



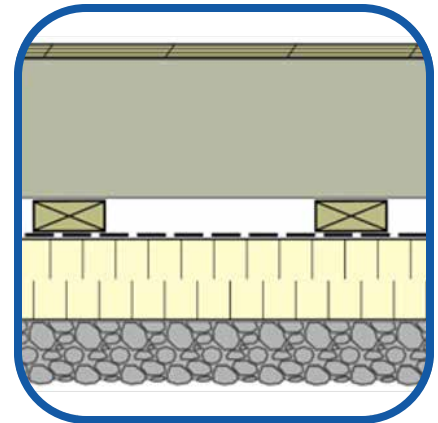
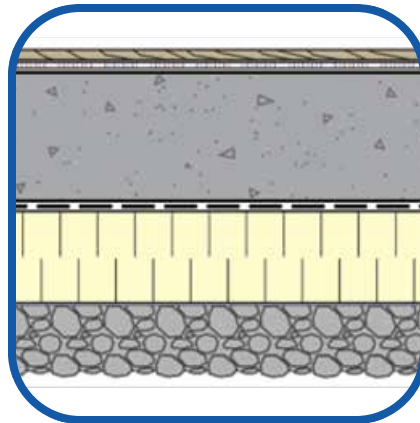
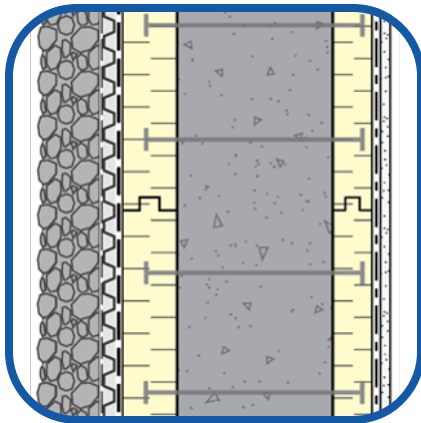
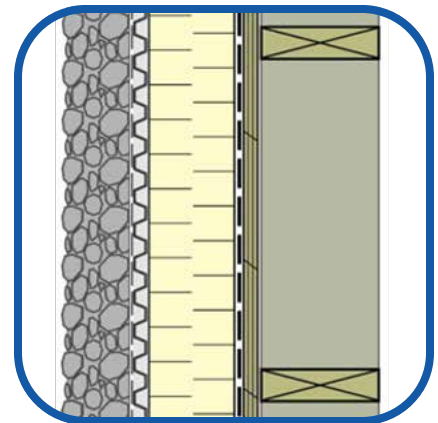
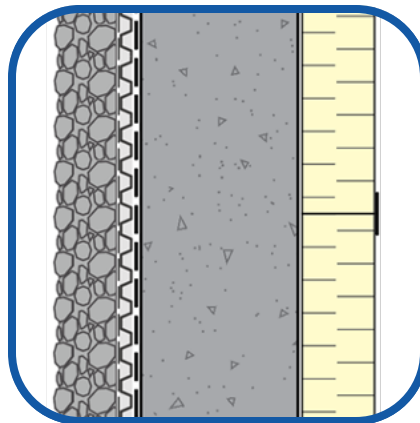
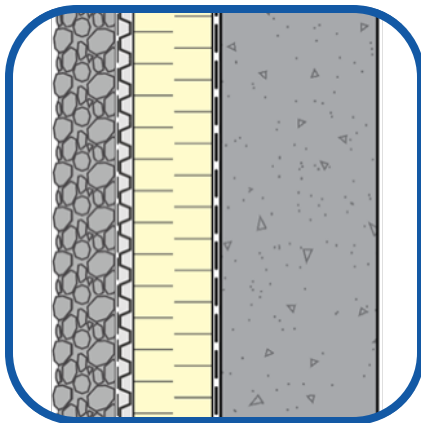
LEEP

LOCAL ENERGY
EFFICIENCY
PARTNERSHIPS

NET ZERO
ENERGY

Foundation Guide #2

Crawl Space and At-Grade Assemblies



Developed by Natural Resources Canada's
Local Energy Efficiency Partnerships (LEEP) team

LEEP Net Zero Energy Foundation Guide #2
Crawl Space and At-Grade Assemblies

M154-220/2-2026E-PDF (On-line) ISBN 978-0-662-71467-5

Aussi disponible en français sous le titre:

«LEEP ENZ Guide #2 sur les fondations : Assemblages de vides sanitaires et fondations au niveau du sol»

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Acknowledgements

The Local Energy Efficiency Partnerships (LEEP) team at CanmetENERGY would like to express appreciation to the many Canadian builders, designers, and industry partners who participate in LEEP programs across the country. Builders are invited through their regional Home Builders Associations to take part in technical forums, workshops, and training. Their input has consistently identified the need for practical, building science based resources, including this updated guide series focused on foundation and roof assemblies for high-performance homes.

We would like to acknowledge RDH Building Science for leading the development and illustration of these guides, for coordinating the technical analysis, and for integrating the broad range of industry feedback received during the review process. We also thank our technical reviewers whose comments and technical insights strengthened the clarity and accuracy of this material.

We would like to acknowledge the valuable support of the many regional partners who help deliver and support LEEP initiatives and make this work possible. We also recognize the provincial and local Home Builders Associations whose participation has been essential, along with ongoing leadership and support from CHBA National.

This Foundation and Roof Guide Series was developed by the team at RDH Building Science under the direction of Graham Finch. This project, *LEEP guides for Net Zero Energy Construction*, was led by Clarice Kramer from the NRCan LEEP team at CanmetENERGY Ottawa. Funding for this work was provided by Natural Resources Canada through the Green Infrastructure Fund.

Disclaimer

This document does not provide assurances or information related to structural systems, seismic performance, or fire safety. It is intended only as a guide on building enclosure science and foundation and roof assembly selection, detailing, materials and performance. The aim of this publication is to provide builders and designers with a framework for making decisions on the type of foundation and roof assemblies to use for individual homes and for new communities.

Natural Resources Canada assumes no liability for injury, property damage, or loss resulting from the use of information contained in this publication. This guide is intended to provide information only and does not express views of the Government of Canada nor does it constitute an endorsement of any commercial product, manufacturer or any individual.

Building science, related products, and construction practices change and improve over time. It is advisable to regularly consult up-to-date technical publications on building science, products, and practices rather than relying solely on this publication. Seek specific information on the use of products, the requirements of good design and construction practices and the requirements of the applicable building codes before undertaking a construction project. Consult the manufacturer's instructions for construction products and also speak with and retain professional consultants who hold a valid license and have appropriate engineering or architectural qualifications. Work with your municipality or local authority having jurisdiction to ensure compliance with issues of design, zoning and construction practices, including life and fire safety.

The effective R-value ranges and assemblies illustrated in this guide represent potential strategies to reach high-performance targets including the upper tiers of the National Building Code of Canada. As with any performance-based energy target, energy modeling must be used to determine appropriate designs for each individual project. Compliance strategies may be influenced by design choices such as building form, window placement, orientation, mechanical systems, and equipment efficiency.

The information included in this guide is generic in nature and is not tied to any specific voluntary labeling program. Builders and renovators looking to qualify their homes under the Canadian Home Builders' Association Net Zero Home Labeling Program must ensure their homes meet all the Technical Requirements of that Program.

LEEP Context

The LEEP Team at CanmetENERGY works with groups of builders, through their Home Builders Associations (HBAs). LEEP programs offer opportunities to identify barriers and gaps in technology and to discuss and evaluate Net Zero Energy (NZE) and high-performance home building strategies. Builders use forums and workshops to identify key technology challenges and invite experts and manufacturers to respond by proposing solutions, innovations and direction on how to integrate these ideas into construction practices. Through their HBAs, builders use LEEP to define and solve technology challenges, and to connect with design professionals who can help them deliver the homes of tomorrow. The goal is builder-driven enhancement to local building practices.

The Need

There is a need for fundamental change in foundation design and construction. Canadian builders are moving beyond typical practices to assemblies that reach higher levels of performance. LEEP technical forums have been delivered in many locations across Canada. Regional LEEP builder groups have consistently identified high-performance foundation assemblies as a key technological challenge. They have requested information on:

- › Increased effective R-values; continuous insulation and reduced thermal bridging
- › Continuous air barrier systems and airtight building enclosures; improved thermal performance, reduced heating and cooling loads, reduced risk of condensation within cavities
- › Robust water-control strategies; dampproofing and drainage systems to manage water and hydrostatic pressure
- › Effective vapour control; reduced risk of trapping moisture within the assembly, assurance that double vapour barriers are not created

There is great diversity in Canadian foundation construction. Foundation details and assembly types vary by region and climate zone. Local construction practices can also vary, along with access to reliable technical information and training. Coordination with trades and consultants is critical when introducing new technology and this should not be overlooked. It is our hope that by providing these guidelines for foundation assemblies with construction details, we will help builders select, plan and construct robust assemblies with success. Project-specific details should always be developed to account for the unique conditions of each project.

We see the LEEP guides for Net Zero Energy Construction not as the end goal, but as an essential tool for the next generation of high-performance buildings.

Documents in This Series

The following is a list of the documents in the LEEP Net Zero Energy Foundation and Roof Technical Guide series:

- YOU** › **Foundation Guide #1:** Basement Below-Grade Assemblies
ARE ➔ **Foundation Guide #2:** Crawl Space and At-Grade Assemblies
HERE › **Foundation Guide #3:** Exposed Floor Assemblies
› **Roof Guide #1:** Vented Attic Roof Assembly
› **Roof Guide #2:** Vented Vaulted Roof Assembly
› **Roof Guide #3:** Exterior-Insulated Sloped Roof Assembly
› **Roof Guide #4:** Vented Flat Roof Assembly
› **Roof Guide #5:** Conventional Flat Roof Assembly

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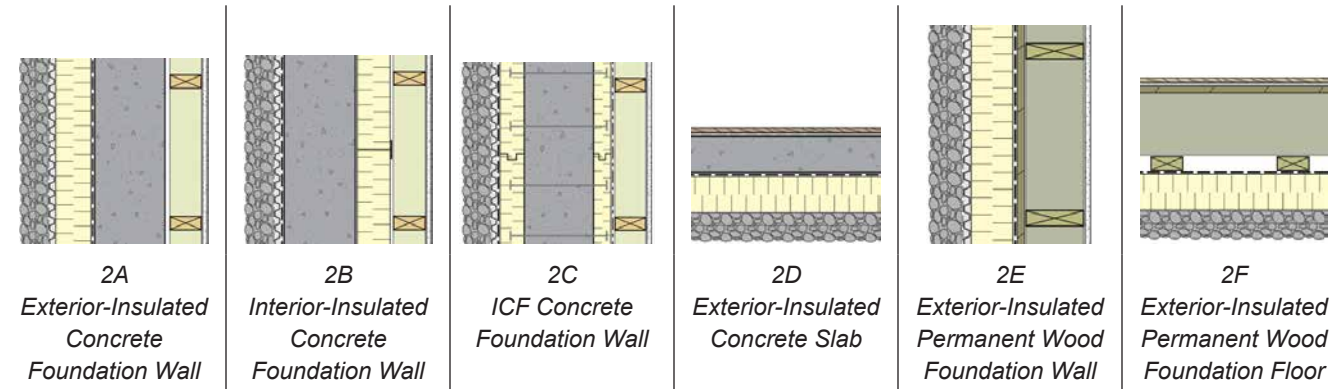
Crawl Space and At-Grade Assemblies Overview

Below-grade and at-grade assemblies form a critical part of the building enclosure. In these conditions, the enclosure is in constant contact with soil and exposed to groundwater, rainwater, snow melt, vapour, and soil gases like radon. Unlike above-grade assemblies, below-grade assemblies cannot readily dry to the exterior and are often subject to sustained high-moisture conditions. Durable design therefore begins with robust water control, integrated with continuous air, vapour, thermal, and soil gas control layers.

But the below-grade building enclosure is only the last line of defense against ground water. Even the most robust assembly will struggle to control the moisture loads if adequate site grading, foundation drainage, and under-slab drainage are not provided. While crawl spaces and at-grade slabs are typically less prone to moisture issues compared to full-depth basements, they still rely on durable water control. Effective performance relies on a system-based approach. The first sections of this guide focus on the key characteristics of effective site and foundation drainage.

This guide also outlines key considerations for various conventional bottom-bearing and raft-slab (i.e., “shallow”) foundation assemblies. The crawl space assemblies are those used with conditioned below-grade crawl spaces that are mechanically heated and ventilated. Refer to Foundation Guide #3: Exposed Floor Assemblies for guidance on assemblies associated with unconditioned crawl spaces.

This guide provides information for the following assemblies:



The best practice guidance and construction details typically show approaches that exceed the minimum requirements of the building code. However, this guide does not specifically reference building code requirements regarding foundation drainage and below-grade assemblies.

Site Water Management

Site grading and water management form the first layer of protection for below-grade assemblies. Reducing the volume of water that reaches the foundation lowers the demand on the enclosure. Properties with high groundwater tables, or sites historically associated with ravines, creeks, or drainage channels, present elevated exposure to moisture. Effective site water management reduces reliance on the foundation drainage system and below-grade enclosure, and supports long-term durability.

Surface Drainage

Surface drainage strategies are used to reduce the amount of water runoff that reaches the building. The key to successful surface drainage is to intercept and direct surface water away from the building with consistent uninterrupted sloping and drainage pathways.

Positive slope away from foundation walls past the foundation backfill zone limits surface water accumulation and reduces moisture loading at the below-grade assemblies. Both impervious hardscaping such as patios and sidewalks and soft permeable landscaping is sloped at least at 5% away from the building. Avoiding large plants and trees directly next to the building helps avoid risk of trapped water in soil as well as potential damage from roots to below-grade assemblies and foundation drainage components. Surface water from lot grading is collected in swales, ditches, lawn basins, and rain gardens, and discharged at a location approved by the local authority having jurisdiction.

Sloped sites that direct water toward the building often require additional interception measures like retaining walls and interception trenches to prevent water from reaching the building.

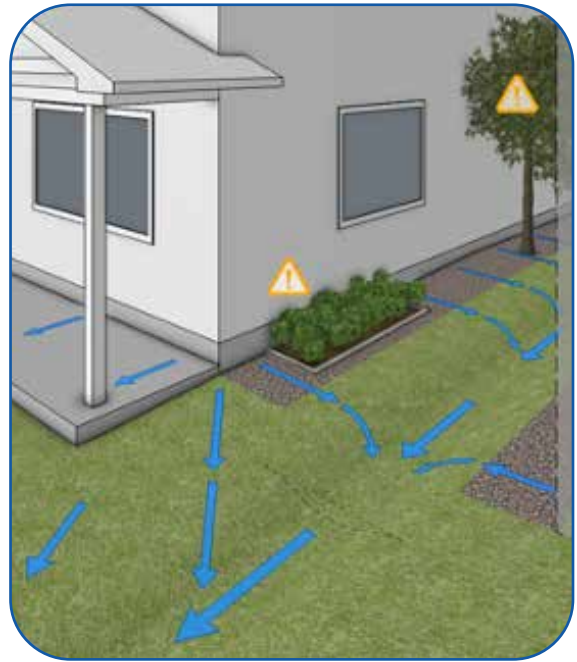


Figure 1 Overview of surface drainage best practices around the building site.

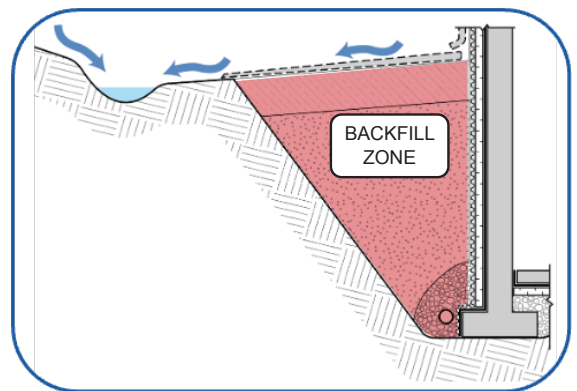


Figure 2 Section view of best practice sloping and RWL discharge management over the foundation wall backfill zone

Roof Drainage and Downspouts

Site surface drainage also includes the water from roof drains. During rainfall, rainwater leader (RWL) downspouts can introduce a large volume of water directly next to the building. To avoid this, splashpads or extensions can be used to extend the downspout discharge out past the backfill zone. Dedicated below-grade RWL drain pipes, separate from the foundation drainage system, are also effective for roof drainage management. Note that many jurisdictions only allow RWL surface discharge or drainage to dedicated detention/retention system such as a dry well.

Subsurface Drainage

Subsurface pathways can introduce water from natural ground water, irrigation systems, downspouts, leaking utilities, or even utility trenches with reverse slopes toward the building. While groundwater movement is difficult to control without large-scale site drainage systems, there are several strategies to reduce the risk of water exposure from subsurface drainage.

- › Ensure the bases of utility trenches are sloped away from the building.
- › Use free-draining clear crushed gravel in backfill zones to allow ground water to reach foundation drainage systems instead of saturating soil next to the building.
- › Avoid infiltration or detention fields on small sites with limited moisture capacity.
- › Coordinate irrigation layouts to avoid spray or concentrated discharge within the backfill zone, and check for system leaks during annual maintenance.

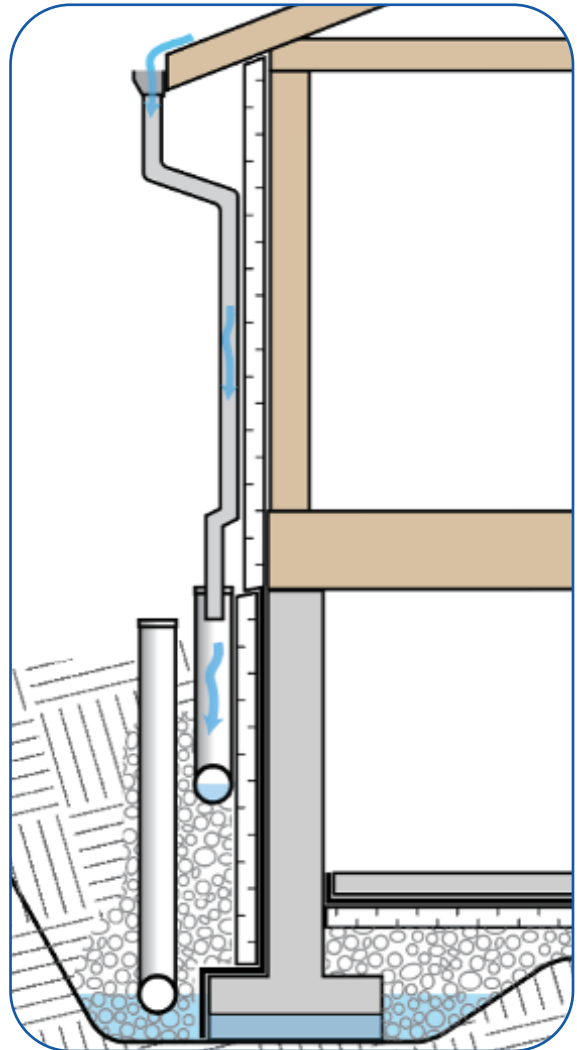


Figure 3 Section view of a dedicated RWL drain pipe system, separate from the foundation drainage system.

Foundation Drainage System

Foundation drainage is a system of backfill materials and drain pipes used to move ground water away from the building. It is used in conditions above the groundwater table to prevent surface and subsurface drainage water from accumulating at the building foundation. Foundation drainage as described in this section is typically not used in conditions below the groundwater table with constant hydrostatic pressure (i.e., for permanent dewatering). The following figure outlines the key design considerations and components used for a high-performance foundation drainage system. Note that foundation drainage systems that operate without the use of sump pumps (i.e., are gravity-drained only) provide the most reliable long-term performance.

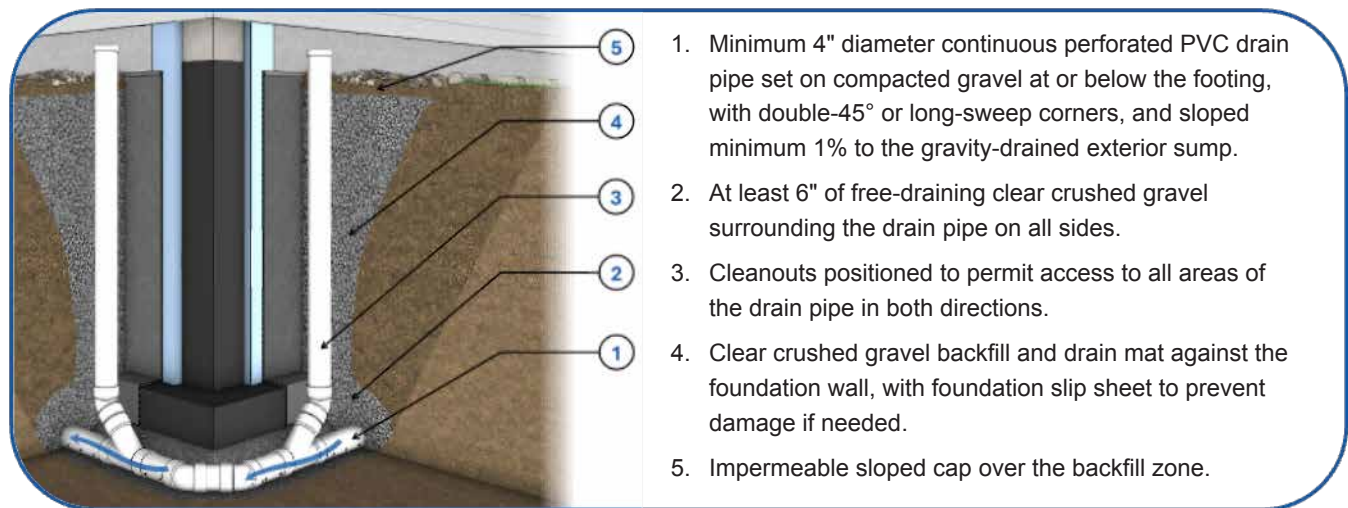


Figure 4 Overview of the optimal foundation perimeter drainage system.

Foundation Water, Thermal, and Soil Gas Control

Below is a summary of the key design and construction considerations for below-grade foundation assemblies. Refer to Foundation Guide #1: Basement Below-Grade Assemblies for more information.

- › **Foundation and Slab Water Control:** Even with effective site water management, below-grade assemblies remain exposed to groundwater due to seasonal weather events, elevated water tables, or inconsistent drainage performance within the backfill zone. The required level of protection correlates directly with the anticipated moisture exposure conditions below grade: optimally drained (conventional liquid-applied asphalt emulsion), partially saturated (multi-coat liquid-applied or impermeable self-adhered bituminous membrane), or hydrostatic (fully bonded waterproofing system).
- › **Slab Drainage:** Slab drainage is typically provided by a 4" layer of clear crushed gravel beneath the basement slab, including over the footings. This helps limit moisture accumulation under the slab and promotes drainage to the foundation perimeter drainage system.
- › **Soil Gas Control:** Sealed polyethylene membrane functions as the soil gas control layer when detailed continuously and combined with free-draining layer, perforated extraction pipe, and depressurization system.

- › **Footing Dampproofing:** Incorporating an impermeable capillary break or continuous dampproofing membrane around the footing or slab foundation limits upward moisture movement from the ground. A barrier at this interface is particularly valuable where backfill conditions are partially saturated or where significant water exposure is expected at the footing elevation.
- › **Foundation Wall Insulation:** Exterior-insulated assemblies are at a lower risk of condensation compared to interior-insulated assemblies. Refer to [Crawl Space Assembly 2B: Interior-Insulated Concrete Foundation Wall on page 14](#) for more information.

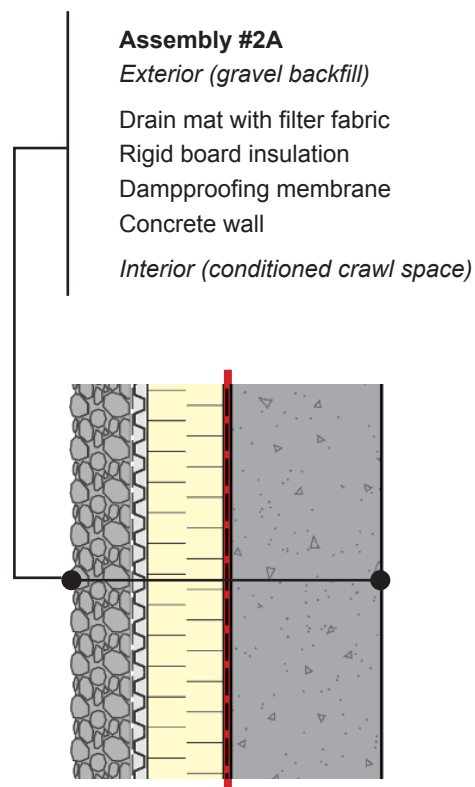
Crawl Space Assembly 2A: Exterior-Insulated Concrete Foundation Wall

This wall assembly consists of rigid insulation installed on the exterior side of the concrete foundation wall. High effective R-values are achieved through continuous insulation located outside the concrete structure. Drainage is provided at the exterior face of the insulation to relieve hydrostatic pressure at the wall.

Water Control Layer (Dampproofing)

Effective site water management and foundation drainage are critical for limiting water accumulation adjacent to the foundation. These measures reduce reliance on the wall assembly to manage bulk water.

Water at the foundation wall is managed with a continuous layer of liquid-applied asphalt emulsion or impermeable self-adhered membrane on the concrete. The selected dampproofing product is based on anticipated ground moisture conditions. Refer to [Foundation Water, Thermal, and Soil Gas Control on page 11](#) for further information. Dampproofing is not required on above-grade portions of the concrete; however, extending the coating above-grade can improve durability and moisture protection. The insulation and drain mat may function as secondary water-management elements, but the dampproofing layer remains the primary water-control layer.



Air Control Layer (Air Barrier System)

The concrete wall is typically the most airtight component of the assembly and can be made continuous with adjacent enclosure elements such as the floor slab and above-grade assemblies. The dampproofing layer can also contribute to airtightness, particularly at penetrations and at minor cracks or gaps in the concrete.

Thermal Control Layer (Exterior Insulation)

The exterior insulation must have sufficient compressive strength to resist backfill loads and must tolerate prolonged exposure to ground moisture. Insulation options include extruded polystyrene, expanded polystyrene, and high-density rigid mineral wool. This assembly does not include interior insulation.

Exterior insulation maintains the concrete structure at temperatures closer to indoor conditions, which reduces the risk of condensation at interior surfaces. Staggered or offset insulation layers reduce thermal bridging and limit pathways for water entry.

A drain mat or cover board is installed above-grade to protect the insulation. Additional protection below-grade may be required to reduce the risk of damage from backfill, roots, rodents, or insects. Exterior insulation below-grade may not be suitable in termite-susceptible regions.

Exterior insulation is typically adhered or mechanically fastened in place until backfill is completed. Thermal bridging from intermittent fasteners is negligible and is typically not included in effective R-value calculations. As a result, the effective R-value of this assembly generally reflects the full nominal R-value of the exterior insulation.

Vapour Control Layer (Vapour Barrier)

The concrete wall typically functions as the vapour barrier because it is impermeable and located on the warm side of the insulation. No interior polyethylene vapour-barrier membrane is installed in this assembly.

Crawl Space Assembly 2B: Interior-Insulated Concrete Foundation Wall

This wall assembly consists of rigid board insulation installed on the interior side of the concrete foundation wall. High effective R-values are achieved by using continuous insulation placed directly against the concrete wall.

Locating insulation on the interior results in lower concrete surface temperatures during winter conditions. This increases the potential for condensation if warm, moist indoor air reaches the concrete surface. As a result, careful detailing of an interior airtight layer is essential.

Water Control Layer (Dampproofing)

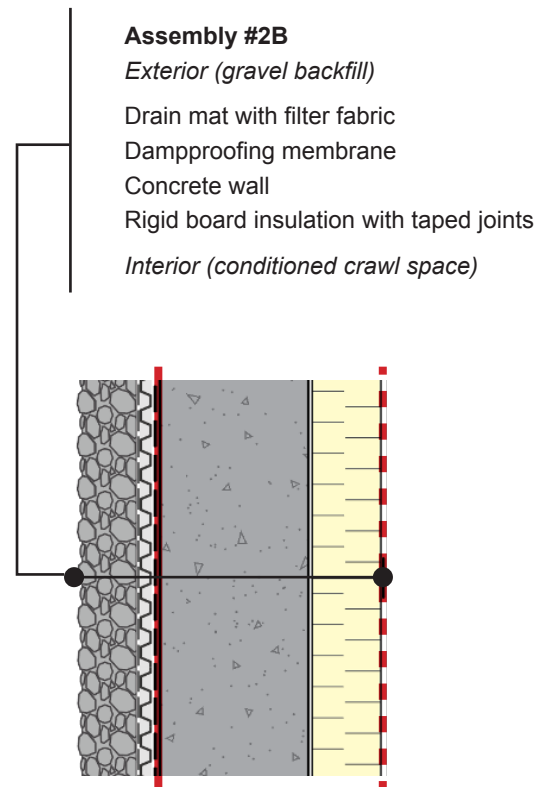
Effective site water management and foundation drainage are critical for limiting water accumulation adjacent to the foundation. These measures reduce reliance on the wall assembly to manage bulk water.

Water at the foundation wall is managed with a continuous layer of liquid-applied asphalt emulsion or non-permeable self-adhered membrane on the concrete. The selected dampproofing product is based on anticipated ground moisture conditions. Refer to [Foundation Water, Thermal, and Soil Gas Control on page 11](#) for further information. Dampproofing is not required on above-grade portions of the concrete; however, extending the coating above-grade can improve durability and moisture protection. The drain mat may function as a secondary water-management element, but the dampproofing layer remains the primary water-control layer.

Air Control Layer (Air Barrier System)

The concrete wall is typically the most airtight component of the assembly and can be made continuous with adjacent enclosure elements such as the floor slab and above-grade assemblies. The dampproofing layer can also contribute to airtightness, particularly at penetrations and at minor cracks or gaps in the concrete.

In addition, an interior airtight layer is required to limit the movement of warm, moist indoor air toward the cold concrete surface behind the insulation. This interior air control function is often provided by sealed rigid insulation boards.



Thermal Control Layer (Interior Insulation)

Interior insulation must be moisture-tolerant and capable of maintaining performance when in contact with concrete. Common insulation options include extruded polystyrene and expanded polystyrene foam board. These materials are relatively air- and vapour-impermeable and can provide both thermal control and interior air control when detailed appropriately. Conditioned crawl spaces typically do not require an interior fire-protection layer for the foamed plastic insulation.

Vapour Control Layer (Vapour Barrier)

The interior insulation layer typically functions as the vapour-control layer. The insulation layer must be sufficiently impermeable to provide the required resistance to outward vapour transmission (i.e., permeance of less than $60 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$).

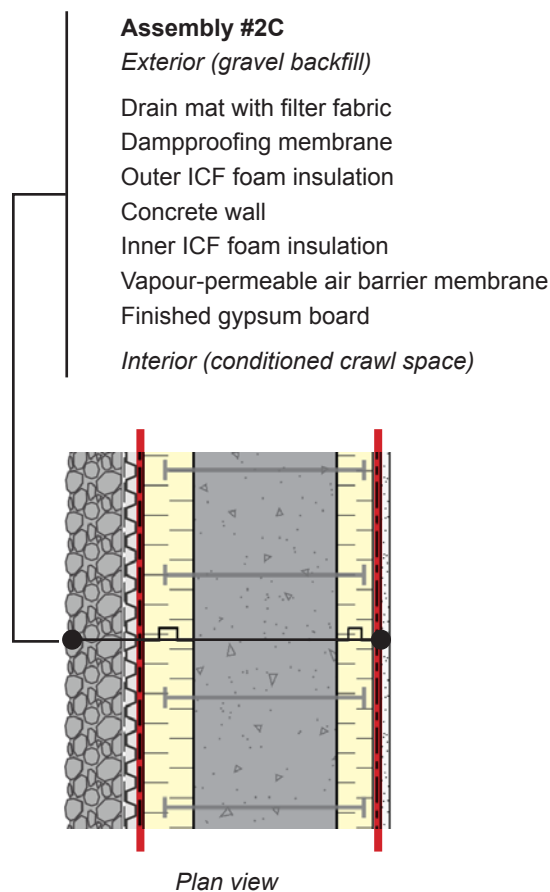
Crawl Space Assembly 2C: ICF Concrete Foundation Wall

This wall assembly consists of an insulating concrete form (ICF) system in which concrete is cast between two layers of interlocking modular formwork made of rigid foam insulation. The insulation remains in place as part of the permanent assembly. High effective R-values are achieved through continuous insulation on both sides of the concrete core. Drainage is provided at the exterior face of the outer insulation layer to relieve hydrostatic pressure at the wall.

Water Control Layer (Dampproofing)

Effective site water management and foundation drainage are critical for limiting water accumulation adjacent to the foundation. These measures reduce reliance on the wall assembly to manage bulk water.

Water at the foundation wall is managed with a continuous layer of impermeable self-adhered membrane on the outer insulation layer. The membrane and adhesives used must be compatible with the ICF formwork, which is typically sensitive to solvents. The selected dampproofing product is based on anticipated ground moisture conditions. Refer to [Foundation Water, Thermal, and Soil Gas Control on page 11](#) for further information. The dampproofing typically extends above grade to improve durability and moisture protection at these areas. The drain mat may function as a secondary water-management element, but the dampproofing layer remains the primary water-control layer.



Air Control Layer (Air Barrier System)

The concrete wall is typically the most airtight component of the assembly and can be made continuous with adjacent enclosure elements such as the floor slab and above-grade assemblies. However, transitioning through the ICF foam insulation modules can be challenging. Therefore, a continuous vapour-permeable air barrier membrane is typically installed on the interior side of the ICF. Interior cover board or finishes can be installed directly onto fastening strips embedded within the ICF to protect the membrane from damage.

Alternatively, a continuous dampproofing membrane around the footing can be used to provide the air barrier transition between the slab poly and the exterior dampproofing membrane. Refer to [Construction Details on page 20](#) for further information. Note that the interlocking modular formwork is not considered airtight.

Thermal Control Layer (ICF Insulation)

The ICF system provides continuous insulation on both sides of the concrete core, which reduces thermal bridging and maintains the concrete at warmer temperatures compared to the exterior. This configuration limits the risk of condensation at interior surfaces. Conditioned crawl spaces typically do not require an interior fire-protection layer for the foamed plastic insulation.

ICF insulation must have sufficient compressive strength to resist concrete and backfill loads and must tolerate prolonged exposure to curing concrete. Additional exterior protection, such as a slip sheet, drain mat, or protection board, may be required to reduce the risk of damage from backfill.

Vapour Control Layer (Vapour Barrier)

The concrete core, in combination with the insulation layers, typically functions as the vapour-control layer. No interior polyethylene vapour-barrier membrane is installed in this assembly.

Assembly 2D: Exterior-Insulated Concrete Structural Slab

This floor assembly consists of rigid insulation installed beneath a taped and sealed polyethylene (poly) membrane air barrier system and concrete slab. High effective R-values are achieved by using continuous insulation located below the slab. A layer of free-draining clear crushed gravel beneath the insulation provides a capillary break and reduces the potential for hydrostatic pressure at the slab. It also provides an air-permeable layer for soil gas control. The sealed poly membrane functions as the vapour barrier, air barrier, dampproofing, and radon barrier in this assembly.

Water Control Layer (Slab Poly)

Effective site water management and foundation drainage are critical for limiting water accumulation adjacent to the foundation. These measures reduce reliance on the slab assembly to manage bulk water.

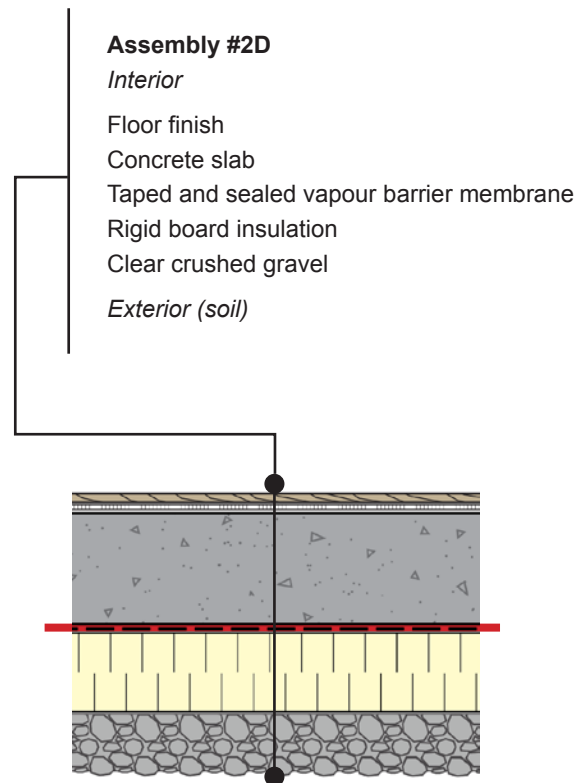
Water beneath the slab is managed with a continuous layer of poly membrane. High-density 10-mil or 15-mil thick poly provides better robustness during installation and concrete placement compared to conventional 6-mil poly. The clear crushed gravel and insulation beneath the membrane may function as secondary water-management elements, but the slab poly remains the primary water-control layer.

Air Control Layer (Air Barrier System)

The taped and sealed poly membrane provides the air control layer in this assembly. This system relies on robust compatible joint tape and sealing accessories to provide sufficient airtightness at the slab. All laps, penetrations, and perimeter terminations, including around the footing in monolithic and raft slab foundation, are taped and sealed to maintain continuity. The concrete slab also contributes to airtightness.

Thermal Control Layer (Exterior Insulation)

Insulation located beneath the slab must have sufficient compressive strength to support slab and occupancy loads. Insulation options include extruded polystyrene and high-density expanded polystyrene. The selected insulation must be moisture-tolerant due to potential exposure to ground moisture.



Continuous insulation beneath the slab maintains the concrete at temperatures closer to indoor conditions, which reduces the risk of condensation and associated durability concerns at the slab surface. The slab insulation may also need to extend beneath the footing and as a skirt around the perimeter of the slab to provide frost protection. See [Detail D2.04 | At-Grade Slab at Above-Grade Wall – Exterior-Insulated Concrete Slab Foundation on page 24](#) for more information. The effective R-value of this assembly generally reflects the full nominal R-value of the insulation layer.

Vapour Control Layer (Vapour Barrier)

The slab poly functions as the vapour barrier in this assembly.

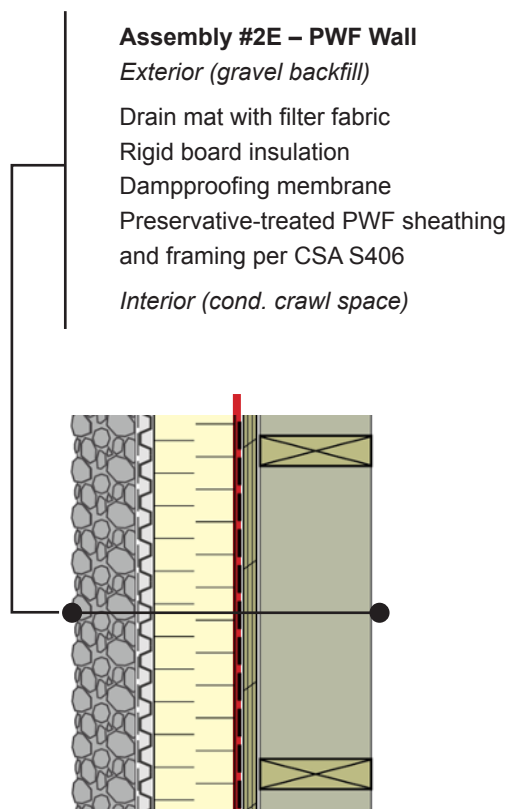
Soil Gas Control

The sealed polyethylene membrane can function as the soil gas control layer when detailed continuously and combined with appropriate free-draining layer, perforated extraction pipe, and depressurization system. Refer to [Foundation Water, Thermal, and Soil Gas Control on page 11](#) for further information.

Crawl Space Assemblies 2E & 2F: Exterior-Insulated Permanent Wood Foundation

This assembly consists of a permanent wood foundation wall and framed floor constructed in accordance with CSA S406 requirements for permanent wood foundation (PWF) systems. All structural framing and sheathing are preservative-treated and all fasteners are hot-dipped galvanized or stainless steel.

The wall configuration follows the same general arrangement as [Crawl Space Assembly 2A: Exterior-Insulated Concrete Foundation Wall \(see page 12\)](#), with dampproofing applied to the exterior face of the sheathing, rigid insulation installed outboard of the structure, and no interior insulation. The floor configuration follows a similar arrangement to [Assembly 2D: Exterior-Insulated Concrete Structural Slab \(see page 17\)](#), with rigid insulation and a sealed polyethylene membrane installed over free-draining granular fill, and preservative-treated sleepers and framing above.



Water Control Layer (Dampproofing and Slab Poly)

Effective site water management and foundation drainage are critical for limiting water accumulation adjacent to the foundation. PWF assemblies are best suited for optimally drained conditions ([see Foundation Water, Thermal, and Soil Gas Control on page 11](#)).

Water at the foundation wall is managed with a continuous layer of impermeable self-adhered membrane on the sheathing, with all laps and penetrations sealed with robust detailing to reduce the risk of leaks.

Water beneath the slab is managed with a continuous layer of poly membrane. High-density 10-mil or 15-mil thick poly provides better robustness during installation and for supporting the wood sleepers, compared to conventional 6-mil poly.

Air Control Layer (Air Barrier System)

The exterior dampproofing provides the air control layer for the wall. The taped and sealed poly membrane provides the air control layer for the floor. All laps, penetrations, and perimeter terminations in the dampproofing and slab poly are taped and sealed with compatible sealing accessories.

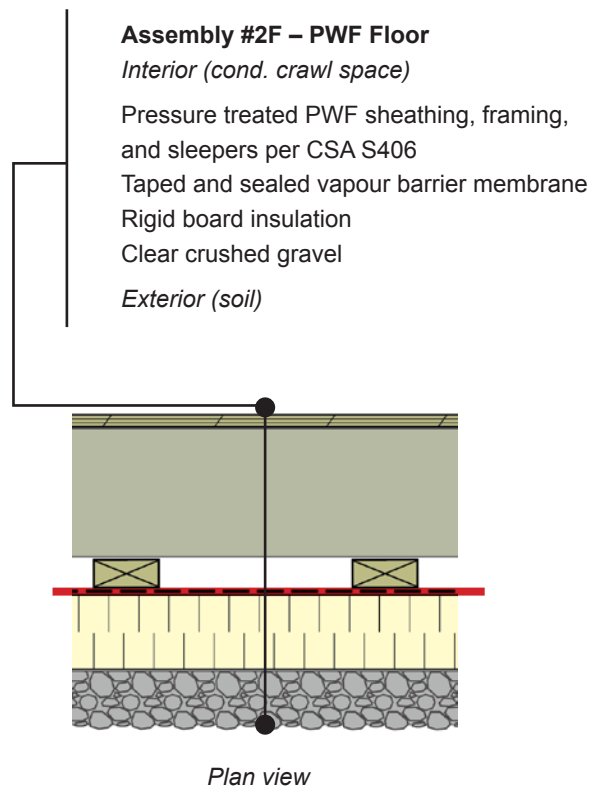
Thermal Control Layer (Exterior Insulation)

The exterior wall and floor insulation must have sufficient compressive strength and must tolerate prolonged exposure to ground moisture. Insulation options include extruded polystyrene and expanded polystyrene. This assembly does not include interior insulation.

Exterior insulation maintains the structure at temperatures closer to indoor conditions, which reduces the risk of condensation at interior surfaces. The effective R-value of these assemblies generally reflects the full nominal R-value of the exterior insulation.

Vapour Control Layer (Vapour Barrier) and Floor Soil Gas Control

The wall dampproofing and floor poly function as the vapour barriers, and the floor poly functions as the soil gas control layer. See also [Foundation Water, Thermal, and Soil Gas Control on page 11](#).



Construction Details

The example details in the following pages establish a common level of detailing for Foundation Guide #2. Each guide in this series provides a similar set of details for its respective set of assemblies. Builders may replicate or adapt these details to meet Net Zero Energy or other high-performance targets, provided the core principles of water control, air barrier and insulation continuity, and vapour and soil gas control are maintained.

The assemblies shown were selected through LEEP initiatives where builder groups requested a focus on practical, regionally appropriate high-performance solutions. Building-science experts reviewed these assemblies based on climate, local construction practices, and code requirements. The details highlight key transition strategies, with red “AB” and “AB/RB” icons identifying air barrier and radon barrier components. Note that the at-grade slab details show raft slab conditions. Refer to Foundation Guide #1: Basement Below-Grade Assemblies for details showing conditions resembling conventional at-grade slabs with perimeter and insulated foundation pony walls.

These illustrations represent best practices. Project-specific work may require additional details, assembly- and product-specific adjustments, and coordination with structural, mechanical, electrical, and life-safety systems. Any modifications should be prepared or reviewed by qualified professionals, as provincial requirements vary.

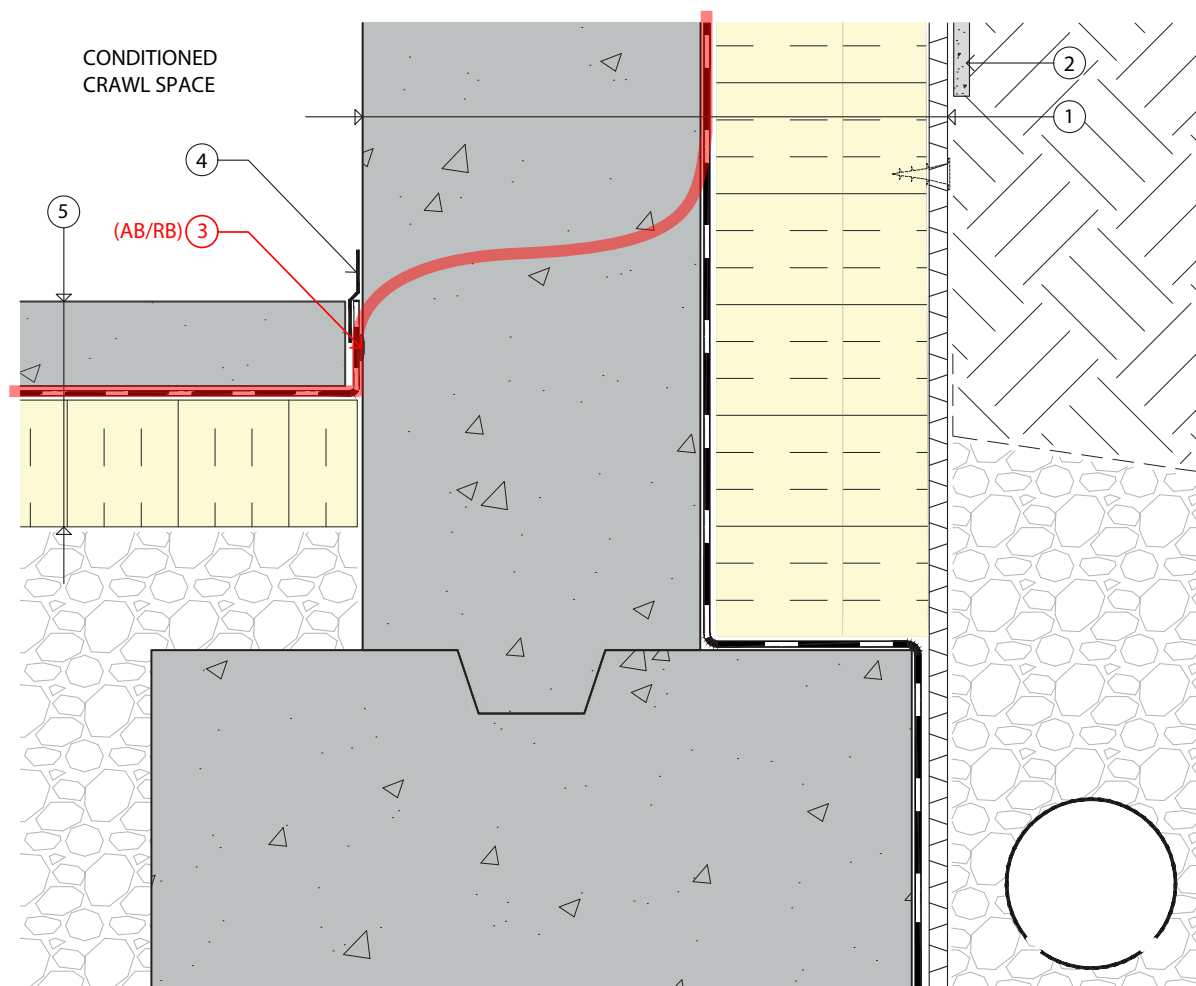
To reduce the risk of water penetration, mould, or other deficiencies, builders are encouraged to review details with a building-science engineer or architect, and to practice installation techniques using full-scale mockups for training and quality control.

Each unique project will require the development of specific details and construction documents to address the varied conditions found in each building and the capacity of local construction trades. In addition, each builder must provide quality control and assume liability for the work they complete. Reliable technical information and training are critical to your success. Builders are encouraged to take advantage of technical guides and training opportunities offered by credible sources and share this training with everyone on your crew. Work with your local Home Builders Association to find more information and to build local capacity.

For more guidance and example detailing for net zero energy crawl space and at-grade assemblies, refer to the following additional resources:

- › Builder Guide to Site and Foundation Drainage – Best Practices for Part 9 Buildings in British Columbia, BC Housing
- › Illustrated Guide – R22+ Effective Walls in Residential Construction in British Columbia, BC Housing
- › Building Envelope Guide for Houses, BC Housing
- › Canadian Home Builders' Association of BC Building Science for New Homes, CHBA BC
- › BC Energy Step Code Builder Guide, BC Housing
- › Building Enclosure Design Guide, BC Housing

Detail 2.01 Crawl Space Concrete Slab at Foundation Wall – Exterior-Insulated Concrete Foundation

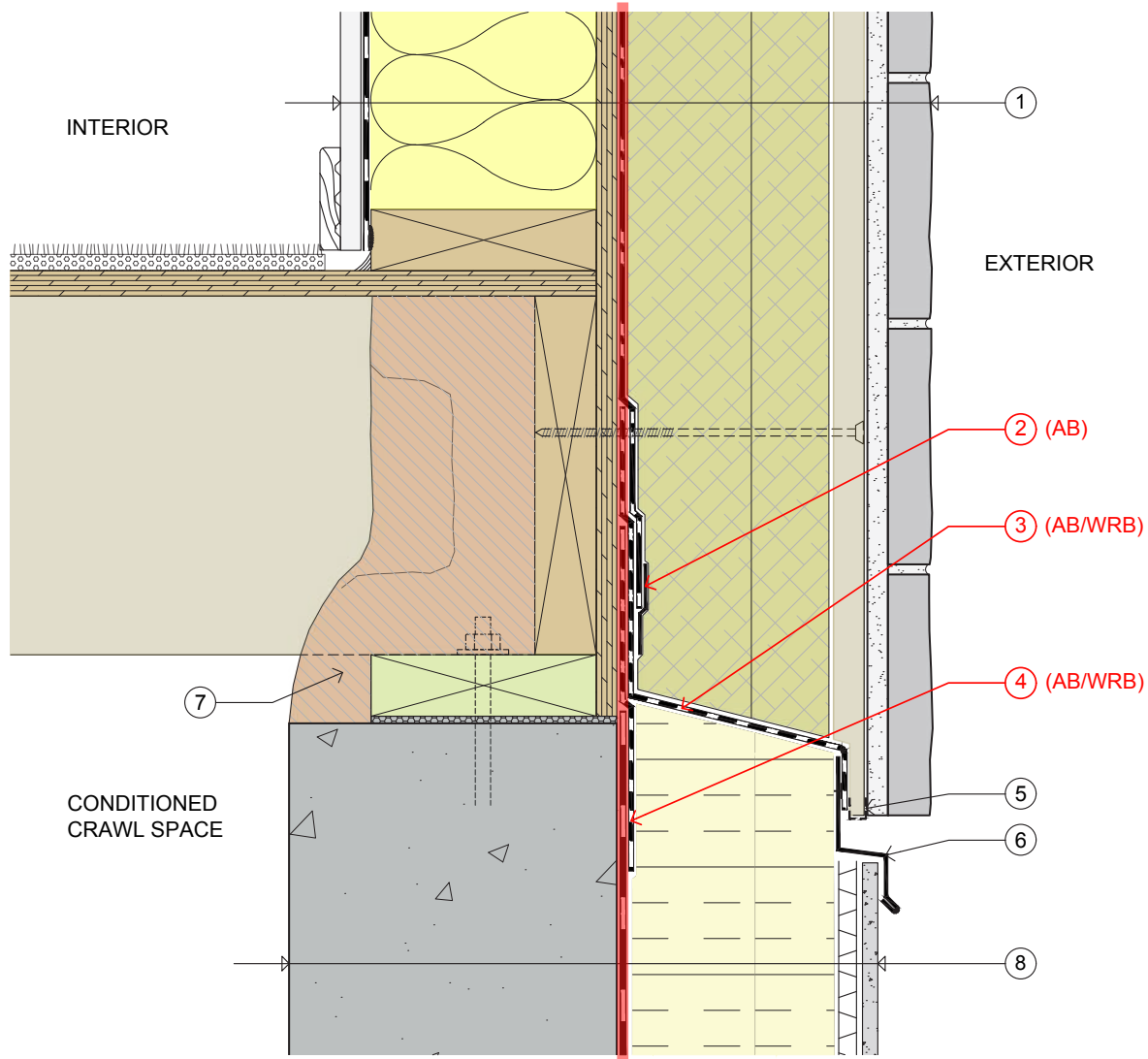


LEGEND

- ① Wall assembly
 - Plastic drain mat with integrated filter fabric
 - Exterior rigid board insulation, adhered in place
 - Below grade dampproofing membrane (AB)
 - Concrete foundation wall (AB)
- ② Cover board exterior finish for above grade
- ③ Continuous sealant between vapour barrier poly and concrete foundation wall (AB/RB)
- ④ Continuous high-performance tape for poly retention
- ⑤ Slab assembly:
 - Concrete screed slab
 - Vapour and radon barrier poly (AB/RB)
 - Rigid board insulation
 - Free draining clear crushed gravel

CRAWL SPACE CONCRETE SLAB AT FOUNDATION WALL | D2.01
EXTERIOR-INSULATED CONCRETE FOUNDATION

Detail 2.02 Crawl Space Foundation Wall at Above-Grade Wall – Exterior-Insulated Concrete Foundation

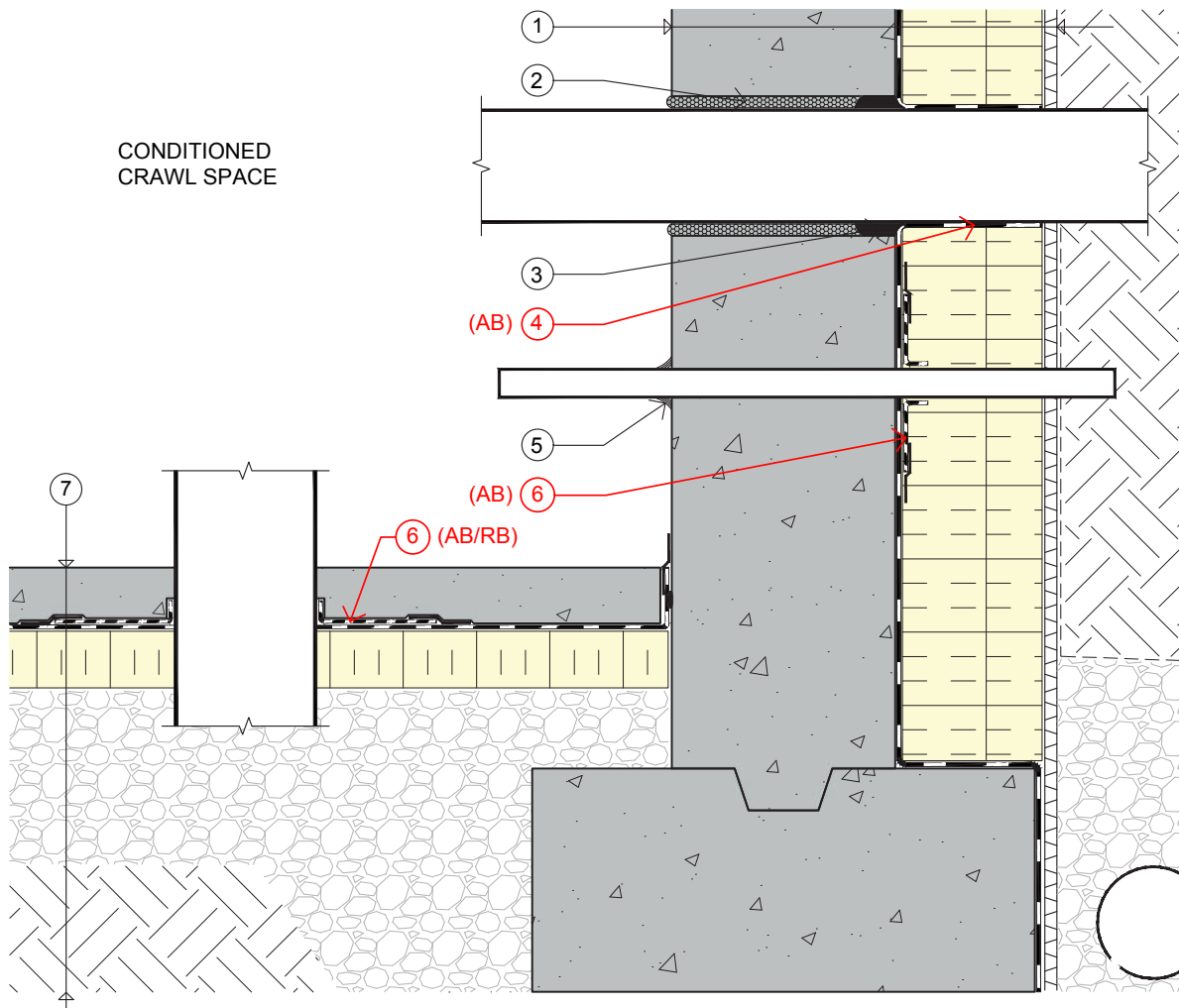


LEGEND

- | | |
|--|---|
| <p>① Above-grade wall assembly with exterior air barrier (AB)</p> <p>② Tape seal (AB)</p> <p>③ Self-adhesive through-wall membrane (AB/WRB)</p> <p>④ Self-adhesive transition membrane (AB/WRB)</p> <p>⑤ Insect screen</p> <p>⑥ Pre-finished metal flashing</p> <p>⑦ Spray foam or batt and poly</p> | <p>⑧ Wall assembly</p> <ul style="list-style-type: none"> • Cover board exterior finish • Plastic drain mat with integrated filter fabric • Exterior rigid board insulation, adhered in place • Below grade dampproofing membrane (AB) • Concrete foundation wall (AB) |
|--|---|

CRAWL SPACE FOUNDATION WALL AT ABOVE-GRADE WALL | D2.02
EXTERIOR-INSULATED CONCRETE FOUNDATION

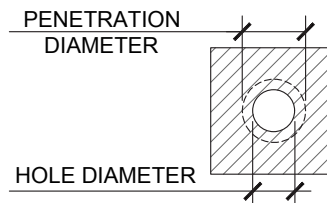
Detail 2.03 Penetrations Through Crawl Space Foundation Wall – Exterior-Insulated Concrete Foundation



LEGEND

- ① Exterior-insulated crawl space concrete foundation wall assembly with below-grade dampproofing (AB)
- ② Spray foam insulation
- ③ Grout pack around penetration and into opening as needed for over-size holes
- ④ Dampproofing membrane around penetration per manufacturer's requirements (AB)
- ⑤ Interior cover sealant around penetration
- ⑥ EPDM membrane gasket with under-sized hole to compress around penetrating element and continuous high-performance tape or compatible dampproofing around perimeter (AB/RB)
- ⑦ Crawl space concrete screed slab assembly with vapour and radon barrier poly (AB/RB)

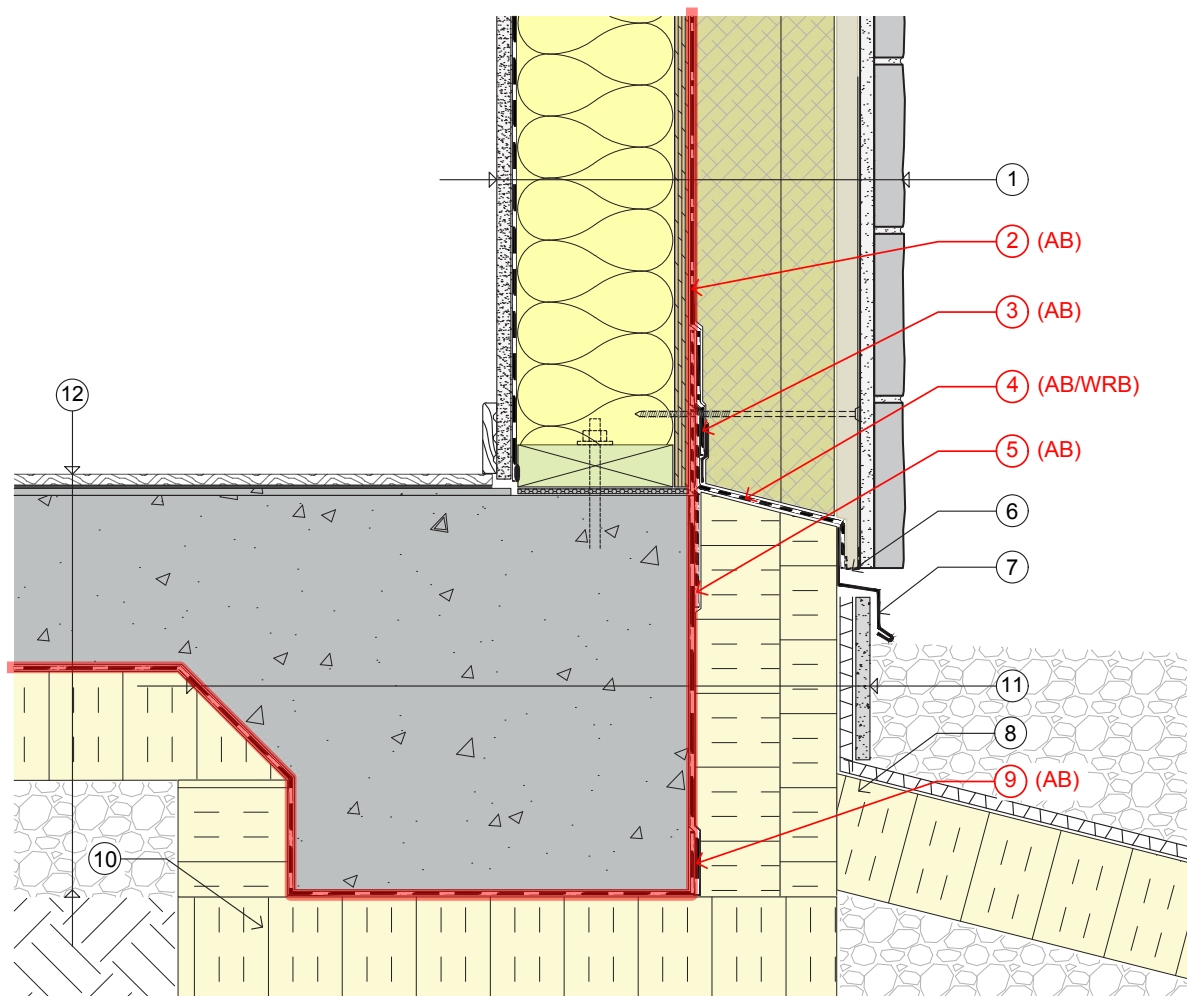
EPDM gasket hole sizing guide based on penetration diameter



- ≤ 1 in, hole dia. ≈ 40% of penetration
- > 1 in to ≤ 3.5 in, hole dia. ≈ 60% of penetration
- > 3.5 in, hole dia. = penetration dia. minus 1.5"

PENETRATIONS THROUGH CRAWL SPACE FOUNDATION | D2.03 EXTERIOR-INSULATED CONCRETE FOUNDATION

Detail 2.04 At-Grade Slab at Above-Grade Wall – Exterior-Insulated Concrete Slab Foundation

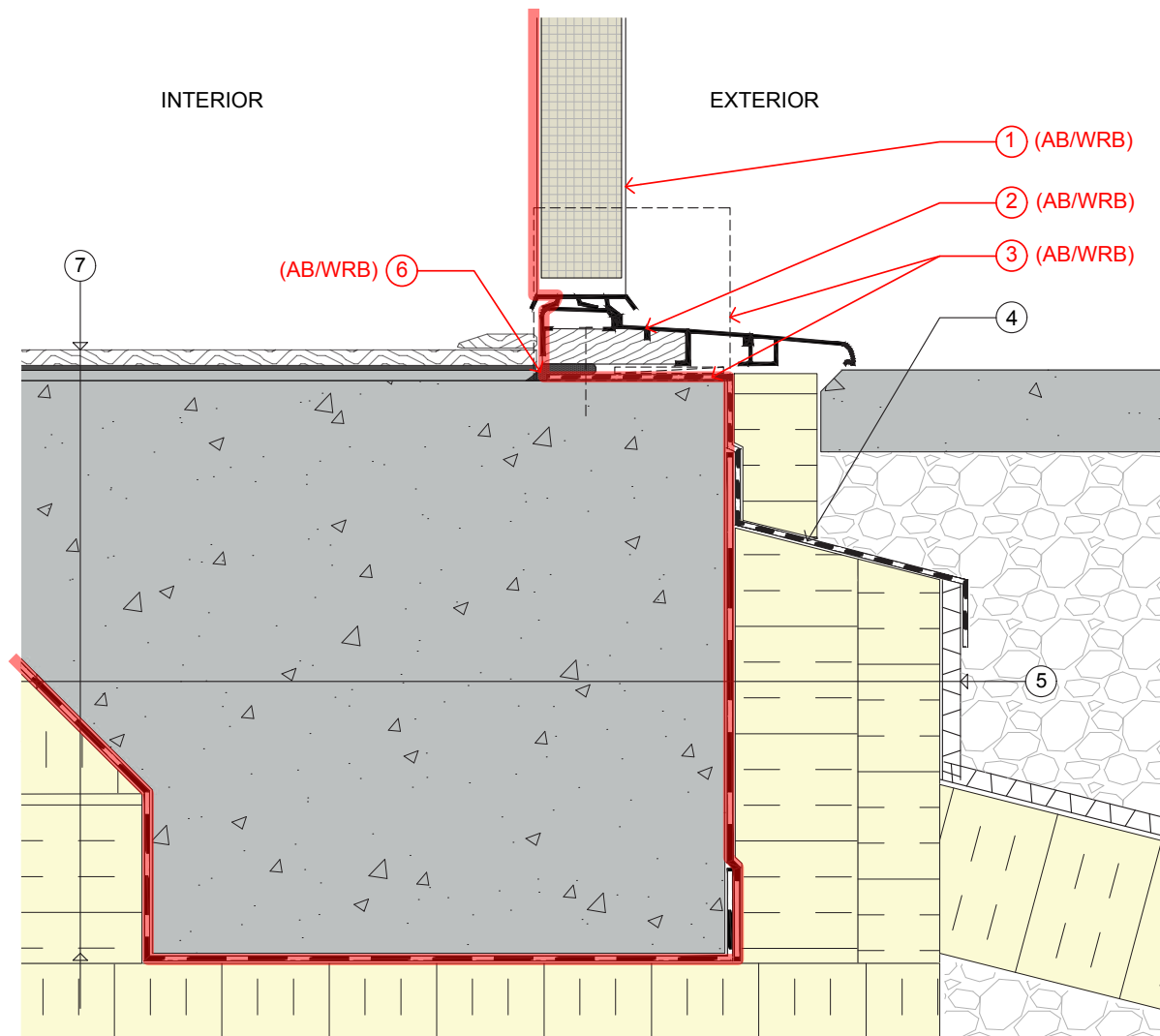


LEGEND

- | | |
|---|--|
| ① Above-grade wall assembly with exterior air barrier (AB) | ⑩ High compression strength foam board insulation under slab footing |
| ② VP sheathing membrane (AB) | ⑪ Slab footing assembly |
| ③ Tape seal (AB) | • Cover board exterior finish |
| ④ Self-adhesive through-wall membrane (AB/WRB) | • Plastic drain mat with integrated filter fabric |
| ⑤ Self-adhesive transition membrane (AB) | • Rigid board insulation |
| ⑥ Insect screen | • Below grade dampproofing membrane (AB) |
| ⑦ Pre-finished metal flashing | • Concrete structural slab footing (AB) |
| ⑧ Rigid board skirt insulation sloped to exterior | ⑫ Slab assembly |
| ⑨ Dampproofing membrane lapped and sealed to slab poly (AB) | • Interior floor finish |
| | • Concrete structural slab on grade |
| | • Vapour and radon barrier poly (AB/RB) |
| | • High compression strength foam insulation |
| | • Free draining clear crushed gravel |

AT GRADE SLAB AT ABOVE-GRADE WALL | D2.04
EXTERIOR-INSULATED CONCRETE SLAB FOUNDATION

Detail 2.05 Foundation Slab at Grade Entry Door – Exterior-Insulated Concrete Slab Foundation

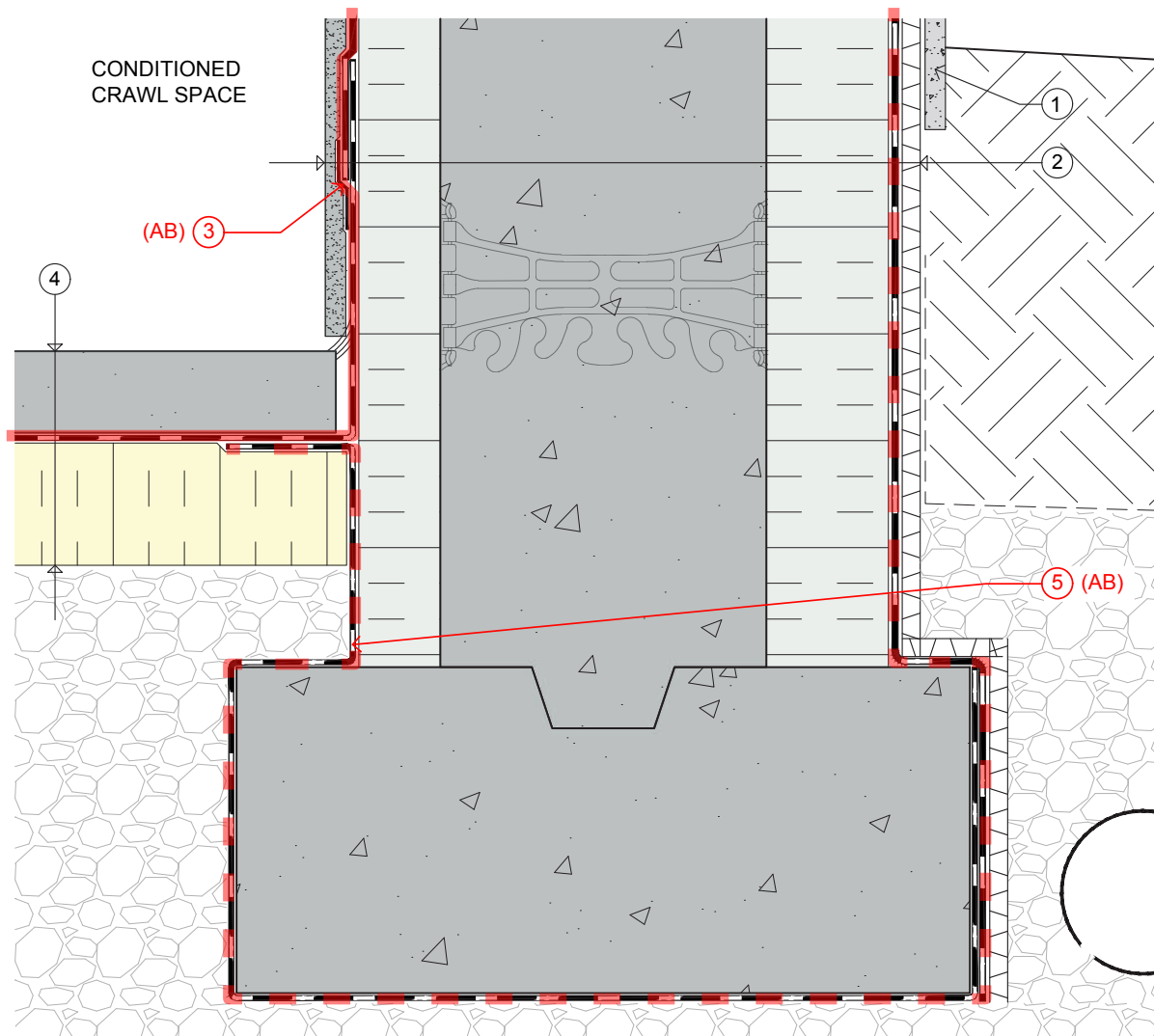


LEGEND

- ① NAFS-rated entry door (AB/WRB)
- ② Door threshold with 2" sill extender set on shims (AB/WRB)
- ③ Self-adhesive dampproofing membrane on slab and below-grade dampproofing and minimum 4" up jambs (AB/WRB)
- ④ Self-adhesive dampproofing membrane over sloped below-grade rigid board insulation and drain mat
- ⑤ Exterior-insulated structural slab footing assembly with below-grade dampproofing (AB)
- ⑥ Continuous sealant between self-adhesive membrane and door threshold (AB/WRB)
- ⑦ Exterior-insulated structural slab assembly with vapour/radon barrier poly (AB/RB)

SLAB AT GRADE ENTRY DOOR | D2.05
EXTERIOR-INSULATED CONCRETE SLAB FOUNDATION

Detail 2.06 Crawl Space Concrete Slab at Foundation Wall – ICF Concrete Foundation

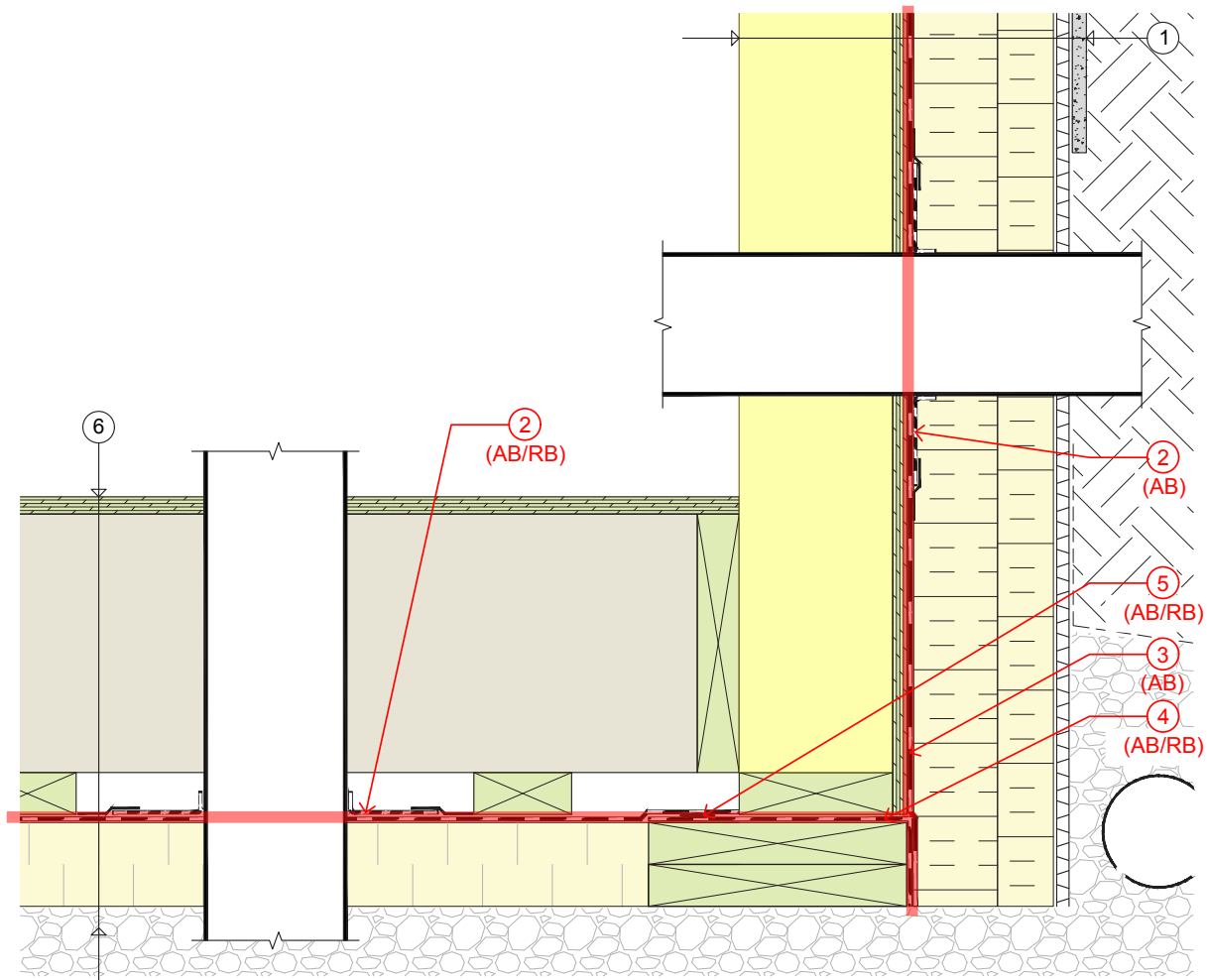


LEGEND

- | | |
|--|--|
| <p>① Cover board exterior finish</p> <p>② Wall assembly</p> <ul style="list-style-type: none"> • Plastic drain mat with integrated filter fabric • Below grade dampproofing membrane • Concrete wall with ICF insulation • VP sheathing membrane (AB) • Interior gypsum wall board (optional) <p>③ Continuous tape between slab poly and wall sheathing membrane (AB)</p> | <p>④ Slab assembly:</p> <ul style="list-style-type: none"> • Concrete screed slab • Vapour and radon barrier poly (AB/RB) • Rigid board insulation • Free draining clear crushed gravel <p>⑤ Optional continuous dampproofing membrane around footing to provide alternative air barrier transition between slab poly and exterior membrane (AB)</p> |
|--|--|

CRAWL SPACE CONCRETE SLAB AT FOUNDATION WALL | D2.06
ICF CONCRETE FOUNDATION

Detail 2.07 PWF Crawl Space Floor at PWF Wall with Penetrations – Crawl Space Permanent Wood Foundation



LEGEND

- | | |
|--|---|
| <p>① PWF crawl space wall assembly</p> <ul style="list-style-type: none"> • Cover board exterior finish (above grade portions) • Plastic drain mat with integrated filter fabric • Exterior rigid board insulation adhered in place • Self-adhesive below grade dampproofing membrane (AB) • Pressure treated plywood sheathing and framing per CSA S406 <p>② EPDM membrane gasket with under-sized hole to compress around penetrating element and continuous high-performance tape or compatible dampproofing around perimeter - see D2.03 (AB/RB)</p> <p>③ Self-adhesive below-grade dampproofing membrane adhered to footing prestrip membrane (AB)</p> | <p>④ Self-adhesive vapour barrier prestrip membrane on top and exterior face of PWF footing (AB/RB)</p> <p>⑤ Continuous sealant between vapour barrier poly and footing self-adhesive prestrip membrane (AB/RB)</p> <p>⑥ PWF crawl space floor assembly</p> <ul style="list-style-type: none"> • Pressure treated sheathing, framing, and sleepers per CSA S406 • Vapour and radon barrier poly membrane (AB/RB) • Exterior rigid board insulation • Clear crushed gravel |
|--|---|

PWF CRAWL SPACE FLOOR AT PWF WALL W/ PENETRATIONS | D2.07
CRAWL SPACE PERMANENT WOOD FOUNDATION ASSEMBLIES

Glossary

Air control layer	The control layer designed to resist the flow of air through the building enclosure. Also referred to as the air barrier system.
Air leakage	Uncontrolled airflow through openings in the building enclosure.
Air permeance	The degree to which a material allows air to flow through it.
Clear crushed gravel	Free-draining, washed aggregate composed of crushed stone with little to no fine particles.
Vapour control layer (vapour barrier / vapour retarder)	The control layer that manages the diffusion of water vapour through materials and resists movement of water vapour across the enclosure.
Vapour diffusion	The movement of water vapour through a material.
Water control layer	The innermost boundary against liquid water intrusion.
Dampproofing	Water-resistive coating or membrane applied to below-grade foundation surfaces to limit the passage of moisture where hydrostatic pressure is not anticipated.
Groundwater table	Refers to the interface between partially and fully saturated soil, below which hydrostatic forces would be exerted on a below-grade structure. As distinct from “ground water” which is moisture in soil and subsurface drainage pathways.
Water load	The liquid water the enclosure manages, including precipitation, runoff, groundwater, and ice melt.
Water-shedding surface (WSS)	The outer surface of the building enclosure that deflects most exterior precipitation away from inner layers.
Thermal control layer	The control layer designed to primarily resist heat flow through the building enclosure.
Radon barrier	Continuous membrane installed within a building assembly to limit the entry of radon gas from the ground into the occupied space. It is typically integrated with a sub-slab depressurization or venting system where required.
R-value / RSI value	The measure of the thermal resistance of a material or assembly of materials.
Penetration	Any intentional opening through an assembly to allow ducts, wires, pipes, or fasteners to pass.
Condensation	The change of water vapour to liquid water.
Continuity (of control layers)	Control layers that span across different material types, transitions, interfaces, and joints without breaks.

Notes



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Developed by Natural Resources Canada's Local Energy Efficiency Partnerships (LEEP) team

LEEP Technology Guides and Tools available online. Search "NRCan LEEP".

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