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Bending Stone Wool Insulation for Curved Designs

As designers continue to push the boundaries of architectural innovation, modern buildings increasingly feature complex geometries. Curved, free-flowing surfaces, inspired by nature, have emerged as a contemporary design trend, infusing spaces with vitality and comfort. Advanced technologies, such as Building Information Modeling (BIM), have made it more feasible to design and construct these intricate forms. However, to meet these evolving design demands, building materials must also advance, offering the necessary flexibility and adaptability to bring the designer's vision to life.

Insulating curved surfaces presents unique challenges that demand careful consideration. Improper installation on these surfaces can result in gaps and cracks in the exterior thermal insulation, compromising its overall performance.

ROCKWOOL stone wool provides numerous benefits for continuous exterior insulation in building enclosure assemblies. These benefits include its noncombustible properties, ease of installation around clips and girts, and ability to accommodate minor surface irregularities. Additionally, ROCKWOOL stone wool has been successfully installed over curved surfaces, further demonstrating its versatility.

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Evaluating the Insulation

The building industry lacks published formal guidance on acceptable curvature and fastening methods for achieving radius bends in insulation installations over curved substrates.

To address this gap, a series of tests were conducted to evaluate the performance and bending capabilities of ROCKWOOL stone wool insulation boards at various curvature radii (Figure 1). These tests aimed to determine the minimum allowable installation radius for each configuration.

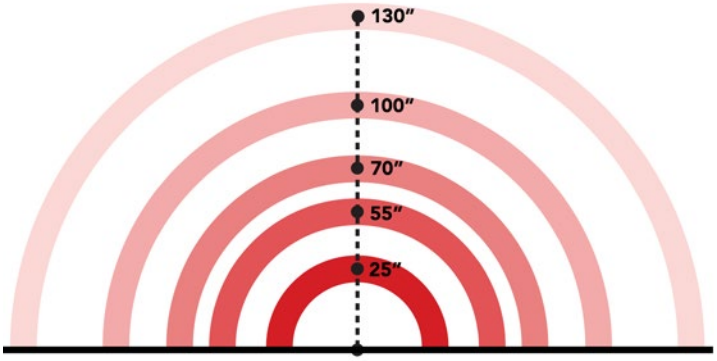


Figure 1: Curvature radii that were used to evaluate the bending capabilities of stone wool insulation

Product Selection

The appropriate product selection must be determined based on the specific application to ensure it meets the project's requirements. Factors such as rigidity, thickness, and intended use should be carefully considered. This approach minimizes waste, and ensures cost-effectiveness, ultimately leading to a more efficient and successful project outcome.

The recommended minimum installation radius for various ROCKWOOL insulation boards is provided in Table 1 on page 3.

ROCKWOOL Products for Exterior Walls

Proper fastening is essential to provide adequate support when installing ROCKWOOL stone wool insulation boards. The recommended fastening patterns provided by ROCKWOOL should be adhered to, but for smaller radii or higher-density products, additional fasteners may be needed at the perimeter or in areas requiring extra support.

Fasteners should be installed starting from one side, then at the center, and finally at the other side to ensure even pressure and minimize gaps. Additionally, to adequately distribute the load and prevent the fastener heads from pulling through the insulation, metal washers with a minimum diameter of 2 inches should be used.

Metal washers are preferred over plastic washers, as plastic washers may deform under load, occasionally allowing fastener heads to pull through. Metal washers, on the other hand, exhibit limited deformation and provide increased load transfer.

As the curve radius decreases, the installation process becomes increasingly challenging. In such cases, the involvement of additional installers and/or the use of alternative fastening methods is recommended to ensure a secure and effective installation.

Finally, uniform pressure application during the installation of insulation boards helps mitigate localized cracking and damage. A long, flat surface, such as a piece of dimensional lumber or a level, for instance, could be used and oriented parallel to the axis of curvature. This technique contributes to ensuring even pressure distribution and minimizes the risk of damaging the insulation.

Avoiding Cracks and Gaps

A successful installation is also characterized by the absence of surface cracks and gaps behind the insulation boards, with gaps being less than or equal to ¼ inch, as maintaining this condition is crucial for preserving the insulation's effectiveness.

Larger cracks and gaps can permit air movement behind the thermal insulation, thus "short-circuiting" it, which subsequently compromises the overall thermal performance of the assembly.

Optimal Fiber Orientation

For the optimal installation of denser products like Toprock® DD insulation on curved surfaces, identifying the correct fiber orientation is essential. Since the boards may not have explicit labeling, a practical method to determine the orientation is the flexibility test.

To perform this test, the board should be gently bent along different axes. The direction that allows for easier bending with less resistance and fewer surface cracks likely represents the parallel fiber orientation. Conversely, the direction that resists bending and exhibits more stress or cracking indicates the perpendicular orientation.

Installing the insulation with the fibers aligned parallel to the axis of curvature ensures greater flexibility and minimizes the risk of damage. This alignment allows the insulation to conform more effectively to curved surfaces, providing a more durable and efficient application.

Table 1: Minimum Acceptable Installation Radius for ROCKWOOL Insulation Boards Products

ROCKWOOL Product	Board Thickness	Board Orientation	Minimum Acceptable Radius
Semi-rigid Boards			
Cavityrock® 24" x 48"	1.0" (25mm)	Long edges of insulation board perpendicular to axis of curvature	55.0" (1397mm)
	2.0" (50mm)		55.0" (1397mm)
	4.0" (102mm)		100.0" (2540mm)*
Cavityrock® Black 24" x 48"	2.0" (50mm)	Long edges of insulation board perpendicular to axis of curvature	55.0" (1397mm)
	4.0" (102mm)		100.0" (2540mm)*
	6.0" (152mm)		130.0" (3302mm)*
Rockboard® 40 24" x 48"	2.5" (64mm)	Long edges of insulation board perpendicular to axis of curvature	70.0" (1778mm)
	4.0" (102mm)		100.0" (2540mm)
Rigid Boards			
Comfortboard® 80 24" x 48"	1.5" (38mm)	Long edges of insulation board perpendicular to axis of curvature	70.0" (1778mm)
	3.0" (76mm)		130.0" (3302mm)*
Toprock® DD 48" x 48"	2.0" (50mm)	Insulation fibers parallel to axis of curvature**	70.0" (1778mm)
	3.0" (76mm)		> 130.0" (3302mm)*
	6.0" (152mm)		> 130.0" (3302mm)*

*Indicates that the board is not damaged under bending; however, gaps between insulation and substrate may exceed ¼ inch.
**For more information about insulation fiber orientation, refer to the section "Optimal Fiber Orientation" on page 3.

Achieving Tighter Radius Bends

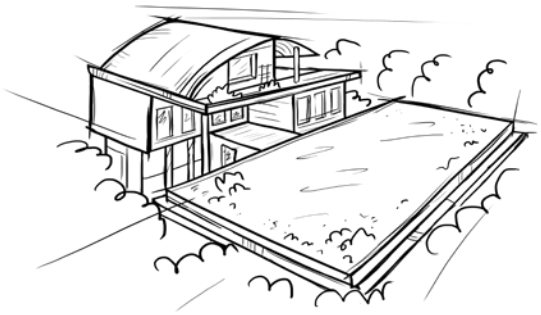
Utilizing multiple thinner layers of insulation can enhance the board's ability to conform to tighter curves while maintaining continuous insulation coverage. This approach not only improves flexibility but also ensures that the insulation remains effective and uninterrupted.

Additionally, staggering the joints between layers of insulation is essential to prevent thermal bridging and to maintain the overall integrity of the insulation system. Staggered joints help to create a more continuous thermal layer, reducing the potential for gaps and improving the overall performance of the insulation.

To achieve even tighter radius bends, relief cuts in the insulation boards are particularly beneficial. A relief cut involves making strategic incisions to reduce surface stress and enhance flexibility.

These cuts are typically made perpendicular to the direction of the curvature on the surface of the insulation material under tension and can vary in depth and spacing depending on the specific requirements of the installation. By alleviating internal stresses within the insulation material, relief cuts prevent cracking and ensure a snug fit against the curved substrate, thereby preserving the integrity and performance of the insulation.

To mitigate the potential negative effects of the cuts on thermal performance, it is recommended to use multiple layers of insulation with staggered joints and relief cuts.



The Importance of On-Site Mock-Ups

To ensure the success of insulating curved surfaces, it is highly advisable to create an on-site mock-up before proceeding with full-scale application. This crucial step allows for the verification of design details, material compatibility, and installation techniques specific to curved insulation. By doing so, potential issues can be identified and resolved early in the process. Additionally, an on-site mock-up serves as a reference point for quality control, enabling consistent and precise execution throughout the project. Investing in this preliminary step enhances efficiency, reduces the risk of costly errors, minimizes waste and ensures superior performance and durability in the final installation.

Modern architectural designs increasingly feature complex, curved geometries, requiring advanced insulation materials like ROCKWOOL stone wool. Selecting the appropriate product based on the radius to accommodate is crucial to ensure optimal performance. Proper fastening with metal washers is essential to distribute the load and prevent deformation. For tighter curves, relief cuts can reduce surface stress and improve flexibility, while using multiple thinner layers with staggered joints can prevent thermal bridging and maintain continuous insulation coverage. These installation techniques help preserve the insulation's integrity and effectiveness.

For more information about stone wool insulation in metal roofing systems, refer to 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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