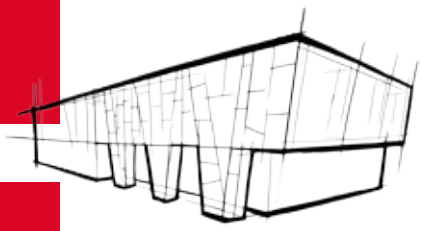
ROCKWOOL®

BUILDING INSULATION

Indoor Acoustic Comfort in Buildings

Safe 'n' Silent™ Solutions in Partition Systems

8TH ANNIVERSARY



Project
Terminal 3, Changi Airport Singapore

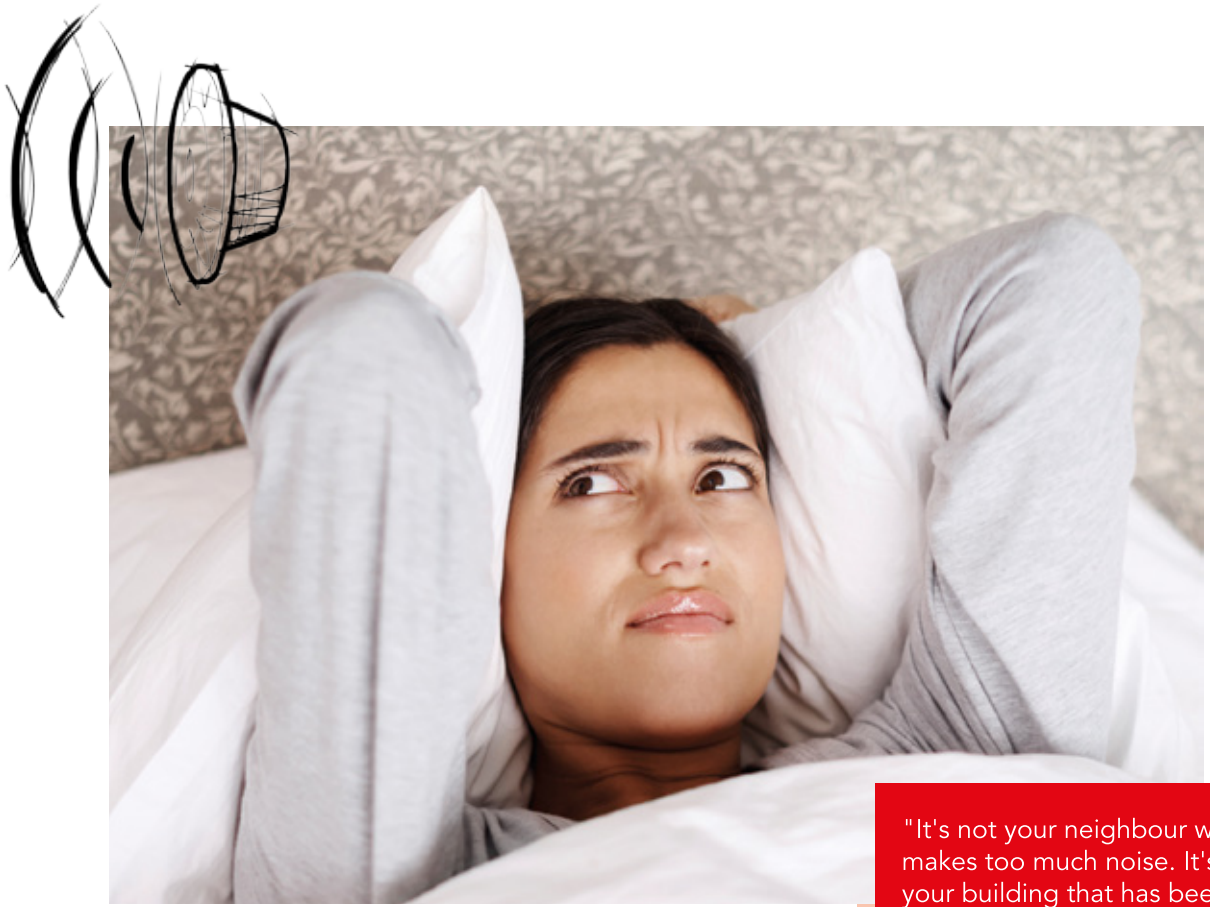
Completed: 2007
Owner: Government of Singapore
Architect: CPG Corporation

Does Noise Matter?

Noise pollution is a major environmental problem affecting millions of people around the world. According to the World Health Organisation (WHO), noise induced hearing impairment is the most prevalent irreversible occupational hazard and it is estimated that 120 million people worldwide have disabling hearing problems.

So do we need be concerned about the constant noise that we are bombarded with day and night, especially if we are living in cities and urban areas?

Noise problem in building envelopes can be the result of impact noise or airborne noise. Both problems require proper understanding and treatments of the walls, ceilings, systems and materials within the room in order to achieve a good indoor acoustic environment.



"It's not your neighbour who makes too much noise. It's your building that has been insufficiently sound proofed."

Prof. Jens Holger Rindel, Noise expert
Technical University of Denmark

Living in a loud world

The main elements contributing to indoor noise problem involve both indoor and outdoor noise sources, affecting our sleeping habits and quality of life.

With the increasing number of people moving into cities as a result of urbanisation; our working and living spaces also becomes more crowded. All these increase the extent of community noise problems or outdoor noise sources, which includes noises from traffic congestion, industries, construction, public work and the neighbourhood disturbance.

In our modern world, the use of equipment such as high-tech entertainment rooms, pinging computers, blaring stereos and ringing phones also contributes to the cacophony of indoor noises.

How noise impacts our lives

Being exposed to high levels of noise affects everyone a little differently. Children in general are more sensitive to excessive levels of noise, along with chronically ill or elderly people. Adults who work in especially noisy environments also experience higher levels of stress and fatigue. Disturbed sleep patterns due to noise pollution can mean higher medical bills, and more seriously for children, impaired childhood development.

WHO has a list of recommended noise levels for different types of interior spaces. For example, WHO recommends less than 30 db(A) of noise for bedrooms and less than 35 db(A) in classrooms to allow for good teaching and learning environments.

The bad news is that studies have shown that a large number of people are regularly subjected to more than the recommended noise levels. In EU (European Union) countries for example, about 40% of the population is exposed to traffic noise at levels exceeding 55 dB(A), and more than 30% are exposed to levels exceeding 55 dB(A) at night.

Acoustic Comfort in Modern Buildings

Noise pollution is a serious concern for everyone. But how do we effectively define noise level in terms of the total acoustic comfort for a particular space?

It is easy enough to measure the noise of a space after it has been built. But by then, rectification to reduce noise levels may prove to be expensive and a hassle. As such, what is more important is how we effectively specify and measure buildings to achieve the desired acoustic comfort during planning and building stage.

Traditionally, the method for mitigating noise intrusion is by introducing the rating system called Sound Transmission Class (STC) or sometimes referred as ISO's Weighted Sound Reduction [Rw). STC essentially describes the ability of a particular material to resist airborne sound. For example, each wall of a room may be given a certain STC rating, which indicates an average quantum of external noise that could potentially be isolated through it. A higher rating will 'block' more noise from transmitting through that particular material or wall.

Although STC or Rw is a norm specified in building designs, it does not provide us the desired acoustic comfort within a room. STC only provides the performance of individual walls and materials. It is not a measurement or specification used for defining the acoustic outcome of the entire functional space.

In reality, the desired acoustic comfort of a particular space depends on a complex combination of sound isolation of partitioning elements, indoor acoustics design and finishes; also noise and vibration mitigation of building equipments (typically mechanical and electrical equipments). It requires a more comprehensive method of measurement and design that provides a better reflection of the total noise levels of that space. Hence, a more defining approach for specifying and measuring indoor acoustic comfort should be used.

In specifying building designs, acoustician, mechanical engineers and architects adopt an approach to use ambient noise level to specify their desired design outcome. Ambient noise level is described as a background sound level for a desired indoor functional space. A good acoustic environment provides an ambient noise level that suits its environment, providing a degree of human comfort and speech intelligibility.

Why STC is not sufficient

To provide an ideal acoustic environment, it may not always be the case where all rooms have to be acoustically quiet. The amount of noise allowed in a room depends on needs, function and feasibility. Hence, using STC or Rw without considering the intended outcome and usage of the room may run the risk of over designing leading to unnecessarily high cost.

The usage of modern electronic devices, tools and appliances which produces lower frequency sounds are much more prevalent today and can negatively affect the peace and quiet in a room as the sound is able to transmit through from room to room. STC ratings alone do not adequately measure and specify for low frequency sounds within the human hearing range.

The Better Solution to Indoor Comfort

In designing buildings to the desired ambient noise level, a recognised and effective method is by using Noise Criteria (NC) as design reference.

NC ratings are determined by measuring the sound pressure levels across various octave bands, and through comparing it with established NC curves, an NC rating is derived.

The NC was designed to relate human perception of hearing to indoor noise level and thus provide a single value rating for this. Since its development, NC has been widely adopted by acousticians and designers. One major advantage of NC is that it is able to give reference of the resultant ambient noise level of a space/ room to ensure occupants are at their intended or desired indoor comfort.

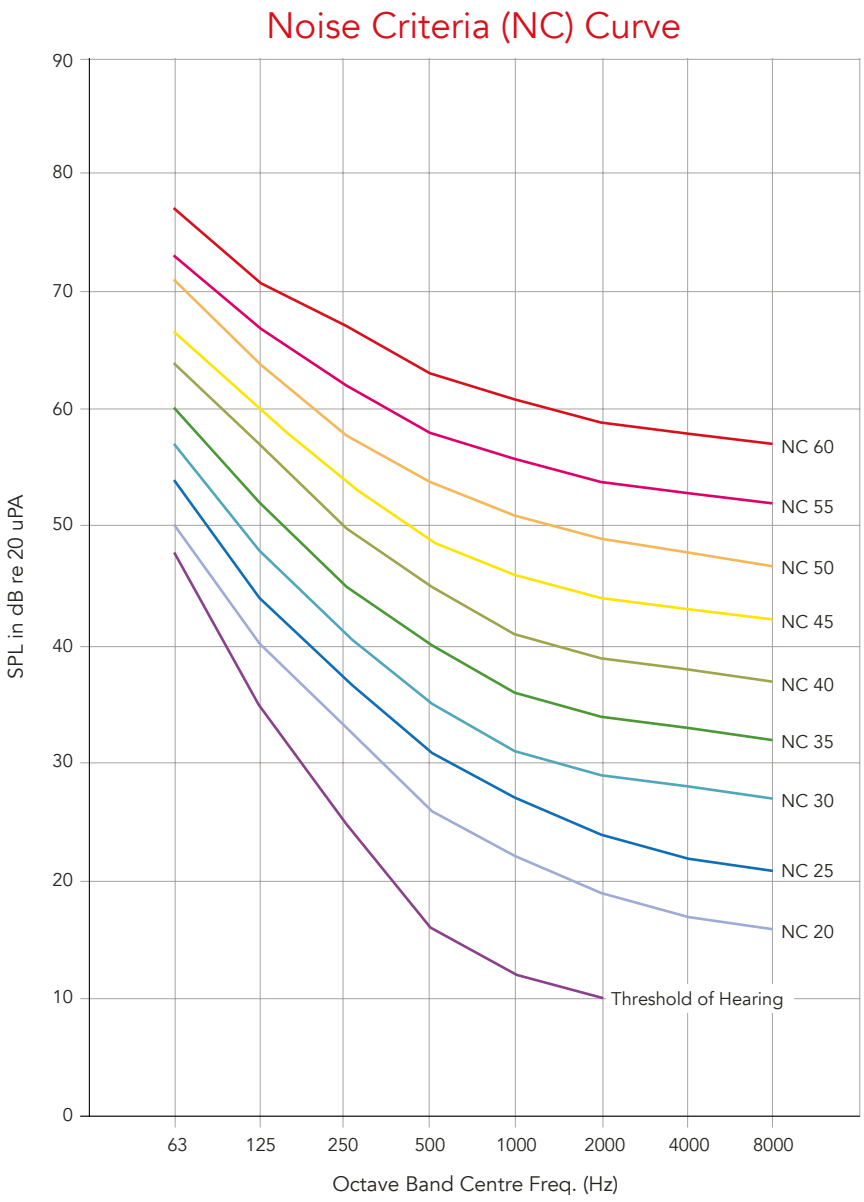
Essentially, NC comprehensively measures the noise levels of a room, and can encompass more variables such as presence of noise sources for example the HVAC systems or electrical and lighting ballasts, and resultant effect of interior acoustics [high or low reverberation), and the sound isolation performance of the various materials that are used to enclose the room.

Total comfort with NC

With advancement of civilisation, human society as a whole continues to seek a high standard of living. We strive to make our work place and home a more pleasurable and comfortable environment free from excessive noise. However, we can never create a completely noise-free environment. Neither do we want to live in a world totally devoid of noise. Hence, what constitutes an ideal ambient noise environment?

A moderate level of ambient noise is often desirable when conversing with each other to avoid an awkward conversation in an office. When resting or sleeping a low level of ambient noise is desirable within a bedroom environment. In a sports hall, a higher level of ambient noise is deemed acceptable. Other places, such as an operating theatre in a hospital, a low level of ambient noise is critical to ensure concentration and focus. In order for occupants to enjoy the desired aural environment for the designed space, NC ratings help to ensure the outcome of the building space satisfy the requirement over a range of human hearing frequencies from 63Hz to 8000Hz.

To establish NC of a room, sound pressure level in decibel dB [linear log scale) which measured over a spectrum of frequencies from 63Hz to 8000Hz, is then plotted over the NC Chart. The maximum point of measurement that meets the lowest NC criteria curve would give the NC rating. The lower the NC level the quieter the ambient noise shall be expected.



The table on the right provides the recommended NC ratings for various indoor environments. The ambient noise level (dBA) represents the desired acoustic level of that particular room. However, it may be inefficient or unfeasible to simply aim for the lowest NC rating for all spaces.

Each space or room has a recommended NC rating, which is based upon the intended requirements, needs and function.

Architects, acousticians, and mechanical engineers will then work towards achieving the intended NC ratings based on these factors, ensuring that each space or room has suitable acoustic environment and desired ambient noise levels for the occupants to carry out their activities comfortably .

In order to achieve the desired NC level, the following parameters need to be considered during design.

- Airborne sound isolation performance of the room/space partitioning elements
- M&E installation within and around the room/space of interest
- Interior acoustics

Presence of noise sources has direct effect on a room's ambient noise level, particularly if the noise source generates sound over long period of time or most part of the day. Typical noise sources often relates to mechanical and electrical installation; such as air conditioning, air handling and fan coil units, ventilation fan, ballast lights, central plant room which operates 24/7 and so on. As such, engineers and architects would need to consider the placement of noise generating equipments to be away from noise sensitive rooms whenever possible. Hence, airborne sound isolation performance of partitioning elements of the room becomes an important point of interest.

Rooms which require low NC rating would require partitioning elements with good airborne sound isolation performance. The NC performance coupled with the performance demands of the adjacent building elements such as roof, door, glass, window and floor ensures the room of interest will have minimal noise intrusion that does not compromise the NC requirements.

	Room/Space	NC	Recommended Rating Ambient Noise Level
Educational	Teaching and Learning Room	30 - 40	35 - 45 dB(A)
	Lecture Theatre	30 - 40	35 - 45 dB(A)
	Libraries	35 - 40	40 - 45 dB(A)
	Music Rooms	35 - 40	40 - 45 dB(A)
Health Care	Consultation Room	35 - 40	40 - 45 dB(A)
	Delivery Suites	40 - 45	45 - 50 dB(A)
	Operating Theatre	35 - 40	40 - 45 dB(A)
	Waiting Area	35 - 45	40 - 50 dB(A)
	Wards	30 - 35	35 - 40 dB(A)
Industrial	Control Rooms	40 - 50	45 - 55 dB(A)
	Offices	35 - 40	40 - 45 dB(A)
Commercial and Leisure	Offices	35 - 40	40 - 45 dB(A)
	Private Offices	30 - 35	35 - 40 dB(A)
	Airport Terminals	40 - 50	45 - 55 dB(A)
	Auditoriums	30 - 35	35 - 40 dB(A)
	Cinemas	35 - 40	40 - 45 dB(A)
	Cafés and Restaurants	40 - 50	45 - 55 dB(A)
	Departmental Store	45 - 50	50 - 55 dB(A)
	Hotel Rooms	30 - 35	35 - 40 dB(A)
	Place of Worship	30 - 35	35 - 40 dB(A)
	Gym	40 - 50	45 - 55 dBIAI
	Sport Centre	45 - 55	50 - 60 dB(A)
Residential	Living Room	35 - 45	40 - 50 dB(A)
	Bedroom	30 - 40	35 - 45 db(A)
	AV Room	35 - 40	40 - 45 dB(A)
	Leisure & Games Space	40 - 50	45 - 55 dB(A)

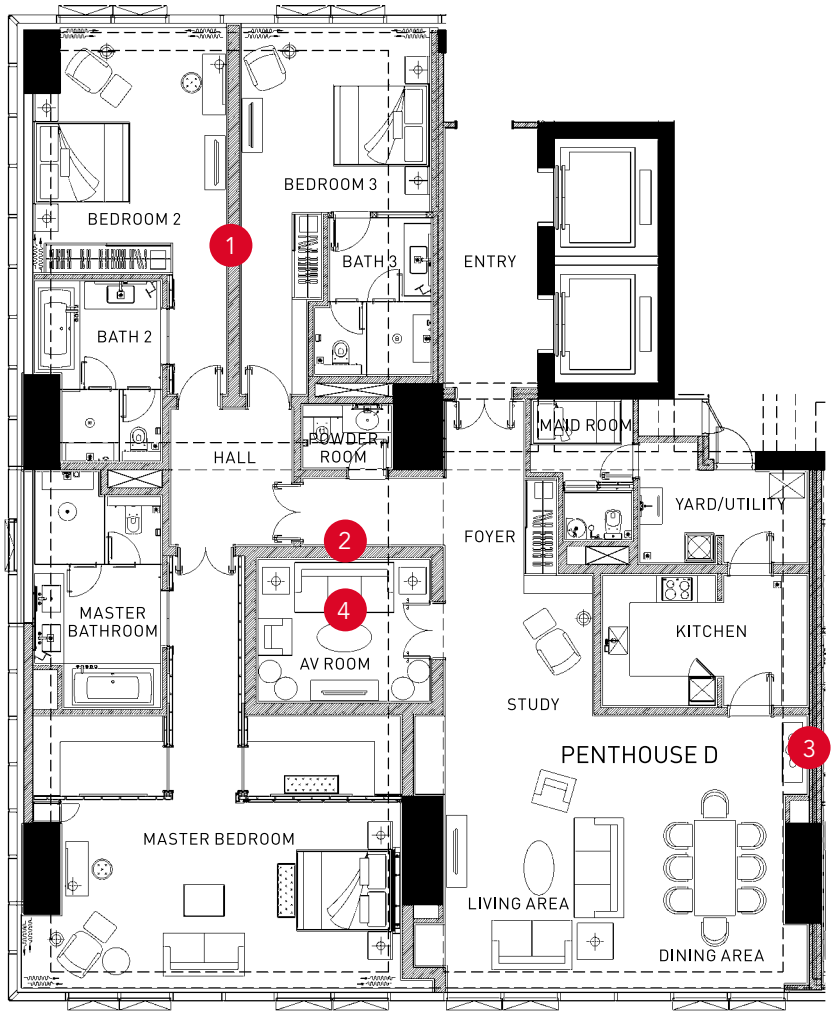
The Safe 'n' Silent Solutions

In order to provide occupants with the acoustic comfort they need for a specific functional space, the ROCKWOOL company has developed a series of acoustic solutions specifically for residential, commercial, educational and healthcare, that would meet the required NC and achieve the desired ambient noise level. The Safe 'n' Silent solutions combine various types of partition systems to meet the required acoustical performance, and with sound absorption values of other materials, to achieve the overall NC rating of the specific room.

Case study on NC application

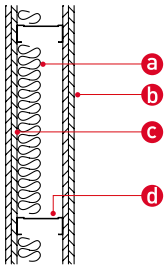
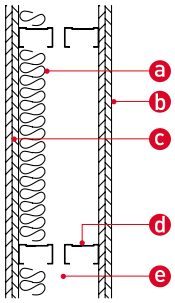
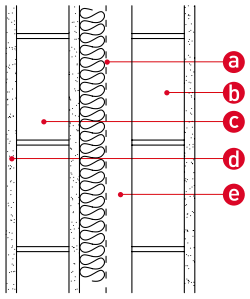
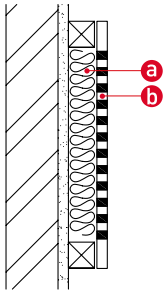
A case study using the example of a high rise residence is presented here to show how the Safe 'n' Silent solutions can achieve the recommended NC ratings based on the acoustic level desired by the occupants.

To establish the desired NC rating for the functional area, ROCKWOOL Asia had commissioned an acoustic consultant to develop a series of recommendations and solutions. The following example provides a detailed solution of adopting Safe 'n' Silent to achieve the desired NC outcomes and illustrates the wall configuration, types of ceiling or floor materials, type of windows and doors, and finally mechanical noise sources like the air conditioning for the specifications.



Space / Room	Recommended Rating	
	NC	Noise Level
Bedrooms	30 - 40	35 - 45 dB(A)
Study Area	30 - 40	35 - 45 dB(A)
AV Room	35 - 40	40 - 45 dB(A)
Living Area	35 - 45	40 - 50 dB(A)
Kitchen	45 - 50	50 - 55 dB(A)
Yard / Utilities	50 - 55	55 - 60 dB(A)

An example of Safe 'n' Silent system configurations are described in the following table:

Item	Elements	Example of Material, Details		Remarks
1	Party wall between bedroom		a) 50 mm thick ROCKWOOL Safe 'n' Silent Pro350 b) 2 x 12 mm thick Plasterboard (min. density 650 kg/cu.m) c) 2 x 12 mm thick Plasterboard (min. density 650 kg/cu.m) d) 92 mm metal stud	Wall to construct to full height
2	Party wall between AV room and other spaces		a) 50 mm thick ROCKWOOL Safe 'n' Silent Pro350 b) 2 x 12 mm thick Plasterboard (min. density 650 kg/cu.m) c) 2 x 12 mm thick Plasterboard (min. density 650 kg/cu.m) d) Separate stud 150 mm deep cavity e) 150mm deep air cavity	Wall to construct to full height
3	Party wall between residential unit		a) 50 mm thick ROCKWOOL Safe 'n' Silent Pro350 b) 100 mm thick clay brick (min. density 1500 kg/cu.m) c) 100 mm thick clay brick (min. density 1500 kg/cu.m) d) 20 mm thick plastering (on 3 sides) e) 100 mm deep air cavity	Wall to construct to full height
4	Acoustic wall lining		a) 50 mm thick ROCKWOOL Safe 'n' Silent Pro350 b) Perforated panel with minimal opening area of 15%	Typically to 70 - 80% of side and rear wall areas

*Note: The above configurations are just an extract for illustration purposes, for the full configurations please contact the ROCKWOOL sales person in your country for more information.

Unique Features and Benefits

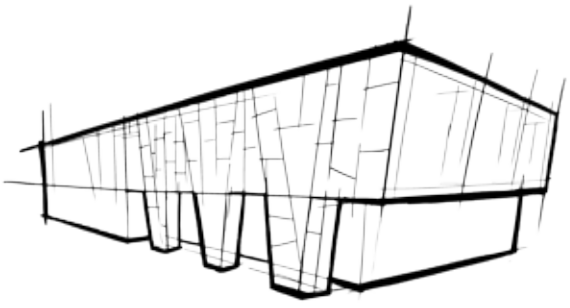
ROCKWOOL Safe 'n' Silent solution is made up of galvanized steel stud frames lined with gypsum, cement or calcium silicate boards on each sides of the frames and the Safe 'n' Silent Pro acoustic insulation inside the cavity of the wall system; giving an excellent overall noise absorption performance.

Safe 'n' Silent Pro is a nature-based insulation made of volcanic stone, a safe and sustainable material that continues to perform and lasts throughout the lifetime of the building. It is a product that harnesses the power from the earth's volcano to spin wool out of stone into superior quality stone wool with a unique range of benefits.

Fire protection

Few insulation can take the heat like we do - with the ability to withstand temperatures of over 1000°C without melting according to DIN 4102-17 and ASTM E794. Safe 'n' Silent Pro is non-combustible and achieves the highest European fire classification, A 1, according to EN13501-1.

This means that it can effectively impede the spread of fire and provides the critical extra minutes for occupants to escape from a room or building. With its fire retardant properties, Safe 'n' Silent Pro also does not contribute to fire load within the building and complies with UL723 to achieve Flame Spread Index of 0 and Smoke Development Index 0.



Fast and easy installation

Safe 'n' Silent Pro is fast and easy to install, helping to reduce the time taken and labour needed for installation work, hence increasing overall speed of construction.

Working with Safe 'n' Silent Pro is easy and can be done in 3 simple steps:

1. Insert

2. Compress

3. Release

It is also simple to cut Safe 'n' Silent Pro to size with a serrated knife, for a fast and easy installation between studs, around electrical boxes, pipes, wiring, ductwork and even between studs and joists of non-standard widths.

Water repellency

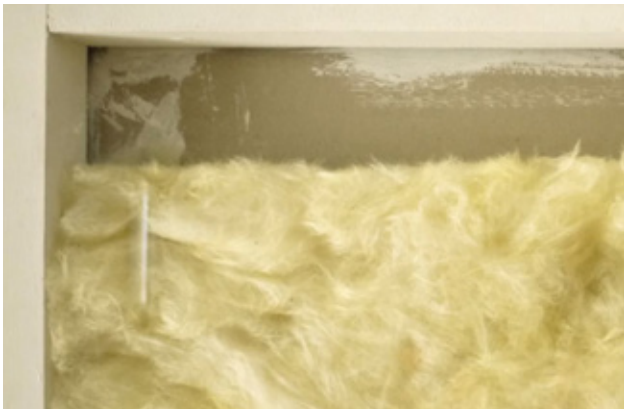
Safe 'n' Silent Pro is both water repellent and moisture resistant (tested under EN 1609). The product repels water even when exposed to temporary splashing of rain water at construction site and still able to maintain its shape over time; thereby delivering maximum noise and fire protection.

Moisture and nutrients are necessary conditions for fungal growth. Since more than 95% of this product is made up of inorganic fibres, there is little nutrient source to allow fungal growth. Hence, it does not cause corrosion of the metal studs nor promote fungi growth within the wall cavity.

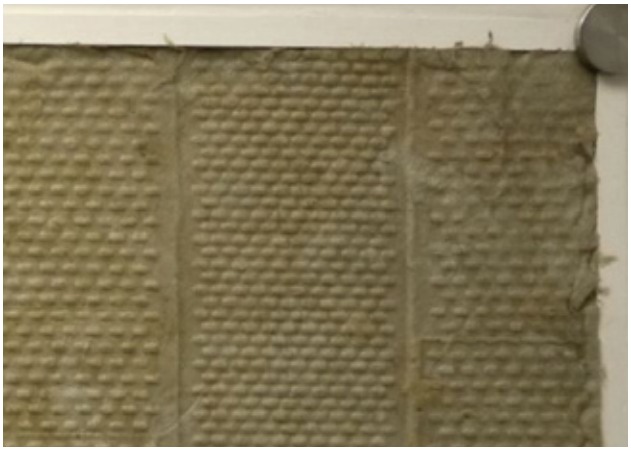
Sag free & tight fit

The very nature of stone wool makes Safe 'n' Silent Pro a wise long term investment that works continuously without requiring any maintenance. The higher density material provides superior sag resistance and fit.

It can be easily cut and trimmed for the best possible fit into the partition wall cavity, assuring there will be no gaps that may compromise the performance of the system. Safe 'n' Silent Pro keeps its shape over time without sagging or slumping in the wall cavity. All these ensure a partition wall system that protects its occupants against noise and fire for the lifetime of the building.



Conventional insulation



Safe 'n' Silent Pro

Proven Solutions

ROCKWOOL insulation is used for a wide range of buildings and industries - such as in roof, ceiling, walls and partitions of commercial and residential buildings. It protects buildings and occupants, keeping them comfortable and safe while at the same time saving energy and reducing carbon emissions resulting from excessive cooling or heating.

ROCKWOOL insulation in partition wall system has been used in many types of buildings across Asia, including some of the world's most iconic structure. It is a proven solution for high perfomance, sustainable building, showcasing not just great architecture but also great functionality in delivering safety and comfort for its occupants.

1 **Hotel**
The St. Regis Bangkok (Thailand)

2 **Residences**
Marina One (Singapore)

3 **Shopping Mall**
Paradigm Mall, Johor (Malaysia)

4 **Residences**
DUO Residences (Singapore)

5 **Office**
EON IT Park (India)

6 **Medical Centre**
Prince Court Medical Centre (Malaysia)

7 **Hospital and Shopping Mall**
Farrer Park Hospital & Connexion (Singapore)

8 **Two Towers Consisting of Offices and Apartments**
Marina Bay FInancial Centre (Singapore)

9 **Parliament House Consisting of Offices and Conference Hall**
National Assembly House (Vietnam)

10 **Hotel**
Marina Bay Sands (Singapore)

Photo courtesy of The St. Regis Bangkok

Photo courtesy of M+S Pte Ltd

Photo courtesy of WCT Hartanah Jaya Sdn Bhd

Photo courtesy of M+S Pte Ltd

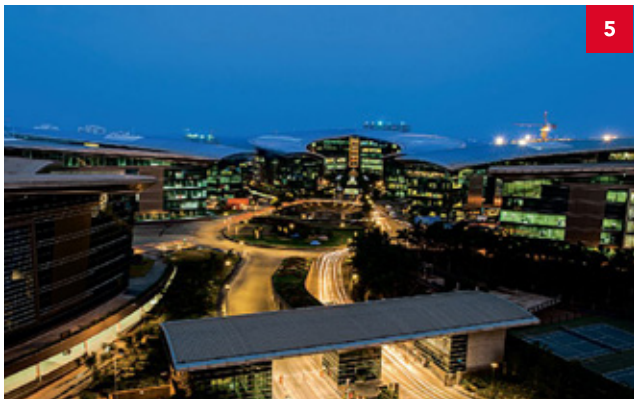


Photo courtesy of Panchshil Realty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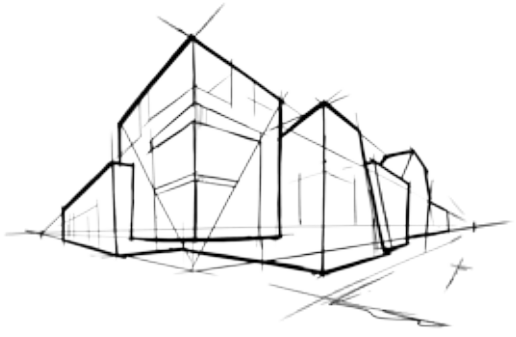

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