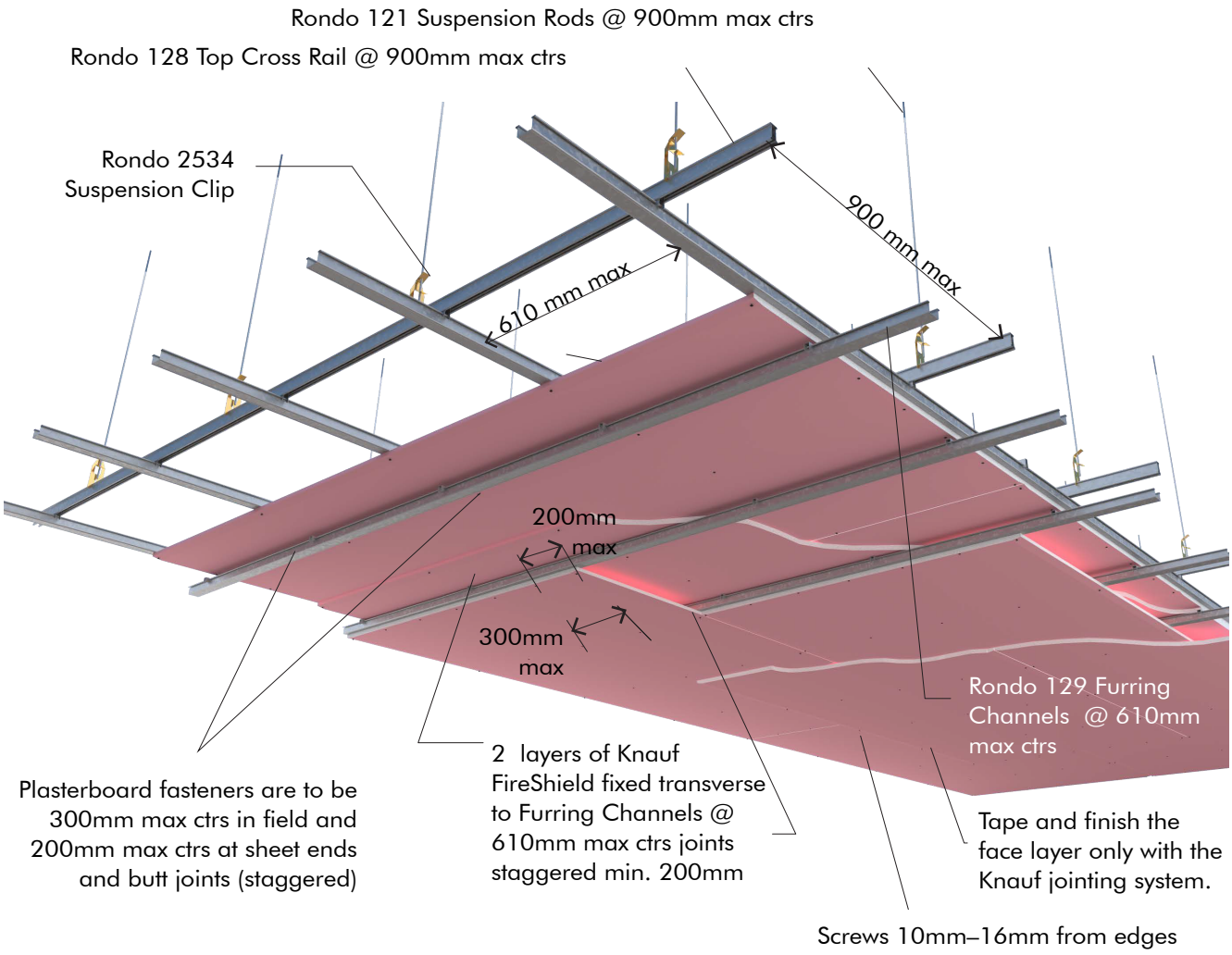


Figure D8: Fire-Rated Ceiling – Screw Fixing Layout

INTRODUCTION

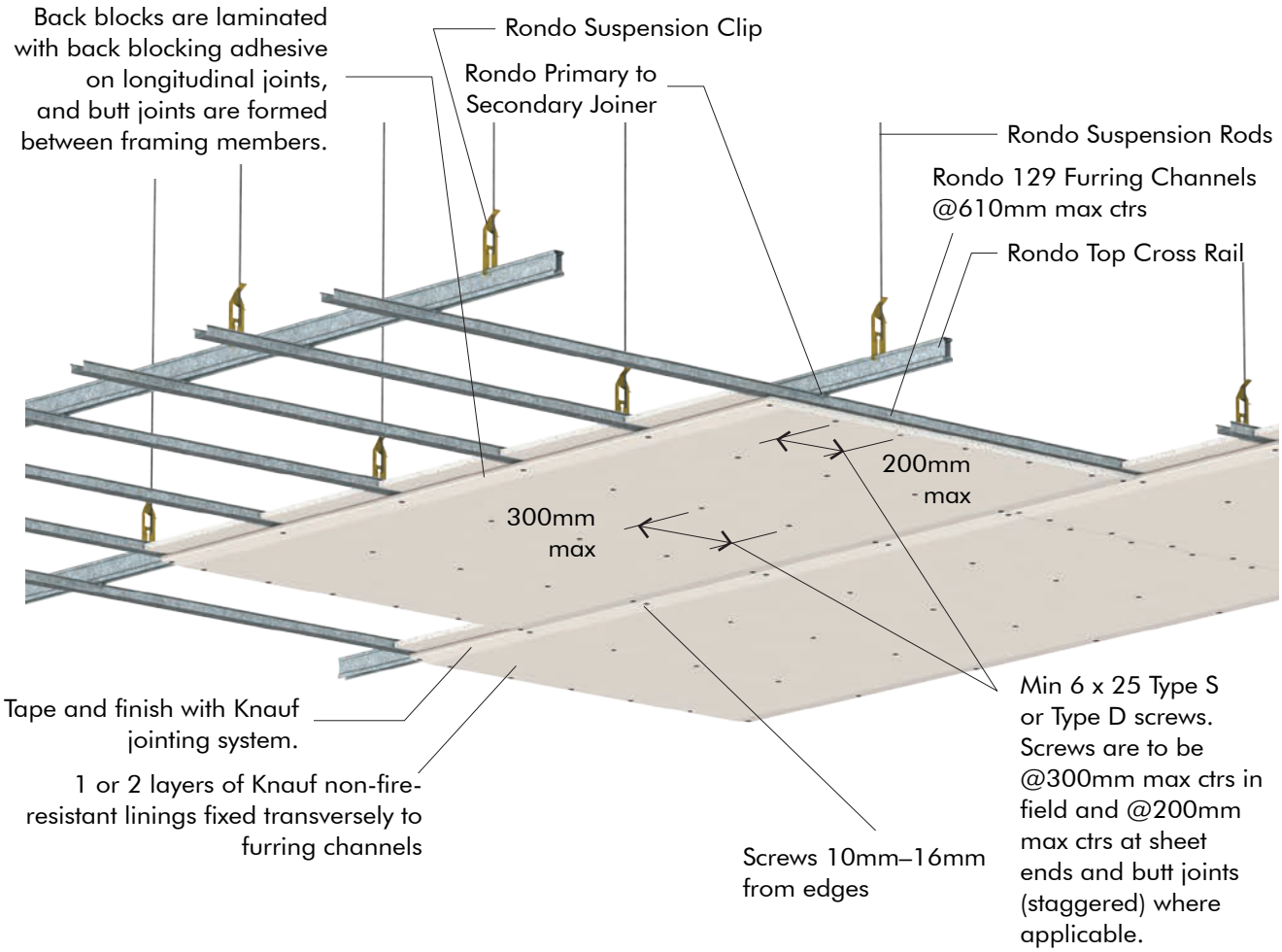


Figure D9: Non-Fire-Rated Ceiling - Screw Fixing Layout

Non-Fire-Rated Ceilings

- Apply plasterboard sheets with recessed edges at right angles to framing members.
- Single-layer non-fire-rated plasterboard ceiling systems can be fixed using a combination of adhesive and mechanical fasteners or mechanical fasteners only.
- Multi-layer non-fire-rated plasterboard ceiling systems must be fixed using mechanical fasteners-only method.
- In single-layer systems, butt joints can be between the framing members and back-blocked.
- All recessed joints in an area containing three or more joints must also be back-blocked.

Notes:

Knauf recommends back-blocking of all ceiling joints. See Page A26.

INTRODUCTION

ACOUSTIC CEILINGS

Description

Knauf Acoustic Ceilings are available in a range of sound absorption, and over partition ratings, and include:

- Echostop® plasterboard
- Cleaneo plasterboard

Design Options

Echostop® Plasterboard Ceilings

Echostop perforated plasterboard ceilings offer the combined benefits of a decorative finish and a high level of sound absorption.

Echostop perforated plasterboard is suitable for full ceiling installation, feature panels on walls, or ceilings.

Created for noise absorption treatment, Echostop is available in a number of stylish designs to suit multiple applications.

Refer to Echostop tables and datasheets for the acoustic performance of various Echostop panels.

Cleaneo Plasterboard Ceilings

Apertura Cleaneo is manufactured with high-quality ultrasharp perforations in a variety of continuous perforated patterns for a seamless finish. It meets the high level of acoustic performance required for commercial public areas such as offices, retail centers, schools, conference halls, and hospitality spaces.

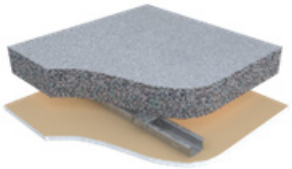
Apertura Cleaneo incorporates dehydrated zeolite, an aggregate mineral with a nanoporous structure, into its patented manufacturing process. Zeolite, together with gypsum, creates a large inner layer of surfaces within the board itself. This inner layer works to reduce both smells and airborne pollutants such as volatile organic compounds (VOCs) such as formaldehyde, benzene, and ammonia.

Figure D10: Echostop Ceiling

CEILING UNDER CONCRETE FLOOR

CC.1a

Fire Resistance Level (refer to slab FRL)



SYSTEM DESCRIPTION

Floor Covering: Refer to the table

Floor Structure: Concrete Slab

Insulation: 11kg/m³ Glasswool

Ceiling Lining: Refer to the table

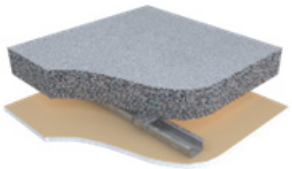
Ceiling Fixing: 28mm furring channels @ 406 mm ctrs + Rondo mounts (refer to the table for ceiling cavity)

ACOUSTIC RATINGS

System	Ceiling Lining	Flooring Type	Ceiling Cavity (mm)	Slab Thickness	150mm		200mm	
				Insulation	STC	IIC	STC	IIC
CC.1a	Any of the following: 1 x 9mm StandardShield 1 x 9mm MoistureShield	Carpet + Foam Underlay	50	nil	57	75	61	78
				50mm	61	76	65	79
			100	nil	58	76	62	79
				50mm	62	77	66	80
		Tiled Foor + min. 4.5mm Acosutic Underlay	100	nil	58	53	62	56
				50mm	62	56	66	59
		Tiled Floor + Flexible Adhesive	50	nil	57	41	61	44
				50mm	61	44	65	47
			100	nil	58	44	62	47
				50mm	62	47	66	50

CC.1b

Fire Resistance Level (refer to slab FRL)



SYSTEM DESCRIPTION

Floor Covering: Refer to the table

Floor Structure: Concrete Slab

Insulation: 11kg/m³ Glasswool

Ceiling Lining: Refer to the table

Ceiling Fixing: 28mm furring channels @ 610 mm ctrs + Rondo mounts (refer to the table for ceiling cavity)

ACOUSTIC RATINGS

System	Ceiling Lining	Flooring Type	Ceiling Cavity (mm)	Slab Thickness	150mm		200mm	
				Insulation	STC	IIC	STC	IIC
CC.1b	Any of the following: 1 x 10mm SpanShield 1 x 12mm StandardShield 1 x 13mm MoistureShield	Carpet + Foam Underlay	50	nil	58	76	62	79
				50mm	62	77	66	80
			100	nil	59	77	63	80
				50mm	63	78	67	81
		Tiled Foor + min. 4.5mm Acosutic Underlay	100	nil	59	54	63	57
				50mm	63	57	67	60
		Tiled Floor + Flexible Adhesive	50	nil	58	42	62	45
				50mm	62	45	66	48
			100	nil	59	45	63	48
				50mm	63	48	67	51

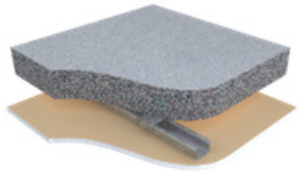
Notes:

- Concrete slab density used is 2300 kg/m³.

CEILING UNDER CONCRETE FLOOR

CC.1c

Fire Resistance Level (refer to slab FRL)



SYSTEM DESCRIPTION

Floor Covering: Refer to the table

Floor Structure: Concrete Slab

Insulation: 11kg/m³ Glasswool

Ceiling Lining: Refer to the table

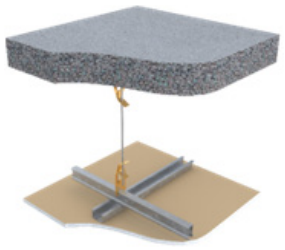
Ceiling Fixing: 28mm furring channels @ 610 mm ctrs + Rondo mounts (refer to the table for ceiling cavity)

ACOUSTIC RATINGS

System	Ceiling Lining	Flooring Type	Ceiling Cavity (mm)	Slab Thickness / Insulation	150mm STC	150mm IIC	200mm STC	200mm IIC
CC.1c	1 x 13mm MultiShield	Carpet + Foam Underlay	50	nil	59	77	63	80
				50mm	63	78	67	81
			100	nil	60	78	64	81
				50mm	64	79	68	82
		Tiled Foor + min. 4.5mm Acoustic Underlay	100	nil	60	55	64	58
				50mm	64	58	68	61
		Tiled Floor + Flexible Adhesive	50	nil	59	43	63	46
				50mm	63	46	67	49
			100	nil	60	46	64	49
				50mm	64	49	68	52

CC.2a

Fire Resistance Level (refer to slab FRL)



SYSTEM DESCRIPTION

Floor Covering: Refer to the table

Floor Structure: Concrete Slab

Insulation: 11kg/m³ Glasswool

Ceiling Lining: Refer to the table

Ceiling Fixing: 28mm furring channels @ 406 mm ctrs + Rondo Keylock (refer to the table for ceiling cavity)

ACOUSTIC RATINGS

System	Ceiling Lining	Flooring Type	Ceiling Cavity (mm)	Slab Thickness / Insulation	150mm STC	150mm IIC	200mm STC	200mm IIC
CC.2a	Any of the following: 1 x 9mm StandardShield 1 x 9mm MoistureShield	Carpet + Foam Underlay	200	nil	58	76	62	79
				50mm	62	77	66	80
			300	nil	59	77	63	80
				50mm	63	78	67	81
		Tiled Floor + Flexible Adhesive	200	nil	58	46	62	49
				50mm	62	49	66	52
			300	nil	59	48	63	51
				50mm	63	51	67	54

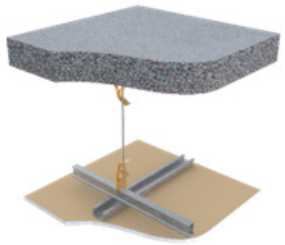
Note:

- Concrete slab density used is 2300 kg/m³.

CEILING UNDER CONCRETE FLOOR

CC.2b

Fire Resistance Level (refer to slab FRL)



SYSTEM DESCRIPTION

Floor Covering: Refer to the table

Floor Structure: Concrete Slab

Insulation: 11kg/m³ Glasswool

Ceiling Lining: Refer to the table

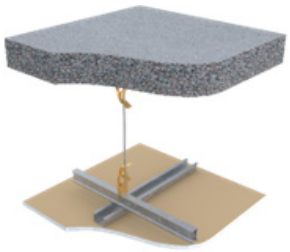
Ceiling Fixing: 28mm furring channels @ 610 mm ctrs + Rondo Keylock (refer to the table for ceiling cavity)

ACOUSTIC RATINGS

System	Ceiling Lining	Flooring Type	Ceiling Cavity (mm)	Slab Thickness / Insulation	150mm STC	150mm IIC	200mm STC	200mm IIC
CC.2b	Any of the following: 1x 10mm SpanShield; 1 x 12mm StandardShield; 1 x 13mm MoistureShield	Carpet + Foam Underlay	200	nil	59	77	63	80
				50mm	63	78	67	81
			300	nil	60	78	64	81
				50mm	64	79	68	82
		Tiled Floor + Flexible Adhesive	200	nil	59	47	63	50
				50mm	63	50	67	53
			300	nil	60	49	64	52
				50mm	64	52	68	55

CC.2c

Fire Resistance Level (refer to slab FRL)



SYSTEM DESCRIPTION

Floor Covering: Refer to the table

Floor Structure: Concrete Slab

Insulation: 11kg/m³ Glasswool

Ceiling Lining: Refer to the table

Ceiling Fixing: 28mm furring channels @ 610 mm ctrs + Rondo Keylock (refer to the table for ceiling cavity)

ACOUSTIC RATINGS

System	Ceiling Lining	Flooring Type	Ceiling Cavity (mm)	Slab Thickness / Insulation	150mm STC	150mm IIC	200mm STC	200mm IIC
CC.2c	1 x 13mm MultiShield	Carpet + Foam Underlay	200	nil	60	78	64	81
				50mm	64	79	68	82
			300	nil	61	79	65	82
				50mm	65	80	69	83
		Tiled Floor + Flexible Adhesive	200	nil	60	48	64	51
				50mm	64	51	68	54
			300	nil	61	50	65	53
				50mm	65	53	69	56

Note:

- Concrete slab density used is 2300 kg/m³.

SECTION E

CEILINGS | 07/23

JUNCTIONS & PENETRATIONS

INTRODUCTION

Description

This section contains the most common junctions and penetrations details in conventional plasterboard systems on fire-rated and non-fire-rated steel stud walls.

See www.knauf.com/en-PH/ for details not covered in this manual.

Description

The following types of details can be found in this section:

Wall Junctions

- X, T, and L intersections
- Base and head details
- Movement/control joints
- Typical door details

Wall Penetrations

- uPVC pipe penetration
- Copper/steel pipe penetration
- Typical plumbing penetration
- GPO details
- Cable penetrations
- HVAC penetrations
- Access panel

Ceiling Junctions

- Back-blocking
- Perimeter details
- Bulkhead
- Movement/control joints
- Recessed lights
- Beam protection

Ceiling Penetrations

- Electrical penetrations
- Loaded penetration
- uPVC pipe penetration
- Copper pipe penetration
- Sprinkler pipe penetration.

Materials

Refer to General Information and other relevant system sections of this manual for more information on the following materials utilised in Knauf systems:

- Linings
- Metal components
- Insulation
- Fasteners
- Jointing tapes
- Jointing compounds
- Sealants

Refer to junctions and penetrations details for materials used in specific details.

Design Considerations

Refer to the General Information section for general design considerations and design notes on:

- Structural
- Fire
- Acoustics
- Wet Area
- Thermal Insulation
- Appearance

Refer to the Steel Stud Walls section for:

- System configurations required to achieve specified fire and acoustic ratings
- Maximum wall heights for various system configurations and stud sizes
- Head track requirements to satisfy design vertical deflection and head reaction
- Load bearing walls
- Movement/control joint requirements

Refer to the Ceilings section for:

- System configurations required to achieve specified fire and acoustic ratings
- Plasterboard spans
- Furring channel spans
- Acoustic mount spacing

Installation

Refer to General Information and the relevant sections in this manual for:

- General construction notes
- Plasterboard fixing instructions
- Frame installation instructions
- Perimeter caulking
- Movement/control joint locations
- Jointing and finishing

Refer to various junctions and penetrations details for detail-specific installation instructions.

Penetrations

Penetrations in a fire-rated system must be treated strictly in accordance with relevant test reports and approved installation details in order to maintain the system's fire resistance level.

Where components by others are specified in Knauf fire-rated penetration details (i.e.,. dampers, GPOs, fire collars, etc.), such components must be installed in accordance with the manufacturer's specifications. It is the responsibility of the component manufacturer to ensure that the fire rating performance of the system is not affected.

FIRE-RATED STEEL STUD WALLS

TERMINALS AND JUNCTIONS

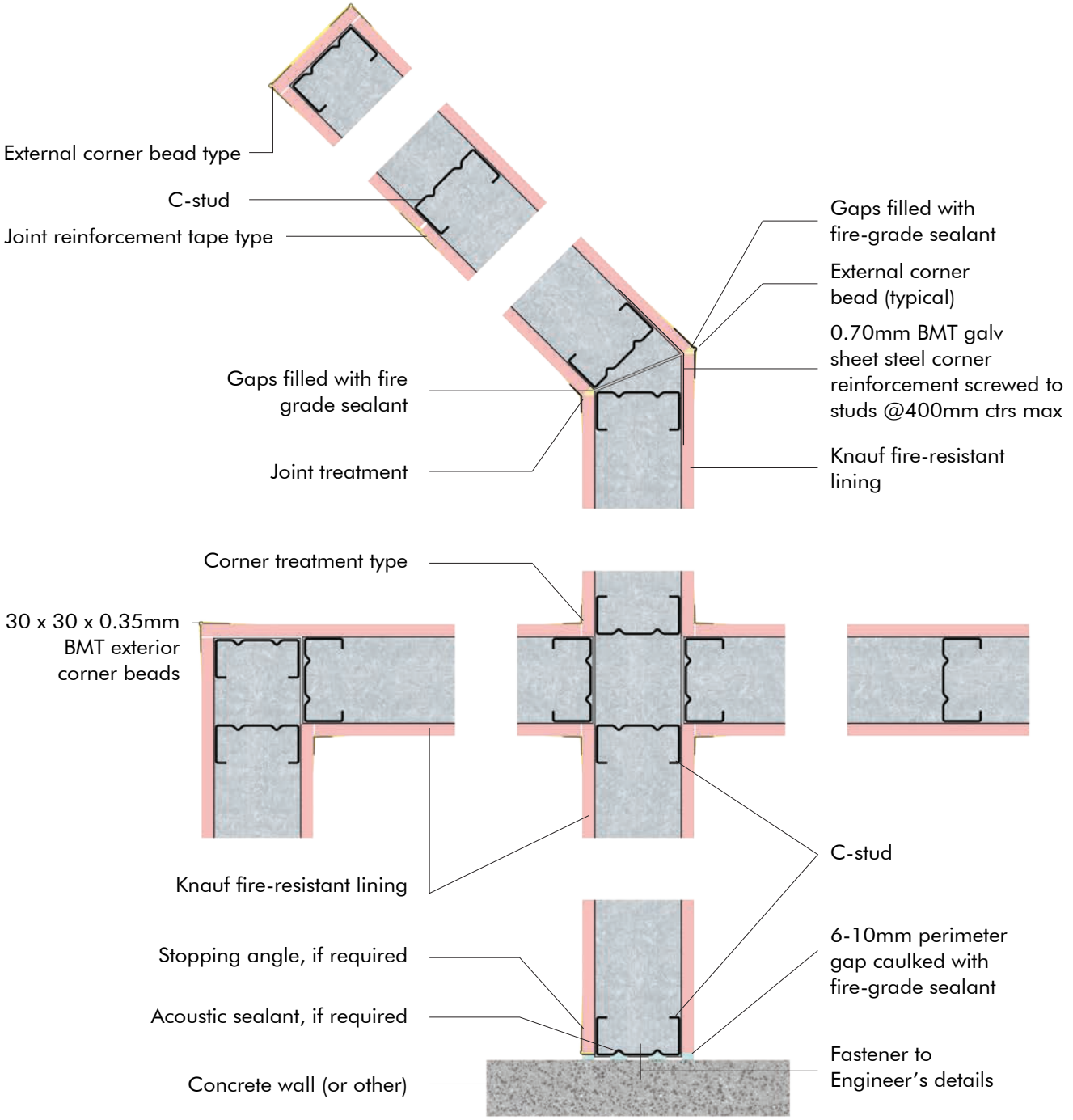


Figure E1: Single Stud Terminal and Junction Details (Twin stud, staggered stud layout similar)

Notes:

- Control joints must coincide with those occurring in the main building structure and/or at maximum 12-meter centers.
- The location of control joints should be verified with the Structural Engineer.

FIRE-RATED STEEL STUD WALLS

TERMINALS AND JUNCTIONS

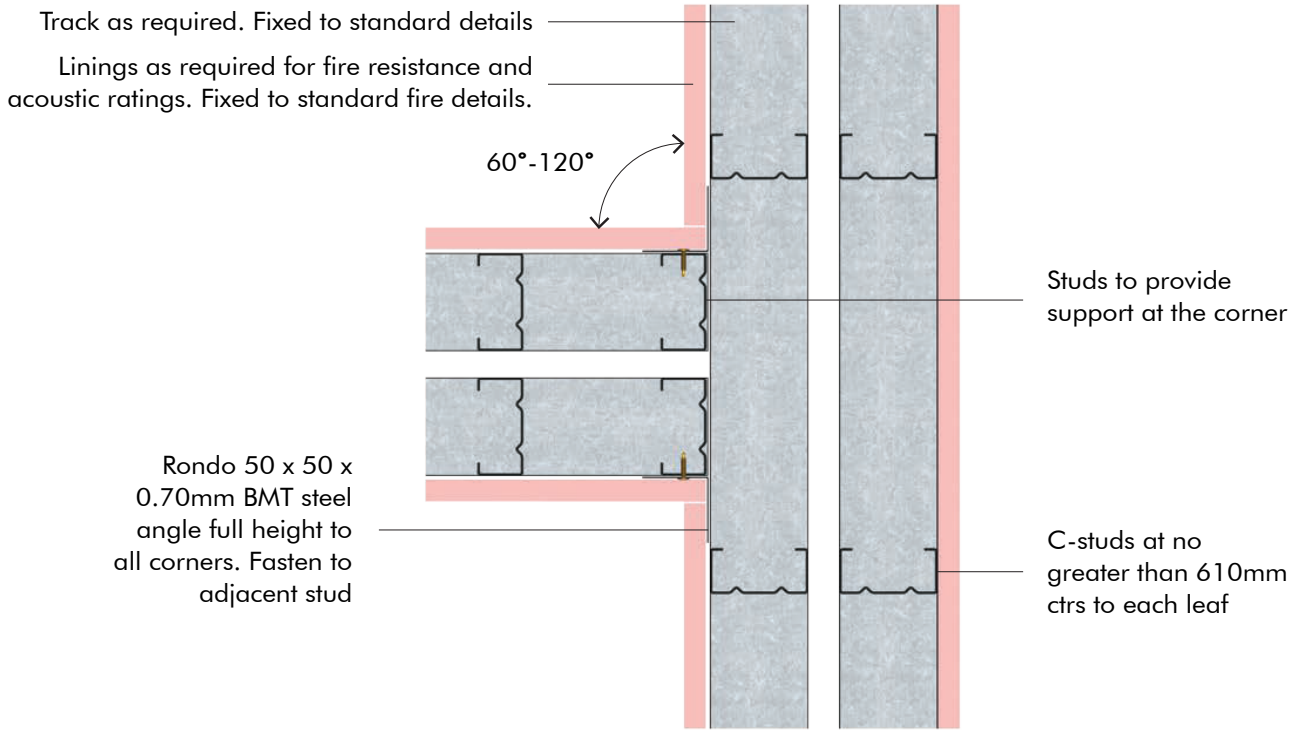


Figure E2a: Twin Steel Stud T-Junction Detail

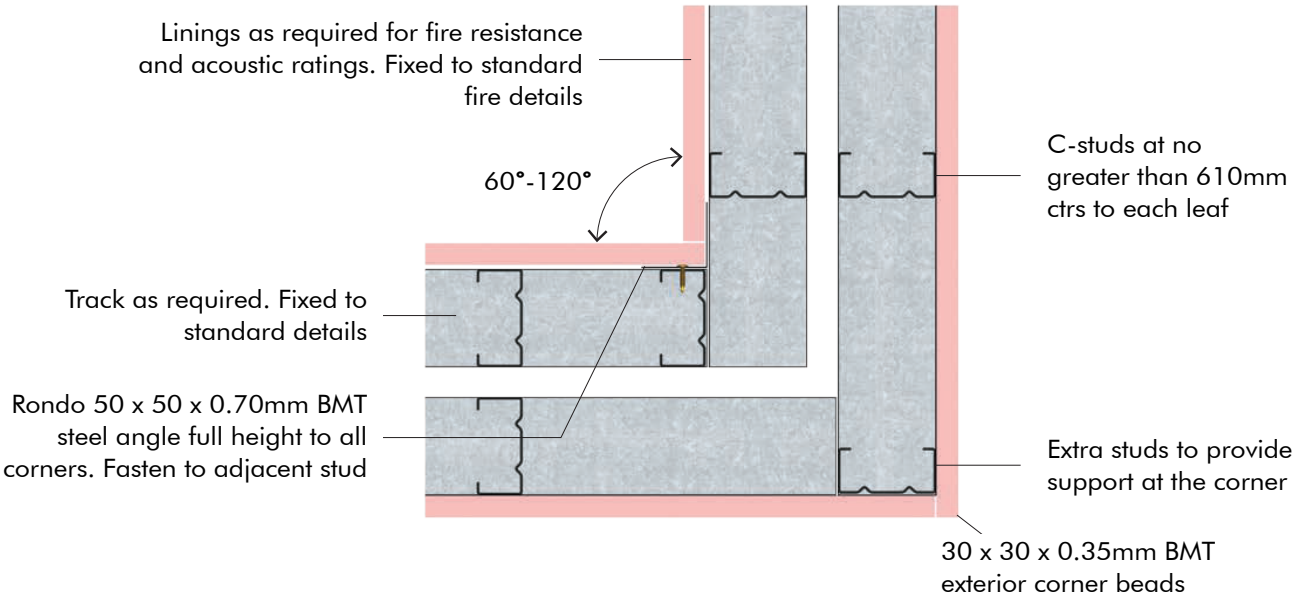


Figure E2b: Twin Steel Stud Corner Detail

FIRE-RATED STEEL STUD WALLS

BASE DETAILS

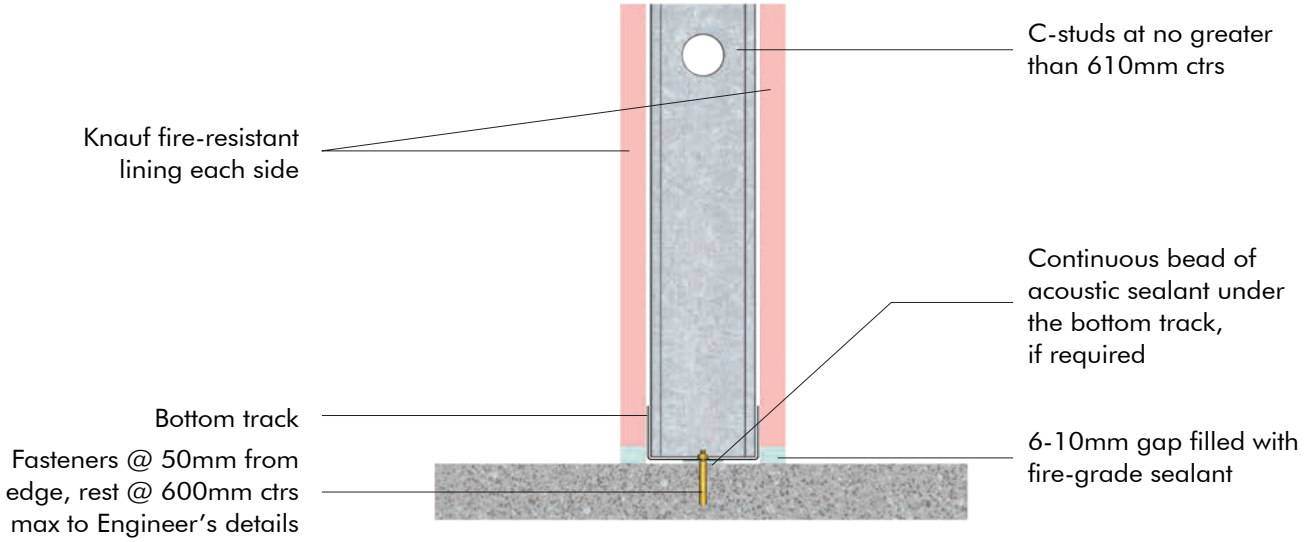


Figure E3: Partition Base Detail

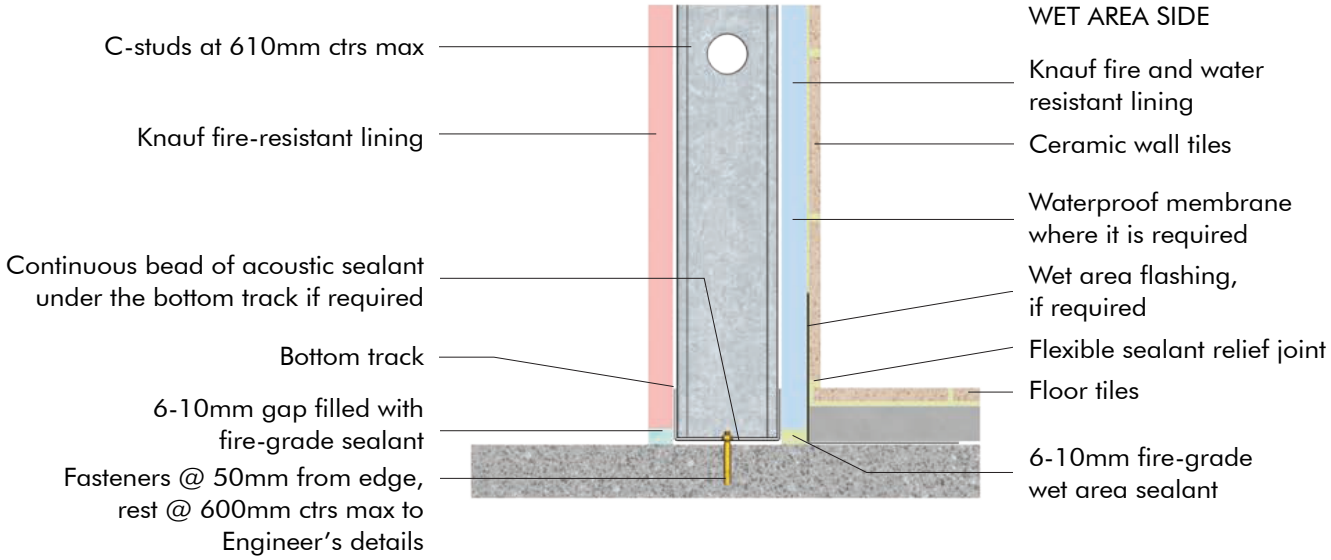


Figure E4: Partition Wet Area Base Detail

FIRE-RATED STEEL STUD WALLS

HEAD DETAILS

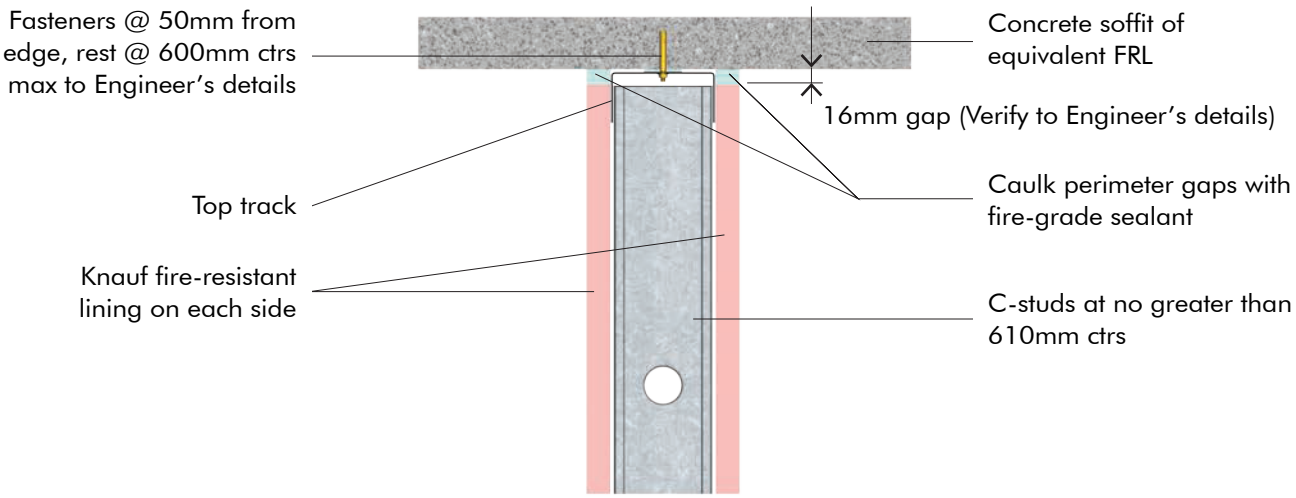


Figure E5: Partition Head Detail

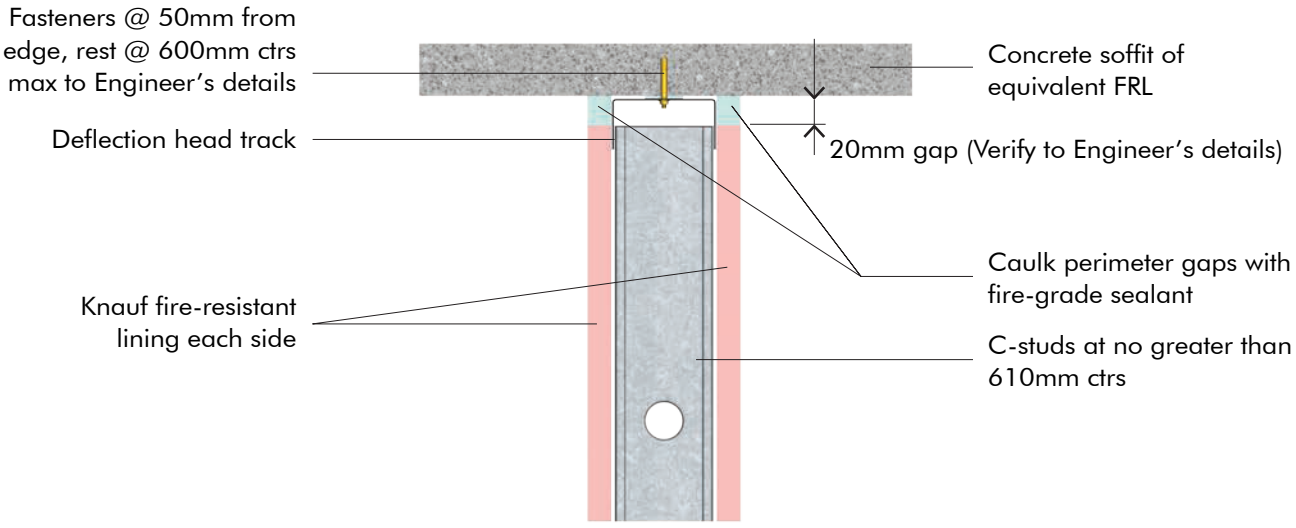


Figure E6: Deflection Head Detail

FIRE-RATED STEEL STUD WALLS

HEAD DETAILS

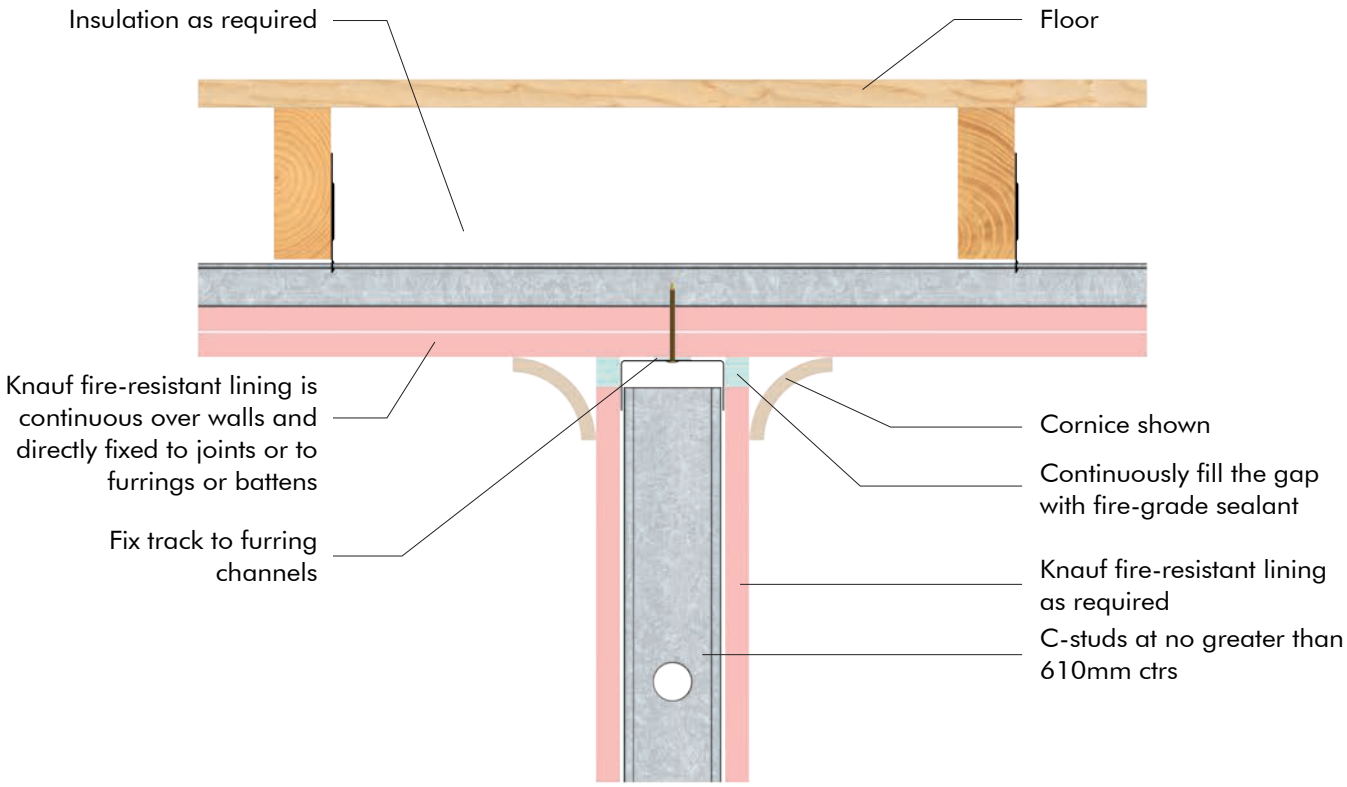


Figure E7: Fire-Rated Wall to Fire-Rated Ceiling Detail

FIRE-RATED STEEL STUD WALLS

CONTROL / MOVEMENT JOINTS

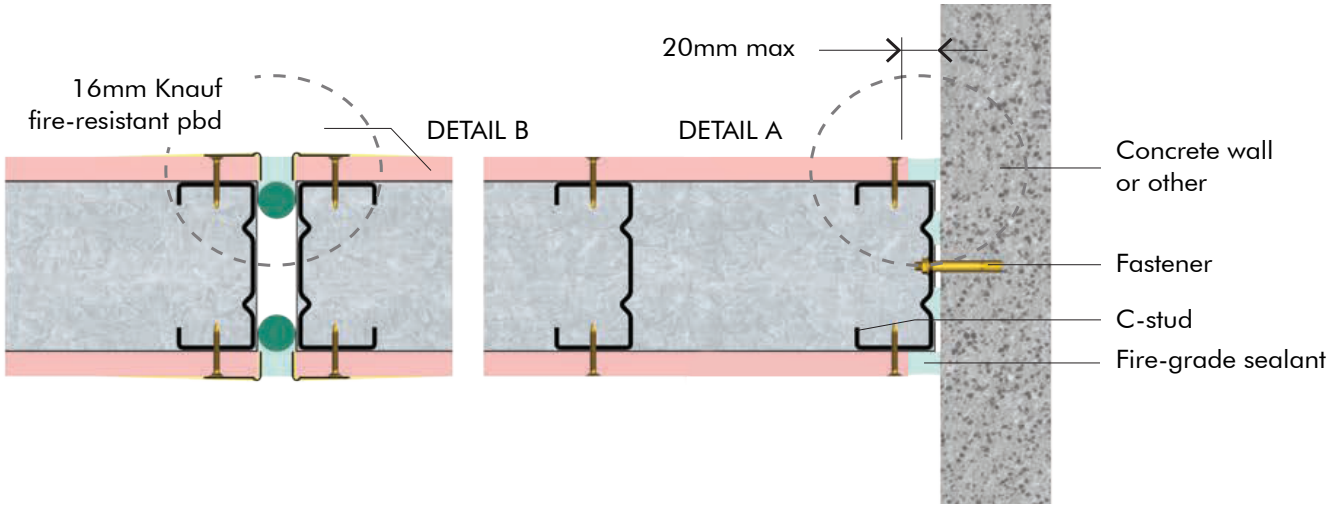


Figure E8: Control Joint Details FRL 60 (also available in other FRLs)

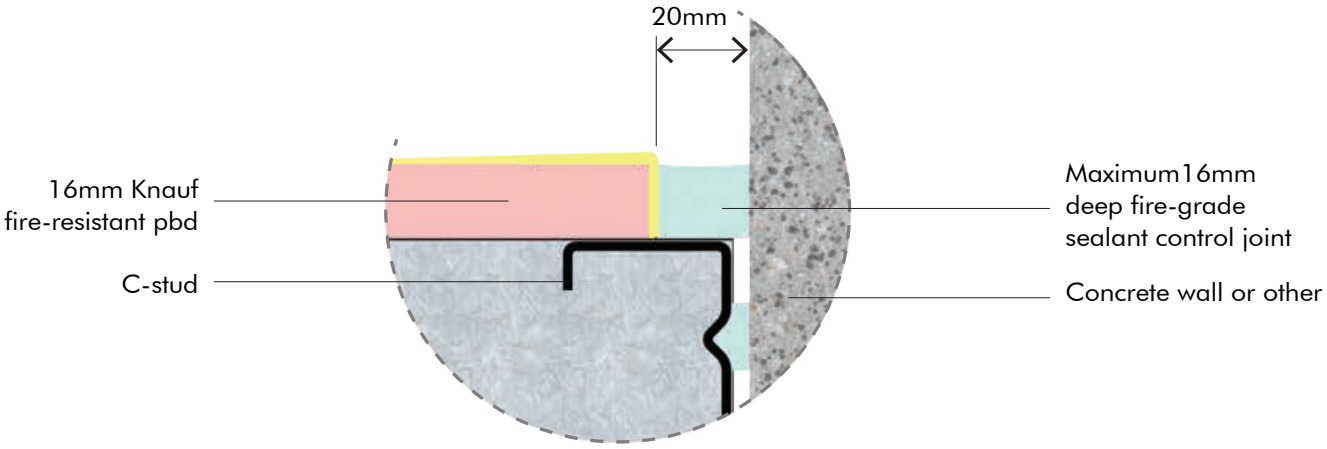


Figure E9: Detail A

FIRE-RATED STEEL STUD WALLS

CONTROL / MOVEMENT JOINTS

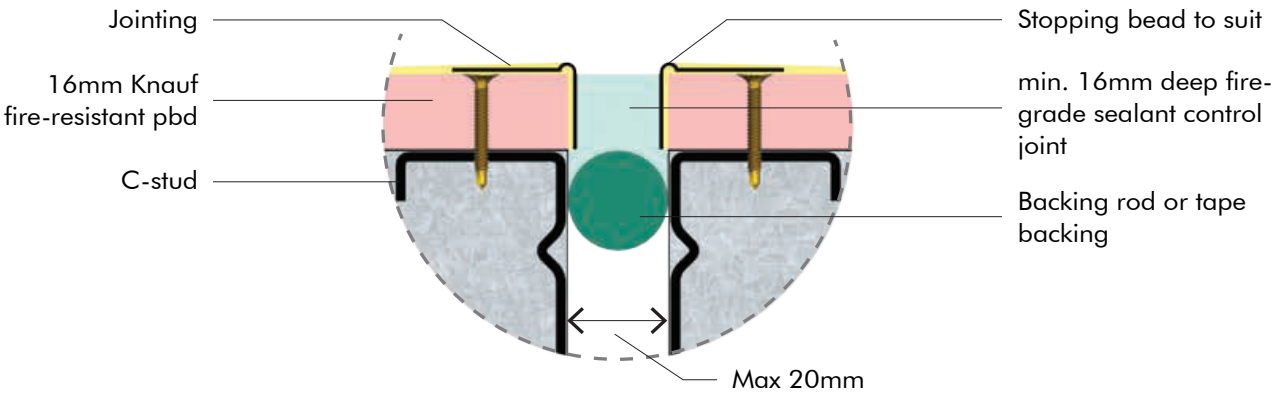


Figure E10: Detail B

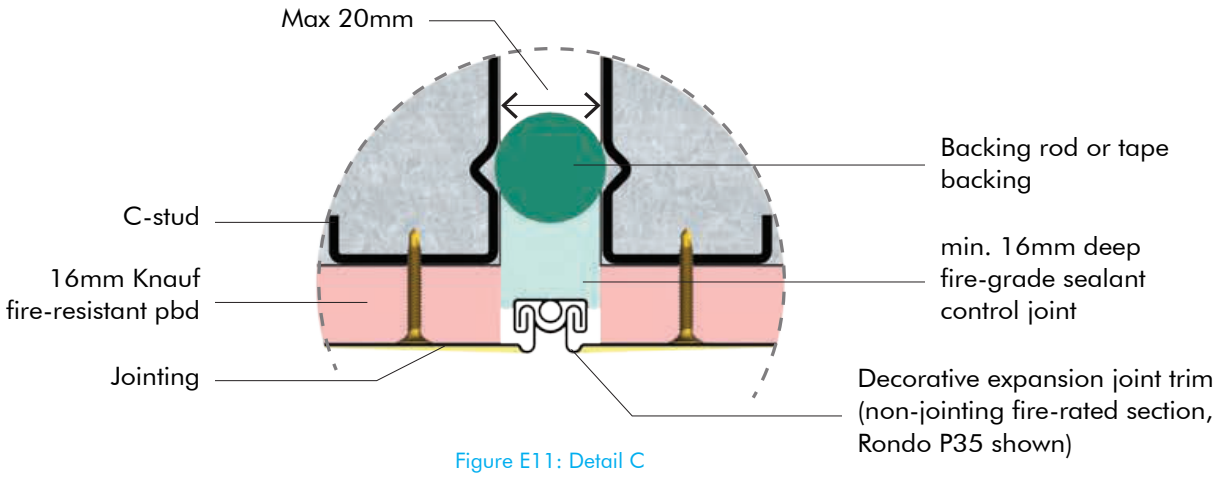


Figure E11: Detail C

FIRE-RATED STEEL STUD WALLS

DOOR DETAILS

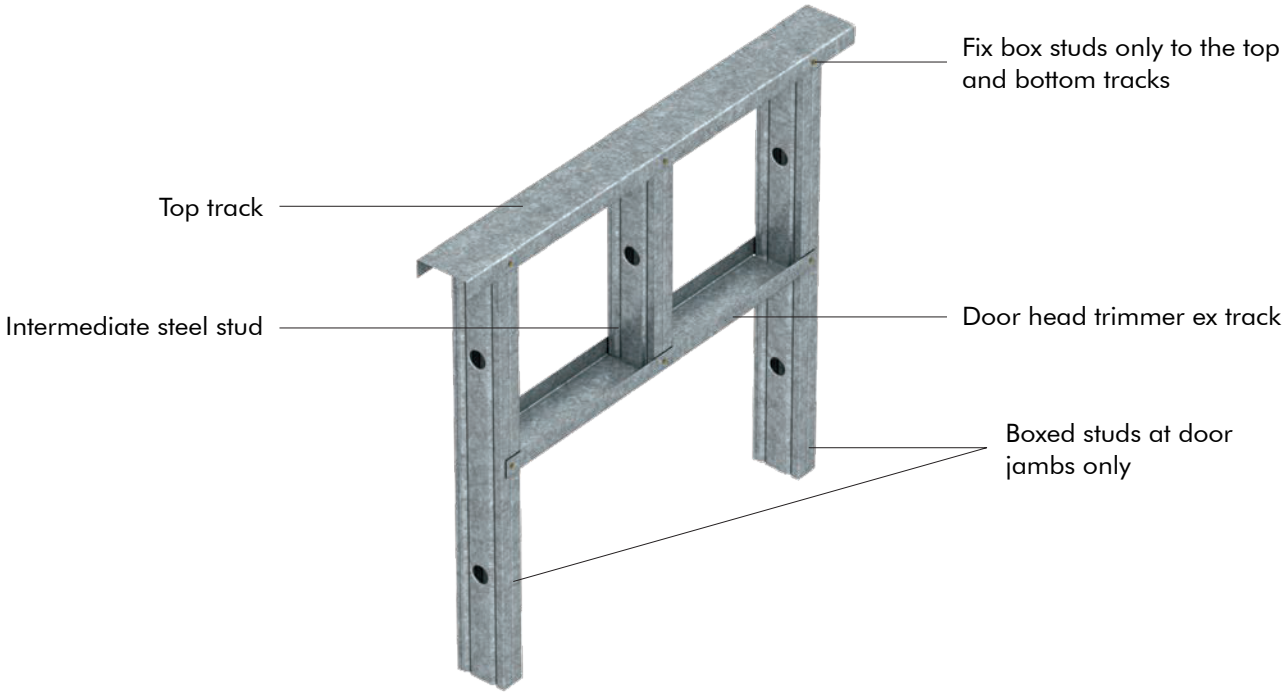


Figure E12: Door Head Trimmer Detail

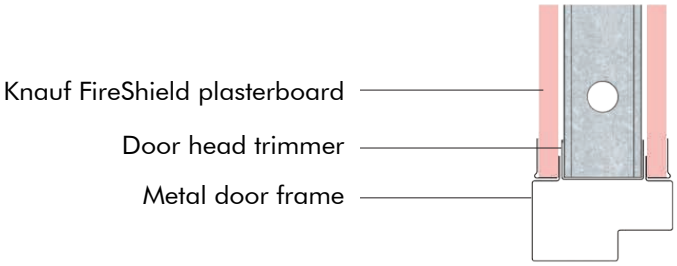


Figure E13: Door Head Detail

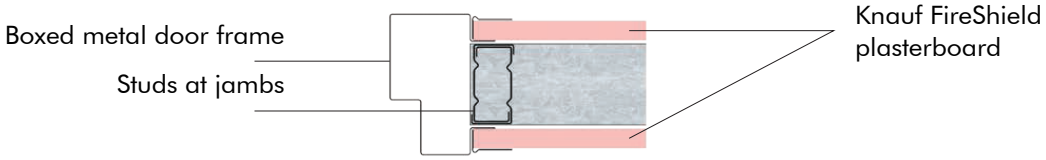


Figure E14: Door Jamb Detail

Notes:

- Jamb studs may consist of double CS studs or boxed CS studs. This may be determined by structural requirements or the fixing details recommended by the door frame manufacturer.
- The above details are typical only. Refer to the fire door manufacturer for full details and installation specifications.

FIRE-RATED STEEL STUD WALLS

PLUMBING PENETRATIONS

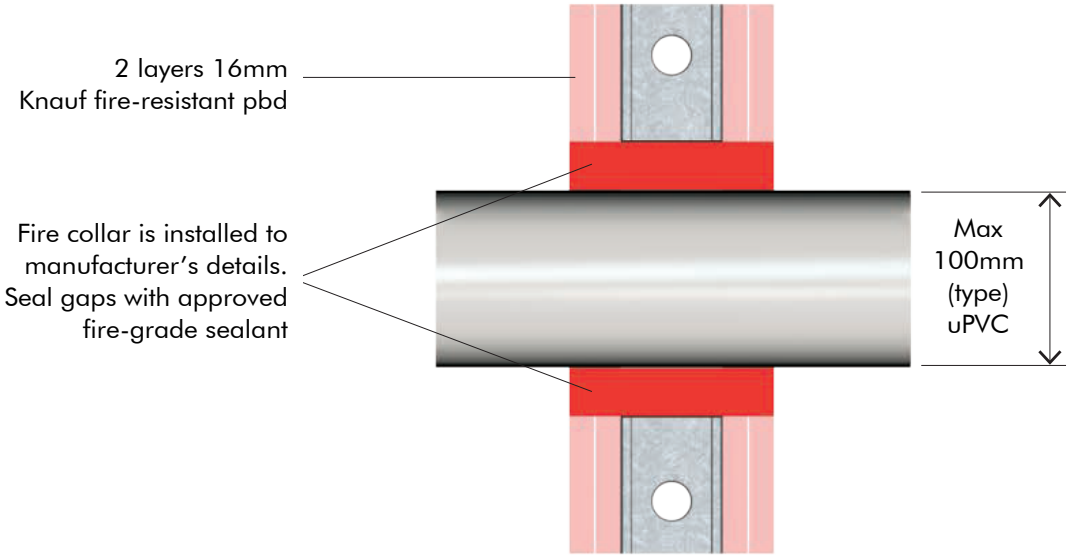


Figure E15: Penetration Detail – uPVC Pipe – Single Stud – Refer to Collar Manufacturer

FIRE-RATED STEEL STUD WALLS

PLUMBING PENETRATIONS

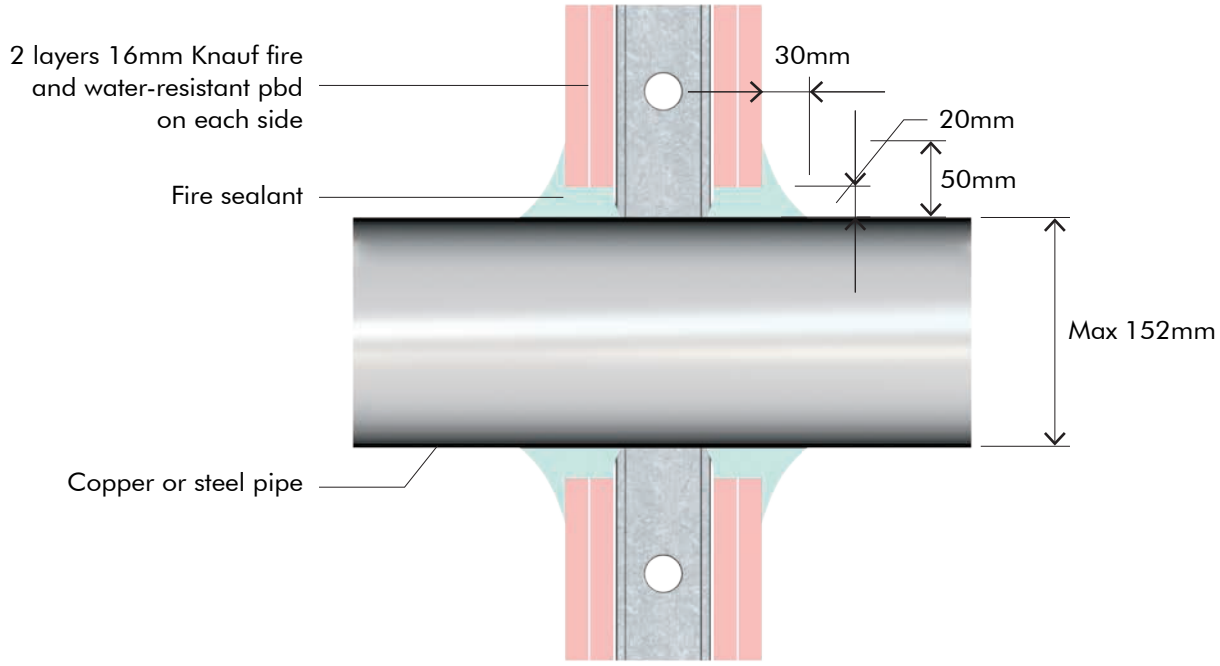


Figure E16: Penetration Detail – Copper/Steel Pipe – Single Stud FRL 120

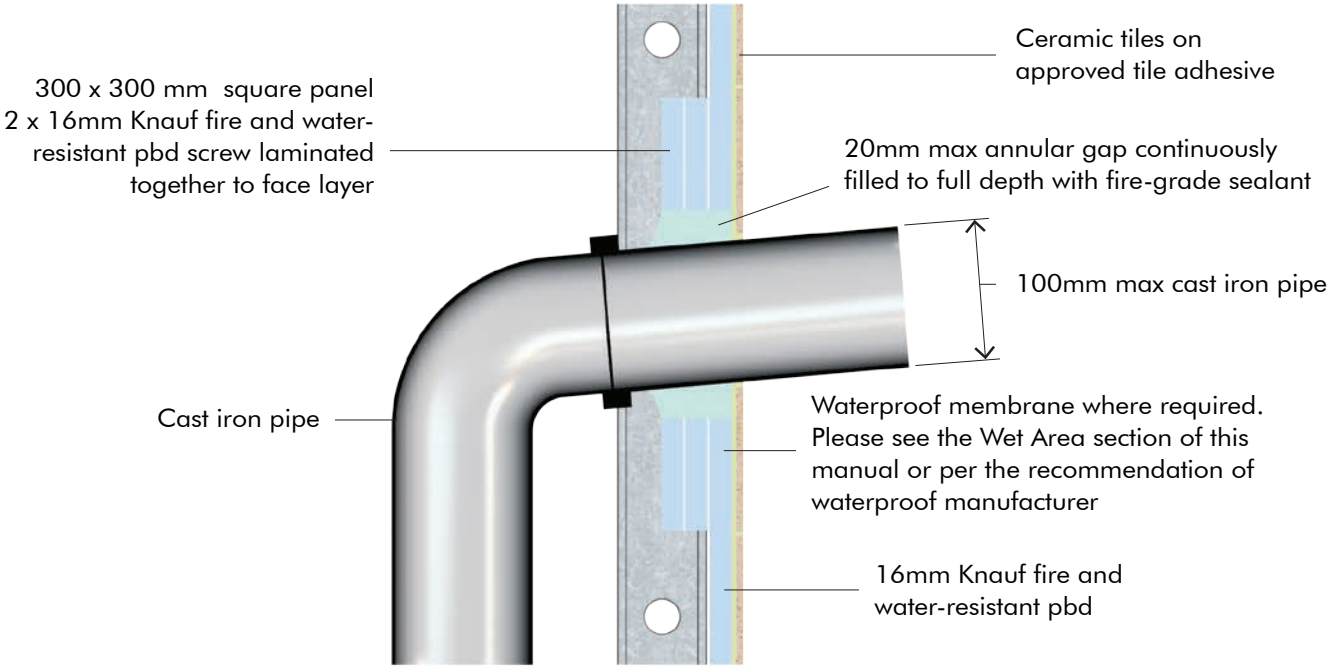


Figure E17: Penetration Detail – Cast Iron Pipe

FIRE-RATED STEEL STUD WALLS

PLUMBING PENETRATIONS

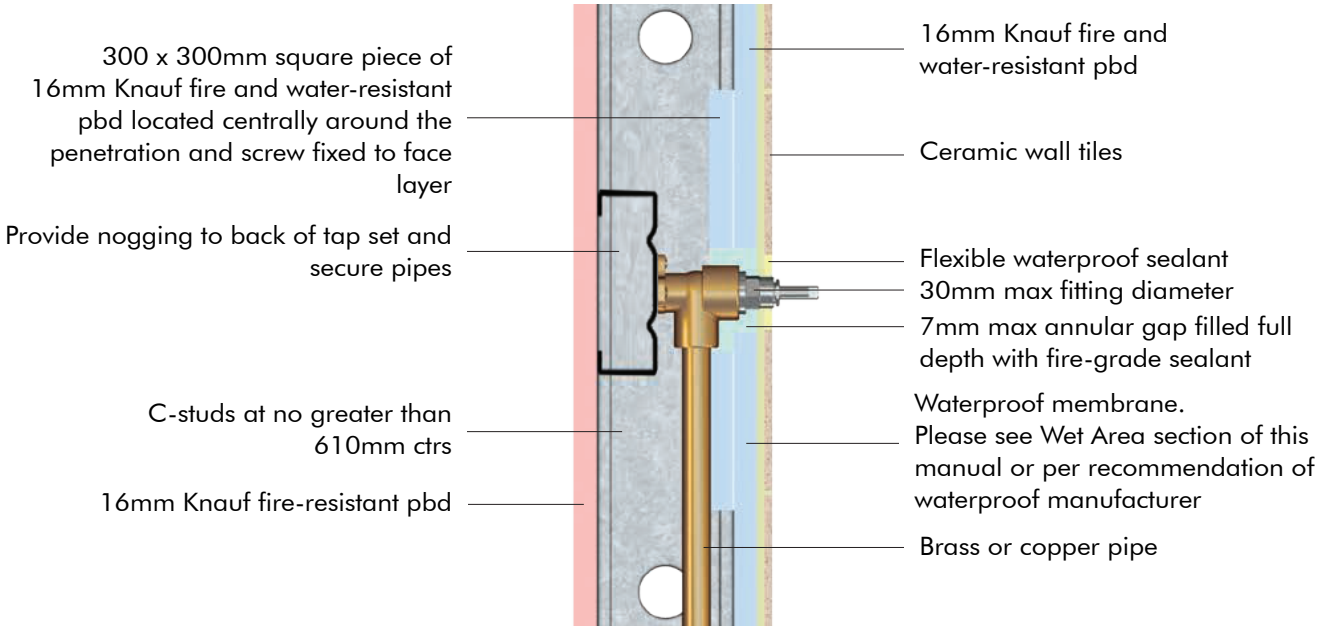


Figure E18: Typical Plumbing Penetration Detail – Section – FRL 60

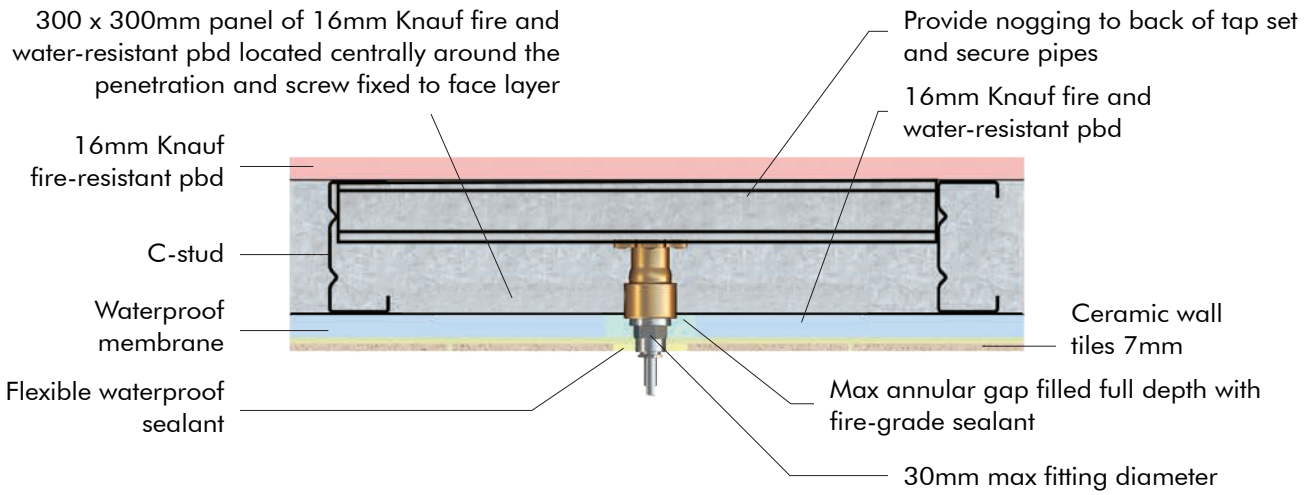


Figure E19: Typical Plumbing Penetration Detail – Plan - FRL 60

Notes:
The following instructions must be followed to achieve satisfactory results:

- Care should be taken to isolate copper pipes from contact with steel framing to avoid problems with corrosion.
- Plasterboard linings are not to act as supports for piping.
- Piping is to be kept clear of face sheets and baffles.
- Ensure that baffles protect the areas immediately behind wall penetrations.
- Pipes are to penetrate one face only of the partition between any two wall studs.
- The total area of all openings between any two wall studs must be no greater than 5000mm^{2}..

FIRE-RATED STEEL STUD WALLS

ELECTRICAL PENETRATIONS

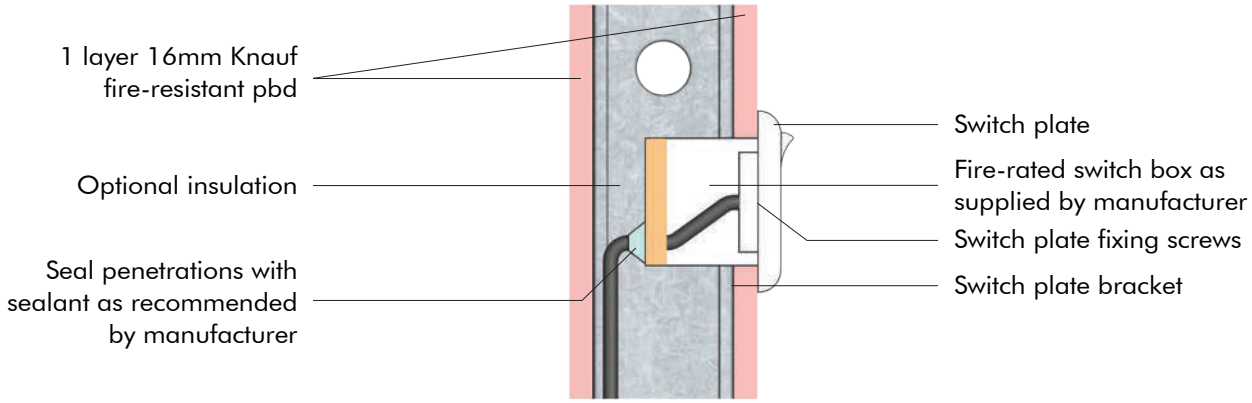


Figure E20: Fire-Rated GPO Detail Only – Partition FRL 60

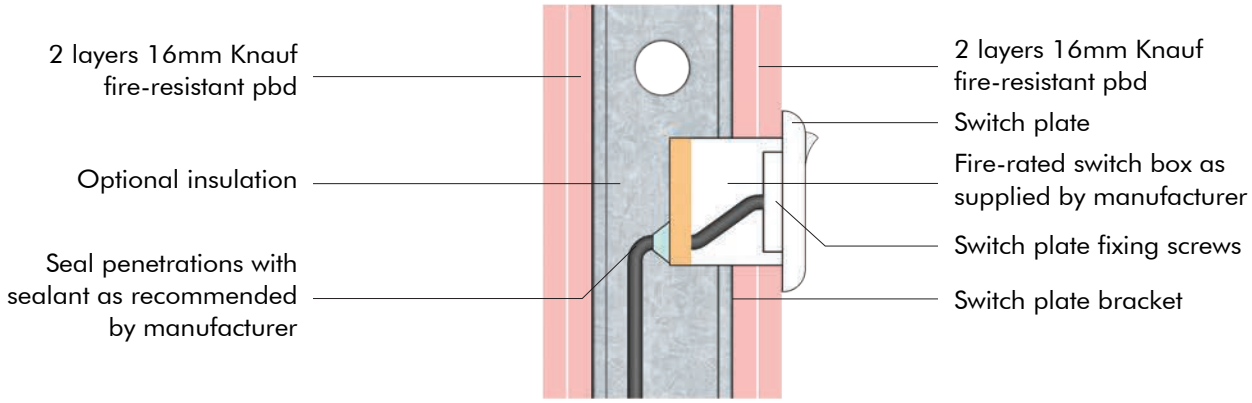


Figure E21: Fire-Rated GPO Detail Only – Partition FRL 120

FIRE-RATED STEEL STUD WALLS

ELECTRICAL PENETRATIONS

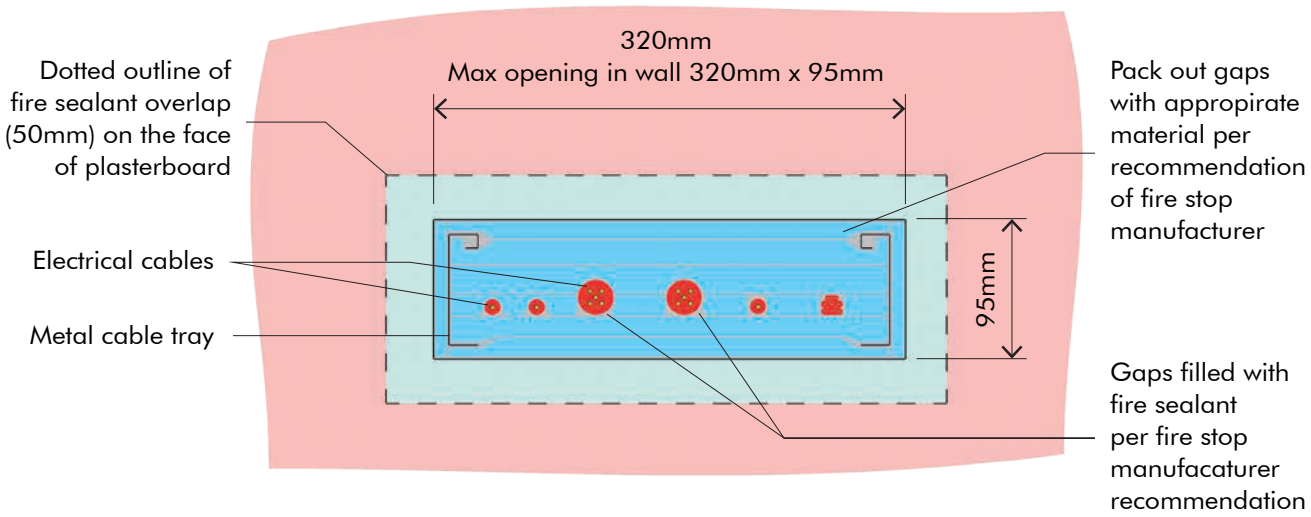


Figure E22: Penetration Detail – Cable Tray – Section Through Tray (Refer to firestop manufacturer for full details and report)

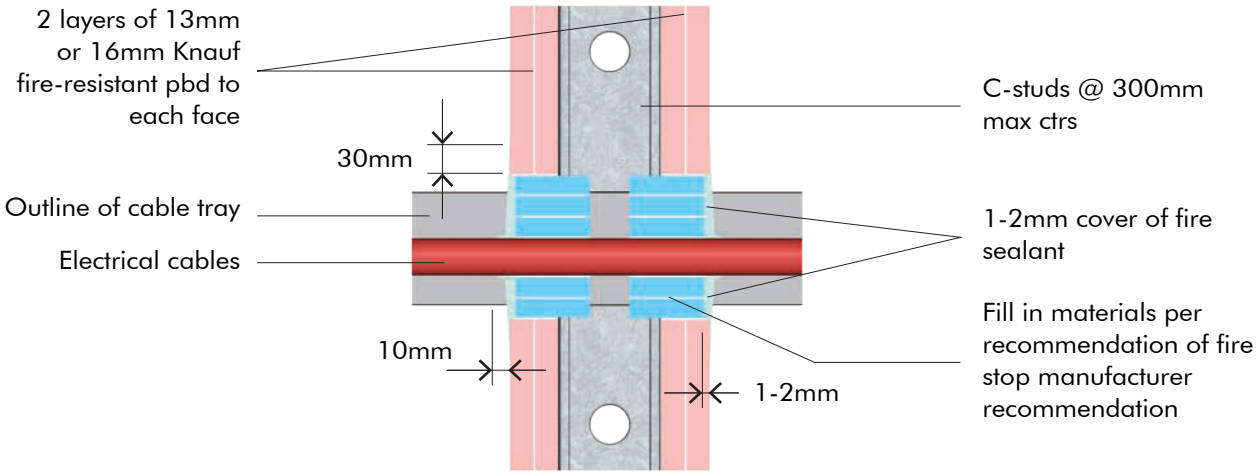


Figure E23: Penetration Detail – Cable Tray – Section Through Wall (Refer to Promat for full details and report)

Notes:

For larger openings, refer to the penetration manufacturer for details and certification.

FIRE-RATED STEEL STUD WALLS

HVAC PENETRATIONS

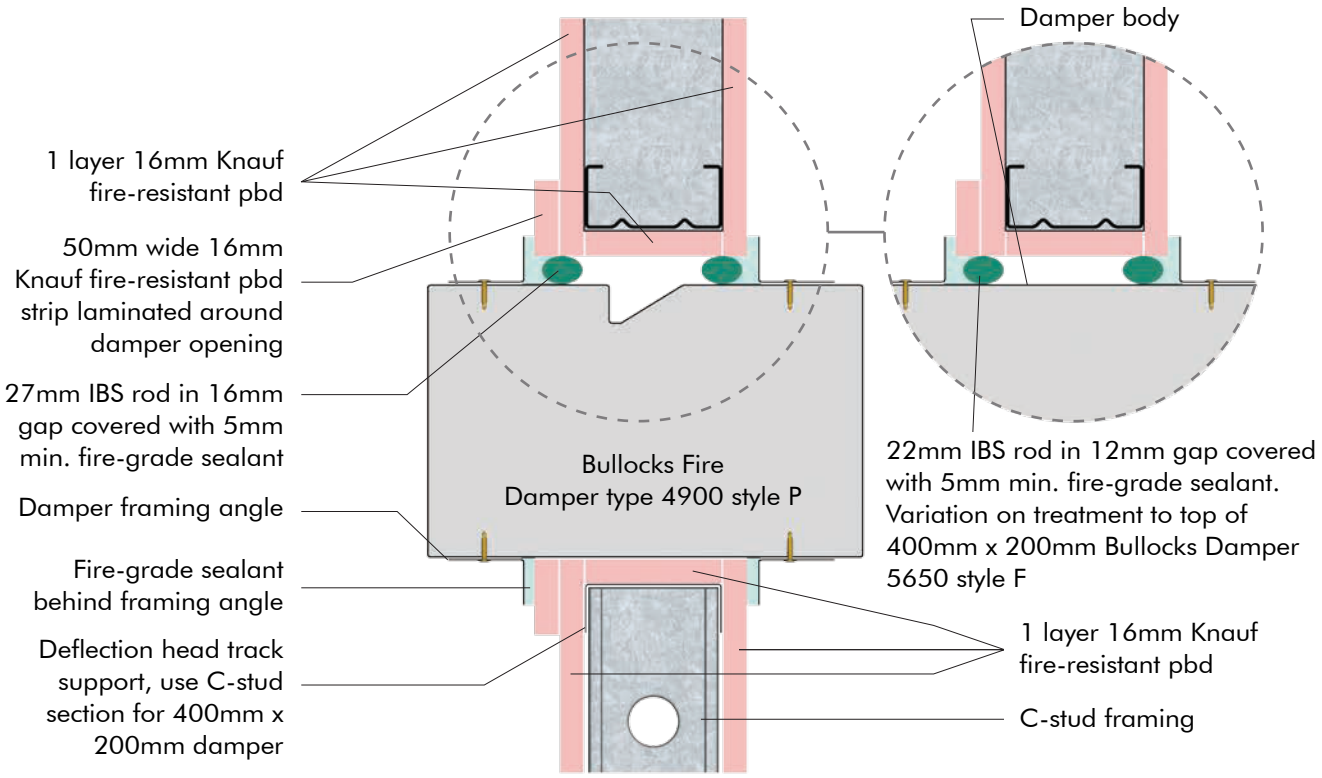


Figure E24: Typical Fire Damper Detail – FRL 60 Steel Stud Wall

FIRE-RATED STEEL STUD WALLS

HVAC PENETRATIONS

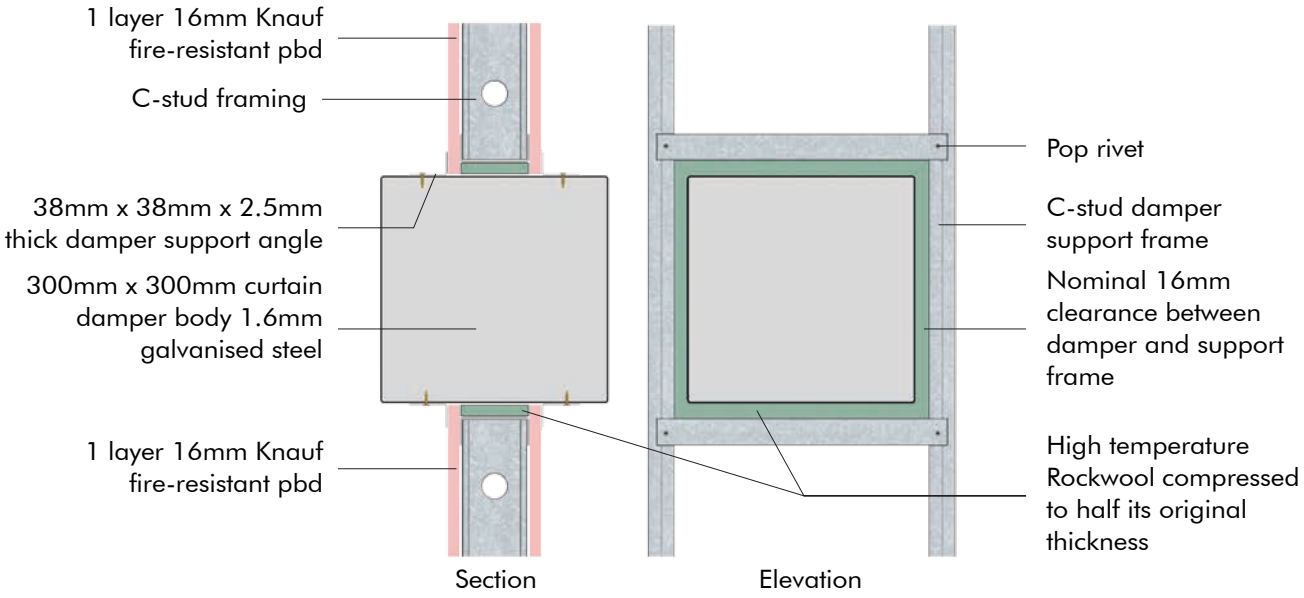


Figure E25: Typical Fire Damper Detail – FRL 60 Steel Stud

Notes:

- Damper penetration details on pages E17 and E19 are specific to the type or model of dampers shown. For other damper types/ models, refer to the damper manufacturer for penetration details to ensure the fire rating of the wall is maintained.
- Consult with mechanical and structural engineers for details on methods of supporting dampers at walls, especially if the damper opening exceeds 600mm x 900mm.
- Refer to the fire damper manufacturer for alternative or additional fixing details.

FIRE-RATED STEEL STUD WALLS

HVAC PENETRATIONS

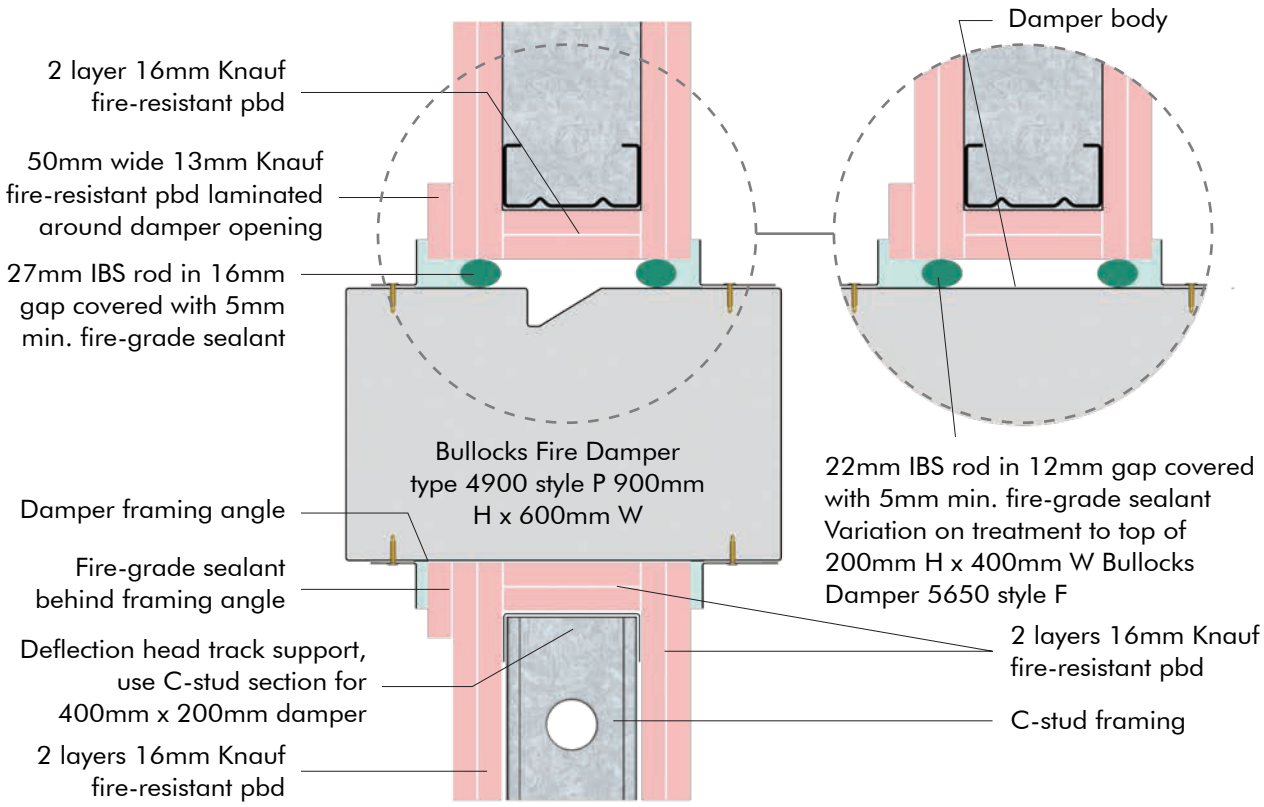


Figure E26: Typical Fire Damper Detail – FRL 120 Steel Stud Wall

NON-FIRE-RATED STEEL STUD WALLS

PLUMBING PENETRATIONS

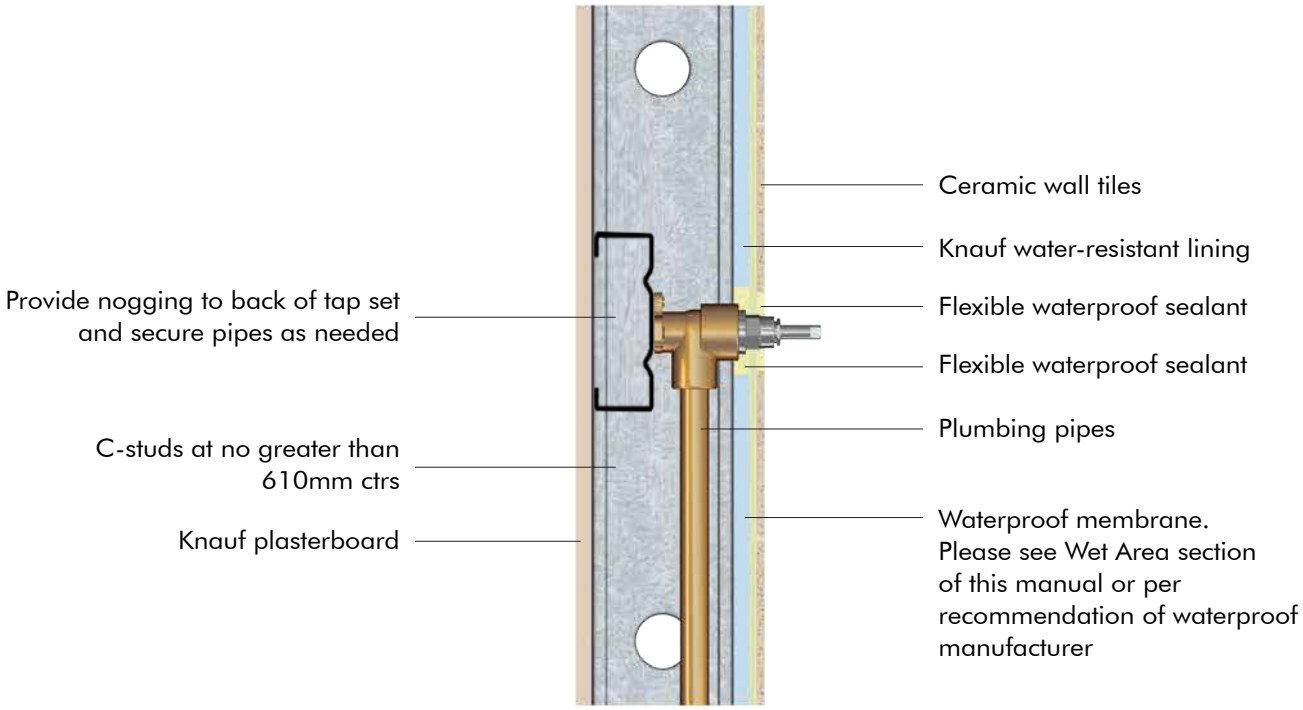


Figure E27: Typical Plumbing Penetration Detail – Section

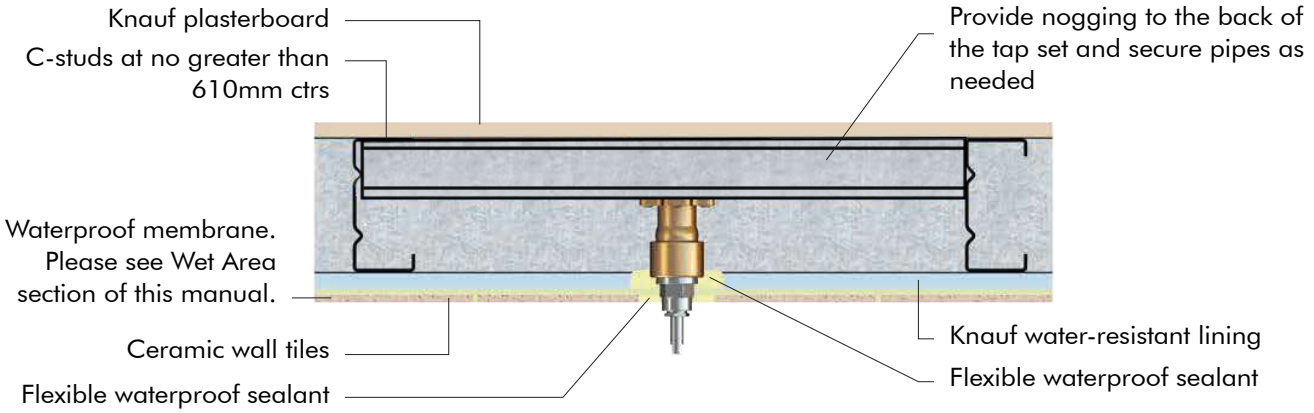


Figure E28: Typical Plumbing Penetration Detail - Plan

Notes:
The following instructions must be followed to achieve satisfactory results:

- Care should be taken to isolate copper pipes away from contact with steel framing to avoid problems with corrosion.
- Linings are not to act as supports for piping.
- Piping is to be kept clear of face sheets.

NON-FIRE-RATED STEEL STUD WALLS

BACK-BLOCKING

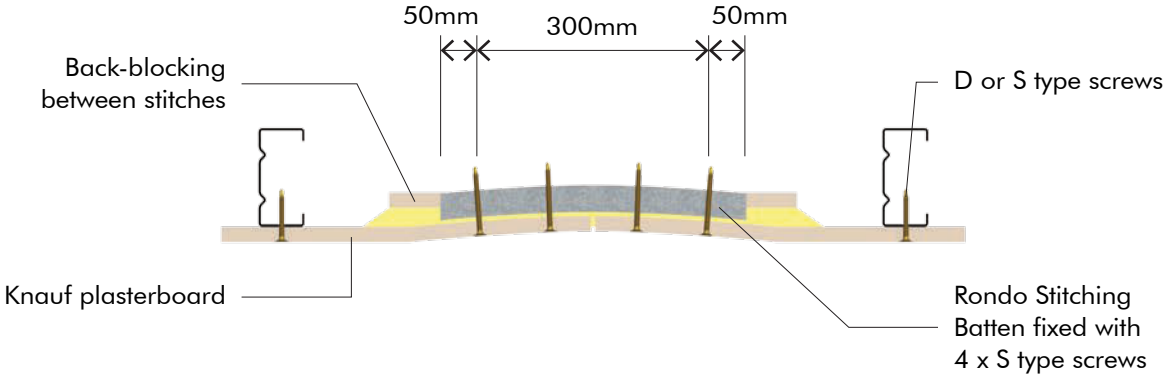


Figure E29: Back-Blocking Using Stitching Batten Detail

DOOR DETAILS

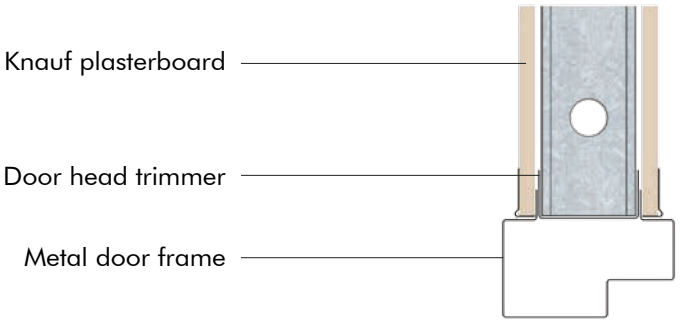


Figure E30: Door Head Detail - Non-Fire-Rated

DOOR DETAILS

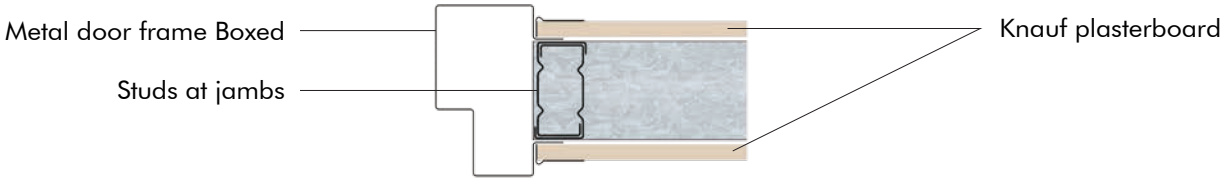


Figure E31: Door Jamb Detail – Non-Fire-Rated

Notes:

- Details shown are generic only.
- Check with the specific door frame manufacturer for alternative detailing.

NON-FIRE-RATED STEEL STUD WALLS

CONTROL JOINTS

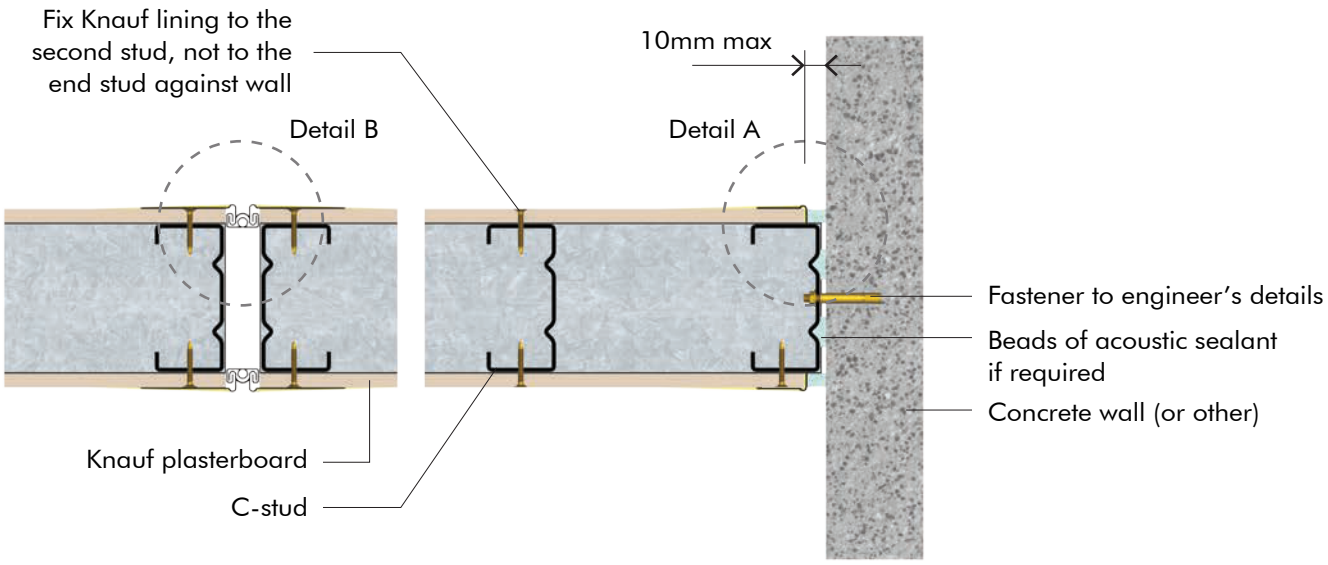


Figure E32: Control Joint Plan Detail

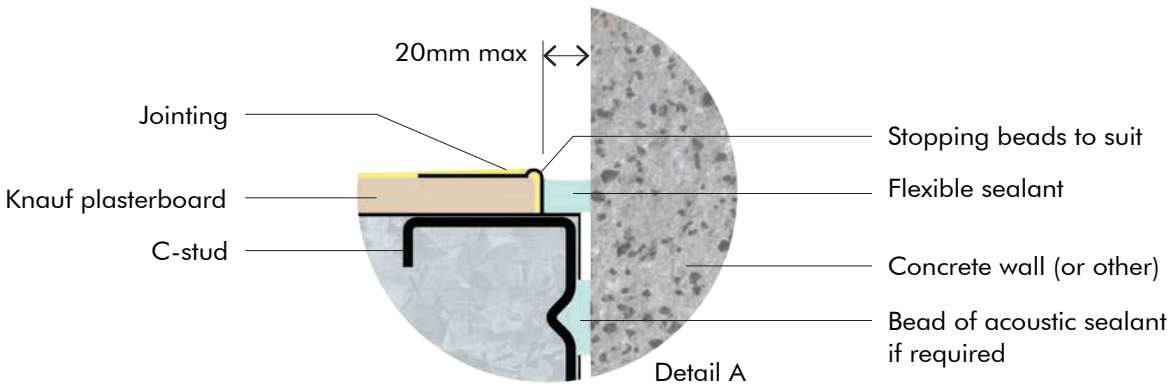


Figure E33: Control Joint – Detail A

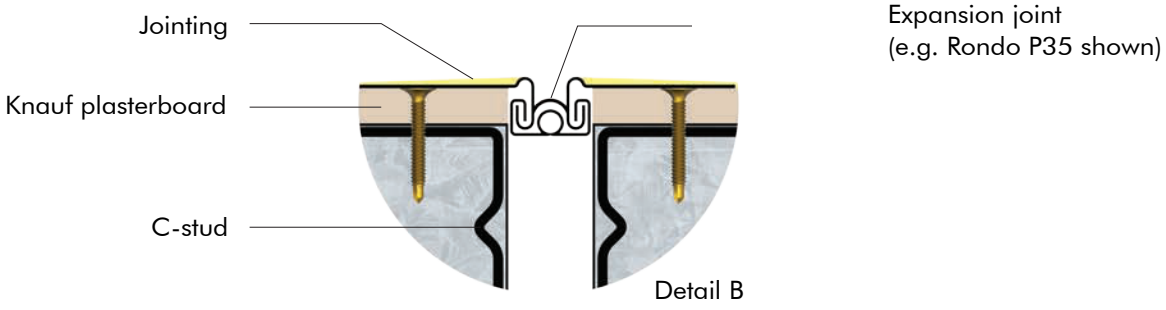


Figure E34: Control Joint – Detail B

NON-FIRE-RATED STEEL STUD WALLS

HEAD DETAILS

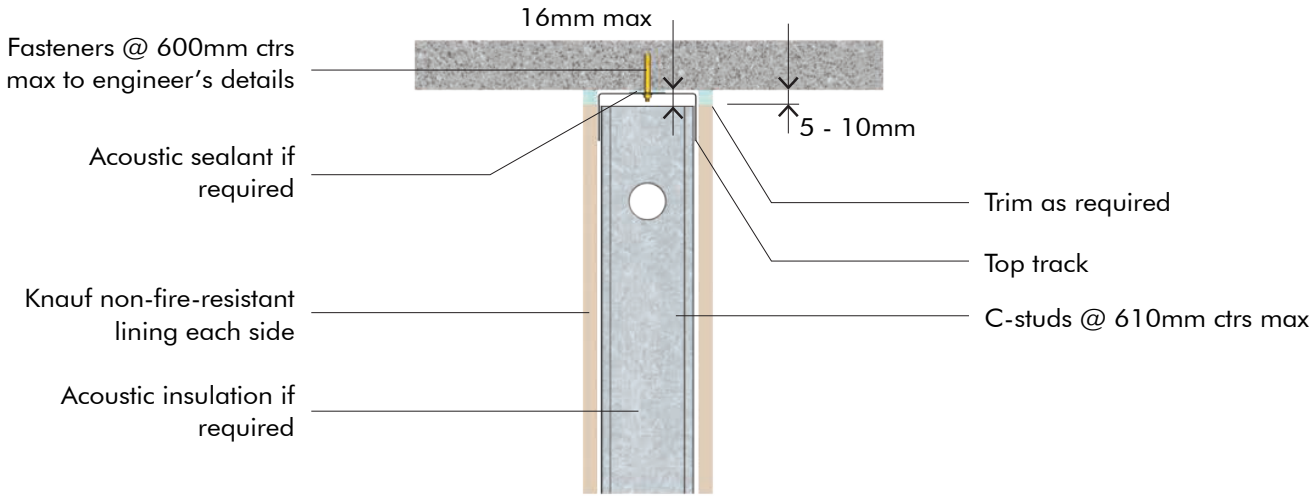


Figure E35: Standard Non-Fire-Rated Wall Head Detail

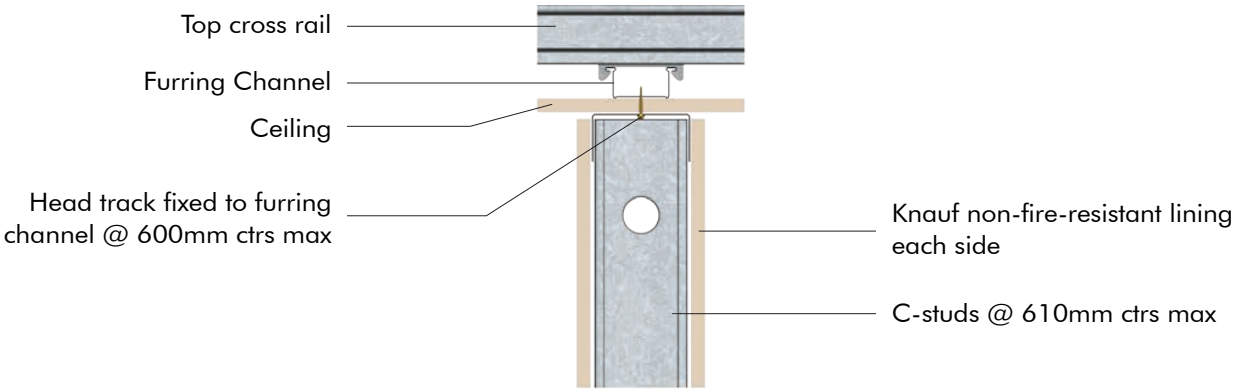


Figure E36: Wall Head Fixing to Suspended Ceiling Detail – Parallel to Furring

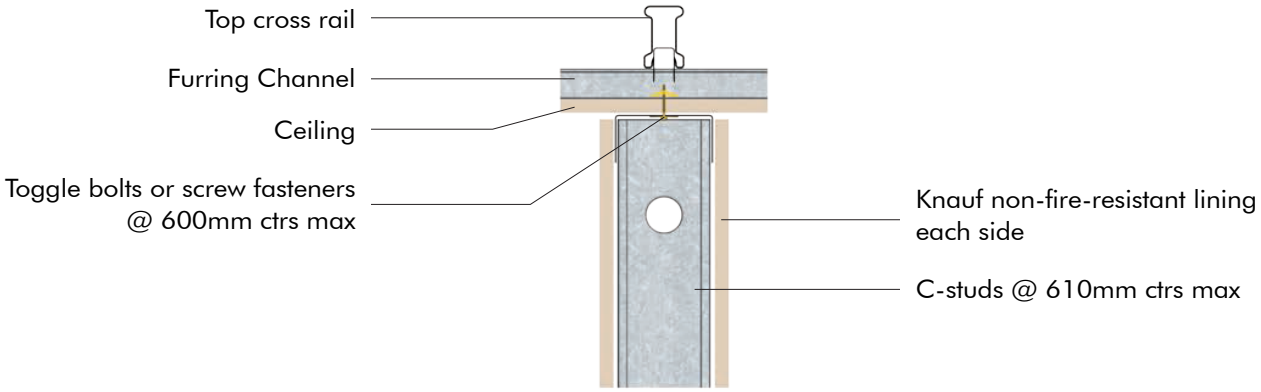


Figure E37: Wall Head Fixing to Suspended Ceiling Detail – Perpendicular to Furring

FIRE-RATED CEILINGS

BACK-BLOCKING

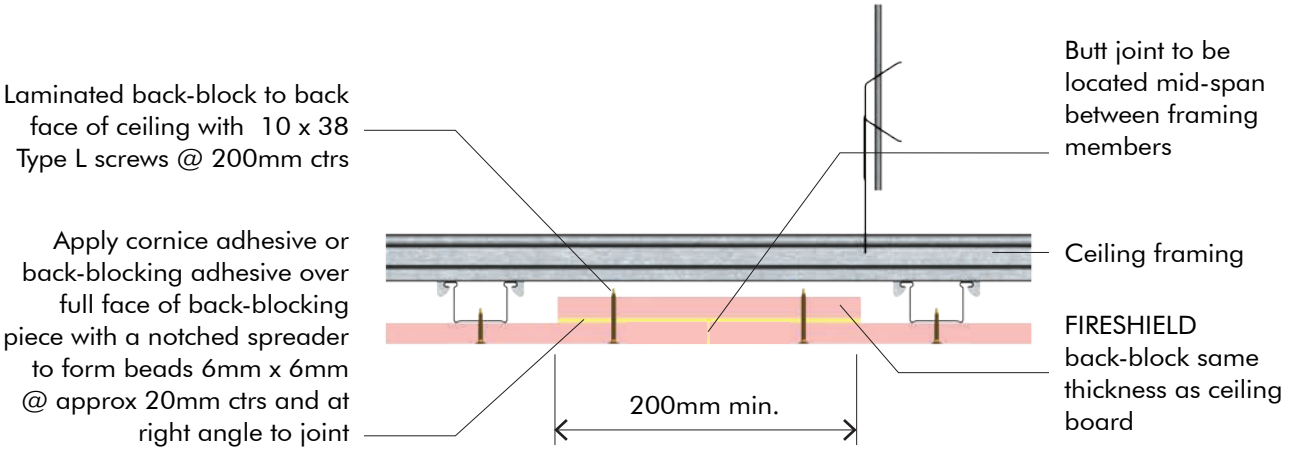


Figure E38: Back Blocking – Detail A

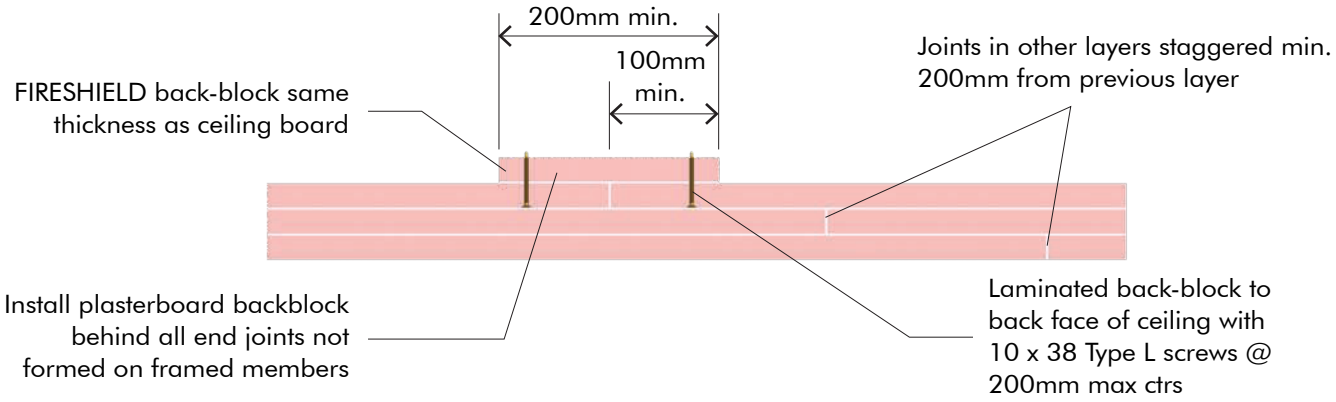


Figure E39: Multi Layer Back-block Detail

FIRE-RATED CEILINGS

PERIMETER DETAILS

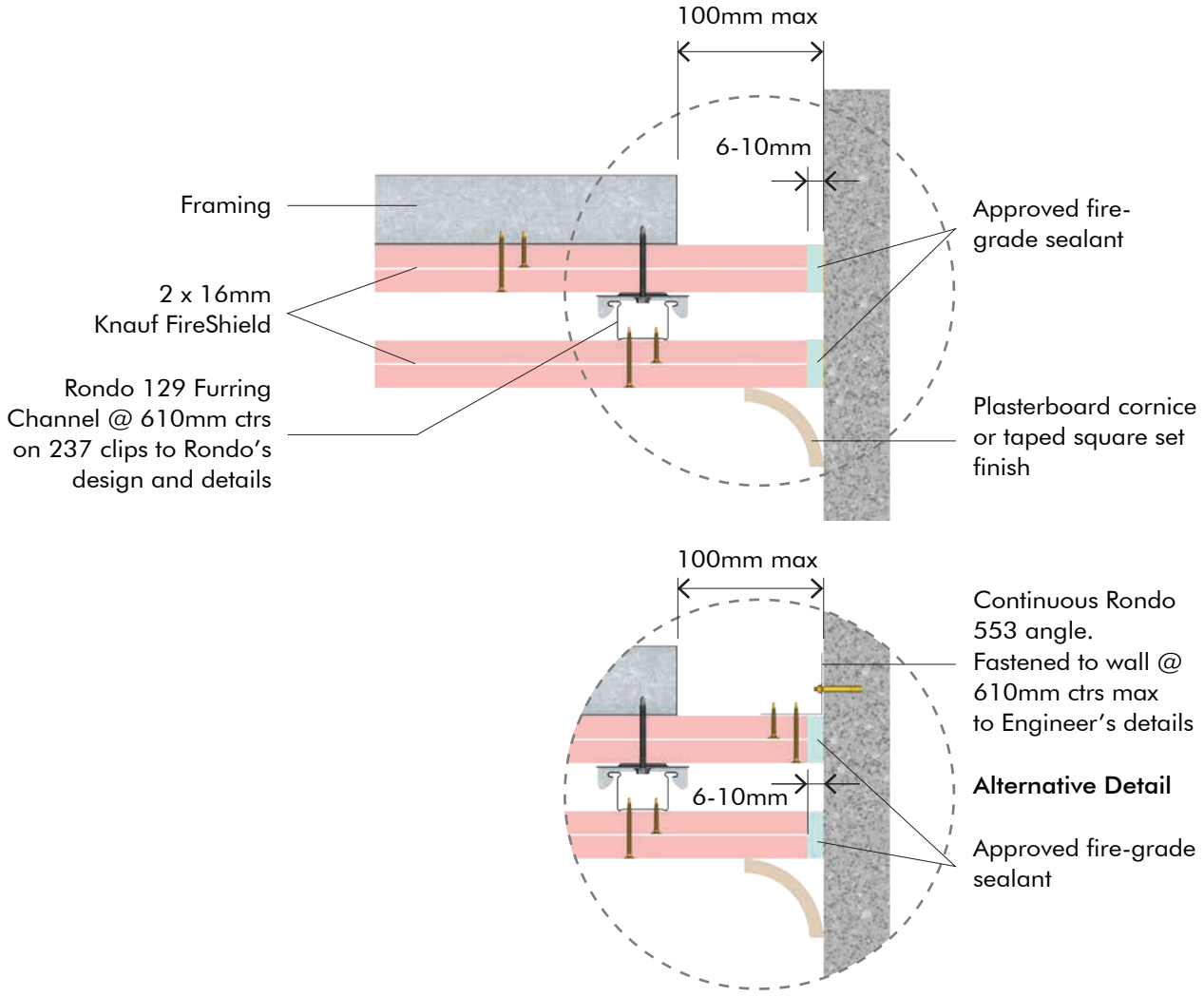


Figure E40: Typical Perimeter Detail – FRL 120

FIRE-RATED CEILINGS

BULKHEAD

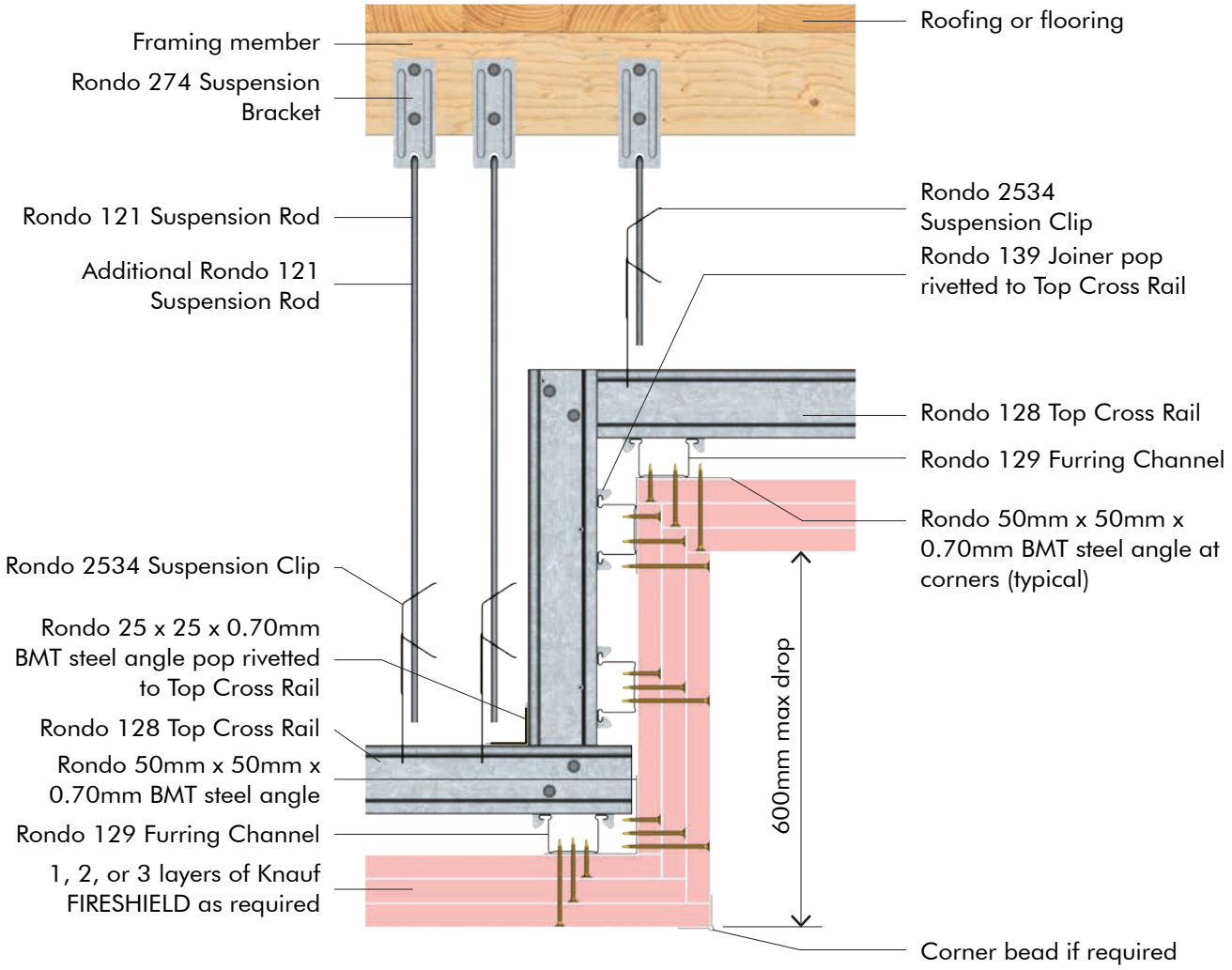


Figure E41: Typical Bulkhead Detail - Maintains FRL of Ceiling System

Notes:
The following instructions must be followed to achieve satisfactory results:

- The configuration of the bulkhead should be consistent with the ceiling system

FIRE-RATED CEILINGS

PLUMBING PENETRATIONS

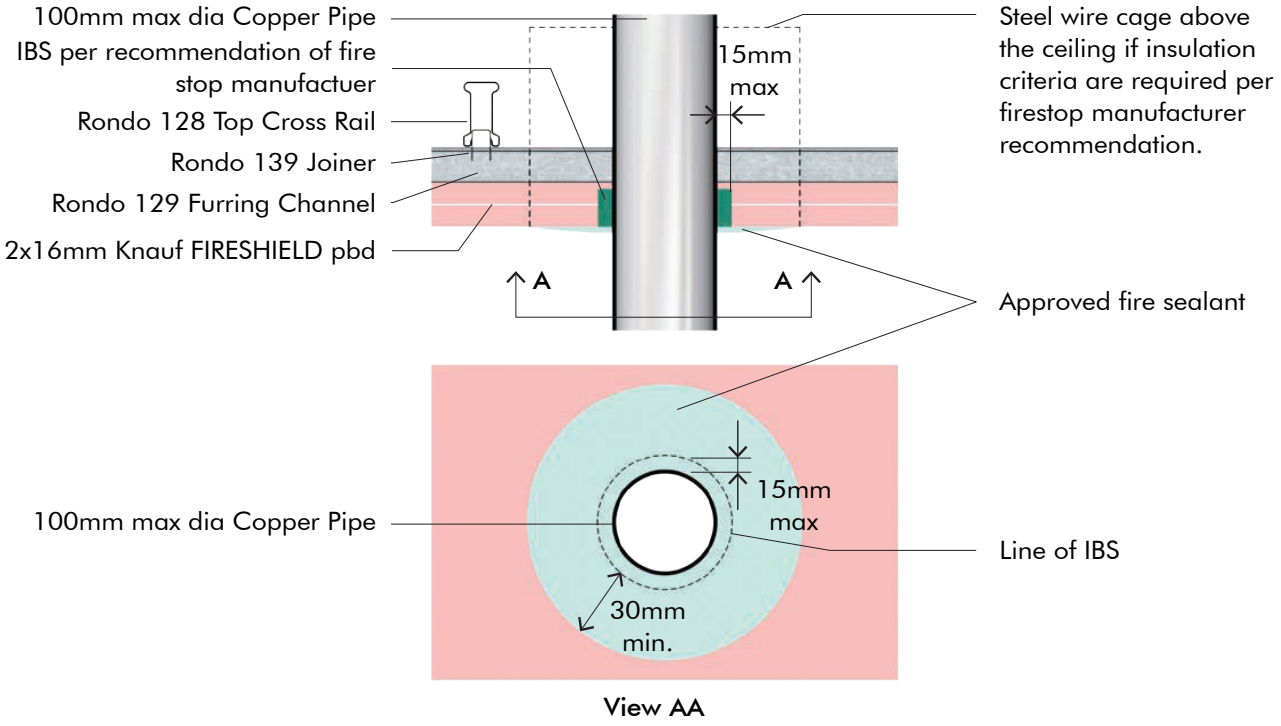


Figure E42: Typical Copper Pipe Penetration

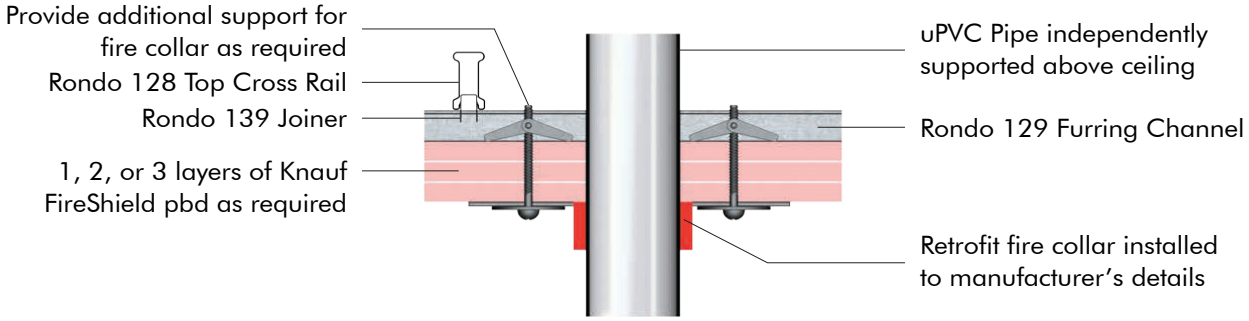


Figure E43: Typical uPVC Pipe Penetration

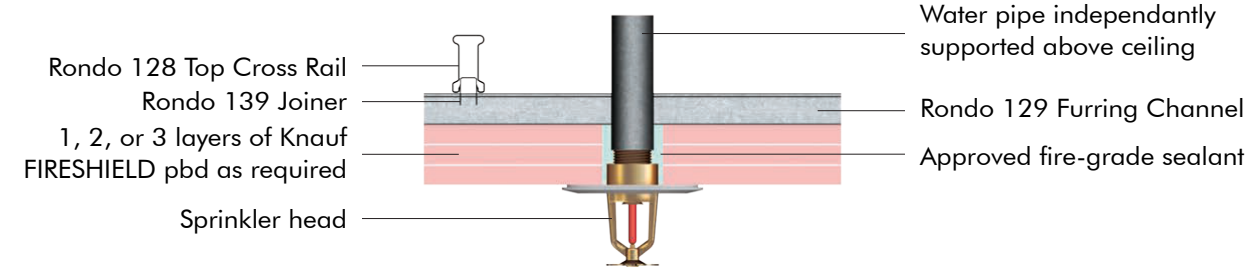


Figure E44: Typical Sprinkler Pipe Penetration - Maintains FRL of Ceiling System

FIRE-RATED CEILINGS

ELECTRICAL AND LOADED PENETRATIONS

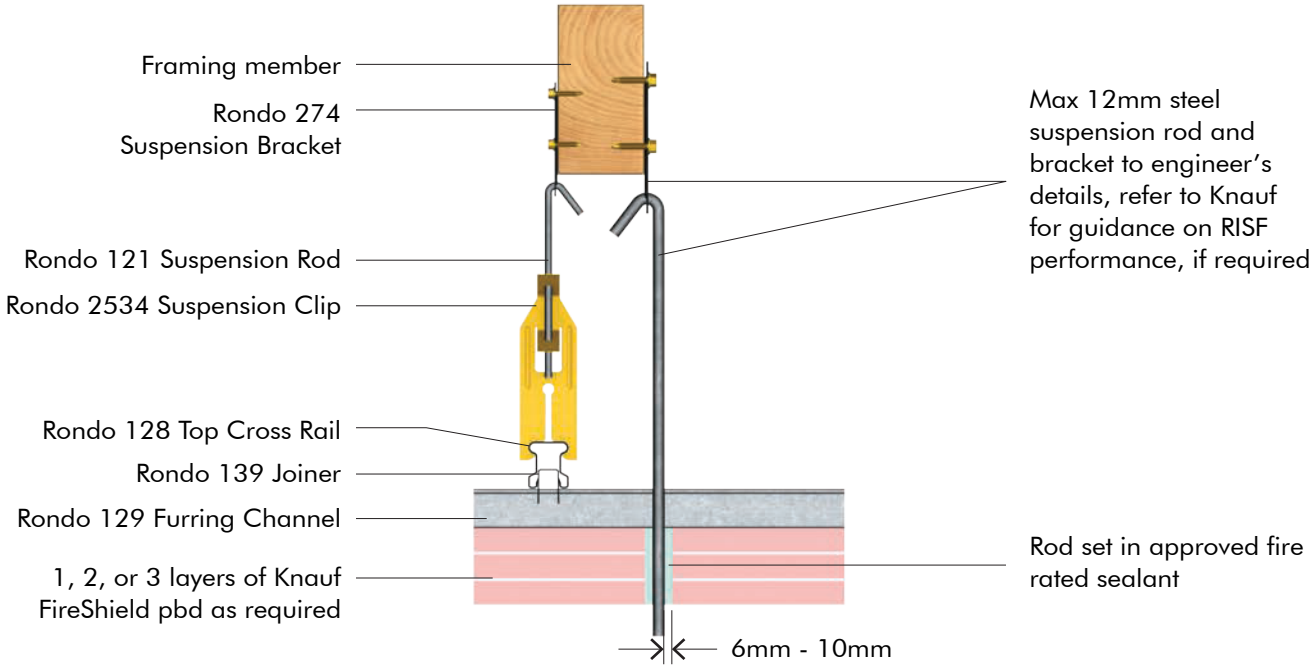


Figure E45: Typical Loaded Penetration Detail - Maintains FRL of Ceiling System

NON-FIRE-RATED CEILINGS

PERIMETER DETAILS

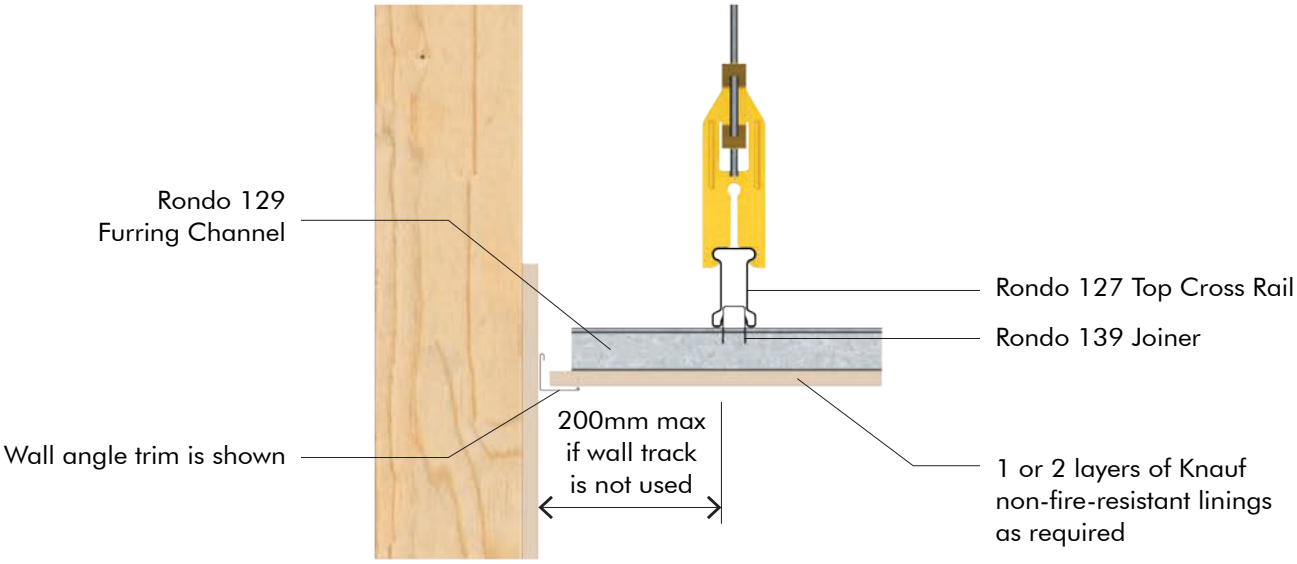


Figure E46: Typical Perimeter Detail – Section Through Top Cross Rail

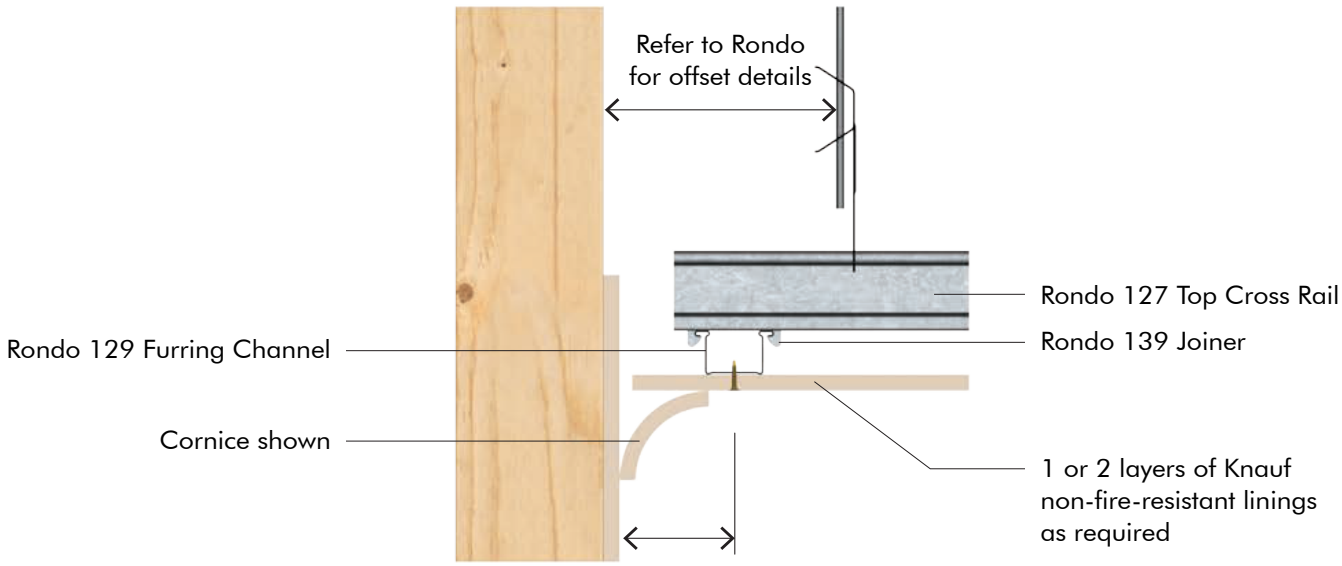


Figure E47: Typical Perimeter Detail – Section Through Furring Channel

NON-FIRE-RATED CEILINGS

PERIMETER DETAILS

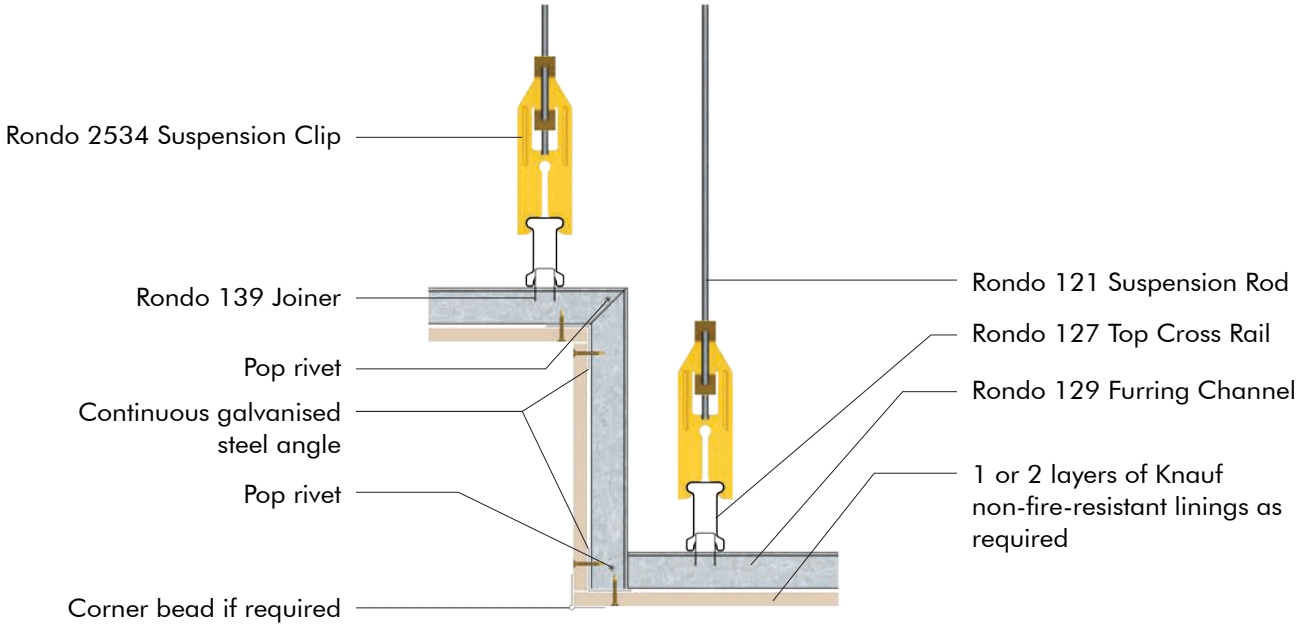


Figure E48: Typical Bulkhead Detail - Penetration Through Top Cross Rail

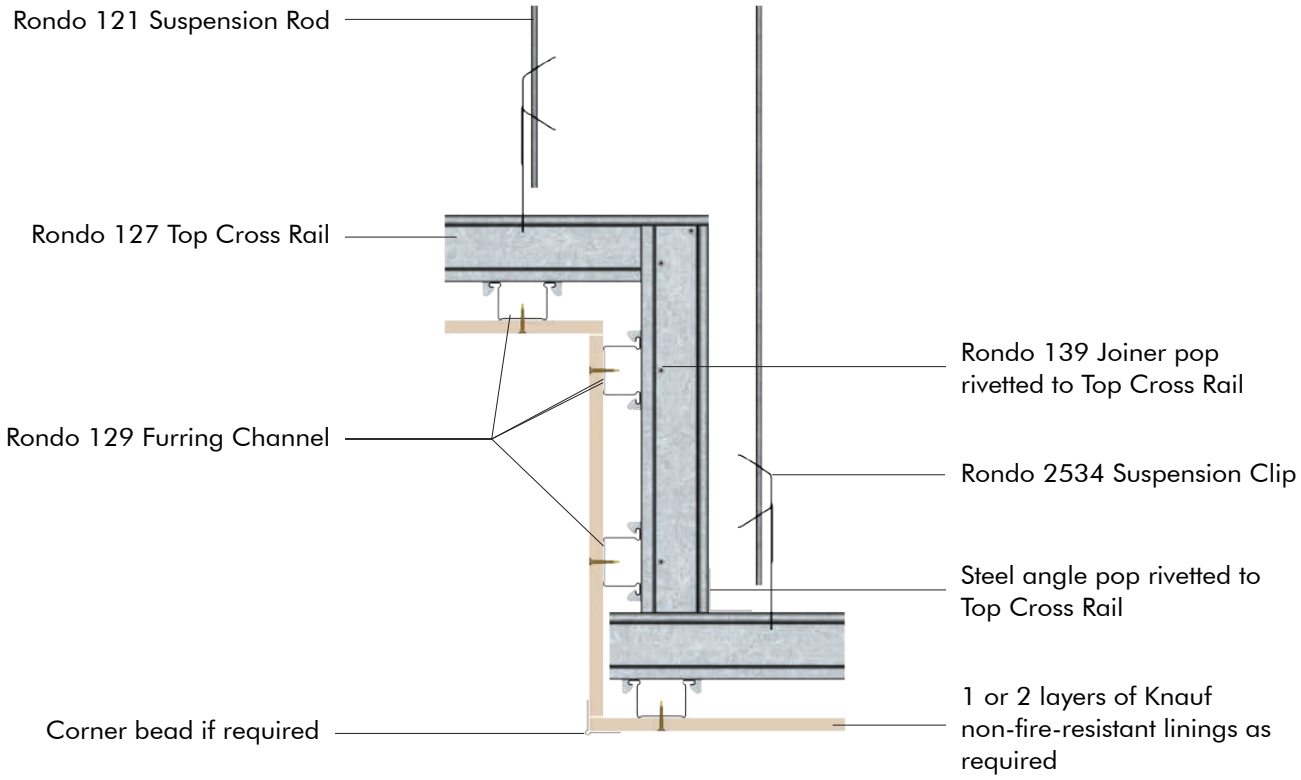


Figure E49: Bulkhead Detail - Section Through Furring Channel

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