Technical Bulletin
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ROCKWOOL Stone Wool Insulation for Below Grade Applications

The use of insulation below grade is a prevalent practice aimed at minimizing heat transfer between a building and the surrounding ground, thereby lowering the building's energy consumption and operational costs while increasing the occupant's comfort. In the absence of below grade insulation, the building's subterranean elements would be in direct contact with the soil or sub-base, leading to continuous heat exchange between these elements.

Below grade insulation, aptly named because it is installed below ground level, can be installed in various subterranean sections of a building. For instance, insulation can be laid horizontally beneath slab-on-grade structures or alternatively, it can be applied vertically along the sides of below grade foundation walls and footings.

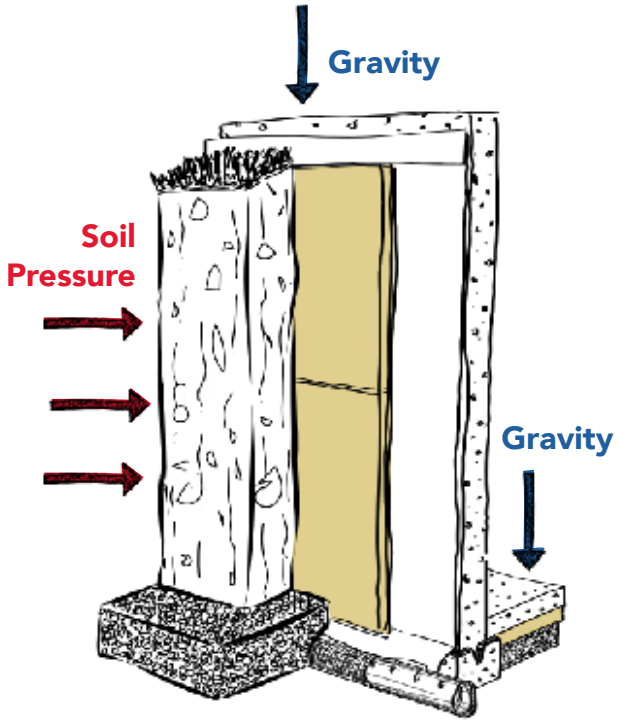
Not all insulation products are suitable for below grade applications. The insulation must be able to withstand the applicable compressive load from the ground, building foundation and floor slab, must be dimensionally stable and durable since it cannot be easily replaced over the lifetime of the building, and must repel groundwater to prevent absorption and preserve its thermal resistance. These specific requirements make ROCKWOOL stone wool insulation an ideal choice.

Design Considerations for Under-slab Use and Below Grade Walls

The most important mechanical property of below grade insulation is its ability to withstand compressive forces, as compression and subsequent deformation of the insulation are critical considerations. When installed horizontally, these compressive forces originate from the gravitational forces, or in other words, weight of the elements above, encompassing both dead and live loads.

The dead load consists of the weight from all permanent structural and non-structural components of a building, typically persisting throughout the building's lifespan, often deriving mainly from the concrete slab in this application. Considering the normal density of concrete (146.7 lbs/ft^3 or 2350.0 kg/m^3), the self-weight of a concrete slab can be calculated for various thicknesses:

- 4 in (100 mm) slab: 48.24 psf (2.31 kPa)
- 5 in (125 mm) slab: 60.36 psf (2.89 kPa)
- 6 in (150 mm) slab: 74.35 psf (3.56 kPa)
- 8 in (200 mm) slab: 96.49 psf (4.62 kPa)
- 10 in (250 mm) slab: 120.51 psf (5.77 kPa)



Live loads, on the other hand, are variable and arise from the building's intended use and occupancy, changing over time. It is essential to consider their sources and potential impact on the structure.

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 4.1.5.3. Full and Partial Loading, among others, specify some live loads to be considered in the design of a building based on the intended use and/or occupancy, as shown in Table 1 on the following page.

The designer should refer to the uniformly distributed live loads specified for an area of floor as listed in the applicable design code; determining the specific dead and live loads that the insulation must support in an under-slab installation is the responsibility of the designer.

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

Specified Design Live Loads*		
Use of area of floor	**Minimum IBC Uniformly Distributed Live Loads (psf)**	**Minimum OBC Specified Uniformly Distributed Live Loads (kPa)**
Assembly Areas with or without fixed seats, such as arenas, museums, theatres, and lecture halls	**60, 100 or 150**	**4.8**
Classroom or courtrooms with or without fixed seats	**40**	**2.4**
Vomitories, exits, lobbies and corridors	**100**	**4.8**
Equipment areas and service rooms	**-**	**3.6**
Garages – Passenger vehicles only, not exceeding 8818.5lbs (4000kg) gross weight	**40**	**2.4**
Operating rooms and laboratories	**60**	**3.6**
Garages – Vehicles exceeding 8818.5lbs (4000kg) but not exceeding 19840lbs (9000kg) gross weight	**-**	**6.0**
Office areas: basement and first storey	**10**	**4.8**
Recreation areas that cannot be used for assembly occupancy: Billiard rooms, Bowling alleys, pool rooms	**75**	**3.6**
Residential areas including sleeping and living quarters in apartments, hotels, motels, boarding schools, and colleges	**40**	**1.9**
Residential areas: work areas within live/work units	**-**	**2.4**
Retail and wholesale areas (first floor)	**100**	**4.8**
Warehouses	**125**	**4.8**
Libraries – Stack rooms	**150**	**7.2**
Libraries – Reading and Study rooms	**60**	**2.9**
Storage areas, including locker rooms in apartment buildings	**-**	**4.8**

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

Below Grade Foundation Insulation

When insulation is installed vertically on the exterior side of foundation walls, it is subject to compressive loads resulting from horizontal forces due to:

- Lateral earth pressure, which is caused by the weight of the soil and increases linearly with depth,
- Any loading on the soil adjacent to the foundation wall, which is referred to as surcharge loads. Surcharge loads include additional loading to the soil, including any finishes at grade (e.g.: concrete sidewalk), vehicle loading, adjacent structures at grade or adjacent structures that are partially below grade.

The calculation of the lateral earth pressure is the responsibility of the building designer and/or a geotechnical engineer, and will inform the choice of the appropriate insulation for the below grade wall.

Another essential property for below grade insulation is dimensional stability over time. Indeed, when a material is subjected to a permanent load, it can continue to deform, albeit at a slower rate than the initial deformation. This ongoing deformation is known as creep. It occurs when a material is exposed to high stress levels over a prolonged period. It is not sufficient for the insulation to resist deformation upon initial loading; it must also continue to resist deformation throughout the lifespan of the building to retain its properties.

Mechanical Performance of ROCKWOOL Stone Wool Insulation Below Grade

Currently, ROCKWOOL Comfortboard® 80 and ROCKWOOL Comfortboard® 110 are recommended as the rigid insulation boards for under-slab installations in buildings that support static live loads of up to 100 psf (4.8 kPa), considering the typical aforementioned concrete slab dead loading. Table 2 provides the deformation results from compressive tests for the Comfortboard® 80 and Comfortboard® 110 products at various thicknesses.

Suitable applications would typically include residential – single and multifamily housing, retail, commercial office spaces, institutional buildings, schools, hospitals, clinics, museums, theaters, and recreational facilities.

Buildings subject to moving loads, such as those involving forklifts or vehicles, as well as live loads with variable, patterned loading, should avoid using these products unless a specialized concrete reinforcement design is implemented.

It is essential that ROCKWOOL products be installed beneath the entire area of the concrete floor slab unless specific design details are provided by the designer for areas without under-slab insulation.

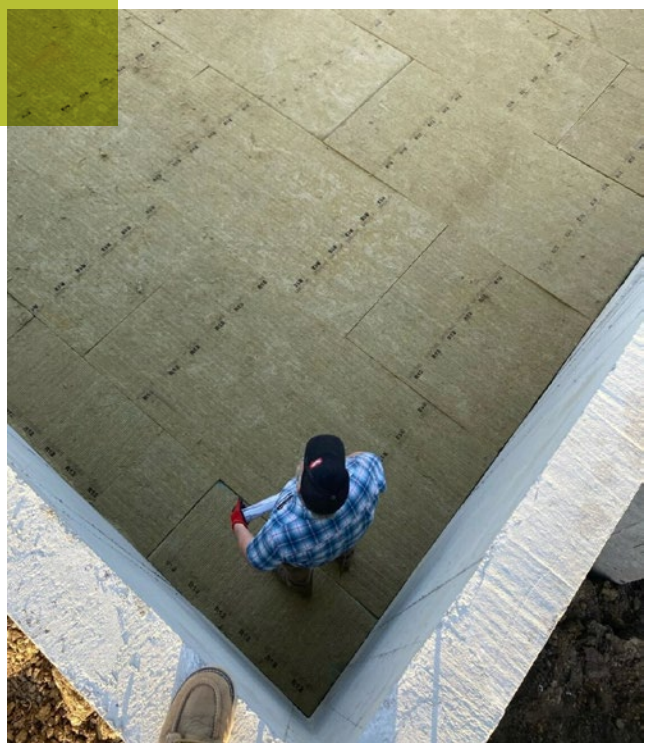


Table 2: Deformation of ROCKWOOL Comfortboard® due to Compression Load

Deformation of Comfortboard® 80 due to Compression Load					
Comfortboard® 80 Board Thickness	Compression Load				
	83 psf (4 kPa)	125 psf (6 kPa)	167 psf (8 kPa)	209 psf (10 kPa)	251 psf (12 kPa)
1.0" (25mm)	0.036" (0.91mm)	0.049" (1.24mm)	0.060" (1.53mm)	0.071" (1.80mm)	0.081" (2.06mm)
2.0" (51mm)	0.063" (1.61mm)	0.089" (2.25mm)	0.112" (2.83mm)	0.133" (3.38mm)	0.155" (3.93mm)
3.0" (76mm)	0.059" (1.50mm)	0.086" (2.19mm)	0.112" (2.83mm)	0.137" (3.47mm)	0.163" (4.13mm)
5.0" (127mm)	0.088" (2.23mm)	0.131" (3.33mm)	0.175" (4.45mm)	0.222" (5.63mm)	0.271" (6.89mm)

Deformation of Comfortboard® 110 due to Compression Load					
Comfortboard® 110 Board Thickness	Compression Load				
	83 psf (4 kPa)	125 psf (6 kPa)	167 psf (8 kPa)	209 psf (10 kPa)	251 psf (12 kPa)
1.0" (25mm)	0.019" (0.48mm)	0.026" (0.66mm)	0.032" (0.81mm)	0.037" (0.94mm)	0.042" (1.06mm)
2.0" (50mm)	0.015" (0.38mm)	0.021" (0.54mm)	0.027" (0.67mm)	0.031" (0.80mm)	0.036" (0.90mm)
3.0" (76mm)	0.017" (0.44mm)	0.025" (0.64mm)	0.032" (0.81mm)	0.038" (0.97mm)	0.044" (1.12mm)
5.0" (127mm)	0.030" (0.77mm)	0.042" (1.07mm)	0.053" (1.33mm)	0.062" (1.56mm)	0.070" (1.78mm)

Floor Finish and Exterior Grading Tolerances

Both products can handle various strains, suitable for under-slab use, but concrete slab tolerances vary by building use and finishes like tiles, which may need grout thickness adjustments for insulation deformation. It is the designer's responsibility to address both dead and live load deflections to prevent floor finish damage, especially near moving joints. Comfortboard® 110, being more dense, exhibits less deflection compared to Comfortboard® 80.

Moreover, because research showed that long-term deformation, or creep, of these ROCKWOOL products occurs mostly within the first 14 days, stabilizing shortly thereafter, the installation of finishes, which would be susceptible to ongoing deformation, should therefore likely not begin until at least 14 days after the placement of a concrete slab. Deformations occurring between day 14 and day 100 can be considered negligible, being less than 0.08 inches (0.2 mm), and thereby pose little to no risk to floor finishes.

Lastly, compression of insulation for below grade foundation walls typically occurs during backfilling and with the application of permanent surcharges. By the end of construction, all significant compression of the insulation should have taken place, with minimal additional compression from periodic surcharges like vehicle loads. Deformation of the ROCKWOOL Comfortboard® insulation for loading of up to 459 psf (22 kPa) appears to be within acceptable exterior grading tolerances, but it is the designer's responsibility to ensure the final grading adjustments accommodate any insulation deformation before applying exterior finishes.

Moisture Management

Historically, untreated fibrous insulation was used as a drainage medium due to its ability to attract water and facilitate downward drainage by gravity. However, it would absorb some water, leading to retention within the material, resulting in a loss of performance of the insulation. This issue prompted the use of hydrophobic fibrous insulation in applications without drainage layers.

Rigid ROCKWOOL Comfortboard® insulation is designed to repel water rather than drain it, which means it does not absorb water when exposed to typical water loads encountered in its intended applications, helping it maintain its thermal resistance. This makes it a particularly effective and durable solution in moist environments, where it can continue to perform optimally without degradation over time.

That said, effective water management around buildings is crucial to prevent foundation damage. Surface water can be controlled by using management systems and strategies such as gutters, downspouts, and proper site grading to direct water away from the foundation and minimize soil saturation.

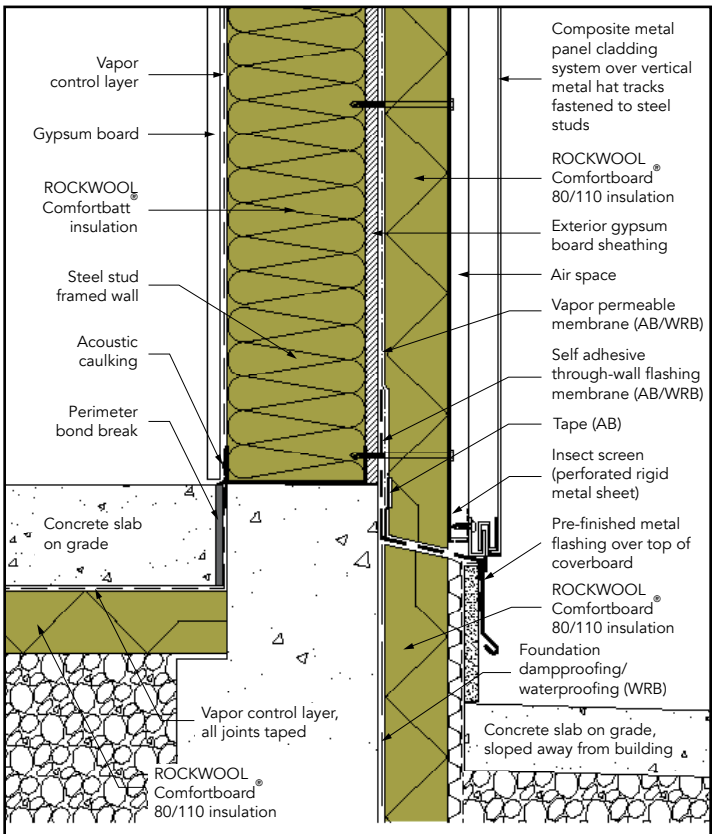
Groundwater management involves preventing water accumulation near foundation walls and beneath slabs using drainage strategies such as free draining backfill with no fines, drainage mats, functional footing drains, and granular fill to mitigate hydrostatic pressure and prevent water ingress through foundation imperfections.

It should be noted that the necessity for a drainage mat in front of below grade ROCKWOOL stone wool insulation varies based on several factors such as soil conditions and the anticipated rain load. Generally, installing a drainage mat may be advised to facilitate water management and shield the insulation from moisture, particularly in regions susceptible to significant rainfall. It is advisable to consult a structural engineer, a drainage system expert, or to adhere to local building codes to ascertain the requirement for a drainage mat in a specific situation.

Materials with high water resistance or flood damage resistance should be utilized in areas with high water tables or areas prone to flooding, thereby advising against the use of ROCKWOOL Comfortboard® under these conditions. Groundwater or floodwater may contain organic contaminants that promote mold growth and compromise the integrity of stone wool insulation. Should ROCKWOOL insulation become submerged by moving water, blackwater, or exposed to a more significant water pressure head, it may gradually absorb water, which could adversely affect its properties.

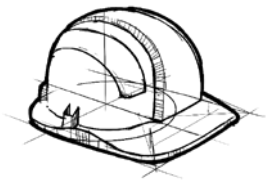
Below slab, the polyethylene sheet, also known as the 'vapor barrier', should be positioned above the insulation, sandwiched between the rigid insulation and the underside of the concrete slab. This placement is crucial as it prevents water vapor from migrating up from the ground into the concrete, and protect it from potential moisture damage, while shielding the insulation from moisture during the pouring and curing of the concrete.

Insulation below grade is often neglected in discussions about insulation placement. Yet, it plays a crucial role in minimizing heat transfer from the building elements to the surrounding soil, thereby lowering operational costs and enhancing comfort for occupants. For durable performance, the insulation must meet specific criteria. ROCKWOOL Comfortboard® stone wool insulation not only fulfills these requirements but also excels as an exceptional choice for below-grade applications.



Architectural details for various applications available at **rockwool.com**

The full study **"Under-Slab and Below Grade Use of ROCKWOOL Stone Wool Insulation"** by Morrison Hershfield from 03/20/2024 is available upon request.



For information about protecting stone wool insulation for foundation at grade, 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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