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Mechanical Performance of ROCKWOOL Stone Wool Insulation in Low-Slope Roofing Applications

With an incline typically less than 3:12, low-slope roofing systems are particularly suitable for large commercial and industrial buildings due to their accessibility and ease of maintenance. Moreover, they provide an ideal platform for the integration of HVAC units, solar panels and other rooftop equipment. The incorporation of high-performance insulation within these roofing systems can further enhance energy efficiency by minimizing heat transfer, thereby reinforcing their status as a superior choice for modern building design.

In both new construction and the rehabilitation or repair of existing buildings, the design phase offers a unique opportunity to enhance the long-term durability and environmental performance of low-slope roof assemblies.

The incorporation of ROCKWOOL Toprock® DD stone wool insulation into these roof systems addresses several critical performance parameters:

- Fire safety is enhanced due to the passive fire protection capabilities of stone wool insulation.
- Acoustic performance is improved through the material's inherent sound attenuation properties.
- Thermal performance is maintained over time, with a stable long-term R-value and low average thermal expansion coefficients, contributing to overall energy efficiency, reduced thermal bridging from insulation gaps and reduced stress on the roofing membrane.
- Durability is ensured, as stone wool insulation consistently performs well throughout its lifetime, requiring no maintenance or regular replacement.

These attributes collectively contribute to more robust and sustainable roof systems, underscoring the importance of material selection and design considerations in achieving desired performance outcomes.

Construction, Dead and Live Loads

Low-slope roof assemblies are subjected to various construction, long-term and live loads, which can lead to permanent damage or a reduced service life if these loads exceed the capacity of any of the roof assembly materials.

Consequently, a critical design consideration for any proposed low-slope roofing product or material is its deformation in response to dead and live loads applied to the roofing assembly. In particular, the insulation material must be selected with adequate compressive capacity and long-term creep performance to effectively support these applied loads.

Construction loads refer to any loads applied to the roof assembly during the construction of the roofing system. These loads can be categorized as uniform loads, point loads, or line loads applied to the insulation, and may result from various activities, including, but not limited to, the stockpiling and hauling of construction materials, and the movement of construction equipment on the insulation. Examples of typical construction load ranges are:

- **20 sheets of ½" gypsum roof boards:** 40 psf (1.9 kPa)
- **24 boards of 2.0" stone wool insulation:** 40 psf (1.9 kPa)
- **Track mounted material handling crane with a total weight of 5000 lbs (22kN):** 1250 psf (60 kPa) track load
- **Material handling cart with a load capacity of 500 lbs (2.2 kN):** 500 psf (24 kPa) wheel load
- **Quad ATV with a total weight of 500 lbs (2.2 kN), no rider:** 180 psf (8.6 kPa) wheel load

The dead load consists of the weight of all permanent structural and non-structural components supported by the finished roofing system. It is a long duration load that remains for the entire lifespan of the roof. The dead load from the components of the finished assembly placed over the ROCKWOOL stone wool insulation is generally minimal, though it can vary. It includes layers, materials, or equipment such as, but not limited to, cover boards, various types of single- or multi-ply membranes, gravel or concrete pavers used as ballast, green roof plantings, and photovoltaic systems.

Examples of typical load ranges, without insulation, are:

- **2-ply SBS modified bitumen membrane:** 2.0 psf (0.10 kPa)
- **80-mil TPO membrane over ½" gypsum coverboard:** 2.4 psf (0.11 kPa)
- **80-mil PVC membrane over ½" gypsum coverboard:** 2.5 psf (0.12kPa)
- **90-mil EPDM membrane with gravel ballast:** 10.6 psf (0.51 kPa)
- **Concrete pavers:** 15 to 22 psf (0.72 to 1.0 kPa)
- **Green roof plantings:** 4.1 to 150 psf (0.2 to 7.2 kPa)
- **Photovoltaic system (ballasted):** 5 to 20 psf (0.24 to 1.0 kPa)

In contrast, live loads are variable loads resulting from applied forces that may change over time with the use and occupancy of the building. It is essential to consider their sources and the potential impact on the structure. Various codes, including the International Building Code (IBC) Chapter 16 Structural Design, Section 1607 Live Loads, the National Building Code of Canada (NBC) Chapter 4 Structural Design, Section 4.1.5. Live Loads Due to Use and Occupancy, and the Ontario Building Code (OBC) Section 4.1.5 Live Loads Due to Use and Occupancy, specify some live loads, not including any environmental loads, to be considered in the design of a roof based on the intended use and/or occupancy, as shown in Table 1.

There are also live loads from environmental factors, such as snow and rain, which are site-specific and calculated based on the geographic location of the proposed building and the relevant building code. These environmental loads must be carefully considered to ensure the structural integrity and safety of the building. In Ontario for instance, the specified (unfactored) climatic values for snow (Ss) range from 16.7 to 75.2 psf (0.8 to 3.6 kPa), while the values for rain (Sr) range from 4.2 to 8.4 psf (0.2 to 0.4 kPa). These values are crucial for accurately determining the live loads that the structure will need to withstand, ensuring that it is designed to accommodate the specific environmental conditions of the site.

Finally, specified concentrated loads must be accounted for to ensure that the roof is designed to withstand localized forces, thereby contributing to the overall safety and durability of the roofing system. For instance, the minimum specified concentrated roof load from the OBC is 1.3 kN over an area of 200mm x 200mm, which is equivalent to 679 psf (32.5 kPa). Similarly, the minimum specified concentrated roof load from the IBC is 300 lbs (1.33 kN) for roofs that are subject to maintenance workers.

It is typically the responsibility of the designer to determine the actual design dead and live loads, including the specified uniformly distributed live loads on an area of roof that are listed in the applicable design code (e.g., NBC, OBC, IBC or other), while the roofing contractor is responsible for identifying the construction loads that the ROCKWOOL insulation product will bear in a low-slope roofing assembly installation.

Table 1: Sample of specified design live loads adapted from the IBC and OBC

Specified Design Live Loads*		
Use or occupancy of Area	**Minimum IBC Uniformly Distributed Live Loads (psf)**	**Minimum OBC Specified Uniformly Distributed Live Loads (kPa)**
Roofs, ordinary (that are not occupiable)	**20**	**1.0**
Roofs with areas accessible to pedestrian traffic and having assembly areas	**100**	**4.8**

* Specified design loads provided for informational purposes only. Refer to the applicable building code for specific load values.

Mechanical Performance of ROCKWOOL Stone Wool Insulation

The maximum compressive loading that can be safely applied to ROCKWOOL stone wool Toprock® DD insulation, a compressible product which will deform under loading, is determined by the minimum value derived from the following criteria:

- The maximum loading that the building structure can support,
- The maximum compressive loading that can be supported by any of the materials or products used in the construction of the roofing assembly,
- The maximum compressive loading that results in a 1/8" (3mm) deflection of the insulation[1].

Determining the maximum compressive loading for other roofing assembly products, materials, and building roof systems is beyond the scope of this document and would be the responsibility of the designer, contractor, or other relevant parties prior to applying any loads to the roof.

Table 2 presents the deformation results obtained from compressive tests conducted on the Toprock® DD product across various thicknesses, showcasing its performance under different load conditions.

Finally, to manage large magnitude loads exceeding 313 psf (15 kPa), and moving wheel loads, it is essential to distribute them over as large an area as possible by utilizing spreader beams, single or multiple layers of plywood, dimensional lumber planks, and other rigid materials. Additionally, point loads should be distributed over a minimum area of 12 in x 12 in (300 mm x 300 mm) using rigid materials to ensure structural integrity.

Flute-Span Capability

The flute-span capability of the insulation is essential for use in steel roof decks. This characteristic ensures the material can cover the gaps (flutes) in the decking, providing support during construction and throughout the roof's life. During construction, the insulation layer must withstand worker and equipment loads without damage. Post-installation, the roof assembly must support the various loads, ensuring long-term durability and performance.

Flute-span/concentrated load tests, performed in accordance with ASTM E661, indicated that ROCKWOOL Toprock® DD experiences deflection when subjected to concentrated static loads. To precisely ascertain the appropriate insulation thickness for spanning wider deck flutes, additional testing is currently being conducted across various load conditions. While empirical evidence indicates that Toprock is capable of spanning common deck flutes without issue, updates to this bulletin will be provided as additional data or new information becomes available.

Table 2: Deformation of ROCKWOOL Toprock® DD due to Compression Load

Deformation of Toprock® DD due to Compression Load					
Board Thickness	**Compression Load**				
	83 psf (4 kPa)	**125 psf (6 kPa)**	**167 psf (8 kPa)**	**209 psf (10 kPa)**	**251 psf (12 kPa)**
2.0" (51mm)	0.018" (0.45mm)	0.025" (0.63mm)	0.031" (0.78mm)	0.036" (0.92mm)	0.041" (1.04mm)
4.0" (102mm)	0.016" (0.41mm)	0.023" (0.58mm)	0.029" (0.72mm)	0.034" (0.86mm)	0.039" (0.99mm)

[1] This deflection limitation was selected based on the load required to achieve this deflection in the 2-inch ROCKWOOL Toprock® DD insulation. According to compression testing results, such deflection of the insulation corresponds to a compressive loading of 1148 psf (55 kPa), an applied load considered a significant roof load for a typical building structure.

[2] Insurance Information Institute, Inc., Facts + Statistics: Hail

Hailstorm Resilience

In North America, hailstorms are a widespread hazard that significantly contribute to property losses. To illustrate, the National Oceanic and Atmospheric Administration (NOAA) reported 6,962 hail events in the United States in 2023, an increase from 4,436 events in 2022. One insurance company alone reported that claims related to hail damage exceeded $3.5 billion in 2022, an increase of more than $1 billion from 2021, with the highest claims coming from Minnesota, Texas, Arkansas, Illinois, and Nebraska[2].

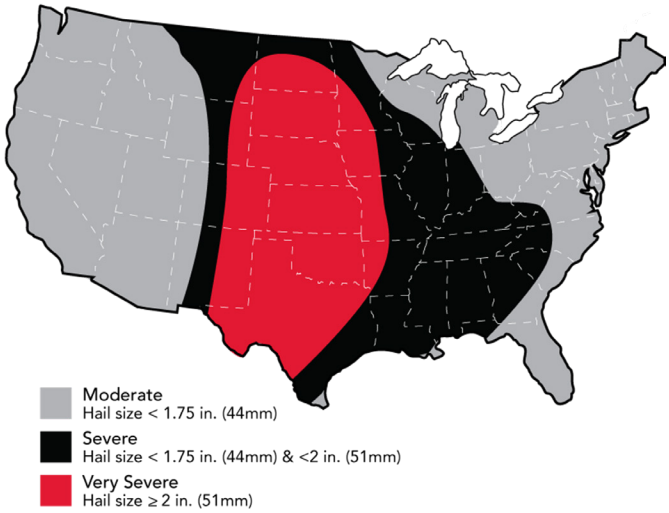
Canada has also faced significant challenges, such as the August 2024 hailstorm in Calgary, which caused nearly $2.8 billion in insured damage, marking it as the second-costliest event in the country's history[3].

The record-setting insured losses during recent summers emphasize the critical importance of incorporating robust hail resistance into roofing design. The increasing frequency and severity of hailstorms underscore the necessity for advanced roofing solutions to mitigate financial impacts and ensure long-term durability.

To address the significant impact of these storms, Factory Mutual Insurance Company (FM) has dedicated the past decade to extensive research and updating standards. Their efforts include developing new hail resistance tests for roof assemblies, creating a detailed hail zone map, and introducing a Very Severe Hail (VSH) rating in roofing standards.

FM Standard 4470[4] outlines the testing and certification requirements for various roofing assemblies, including single-ply, polymer-modified bitumen sheet, built-up roof (BUR), and liquid-applied roof assemblies. This standard includes classifications for Moderate Hail (Class 1-MH), Severe Hail (Class 1-SH), and Very Severe Hail (Class 1-VSH). These ratings are determined through rigorous testing, involving the dropping or launching of steel and ice balls to simulate hail impacts, and require that there be no visual damage to the membrane or underlying components.

Designers can rely on FM approved designs to select roofing solutions that can withstand varying levels of hail severity, ensuring robust hail resistance and long-term durability, based on the hailstorm hazard determined by the location of the project. The hail zone map by FM provides a comprehensive view of hail risk zones across the United States, aiding in identifying and minimizing hail damage risks. This map, part of the FM Property Loss Prevention Data Sheets 1-34, highlights regions where hail over 2 inches in diameter is likely.



ROCKWOOL stone wool insulation is a key component of a vast array of FM approved designs for VSH resistance. The lower density layer of dual-density ROCKWOOL Toprock® DD roofing insulation, which constitutes all but the top layer of the insulation board, effectively absorbs much of the kinetic energy from hail impact. Meanwhile, the higher density layer provides sufficient hardness to reduce indentation while remaining flexible enough to mitigate mass loss from the bottom of the board after impact.

The FM Approvals database RoofNav[5] provides easy access to the most up-to-date FM Approved roofing-related information and related installation recommendations that include ROCKWOOL products.

Appendix A on page 6 provides a non-exhaustive list of FM approved assemblies incorporating stone wool insulation.

[3] Insurance Bureau of Canada: Alberta continues to see large-scale impacts from hailstorms, October 10, 2024

[4] Examination Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction Class Number 4470

[5] FM Approvals RoofNav

Low-slope roofing systems are ideal for large commercial buildings, offering easy maintenance, integration of rooftop equipment, and enhanced energy efficiency—especially when paired with high-performance insulation like ROCKWOOL Toprock® stone wool. This insulation not only delivers superior fire, acoustic, and thermal performance but also ensures long-term durability and resilience against construction, environmental, and hail-related loads, making it a smart and sustainable choice for modern building design.

The full study **"Applied Loads on ROCKWOOL Stone Wool Insulation in Roof Assembly"** by Stantec from 12/16/2024 is available upon request.

ROCKWOOL Roofing Board Insulation Options

Roof Membrane Attachment Options*	Toprock® DD	Toprock® DD Plus
Mech. Fastened	✓	✓
Torched	✗	✓
Hot Mopped	✗	✓
Cold Adhered**	✓	✓

* Certain roof membrane types, attachment methods, or project-specific load requirements may necessitate the use of additional components—such as a gypsum coverboard—between the insulation and roof membrane to ensure adequate long-term support and durability. A qualified design professional can help you determine whether the use of a coverboard is needed for your project.
** Applicable to certain applications. Consult ROCKWOOL Technical Services.

ROCKWOOL tested numerous roofing assemblies for their ability to control noise, including stone wool specific and hybrid roof assemblies.

For tested acoustic performance of assemblies using Toprock® DD and Toprock® DD Plus, refer to ROCKWOOL's **Catalog of Acoustical Roofing Assemblies**.

For information about stone wool insulation within metal roofing systems, access **ROCKWOOL's Technical Bulletin** available at rockwool.com.

To get in touch with the ROCKWOOL Technical Services team, visit **rockwool.com/north-america/contact/** or call at 1-877-823-9790

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Appendix A: Examples of FM approved designs with various hail ratings including ROCKWOOL stone wool insulation products

FM Assembly No.	Deck Type	Insulation Board	Coverboard	Membrane Type	Cover Securement	Fire Rating (Internal/ External)	Wind Uplift (psf)	Hail Rating	Partners
219560-0-0	Steel	Toprock® DD	Toprock® DD	PVC	Mech. Attached	1/A	90	SH	Tremco, SOPREMA, Johns Manville
535070-0-0	Steel	Polyiso	Toprock® DD	TPO	Adhered	1/A	90	VSH	GAF
281148-48574-0	Steel	Polyiso	Toprock® DD Plus	ModBit/SBS	Adhered	1/A	90	SH	JM, Tremco
282113-50227-0	Steel	Polyiso	Toprock® DD Plus	ModBit/SBS	Adhered	1/A	90	SH	Tremco
546322-546290-0	Concrete	Polyiso	Toprock® DD	ModBit/SBS	Adhered	Noncomb./A	90	VSH	Tremco
108288-0-0	Steel	Toprock® DD	Toprock® DD	PVC	Mech. Attached	1/A	120	SH	Sika
257379-0-0	Steel	Toprock® DD	Toprock® DD	EPDM	Mech. Attached	1/A	120	SH	Firestone
207177-0-0	Steel	Toprock® DD	Toprock® DD	PVC	Mech. Attached	1/A	120	SH	Tremco, SOPREMA, Johns Manville
108891-0-0	Steel	Toprock® DD	Toprock® DD	PVC	Mech. Attached	1/A	135	SH	Sika
338065-0-0	Steel	Toprock® DD	Toprock® DD	TPO	Mech. Attached	1/A	150	SH	GenFlex Roofing Systems
196886-0-0	Steel	Toprock® DD	Toprock® DD	TPO	Mech. Attached	1/A	165	SH	GenFlex Roofing Systems
284973-0-0	Steel	Polyiso	Toprock® DD	PVC	Mech. Attached	1/A	180	SH	Sika
258241-0-0	Steel	Toprock® DD	Toprock® DD	TPO	Mech. Attached	1/A	210	SH	GenFlex Roofing Systems

For more FM approved roof assemblies incorporating ROCKWOOL stone wool insulation, visit **roofnav.com**

Appendix B: Roof Insulation Board R-value Weight Table

This table presents the R-values and the board and pallet weights for ROCKWOOL roofing boards at various thicknesses. Both products are made from the same high-density stone wool base material, and the coating weight is minimal; therefore, it has been excluded from this analysis. Please note that not all products are available in every thickness listed. Detailed information regarding the available thicknesses for each product can be found in the product's technical data sheet and the **ROCKWOOL pricelist**.

Board Thickness	R-Value at 75°F in (hr.ft².°F)/Btu [RSI in (m².K)/W]	Board Dimensions		Board Weight*	Board Area Weight	ft²/pallet	Gross Pallet Weight**
		Length	Width				
2.0" (51mm)	R-7.6 (RSI-1.3)	48" (1219mm)	48" (1219mm)	29.8 lbs (13.5 kg)	1.86 psf (9.08 kg/m²)	336 ft² (31 m²)	652.6 lbs (295.7 kg)
2.5" (64mm)	R-9.5 (RSI-1.7)	48" (1219mm)	48" (1219mm)	36.5 lbs (16.5 kg)	2.28 psf (11.13 kg/m²)	256 ft² (24 m²)	610.3 lbs (276.8 kg)
3.0" (76mm)	R-11.4 (RSI-2.0)	48" (1219mm)	48" (1219mm)	41.1 lbs (18.6 kg)	2.57 psf (12.55 kg/m²)	240 ft² (22 m²)	643.5 lbs (291.8 kg)
3.5" (89mm)	R-13.3 (RSI-2.3)	48" (1219mm)	48" (1219mm)	47.3 lbs (21.5 kg)	2.96 psf (14.45 kg/m²)	192 ft² (18 m²)	595.1 lbs (269.9 kg)
4.0" (102mm)	R-15.2 (RSI-2.7)	48" (1219mm)	48" (1219mm)	53.6 lbs (24.3 kg)	3.35 psf (16.36 kg/m²)	160 ft² (15 m²)	562.8 lbs (255.3 kg)
4.5" (114mm)	R-17.1 (RSI-3.0)	48" (1219mm)	48" (1219mm)	59.8 lbs (27.1 kg)	3.74 psf (18.26 kg/m²)	144 ft² (13 m²)	565.4 lbs (256.5 kg)
5.0" (127mm)	R-19.0 (RSI-3.3)	48" (1219mm)	48" (1219mm)	66.1 lbs (30.0 kg)	4.13 psf (20.17 kg/m²)	144 ft² (13 m²)	621.5 lbs (281.9 kg)
5.5" (140mm)	R-20.9 (RSI-3.7)	48" (1219mm)	48" (1219mm)	72.3 lbs (32.8 kg)	4.52 psf (22.07 kg/m²)	128 ft² (12 m²)	605.4 lbs (274.6 kg)
6.0" (152mm)	R-22.8 (RSI-4.0)	48" (1219mm)	48" (1219mm)	78.5 lbs (35.6 kg)	4.91 psf (23.97 kg/m²)	96 ft² (9 m²)	498.2 lbs (226.0 kg)

Note: All values are provided for informational purposes and are rounded
*Board and resulting pallet weights may vary by +/- 10 percent from the posted values, due to production tolerances
**Assuming pallet weight of 27 lbs