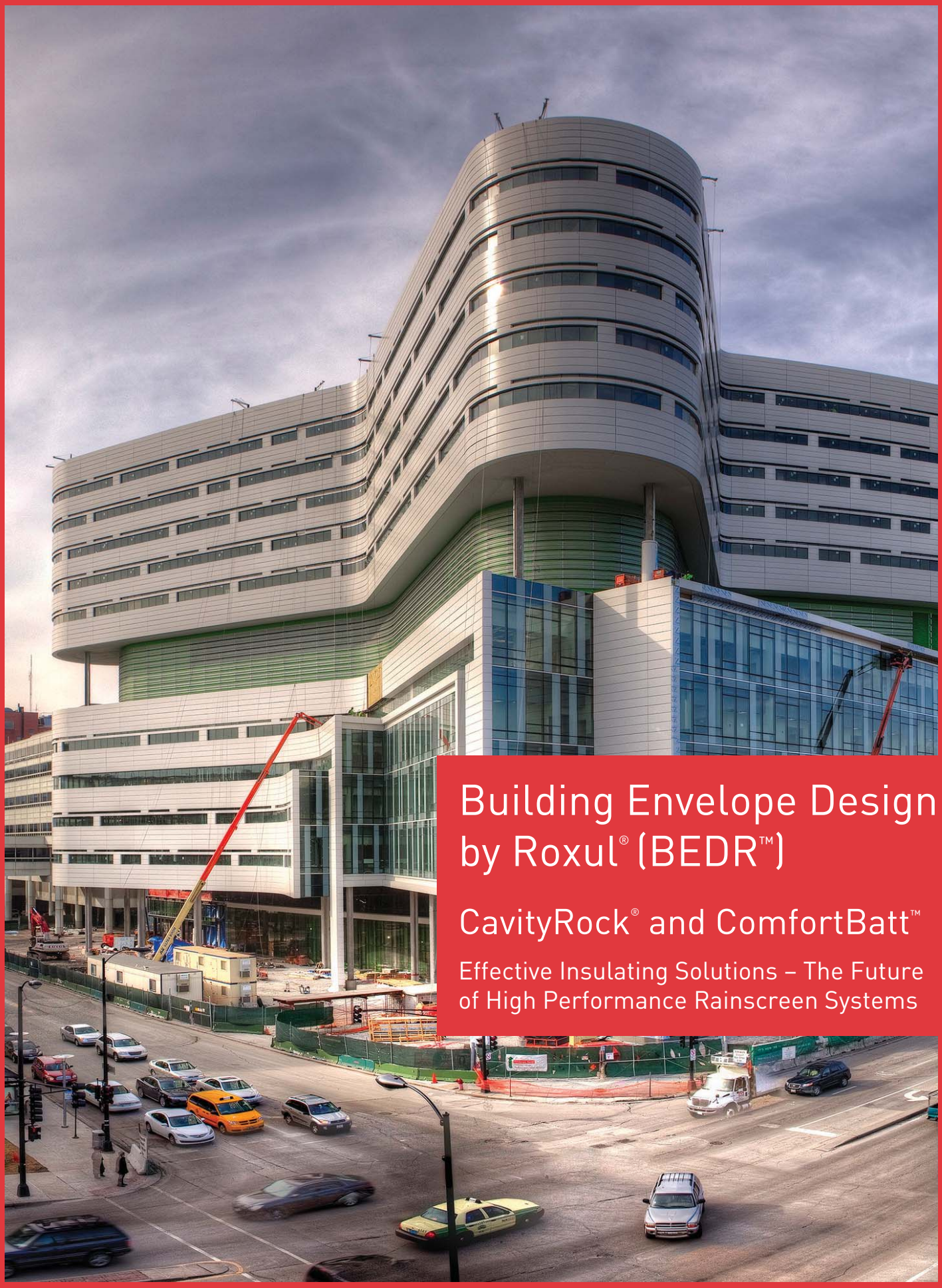


Building Envelope Design by Roxul® (BEDR™)

CavityRock® and ComfortBatt™

Effective Insulating Solutions – The Future of High Performance Rainscreen Systems

Rush University Medical Center, Chicago, Illinois
ROXUL CavityRock®

ROXUL®
The Better Insulation™

The Building Envelope Design by Roxul® [BEDR™] Wall System Philosophy:

Evolution of Rainscreen Systems

The primary functions of a wall system* – to protect, facilitate, and/or provide heat, air, rain penetration, movement of moisture, fire, durability, noise, light, strength, and aesthetics, have not changed over the past 40 years. The same cannot be said for the components and design of cavity wall systems, which have undergone a significant transformation in North America.

This change in design requirements is a result of the increased focus on ASHRAE standards and the need for continuous insulation (c.i.) to meet the R-value and U-value requirements of ASHRAE 90.1.

Roxul is at the forefront of developing wall systems that meet this call for higher energy efficiency, sustainability, durability and better overall performance in commercial buildings.

*Canadian Building Digest, NRC National Research Council Canada

1970

All insulation in the stud wall with building paper on the exterior. No cavity wall insulation used.

1990

All insulation in the cavity with no insulation in the steel stud. High performance air/vapor barriers used.

2010

A combination of insulation within the steel stud and cavity. Vapor permeable air barriers used.

The Roxul Difference

The R-value of Roxul insulation does not change over time because stone wool is not produced with blowing agents, which off-gas and result in lower thermal performance. Not only is the thermal performance of Roxul insulation maintained over its lifetime, but the wall system's thermal performance is maintained because Roxul products are dimensionally stable.

Roxul insulation will not slump in stud spacing causing gaps, will not expand or contract due to temperature variances in the rainscreen system, nor is it adversely affected by the presence of moisture in the system, all of which contribute to the optimal thermal performance of a building envelope. Roxul insulation is made from stone and is non-combustible with an extremely high melting point, making it the safest insulation when compared to both fiberglass and foam plastics.

Over 60,000 sq. ft. of Roxul CavityRock® DD was installed in the Rush University Medical Center's 14-story hospital in Chicago. (Also shown on front cover.) Rush is seeking gold leadership in energy and environment design (LEED) certification for the new hospital. "From the beginning, it's been designed to use water and energy efficiently and keep down waste. We're using environmentally responsible building materials, and we're recycling as much as we possibly can," says Mick Zdeblick, vice president, campus transformation.*

*http://transforming.rush.edu

The Future of High Performance Rainscreen Systems

- ✓ Stable Long-Term Thermal Resistance
- ✓ Sound Absorbent
- ✓ Fire Resistant
- ✓ Vapor Permeable
- ✓ Continuous Insulation
- ✓ Environmentally Sustainable

The BEDR™ Wall – Rainscreen System

The Roxul® BEDR Wall Rainsceen System is comprised of Roxul thermal batt insulation in the exterior stud wall cavity (up to 6"), combined with a high density, semi-rigid Roxul insulation board (up to 5") in the external cavity.

Roxul insulation within the exterior wall stud cavity and the external cavity offers superior long-term thermal efficiency, fire resistance, moisture control, and acoustic performance.

BEDR Rainscreen System Zone 4-8

Components: Cladding, Air space, CavityRock® DD or CavityRock® MD, Permeable air barrier, Exterior gypsum board, Steel stud, ComfortBatt™, Vapor barrier, Gypsum board.

Note: In climates dominated by heating degree days (HDDs), the blue air barrier material should be vapor permeable.

Roxul® ComfortBatt™ and CavityRock®– BEDR™ Wall Combination

Roxul ComfortBatt™

The ComfortBatt™ product line is a non-combustible, semi-rigid batt insulation range that is designed for exterior steel stud wall applications.

ComfortBatt products are available from 2.5" to 6" in thickness and have standard R-values ranging from R10 to R24. Stone wool batt insulation will not slump inside the wall cavity over time as fiberglass often tends to do. ComfortBatt products also provide excellent sound absorption characteristics.

Roxul CavityRock®

Roxul CavityRock® products are non-combustible, semi-rigid insulation boards specifically engineered for cavity wall applications.

CavityRock® DD is a dual density insulation board with a high-density outer layer, offering greater rigidity and water repellency, and a lower density inner layer that has a higher thermal performance and helps to conform to architectural features and minor wall irregularities. The result is a durable product with enhanced performance where continuous insulation is required. Available from 2.5" to 5" in thickness, with stable, long-term R-values ranging from R10.75 to R21.5.

CavityRock® MD is a single density insulation board available from 1" to 2" in thickness. It is also used for cavity wall applications, with R-values ranging from R4.2 to R8.4.

Why this BEDR™ Wall is a Better Wall

Dimensional Stability

The dimensional stability of an insulation material is necessary for the faultless function of an insulation system. Dimensional changes in materials vary according to their physical properties. Thermal expansion co-efficients express the rate at which materials shrink or expand when cooled or heated. Roxul insulation has a much smaller thermal expansion coefficient than organic insulation materials such as foam plastics.

Poor dimensional stability can cause shrinking, expansion, and buckling of a system's insulation. These actions can lead to thermal bridging, waterproofing breaches, and unpredictable insulation performance.

Material Type	Expansion Co-Efficient 10^{-6} m/m°C	Actual Expansion at Temperature Difference 50° on a 10 Metre Board (mm)
Stone Wool	5.5	3
Concrete	12	6
Steel	12	6
Expanded Polystyrene	70	35
Extruded Polystyrene	80	40
Polyurethane	100	50
Polyisocyanurate	120	60

Water Vapor Permeance

The water vapor permeance of Roxul® insulation allows for increased potential for drying "breathability" without trapping transient moisture in the assembly. Roxul CavityRock® and ComfortBatt™ are water repellent yet vapor permeable insulation products, and will allow transient vapors to pass through without restriction. Lower permeable insulations such as foam plastics can work as vapor retarders and will greatly affect the drying potential of many typical building assemblies.

Long-Term Thermal Performance

As the building industry seeks new and innovative solutions that are truly energy efficient, Roxul leads the way in developing wall systems with excellent long-term thermal performance. This is the result of two inherent properties in its BEDR insulating systems – lack of thermal loss due to dimensional changes, and the insulation's ability to repel water, which aids in the control of heat loss and gain.

The use of CavityRock as a continuous insulation (c.i.) results in a BEDR wall with higher effective thermal resistance values than foam plastics.

Soleno Project, Montreal PQ
Roxul CavityRock® MD

Meeting the Challenges of Today's Climate Zones

ASHRAE – History of R-Value Requirements

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), is an international Society of technical individuals who provide knowledge to the building industry on heating, ventilation, air-conditioning, and refrigeration (HVAC&R). The Society developed ASHRAE 90.1, an energy conservation standard that provides the minimum requirements for energy efficient buildings. This standard, or an equivalent, is applied today in many states for commercial, government and high-rise building applications. In Canada, look to the National Building Code and refer to section A-5.3.1.2 for information on condensation and energy conservation standards.

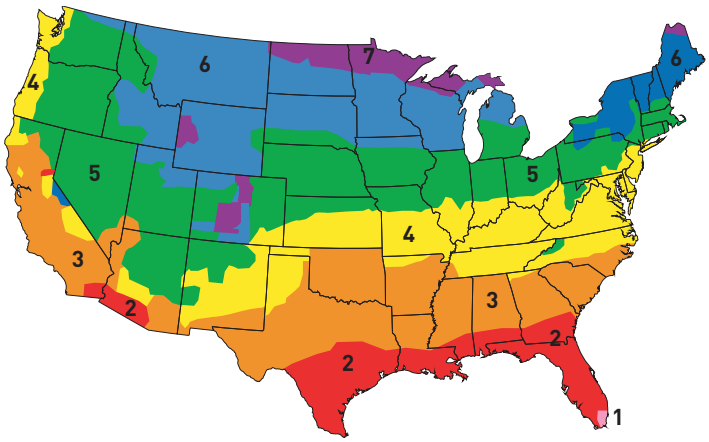
ASHRAE 90.1 2010/IECC Standards 2009 All Buildings Non-Residential Specific to Cavity Wall/Rainscreen Requirements by Climate Zone

City/State	Climate Zone	Mass*	Metal Framed**
Miami, FL	1	NR	R 13
Tampa, FL	2	R 5.7 ci	R 13
Charelston, SC	3	R 7.6 ci	R 13 + R 3.8 ci
New York, NY	4 (except marine)	R 9.5 ci	R 13 + R 7.5 ci
Spokane, WA	5 (and marine)	R 11.4 ci	R 13 + R 7.5 ci
Milwaukee, WI	6	R 13.3 ci	R 13 + R 7.5 ci
Anchorage, AK	7	R 15.2 ci	R 13 + R 7.5 ci
Nome, AK	8	R 25.0 ci	R 13 + R 7.5 ci

* Wall without Steel Studs eg. Concrete
** Steel Stud and Cavity Wall

Canadian Equivalents to US Climate Zones

City	Province	Climate Zone
Vancouver	British Columbia	5
Calgary	Alberta	7
Regina	Saskatchewan	7
Winnipeg	Manitoba	7
Toronto	Ontario	6
Montreal	Quebec	6
Halifax	Nova Scotia	6



ASHRAE Map of Climate Zones

Every rating agency has its own maps that divide regions into thermal or climate zones to tailor codes and standards to what is appropriate for that particular region.

ASHRAE Correction Factors for Metal Wall Framing

Metal Stud Size	Stud Spacing O.C.	Cavity Insulation*	Correction Factor	Effective R-value
2x4	16"	R11	0.50	5.50
		R13	0.46	6.00
		R15	0.43	6.40
	24"	R11	0.60	6.60
		R13	0.55	7.20
		R15	0.52	7.80
2x6	16"	R19	0.37	7.10
		R21	0.35	7.40
	24"	R19	0.45	8.60
		R21	0.43	9.00
2x8	16"	R25	0.31	7.80
	24"	R25	0.38	9.60

* Cavity Insulation = Steel Stud Wall Insulation

Build Your BEDR™ Wall Rainscreen System

	R-value and Thickness	ComfortBatt™								
		Canada Only		US Only		North America				
		R14 (3.5")		R15 (3.5")		R22.5 (6")		R24 (6")		
		16"	24"	16"	24"	16"	24"	16"	24"	
CavityRock® MD	R4.20 (1")	19.95	19.95	20.95	20.95	28.45	28.45	29.95	29.95	Stated R-value
		12.15	13.45	12.35	13.75	13.85	15.55	14.45	16.25	6.45 Effective R-value
	R6.30 (1.5")	22.05	22.05	23.05	23.05	30.55	30.55	32.05	32.05	Stated R-value
		14.25	15.55	14.45	15.85	15.65	17.25	15.75	17.55	8.05 Effective R-value
	R8.40 (2")	24.15	24.15	25.15	25.15	32.65	32.65	34.15	34.15	Stated R-value
		16.35	17.65	16.55	17.95	18.05	19.75	18.65	20.45	10.65 Effective R-value
CavityRock® DD	R10.75 (2.5")	26.50	26.50	27.50	27.50	35.00	35.00	36.50	36.50	Stated R-value
		18.70	20.00	18.90	20.30	20.40	22.10	21.00	22.80	13.00 Effective R-value
	R12.90 (3")	28.65	28.65	29.65	29.65	37.15	37.15	38.65	38.65	Stated R-value
		20.85	22.15	21.05	22.45	22.55	24.25	23.15	24.95	15.15 Effective R-value
	R15.05 (3.5")	30.80	30.80	31.80	31.80	39.30	39.30	40.80	40.80	Stated R-value
		23.00	24.30	23.20	24.60	24.70	26.40	25.30	27.10	17.30 Effective R-value
	R17.20 (4")	32.95	32.95	33.95	33.95	41.45	41.45	42.95	42.95	Stated R-value
		25.15	26.45	25.35	26.75	26.85	28.55	27.45	29.25	19.45 Effective R-value
	R21.50 (5")	37.25	37.25	38.25	38.25	45.75	45.75	47.25	47.25	Stated R-value
		29.45	30.75	29.65	30.05	31.15	32.85	31.75	33.55	23.75 Effective R-value
		15.75	15.75	16.76	16.75	24.25	24.25	25.75	25.75	Stated R-value
		7.95	9.25	8.15	9.55	9.65	11.35	10.25	12.05	Effective R-value

- Effective Insulation/Framing Layer R-values between steel framing factors were obtained from ASHRAE 90.1-2010 Table A9.2B
- Effective R-values are shown for thermal design only. Assumes CavityRock® is installed as continuous insulation (c.i.).
- Moisture and condensation potential should be calculated for each assembly designed.
- ComfortBatt™ is also available in 2.5" for steel stud applications.

Effective R-values - Example Calculation

Components	R-values
Air Film Int	0.68
Insulation in the Cavity	6.30
Gypsum	0.45
Insulation in the Stud	0
Air Space	0
Gypsum	0.45
Air Film Ext	0.17
Total	**8.05**

Superior Sound Absorption

Architects are increasingly choosing cladding facades on buildings, which, when compared to brick, tends to reduce the acoustical performance value of the wall system. With recent trends towards the use of new lightweight construction techniques and cladding materials, Roxul stone wool cavity wall insulation provides added acoustical value by outperforming traditional foam plastic insulation.

In a BEDR™ wall system, stone wool provides improved low frequency sound absorption to both normal and random incidents of noise. Reduced noise in the workplace can result in a more efficient and pleasant work environment for building occupants.

The stone wool fiber orientation and increased density of both CavityRock® and ComfortBatt™, compared to other types of insulation, effectively reduces sound transmission across the wall system. Greater noise or sound control is further achieved when thicker CavityRock, ComfortBatt, and gypsum board are used together.

CavityRock® DD – Acoustical Performance

ASTM C 423
CO-EFFICIENTS AT FREQUENCIES

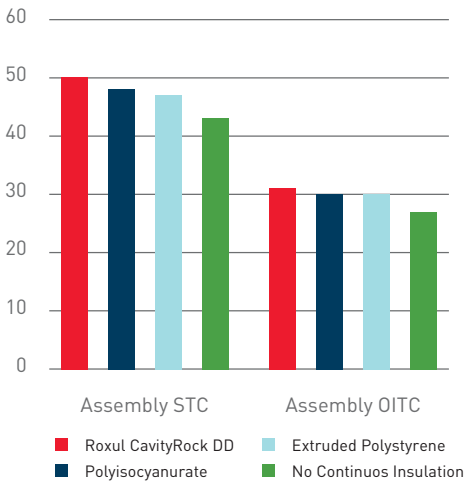
Thickness	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
3"	0.72	0.93	0.88	0.84	0.90	0.97	0.90

CavityRock® MD – Acoustical Performance

ASTM C 423
CO-EFFICIENTS AT FREQUENCIES

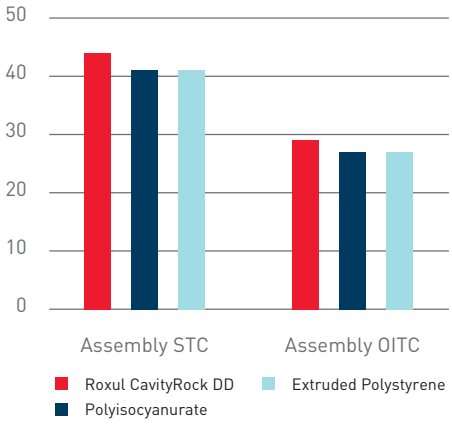
Thickness	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
1.5"	0.19	0.55	1.03	1.06	1.02	1.01	0.90
2.0"	0.26	0.71	1.14	1.09	1.04	1.03	1.00

ASTM E90 Sound Transmission Loss Test
(Metal stud wall with exterior cladding system)



Test Wall: (Inside to Outside) 1/2" Gypsum, 6" Steel stud, Roxul ComfortBatt™ 6" insulation, 5/8" Gypsum board, Air/Vapor retarder, Roxul CavityRock® DD 3" insulation, Airspace, 3/8" Cement board cladding.

ASTM E90 Sound Transmission Loss Test
(Metal stud wall without exterior cladding system)

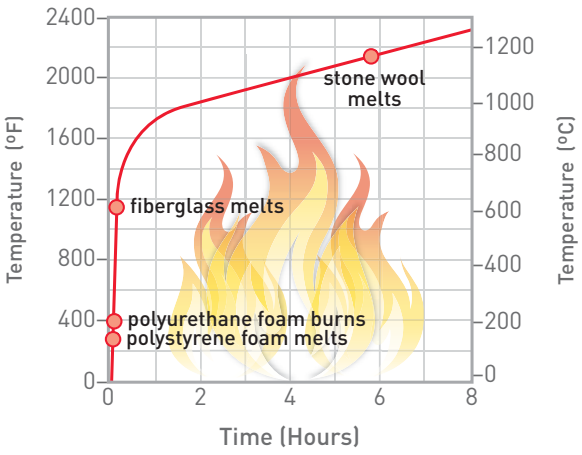


Test Wall: (Inside to Outside) ½" Gypsum, 6" Steel stud, Gypsum board, Air/Vapor retarder, Roxul CavityRock® DD 3" insulation, Airspace, 3/8" Cement board cladding.

Roxul Stone Wool: Fire Resistant, Non-Combustible Insulation

A key feature of Roxul® products is its fire resistance. CavityRock® is classified as "non-combustible" as determined by ASTM E136 and CAN4-S114. It will not develop toxic smoke or promote flame spread, even when directly exposed to fire, as most other insulation materials do. When tested in accordance with ASTM E 84 results typically show a flame spread of 0 and a smoke development of 0 to 5. By comparison, spray polyurethane foam (SPUF) results, when tested to ASTM E84, typically achieve a flame of 25 and smoke developed in the 350 to 500 range. Roxul CavityRock and ComfortBatt™ stone wool insulation have a melting point of approximately 2150 ºF (1177 ºC).

Temperature Development in a Standard Fire (ASTM E119)



Fire Safety: Stone Wool Versus Foam

More recently, as a result of the Shanghai fire in 2010, new concerns have been raised about fire safety during construction. In the case of the Shanghai fire, foam insulation was ignited accidentally during construction and quickly spread through the building exterior. Because of these safety concerns, Roxul firmly believes in the added value that passive fire resistance provides for buildings.

The severity of the Shanghai fire was partially a result of the use of urethane foam insulation, which aided in the spread of flame and smoke.

Fire Performance

Product	Specification	Test	Result
CavityRock® MD/DD	ASTM E 136	Behavior of Materials at 1382 ºF (750 ºC)	Non-Combustible
CavityRock® MD/DD, ComfortBatt™	CAN4 S114	Non-Combustibility in Building Materials	Non-Combustible
CavityRock® MD/DD	ASTM E 84 (UL 723)	Surface Burning Characteristics	Flame Spread = 0 Smoke Developed = 0
CavityRock® DD	CAN/ULC S102	Surface Burning Characteristics	Flame Spread = 0 Smoke Developed = 5
ComfortBatt™, CavityRock® MD	CAN/ULC S102	Surface Burning Characteristics	Flame Spread = 0 Smoke Developed = 0

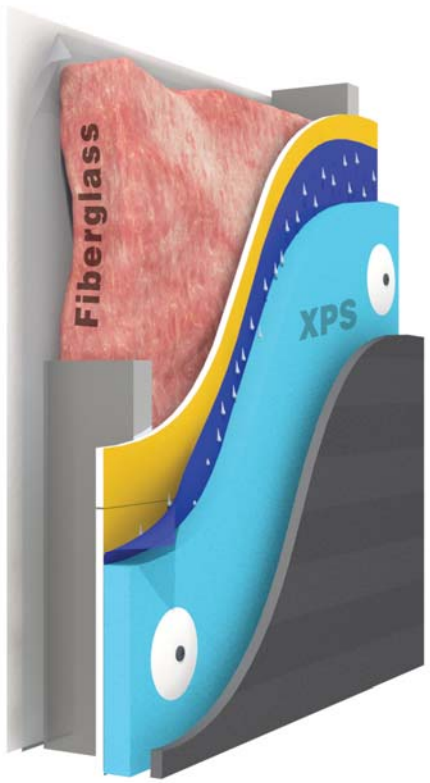
Moisture Management

Moisture Retention Comparison

To obtain a better understanding of the characteristics of in situ thermal insulation within cavity walls, Roxul's certified Building Science expert reviewed two applicable scenarios in Seattle, Washington. These were modeled for a three-year period and the theoretical wall was located at mid-level of a high-rise on the western elevation. The charts to the right represent the first modeled scenario. Note that CavityRock® DD stone wool had much less moisture content over the same period than XPS foam insulation under the same conditions.

Double Vapor Barriers can Lead to Moisture Problems

Typical Fiberglass/Extruded Polystyrene System



Fiberglass batt insulation will tend to lose its shape within the steel stud and eventually slump, creating gaps and voids and compromising R-value over time. Lower permeable insulations such as spray foam or XPS can also work as vapor retarders and may affect the drying potential of many typical building assemblies.

WUFI* – Seattle, Washington Climate Zone 4 Wall with XPS [(Water Content (kg/m³)]

Layer/Material	Start of Calc.	End of Calc.	Min.	Max.
Brick (Old)	3.34	3.01	1.19	195.38
Air Layer 25 mm	1.88	2.44	.044	24.27
Extruded Polystyrene	0.31	.033	0.12	0.68
Vapor Retarder (1 perm)	0.00	0.00	0.00	0.00
Concrete Blocks, Pumice Aggregate	28.00	10.85	8.17	28.00
Total Water Content (kg/m²)	6.03	2.58	2.13	24.89

Wall with Roxul CavityRock® [(Water Content (kg/m³)]

Layer/Material	Start of Calc.	End of Calc.	Min.	Max.
Brick (Old)	3.34	2.91	1.19	195.38
Air Layer 25 mm	1.88	2.07	0.46	23.48
Roxul CavityRock® DD	0.02	0.02	0.00	0.07
Vapor Retarder (1 perm)	0.00	0.00	0.00	0.00
Concrete Blocks, Pumice Aggregate	28.00	11.13	8.33	28.00
Total Water Content (kg/m²)	6.0	2.58	2.16	24.79

Results: Mineral wool insulation in a typical cavity wall will at maximum increase water content from 0.02 kg/m³ to 0.07 kg/m³. XPS had an increase in water content from 0.31 kg/m³ to 0.68 kg/m³. Ten air changes/hour were included in this calculation.

More "Breathability" than Plastic Foams

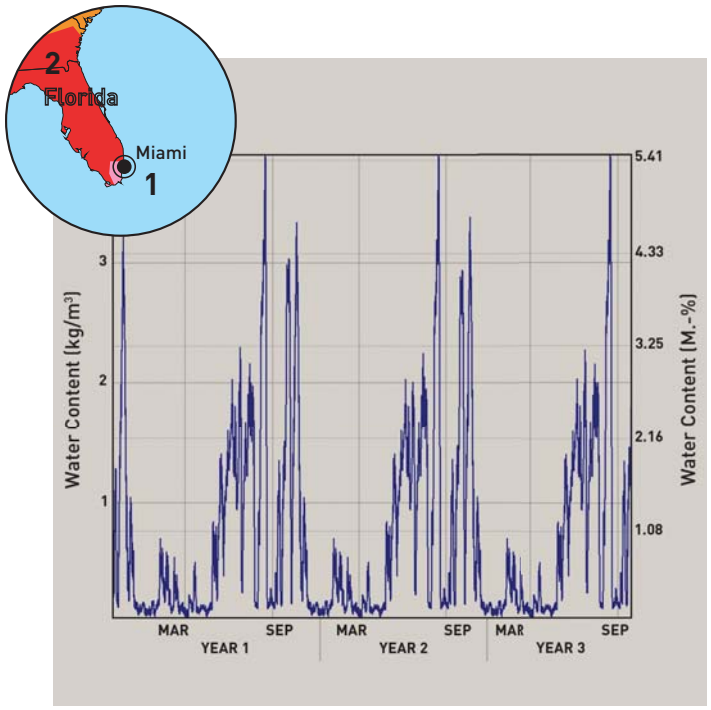
CavityRock® and ComfortBatt™ are water repellent, yet vapor permeable insulation (30-40 perms) and will allow transient vapors to pass through without restriction. This vapor permeable quality of Roxul's cavity wall insulation allows for an increased potential for drying "breathability" without trapping water in the wall assembly.

The stone wool insulation in a BEDR™ wall assembly does not wick water, which means that any bulk water that contacts the outer surface will drain and not be absorbed into the body of the insulation.

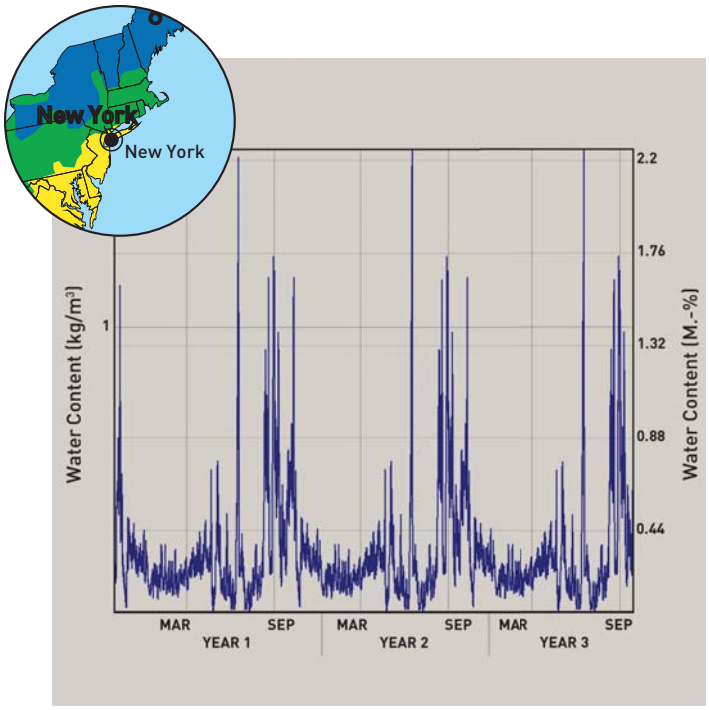
*WUFI is the acronym for "Wärme – und Feuchtetransport instationär" ("Transient Heat and Moisture Transport"). WUFI is designed to calculate the simultaneous heat and moisture transport in multi-layered building components.

Long Term Thermal Cycling

WUFI* – Moisture Content within BEDR Wall over 3 Years in Climate Zone 1



WUFI* – Moisture Content within BEDR Wall over 3 Years in Climate Zone 4



- Graphs indicate the moisture performance of CavityRock® over a 3-year timeframe.
- CavityRock dries out year over year to the same levels, indicating that moisture does not build up in the insulation over time.

BEDR Wall Layer/Material Climate Zone 1	Start of Calc.	End of Calc.	Min.	Max.
Cement Board	43.71	197.46	16.46	349.35
Air Layer (25 mm)	1.88	13.97	0.45	26.14
Roxul CavityRock®	0.20	2.19	0.05	3.89
Vapor Retarder (10 perm)	0.00	0.00	0.00	0.00
Gypsum Board (USA)	6.19	4.32	2.74	6.19
Roxul ComfortBatt™	0.07	0.04	0.02	0.07
Interior Gypsum Board	8.65	5.24	3.45	8.65
Total Water Content*	0.79	3.05	0.3	5.19

*Water content (kg/m³)

Roxul CavityRock thermal insulation has a very low moisture vapor sorption and does not permit the horizontal transmission of bulk moisture through the material or the assembly.

BEDR Wall Layer/Material Climate Zone 4	Start of Calc.	End of Calc.	Min.	Max.
Cement Board	43.71	144.77	13.08	348.58
Air Layer (25 mm)	1.88	9.46	0.34	17.99
Roxul CavityRock®	0.20	0.46	0.04	1.60
Vapor Retarder (10 perm)	0.00	0.00	0.00	0.01
Gypsum Board (USA)	6.19	6.18	2.44	11.79
ComfortBatt™	0.07	0.06	0.01	1.41
Vapor Retarder (0.1 perm)	0.00	0.00	0.00	0.00
Interior Gypsum Board	8.65	4.99	3.56	8.65
Total Water Content*	0.79	2.21	0.28	4.86

*Water content (kg/m³)

A Global Leader

Roxul Inc. is part of Rockwool International, the largest producer of stone wool insulation, which is made from natural basalt rock and recycled material.

Rockwool International was founded in 1909 and today operates worldwide with more than 8,500 employees, with 25 factories across three continents.

Rockwool has more than 40 years experience in developing and manufacturing advanced wall system products. For more than 20 years, Roxul has been serving the North American market.

In addition to cavity wall and steel stud batt insulation for commercial construction, Roxul also manufactures a range of other premium insulation products for multiple applications.

Roxul is the Better Insulation

Roxul ComfortBatt™ and CavityRock® are innovative insulations offering a world of green features. When Roxul is the specified insulation, green building developers can earn a variety of LEED® (Leadership in Energy and Environmental Design) points across four key categories toward sustainable development.

Environmentally Sustainable

Our stone wool production process utilizes some of the most advanced technology available. The Roxul facility is designed to capture and recycle rainwater, reduce energy consumption, and create zero waste to landfill by recycling raw materials back into the production process.

Roxul insulations are created using naturally occurring, inorganic raw materials and materials with a high-recycled content. Stone wool insulation is non-combustible and achieves its thermal performance without the use of blowing agents. The products do not off-gas and are fully recyclable, therefore contributing to a sustainable environment.

Roxul is pleased to have third-party certification of our products' recycled content for our Milton facility, completed by **ICC-ES SAVE**™. All Roxul products produced in the Milton facility contain a minimum of **75% recycled content.** Our Milton facility is certified to produce products containing up to 93% recycled content. For further details, contact your Roxul Sales Representative. Roxul products produced in our Grand Forks facility are currently under ICC-ES SAVE™ Certification review. Please visit **www.roxul.com** for the latest information.

ICC ES SAVE™

HIGH RECYCLED CONTENT • RECYCLABLE •
*Contact us for details.

NFPA MEMBER 2010-2011

ROXUL INC.
420 Bronte Street South
Suite 105,
Milton, Ontario L9T 0H9
Tel: 1-800-265-6878
www.roxul.com

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