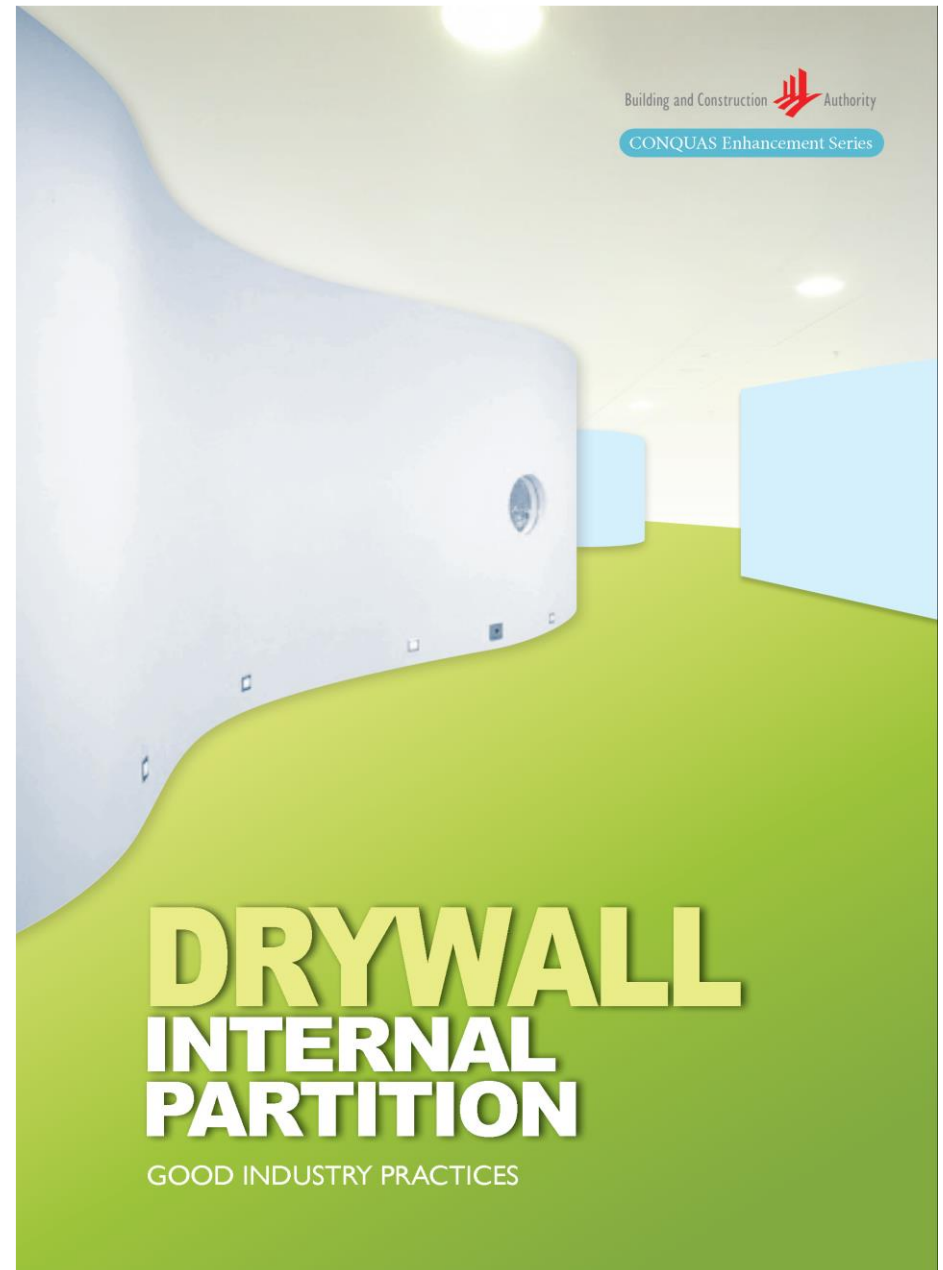


Good Industry Practices - Drywall Internal Partition

By ALLEN CHIA



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OBJECTIVES

This course aims to provide participants with :

A good understanding on drywall design, including drywall structure, material, preparation and installation, common defects and corresponding remedies.

CONTENTS

1. INTRODUCTION
2. DESIGN CONSIDERATION
3. MATERIAL SELECTION
4. DELIVERY, HANDLING AND STORAGE OF MATERIALS
5. PREPARATORY WORKS
6. INSTALLATION PROCEDURES
7. PROTECTION
8. WET AREAS APPLICATION
9. AN OVERVIEW OF DRYWALL IN PBU / PPVC
10. TYPES OF PBU / PPVC
11. REQUIREMENT OF DRYWALL PBU / PPVC

Learning outcomes

By the end of this session, you should be able to:

- Know what is Drywall.
- Benefits in using Drywall.

A brief overview of drywall adoption in Singapore



Brickwall



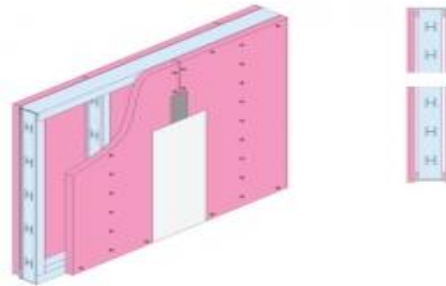
Lightweight Block



Lightweight Panel




Lightweight Sandwich Panel



Drywall Construction



What is Drywall ?

A You
Definition of Drywall


ChatGPT

Drywall, also known as plasterboard, gypsum board, or wallboard, is a construction material used for interior walls and ceilings. It consists of a core of gypsum plaster pressed between two layers of heavy paper or fiberglass mats. Drywall is manufactured in large sheets and comes in various thicknesses and sizes to suit different construction needs.

Drywall is widely used in both residential and commercial construction due to several advantages:

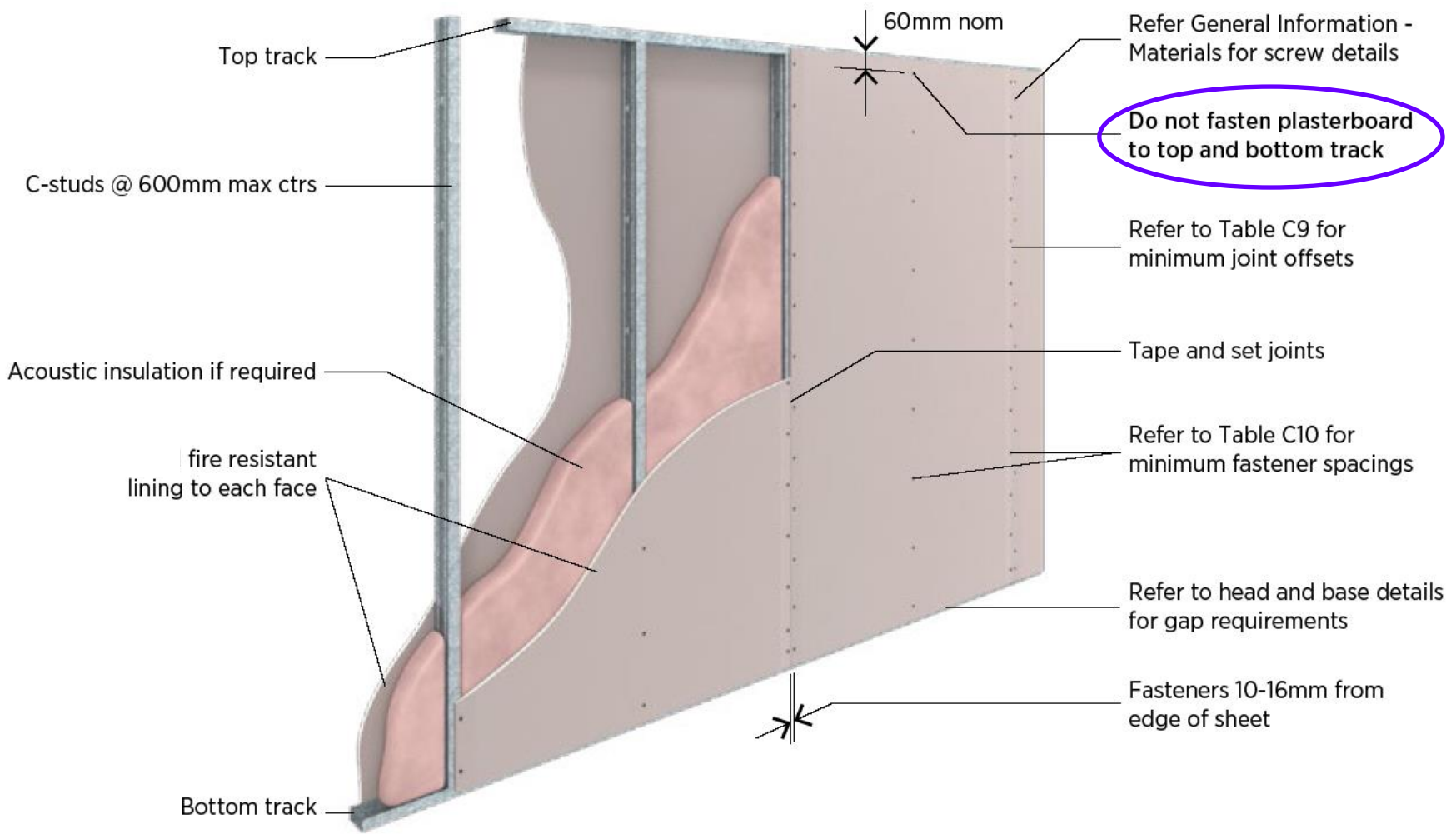
- 1. Ease of Installation:** Drywall is lightweight and relatively easy to handle, transport, and install compared to traditional plaster and lath construction methods.
- 2. Smooth Surface:** It provides a smooth, flat surface that is ideal for painting, wallpapering, or applying other decorative finishes.
- 3. Fire Resistance:** Gypsum, the primary component of drywall, has inherent fire-resistant properties, making drywall a preferred choice for building interiors where fire safety is a concern.
- 4. Sound Insulation:** Depending on its thickness and construction, drywall can offer some degree of sound insulation, helping to reduce noise transmission between rooms.
- 5. Cost-Effectiveness:** Drywall is generally more cost-effective and less labor-intensive than traditional plaster construction methods, making it a popular choice for a wide range of construction projects.

Overall, drywall is a versatile and widely used building material that provides an efficient and economical solution for interior wall and ceiling construction.

Message ChatGPT...

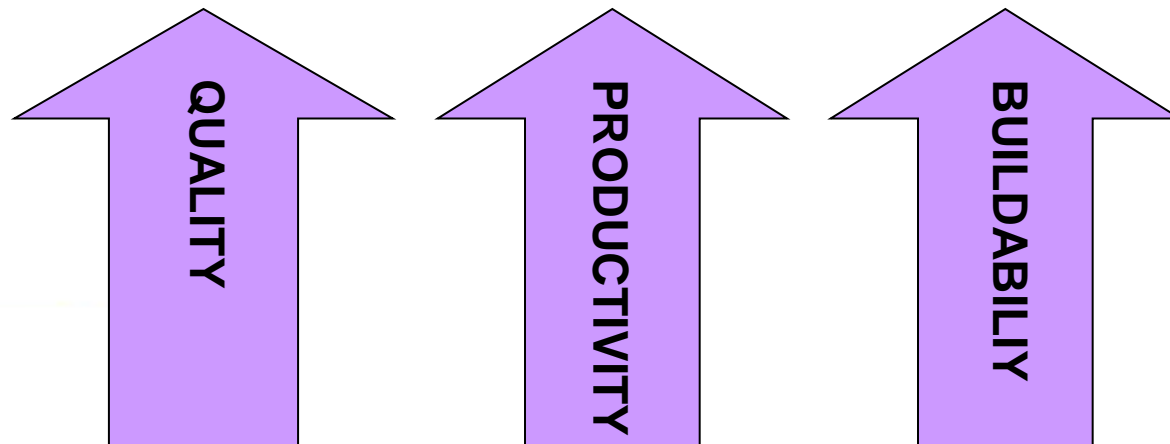


1. INTRODUCTION



1. INTRODUCTION

- Achieving quality finishing with higher productivity without compromising its primary functionality as an internal wall.
- Meet the standards expectation of conventional brick or block wall construction.
 - ✓ Acoustic performance, (ASTM E90, ISO 140-14)
 - ✓ Fire resistance performance (BS 476 Part 22, EN 1364-1, AS 1530 Part 4)
 - ✓ Impact performance (SS492, BS 5234 Pt 2)



2. DESIGN CONSIDERATION

2.3 Fire Resistance

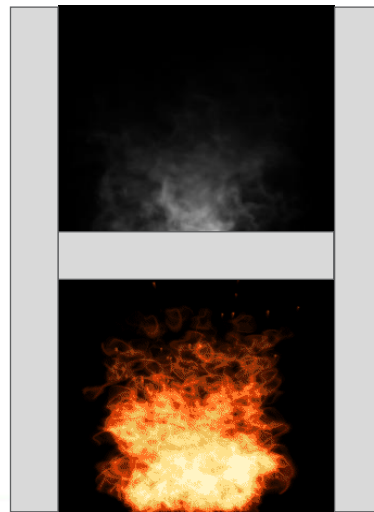
Up to 4 hours fire rating
Non-combustible board

*Load bearing capacity
under fire*



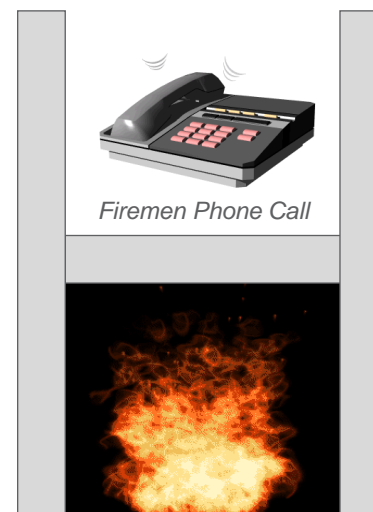
1: Loadbearing capacity

*Tightness against flames
and flammable gas*



2: Integrity

*Elevation of temperature
 $\leq 140^{\circ}\text{C}$ (average) and
 $\leq 180^{\circ}\text{C}$ (max)*



3: Insulation

2. DESIGN CONSIDERATION

2.3 Fire Resistance

FIRE RESISTANCE - Criteria

Loadbearing capacity (R) or **FRL x/-/-** ✓

The system can no longer carry the load applied on it.

Integrity (E) or **FRL -/x/-** ✓

Cracks or openings developed that allow the passage of flames or hot gasses.

Insulation (I) or **FRL -/-/x** ✓

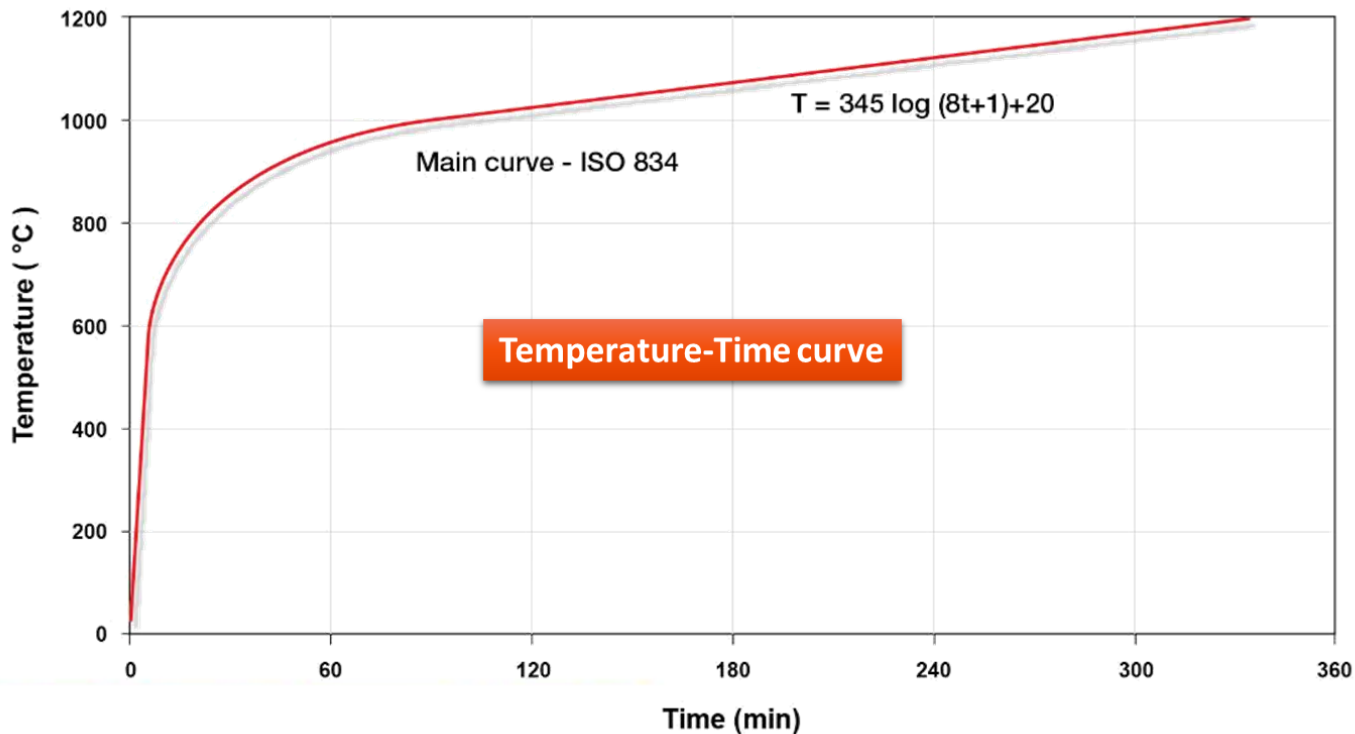
The unexposed face temperature rises by more than 140° C (250° F) on average or 180° C (325° F) for a single point.

- ✓ **Factors to consider when designing fire resistance drywall partition**

2. DESIGN CONSIDERATION

2.3 Fire Resistance

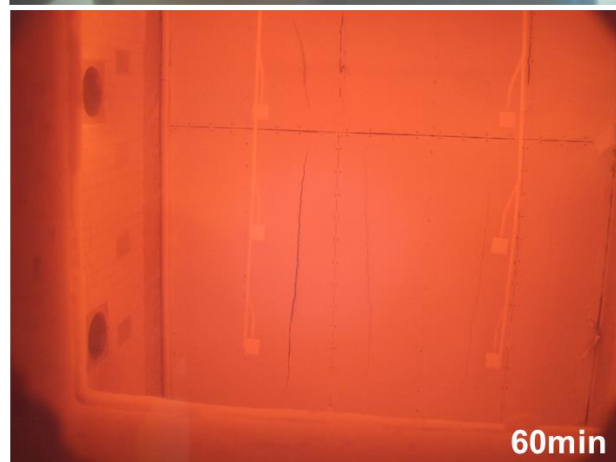
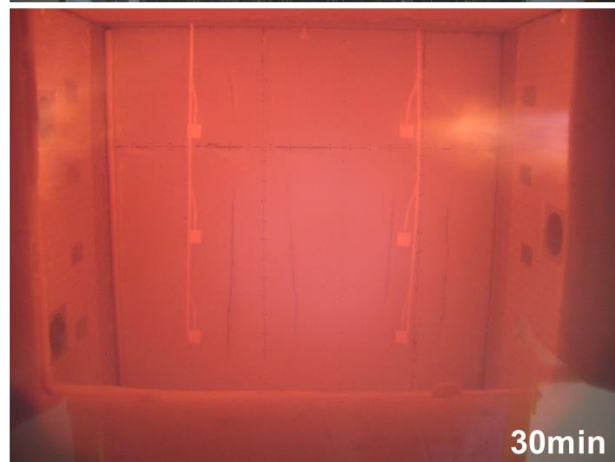
FIRE RESISTANCE TEST



5min:	555C
10min:	660C
30min:	820C
60min:	925C
90min:	985C
120min:	1030C
180min:	1090C
240min:	1130C

2. DESIGN CONSIDERATION

2.3 Fire Resistance



2. DESIGN CONSIDERATION

2.3 Fire Resistance



1H10min



1H35min



2H05min



2:09:25
End

2. DESIGN CONSIDERATION

2.3 Fire Resistance



Unexposed surface of the specimen after the test – 1H



Exposed surface of the specimen after the test-1H
2 exposed layers have fallen, as well as the inner layer of the non-exposed face

2. DESIGN CONSIDERATION

2.3 Fire Resistance

<https://www.youtube.com/watch?v=Ga20jKMZ9VA>

DID YOU KNOW?

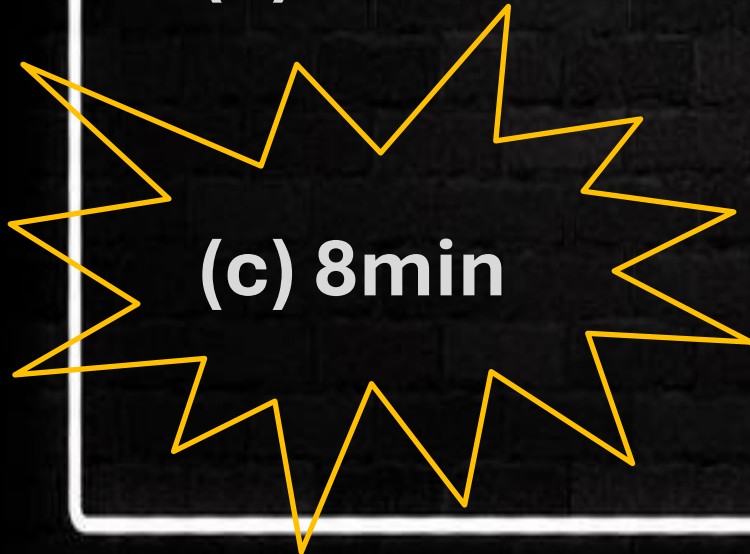
Q: What is the response time for SCDF ?

(a) 3min

(b) 5min

(c) 8min

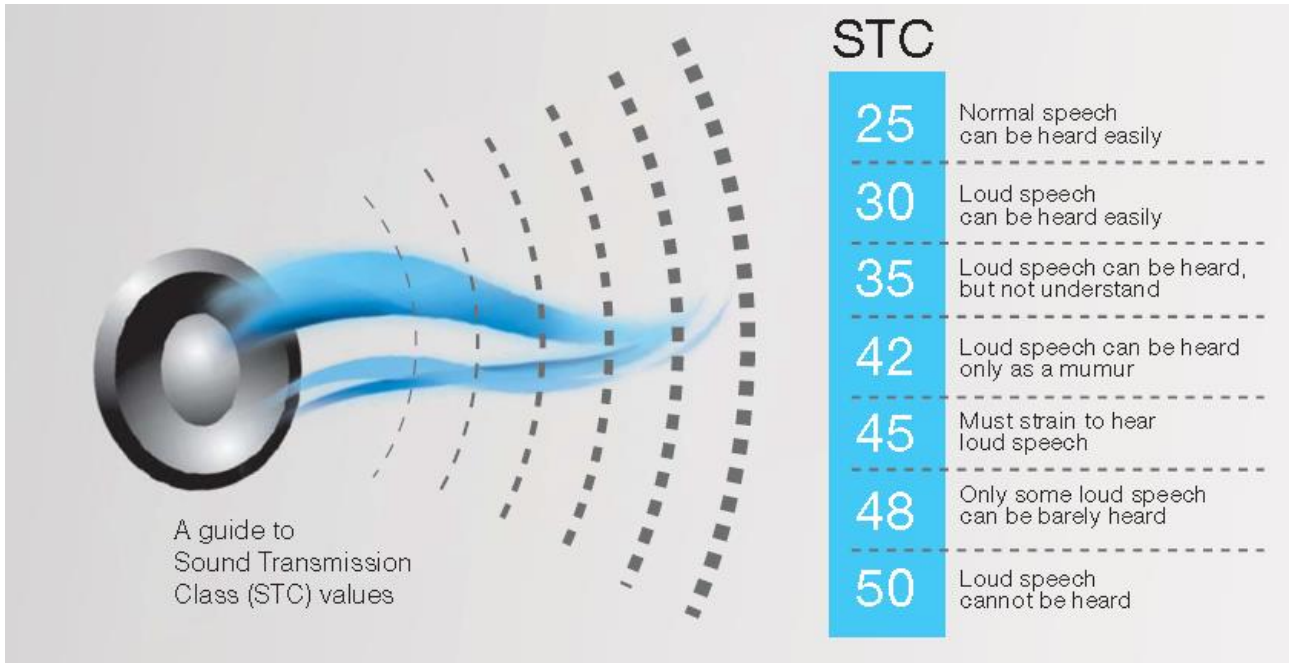
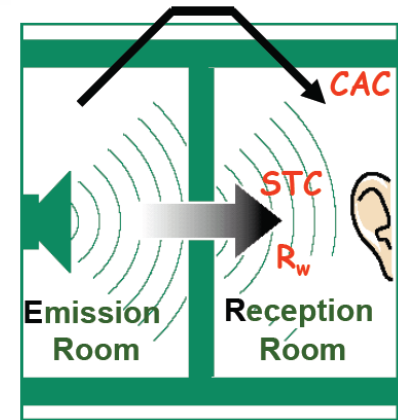
(d) 12min



2. DESIGN CONSIDERATION

2.4 Acoustic

Noise control from both interior and exterior
Ability to develop quiet zones



Frequency (Hz)	
Octive Bands (Hz)	1/3 Octive Bands (Hz)
63	63
	80
	100
125	125
	160
	200
250	250
	315
	400
500	500
	630
	800
1000	1000
	1250
	1600
2000	2000
	2500
	3150
4000	4000
	5000
	6300
8000	8000
	10000
	12500

<https://www.youtube.com/watch?v=OjHj0vvdO5M>

2. DESIGN CONSIDERATION

2.4 Acoustic

***dB** – **Decibel** is a [logarithmic unit](#) used to express the ratio between two values of a physical quantity, often [power](#) or [intensity](#).

CAC – **Ceiling Attenuation Class**, is the measurement for the performance of a ceiling.

***STC** – **Sound Transmission Class** is an [integer](#) rating of how well a [building partition](#) attenuates airborne [sound](#).

NRC – **Noise Reduction Coefficient** is the measure that a material has to absorb sound.



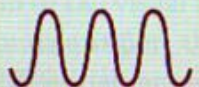



ASTM E90 (STC) / ISO 140 (Rw) / ASTM C423 (NRC)

2. DESIGN CONSIDERATION

2.4 Acoustic

What is sound?

- Sound = vibrations that travel through the air or another medium and can be heard when they reach a person's ear
- All sound is carried through air or other mediums as sound waves

<p>Frequency (pitch) The rate at which waves vibrate, measured as cycles per second, or hertz (Hz). Frequency roughly corresponds to our perception of pitch.</p>	 Low frequency (low-pitched sound)	 High frequency (high-pitched sound)
<p>Amplitude (loudness) The intensity of sound, usually measured in decibels (dB). Amplitude roughly corresponds to our perception of loudness.</p>	 High amplitude (loud sound)	 Low amplitude (soft sound)
<p>Complexity (timbre) Most sounds are a mixture of frequencies. The particular mixture determines the sound's timbre, or perceived uniqueness. Timbre provides information about the nature of a sound. For example, timbre allows us to distinguish the sound of a trombone from that of a violin playing the same note.</p>	 Simple	 Complex

2. DESIGN CONSIDERATION

2.4 Acoustic

□ Sound Insulation Ratings

Standard	Laboratory test ratings	Field test ratings
ISO based	R_w (Weighted sound reduction index) C_{tr} (Spectrum adaptation term) $L_{n,w}$ (Weighted normalised impact sound pressure level)	R'_w (Weighted apparent sound reduction index) $D_{nT,w}$ (Weighted standardized level difference) C_{tr} (Spectrum adaptation term)
ASTM based	STC (Sound Transmission Class) IIC (Impact Isolation Class)	FSTC (Field Sound Transmission Class) ASTC (Apparent Sound Transmission Class)

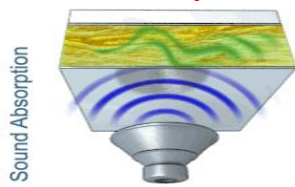
- How lightweight partitions work acoustically
- The role that insulation plays
- Good Construction Practice for Acoustic Isolation
- Assessment

2. DESIGN CONSIDERATION

2.4 Acoustic

Sound Isolation:
Relates to the actual reduction in sound traveling from one area to another through a wall, floor or ceiling.

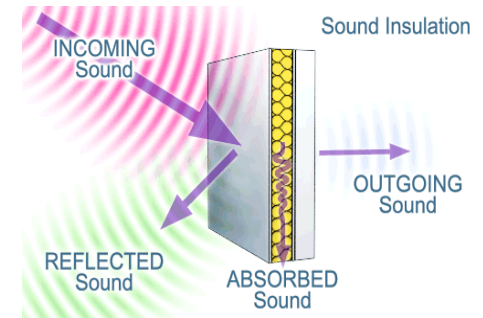
- **Sound Absorption:**
- Relates to the amount of reverberation (echo) within a room and its effect on sound quality and intelligibility.



OFFICE 1



OFFICE 2

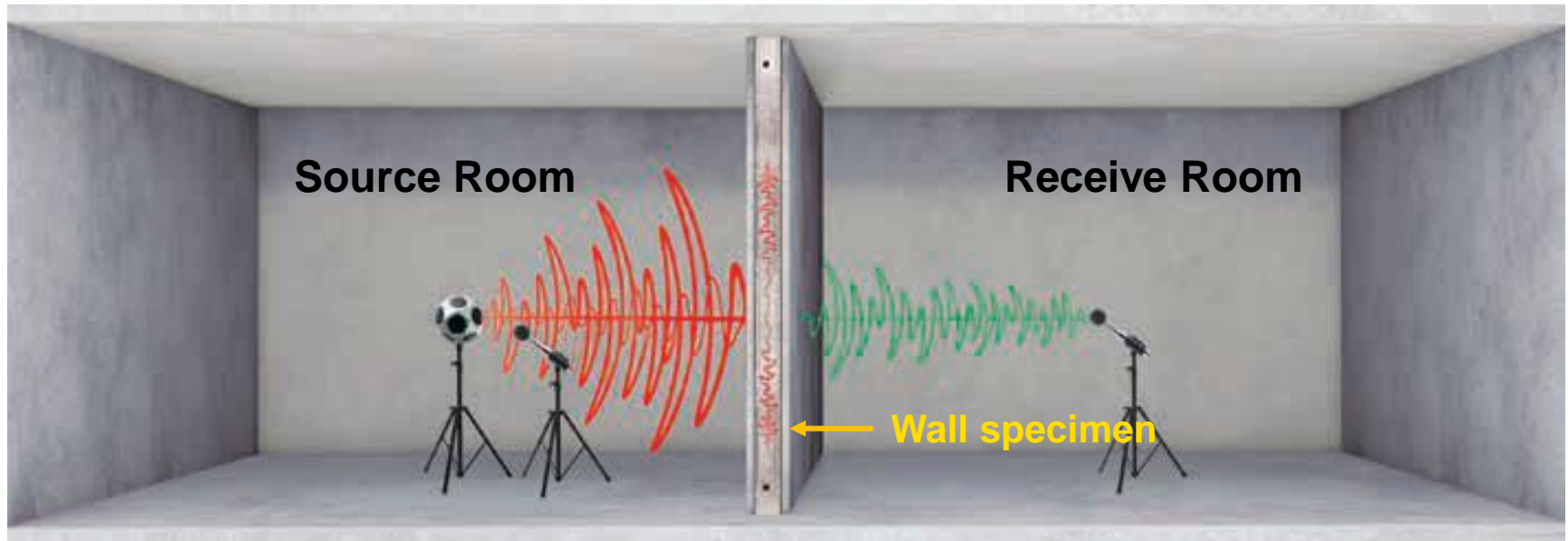


2. DESIGN CONSIDERATION

2.4 Acoustic

Sound insulation RATINGS

R_w & STC - it all starts with laboratory acoustic testing



2. DESIGN CONSIDERATION

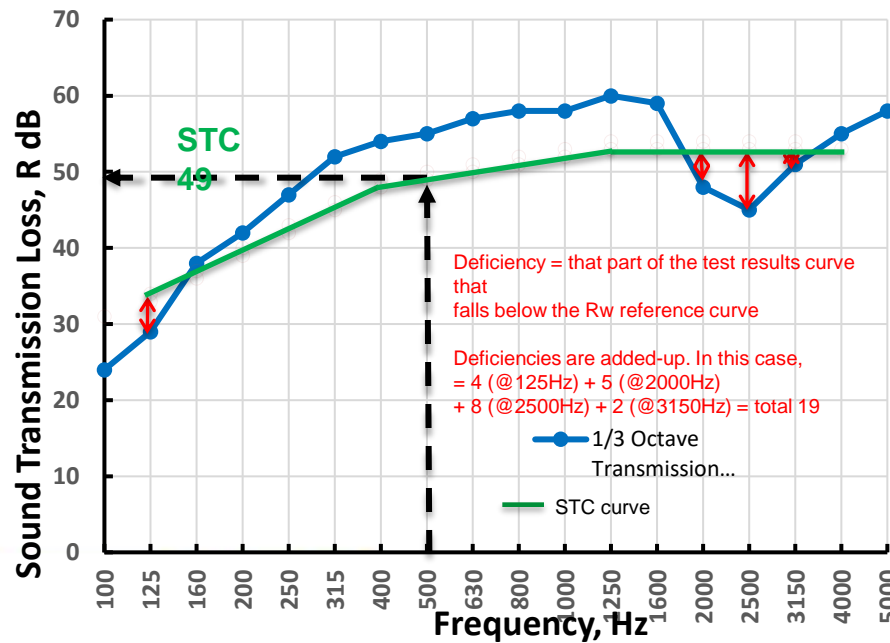
2.4 Acoustic

Sound insulation RATINGS

STC – there are a number of steps to determine the rating

Relevant Standard to determine STC

- ASTM E413 “Classification for Rating Sound Insulation”

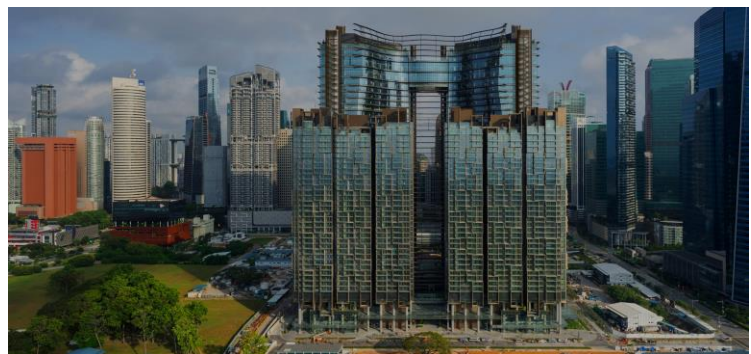


STEP 1: Plot lab test results measured in third octave bands from 100Hz to 5000Hz

STEP 2: Apply STC reference curve
 Note: only takes into account 125Hz to 4000Hz
 (Rule to determine STC is ≤ 32 deficiencies allowed and max. 8dB at any one frequency)

STEP 3: Read up from 500Hz to the STC reference curve and read across to determine the STC rating

1. INTRODUCTION



1. INTRODUCTION

** Drywall benefits the construction of the building include:

- Increase Buildability
- Increase Productivity
- Improve Quality

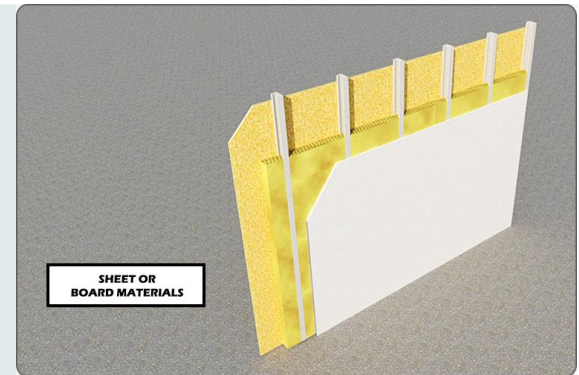
Quality



Buildability



Productivity



1. INTRODUCTION



MEDIA RELEASE

NEW REGULATIONS TO IMPROVE PRODUCTIVITY IN THE CONSTRUCTION SECTOR

6 Nov 2014 – To further raise construction productivity as outlined in the Budget 2014, the Building and Construction Authority (BCA) announced that the Building Control (Buildability and Productivity) Regulations now include requirements on the use of labour-efficient construction methods and building design.

2. From 1 November 2014, projects are required to:
 - a) **Meet higher minimum Buildable Design and Constructability standards.** This will make buildings easier to construct and encourage the use of efficient construction methods and processes.

1. INTRODUCTION

B) Use of prefabricated and standardised components

(a) **Mandatory items.** To raise the adoption of key productivity components, the following components will be mandatory:

Types of development	Mandatory items to adopt
Residential (non-landed) developments and residential non-landed component of mixed-used developments	Dry partition wall for all internal dry areas (exclude party wall, toilet and kitchen)
	Standardised floor heights
	Standardised structural openings for doors
Office developments	Standard precast refuse chutes
All developments	Standardised floor heights
	Standardised prefabricated staircases

(b) **Demerit Points for the use of Brickwall.** To discourage non-productive method of construction, demerit points will be given for the use of brickwall.

1. INTRODUCTION

- 1st HDB BTO 2012 (928 units) at Sengkang (Compassvale Mast)



<http://sengkangzai.blogspot.sg>

CONTENTS

1. INTRODUCTION
2. DESIGN CONSIDERATION

Learning outcomes

By the end of this session, you should be able to:

Know design considerations in using Drywall.

2. DESIGN CONSIDERATION

Design considerations and features:-

- 2.1 Architectural
- 2.2 Impact performance
- 2.3 Fire resistance
- 2.4 Acoustic performance
- 2.5 Wet Area Usage; and
- 2.6 High Wall



Figure 2.1a Example in a Unit Layout

2. DESIGN CONSIDERATION

Comparison of Brick Wall and Dry Wall by Functional requirement.

Brick Walls

- Heavy materials to move onto site
- Consumes floor space during construction
- Slow to construct
- Job-site often messy
- High wastage (damaged/cut bricks)



Dry Wall

- Lightweight, easier to move onto site.
- Consume less floor space during construction
- Faster construction
- Cleaner job-sites
- Low wastage (can be as low as 5%)
- Can be recycled

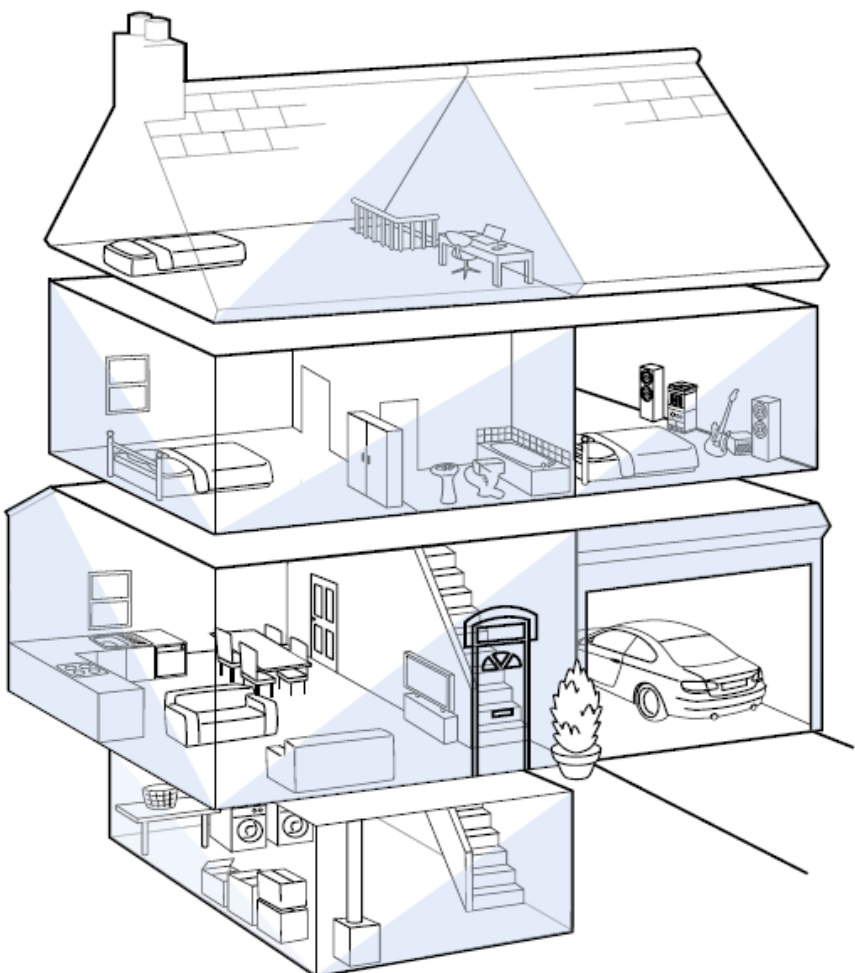
2. DESIGN CONSIDERATION

Comparison of Brick Wall and Dry Wall by Functional requirement.

Requirement	Brick Wall	Dry Wall
Weight	~ 900kg/m	~ 113kg/m
Productivity	4-7m ² /man day	20-25m ² / man day
Acoustic	~ STC 35-40	~ STC 45-50
Concealed pipework	By surface hacking	Embeds inside system
Flexibility of relocation	Slow, Noisy, Dusty	Quick and easy

2. DESIGN CONSIDERATION

Design considerations and features:-



All round solutions
all around the house



Sound insulation
- Noisy neighbours
- Internal walls and floors



Moisture resistance
- Bathrooms
- Kitchens



Fire resistance
- Integral garage roofs
- Loft conversions



Vapour control
- Bathrooms
- Kitchens
- Loft conversions



Thermal insulation
- Cold rooms
- Exterior walls
- Basements
- Loft conversions

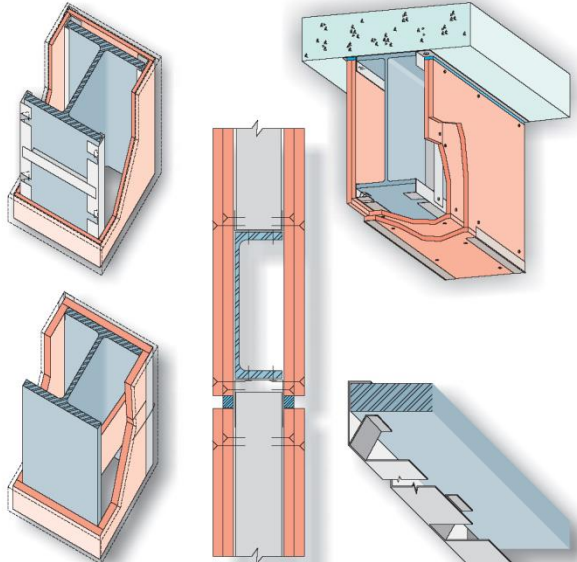


Impact resistance
- Stairways
- Hallways
- Garage walls
- Damaged walls

2. DESIGN CONSIDERATION

2.1 Architectural

- Design flexibility
- Flatter and smoother surface
- Better finishes



2. DESIGN CONSIDERATION

2.2 Impact

Protection in high activity areas
Inter-tenancy wall security



Education Sector



Sport Sector



Healthcare Sector

2. DESIGN CONSIDERATION

2.2 Impact

Protection in high activity areas

Damages from attack / punching / scratching (Severe duty area)



2. DESIGN CONSIDERATION

2.2 Impact

Protection in high activity areas

Damages from attack / punching / scratching (Severe duty area)



2. DESIGN CONSIDERATION

2.2 Impact - Protection in high activity areas



- *To Fasten Steel Sheet at 1200mm*
- *Back of House*
- *Loading Bay*
- *Dry Kitchen*
- *Hospital*

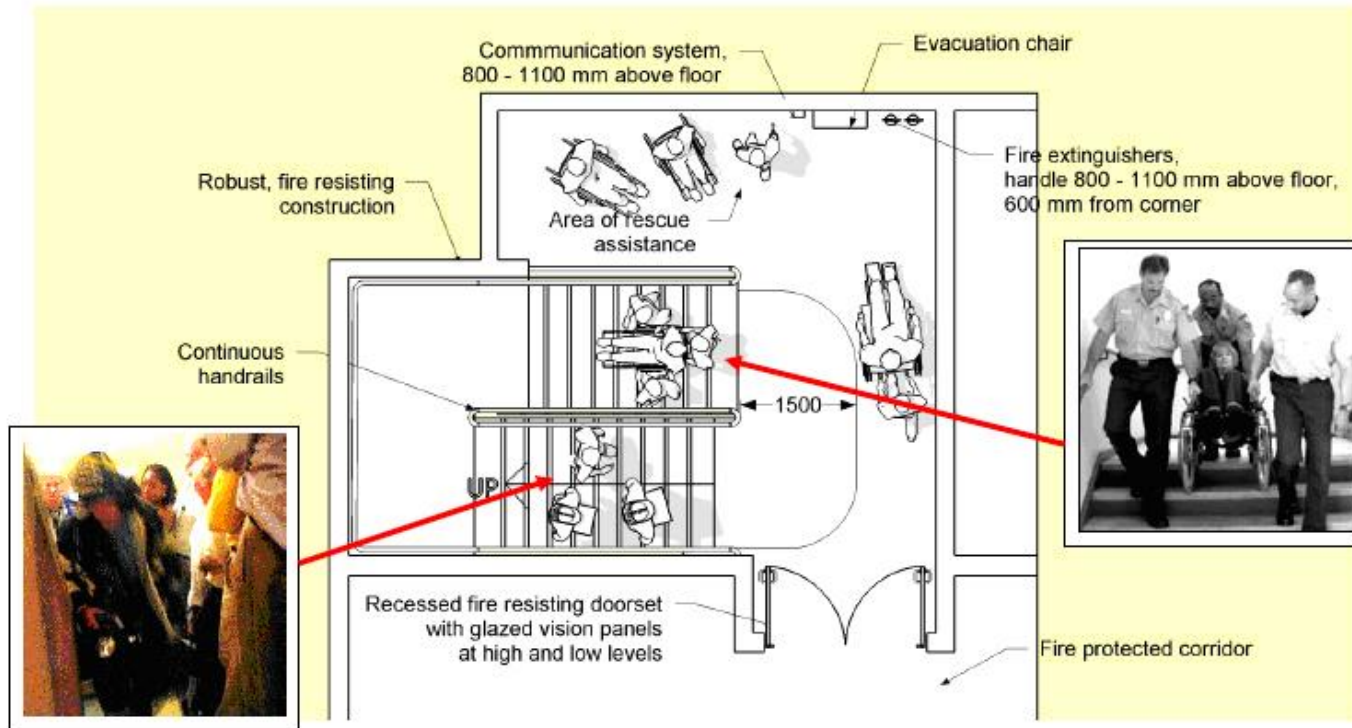


2. DESIGN CONSIDERATION

2.2 Impact

Protection in high activity areas

Safe from fire (Immediate and total fire evacuation)



2. DESIGN CONSIDERATION

2.2 Impact

SS 492 : 2001

BS 5234 : Part 2 : 1992

SPECIFICATION FOR

Performance requirements for strength and robustness (including methods of test) for partition walls

Partition wall grades by performance level

Grade	Category of duty
Light duty (LD)	Minimal stiffness required. Small chance of impact loads
Medium duty (MD)	Moderate stiffness required. Some chance of accident occurring.
Heavy duty (HD)	High stiffness required. Chances of impact loads
Severe duty (SD)	Prone to vandalisim and adnormally rough use

2. DESIGN CONSIDERATION

2.2 Impact

- ✓ 11 test perimeters

BS 5234 – Performance Tables

Partition grades: Summary of requirements and principle test performance levels.

Requirement & test method ⁽¹⁾	Units	Grade				Principal criteria
		LD	MD	HD	SD	
Stiffness (A)	mm	25	20	15	10	Maximum deflection
	mm	5	3	2	1	Maximum residual deformation
Small hard body impact:						
Surface damage (B)	N.m	3	3	6	10	Judgement of incident
Perforation (D)	N.m	(2)	5	15	30	No perforation on facing
Large soft body impact:						
Damage (C)	N.m	20	20	40	100	2mm maximum deflection
Structural Damage	N.m	60	60	120	120	No collapse or dislocation
Door slam	No.	20	20	100	100	No damage and 1mm maximum displacement

(1) Test methods are shown by letters in brackets which refer to annexes in BS 5234: Part 2: 1992

(2) No requirements for this grade

2. DESIGN CONSIDERATION

2.2 Impact

- ✓ 11 test perimeters

Table 3. Summary of tests for crowd pressure, lightweight anchorages and heavyweight anchorages

Requirement	Units	Performance level	Principal criteria		Test method
			Clause	Summary	
Crowd pressure	kN/m	0.75, 1.5 or 3.0	1.6.7	No collapse or dangerous damage	Annex G
Lightweight anchorages:					
pull-out	N	100 minimum	1.6.8	Shim retained	Annex H
pull-down	N	250 minimum	1.6.9	Shim retained and 2 mm maximum displacement	Annex J
Heavyweight anchorages:					
wash basin	N	500 minimum	1.6.10	5 mm maximum deflection	Annex K
	N	1000 to 1500 range		20 mm maximum deflection	
wall cupboard	N	2000 to 4000 range	1.6.11	5 mm maximum deflection	Annex L

2. DESIGN CONSIDERATION

TABLE 11A : LIST OF REGULATED FIRE SAFETY PRODUCTS & MATERIALS

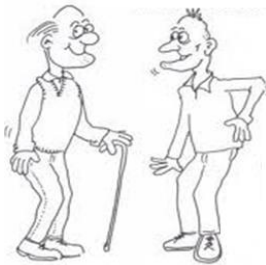
S/N	Products / Materials	Acceptable Standards	Certification Scheme	Surveillance Regime	
				Testing	Factory/Site Inspection
3.	Fire-rated partition ⁽¹⁶⁾ Materials are listed under BS 476-4 or BS 476-11 or EN 13501-1 (min. A2 class) under PLS Scheme 2				
3.1	Compartment wall	(a) BS 476-22 or EN 1364-1 or AS 1530-4 or ASTM E119 or ISO 834-8; and (b) Timber products: See section on cross/glued laminated timber.	Scheme 5 (DoC ⁽¹⁾ issued)	Site inspection triggered by DoC (every 3500m ²) Annual surveillance test on material under Scheme 2	At least once annually
3.2	Protected shaft enclosing lift ⁽²⁾	(a) BS 476-22 or EN 1364-1 or AS 1530-4 or ASTM E119 or ISO 834-8; and (b) BS 5234-2; and (c) BS EN 520 (for gypsum plaster board); and (d) ISO 1896 (for calcium silicate or cement board); and (e) Cyclic loading & dynamic test as specified under Cl 3.8.8	Scheme 5 (DoC issued)	Site inspection triggered by DoC (every 3500m ²) Annual surveillance test on material under Scheme 2	At least once annually
3.3	Protected shaft enclosing staircase or services	(a) BS 476-22 or EN 1364-1 or AS 1530-4 or ASTM E119 or ISO 834-8; and (b) BS 5234-2; and (c) EN 520 (for gypsum plaster board); and (d) ISO 1896 (for calcium silicate or cement board)	Scheme 5 (DoC issued)	Site inspection triggered by DoC (every 3500m ²) Annual surveillance test on material under Scheme 2	At least once annually

2. DESIGN CONSIDERATION

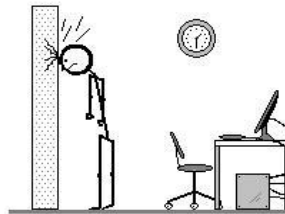
2.2 Impact

Mandatory Tests For Duty Grade

1. Stiffness



2. Small hard body impact



3. Large soft body impact



4. Door slam



The standard also includes optional tests, to ensure the partition performance contributed to everyday function, which are not included in the evaluation of duty grading system.

These are:

- Crowd pressure
- Lightweight anchorages
- Heavyweight anchorages



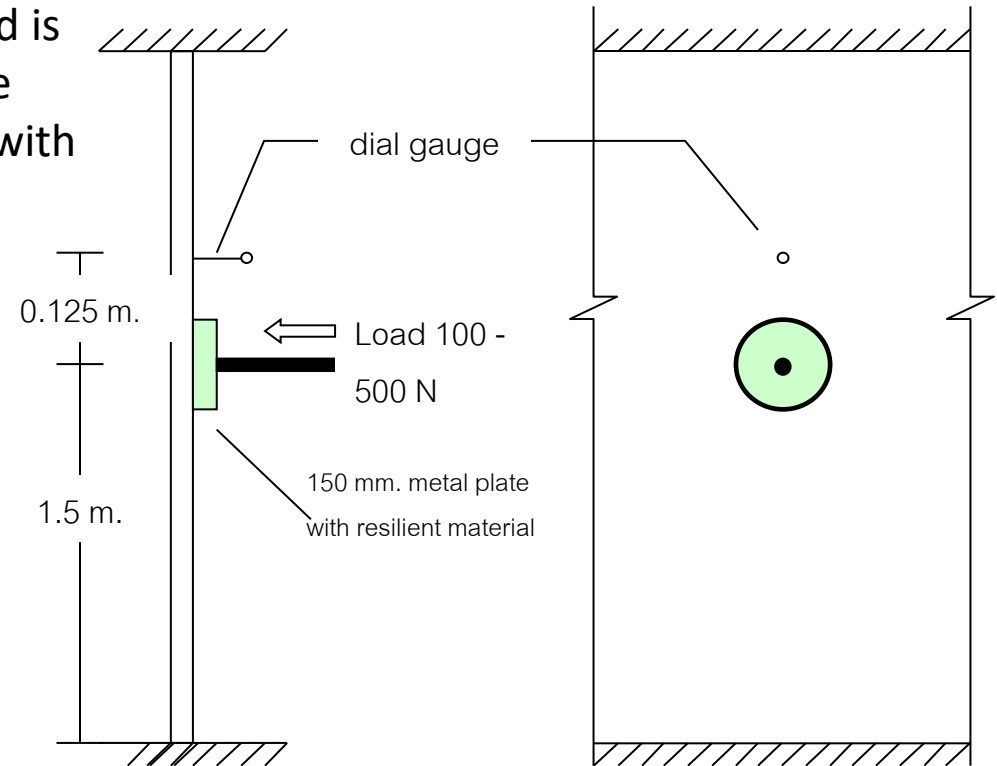
2. DESIGN CONSIDERATION

2.2 Impact



Partition Grade Test

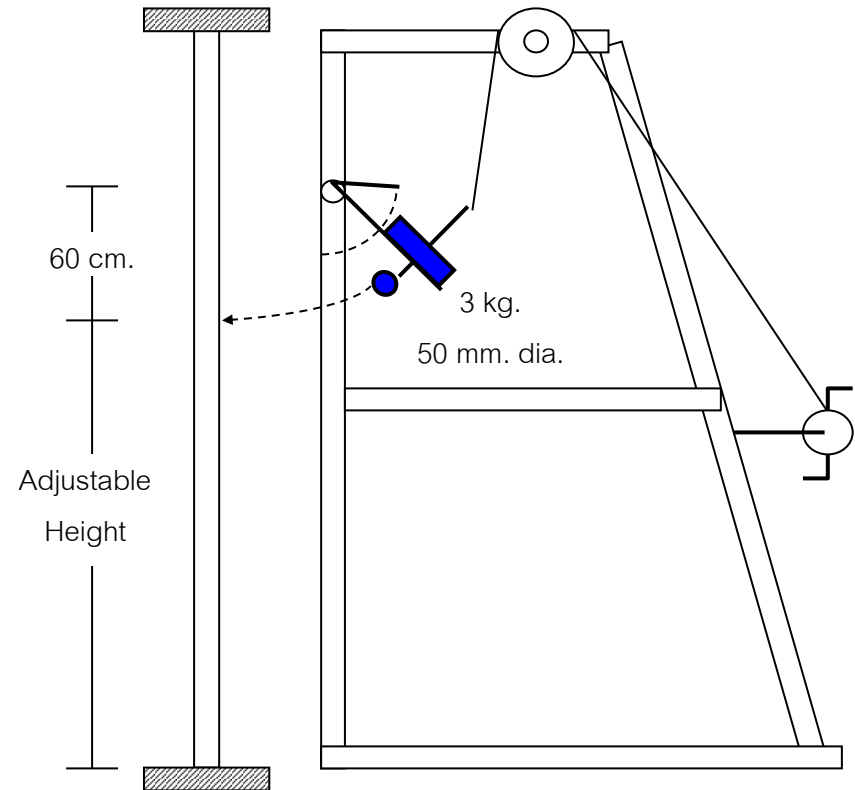
- 1. Partition Stiffness** - a point load is applied to the partition and the maximum deflection together with any residual damage recorded.



Stiffness Test

Partition Grade Test

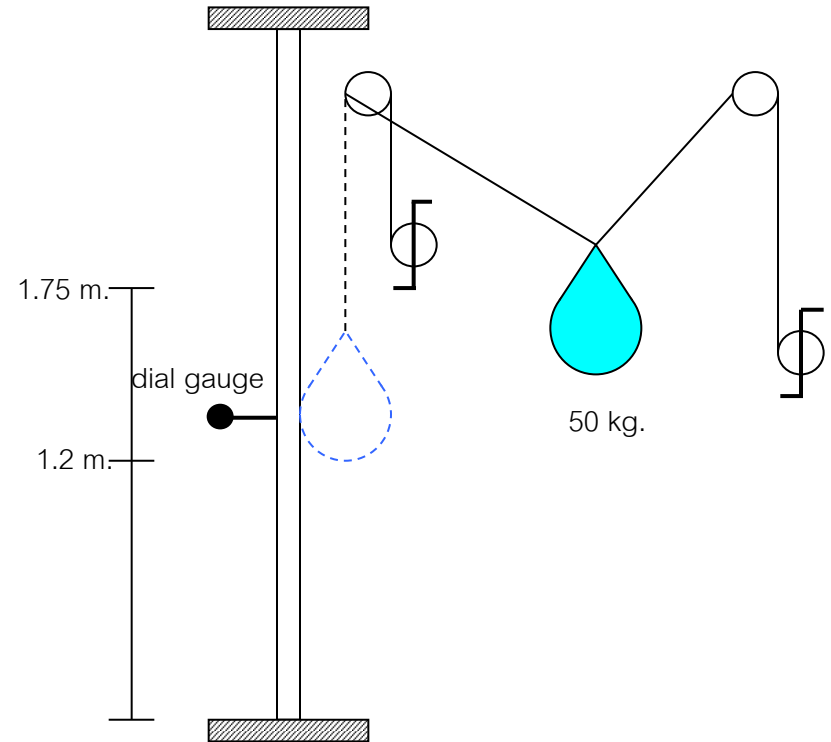
2. **Small hard body impact** - two levels of impact are applied to the partition firstly to assess the resistance to damage of the partition lining and the second to assess the resistance to perforation.



[Small Hard Body Impact Test](#)

Partition Grade Test

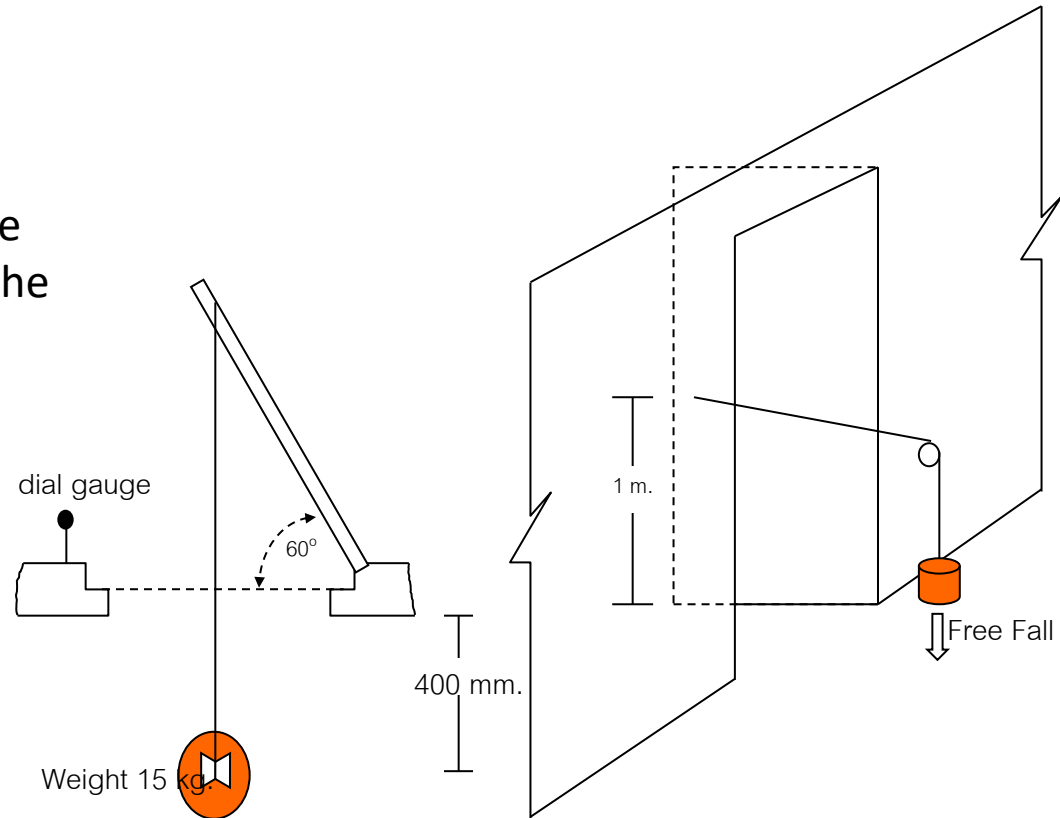
- 3. **Large soft body impact** - two levels of impact are applied the first to assess the resistance to aesthetic damage and the second to assess the resistance to structural damage.



Large Soft Body Impact Test

Partition Grade Test

4. **Door slamming-** a door built within the partition system is mechanically slammed and the deformation and damage on the partition system assessed.



Door Slamming Test

2. DESIGN CONSIDERATION

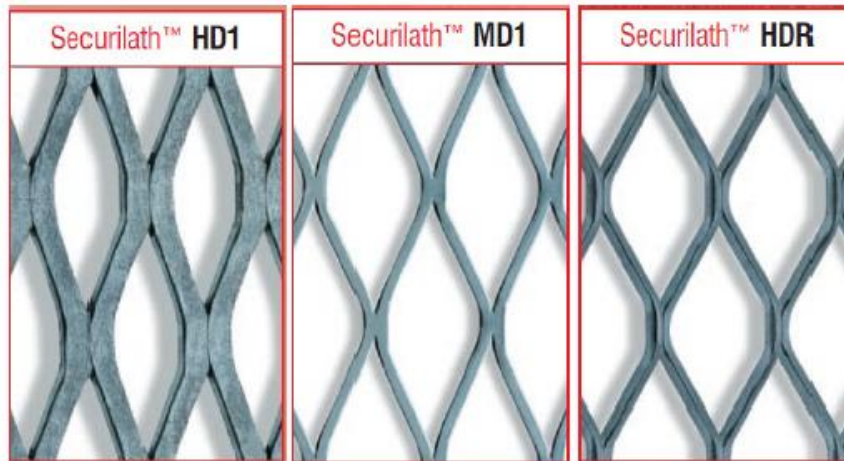
2.2 Impact

Inter-tenancy wall security



2. DESIGN CONSIDERATION

2.2 Impact - Inter-tenancy wall security



Product Reference	Application	Material Finish	Production Process	Weight kg/m ²	Stock Sheet Sizes (mm)
HD1	Heavyweight option for security in walls, partitions and ceilings.	Mild Steel Galvanised Painted	3mm thick flattened mesh	8.59	2440 x 1220 LW SW
MD1	Lighter weight option for security in walls, partitions and ceilings and roofs.	Mild Steel Galvanised Painted	1.2mm thick flattened mesh	1.85	2440 x 1220 1220 x 2440 LW SW
HDR	For internal/external brick or block walls. An excellent key for plaster/render finishes.	Mild Steel Galvanised* Painted	3mm thick standard profile mesh, raised edge for rendering	6.52	2440 x 1220 LW SW



TYPICAL APPLICATIONS

- Cash Handling Stores
- Wholesale and Retail Outlets
- Control Rooms
- Petrol Station Kiosks
- Firearm Stores
- High Value Goods Stores
- Computer Rooms
- Secure Units
- Remote Facility
- Security Pharmaceutical Stores

2. DESIGN CONSIDERATION

2.2 Impact - Inter-tenancy wall security

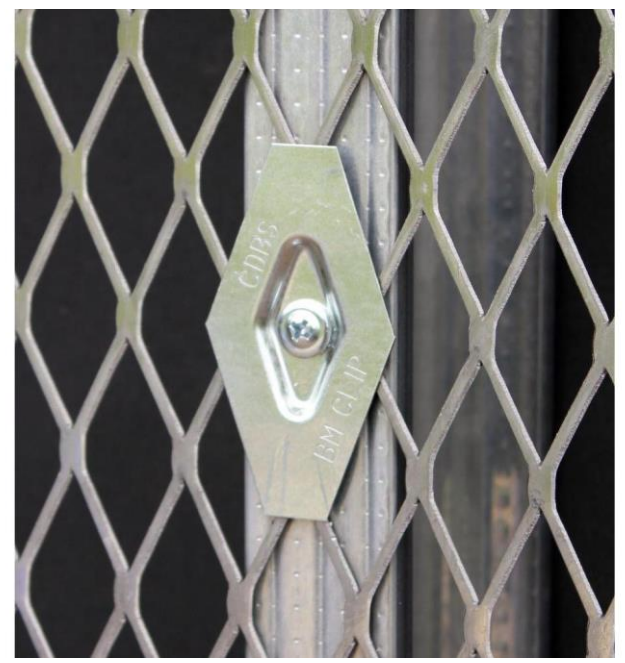


Mesh Incorporated to Drywall Design for Security



Incorporation of Security Mesh as Reinforcement

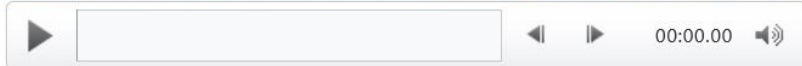
Fastening of Mesh to Steel Stud Framing



2. DESIGN CONSIDERATION

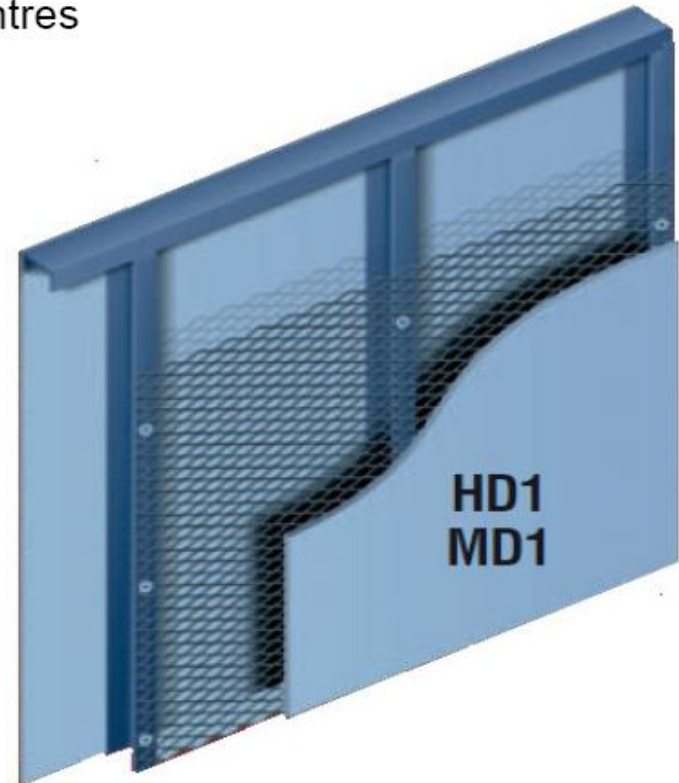
2.2 Impact

Inter-tenancy wall security



STEEL MESH - METAL STUD WALLS

Fix to studs using #6 x 30mm zink plated self tapping screws complete with 25mm di x 1.5mm washers at maximum 450mm centres



2. DESIGN CONSIDERATION

2.3 Fire Resistance

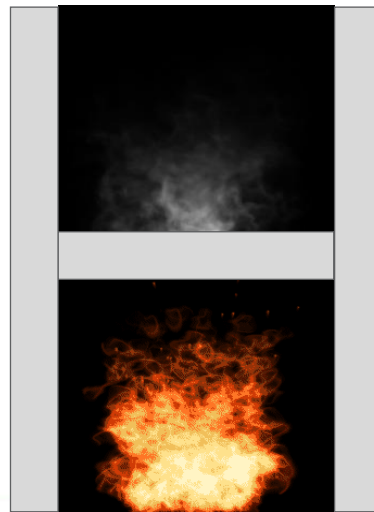
Up to 4 hours fire rating
Non-combustible board

*Load bearing capacity
under fire*



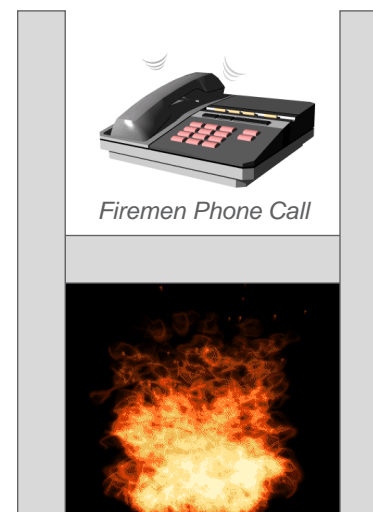
1: Loadbearing capacity

*Tightness against flames
and flammable gas*



2: Integrity

*Elevation of temperature
 $\leq 140^{\circ}\text{C}$ (average) and
 $\leq 180^{\circ}\text{C}$ (max)*



3: Insulation

2. DESIGN CONSIDERATION

2.3 Fire Resistance

FIRE RESISTANCE - Criteria

Loadbearing capacity (R) or **FRL x/-/-** ✓

The system can no longer carry the load applied on it.

Integrity (E) or **FRL -/x/-** ✓

Cracks or openings developed that allow the passage of flames or hot gasses.

Insulation (I) or **FRL -/-/x** ✓

The unexposed face temperature rises by more than 140° C (250° F) on average or 180° C (325° F) for a single point.

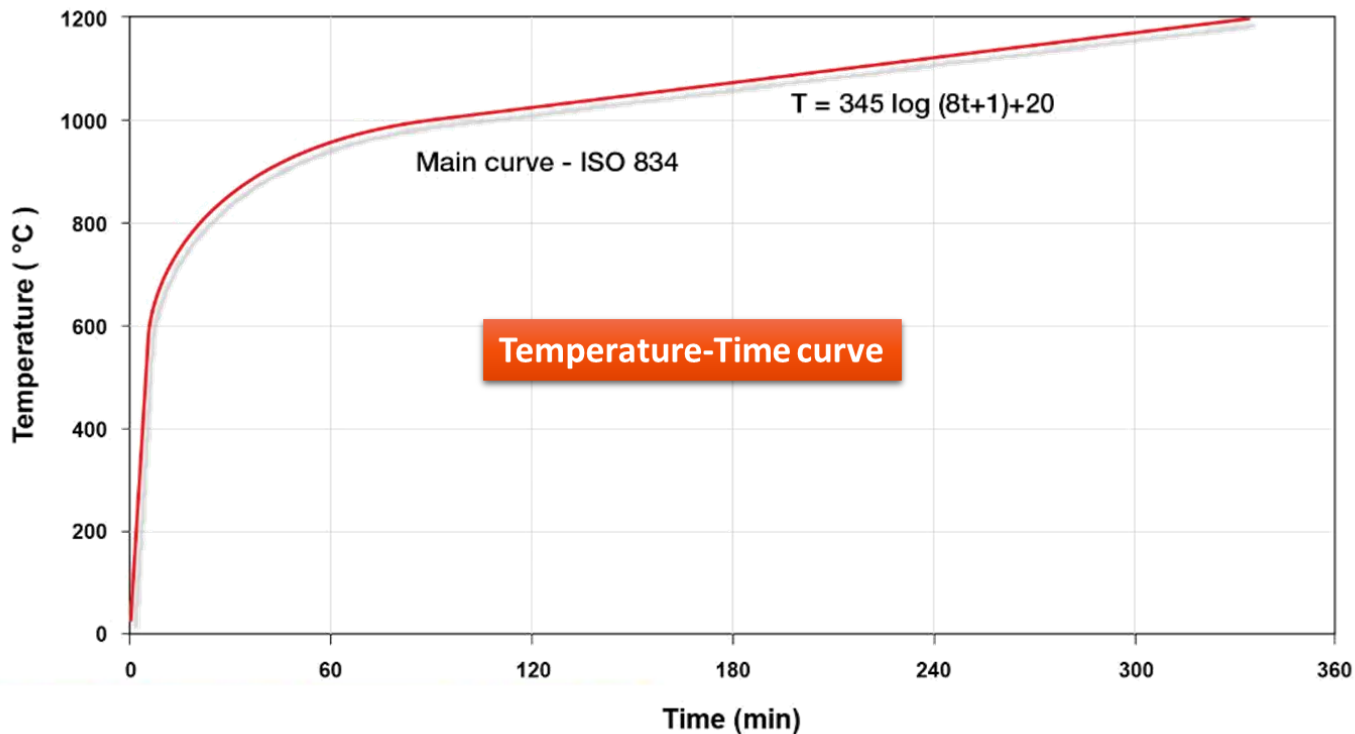


- **Factors to consider when designing fire resistance drywall partition**

2. DESIGN CONSIDERATION

2.3 Fire Resistance

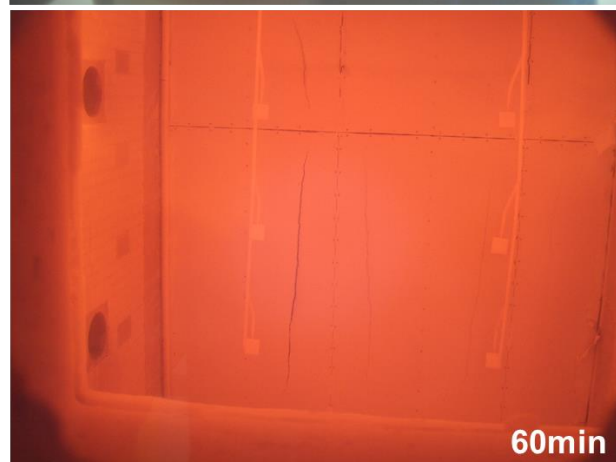
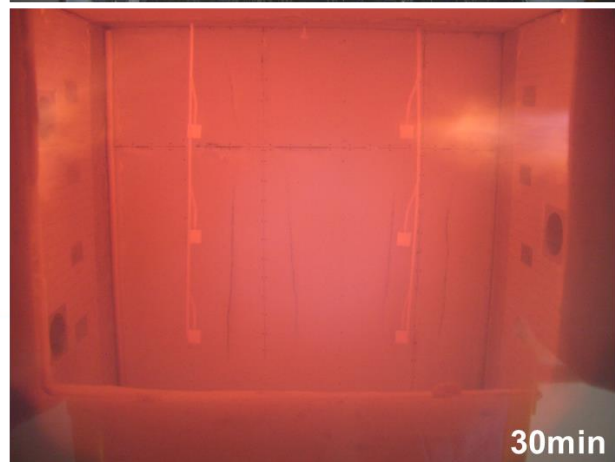
FIRE RESISTANCE TEST



5min:	555C
10min:	660C
30min:	820C
60min:	925C
90min:	985C
120min:	1030C
180min:	1090C
240min:	1130C

2. DESIGN CONSIDERATION

2.3 Fire Resistance

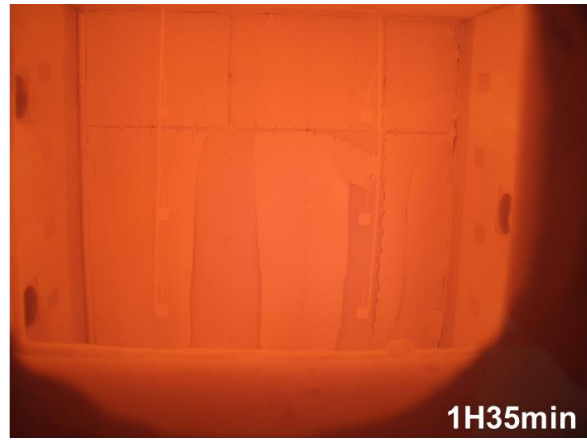


2. DESIGN CONSIDERATION

2.3 Fire Resistance



1H10min



1H35min



2H05min



2:09:25 End

2. DESIGN CONSIDERATION

2.3 Fire Resistance



Unexposed surface of the specimen after the test – 1H



Exposed surface of the specimen after the test-1H
2 exposed layers have fallen, as well as the inner layer of the non-exposed face

2. DESIGN CONSIDERATION

2.3 Fire Resistance

<https://www.youtube.com/watch?v=Ga20jKMZ9VA>

DID YOU KNOW?

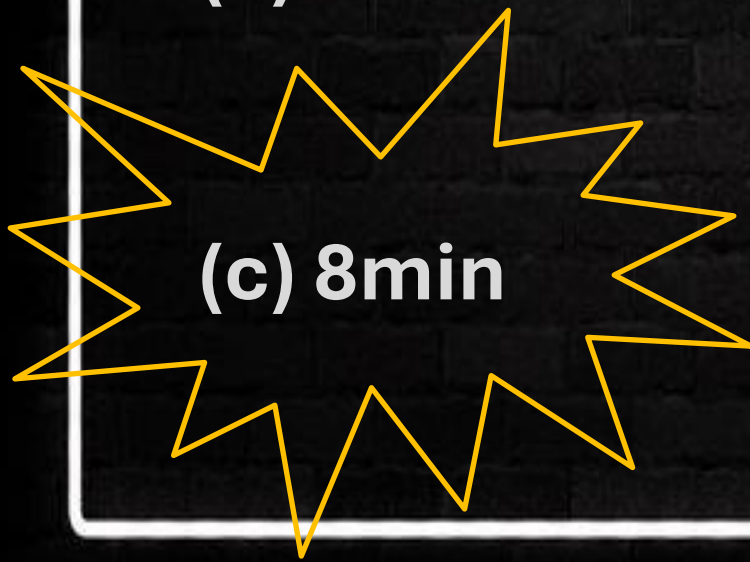
Q: What is the response time for SCDF ?

(a) 3min

(b) 5min

(c) 8min

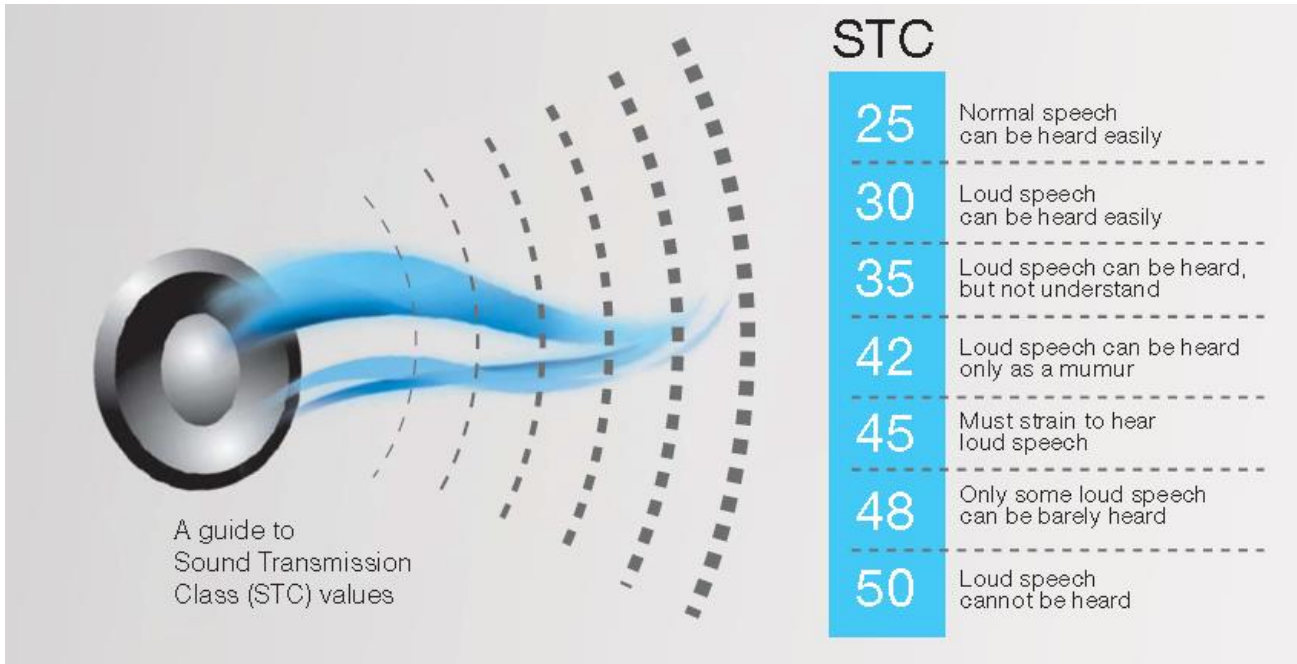
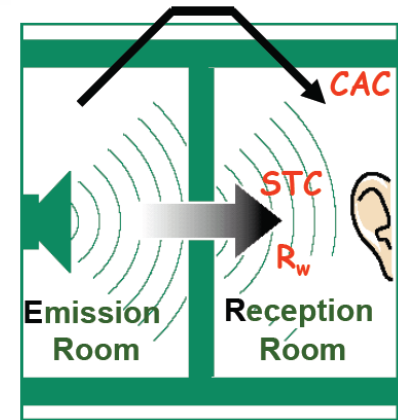
(d) 12min



2. DESIGN CONSIDERATION

2.4 Acoustic

Noise control from both interior and exterior
Ability to develop quiet zones



Frequency (Hz)	
Octive Bands (Hz)	1/3 Octive Bands (Hz)
63	63
	80
	100
125	125
	160
	200
250	250
	315
	400
500	500
	630
	800
1000	1000
	1250
	1600
2000	2000
	2500
	3150
4000	4000
	5000
	6300
8000	8000
	10000
	12500

<https://www.youtube.com/watch?v=OjHj0vvdO5M>

2. DESIGN CONSIDERATION

2.4 Acoustic

***dB** – **Decibel** is a [logarithmic unit](#) used to express the ratio between two values of a physical quantity, often [power](#) or [intensity](#).

CAC – **Ceiling Attenuation Class**, is the measurement for the performance of a ceiling.

***STC** – **Sound Transmission Class** is an [integer](#) rating of how well a [building partition](#) attenuates airborne [sound](#).

NRC – **Noise Reduction Coefficient** is the measure that a material has to absorb sound.







ASTM E90 (STC) / ISO 140 (Rw) / ASTM C423 (NRC)

2. DESIGN CONSIDERATION

2.4 Acoustic

What is sound?

- Sound = vibrations that travel through the air or another medium and can be heard when they reach a person's ear
- All sound is carried through air or other mediums as sound waves

<p>Frequency (pitch) The rate at which waves vibrate, measured as cycles per second, or hertz (Hz). Frequency roughly corresponds to our perception of pitch.</p>	 Low frequency (low-pitched sound)	 High frequency (high-pitched sound)
<p>Amplitude (loudness) The intensity of sound, usually measured in decibels (dB). Amplitude roughly corresponds to our perception of loudness.</p>	 High amplitude (loud sound)	 Low amplitude (soft sound)
<p>Complexity (timbre) Most sounds are a mixture of frequencies. The particular mixture determines the sound's timbre, or perceived uniqueness. Timbre provides information about the nature of a sound. For example, timbre allows us to distinguish the sound of a trombone from that of a violin playing the same note.</p>	 Simple	 Complex

2. DESIGN CONSIDERATION

2.4 Acoustic

□ Sound Insulation Ratings

Standard	Laboratory test ratings	Field test ratings
ISO based	R_w (Weighted sound reduction index) C_{tr} (Spectrum adaptation term) $L_{n,w}$ (Weighted normalised impact sound pressure level)	R'_w (Weighted apparent sound reduction index) $D_{nT,w}$ (Weighted standardized level difference) C_{tr} (Spectrum adaptation term)
ASTM based	STC (Sound Transmission Class) IIC (Impact Isolation Class)	FSTC (Field Sound Transmission Class) ASTC (Apparent Sound Transmission Class)

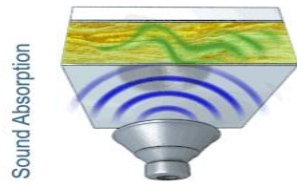
- How lightweight partitions work acoustically
- The role that insulation plays
- Good Construction Practice for Acoustic Isolation
- Assessment

2. DESIGN CONSIDERATION

2.4 Acoustic

Sound Isolation:
Relates to the actual reduction in sound traveling from one area to another through a wall, floor or ceiling.

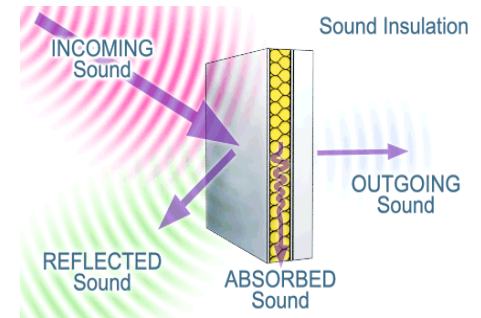
- **Sound Absorption:**
- Relates to the amount of reverberation (echo) within a room and its effect on sound quality and intelligibility.



OFFICE 1



OFFICE 2

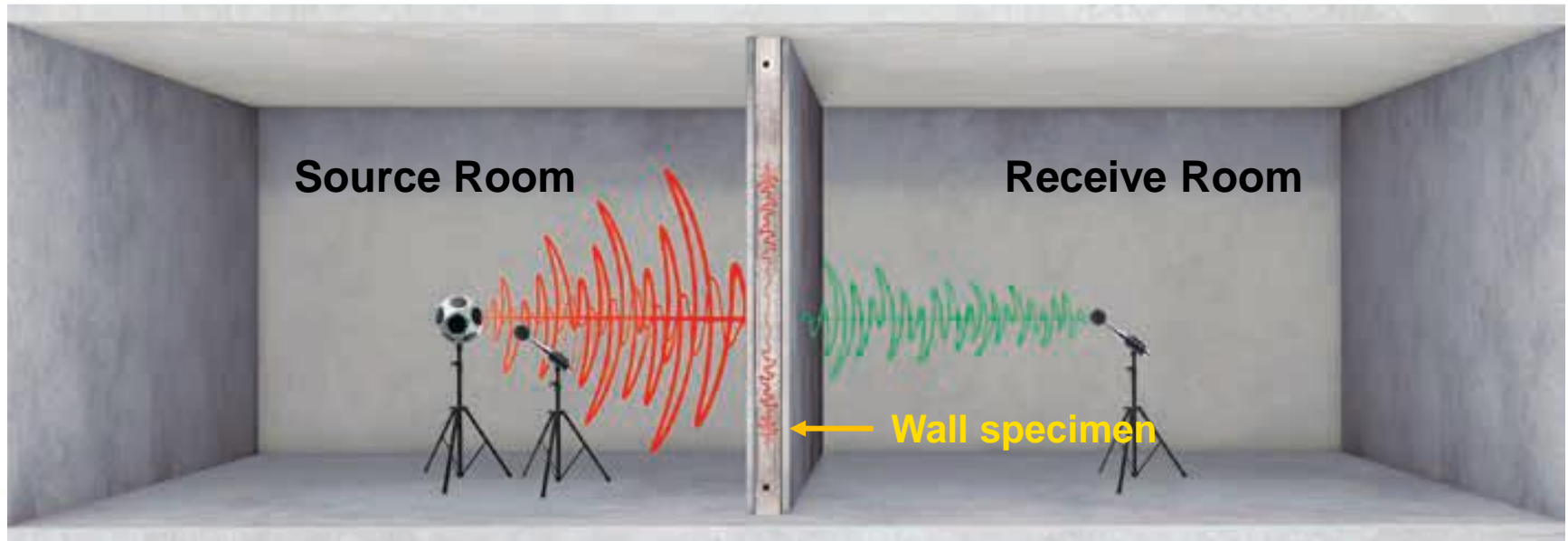


2. DESIGN CONSIDERATION

2.4 Acoustic

Sound insulation RATINGS

R_w & STC - it all starts with laboratory acoustic testing



2. DESIGN CONSIDERATION

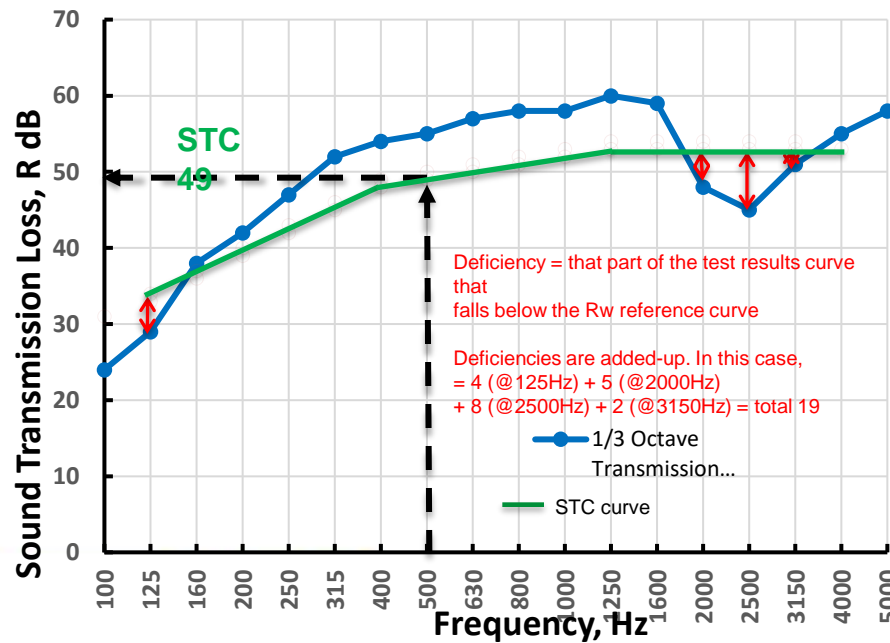
2.4 Acoustic

Sound insulation RATINGS

STC – there are a number of steps to determine the rating

Relevant Standard to determine STC

- ASTM E413 “Classification for Rating Sound Insulation”



STEP 1: Plot lab test results measured in third octave bands from 100Hz to 5000Hz

STEP 2: Apply STC reference curve
 Note: only takes into account 125Hz to 4000Hz
 (Rule to determine STC is ≤ 32 deficiencies allowed and max. 8dB at any one frequency)

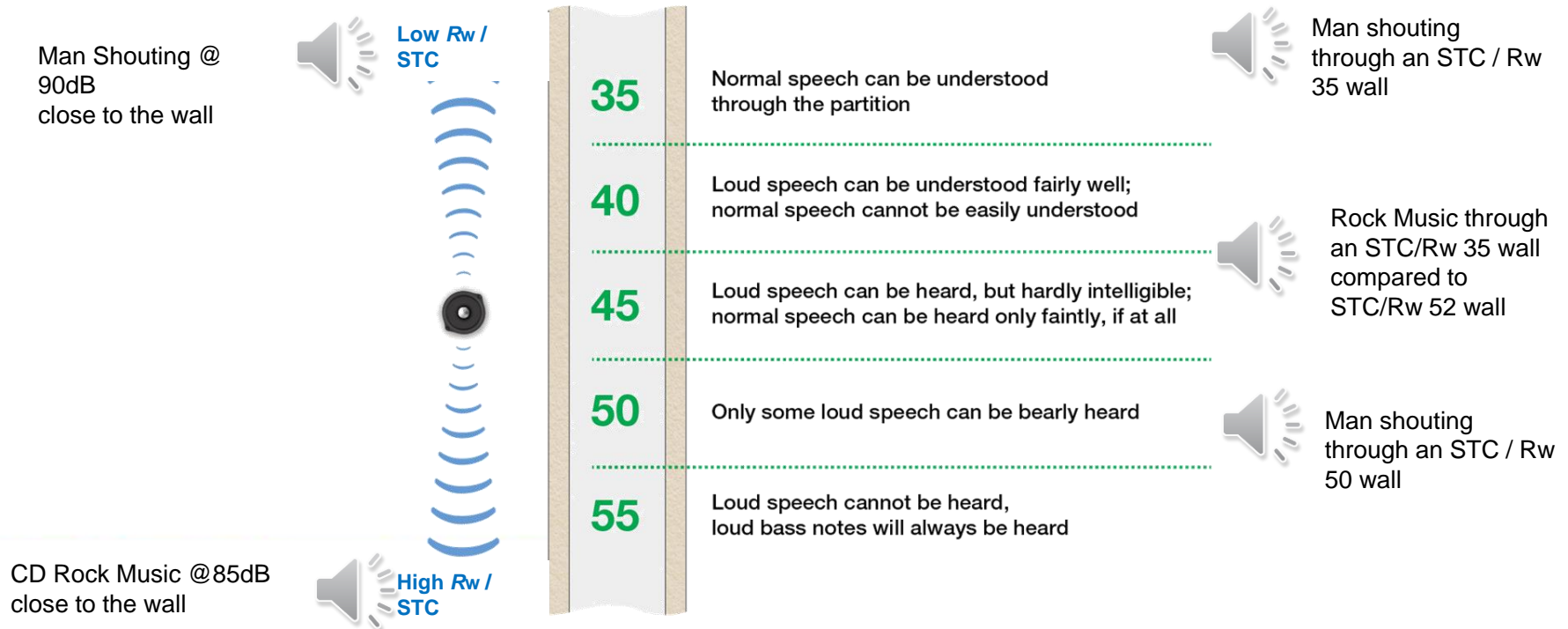
STEP 3: Read up from 500Hz to the STC reference curve and read across to determine the STC rating

2. DESIGN CONSIDERATION

2.4 Acoustic

Sound insulation ratings

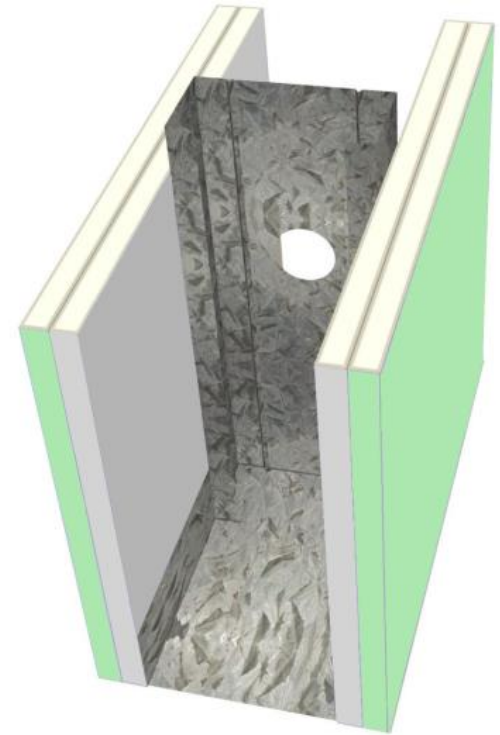
Rw & STC – is a good subjective guide when it comes to speech



2. DESIGN CONSIDERATION

2.4 Acoustic

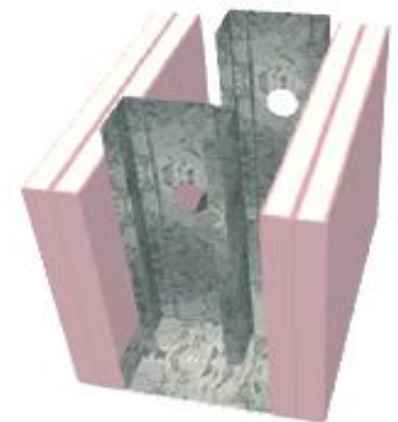
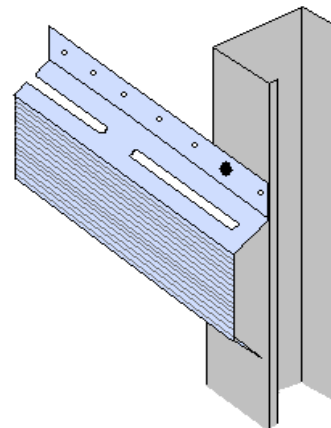
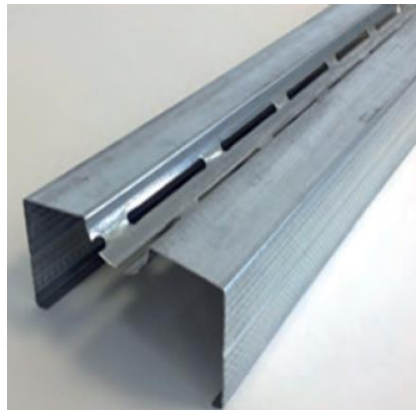
Noise control from both interior and exterior
Ability to develop quiet zones



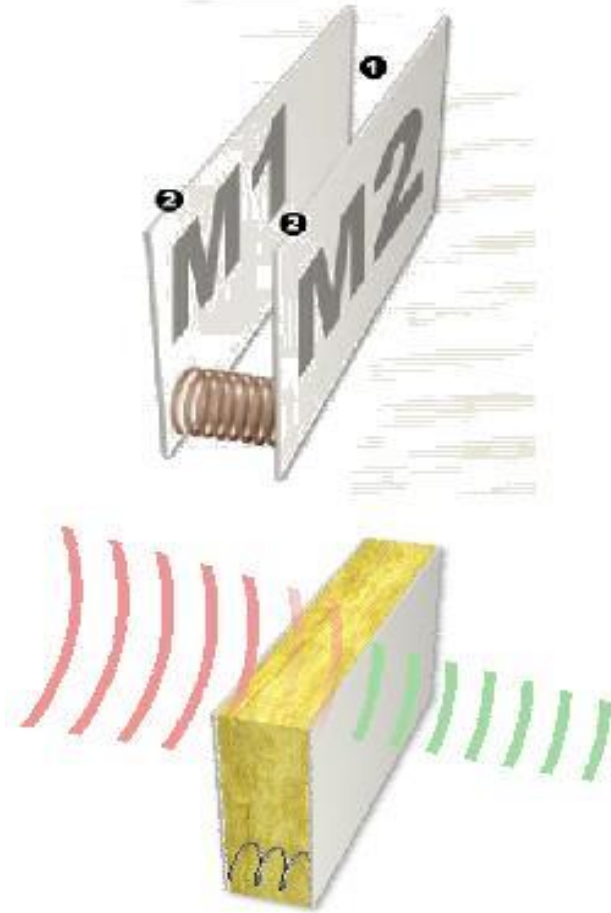
Boards



Studs



•MASS – SPRING – MASS THEORY



•OVERVIEW

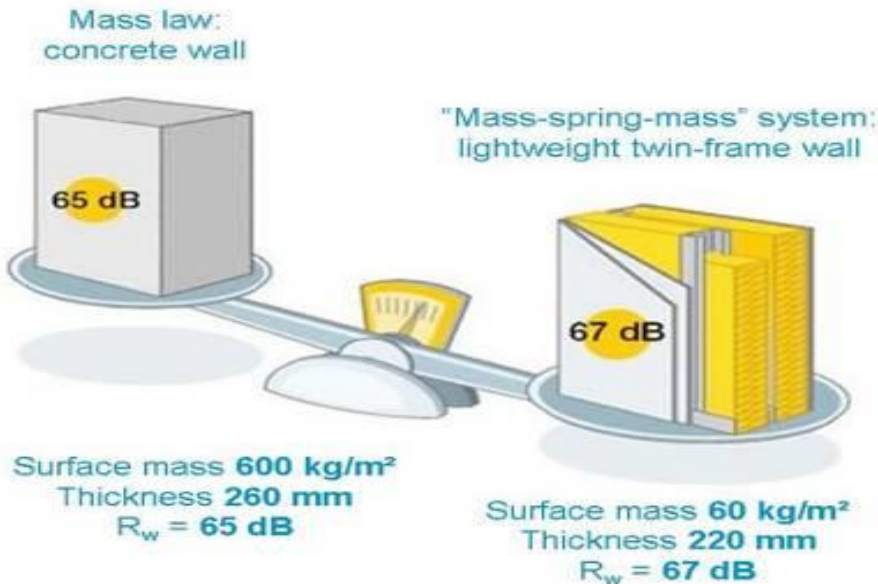
- Based on an ****acoustical theory** called **“mass-spring-mass”** system, it involves double partition leaves (lightweight drywall boards) with a cavity in-between.

- This principle constitutes the most effective and cost efficient acoustical performance for separating walls between adjacent rooms.

- Two **masses** marked **②** (board panels) M1 & M2 (left) shows with an air gap between **① (spring)** them.

- The sound insulation can be strongly improved by adding lightweight porous insulation material such as stonewool slab.

•MASS – SPRING – MASS SYSTEM VERSUS MASS LAW



With a "mass-spring-mass" system of equivalent thickness and for similar sound insulation performance, the wall weight is divided by 10.

•OVERVIEW

- Based on ****an acoustical theory** called "**mass-spring-mass**" system, it involves double partition leaves (lightweight drywall boards) with a cavity in-between.

- This principle constitutes the most effective and cost efficient acoustical performance for separating walls between adjacent rooms.

- Two **masses** marked **②** (board panels) M1 & M2 (left) shows with an air gap between **① (spring)** them.

- The sound insulation can be strongly improved by adding lightweight porous insulation material such as stonewool slab.

2. DESIGN CONSIDERATION

2.4 Acoustic – Acoustic Site Value [What is NIC]

Room-to-Room Privacy and Acoustical Design Criteria

J. T. Weissenburger, Engineering Dynamics International, St. Louis, Missouri

Table 1. Approximate relationship of Articulation Index (AI) to speech privacy, speaker speaking with raised voice; NIC values are recommended to assure degree of privacy; to be safe, STC ratings should be at least eight (8) points greater than NIC ratings.

Articulation Index	Degree of Privacy	Listener Conditions	Typical Subjective Response
0 to 0.05	A. Confidential STC > 55 (NIC > 47)	Cannot understand speech from adjacent room. May not be aware of the presence of others next door. May not hear activity sounds of others. Music usually can be heard, particularly when loud.	Complete privacy Sense of isolation No privacy complaints expected.
0.05 to 0.15	B. Normal STC 52 – 55 (NIC 44 – 47)	Occasionally hear the activity sounds of others in adjacent room. Aware of presence of others. Speech and machines audible, but not distracting. Music (usually) and other louder sounds can be heard.	Sense of privacy Some feeling of isolation No privacy complaints expected
0.15 to 0.20	C. Marginal STC 50 – 52 (NIC 42 – 44)	Aware of presence of others next door. Sense of community. Often hear activity sounds and voices of others. Conversations of others occasionally understood. Machines and speech audible and occasionally distracting.	Minimal sense of privacy Some loss of territory Privacy complaints may be expected
0.20 to 0.30	D. Poor STC 47 – 50 (NIC 39 – 42)	Continually aware of the presence of others. Activity sounds, speech and machines will be continually heard. Frequent distractions. expected.	Sense of community Loss of privacy Some loss of territory Privacy complaints
0.30 to 1.00	E. None STC < 47 (NIC < 39)	Conversation easily understood. Machine and activity sounds clearly audible. Total distraction from other tasks.	Sense of community Sense of intrusion on territory. No sense of privacy Many privacy complaints expected

2. DESIGN CONSIDERATION

2.4 Acoustic – Acoustic Site Test [What is NC]

The National Institutes of Health | Division of Technical Resources | Office of Research Facilities

Design
Requirements
Manual

News to Use

September 2019

Vol. 02, No. 33

The formulae $\frac{\partial p_i}{\partial x_j} + \frac{\partial}{\partial x_j}(\rho v_i v_j) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial v_i}{\partial x_j} \right) + g_i(\rho - \rho_0)$ for building $\frac{\partial}{\partial x_j}(\rho \bar{v}_i \bar{v}_j) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial \bar{v}_i}{\partial x_j} - \rho \bar{v}_i \bar{v}_j \right) + g_i(\rho - \rho_0)$ state of the art $\frac{\partial}{\partial x_i}(\rho \bar{v}_i \bar{v}_i) = \frac{\partial}{\partial x_i} \left(\lambda \frac{\partial \bar{v}_i}{\partial x_i} - \rho \bar{v}_i \bar{v}_i \right)$ biomedical research facilities.

Sound Design Metrics

NC is a measure of the background sound level in a space. According to Jonah Sacks, Principal Consultant at ACENTECH, dBA (A-weighted decibels) should be used to measure intrusive transient sounds and NC for steady background noise. Sacks says that this is because “Intrusive transient sounds, like voices, or a truck going by, or the bass beat of music, are more noticeable and disturbing than steady noise from HVAC.” He adds that while there is no perfect conversion, a rule of thumb is 35 dBA is about NC-30, which is roughly 5 points smaller for the same actual sound level.

2. DESIGN CONSIDERATION

2.5 Wet Area Usage

- Protection against steam & moisture
- Better mould resistance
- Better finishes



2. DESIGN CONSIDERATION

2.5 Wet Area Usage - Protection against steam & moisture, Better mould resistance & Better finishes

- *Yes, Drywall can be designed for moisture resistance requirement.*
- *But, why there are mold found on drywall?*
- *Because it wasn't designed to it. OR*
- *Due to site condition, that led to mold.*
- *Mold resistance drywall applies to: Bathroom, Toilet, etc*
- *Thermal performance drywall*
- *Mold resistance panel board does not guarantee a total mold resistance*

2. DESIGN CONSIDERATION

2.6 High Wall:

- Structural stability
- Higher productivity
- Better finishes

1. INTRODUCTION → QUICK RECAP

- Background of Drywall
- Types of Boards
- Overview of drywall build-up
- Drywall Adoption in Singapore
- Benefits to construction of the building

1. INTRODUCTION

** Drywall benefits the construction of the building include:

- Increase Buildability
- Increase Productivity
- Improve Quality



Conclusion: Drywall benefits the construction of the building include:

- Increase Buildability*
- Increase Productivity*
- Improve Quality*

2. DESIGN CONSIDERATION → QUICK RECAP

→ Architectural

→ Wet Area Usage

→ Impact Performance

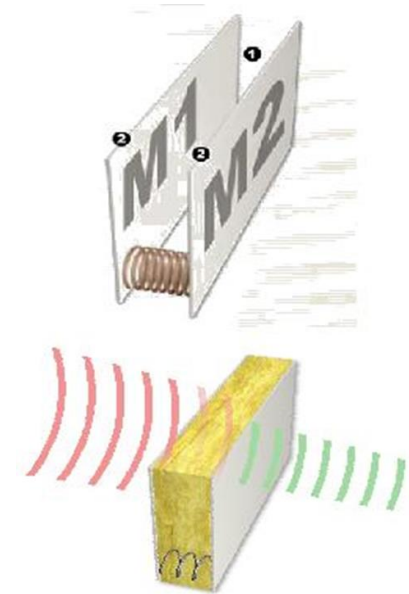
→ High Wall

→ Fire Resistance

→ Acoustic Performance

→ STC & dB

→ Acoustic Theory – Mass-Spring-Mass



Conclusion:

*The main design consideration is **Architectural Requirements**, NOT brand or cost.*

*The acoustic measurement unit is **dB** (decibel), NOT STC.*

*The **acoustic theory** ‘mass-spring – mass’*

CONTENTS

1. INTRODUCTION ✓

2. DESIGN CONSIDERATION ✓

3. MATERIAL SELECTION

4. DELIVERY, HANDLING AND STORAGE OF MATERIALS

5. PREPARATORY WORKS

6. INSTALLATION PROCEDURES

7. PROTECTION

8. WET AREAS APPLICATION

9. AN OVERVIEW OF DRYWALL IN PBU / PPVC

10. TYPES OF PBU / PPVC

11. REQUIREMENT OF DRYWALL PBU / PPVC



Learning outcomes

By the end of this session, you should be able to:

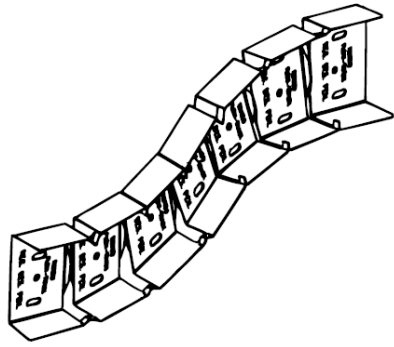
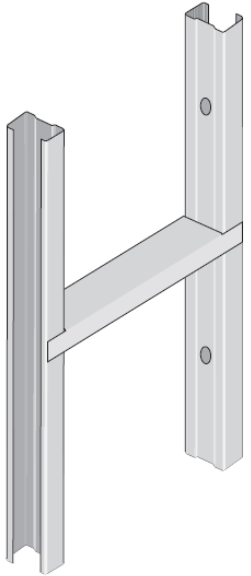
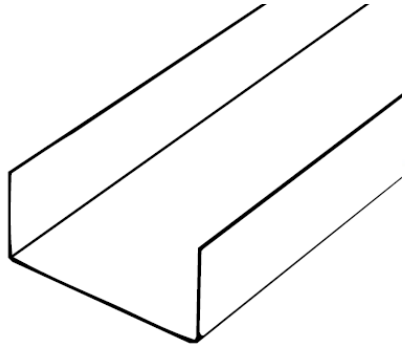
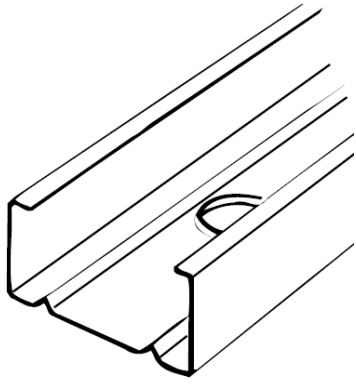
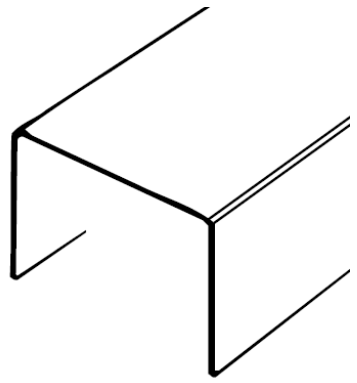
Materials selection for various Architectural designs.

3. MATERIAL SELECTION

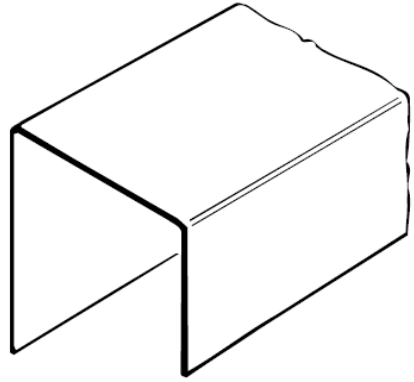
- 3.1 Framing system**
- 3.2 Boards Usage**
- 3.3 Infill and Insulation Material**
- 3.4 Joint Materials**
- 3.5 Accessories**
- 3.6 Tools**

3. MATERIAL SELECTION

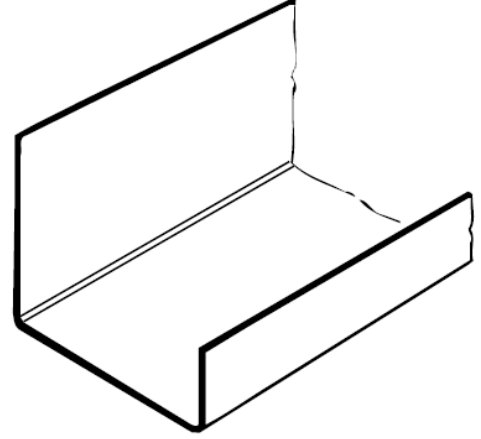
3.1 Framing System



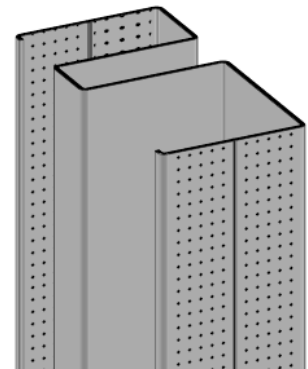
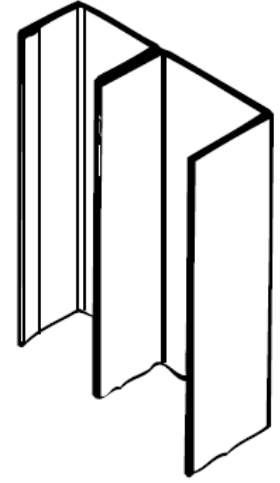
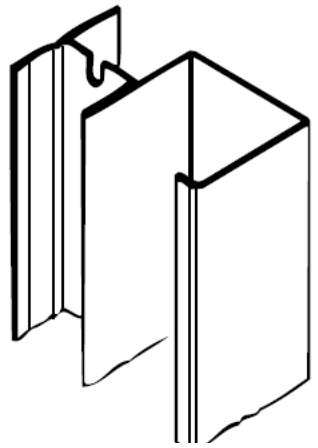
FLEXIBLE TRACK



J RUNNER



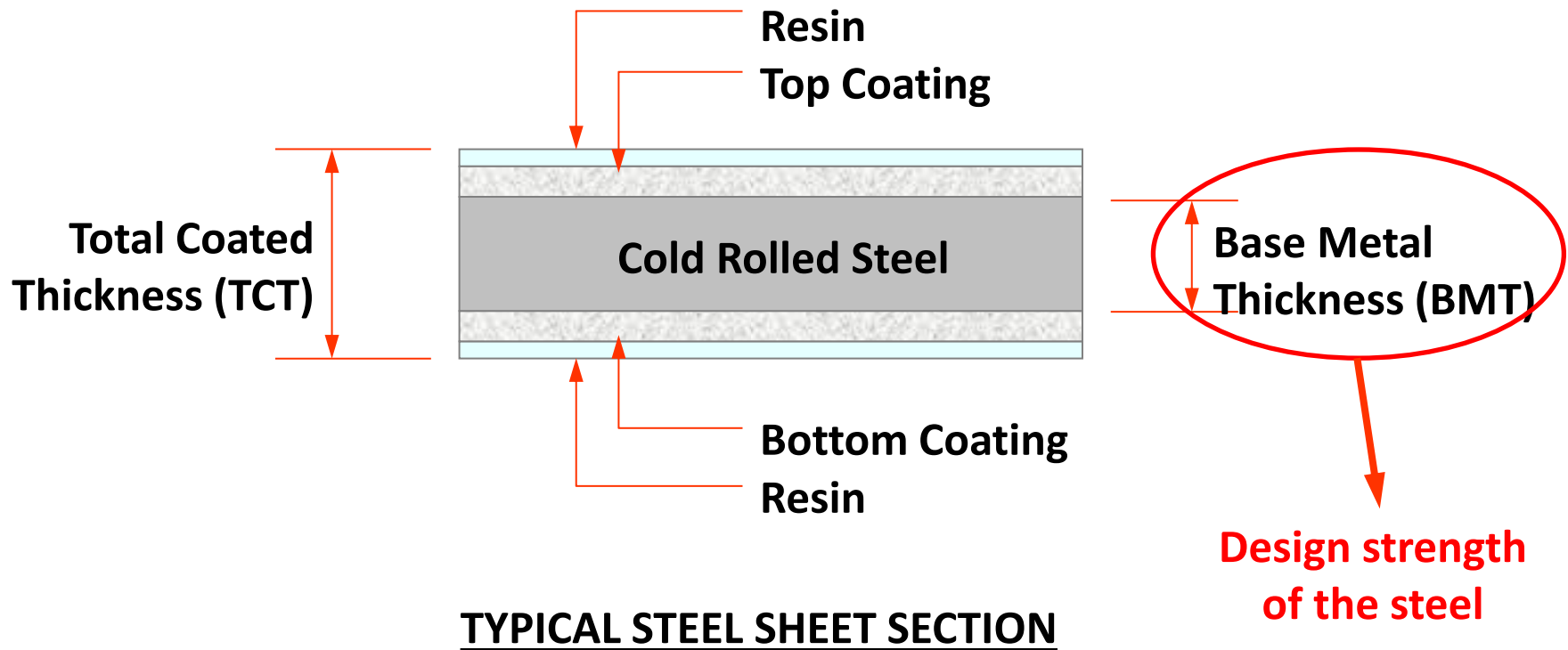
E STUD



3. MATERIAL SELECTION

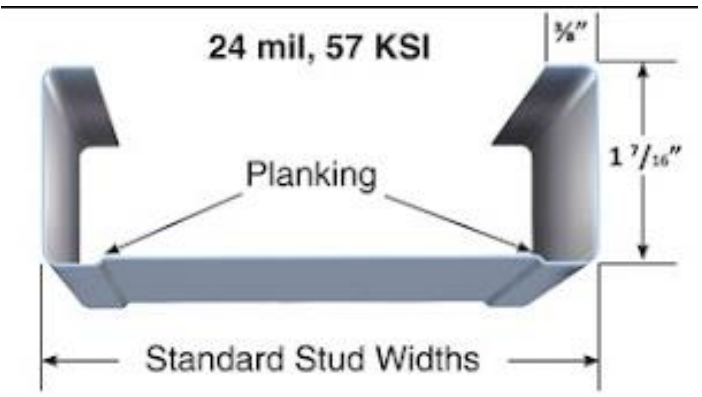
3.1 Framing System

What is steel Thickness (BMT or TCT)?



3. MATERIAL SELECTION

3.1 Framing System – Galvanised & Zincalume Coated



3. MATERIAL SELECTION

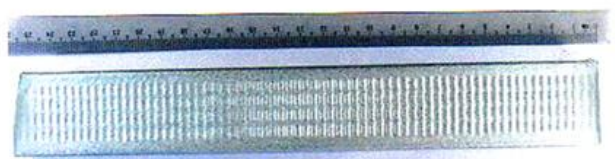
3.1 Framing System – Galvanised & Zincalume Coated

PSB Corporation

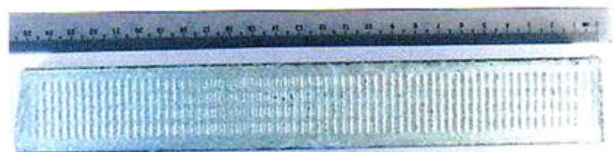
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Page 3 of 4

72 hours Salt Spray Test - Specimen 1



SPECIMEN 1 BEFORE TEST



SPECIMEN 1 AFTER 72 HOURS SALT SPRAY TEST

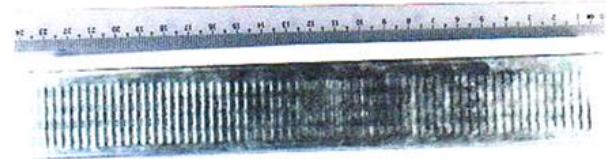
Handwritten signature

PSB Corporation

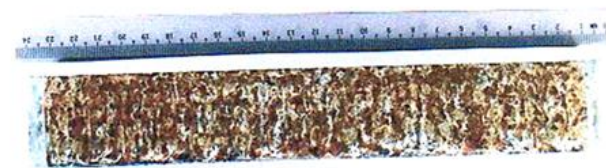
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Page 3 of 4

72 hours Salt Spray Test - Specimen 1



SPECIMEN 1 BEFORE TEST



SPECIMEN 1 AFTER 72 HOURS SALT SPRAY TEST

Handwritten signature

72 Hours Salt-Spray Test – [ASTM B117]

3. MATERIAL SELECTION

3.2 Board Usage

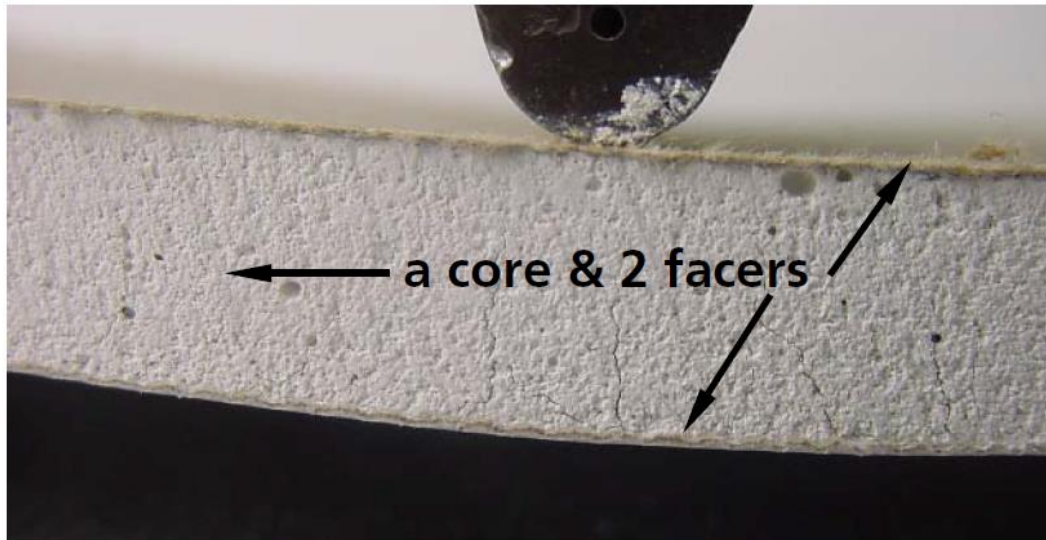


<https://www.youtube.com/watch?v=sUCfQPcnllk>

3. MATERIAL SELECTION

3.2 Board Usage

⚙️ A plasterboard is composed of ...



- core quality = fire, acoustic, hardness, water resistance
- paper quality = response to fire, paint finish

3. MATERIAL SELECTION

3.2 Board Usage

STD board recipe



Mold resistant

Anti-mold agent

Moisture resistant

Wax / Silicon

Fire resistant

Glass fiber, Clay, Vermiculite

Fire moisture resistant

Glass fiber, Clay, Vermiculite, and Wax

Acoustic

More gypsum and Clay for higher density

Wet area (WAB)

Wax, Glass fiber, Anti-mold agent



3. MATERIAL SELECTION

3.2 Board Usage

Edge Type



Square edge (SE)

Application: Wall & ceiling

Feature: Suitable for 1st layer and for wall paper finishing

- Korea: 85% of PB with square edge



Tapered edge / Recess edge (TE / RE)

Application: Wall & ceiling

Feature: Suitable for smooth surface finishing with paint

- Most common in the market: 95% of PB with tapered edge



Beveled edge

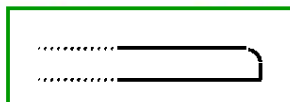
Application: Wall (shaft wall)

Feature: Suitable for Shaft wall installation (CH stud)

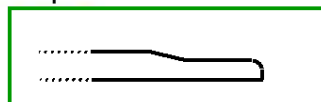
- Mainly used for 25mm (1 inch) shaft liner board

Other edge type

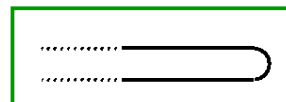
1/4 round



Tapered and 1/4 round



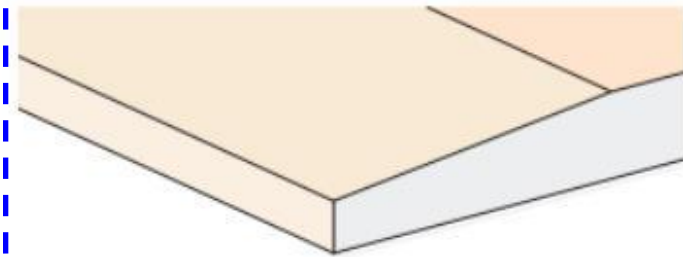
Round



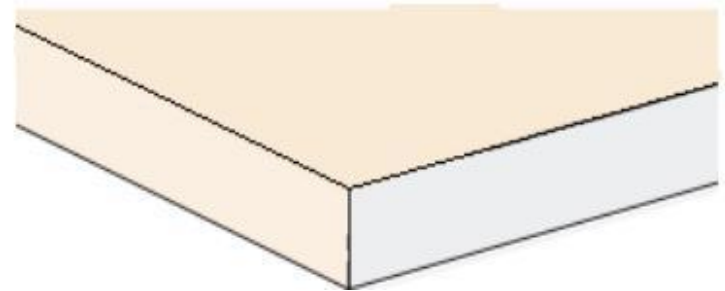
3. MATERIAL SELECTION

3.2 Board Usage

Tapered Edge

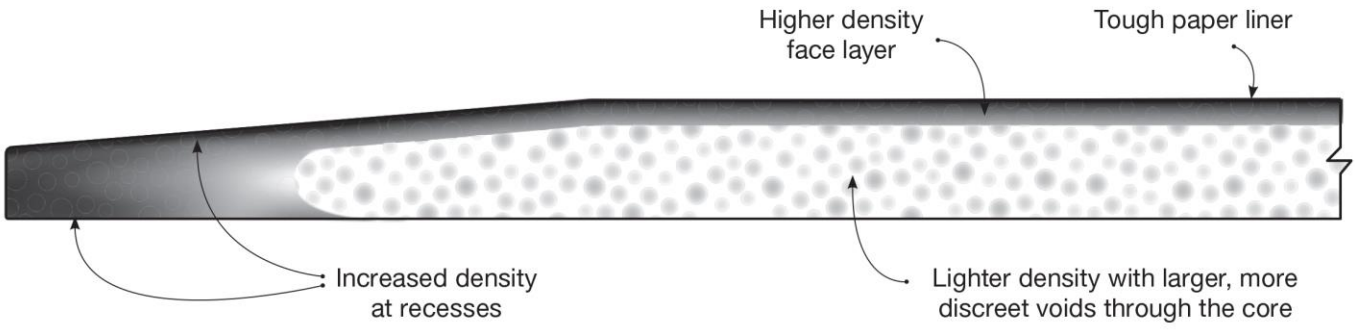


Square Edge



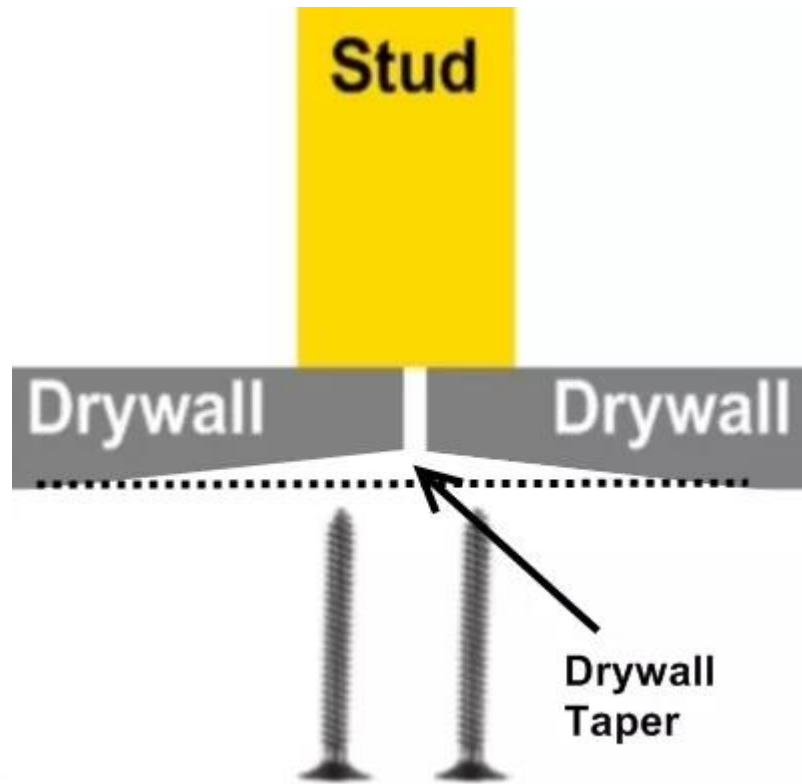
3. MATERIAL SELECTION

3.2 Board Usage



3. MATERIAL SELECTION

3.2 Board Usage



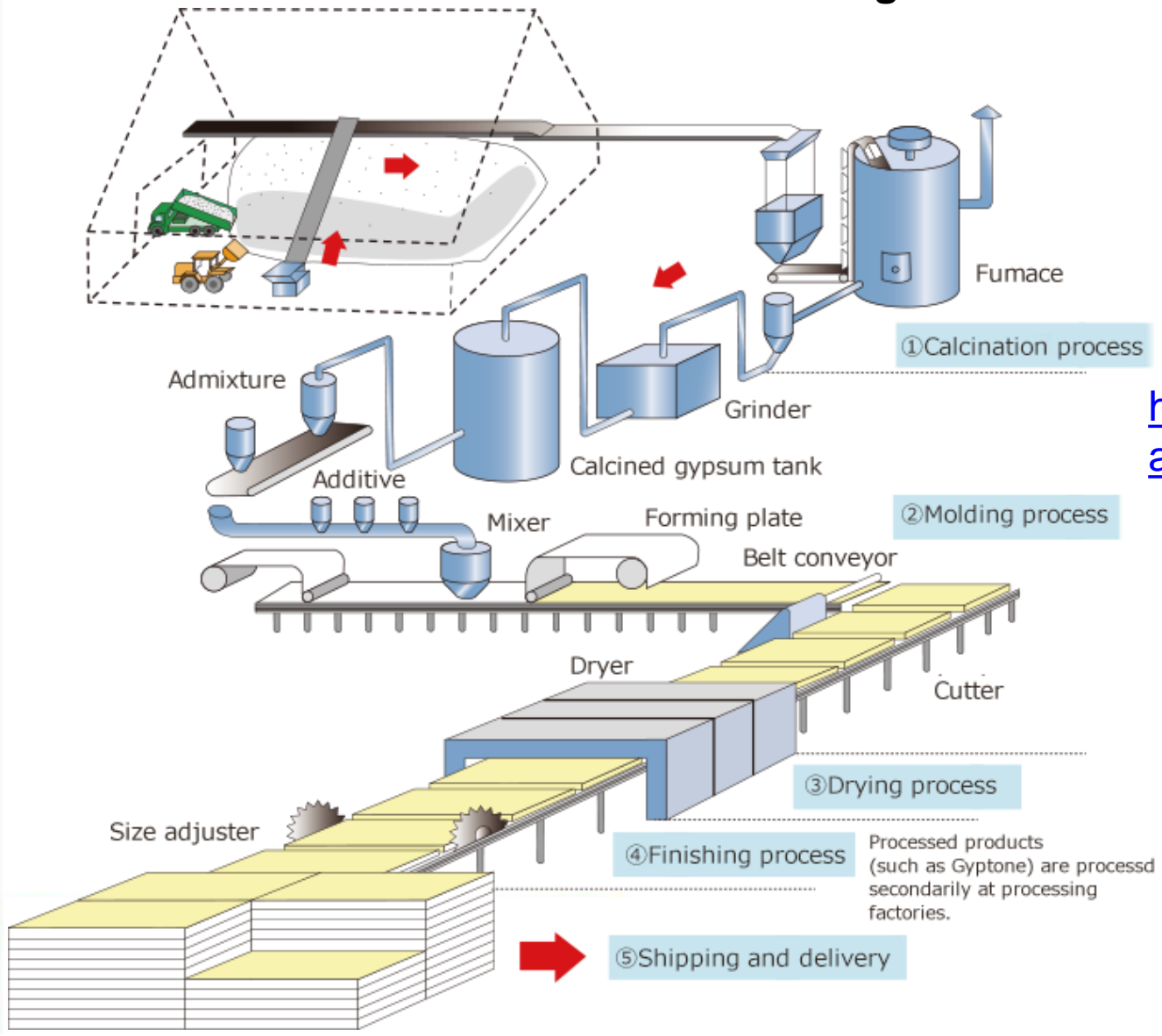
3. MATERIAL SELECTION

3.2 Board Usage



3. MATERIAL SELECTION

3.2 Board Usage



<https://www.youtube.com/watch?v=46OwU7zGMIw>

Processed products (such as Gyptone) are processed secondarily at processing factories.

3. MATERIAL SELECTION

3.3 Infill and Insulation Materials

Ensure all infill and insulation materials used are non-combustible.



3. MATERIAL SELECTION

3.4 Type of Joint Materials



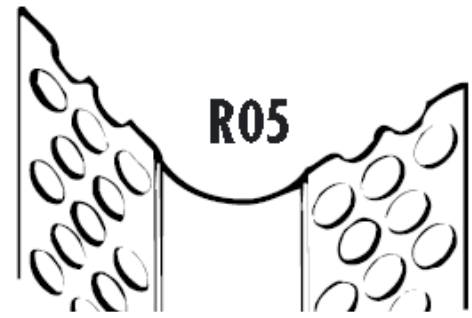
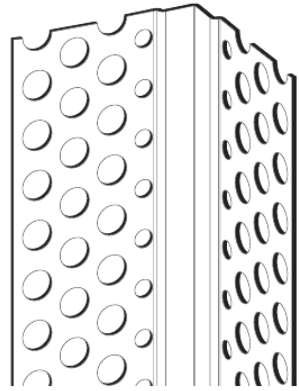
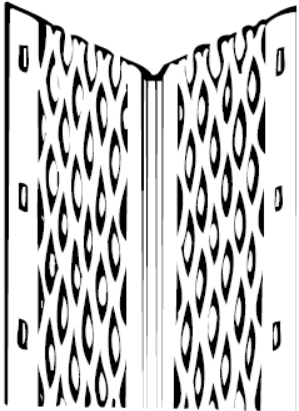
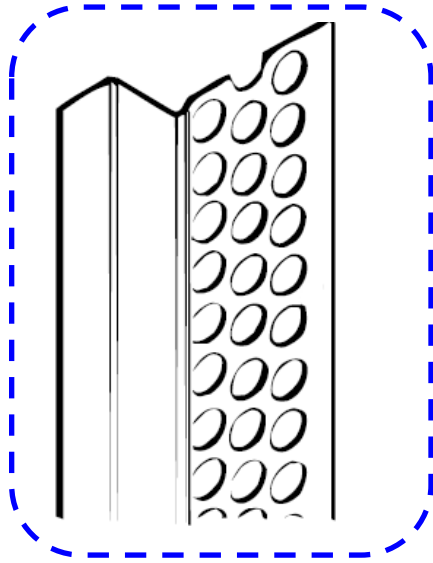
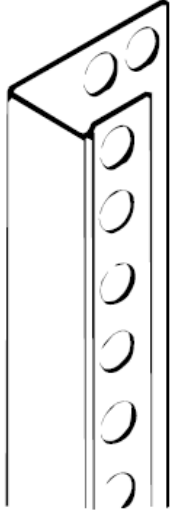
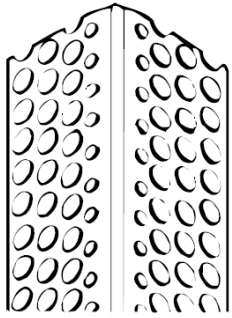
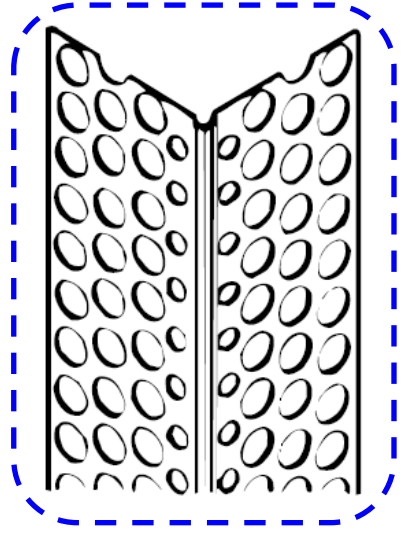
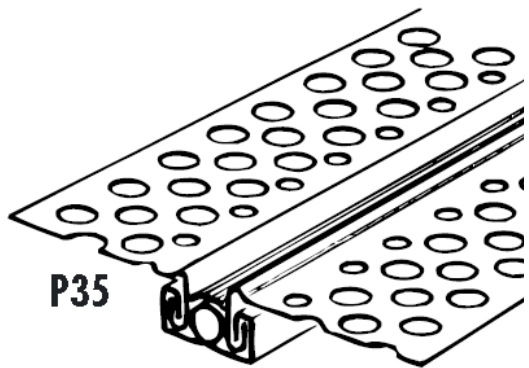
3. MATERIAL SELECTION

3.4 Type of Joint Materials



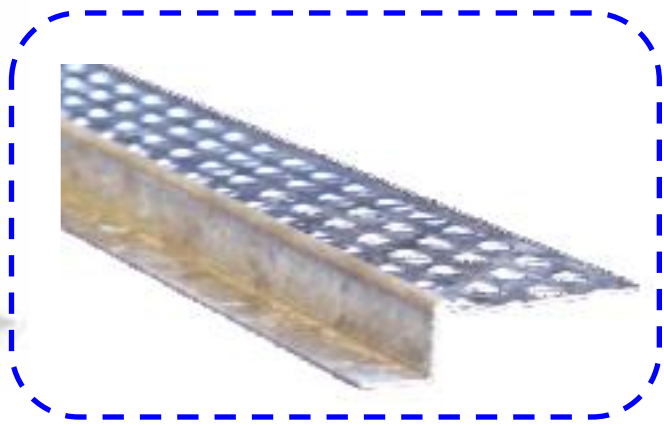
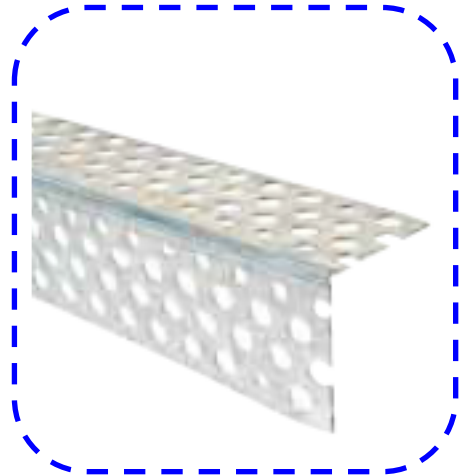
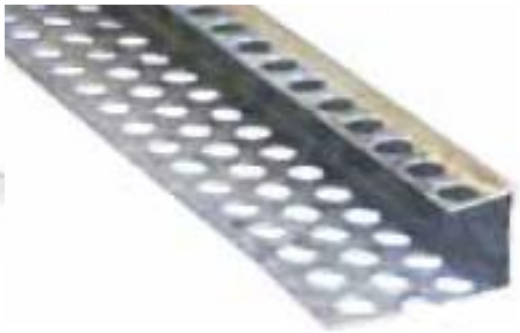
3. MATERIAL SELECTION

3.5 Accessories



3. MATERIAL SELECTION

3.5 Accessories



3. MATERIAL SELECTION

3.5 Accessories



3. MATERIAL SELECTION

W Type



Application / Use

Recommended for fixing single or multi-layer plasterboard to timber only.

Size 6g **Std lengths** 25mm-60mm **Packaging** Packs of 1000.

S Type



Application / Use

For steel BMT* up to 0.8 mm. Recommended for fixing single or multi-layer plasterboard to timber and light gauge metal framing up to 0.8 mm.

Size 6g **Std lengths** 25mm-50mm **Packaging** Packs of 1000.

D Type



Application / Use

For steel BMT* 0.8mm - 2.00mm. Used for fixing single and multi-layer plasterboard to heavy gauge metal framing or studs up to 2mm (14 gauge).

Size 6g **Std lengths** 25mm and 45mm.

L Type



Application / Use

Used for laminating plasterboard to plasterboard multi-layer systems.

Size 10g x 40mm, 6g x 50mm **Packaging** Packs of 400 to 1000 depending on length.

FibreTek



Application / Use

Used with fibre cement board.

*Base Metal Thickness

3. MATERIAL SELECTION

3.6 Tools Selection

- Appropriate tools
- Proper maintained
- Cleaned daily
- Stored dry & safe






3. MATERIAL SELECTION

3.6 Tools Selection






3. MATERIAL SELECTION

3.6 Tools Selection

<p>List of tools</p>	<p>Measuring tape</p> 	<p>Carpenter's pencil</p> 	<p>Plumb bob</p> 
<p>Usage</p>	<p>To measure dimension of various materials</p>	<p>To mark the length before cutting</p>	<p>To transfer set out marks from the floor to the ceiling and vice versa</p>

3. MATERIAL SELECTION

3.6 Tools Selection

<p>List of tools</p>	<p>Plastering knife</p> 	<p>Plastering hawk</p> 	<p>Spirit level</p> 
<p>Usage</p>	<p>To apply joint compound to plasterboard</p>	<p>To transfer joint compound from its container to plasterboard</p>	<p>To ensure verticality and alignment</p>

3. MATERIAL SELECTION

3.6 Tools Selection

<p>List of tools</p>	<p>Aviation snipper</p> 	<p>Hammer</p> 	<p>Drill & Drill Bit</p> 
<p>Usage</p>	<p>To snip tracks, bracings and studs into appropriate sizes</p>	<p>To anchor framing onto ground with nails</p>	<p>To fasten tracks, studs, bracings and boards into position</p>

3. MATERIAL SELECTION

3.6 Tools Selection

List of tools	<p>Crowbar</p> 	<p>Crimper</p> 	<p>Ink pad</p> 
Usage	<p>To adjust plasterboard into position</p>	<p>To join stud and track together</p>	<p>To mark out setting out position</p>


3. MATERIAL SELECTION

3.6 Tools Selection

<p>List of tools</p>	<p>Builder's square</p> 	<p>Flat file</p> 	<p>Auto-level</p> 
<p>Usage</p>	<p>To verify right angle</p>	<p>To file plasterboard and tracks/studs</p>	<p>To make setting out position</p>

3. MATERIAL SELECTION

3.6 Tools Selection

<p>List of tools</p>	<p>Ladder or bench</p> 	<p>Mitre Saw</p> 	<p>Fastener</p> 
<p>Usage</p>	<p>To access to top track/ runner and top of board</p>	<p>To make accurate crosscuts</p>	<p>To secure boards</p>

CONTENTS

1. INTRODUCTION
2. DESIGN CONSIDERATION
3. MATERIAL SELECTION
4. DELIVERY, HANDLING AND STORAGE OF MATERIALS
5. PREPARATORY WORKS
6. INSTALLATION PROCEDURES
7. PROTECTION
8. WET AREAS APPLICATION
9. INTRODUCTION OF PBU
10. TYPES OF PBU
11. REQUIREMENT OF DRYWALL PBU

Learning outcomes

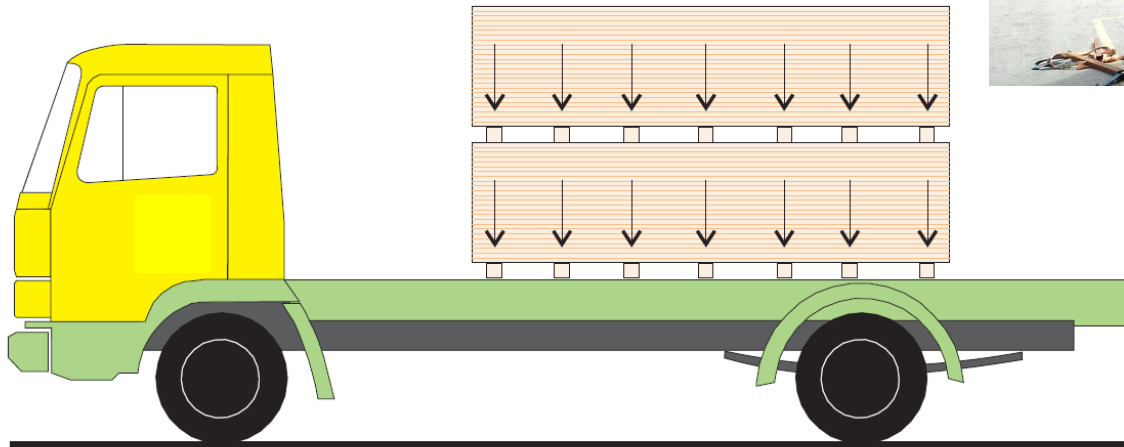
By the end of this session, you should be able to:

Good Practice on materials delivery, handling and storage.

4. DELIVERY, HANDLING AND STORAGE

Proper delivery, handling and storage procedures and relevant good practices are important to ensure materials are not damaged prior to installation.

4.1 Delivery



4. DELIVERY, HANDLING AND STORAGE

4.1 Delivery



4. DELIVERY, HANDLING AND STORAGE

4.2 Handling

STORYBOARD

BEFORE USE THE SHEET MATERIAL IS NORMALLY STACKED. THE SHEET MUST BE SEPERATED FROM THE STACK BEFORE PICKING IT UP.

THE MATERIAL MUST BE THEN BROUGHT TO AN UPRIGHT POSITION SO AS IT CAN BE GRIPPED.

LARGE MATERIAL FORCES ARMS AND BODY TO TWIST DURING LIFTING. ALSO THE GENERALLY ROUGH TERRAIN OF BUILDING SITES MAKES IT MORE HAZARDOUS.

THE LENGTH OF SHEETS CAN POSE AS A DIFFICULTY FOR BALANCE AND CONTROL

IDEALLY, FOR SAFE LIFTING THE ARM SPAN SHOULD BE GREATER THAN THE SHEET

THE SIZE ALSO MAKES IT NECESSARY TO HAVE MULTIPLE HELPERS TO DISTRIBUTE FORCE EVENLY AROUND THE SHEET TO HOLD IN PLACE FOR WORKING ON IT

4. DELIVERY, HANDLING AND STORAGE

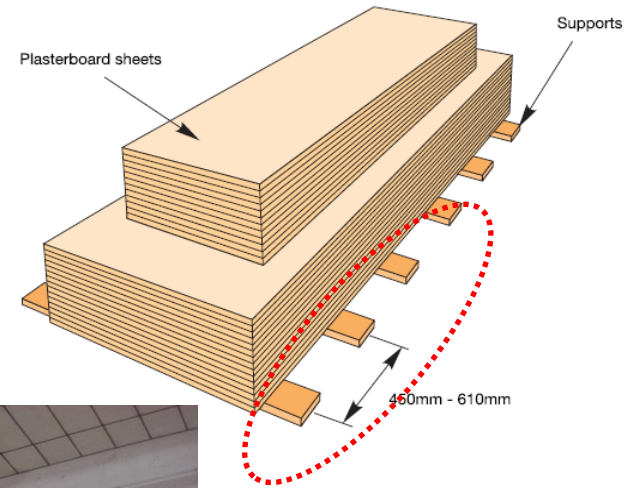
4.2 Handling

- **When handling long a board, 2 people is recommended**



4. DELIVERY, HANDLING AND STORAGE

4.3 Storage



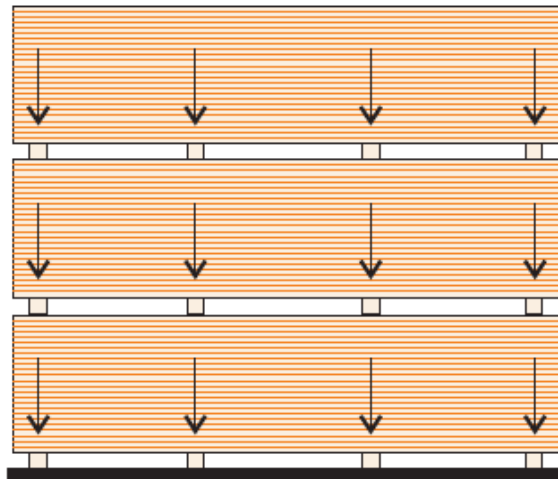
4. DELIVERY, HANDLING AND STORAGE

4.3 Storage - Placing Billets

*** Important: Board Sagging due to Incorrect Placement**

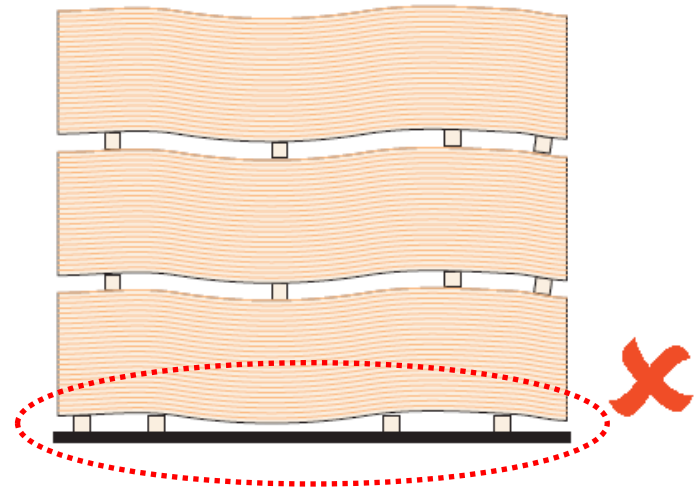
Correct Placement

All billets are to be placed in proper vertical alignment so each tier is evenly supported. Arrows indicate pressure.



Incorrect Placement

Cumulative pressure on unsupported lower units causes plasterboard to sag, if billets are not spaced evenly or in vertical alignment.



Incorrect Placement of Billets

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1. INTRODUCTION
2. DESIGN CONSIDERATION
3. MATERIAL SELECTION
4. DELIVERY, HANDLING AND STORAGE



CONTENTS

1. INTRODUCTION
2. DESIGN CONSIDERATION
3. MATERIAL SELECTION
4. DELIVERY, HANDLING AND STORAGE
5. PREPARATORY WORKS

Learning outcomes

By the end of this session, you should be able to:

Know the preparatory requirement for adopting Drywall.

5. PREPARATORY WORKS

Proper setting out, dimensional control, sufficient structural support for mechanical and electrical services, openings, together with surface preparation are critical in ensuring drywall sturdiness and quality.

The approved shop drawings dictate the setting out and dimensional control while the approved method statement governs the performance and technical requirement of relevant system, governing standards as well as installation procedures.

The approved materials and samples determine the right type of materials to be used.

5. PREPARATORY WORKS

5.1 Approved Shop Drawing, Method Statement, Material and Sample

5.2 Contact Surface Preparation

5.3 Setting Out Preparation

5. PREPARATORY WORKS

5.2 Contact Surface Preparation

5.2.1 Vertically of end wall / column

5.2.2 Evenness of Soffit / Floor slab

5.2.3 Straightness and evenness of Kerb (Wet Area)

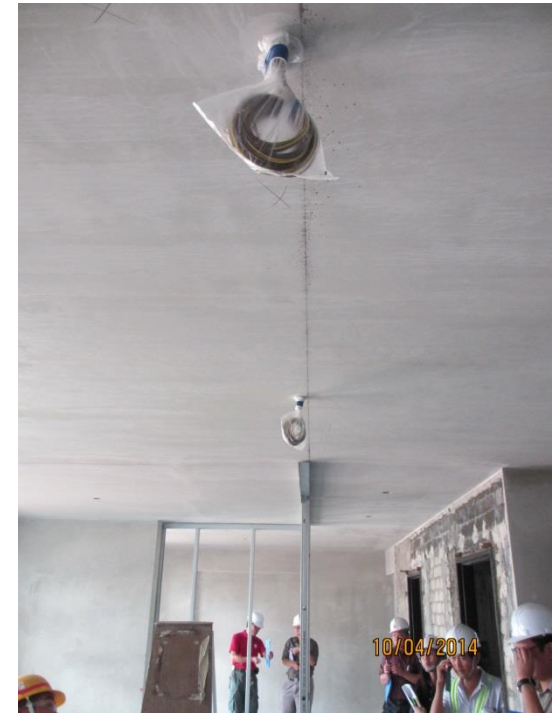


5. PREPARATORY WORKS

5.3 Setting Out Preparation

5.3.1 Line marked out on Soffit and Floor slab

5.3.2 Line marked out on Door opening



CONTENTS

1. INTRODUCTION
2. DESIGN CONSIDERATION
3. MATERIAL SELECTION
4. DELIVERY, HANDLING AND STORAGE
5. PREPARATORY WORKS
6. INSTALLATION PROCEDURES & PROTECTION

Learning outcomes

By the end of this session, you should be able to:

Know installation consideration for Drywall.

6. INSTALLATION

6.1 Framing Works

6.2 Opening

6.3 Additional Supports for M&E Services and Other fixtures

6.4 Board Installation

6.5 Infill and Insulation Installation

6.6 Joint Treatment

6.7 Fixing Items to Drywall

6. INSTALLATION

6.1 Framing Works

Top Track



Bottom Track



First Stud



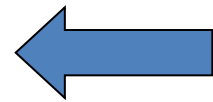
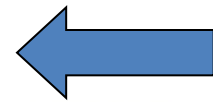
Incorporated M&E



Noggings



Intermediate Studs



6. INSTALLATION

6.1 Framing Works



• 25mm downward deflection only – stud too long and will not allow deflection to occur



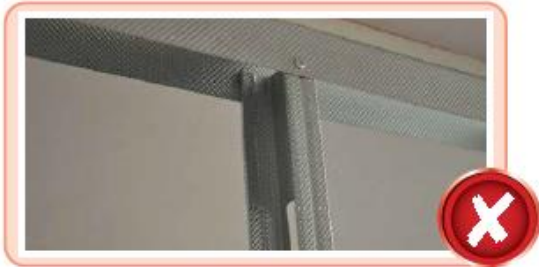
• 25mm downward deflection only, minimum 20mm engagement – stud out short to allow deflection



• Service cut-outs should not coincide with head or base channel



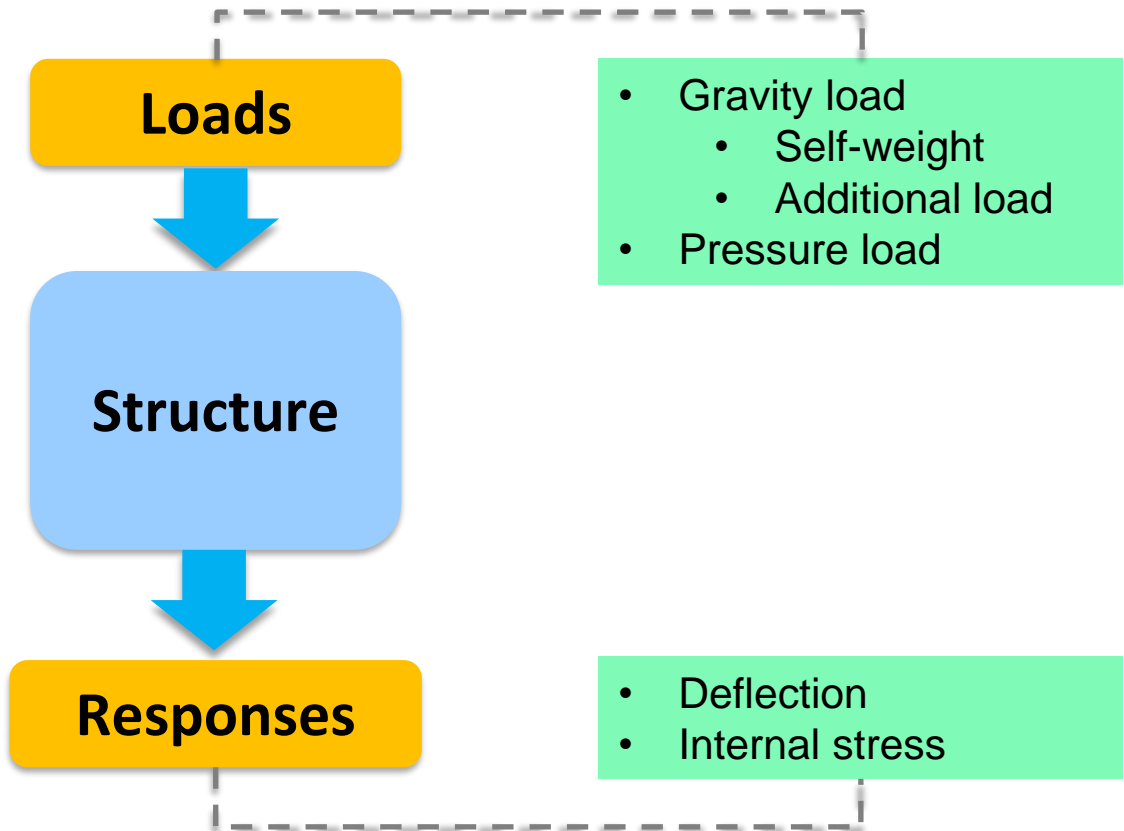
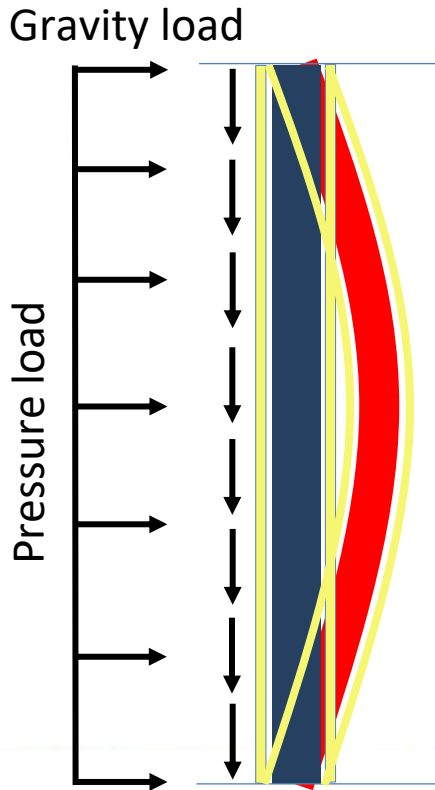
• Cut through solid section of stud profile



• When deflection heads are installed, do not fix the Cyprane stud into the head track as this will prevent deflection occurring

6. INSTALLATION

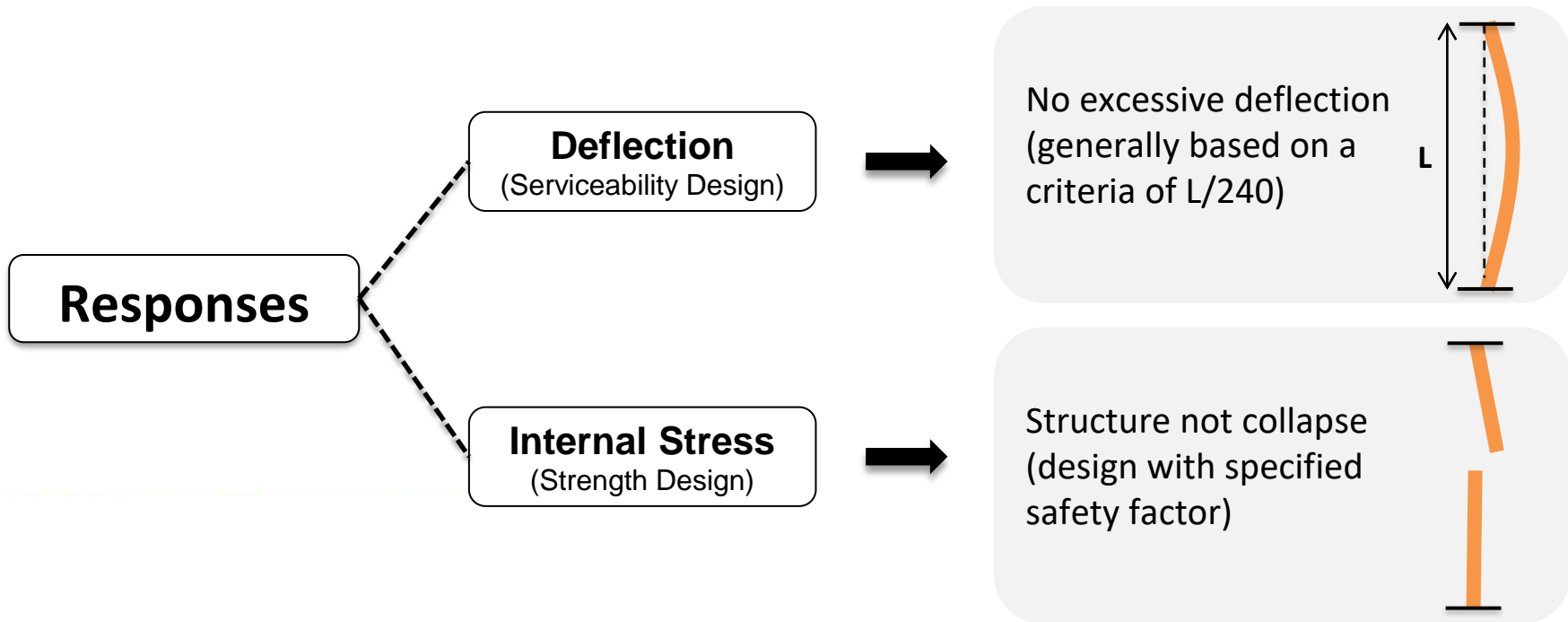
6.1 Framing Works



6. INSTALLATION

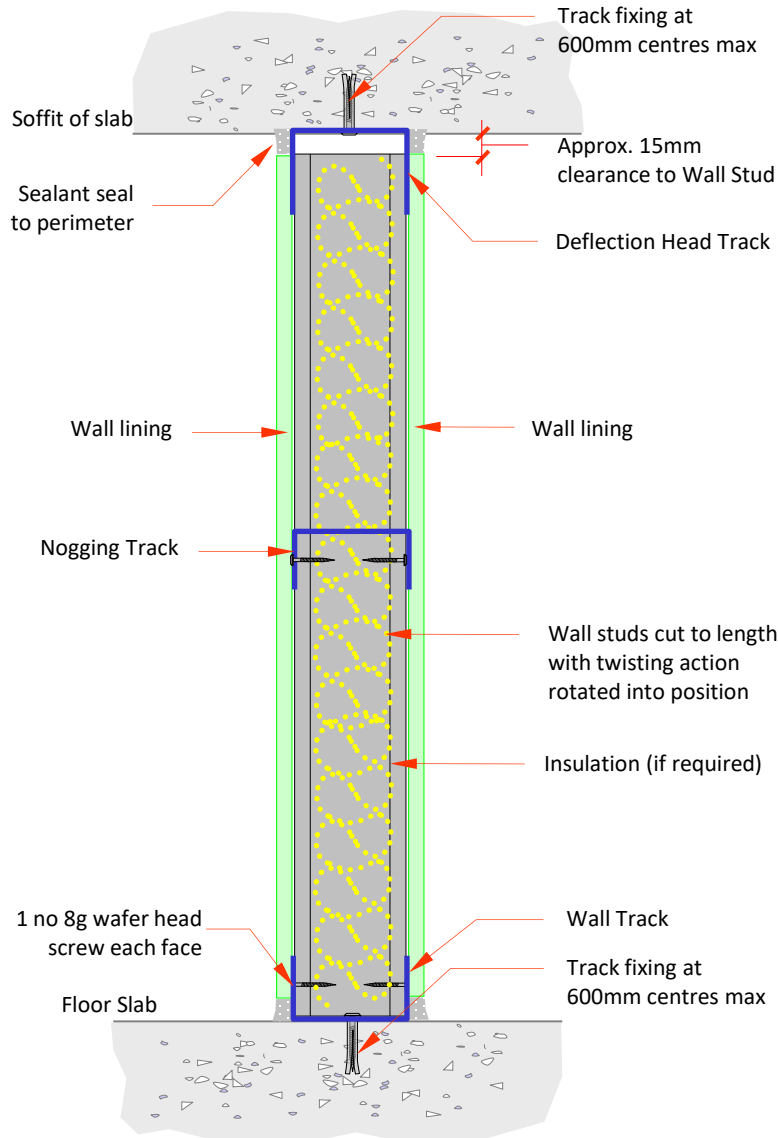
6.1 Framing Works

The structure is designed to resist the **LOADS** while the **RESPONSE** of the structure is within the acceptable criteria.



6. INSTALLATION

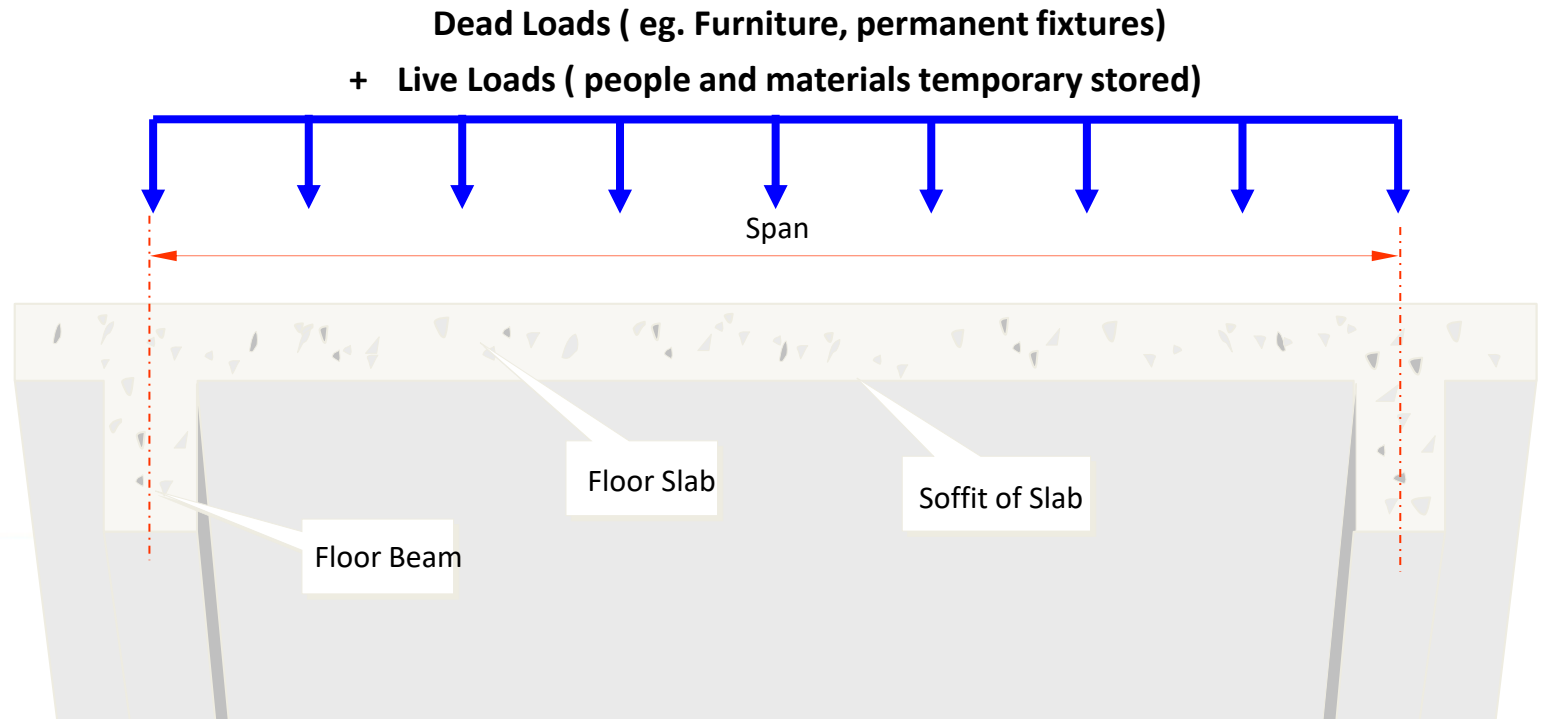
6.1 Framing Works



6. INSTALLATION

6.1 Framing Works

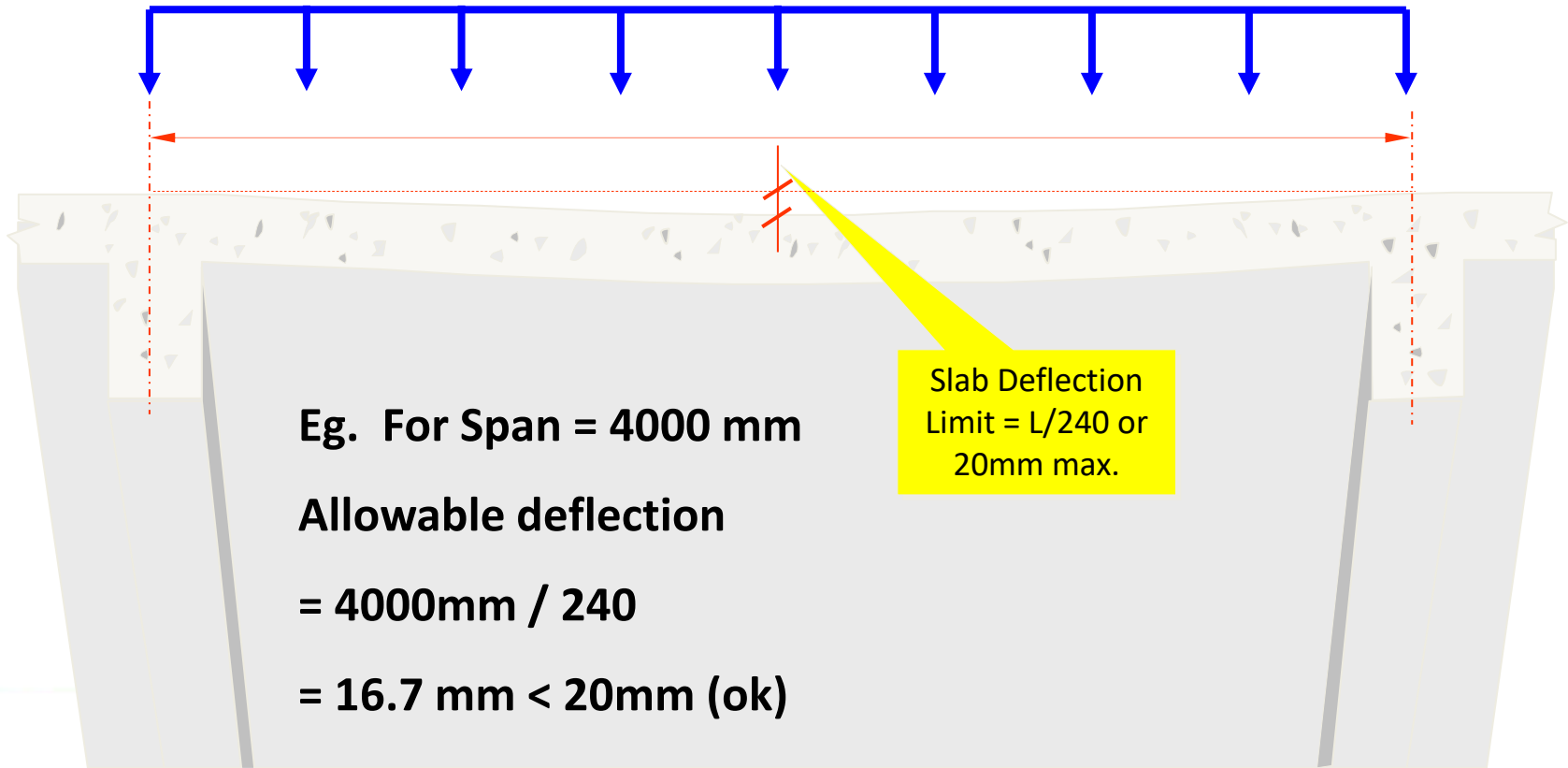
Deflection is the movement at any point on a member when subjected to load, due to either its self weight or any imposed live load



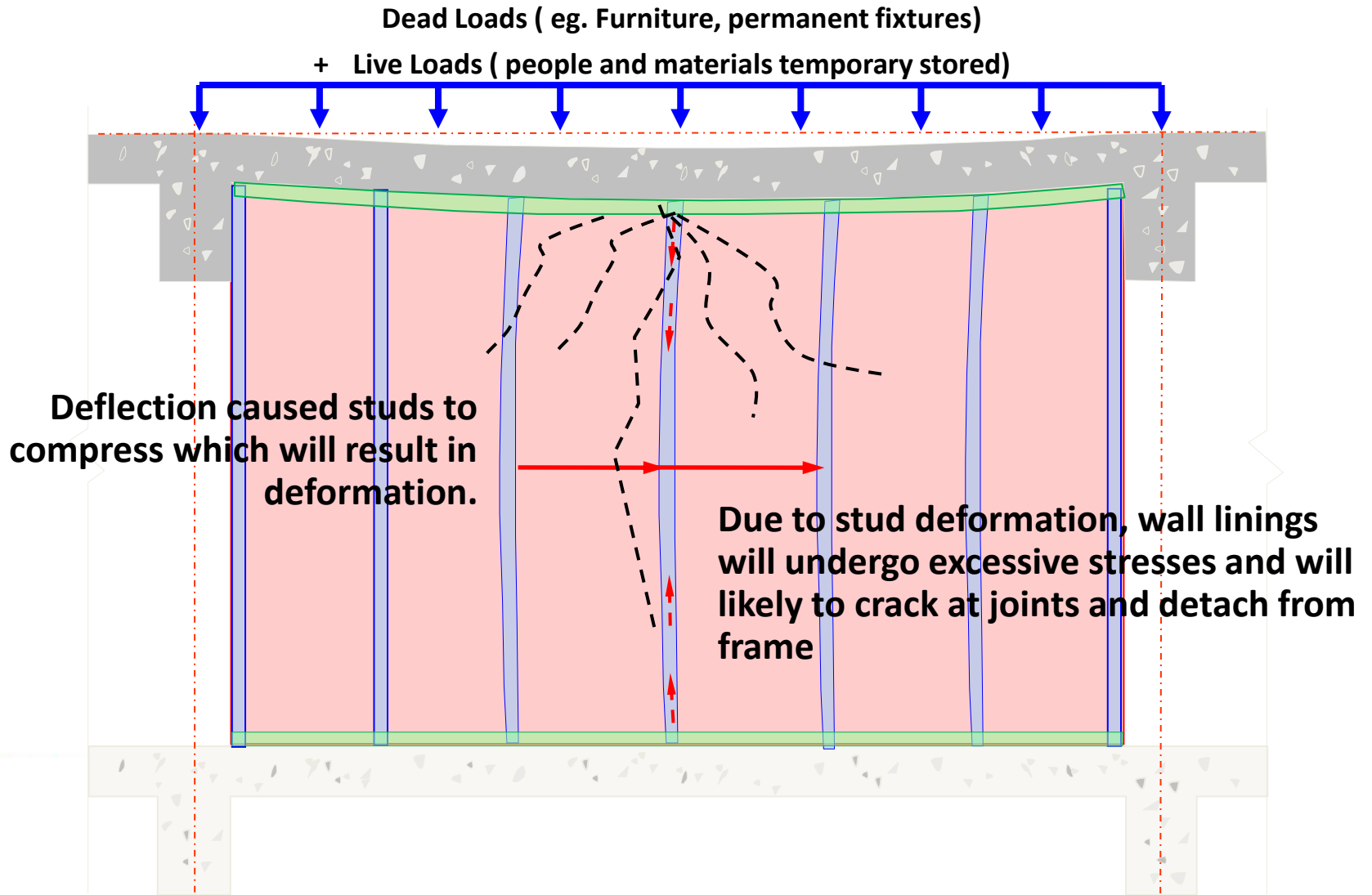
6. INSTALLATION

6.1 Framing Works

Slab deflected after subjected to loading

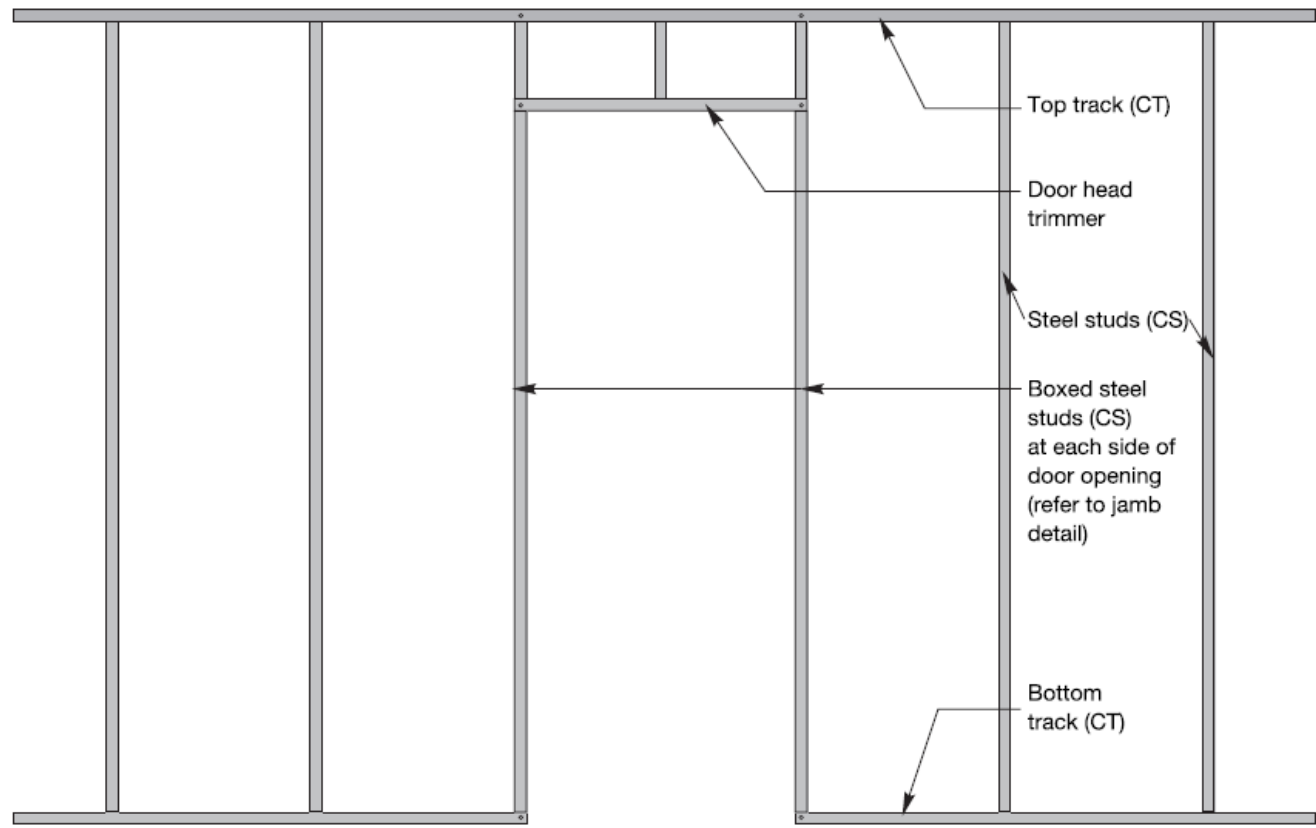
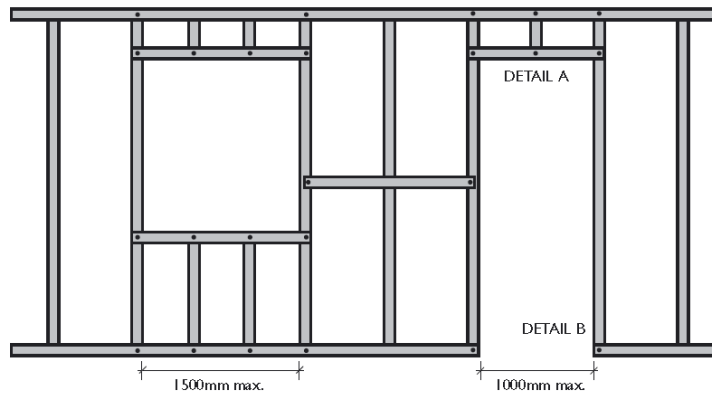


6. INSTALLATION



6. INSTALLATION

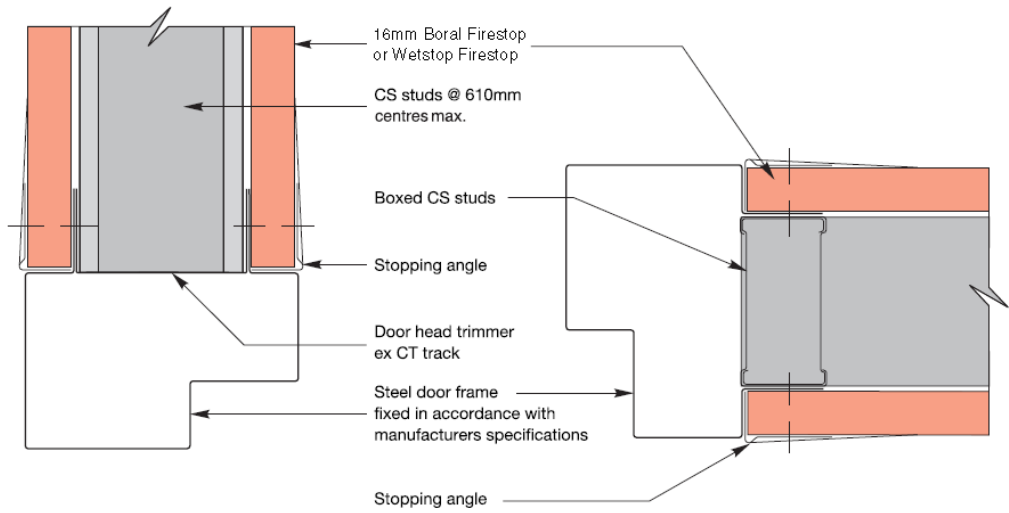
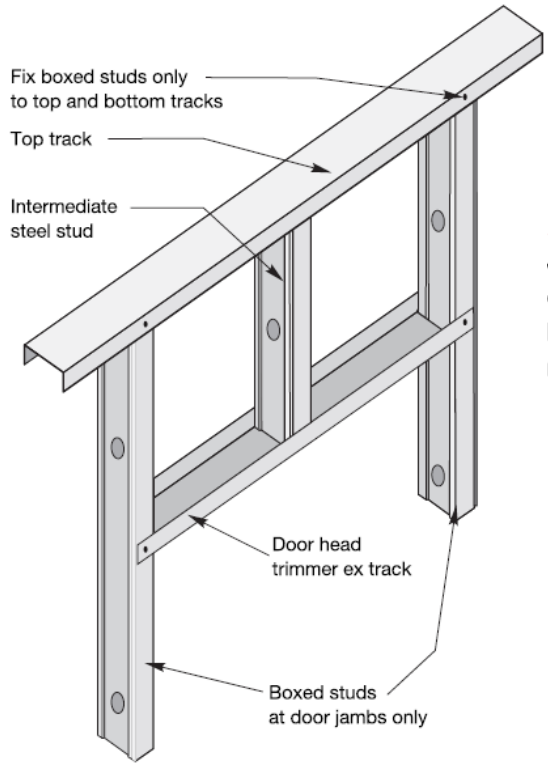
6.2 Opening



Layout of Door Studs - Elevation

6. INSTALLATION

6.2 Opening

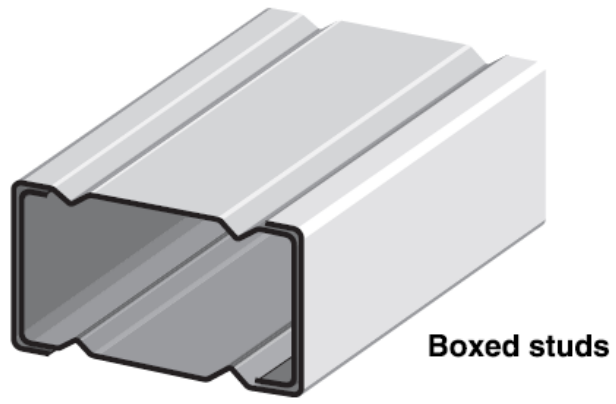


Typical Door Head

Typical Door Jamb

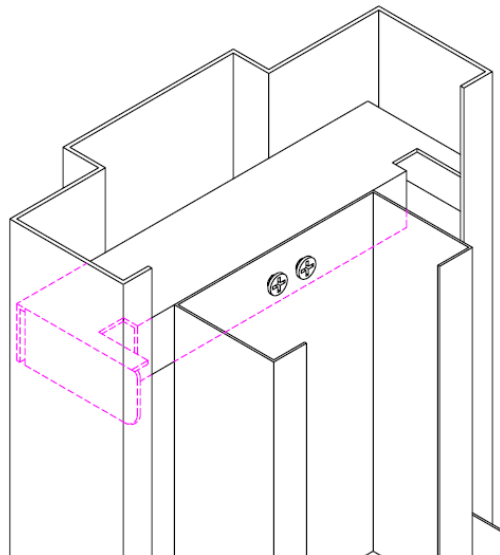
Note: Jamb studs may consist of double CS studs or boxed CS studs. This may be determined by structural requirements or the fixing detail recommended by the door frame manufacturer.

Door Head Trimmer Details



6. INSTALLATION

6.2 Opening



6. INSTALLATION

6.2 Opening

DOOR JAMBS

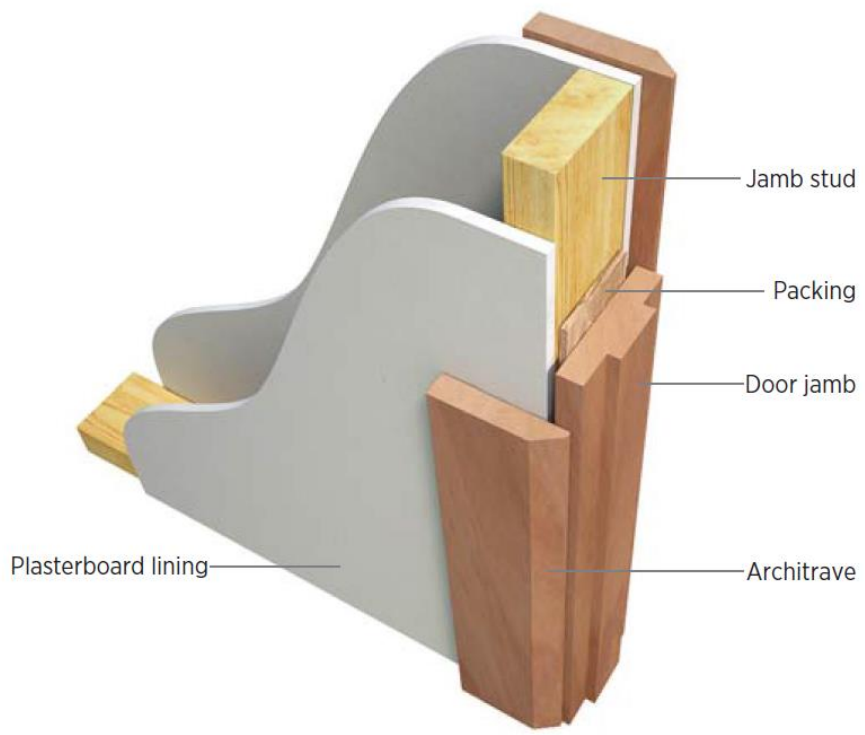


Figure 38: Door Jamb With Architraves

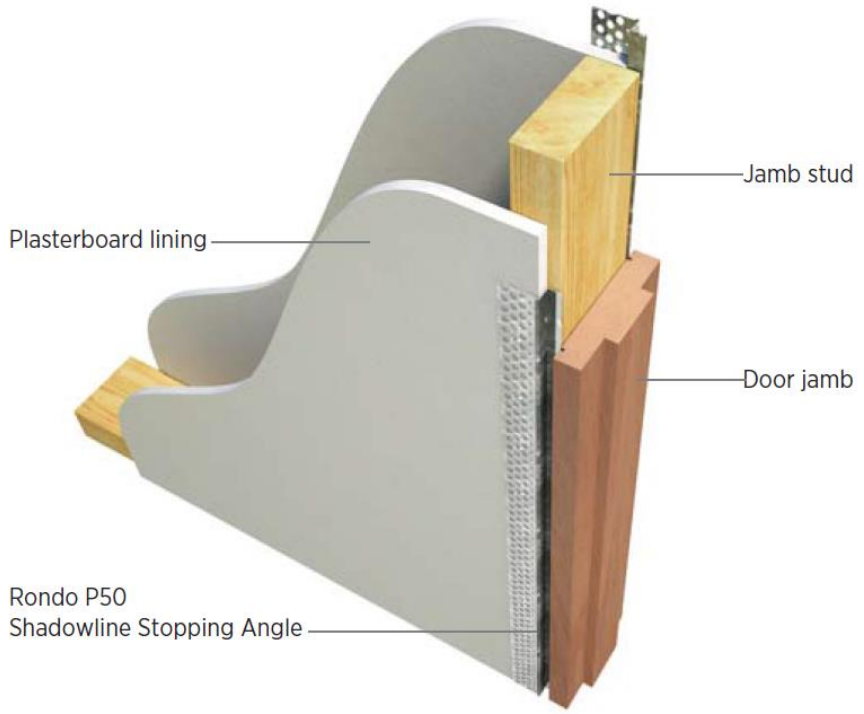


Figure 39: Door Jamb With Shadowline Stopping Angle

6. INSTALLATION

6.3 Additional Supports for M&E Services and Other fixtures

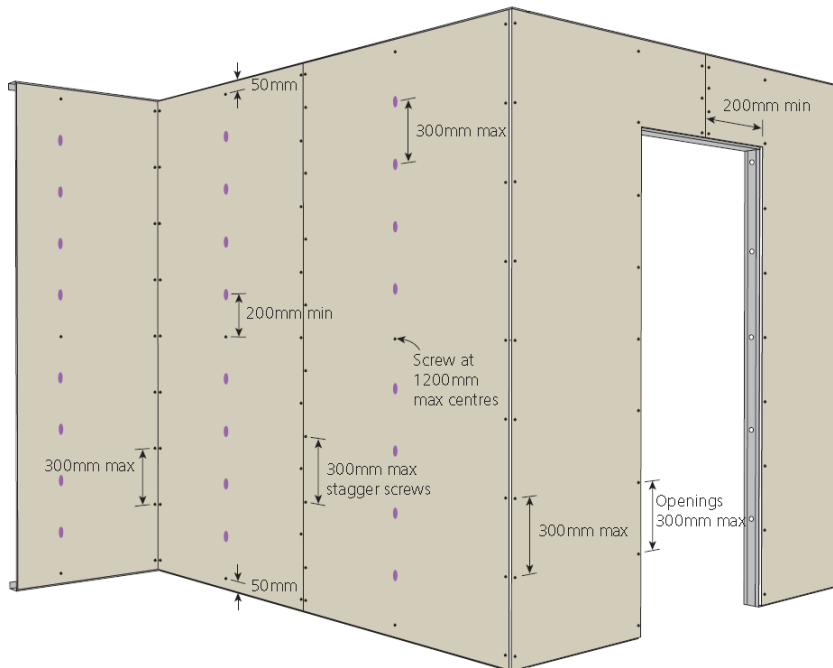


6. INSTALLATION

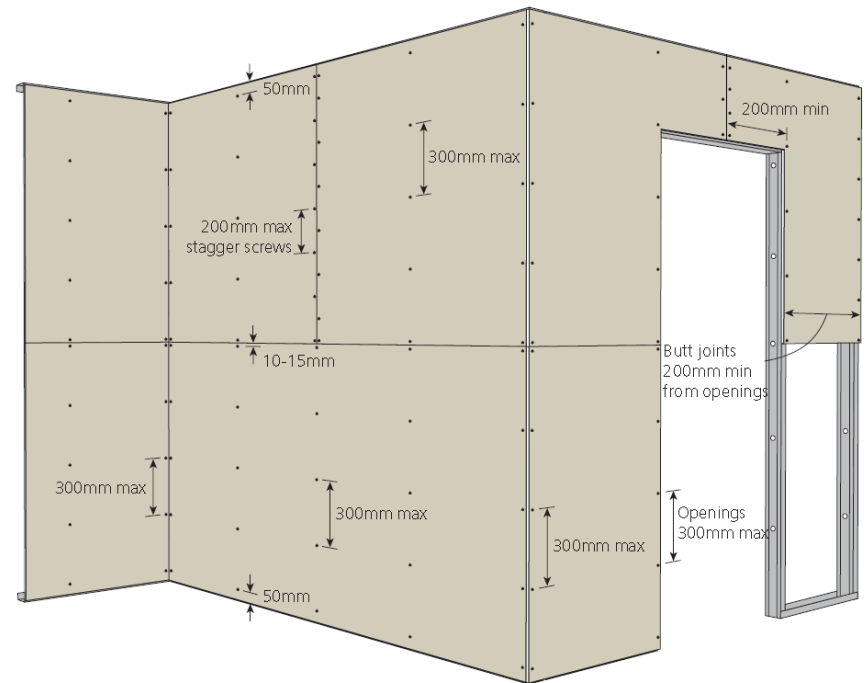
6.4 Board Installation

- Identify and calculate area / layout of board.
- Use proper tools to cut boards.

Vertical

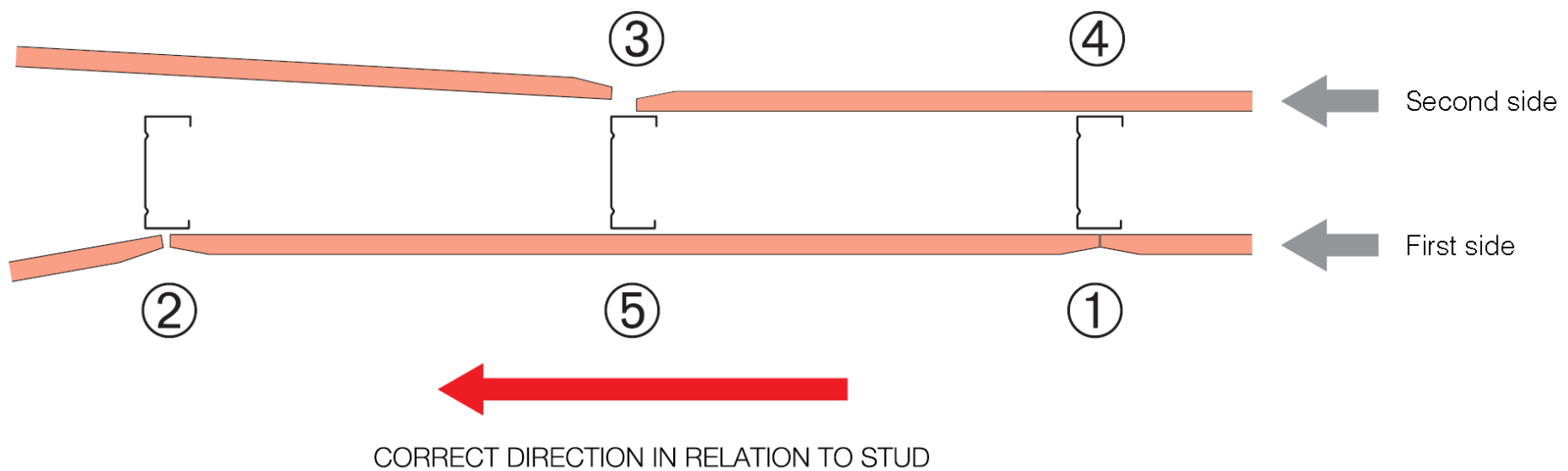
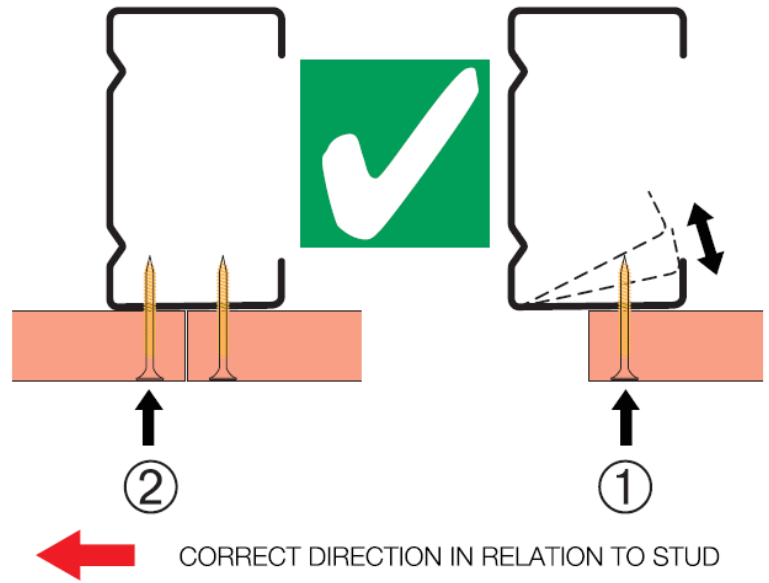


Horizontal



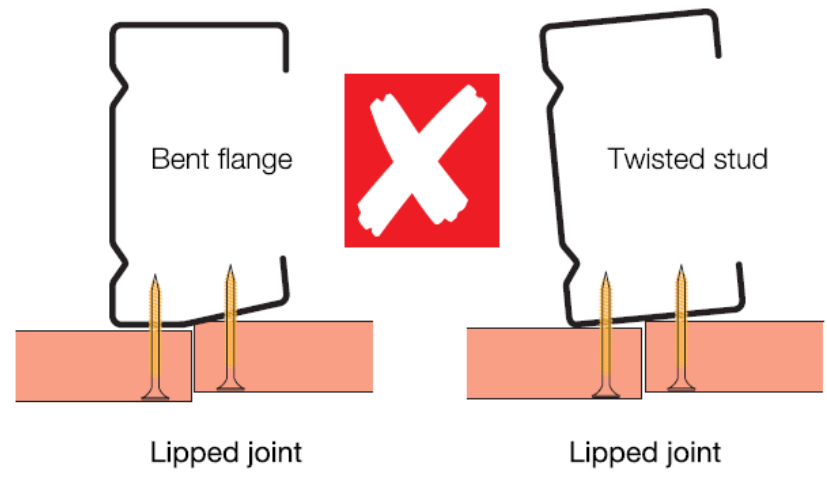
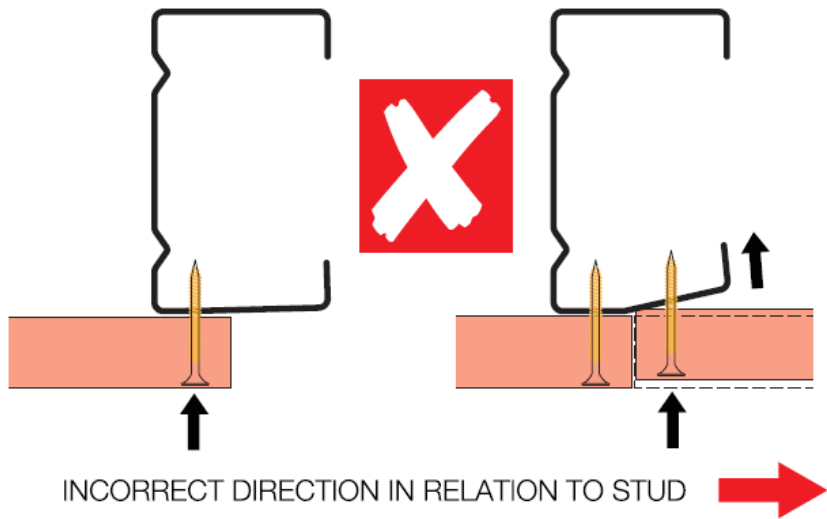
6. INSTALLATION

6.4 Board Installation



6. INSTALLATION

6.4 Board Installation



6. INSTALLATION

6.5 Infill and Insulation Installation



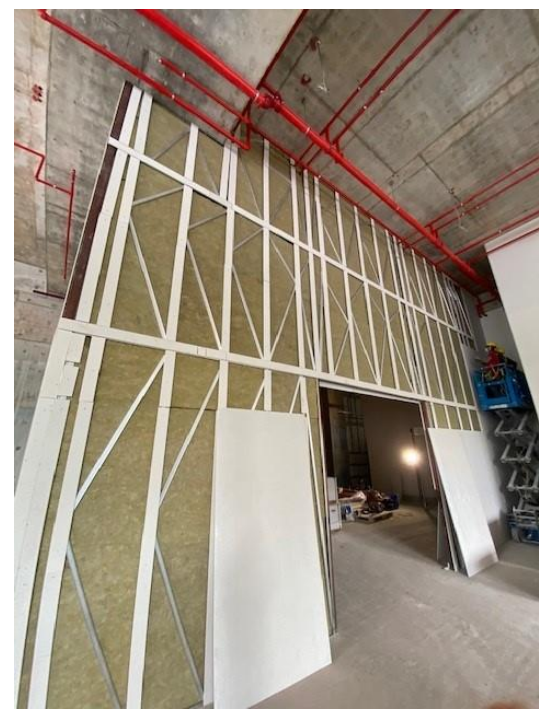
6. INSTALLATION

6.5 Infill and Insulation Installation



6. INSTALLATION

6.5 Infill and Insulation Installation



6. INSTALLATION

6.6 Joint Treatment

6.6.1 Recessed / Square Edge Joints

6.6.2 Internal Angles

6.6.3 External Angles

6. INSTALLATION

6.6 Joint Treatment

Levels of Finish

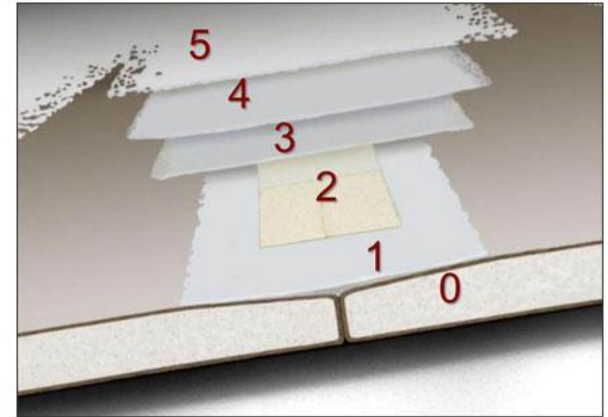
Definition

The term 'level of finish' applies to plasterboard linings prior to decoration.

AS/NZS 2589:2007 'Gypsum linings - Application and Finishing' defines three levels of finish: Levels 3, 4 and 5. Level 4 is the default level of finish for plasterboard surfaces, unless specified otherwise.

6. INSTALLATION

6.6 Joint Treatment



Five Levels Of Finishing in Brief

LEVEL 1

Used in concealed applications, example area is plenum areas above ceilings. Not open to public view.

LEVEL 2

Suitable where surface appearance is not of primary concern like warehouse, storage or other similar areas.

LEVEL 3

Suitable for surfaces intended to have heavy or medium textured coatings through sprayed or hand-held application. Also suitable where heavy wall coverings like wall paper is the desired final decoration.

LEVEL 4

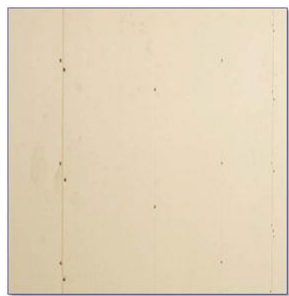
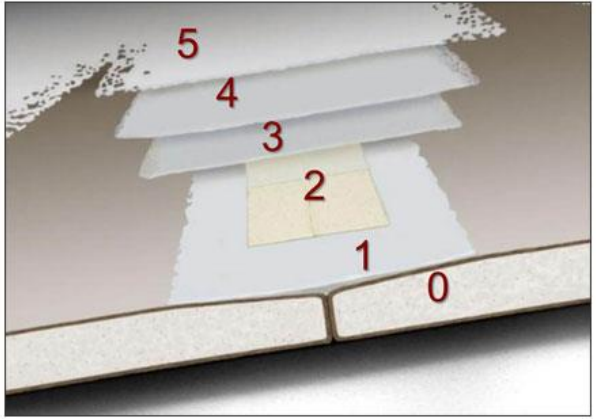
The accepted level of finish for most construction. Used where critical lighting shines on light textured coatings, medium or light wall coverings like wall paper. Also used where smooth textured finishes like satin/flat/low sheen paints are illuminated by non-critical lighting.

LEVEL 5

Used where gloss or semi-gloss paints are specified. Also used where critical lighting affects smooth satin/flat or low-sheen paints. Joints and plasterboard will require a skim coating to remove differential surface textures and porosity.

6. INSTALLATION

6.6 Joint Treatment



Level 0



Level 1



Level 2

https://www.youtube.com/watch?v=J781sKp_eVg



Level 3



Level 4



Level 5

6. INSTALLATION

6.6 Joint Treatment

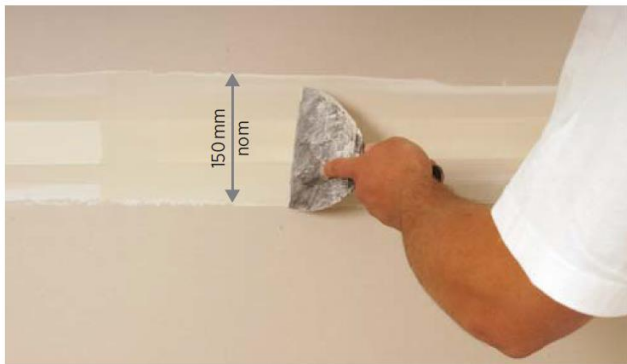
6.6.1 Recessed Joints



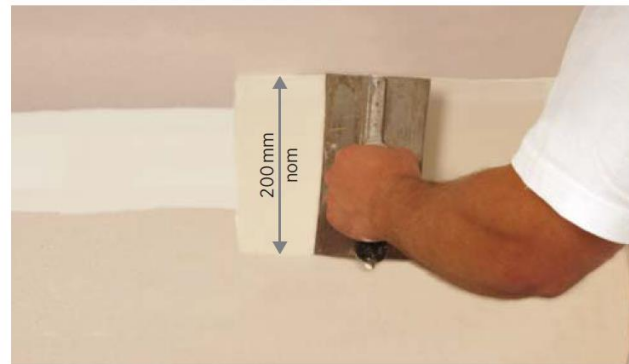
1. First coat - Bedding compound



2. First coat - Bed tape



3. First coat - Skim coat

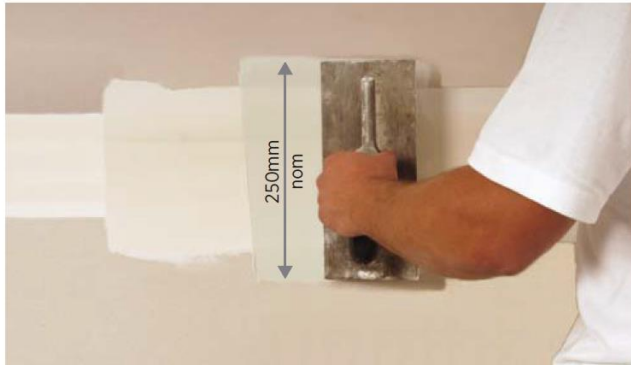


4. Second coat

6. INSTALLATION

6.6 Joint Treatment

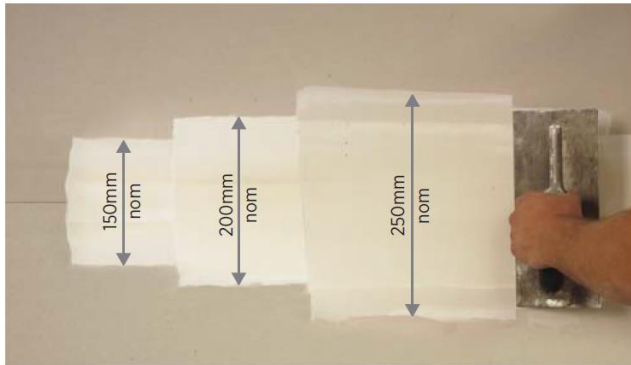
6.6.1 Recessed Joints



5. Finishing coat



6. Dry sanding

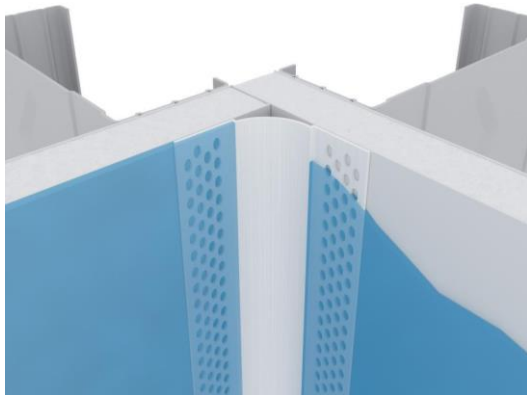


7. Total recessed joint system

6. INSTALLATION

6.6 Joint Treatment

6.6.2 Internal Corner Joints



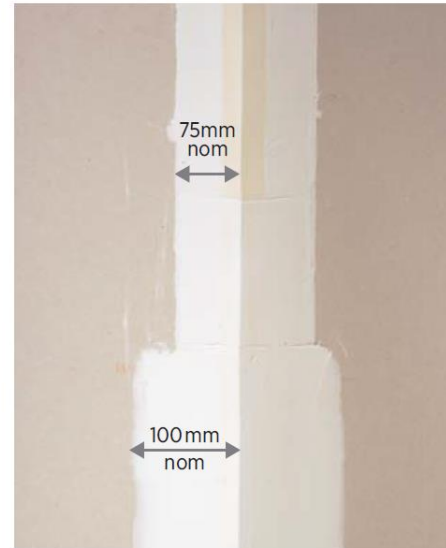
1. Apply base compound



2. Bed tape



3. Apply second coat



4. Internal angle jointing system

Figure 83: Stopping Internal Corners

6. INSTALLATION

6.6 Joint Treatment

6.6.3 External Corner Joints



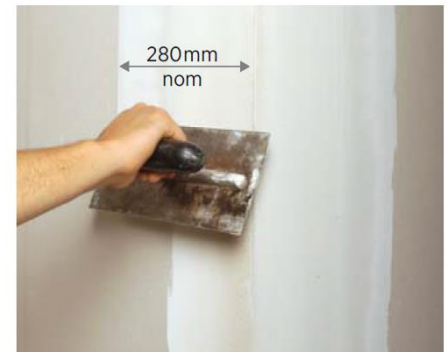
1. Cut angle and fix to sides of corner @ 300mm ctrs



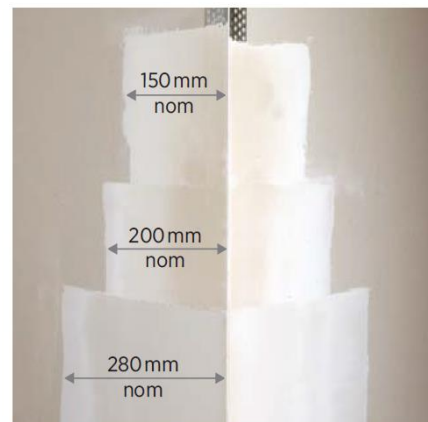
2. Apply first coat to both corner faces



3. Apply second coat to corner faces



4. Apply third coat to corner faces



5. External Angle Jointing system

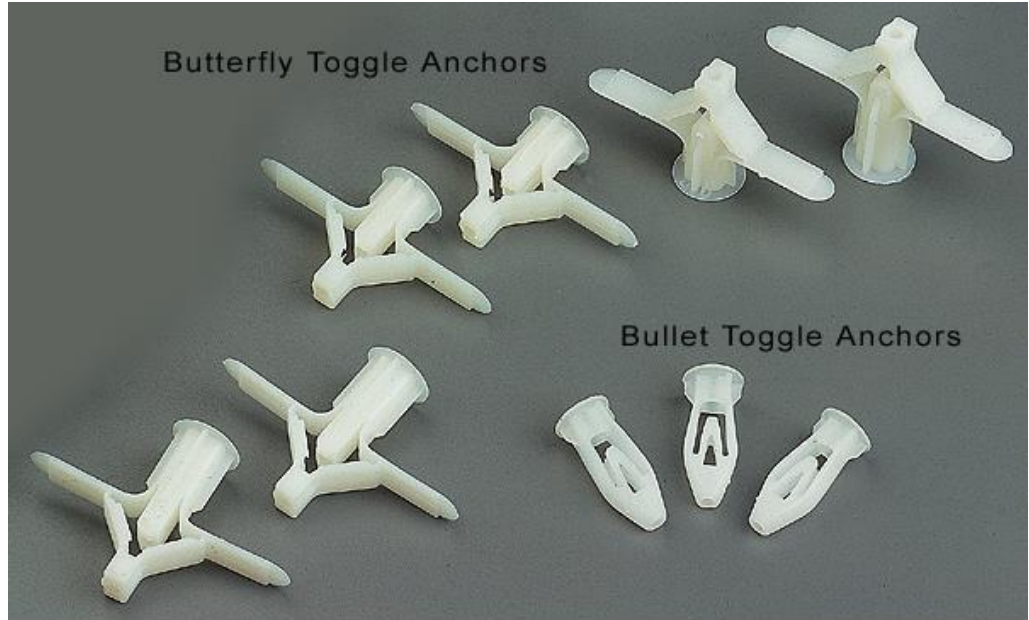
6. INSTALLATION

6.7 Fixing Items to Drywall



6. INSTALLATION

6.7 Fixing Items to Drywall



BUTTERFLY TOGGLE ANCHORS


CODE NO#	SIZE
#B 7100	LARGE
#B 7200	SMALL



6. INSTALLATION

6.7 Fixing Items to Drywall

HLD Light duty anchor

	Anchor version	Benefits
	HLD	<ul style="list-style-type: none">- plastic undercut anchor- simple setting- esp. for drywall applications

6. INSTALLATION

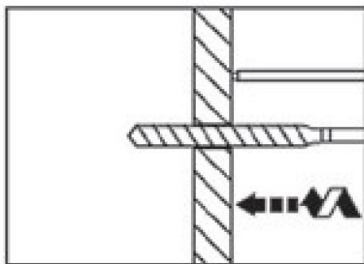
6.7 Fixing Items to Drywall

Setting

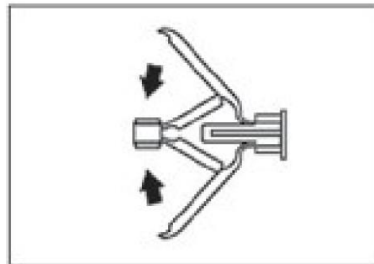
Installation equipment

Anchor size	
Rotary hammer	TE 2 – TE 16
Other tools	Screwdriver

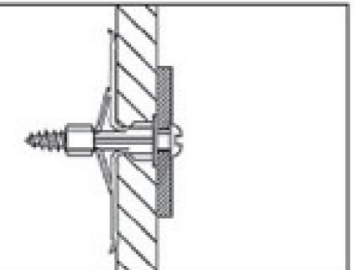
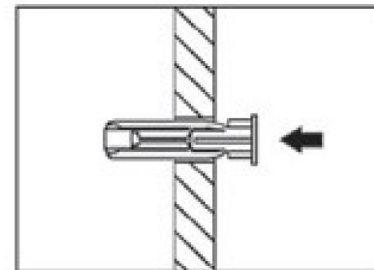
Setting instruction



Drill hole with drill bit.



Install the HLD anchor.



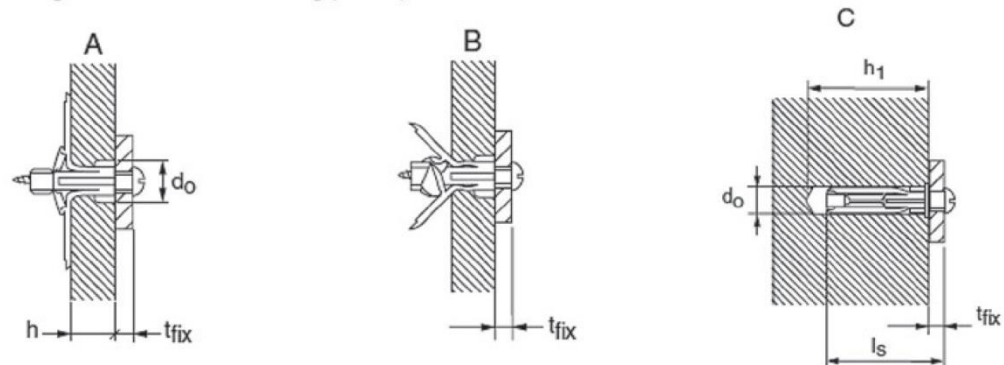
Drive in the screw.

For detailed information on installation see instruction for use given with the package of the product.

6. INSTALLATION

6.7 Fixing Items to Drywall

Setting details and anchoring principles:




Setting details HSP / HFP

Anchor version			HLD 2	HLD 3	HLD 4
Nominal diameter of drill bit	d_o	[mm]	10		
Depth of drill hole	(only anchoring principle C)	$h_1 \geq$	50	56	66
Screw length	(anchoring principle A/B)	l_s	$33 + t_{fix}$	$40 + t_{fix}$	$49 + t_{fix}$
	(anchoring principle C)	l_s	$40 + t_{fix}$	$46 + t_{fix}$	$56 + t_{fix}$
Screw diameter	(anchoring principle A/B)	d_s	4 – 5		
	(anchoring principle C)	d_s	5 – 6		
Wall / panel thickness	(anchoring principle A)	h	4 – 12	15 – 19	24 – 28
	(anchoring principle B)	h	12 – 16	19 – 25	28 – 32
	(anchoring principle C)	$h \geq$	35	42	50
Installation temperature		[°C]	-10 to +40		

6. INSTALLATION

6.7 Fixing Items to Drywall

HHD-S Cavity anchor

	Anchor version	Benefits
	HHD-S	<ul style="list-style-type: none"> - metal undercut anchor with metric screw, esp. for drywall - metal to metal fastening - reliable undercut



Drywall

Basic loading data (for a single anchor)

All data in this section applies to

- Correct setting (See setting instruction)
- No edge distance and spacing influence
- Base material as specified in the table
- Borehole drilling without hammering

6. INSTALLATION

6.7 Fixing Items to Drywall

Recommended loads ^{a)}

Anchor size		M4	M5	M6	M8
Hollow brick web thickness 20mm	N_{rec} [kN]	0,1	-	-	-
	V_{rec} [kN]	0,3	-	-	-
Gypsum board Thickness 10mm	N_{rec} [kN]	0,2	0,2	0,2	0,2
	V_{rec} [kN]	0,5	0,5	0,5	0,5
Gypsum board Thickness 12,5mm	N_{rec} [kN]	0,2	0,2	0,2	0,2
	V_{rec} [kN]	0,5	0,5	0,5	0,5
Gypsum board Thickness 2x12,5mm	N_{rec} [kN]	-	0,4	0,3	0,4
	V_{rec} [kN]	-	1	0,9	1
Fibre reinforced gypsum board Thickness 10mm	N_{rec} [kN]	0,2	0,3	0,25	0,4
	V_{rec} [kN]	0,5	0,6	0,8	0,9
Fibre reinforced gypsum board Thickness 12,5mm	N_{rec} [kN]	0,3	0,5	0,3	0,6
	V_{rec} [kN]	0,6	1	1	1,2
Fibre reinforced gypsum board Thickness 2x12,5mm	N_{rec} [kN]	-	0,9	0,8	0,9
	V_{rec} [kN]	-	1,1	1,8	1,7

a) With overall global safety factor $\gamma = 3$ to the characteristic loads and a partial safety factor of $\gamma = 1,4$ to the design values.

Materials

Material quality

Part	Material
Sleeve	Carbon steel, galvanised
Screw	Carbon steel, galvanised

6. INSTALLATION

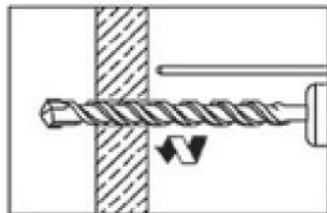
6.7 Fixing Items to Drywall

Setting

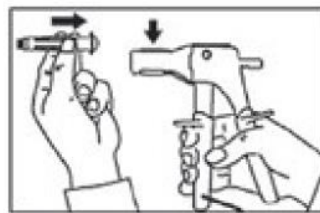
Installation equipment

Anchor size	
Rotary hammer	TE2... TE16
Other tools	Screwdriver, HHD-SZ2 expansion tool

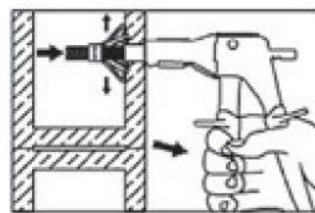
Setting instruction



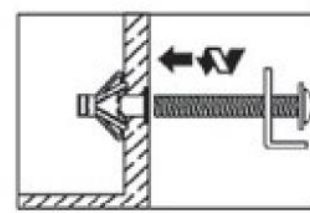
Drill hole with drill bit.



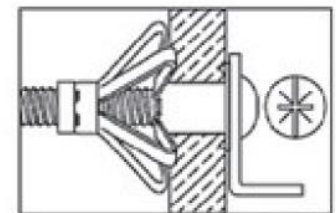
Put anchor into setting tool.



Install anchor with setting tool.

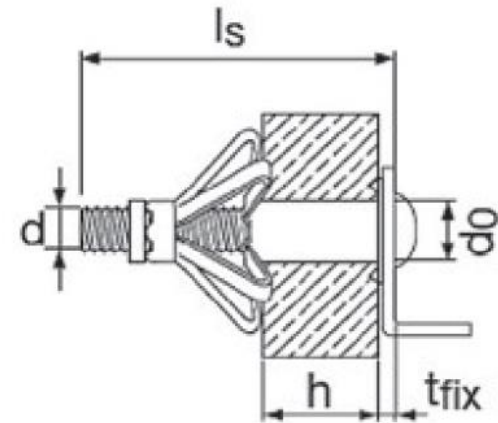


Remove screw from anchor and screw in gain with part being fastened attached.



6. INSTALLATION

6.7 Fixing Items to Drywall



Setting details HHD-S

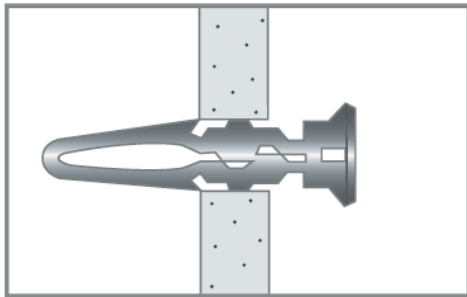
Anchor version			M4/4	M4/6	M4/12	M4/19	M5/8	M5/12	M5/25
Nominal diameter of drill bit	d_o	[mm]	8	8	8	8	10	10	10
Anchor length	l	[mm]	20	32	38	45	38	52	65
Anchor neck length	h	[mm]	4	6	12,5	19	8	12,5	25
Screw length	$l_s \geq$	[mm]	25	39	45	52	45	58	71
Screw diameter	d		M4	M4	M4	M4	M5	M5	M5
Panel thickness	$h_{min,max}$	[mm]	3 - 4	6 - 7	10 - 13	18 - 20	6 - 8	11 - 13	23 - 25
Max. fixable thickness for pre-setting	t_{fix}	[mm]	15	25	25	25	25	30	30

Anchor version			M6/9	M6/12	M6/24	M6/40	M8/12	M8/24	M8/40
Nominal diameter of drill bit	d_o	[mm]	12	12	12	12	12	12	12
Anchor length	l	[mm]	38	52	65	80	54	66	83
Anchor neck length	h	[mm]	9	12,5	25	40	12,5	25	40
Screw length	$l_s \geq$	[mm]	45	58	71	88	60	72	90
Screw diameter	d		M6	M6	M6	M6	M8	M8	M8
Panel thickness	$h_{min,max}$	[mm]	7 - 9	11 - 13	23 - 25	38 - 40	11 - 13	23 - 25	38 - 40
Max. fixable thickness for pre-setting	t_{fix}	[mm]	20	30	30	30	30	30	35

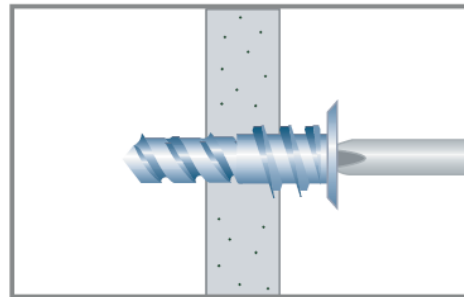
6. INSTALLATION

6.7 Fixing Items to Drywall

Light duty anchor



Plasterboard plug



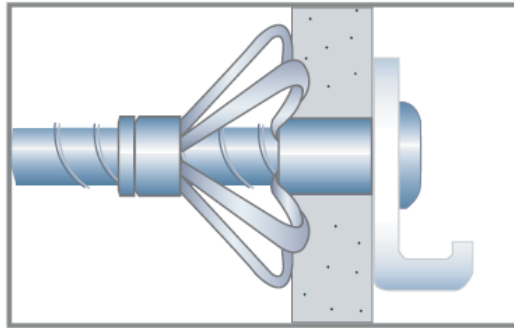
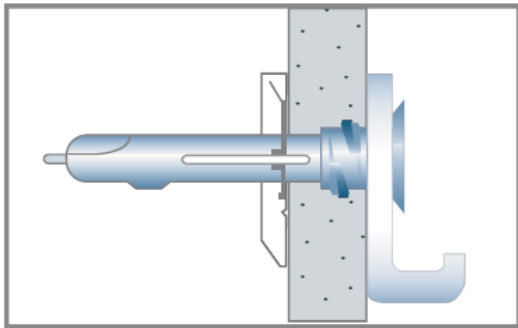
Self-drill fixing



6. INSTALLATION

6.7 Fixing Items to Drywall

Heavy duty anchor



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7. PROTECTION

7.1 Protection

- 7.1.1 Construct external wall first
- 7.1.2 Detail Form for handing over
- 7.1.3 Designated person access to units



SECTION 2		01-00000 REQUEST FOR WORK INSPECTION DRYWALL PARTITIONS		01-00000 QUALITY SYSTEM REQUEST FOR WORK INSPECTION	
PROJECT NAME: [Blank] UNIT NO: [Blank] UNIT TYPE: [Blank]		DRAWING NO: [Blank] DRAWING DATE: [Blank]		REQUEST NO: [Blank]	
LOCATION: [Blank]		SET OFF REFERENCE: 68		DRAWING DATE: [Blank]	
CHECKS (see activity)		Remarks		Date	
1. APPROVAL OF SHOP DRAWINGS & RECEIPT OF MATERIALS		[Handwritten: 1/1/14]		[Blank]	
2. FITTING OUT		[Handwritten: 1/1/14]		[Blank]	
3. INSTALLATION OF WALL, FLOORING, CEILING & FITTING OF DOORS		[Handwritten: 1/1/14]		[Blank]	
4. FINISH OF GYPSUM BOARD		[Handwritten: 1/1/14]		[Blank]	
5. CUTTING OF PARTITIONS		[Handwritten: 1/1/14]		[Blank]	
6. FINAL CHECKS		[Handwritten: 1/1/14]		[Blank]	
AUTHORITY IS GIVEN TO PROCEED TO NEXT STAGE					
SIGNED FOR: [Blank]		SIGNED FOR: [Blank]		DATE: [Blank]	



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8. WET AREAS APPLICATION



The bathroom is usually one of the smallest rooms in a dwelling unit. Nevertheless, it is also one of the most labour intensive elements to be constructed. It involves almost all building trades such as waterproofing, finishes, accessories, plumbing, sanitary and electrical works.

8. WET AREAS APPLICATION

→ Majority of wet construction problems originate with WATER LEAKS

→ Can the concept of Drywall construction be used in WET AREAS?

8. WET AREAS APPLICATION



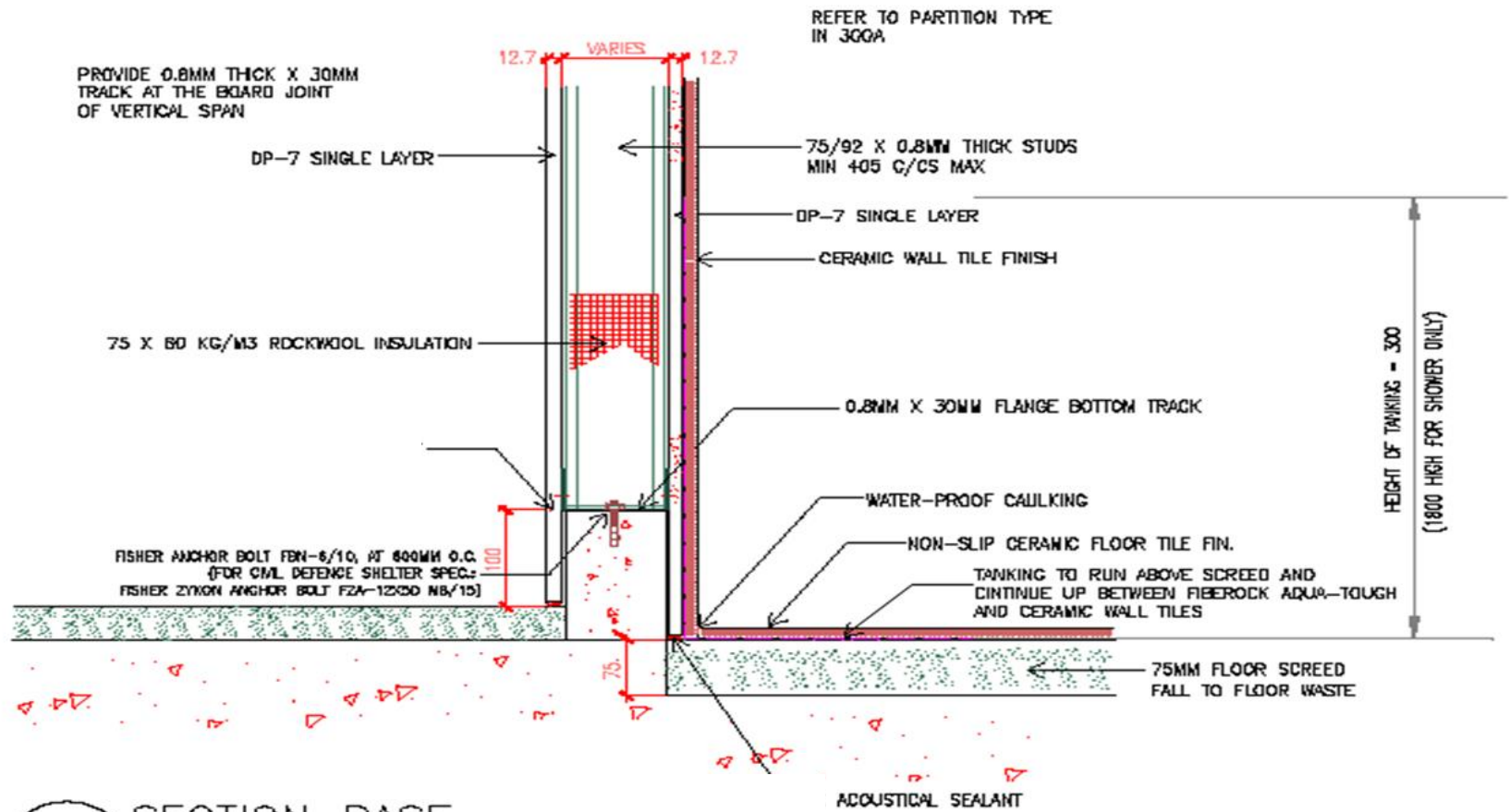
Before



After

8. WET AREAS APPLICATION

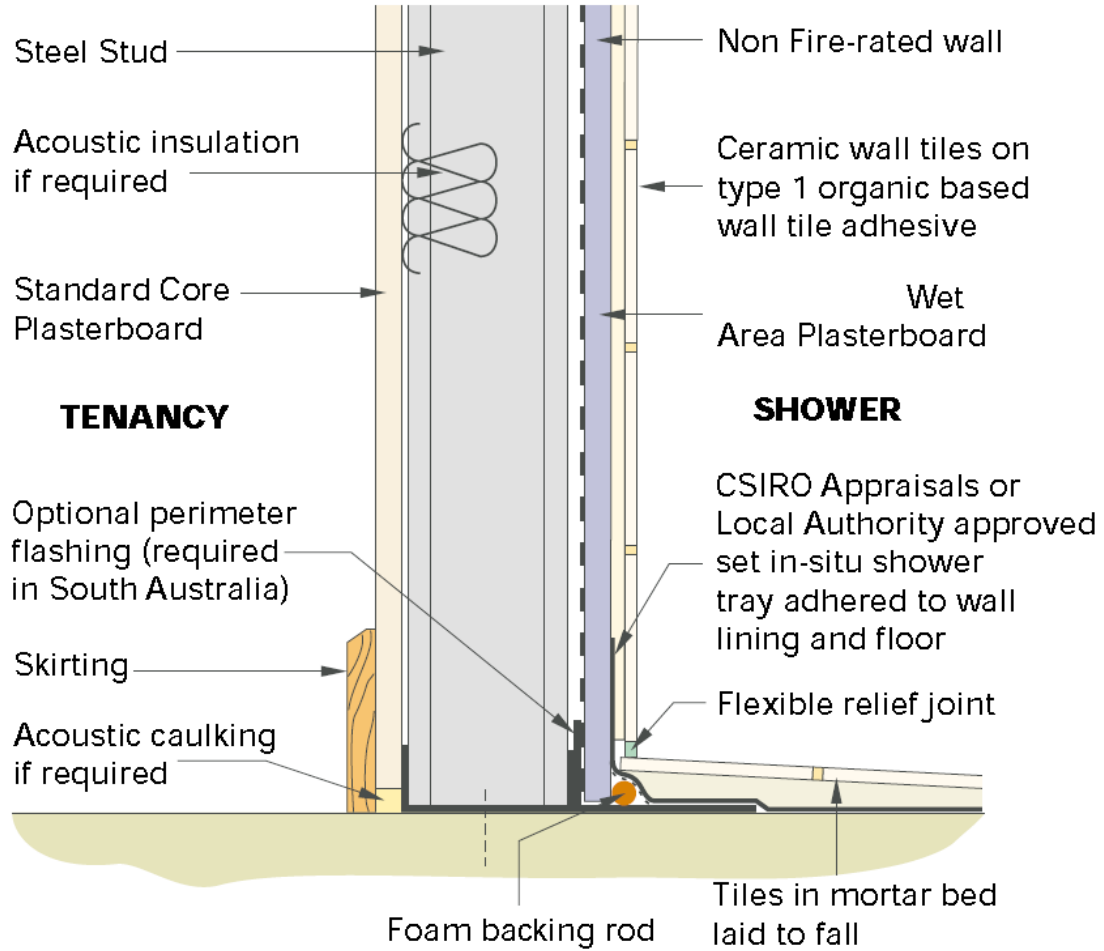
8.1 Board System



12 SECTION BASE
NTS

8. WET AREAS APPLICATION

8.1 Board System



8. WET AREAS APPLICATION

8.1 Board System

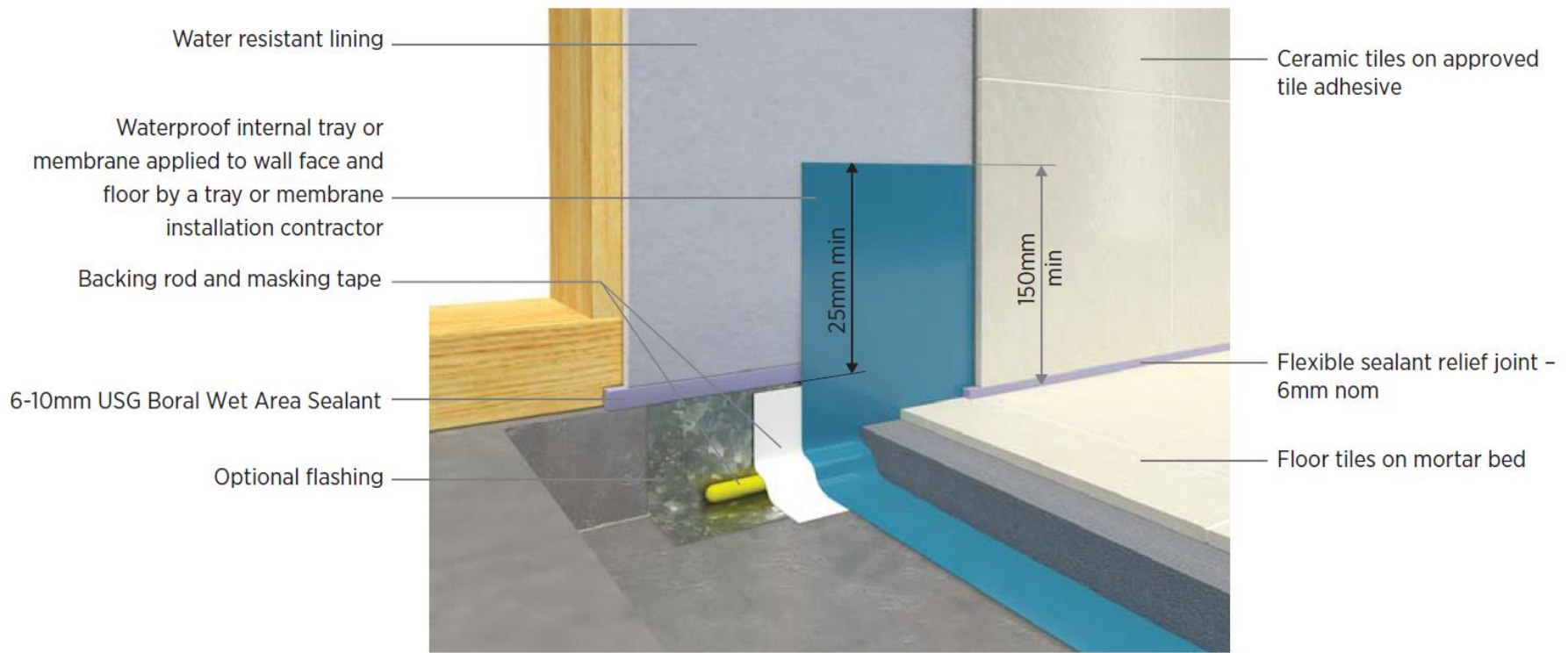


Figure 67: Set-down shower base and wall junction

8. WET AREAS APPLICATION

8.1 Board System

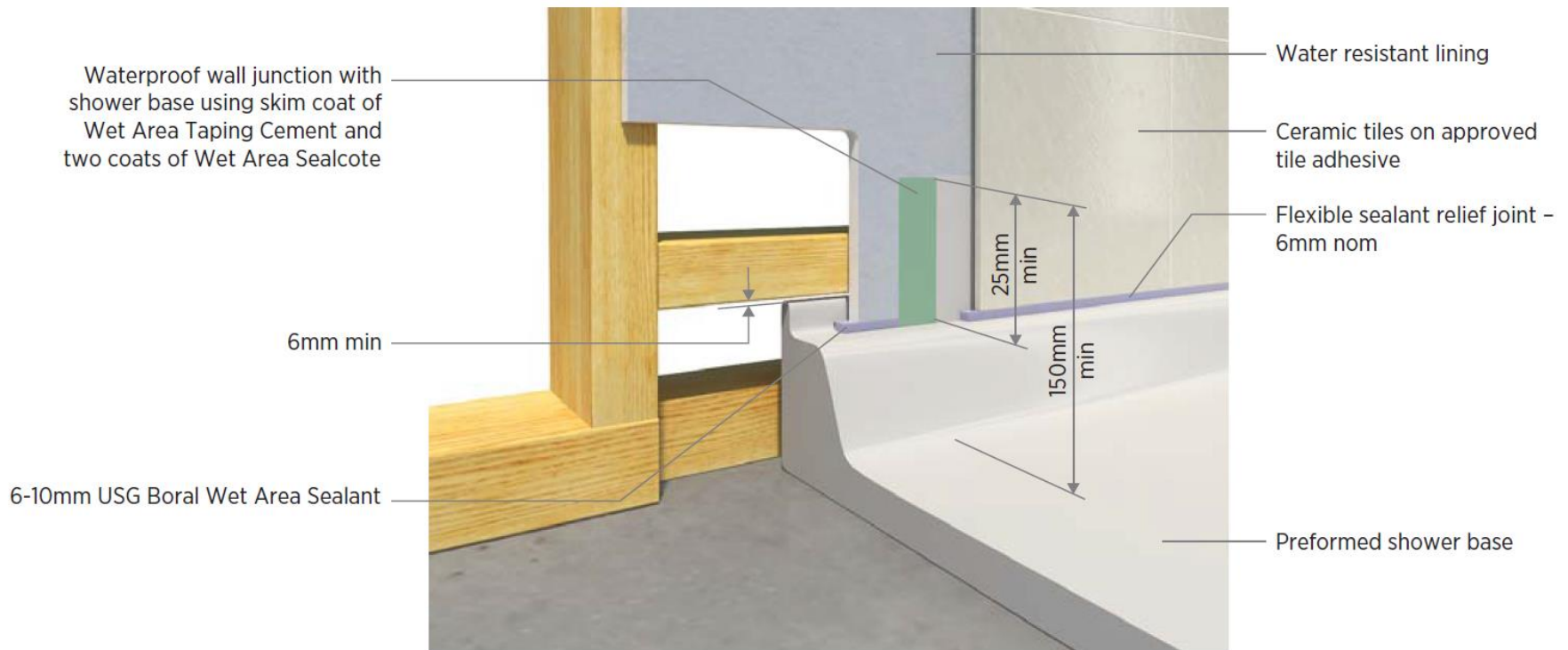


Figure 65: **Preformed shower base and wall junction**

8. WET AREAS APPLICATION

8.2 Waterproofing



Figure 53: Waterproofing of enclosed shower over bath

8. WET AREAS APPLICATION

8.2 Waterproofing



Figure 54: Waterproofing of enclosed shower

8. WET AREAS APPLICATION

8.2 Waterproofing

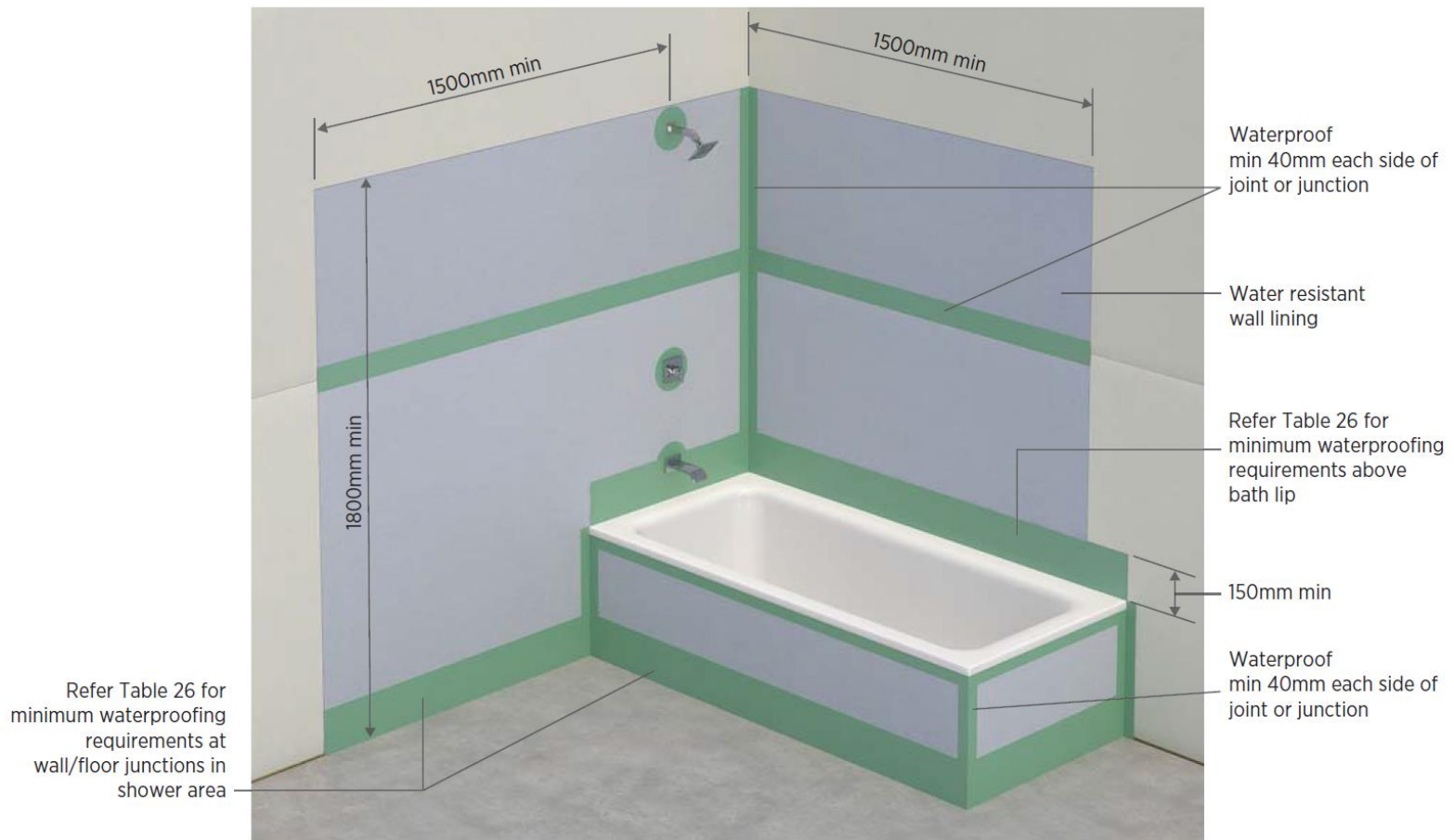


Figure 55: Waterproofing of unenclosed shower over bath

8. WET AREAS APPLICATION

8.2 Waterproofing

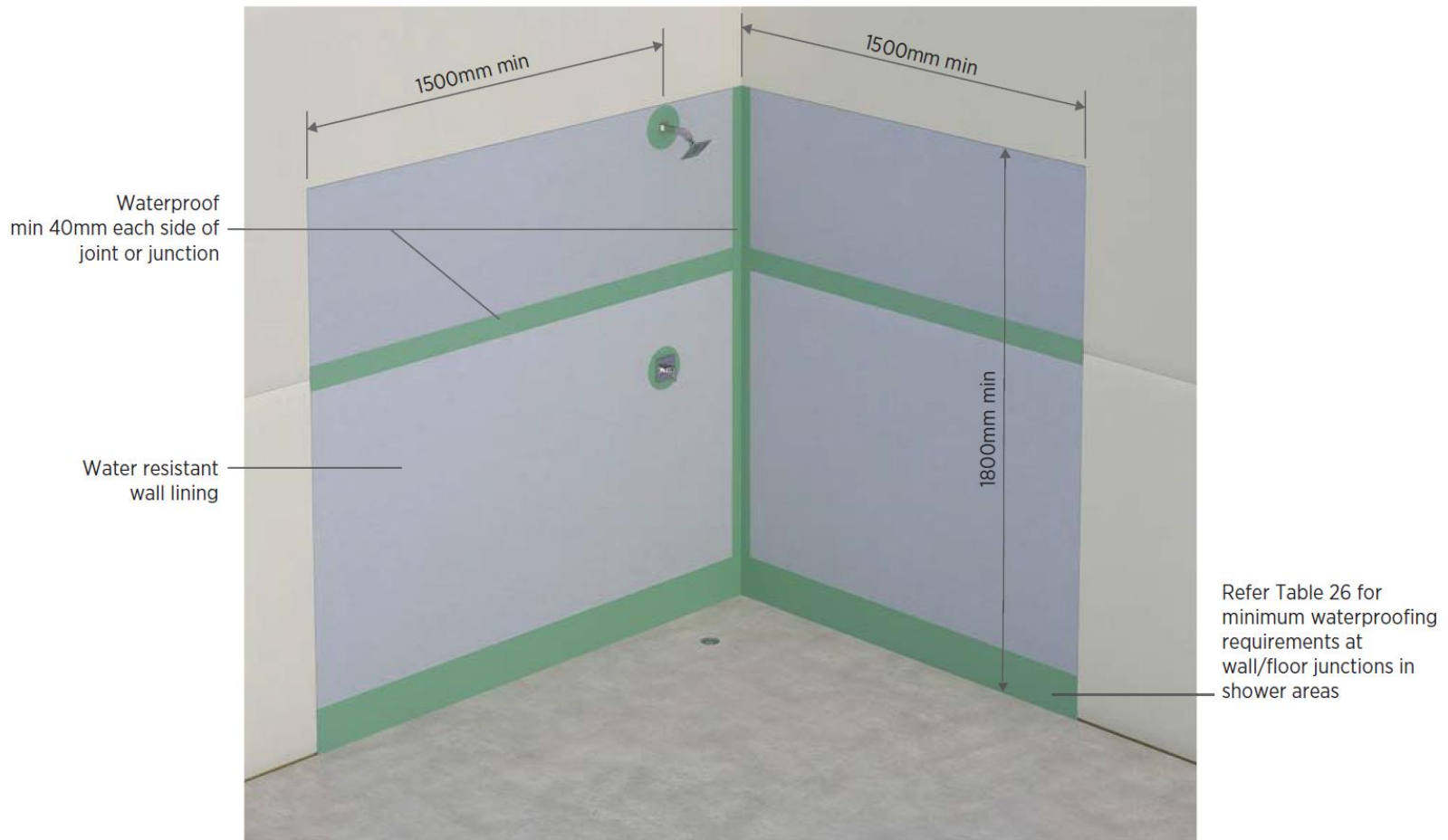


Figure 56: Waterproofing of unenclosed shower

8. WET AREAS APPLICATION

8.2 Waterproofing

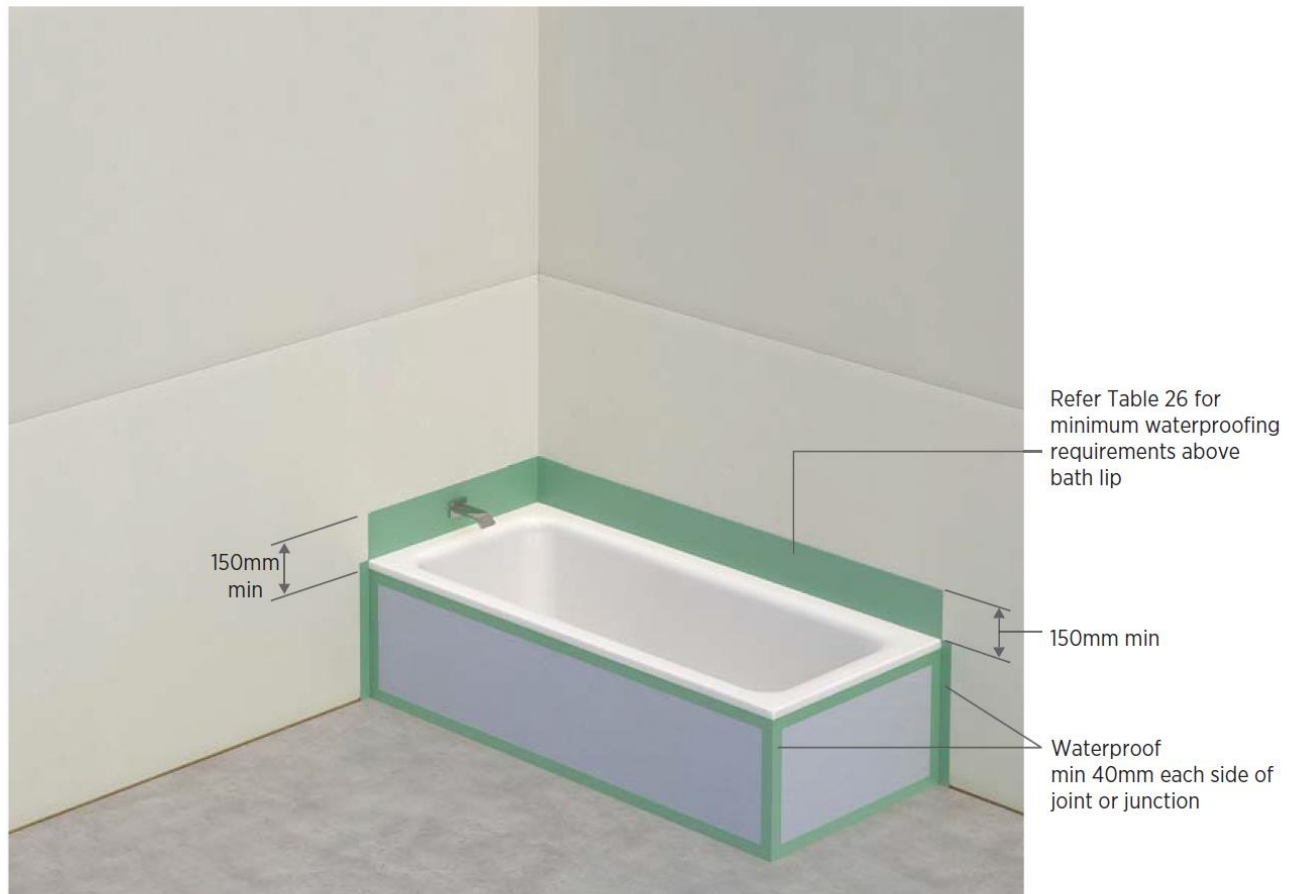


Figure 57: Waterproofing of bath

8. WET AREAS APPLICATION

8.2 Waterproofing



Figure 58: Waterproofing of basin

8. WET AREAS APPLICATION

8.2 Waterproofing



1. Apply bedding coat of Wet Area Taping Cement.



2. Bed in paper jointing tape in the corners.



3. Bed in paper jointing tape at sheet joints.

8. WET AREAS APPLICATION

8.2 Waterproofing



4. Apply skim coat of Wet Area Taping Cement at joints and around penetrations.



5. Apply skim coat of Wet Area Taping Cement to fastener heads.



6. Apply skim coat of Wet Area Taping Cement at sheet base.

8. WET AREAS APPLICATION

8.2 Waterproofing



7. Apply two liberal coats of Wet Area SealCote at all joints, junctions, penetrations and fastener heads.



8. Completed shower enclosure.

8. WET AREAS APPLICATION

8.2 Waterproofing

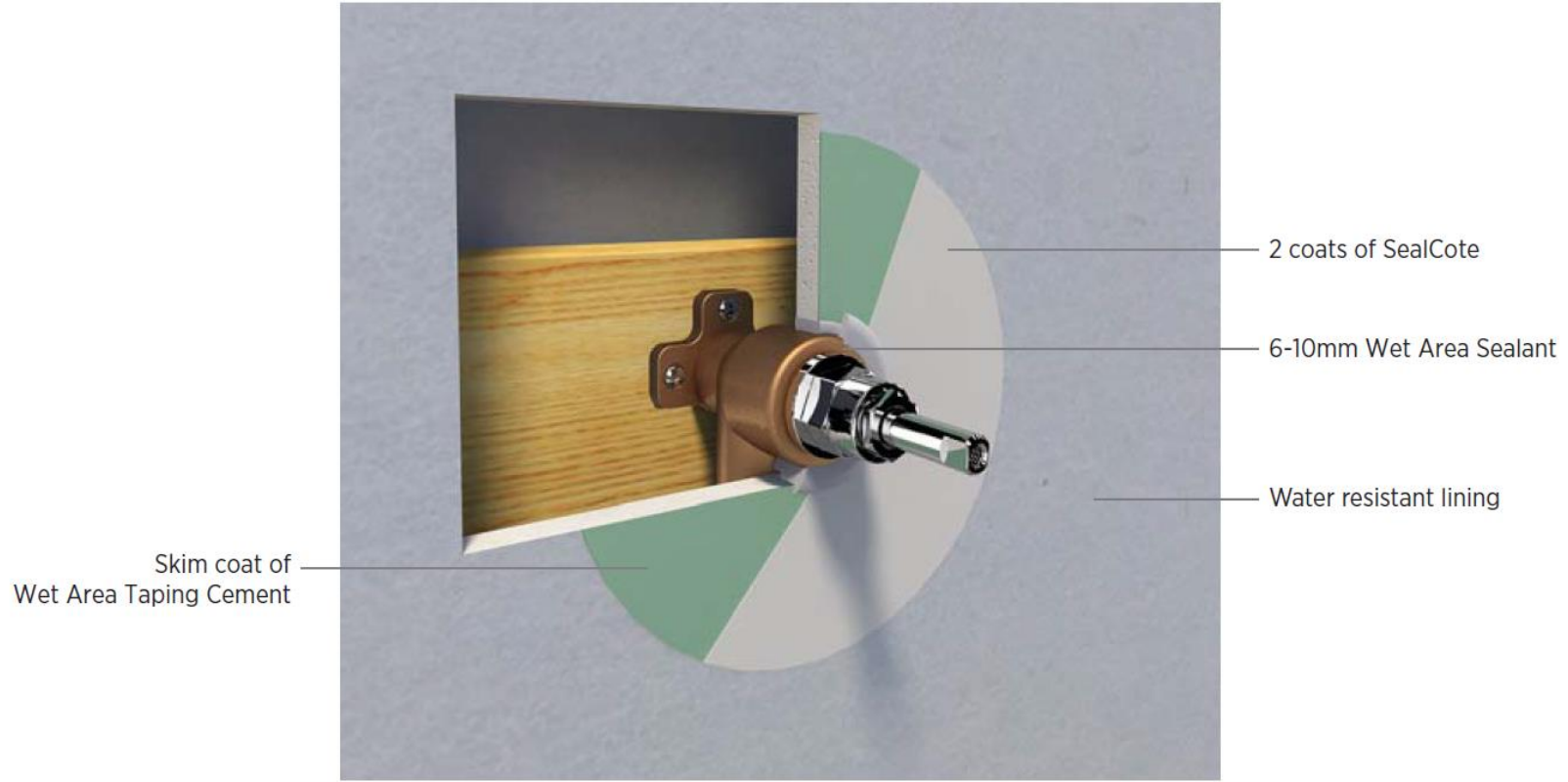


Figure 69: Plumbing Penetrations - Sealed

8. WET AREAS APPLICATION

8.2 Waterproofing

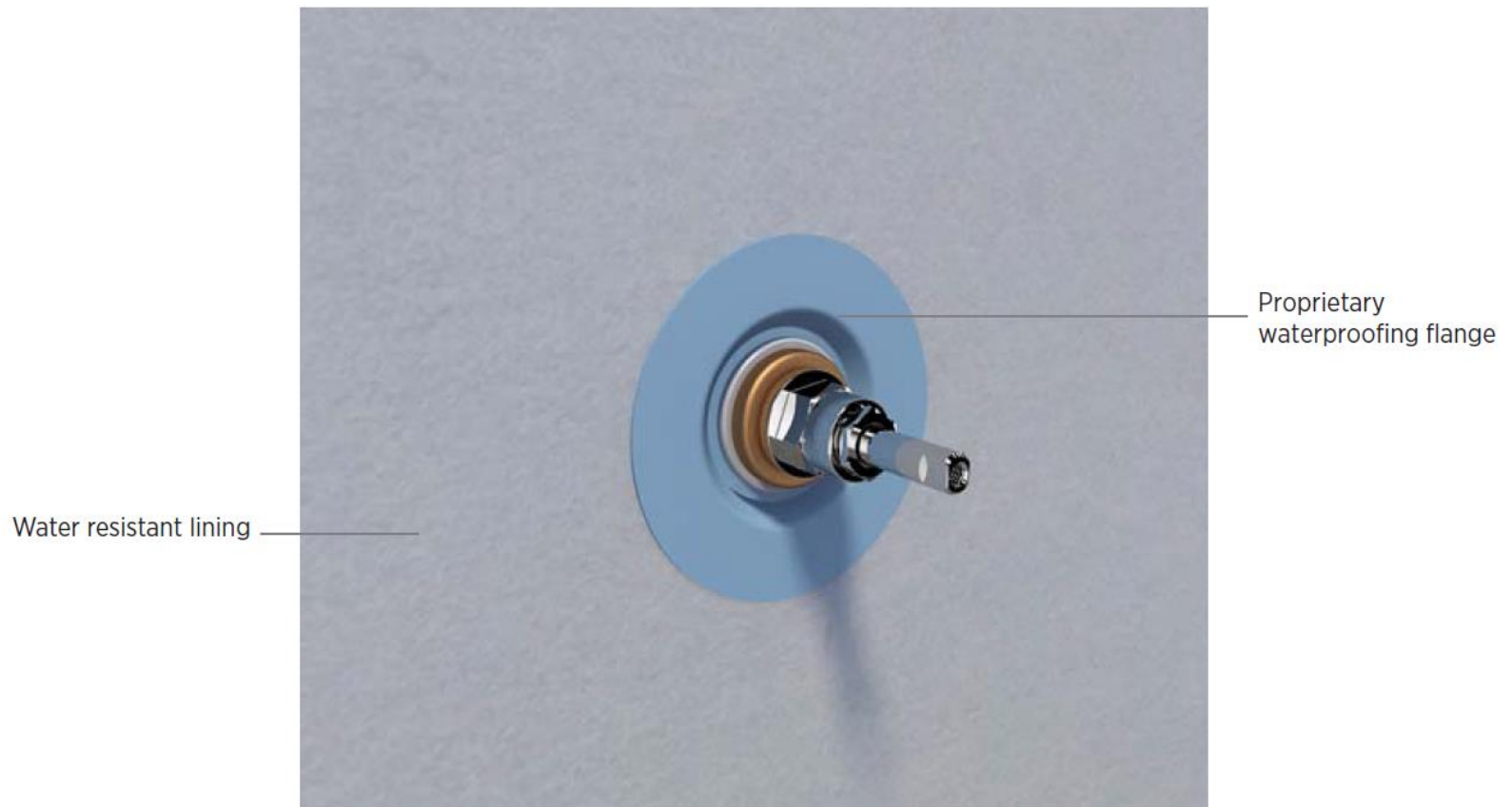
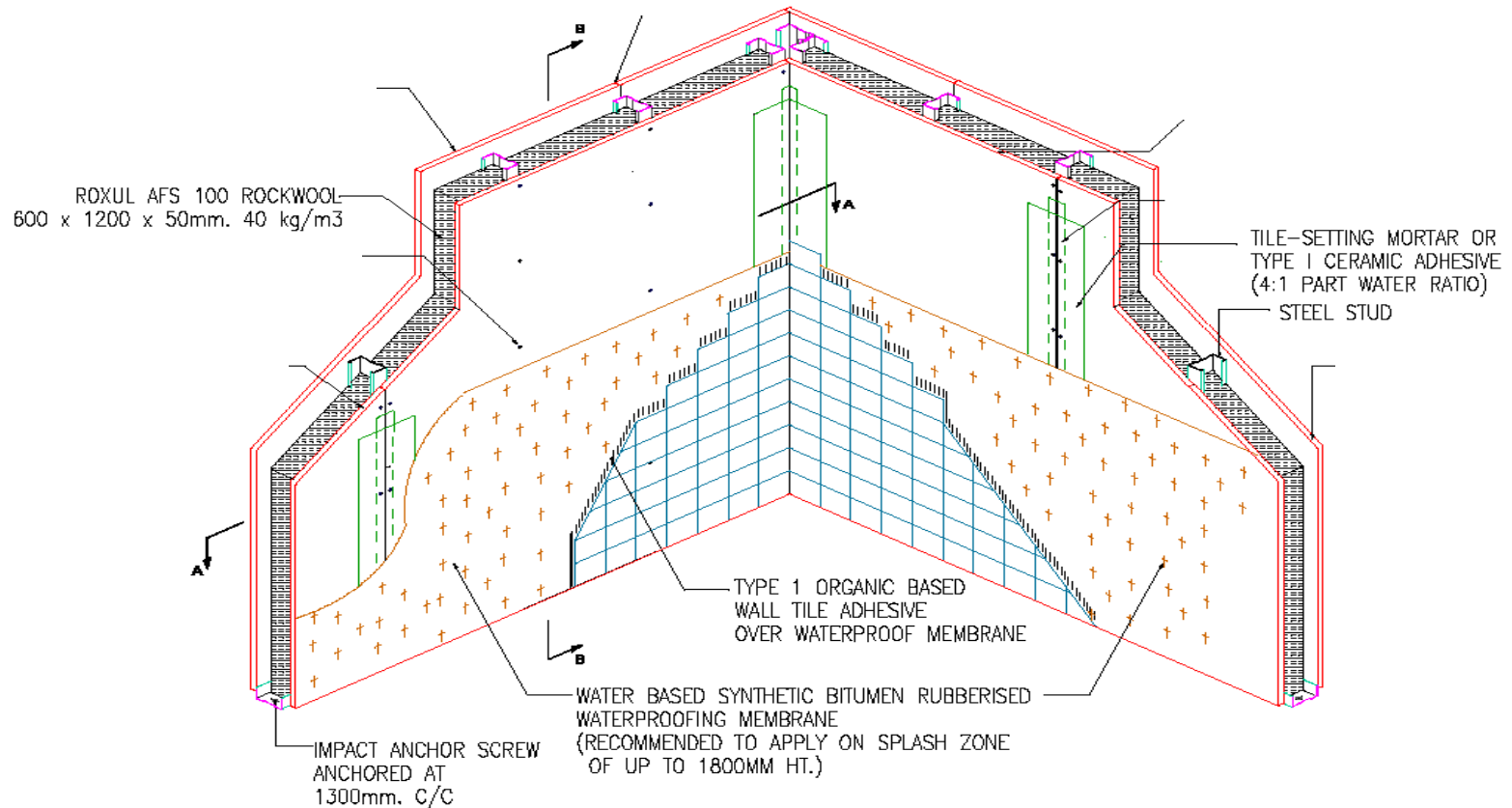


Figure 70: Plumbing Penetrations With Proprietary Waterproofing Components

8. WET AREAS APPLICATION

8.2 Waterproofing



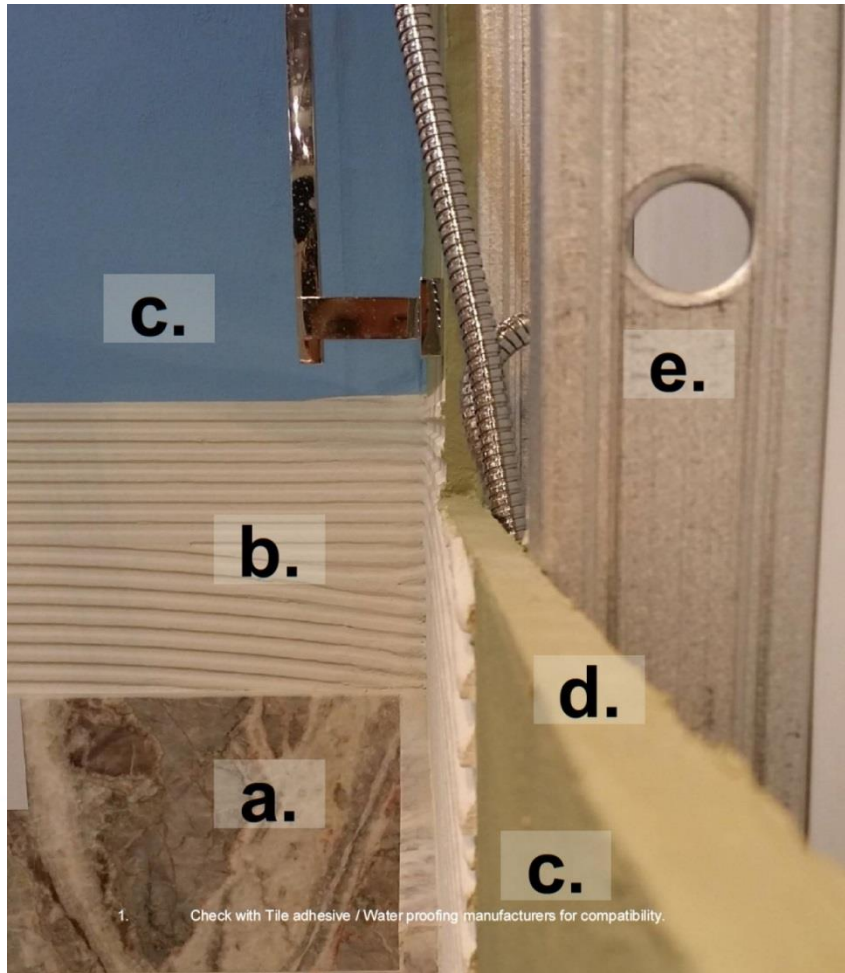
8. WET AREAS APPLICATION

8.2 Waterproofing



8. WET AREAS APPLICATION

8.2 Waterproofing



Water Seepage



a	Marble or Ceramic Tile
b	Tile Adhesive / Grout
c	Water Proofing Membrane
d	Water Resistant Wallboard
e	Zincalume® Steel Frame

Image (left) illustrates the full work sequence of water protection of drywall used for shower wet area.

1. Check with Tile adhesive / Water proofing manufacturers for compatibility.

8. WET AREAS APPLICATION

8.3 Tiles pull out tests Requirement

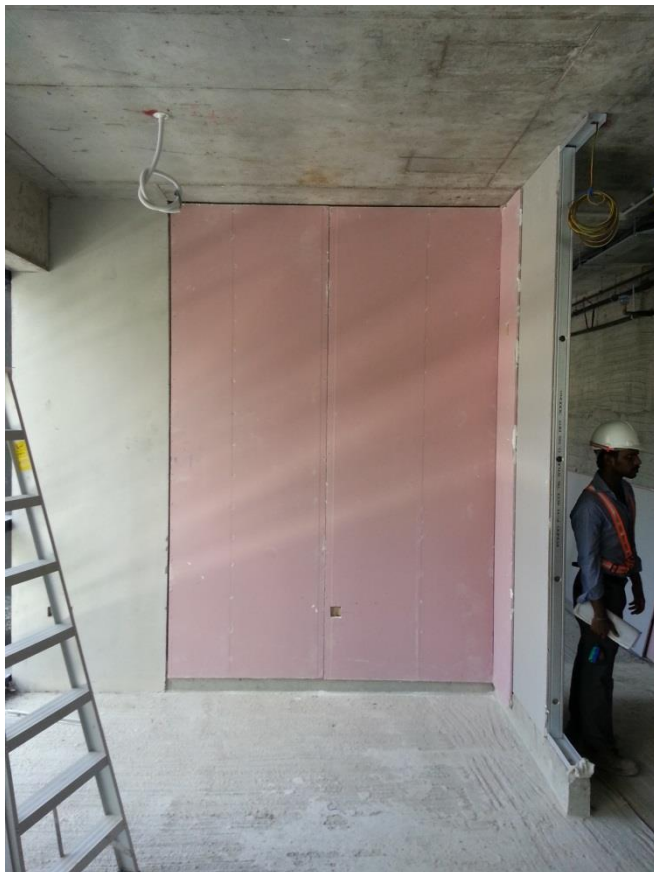
BCA's CONQUAS Quality Standard for Architectural works

Pull Out Test (POT) requirement for Internal Wall Tiles

- Minimum tensile strength of 0.15 N / mm^2 (Not for Drywall yet).

8. WET AREAS APPLICATION

8.4 Recommended Good Practices



8. WET AREAS APPLICATION

Drywall Use for Toilet Area: Site Reference



Setting out Kerb at toilet area.



Drywall will fix on the concrete kerb with water proofing..



Steel member will require for fixtures like WC unit or vanity top.

8. WET AREAS APPLICATION

Drywall Use for Toilet Area: Site Reference



Drywall construction in wet area where fibre cement to be used in wet area.

Opening to drywall can be created for glass panel ets..

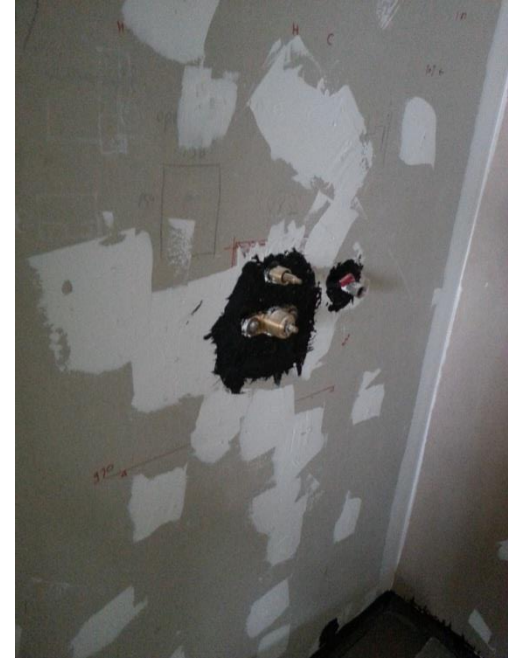


Gypsum plasterboard will be used where interface to dry area..



8. WET AREAS APPLICATION

Drywall Use for Toilet Area: Site Reference



All services will be sealed & plastered.
Lastly water proof treatment specialist.

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9. INTRODUCTION OF PBU

10. TYPES OF PBU

11. REQUIREMENT OF DRYWALL PBU

9. INTRODUCTION OF PBU

The bathroom is an indispensable component in all buildings. The conventional method of constructing a bathroom on site involves many labour intensive building trades such as brick or block work, waterproofing, finishes, plumbing, sanitary, electrical works and accessories installation. This requires extensive manpower, time and co-ordination among trades within a restricted site environment.

A prefabricated bathroom unit (PBU) refers to a bathroom unit preassembled off-site complete with finishes, sanitary wares, concealed pipes, conduits, ceiling and bathroom cabinets before installing into position. A PBU which integrates various trades and constructed in an off-site factory environment can achieve consistent and high quality workmanship and improved site productivity.

9. INTRODUCTION OF PBU

The introduction of PBU can address the extensive on-site manpower, time, and coordination issues. Off-site fabrication can run parallel to other construction site activities, thereby shortening the construction cycle. The effects of inclement weather downtime are also minimized. Other benefits of PBU include better control of materials, streamlined factory fabrication and production processes, less co-ordination with multiple trades/parties, less abortive work for construction sites, etc.

PBUs have been widely used around the world including Japan, USA, UK, Italy and many other countries. There are many types and variants of PBU in the market. In Singapore, both HDB and private developers have used PBUs in some projects since the mid-90s.

9. INTRODUCTION OF PBU

What is a Prefabricated Bathroom Unit (PBU)?

A prefabricated bathroom unit refers to a bathroom unit preassembled off-site complete with finishes, sanitary wares, concealed pipes, conduits, ceiling, bathroom cabinets, shower screen and fittings before installing in position.

What are the **benefits** of using PBUs?

By shifting most of the fabrication work and wet trades off-site to the controlled environment of a factory, PBUs can yield both time and manpower savings by about 60%. **Downtime can be minimised as production of PBUs can continue** even during times of inclement weather. Furthermore, there is a better control of both materials and the prefabrication process, resulting in higher quality finishes and lesser wastage.

In factory..

Save Time / Manpower

Higher Quality Finishes



9. INTRODUCTION OF PBU

Mandated Use of Prefabricated Bathroom Unit (PBU)

The use of prefabricated bathroom unit (PBU) is [mandatory for all non-landed residential Government Land Sale \(GLS\) sites from 1 Nov 2014 onwards](#). Further details on the mandatory requirement are stipulated in the Code of Practice on Buildability 2014.

Prefabricated Bathroom Unit (PBU) Acceptance Framework

Under the PBU acceptance framework, PBU suppliers and manufacturers who intend to supply their PBU systems to be used at development sites where PBU is mandated must first ensure that their PBU system can meet the [PBU performance requirement](#). The proposed PBU systems will also be subjected to the evaluation and acceptance of the [Building Innovation Panel \(BIP\)](#).

9. INTRODUCTION OF PBU

PBU Manufacturer Accreditation Scheme (PBU MAS)

The manufacturer and production facilities of the PBU system must be accredited under the PBU Manufacturer Accreditation Scheme (PBU MAS) before the PBU system can be used at development sites where the use of PBU is mandated.

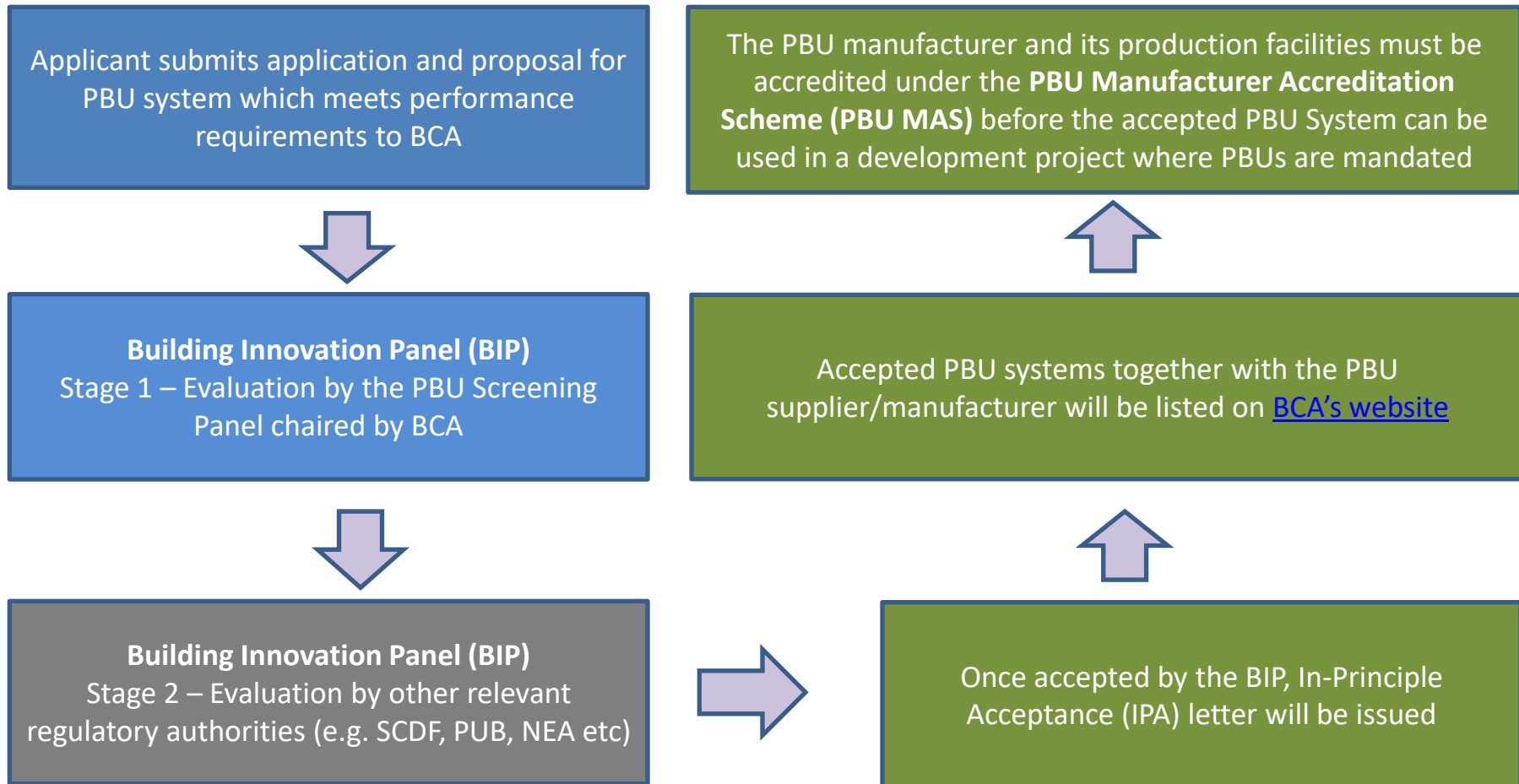
Additional Information

The detailed layout and design of the PBU system, when used in a development project, are to be satisfactory and in compliance with the technical requirements of all other relevant regulatory authorities.

Designers, builders and manufacturers may refer to the [Good Industry Practices Guide](#) for further information and recommendations on areas such as transportation, protection measures, installation, renovation as well as maintenance of PBU.

9. INTRODUCTION OF PBU

Acceptance Framework Flowchart



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9. INTRODUCTION OF PBU

10. TYPES OF PBU

10. TYPES OF PBU

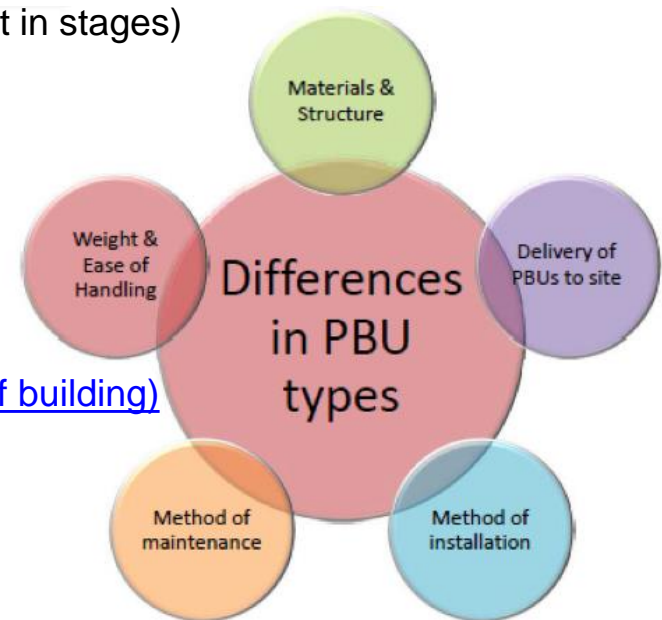
- Wall & Floor : Concrete
- Wall : Steel Panel / Floor: Concrete
- Wall: Lightweight Concrete / Floor Concrete
- Wall & Floor : Fiber reinforced Panel (FRP)
- Wall : Drywall Panel / Floor Concrete



10. TYPES OF PBU

Characteristic of PBU

- Materials & Structure
 - Volumetric concrete (monolithic casting / cast in stages)
 - Steel panel as wall frame
 - Steel sections as wall frame
- Weight & Ease of Handling
 - Critical path method
(using Hoist-in method from top of building)
 - Non critical path method
(using Slotted-in method to push from side of building)
- Method of Installation
 - Pre-assembled in factory
 - Assembled at site
- Delivery of PBUs to site
- Methods of maintenance



CONTENTS

9. DEFINITION OF PBU

10. TYPES OF PBU

11. REQUIREMENT OF DRYWALL PBU

11. REQUIREMENT OF DRYWALL PBU

The Drywall PBU (Prefabricated Bathroom Unit) is constructed using dry installation method. The unit is pre-assembled in factory and delivered to site for installation.



11. REQUIREMENT OF DRYWALL PBU

- 1. Strength and Robustness of Wall Panels**
- 2. Access to Utilities for Maintenance, Repair and Replacement**
- 3. Replacement of Tiles**
- 4. Provision for Barrier-Free Accessibility design requirements**
- 5. Manufacturer's Label**
- 6. Homeowner User Manual**

11. REQUIREMENT OF DRYWALL PBU

1. Strength and Robustness of Wall Panels

- a) For PBU with wall panels manufactured with non-concrete or lightweight concrete materials, the wall panels are to be tested in accordance with the Specification for performance requirement for strength and robustness (including methods of test) for partition walls – SS492:2001 to achieve a minimum grade of **Medium Duty**.
- b) The wall panel should not be susceptible to corrosion in the long term.

11. REQUIREMENT OF DRYWALL PBU

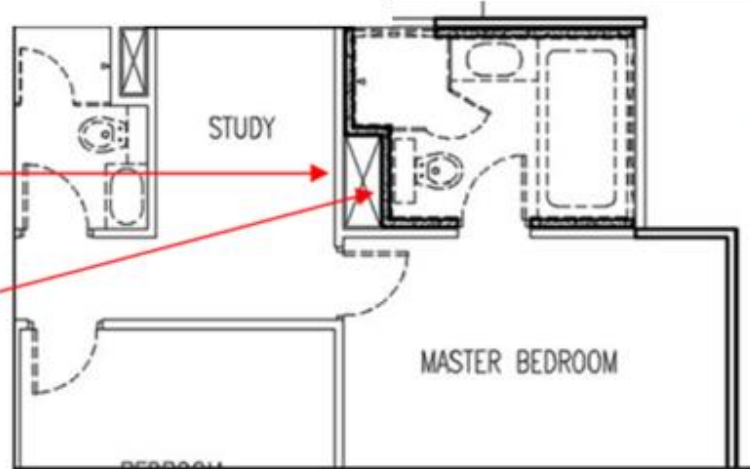


Layout 1

X The services shaft is not accessible once the PBU is placed into position

Dry wall partition

✓ The vertical shaft is accessible for repair and maintenance from bedroom or study room



11. REQUIREMENT OF DRYWALL PBU

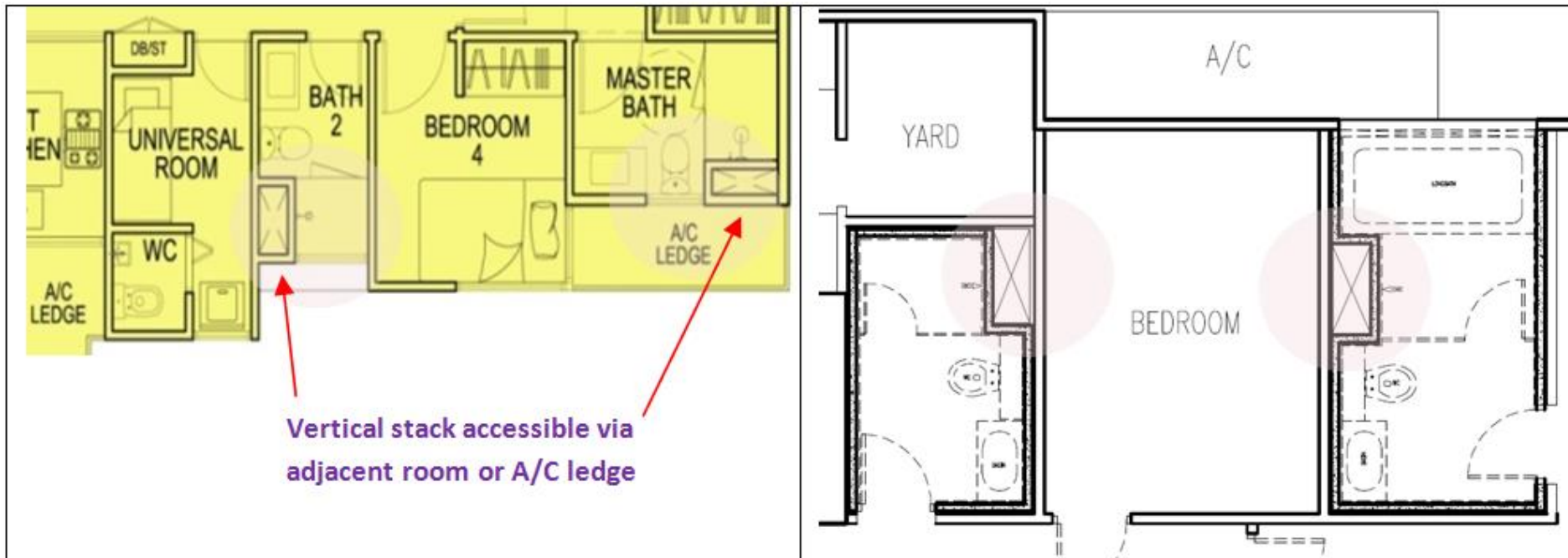


Figure 2: Alternative layout options which allow the vertical stack to be accessible for future maintenance from air-conditioning ledge or an adjacent room

11. REQUIREMENT OF DRYWALL PBU

2. Access to Utilities for Maintenance, Repair and Replacement

- a) The vertical soil stack shall be located such that it is readily accessible from outside the PBU and within the dwelling unit or from the common areas of the same floor.

- b) Access panel must be provided at the ceiling within the PBU to provide access for maintenance, repair and replacement of overhead services and utilities.



11. REQUIREMENT OF DRYWALL PBU

3. Replacement of Tiles

The PBU must allow for tiles replacement to be done via hacking with chisel and hammer, or their equivalent tools, without resulting in damage to the wall panels or backing board.



11. REQUIREMENT OF DRYWALL PBU

4. Provision for Barrier-Free Accessibility design requirements

Provision shall be made on the wall panels for future installation of grab bars in the PBU.

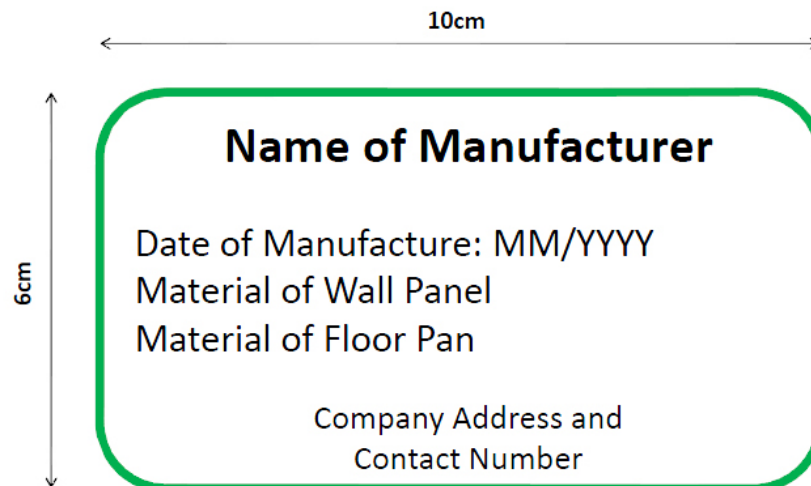
Information such as the location for future installation of grab bars and the installation method statement shall be included in the homeowner user manual.



11. REQUIREMENT OF DRYWALL PBU

5. Manufacturer's Label

The manufacturer's label should be incorporated in the completed PBU before delivery. This label must be visible to users and should be used as a reference for any repair, replacement and renovation work. It is recommended that the location of the manufacturer's label be provided in the homeowner user manual



11. REQUIREMENT OF DRYWALL PBU

6. Homeowner User Manual

A user manual containing the following list of information shall be provided to homeowners upon the handing over of the unit:

- (a) General information about the PBU
 - Introduction to the PBU
 - Safety notices
 - Instructions for use
- (b) Structure of the PBU
 - Floor
 - Wall
 - Ceiling
 - Water piping
 - Sanitary discharge pipe/vertical soil stack
 - Electrical conduits
- (c) Layout of the PBU
 - General layout of the PBU
 - Locations of concealed services
 - Location of the manufacturers label
- (d) Cleaning and maintenance advice
 - Internal fittings, tiles and accessories
 - Floor trap
 - Ceiling access panels
 - Access to vertical stack
- (e) Alteration, repair and replacement works
 - Replacement of accessories/installation of additional fittings
 - Availability and supply of spare parts
 - Instructions for drilling and fixing
 - Instructions for tile replacement
 - Instructions for grab bars installation

CONTENTS

- 9. INTRODUCTION – DRYWALL PBU
- 10. TYPES OF PBU
- 11. REQUIREMENT OF DRYWALL PBU
- 12. REPLACE TILES IN DRYWALL PBU

12. REPLACE TILES IN DRYWALL PBU



<https://www.youtube.com/watch?v=gdxx4-jCWkk>



THE END

1. COURSE EVALUATION
2. QR CODE CHECK IN
3. ASSESSMENT

