

Exterior stone wool wall insulation for pre-engineered metal buildings

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Pre-engineered metal buildings (PEMBs), predominantly used for industrial facilities, barns, hangars, storage units, retail shops and commercial buildings, are a highly flexible and popular building solution. By streamlining the design process, these buildings have the potential to reduce costs. A construction team can rapidly assemble the structure, made from prefabricated parts built off-site in a factory, upon delivery to the job site, resulting in a faster project turnaround.

While there are variations, PEMBs consistently feature a noncombustible structure that is built for structural integrity using three key components.

1. **Primary framing** consists of constant depth or web-tapered structural steel frames and bracing.
2. **Secondary members** are made from cold-formed steel or steel joists (wall girts and roof purlins).
3. **The building envelope** (i.e., building enclosure), is the third essential component, which typically includes a metal panel roof system and exterior wall cladding, thermal insulation, and either an interior skin made of metal panel or polyethylene sheet product.

Metal panel roofing and cladding can be made from either steel or aluminum, both of which are durable and suitable for extreme weather conditions, while also enhancing the building's aesthetic appeal.

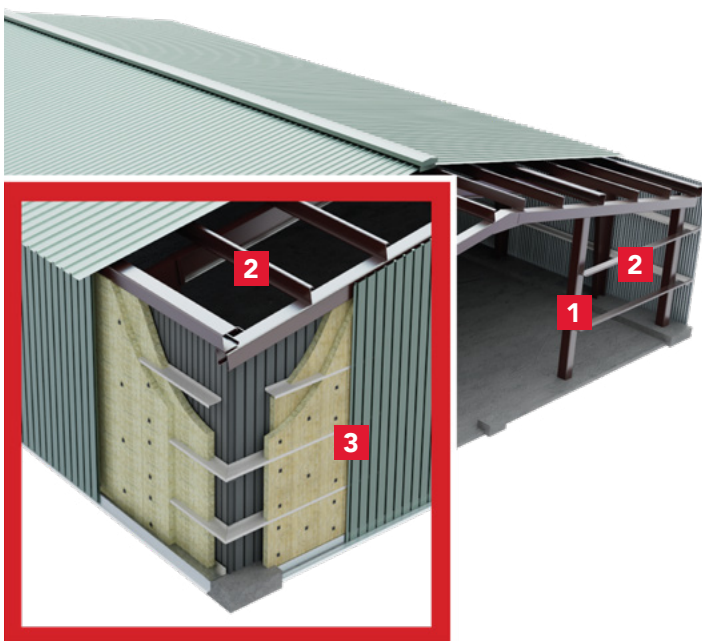


Optimizing metal buildings with insulation

Insulating a metal building is crucial for improving its thermal performance and providing occupant comfort. Effective insulation stabilizes internal temperatures, thereby reducing the need for extensive heating and cooling systems. This not only improves thermal comfort but also lowers energy consumption and costs, contributing to a reduced environmental impact. Additionally, insulation can minimize condensation risks on the interior metal skin, thereby reducing the risk of corrosion, and extending its lifespan.

Insulating PEMBs can also contribute to improving the acoustic performance of the structure by both blocking sound from entering or exiting the building and by absorbing internal noises, creating a quieter and more comfortable internal environment. Furthermore, by lowering the building's energy usage, insulation contributes to a reduced carbon footprint, supporting more sustainable construction practices.

Given these benefits, insulation is not just an additional feature but a fundamental component of metal building construction, vital for ensuring thermal efficiency, durability, and environmental compatibility.



The superior fire resistance of stone wool

For most applications, single-story metal buildings are generally exempt from the requirement of structural fire protection under building codes, due to their noncombustible steel construction, specific occupancy types, and limited dimensions.

However, in certain scenarios, fire resistance measures may be mandated for parts of these buildings or specific structural elements due to requirements that arise from factors such as proximity to adjacent properties, multiple story configurations, or the need for separation between different occupancy zones and internal spaces. Although steel is noncombustible, it could soften and fail in a fire unless it is adequately protected. ROCKWOOL insulation can contribute to providing the necessary protection to ensure the structural integrity of steel in fire conditions.

Moreover, as energy codes demand more thermal insulation, the potential negative impact of combustible insulation materials must be addressed. Specifically, wall and ceiling assemblies are particularly sensitive to the insulation's characteristics and placement.

For this reason, ROCKWOOL stone wool insulation is an optimal choice for insulating metal buildings. It offers durable thermal and acoustic capabilities and, arguably most importantly, fire-resistant properties. These features significantly contribute to enhancing the building's passive fire protection, making it an essential component.

ROCKWOOL products for exterior walls

There are two main strategies to insulate a PEMB with stone wool insulation. The first strategy is the use of continuous insulation, installed on the exterior side of the metal skin, between thermally broken clips or girts in a rainscreen type system.

A more common approach for this type of building is the installation of stone wool insulation between the secondary framing members, the girts and purlins, ensuring there are no significant voids and that the full cavity depth is filled, as shown in Assemblies 1 and 2. This method typically provides greater thermal performance than traditional draped insulation. However, it is crucial to consider the depth of the purlin or girt, fully fill the cavity, and provide measures to control air leakage and water vapor diffusion to reduce the risk of condensation.

For superior thermal performance, an additional layer of rigid continuous insulation can be added between the girts and the exterior metal skin to reduce thermal bridging, as shown in Assembly 3. In this configuration, the metal skin is attached to hat channels, which are fastened through the insulation to the girts.



Assembly 1: Exterior wall with no fire-resistance requirement.

Assembly 2: Exterior wall with a 1- or 2-hour fire rating requirement. Note the ceramic fiber blanket on the front of the horizontal girts.

Assembly 3: Exterior wall with no fire-resistance requirement but high thermal performance desired. An extra layer of continuous insulation (c.i.) is added over the horizontal girts, with hat channels fastened through the c.i.

ROCKWOOL products for PEMB exterior walls

ROCKWOOL Plus™ MB is designed to provide thermal resistance in exterior wall assemblies that do not require a fire-resistance rating.

In contrast, **ROXUL Safe® 55** and **ROXUL Safe® 65** are designed for interior or exterior non-load-bearing metal panel wall assemblies. These products are ideally suited for zero lot line applications, where buildings are in close proximity and a fire resistance rating is required:

- **ROXUL Safe® 65** is used in exterior wall assemblies requiring a 1-hour fire resistance rating,
- **ROXUL Safe® 55** is used in exterior wall assemblies requiring a 2-hour fire resistance rating.

ROCKWOOL Plus™ MB, **ROXUL Safe® 55** and **ROXUL Safe® 65** are noncombustible, as per ASTM E136¹ and CAN/ULC S114², and have a flame spread and smoke developed rating and classification of 0, respectively, as per ASTM E84 (UL 723)³ and CAN/ULC S102⁴, thereby contributing to the fire resistance of the assembly.

ROCKWOOL Plus™ MB

ROXUL Safe® 55/65

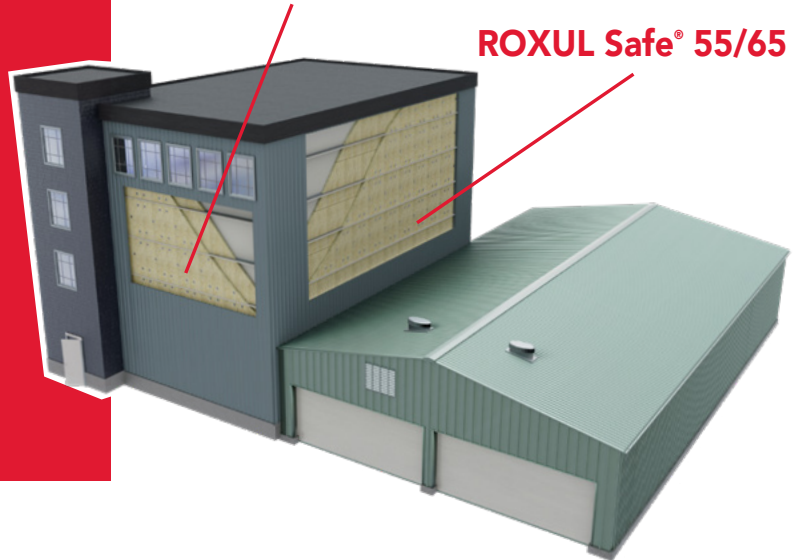


Table 1: Fire-rated assemblies with ROCKWOOL ROXUL Safe® 65 & 55

ROCKWOOL product	Assembly rating	Fire exposure side	Design no.	
			UL (USA)	ULC (Canada)
ROXUL Safe® 65	1 hour	Interior side only	-	W605
		Interior side only	U654	W609
		Both sides	U658	W610
ROXUL Safe® 55	2 hours	Interior side only	U655	W606
		Both sides	U659	W611

¹ ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C

² CAN/ULC S114 - Standard Method of Test for Determination of Non-Combustibility in Building Materials

³ ASTM E84 (UL 723) - Standard Test Method for Surface Burning Characteristics of Building Materials

⁴ CAN/ULC S102 - Surface Burning Characteristics of Building Materials and Assemblies

Thermal performance of fire-rated walls

Besides adhering to fire safety regulations, most municipalities across the United States and Canada have implemented various forms of energy codes; strategic planning and strict adherence to energy conservation principles ensure compliance with these regulations.

When installing insulation within an exterior fire-rated wall system, the achievable thermal performance is influenced by both the thickness of the insulation and the fire-listing requirements. These requirements constrain the available combination options by specifying elements such as cavity fill and girt spacing. For instance, UL assembly listings W605 and W606 state: "The overall thickness of the wall may be increased provided the Mineral Fibre Insulation is used to completely fill the wall cavity, and provided the size

of the Flashing Channels and Z-Bar are increased to match the thicker walls." Furthermore, the available combinations also depend on the insulation thicknesses available on the market. The selected solution must adhere to all these parameters.

Table 2 outlines the estimated thermal performance of various fire-rated wall systems, considering both the insulation thickness and the Z-Bar sub-girt spacing. It was estimated using THERM Finite Element Simulator version 7.7.7.0, a two-dimensional finite element heat transfer analysis program developed at the University of California, recognized as a well-benchmarked tool for accurately determining energy losses.

Table 2: U-factors of typical fire-rated assemblies with ROCKWOOL insulation

Assembly fire listing	Insulation thickness	Galvanized steel Z-bar spacing	Insulation nominal thermal resistance	Thermal transmittance (U-Value)
			ft ² ·°F·hr/BTU (m ² ·k/W)	BTU/ft ² ·°F·hr (W/m ² ·k)
UL design no. U654 ULC design no. W605	6.0" (152mm)	36.0" (914mm)	R-24.6 (RSI-4.33)	0.058 (0.331)
	6.0" (152mm)	48.0" (1220mm)	R-24.6 (RSI-4.33)	0.053 (0.303)
	6.0" (152mm)	60.0" (1524mm)	R-24.6 (RSI-4.33)	0.050 (0.286)
	9.0" (228mm)	36.0" (914mm)	R-36.9 (RSI-6.49)	0.045 (0.257)
	9.0" (228mm)	48.0" (1220mm)	R-36.9 (RSI-6.49)	0.040 (0.230)
	9.0" (228mm)	60.0" (1524mm)	R-36.9 (RSI-6.49)	0.037 (0.214)
UL design no. U655 ULC design no. W606	8.0" (203mm)	36.0" (914mm)	R-33.6 (RSI-5.91)	0.048 (0.273)
	8.0" (203mm)	48.0" (1220mm)	R-33.6 (RSI-5.91)	0.043 (0.245)
	8.0" (203mm)	60.0" (1524mm)	R-33.6 (RSI-5.91)	0.040 (0.229)
	12.0" (305mm)	36.0" (914mm)	R-50.4 (RSI-8.87)	0.037 (0.213)
	12.0" (305mm)	48.0" (1220mm)	R-50.4 (RSI-8.87)	0.032 (0.186)
	12.0" (305mm)	60.0" (1524mm)	R-50.4 (RSI-8.87)	0.030 (0.171)
UL design no. U658 ULC design no. W610	6.0" (152mm)	36.0" (914mm)	R-24.6 (RSI-4.33)	0.059 (0.335)
	6.0" (152mm)	48.0" (1220mm)	R-24.6 (RSI-4.33)	0.053 (0.304)
	6.0" (152mm)	60.0" (1524mm)	R-24.6 (RSI-4.33)	0.286 (0.050)
	9.0" (228mm)	36.0" (914mm)	R-36.9 (RSI-6.49)	0.045 (0.260)
	9.0" (228mm)	48.0" (1220mm)	R-36.9 (RSI-6.49)	0.040 (0.231)
	9.0" (228mm)	60.0" (1524mm)	R-36.9 (RSI-6.49)	0.037 (0.214)
UL design no. U659 ULC design no. W611	8.0" (203mm)	36.0" (914mm)	R-33.6 (RSI-5.91)	0.048 (0.276)
	8.0" (203mm)	48.0" (1220mm)	R-33.6 (RSI-5.91)	0.043 (0.245)
	8.0" (203mm)	60.0" (1524mm)	R-33.6 (RSI-5.91)	0.040 (0.228)
	12.0" (305mm)	36.0" (914mm)	R-50.4 (RSI-8.87)	0.037 (0.214)
	12.0" (305mm)	48.0" (1220mm)	R-50.4 (RSI-8.87)	0.033 (0.189)
	12.0" (305mm)	60.0" (1524mm)	R-50.4 (RSI-8.87)	0.030 (0.171)

Water, air and vapor control layers

ROCKWOOL stone wool insulation products are ideal for PEMB assemblies, offering effective water, air, and vapor control.

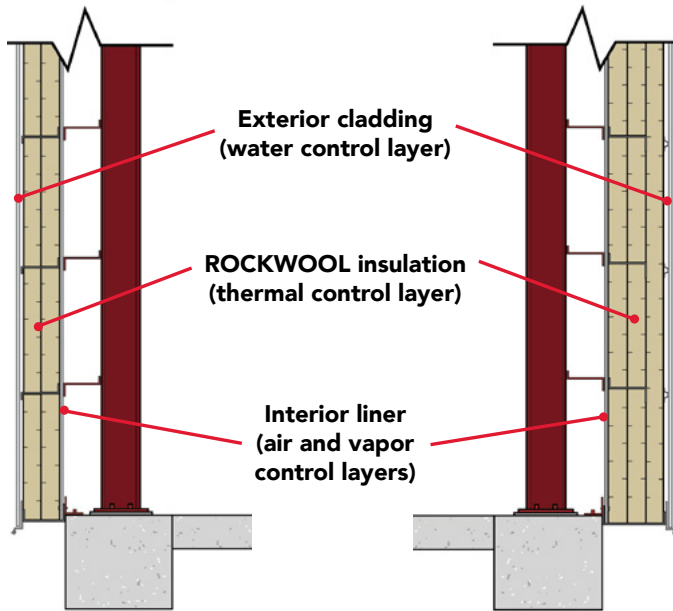


Figure 1: Schematics of control layers in PEMB exterior wall assemblies: The left shows an assembly with Plus MB or ROXUL Safe 55/65, while the right shows an assembly with Plus MB and Comfortboard as exterior c.i.

Water control: In PEMB assemblies, the metal cladding acts as the water control layer. The metal cladding and its lapped joints act as a “barrier system” to shed rainwater and snow melt. At wall penetrations, such as windows and doors, sealant and membrane flashing may be used to ensure continuity of the cladding to effectively manage water ingress. While there is some risk of water entering the assembly with a barrier system, ROCKWOOL stone wool insulation is water-repellent and is designed to not absorb water when exposed to typical water loads encountered in its intended applications. These properties may reduce the extent of required material damage and replacement should a water leak occur.

Water should also be managed by utilizing appropriate sheet metal flashing and trim components at the top and bottom of the exterior cladding, employing cap or drip flashings at the top, and drip flashings at the bottom.



Air control: As energy codes advance, there is a growing emphasis on managing air leakage through the building envelope. In PEMB assemblies, either a sealed interior metal liner or an interior polyethylene sheet act as the air control layer. Sealants and tapes complete the system, providing a continuous air control layer at liner or sheet laps, transitions, and terminations. Managing air leakage across the envelope not only improves the energy efficiency of the PEMB but also reduces the risk of condensation, as a result of air leakage, within the envelope.



Vapor control: The interior metal liner or interior polyethylene sheet in a PEMB assembly also provides vapor control. The use of a vapor control layer at the interior of the assembly limits outward vapor drive into the assembly (in heating-dominated climates), thereby limiting the risk of condensation within the assembly.



Pre-engineered metal buildings (PEMBs) provide a cost-effective and efficient solution for industrial and commercial applications, characterized by their quick assembly from prefabricated parts. These buildings feature a noncombustible steel frame, secondary steel members, and a building envelope with metal panel roofing and cladding.

ROCKWOOL stone wool insulation is ideal for PEMBAs, offering enhanced thermal performance, contributing to reduced energy consumption, and exceptional fire resistance.

ROCKWOOL Plus™ MB, ROXUL Safe® 55, and ROXUL Safe® 65 deliver superior thermal, acoustic, and fire-resistant properties. Additionally, implementing effective water, air, and vapor control strategies is crucial for ensuring the long-term durability and efficiency of these structures.



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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