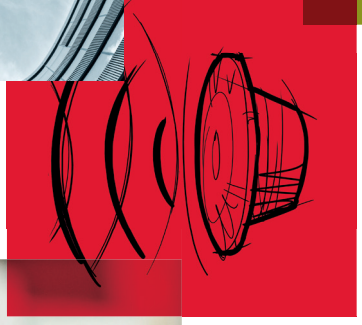
ROCKWOOL™

Building envelop acoustic solutions



Stone wool solutions for improving
Occupant comfort

Planning for acoustic comfort

Considering acoustic control in the design phase of a project will allow for a more cost effective design, as well as more control over the final outcome.

It is easy enough to measure the noise within a space after it has been built, but by then, rectification can be very difficult and expensive. It is important that we effectively measure noise levels during the planning phase to ensure that the desired acoustic comfort is achieved within the finished build.

The noise sources in close proximity to the building being designed will have a major effect on what type of building envelop should be used. While there are many sources of noise that should be considered, some examples are:

- Proximity to large or busy highways
- Traffic Flow and speed
- Nearby airports, industry and railways
- Height of the building will affect the noise leve

It is essential that the proposed site is assessed to identify existing and potential noise sources at planning and early design stages of the development.

This assessment provides the essential data needed to determine the appropriate levels of sound insulation that needs to be achieved within the building envelop.

Fact

A single passing diesel truck can produce noise levels as high as 85dB and a motorcycle can be as high as 100dB

New York acoustical analysis

A study conducted by AKRF inc. (environmental engineering) considered the noise effects of rooftop playgrounds in busy urban areas of New York City. This study determined the required reduction in noise levels for building facades in order to maintain an interior noise level below 45 dB.

AKRF determined that with an average sound level of 86.7 dB, building facade assemblies (and sound insulation) would need to facilitate a dicible reduction between 26 dB and 39 dB depending on the distance from the noise source.

Creating a comfortable living space for building occupants will mean more than simply thermal design. Architects will need to also need to factor in sound control, taking into consideration the outdoor indoor transmission class (OITC) levels required for the assemblies around the building. This study shows only one example of why evaluating the acoustical control of a building envelop is critical in ensuring a productive work environment and a healthy home.

Actual vs perceived changes in sound level

Sound level change (dB)	Perceived change in noise
2-3	Barely perceptible
5	Readily noticeable
10	Double the loudness
20	A "dramatic change"
40	Difference between faintly audible and very loud

Administration, Report # PB-222-7

Maintain a healthy living environment

Exposure to noise has been shown to have numerous detrimental effects on health and child development

The reassurance provided by definitive acoustic test data for ROCKWOOL™ products within rainscreen and roofing systems provides comfort and peace of mind for the health and well being of its occupants.

Recent research has shown many negative effects of being exposed to large amounts or constant noise in the workplace, in schools and in our daily lives.

At ROCKWOOL, we have a multitude of tested assemblies to help reduce the unwanted noise from entering your factories, offices and homes.

Below are just a few studies showing the harmful effects that excessive noise can cause:

- C. Clark et al (2005) found a 20db increase reduced reading comprehension in children.
- Correia et al (2013) found long-term exposure to aircraft noise is associated with cardiovascular disease.
- Stansfeld and Matheson (2003) has stated that chronic exposure to continuous noise of at least 85 db can cause higher blood pressure in individuals.
- The World Health Organization lists the main health risks of noise to include increased aggressiveness, sleep disturbance, cardiovascular effects and performance at work and school decreases.

Fact

The cognitive performance of both children and adults is reduced by noise. Their ability to learn is impaired in noisy environments.

80-125 Hz

Low frequency noise captured by the OITC rating

Code requirements

As updated codes are adopted, methods of sound control are becoming more common as is their enforcement.

If you are designing a building enclosure that is required to meet certain performance requirements either by code or by request, it is important to understand what codes are looking for and what the performance levels mean.

STC vs. OITC

The STC (Sound Transmission Class) rating was created to provide a rating for interior building partitions that are subjected to noises from mid to high frequency noise sources. As such, it is calculated over the frequency range of 125 to 4000 hertz.

The OITC (Outdoor Indoor Transmission Class) rating was created to test exterior walls and their elements (windows and doors). Because of the larger range in expected sound, OITC values are determined for lower frequencies as well, in the range of 80 to 4000 hertz. When choosing building envelop designs, designing using the OITC rating will provide more accurate results when lower frequency noises are expected.

ROCKWOOL assemblies have been tested for both STC and OITC ratings. This will provide a better understanding of the assembly performance under different frequency ranges, and will give a better overall understanding of the assemblies' ability to control noise.

Noise control

Flanking noise

When considering a complete wall design, not only does the wall or roof system need to be considered, but the connecting assemblies as well.

In many cases, a large portion of noise can be brought into the building through windows, doors, or connecting walls not designed with the same acoustic control in mind.

This type of noise transmission is called flanking noise. The assembly and its connecting features should be tested during planning in order to minimize flanking through other parts of the building envelop. This can be done by testing a mock up that includes all of the individual elements, or the individual elements can be tested separately and a composite sound transmission loss calculation can be performed based on the area and performance of the individual elements. On-site field testing, can also be performed very early in construction to determine if there are any flanking issues.

Code specified requirements

Various codes are being adopted to combat increasing urban noise levels. These requirements will give an insight as to the level of noise reduction expected, and what is required when designing a building envelop.

- LEED® v4 has introduced new requirements to earn points for healthcare buildings. Buildings are able to earn up to 2 points for minimizing the effects of exterior noise in healthcare facilities.
- ANSI S12.60, section 5.4, provides minimum OITC ratings for walls and roofs from 30 to 56, correlated to varying outdoor noise levels. This is used in LEED for school buildings, which also includes a maximum background noise level of 45 dB.
- 2015 IGCC requires an OITC rating of 40, or an STC rating of 50 for the building envelop, wall and roof- ceiling assemblies when they are in close proximity to high noise sources.
- Housing and Urban Development (HUD) goals include a maximum interior equivalent day-night noise level of 45 dB.

The need for tested solutions

Finding actual acoustic test data for building envelop systems is not easy and up until now, there have been few or no tested solutions which provide reliable data on sound reduction performance.

For a large majority of projects this results in trying to determine the performance through acoustic assessments. A lack of data often leads to over engineered systems which incorporate additional mass layers as a method of building in a safety factor in the absence of any test data.

Adding additional layers of mass to the system can present unnecessary obstacles which include:

- Additional costs (labour and materials)
- Complex installation
- Increased build time

ROCKWOOL has partnered with Intertek to provide full building envelop solutions for peak acoustical performance of wall and roof systems, providing the accuracy needed for more efficient building designs.

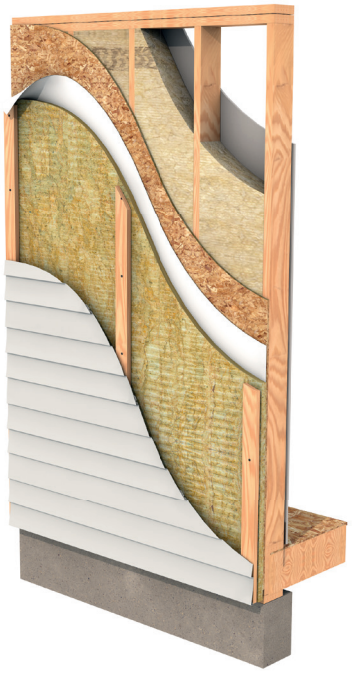
Fact

In hospital environments, noise control is very important for the recovery of patients as ''unwanted sound" can increase heart rate, blood pressure and respiration rate.

Complete ROCKWOOL acoustic system

At ROCKWOOL, we continually strive towards the development of products that simplify the specification process, provide peace of mind and improve the quality of life.

We have completed acoustic testing on rainscreen and roof assemblies that can be used to specify complete building envelop systems. A detailed list of tested assemblies can be found by contacting your local ROCKWOOL sales representative



Wood stud wall assembly

Here we show an example of a wood stud wall using ROCKWOOL COMFORTBATT® in a 5.5" cavity, and 1.5" of exterior continuous COMFORTBOARD™ 80 insulation.

This assembly can be expected to perform with an STC of 39, and an OITC of 29. This 1.5" layer contributes to a 4 STC point increase compared to using no continuous insulation at all.

Rainscreen assemblies

Windows

Windows can be the one of the largest deficits in a wall design, for not only heat loss but also acoustical control. A high level of care must be taken when designing the windows and their connections to the wall elements when looking for a high performance wall systems.

Consideration of the type of window, window design such as materials used, pane thickness or airspace, and how it is installed will all impact the performance of the complete system.

The higher density of ROCKWOOL stone wool insulation offers excellent sound absorption characteristics because of its unique fibre structure compared to other insulation types

4 STC increase

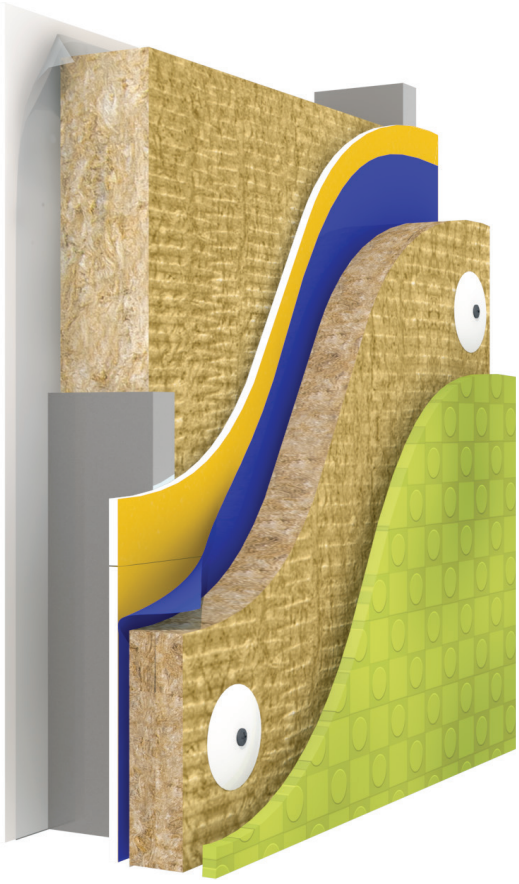
With the addition of only 1.5" exterior insulation

Complete ROCKWOOL acoustic system (continued)

Steel stud assembly comparison

The table below gives a summary of some of the steel stud assemblies tested for STC and OITC ratings. The importance of a split insulation system is apparent from the tests conducted. Providing insulation in both the stud cavity and behind the sheathing proves to create the highest performing system, well above using insulation in only the stud space, or outboard of the sheathing. For specific assembly details please contact your local ROCKWOOL representative.

Based on third party testing, using stone wool as the exterior insulation can add up to a 3 STC point increase over foam plastic insulation in a like for like assembly



6" Steel stud cavity	Exterior insulation between Z-girts	STC	OITC
6" Stone wool	Airspace	43	27
Uninsulated	3" CAVITYROCK®	44	29
6" Stone wool	3" CAVITYROCK®	50	31

6" Steel stud cavity	Exterior insulation screw through	STC	OITC
Uninsulated	1" COMFORTBOARD™ 80	43	30
3.5" Stone wool	2" COMFORTBOARD™ 80	52	33

Full building envelop design
Considering the acoustical performance of every assembly on the building envelop is critical when designing for a high-performance system. Noise will travel through the weakest sections of the building envelop, and the effectiveness of a high performing wall or roof system may be reduced when the rest of the building is not equally designed for.

ROCKWOOL stone wool insulation can reduce external noise when a component of wall and roof assemblies, creating a comfortable and healthy living space. It's the unique stone wool characteristics found within our products that make them efficient at reducing noise.

Dual density technology
For insulation thicknesses above 2", the top layer of each CAVITYROCK® board is manufactured at a higher density than the remainder of the board. The resulting change in acoustic impedance means that sound is reflected at the interface between the two layers.

Roofing assembly design

Tested roofing systems available

If you're considering different strategies to improve an existing system, that doesn't require prescriptive requirements, whether in use or in the design stage, consider these tips to improve the acoustic performance.

The most common ways to improve the acoustic performance of a roof assembly are:

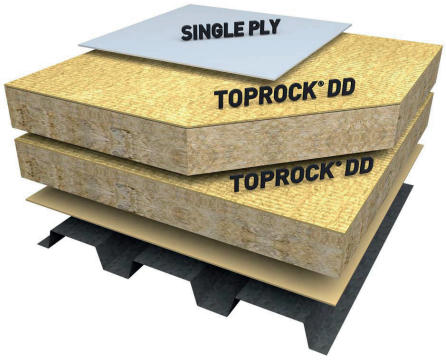
- **Adding mass -** Increased mass in the system improves the sound attenuation of the assembly. Dense insulation layers or cover boards can do this most effectively
- **Alternating layers -** Using multiple layers can improve on both the acoustic control and thermal properties of the roof system
- **Sandwiching materials -** Changing density through the roof assembly significantly improves acoustic performance

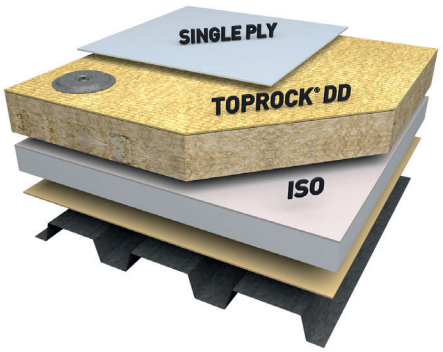
ROCKWOOL has tested numerous roofing assemblies for their ability to control noise. This testing was done on stone wool specific designs as well as hybrid systems to show the effects of differing materials on both acoustic and thermal performance. Varying thicknesses, mass layers, membranes and fastening positions were all considered during this testing, providing a wide range of values to consider when designing for a specific project. The tested acoustic performance can be met by using both ROCKWOOL TOPROCK® DD or ROCKWOOL MULTIFIX™ as part of the roof assembly.

ROCKWOOL will be able to provide a list of complete roof assemblies for both full stone wool and hybrid systems. Please reach out to your local ROCKWOOL representative for further information.

Stone wool assembly
A complete stone wool assembly with varying thicknesses and dense roof boards provides:

Tested STC: 36 up to 53
Tested OITC: 28 up to 40
Minimum R-value: 19 up to 36.6





Hybrid assembly
Using a combination of stone wool and foam boards tested assemblies were able to combine higher thermal resistance with better acoustical control. Tested values ranged from:

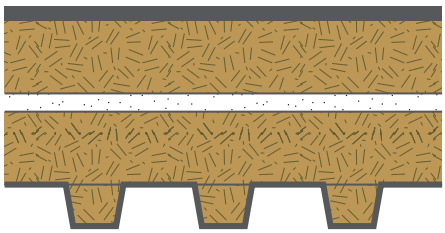
Tested STC: 35 up to 53
Tested OITC: 25 up to 40
Minimum R-value: 22.6 up to 38

Roofing assembly design (continued)

Standing seam metal roof assemblies

Standing Seam Metal Roof systems have become increasingly popular. One of the main concerns when dealing with this type of roof system is the noise level caused by rainfall or high levels of weather. ROCKWOOL standing seam roofing systems have been tested for rainfall noise levels, and can assist in your design process to determine the best assembly for each building envelop design. Below is a comparison between three different assemblies tested for rainfall noise levels. ROCKWOOL stone wool is found to add a significant level of noise control both in STC/OITC testing and from noise generated from rainfall. The assemblies compared use 2 layers of either polyisocyanurate, ROCKWOOL TOPROCK® DD, or a hybrid of both products, with a layer of high density glass fibre gypsum board between, all underneath a 24 Gauge Standing Seam Metal Roof.

A.



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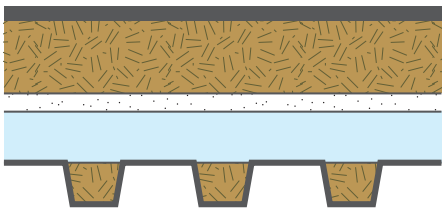
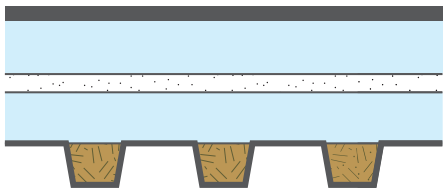


C.

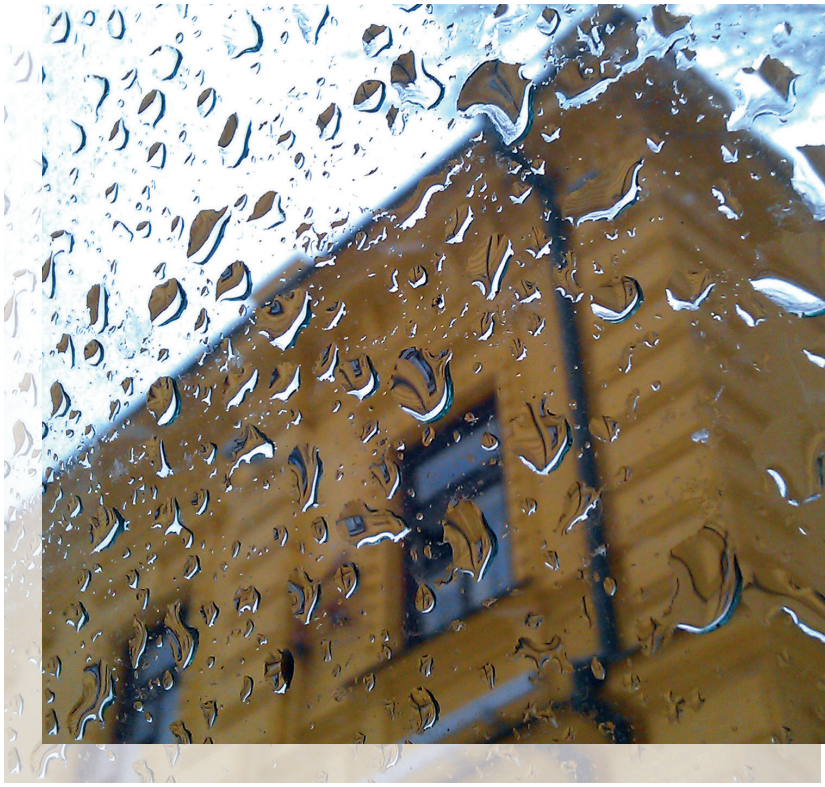


Insulation type	ROCKWOOL Stone wool (A)	Hybrid system (B)	Polyisocyanurate (C)
STC rating	38	36	32
OITC rating	30	27	25
Rainfall dB level	47.1	48.3	52.6

Rainfall noise testing

To understand the effect of rainfall on interior noise levels, ISO 140-18 or ISO 10140-5 may be referenced in code or specifications for buildings, such as ANSI S12.60. This code may be of particular interest for areas or buildings where standing seam metal or single- ply membrane roof systems are typical or where heavy rain fall is prevalent.

For metal roof systems, the impact of the rain can cause significant disruption if a properly designed system is not installed underneath. Buildings with occupants may want to consider adding materials to improve the acoustic performance when heavy or consistent rainfall is expected.



Fact

Based on the same thermal performance, if you insulate a metal roof with stone wool you can hear half the rain noise from outside compared to when insulating with some other kind of insulation

ISO 140-18

ISO 140-18 is a test performed on a complete roof assembly to measure the level of noise transmitted through that assembly. The lower the dB level, the better acoustical performance the roof system has. ROCKWOOL has tested using the highest rainfall rate available in this test in order to determine the maximum levels of noise transmitted through these systems.

Examples of rainfall decibel levels can be seen in the examples above. A full list of tested assemblies using both ROCKWOOL stone wool and ISO boards can be reviewed by contacting your local ROCKWOOL roofing sales representative.

At the ROCKWOOL Group, we are committed to enriching the lives of everyone who comes into contact with our solutions. Our expertise is perfectly suited to tackle many of today's biggest sustainability and development challenges, from energy consumption and noise pollution to fire resilience, water scarcity and flooding. Our range of products reflects the diversity of the world's needs, while supporting our stakeholders in reducing their own carbon footprint.

Stone wool is a versatile material and forms the basis of all our businesses. With approx. 10,500 passionate colleagues in 38 countries, we are the world leader in stone wool solutions, from building insulation to acoustic ceilings, external cladding systems to horticultural solutions, engineered fibres for industrial use to insulation for the process industry and marine & offshore.

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