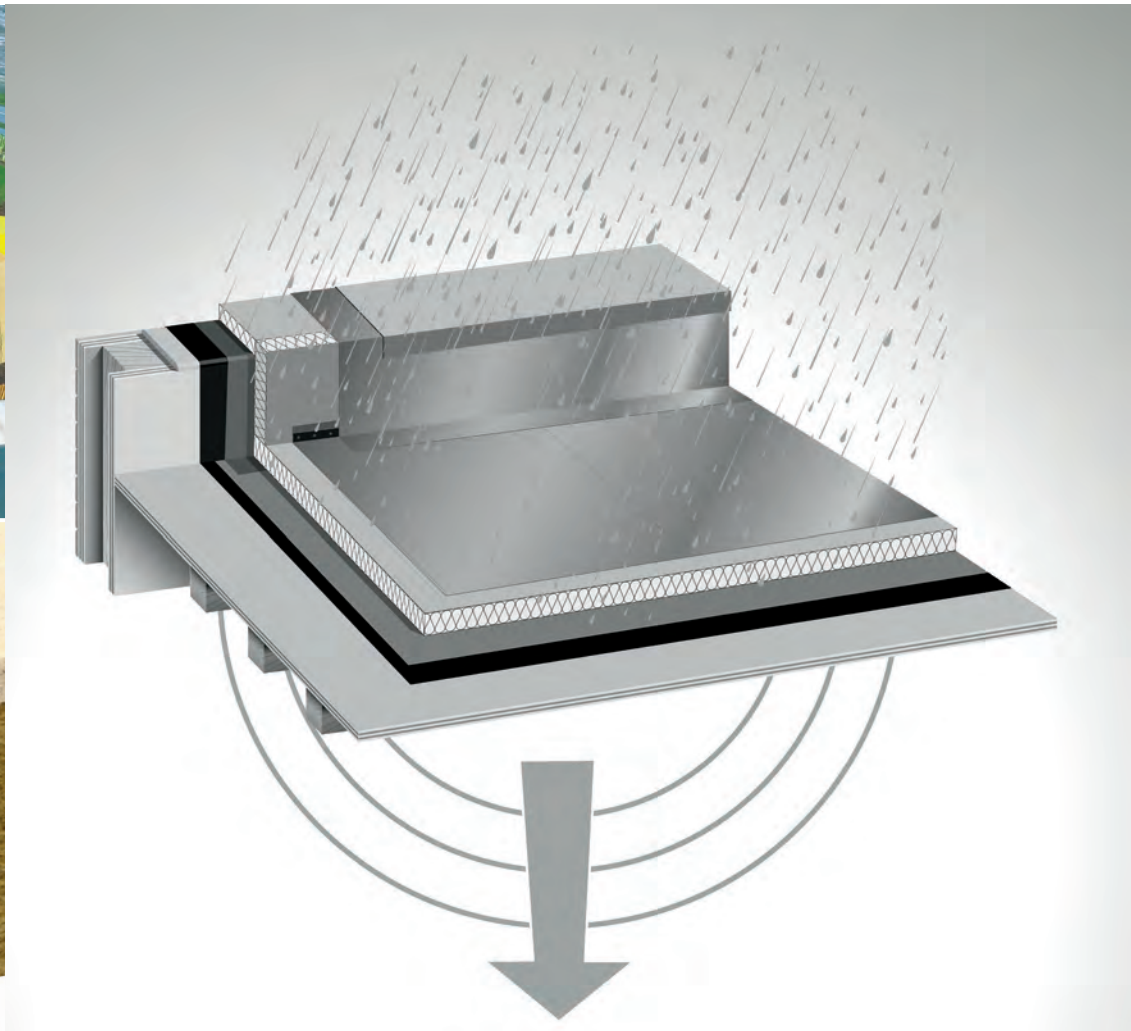
BAUDER
making roofs secure.

Design Considerations Guide

Acoustic flat roof solutions



Ramsden Hall Academy
Billericay, Essex

BUILDING BOARD

Type: New build

Roof size: 2,500 m²

Acoustic solution: The installed Bauder Thermofol single ply PVC system incorporated BauderROCK mineral wool insulation, providing a single-source solution to meet the project's acoustic performance requirements.

Bauder is a leading European manufacturer of flat roof waterproofing membranes and insulation to make buildings watertight and thermally efficient; photovoltaic systems for renewable energy generation; green roofs to support the environment and create living and working spaces for people; and blue roofs to attenuate stormwater.

Customers choose us because of the way we do business, our robust advice on the right solutions, and our approach to delivering projects. We collaborate with clients to find the optimal solution for a building from our broad portfolio of systems.

Acoustic Roof Solutions Design Considerations

Flat roof systems play an important part in helping to control noise inside, entering, and leaving buildings. This guide states some common types of noise experienced within a building and the Bauder systems best suited to dealing with them.

This document is intended to support our clients in making informed decisions when considering an acoustic solution for the building when specifying a Bauder flat roof system. It does not replace the need for client expertise or specialist advice. An acoustic solution should be designed on a project-by-project basis. For further, in-depth guidance and standards, the following can be consulted:

- BS EN ISO 140-18:2006
- BS EN ISO 354
- *BB93: Acoustic design of schools: performance standards* (Department for Education)
- *The School Premises Regulations* (2012) (Department for Education)
- *The Independent School Standards (2013)* (Department for Education)
- *Health Technical Memorandum 08-01: Acoustics (HTM 08-01)* (Department for Health)
- *The Health and Wellbeing category of the BREEAM standards*

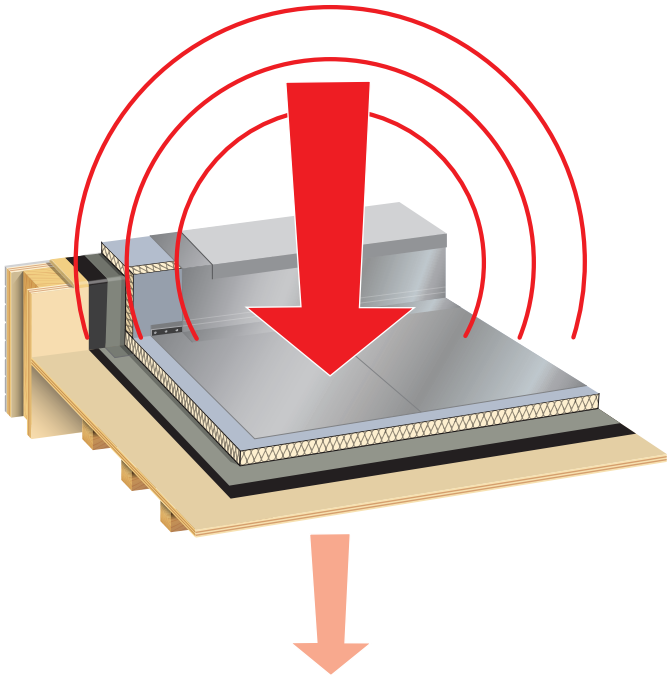
Contents

1 Types of Noise Experienced in Buildings

Three of the main types of noise experienced in buildings include airborne noise, rain impact noise, and reverberation. Consideration of each noise type helps inform the choice of Bauder system best suited to limiting the noise and improving conditions for the building's occupants.

Airborne noise

Airborne noise refers to noise travelling through the air. In the outside environment, this includes noise created by road, rail and air traffic. Inside, it could be noise from machinery or amplified music, for example, where the air carries sound waves until they reach a solid object like a roof construction. The impact of airwaves creates vibrations in the roof structure causing sound that transmit into the airspace beyond. Roof constructions that mitigate this type of noise are dense and/or contain sound-absorbing materials.

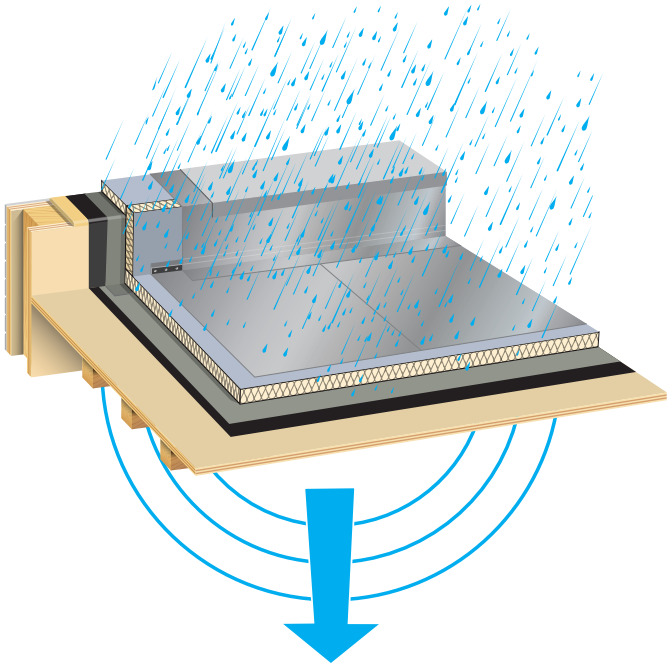


Rain impact noise

The impact of rainfall onto the external surface of a roof causes vibrations within the structure, which reradiate inside the building as airborne noise. Using an open, soft texture on the roof's surface and/or a dense, sound-absorbent roof build-up reduces this noise.

Rain noise reduction can also be achieved by adding:

- Ceiling tiles (approx. 5-8 dB improvement)
- A plasterboard ceiling (approx. 10-15 dB improvement)
- Solar panels above the roof (requires specialist calculation)
- A Bauder green roof system

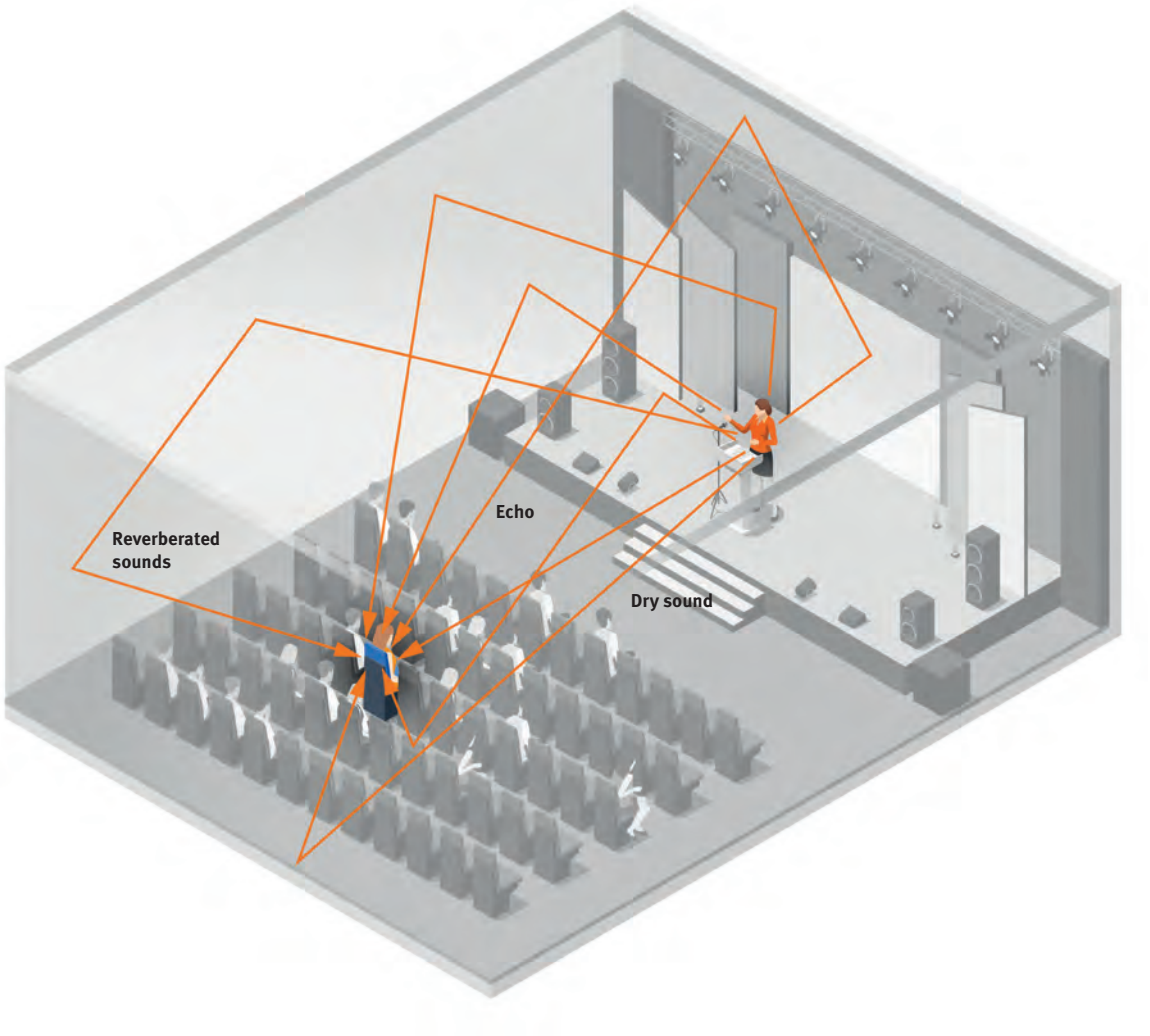


1 Types of Noise Experienced in Buildings *continued*

Reverberation

Buildings that generate elevated levels of noise (e.g. concert halls, swimming pools and factories) benefit from incorporating roof systems that absorb excess noise levels to reduce sound reverberation. Roof construction designs that do not incorporate an acoustically absorbent ceiling require an exposed, perforated, profiled structural metal deck with an open texture insulation within the troughs to absorb the excess noise.

The occupants of the space benefit from lower sound levels and/or better sound quality, and level of sound breaking out of the building into the local environment is also lower due to the absorption of sound by the roof system.



2 Rain Noise Testing

BS EN ISO 140-18:2006 is a British Standard that aligns with the European (EN) and International (ISO) standards.

The standard outlines a laboratory method for measuring the impact sound insulation of roofs, roof/ceiling assemblies and skylights when subjected to simulated rainfall. The data obtained can help evaluate the level of noise generated by rain on a specific building component in the space below. It also serves as a basis for comparing the rain sound insulation performance of different elements and for designing components with enhanced acoustic properties to reduce noise.

Bauder conducts rain noise tests, as shown in the photos. All tests are done in accordance with BS EN ISO 140-18:2006.

3 Types of Building Where Noise Reduction is Most Important

Education buildings

Research indicates that excessive noise and poor acoustic conditions in schools can significantly hinder students' academic performance and place children with hearing difficulties at a disadvantage. Furthermore, inadequate classroom acoustics may undermine teachers' ability to maintain control, potentially impacting their mental well-being.

The Department for Education document *Acoustic Design of Schools: Performance Standards,* Building Bulletin 93 (BB93) sets out the minimum acoustic performance of school buildings. It describes the normal means of demonstrating compliance with the building regulations and provides guidance in support of *The School Premises Regulations (2012) and The Independent School Standards (2013),* both published by the UK government's Department for Education.

Whether aiming to reduce noise entering the school building, remove disruption from rain noise, or mitigate reverberation, Bauder provides solutions to help achieve the requirements of BB93.

Healthcare buildings

Health Technical Memorandum 08-01: Acoustics (HTM 08-01), published by the UK government's Department for Health recognises the importance of acoustic design in healthcare facilities, stating that:

"Good acoustic conditions improve patient privacy and dignity, and promote essential sleep patterns. Such conditions are key to healing. Good acoustic design brings other benefits in terms of patient and staff comfort and morale, as well as improved efficiency and usability of equipment."

Bauder flat roof systems can help create a healthier acoustic environment, providing the right internal conditions for both patients and staff.

Coláiste an Chláirín Athenry, Ireland

Buildings subject to BREEAM assessments

The Health and Wellbeing sections of the BREEAM standards offer credits for providing sound insulation achieving certain internal ambient noise levels and room acoustics. These vary depending on the type of building assessed.

4 Bauder Solutions for the Reduction of Airborne Noise

The tables below outline the most suitable Bauder roof system solution for each type of noise. These are based on metal deck construction as this is the material commonly used in laboratory testing and is deemed to represent the 'worst case' outcome in terms of noise reduction.

Designing the building with a concrete structural deck is normally sufficient to prevent high levels of airborne sound. However, if the roof structure is a lightweight construction of timber or metal, the type of waterproofing and insulation used significantly affects results.

The Bauder Reinforced Bitumen Membrane system with BauderROCK mineral wool insulation achieves the best results.

Waterproofing	Insulation	AVCL	Deck type	U value achieved (W/m^2K)	Sound reduction expected (Rw)
Bauderflex / Bauder Total Roof / Airtech System	BauderROCK (210 mm)	TEC KSD mica	Profiled metal	0.18	47
Thermofol/Thermoplan/LiquiTEC	BauderROCK (210 mm)	DB100 / TEC KSD DUO	Profiled metal	0.18	42
Bauderflex/Bauder Total Roof System	BauderPIR (120 mm)	TEC KSD mica	Profiled metal	0.18	38

Predicted *sound reduction* figures based on results from actual test reports.

Single Ply/Cold Applied Liquid systems incorporating solely BauderPIR do not provide effective airborne noise reduction. However, for projects that can withstand the extra weight loading imposed by BauderROCK, using a combination of insulant types can help improve performance. The table below provides two examples.

Waterproofing	Insulation	AVCL	Deck type	U value achieved (W/m^2K)	Sound reduction expected (Rw)
Thermofol/Thermoplan/ LiquiTECLiquiTOP	BauderROCK (30 mm) + BauderPIR (100 mm)	DB100/TEC KSD DUO	Profiled metal	0.18	32
Thermofol/Thermoplan/LiquiTEC/LiquiTOP	BauderROCK (120 mm) + BauderPIR (60 mm)	DB100/TEC KSD DUO	Profiled metal	0.18	35

Predicted *sound reduction* figures based on results from actual test reports.

The incorporation of a mineral fibre tile ceiling into the room beneath offers a reduction in airborne noise transmission. However, this is outside of the scope of the Bauder specification.

The tables above outline the most suitable Bauder roof system solution for each type of noise, based on metal deck construction (the most commonly used material in laboratory testing and representing the 'worst case' noise reduction outcome).

5 Bauder Solutions for the Reduction of Rain Noise

BauderGREEN systems achieve optimal results due to their absorbent surface texture and ability to refract and deflect sound waves, reducing their intensity and impact. If a landscaped roof is not possible, a Bauder RBM waterproofing provides better results than Bauder single ply or cold liquid applied membranes, as the chart below shows. When testing, Bauder often uses a single ply waterproofing to represent 'worst case' results.

BB93 states, *"Levels during heavy rain should not be more than 25 dB above the appropriate indoor ambient noise level given in table 1".*

The internal noise levels during heavy rain can be calculated using laboratory test data for the roof, the roof area, room dimensions and reverberation time. As a guide, for school classrooms, adding 8 dB to the sound intensity level value in the table below gives an indication of the internal noise level.

Landscaping	Waterproofing	Insulation	AVCL	Deck type	U value achieved	Sound intensity level L^{IA} (dB)	Indoor ambient noise level expectedLAeq, 30mins (dB)
XF301	Bauderflex/Bauder Total - Roof/Airtech System	BauderPIR (120 mm)	TEC KSD FBS	Profiled metal	0.18	33.5	41.5
XF301	Thermofol/Thermoplan/ LiquiTEC/LiquiTOP	BauderPIR (120 mm)	TEC KSD FBS	Profiled metal	0.18	37.5	45.5
None	Bauderflex/Bauder Total - Roof/Airtech System	BauderPIR (120 mm)	TEC KSD FBS	Profiled metal	0.18	48.9	56.9
None	Thermofol/Thermoplan/ LiquiTEC/LiquiTOP	BauderROCK (210 mm)	TEC DBR / TEC KSD FBS or DUO	Profiled metal	0.18	53.2	61.2
None	Thermofol/Thermoplan/ LiquiTEC/LiquiTOP	BauderPIR (120 mm)	TEC KSD FBS or DUO	Profiled metal	0.18	59.5	67.5
None	Thermofol/Thermoplan/ LiquiTEC/LiquiTOP	BauderPIR (140 mm FA)	DB100	Profiled metal	0.15	57.3	65.3

Predicted *sound reduction* figures based on results from actual test reports.

Indoor ambient noise level expected only applies to normal teaching spaces (classrooms) and sports halls, based on the typical room heights for school buildings.

The incorporation of a ceiling into the room beneath offers a reduction in rain noise transmission. Bauder tested the following build-ups in accordance with BS EN ISO 14018:2006.

Waterproofing	Insulation	AVCL	Deck type	Ceiling type	U value achieved	Sound intensity level L^{IA} (dB)	Indoor ambient noise level expected LAeq, 30mins (dB)
Thermofol	BauderPIR 140 mm FA	DB100	0.7 mm steel	Min. fibre ceiling tiles (min. 39 dB Dnfw) with 500 mm void	0.15	50.5	58.5
Thermofol	BauderPIR 140 mm FA	DB100	0.7 mm steel	Metal perf. Ceiling tiles with fibre insert (min.24 dB Dnfw) with 500 mm void	0.15	52.9	60.9
Thermofol	BauderPIR 140 mm FA	DB100	0.7 mm steel	12.5 mm plasterboard ceiling with 500 mm void	0.15	42.2	50.2

The tables above outline the most suitable Bauder roof system solution for each type of noise, based on metal deck construction (the most commonly used material in laboratory testing and representing the 'worst case' noise reduction outcome).

6 Bauder Solutions for Sound Absorption

The type of waterproofing and thermal insulation used within the roof build-up does not have any bearing on the sound absorption figures achieved internally. Therefore, unless the aim is also to mitigate airborne noise or rain noise, any combination is acceptable if a perforated structural metal deck and acoustic infills are used.

Waterproofing	Insulation	AVCL	Deck type	Trough filler
Bitumen/Single Ply/Cold Applied Liquid	BauderPIR/BauderROCK/ BauderGLAS	DB100/TEC KSD FBS or DUO	Perforated profiled metal	BauderROCK Acoustic Infills

The ability of the underside of the following roof build-up to absorb sound was tested to BS EN ISO 354:

- Bauder Acoustic Infills within perforated TATA D60 perforated steel deck (13% open area)
- 0.22 mm air and vapour control layer
- 210 mm BauderROCK
- Mechanically fastened 1.5 mm single ply membrane

Results

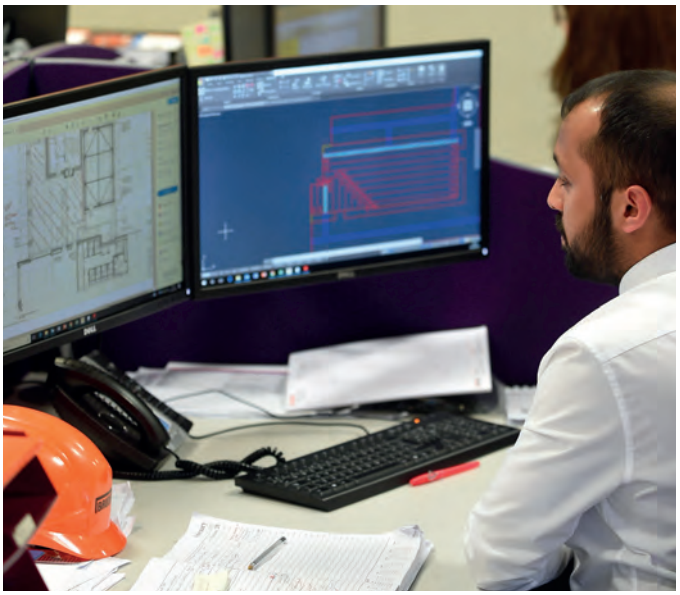
Sound absorption coefficient frequency (Hz)						Weighted Sound Absorption Coefficient (α_w)	Noise Reduction Coefficient (NRC) ASTM C 423-01	Absorption Classification Class BS EN ISO 11654
125	250	500	1K	2K	4K			
0.55	0.95	1.00	0.90	0.60	0.45	0.60 (LM)	0.90	C

The table above outlines the most suitable Bauder roof system solution for each type of noise, based on metal deck construction (the most commonly used material in laboratory testing and representing the 'worst case' noise reduction outcome).

Speak to us

When designing buildings with specific acoustic requirements, it is recommended to employ the services of an acoustics engineer. Once the performance required by the roof element has been determined, Bauder can help to provide the system that best meets those needs.

Get in touch at bauder.co.uk/contact-us, or by calling 01473 257671



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