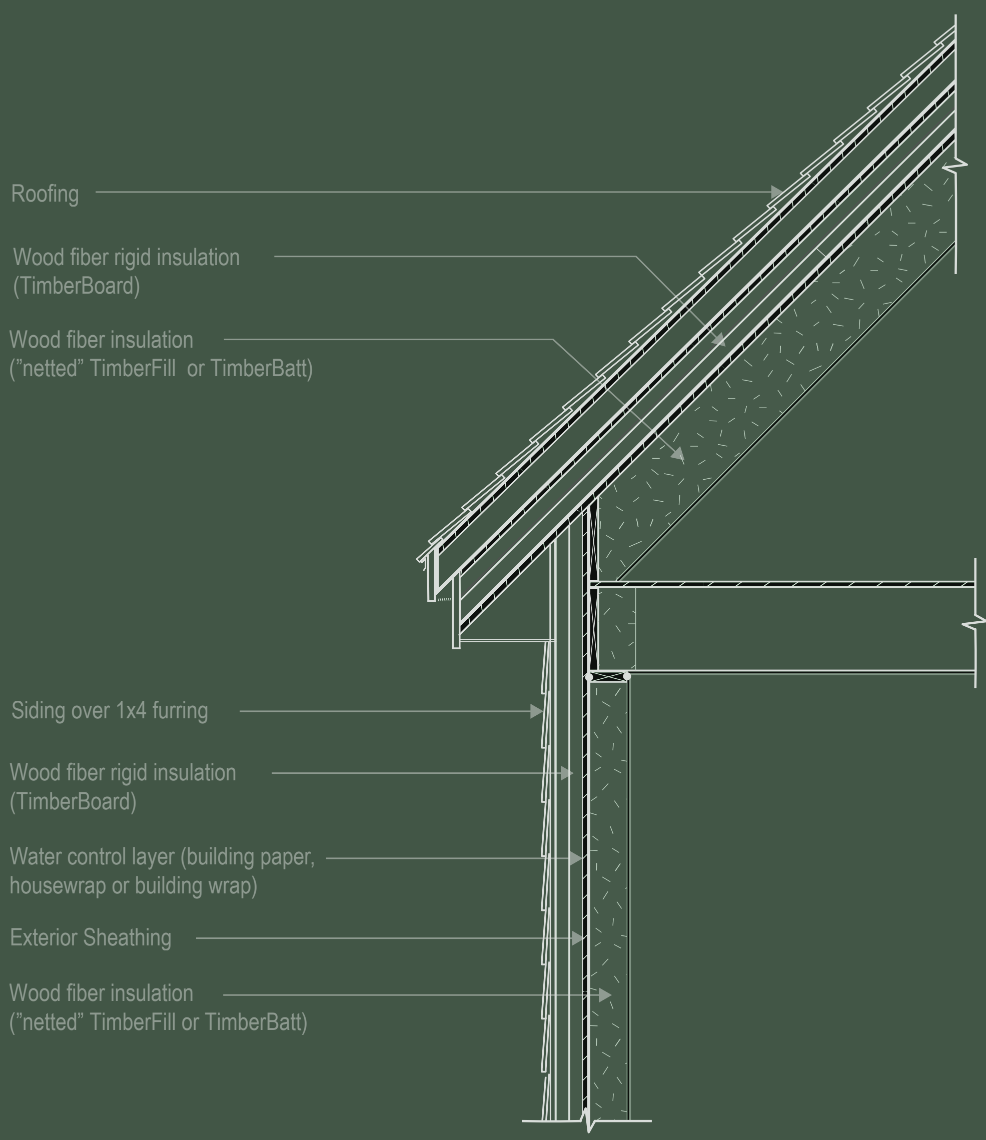
TimberHP's Guide for Builders

Roof and Wall Details and Best Practices for Building Better



April 2024 - V 02

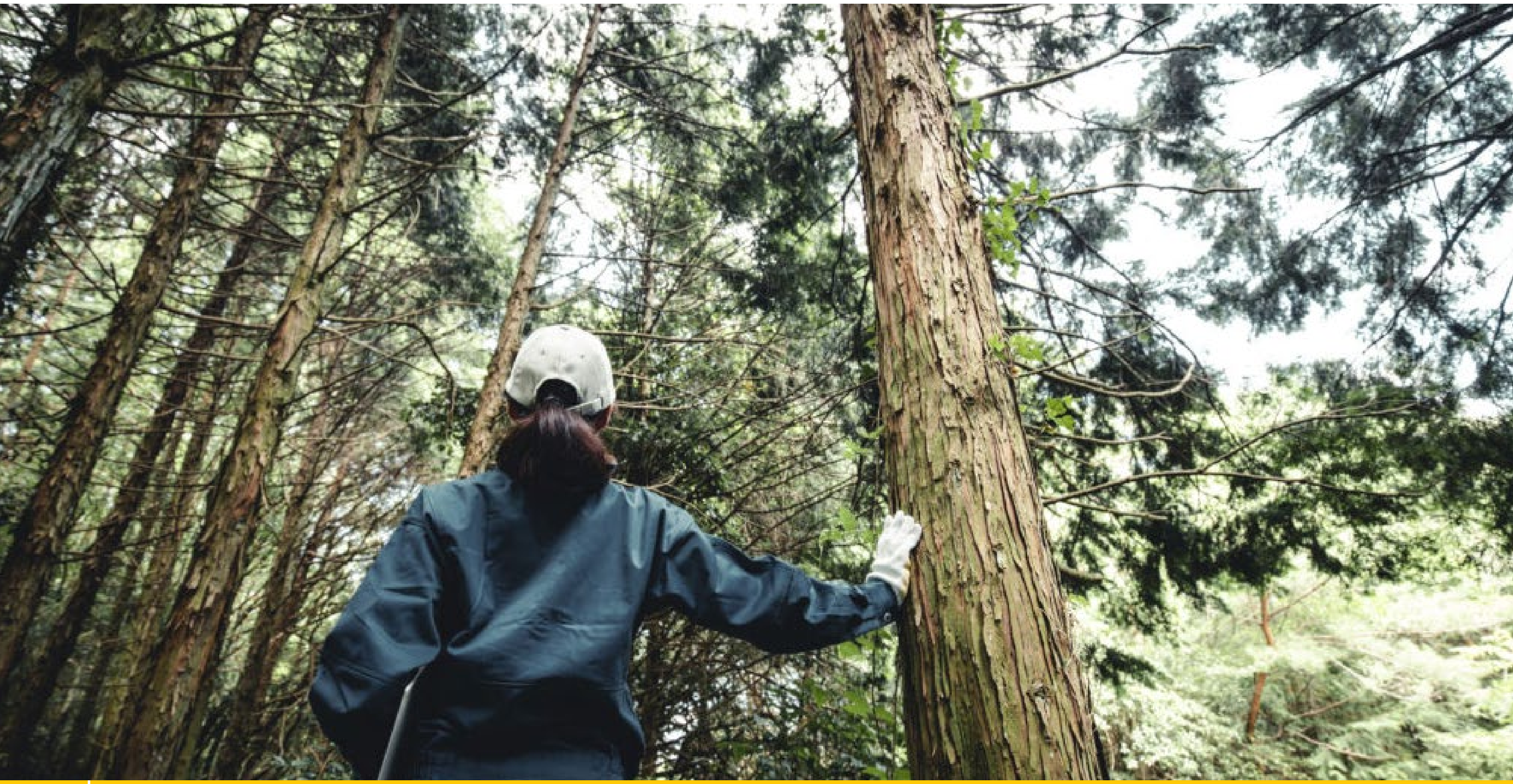
INSULATE BETTER. LIVE BETTER. ™

Disclaimer: Note that these drawings are diagrammatic and are not intended for direct use. A professional architect, engineer or builder must evaluate and customize per specific job and building code requirements.

This document is applicable in conjunction with other TimberHP documentation. Please heed our detailed application notes in your application. National building regulations must be complied with. Information on and suitability of the material for the intended purpose must in each case be examined by the customer. TimberHP® accepts no liability. This also applies to printing errors and subsequent amendments to technical data. REV 3-2024

TimberHP
1 Main Street
Madison, Maine 04950
1-855-755-1359

www.timberhp.com



Contents

Preface

TimberHP's line of blown-in, batt, and board insulations originate from softwood chips left over from lumber production. TimberFill, TimberBatt, and TimberBoard can stand alone as drop-in replacements for other above-grade insulation products; or they can work together to satisfy all cavity and continuous needs for a complete solution. Wood fiber insulation allows the creation of resilient designs to achieve industry-leading thermal and acoustic potential while supporting healthy indoor air quality and addressing our impact on the environment. TimberHP products are renewable and recyclable, free of toxins and abrasive fibers, and arrive at the jobsite carbon negative.

Insulate Better. Live Better.

A TimberFill

Loose fill and dense pack insulation for attics and stud cavities

B TimberBatt

Wall cavities, rafters, attics, floors, and interior partitions

C TimberBoard

Continuous insulation to reduce thermal bridging and sound transfer

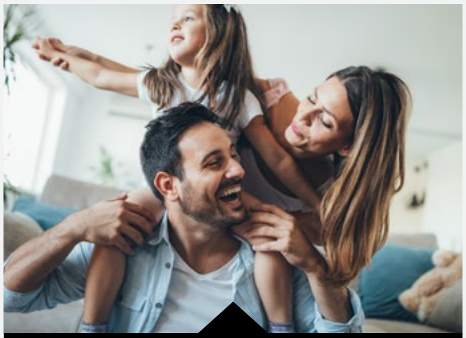
TIMBER + HP = High Performance / Healthy Planet / Healthy People

High Performance

Building envelope, thermal, and acoustic solutions
A comprehensive, above-grade product line to create wind-tight, vapor-open assemblies offering stable, long-term R-values, improved temperature stability, and premium sound protection

Healthy Planet

Renewable, non-toxic, and carbon negative
Made from residual wood chips to maximize the use of our renewable forest resource. As a high-value insulator with a negative carbon footprint, reduces a building's global warming potential on day one and everyday it operates



Healthy People

Moisture managing, safe, and sound absorbing
Installers benefit from the absence of dangerous fibers that harm skin and negatively impact air quality. Leads to the creation of safe, quiet indoor habitats, free of airborne toxins and trapped humidity

Insulation Solutions for Above-Grade Applications

TimberBoard

TimberBoard excels as a vapor open, continuous insulation (CI) with a stable R-value, high heat capacity, and high compressive strength. A combination of density and low conductivity protects against heat loss in the winter and provides exceptional buffering of summertime heat gain. Wood fiber continuous insulation meets residential fire standards and offers superior fire protection vs foam-based products. Wood fiber CI prevents the trapping of unwanted moisture within assemblies and offers the compressive strength required for efficient cladding installs.

Key Attributes

- Low thermal conductivity and high heat capacity—insulation for all seasons R-3.4 to 3.7/in
- 1-9.25” thicknesses. Square-edge 2’x4’; 2’x8’; and 4’x8’ sheets. Tongue and groove 2’x4’ and 2’x8’ sheets
- Windproof, water-resistant, vapor-open continuous insulation solution for walls and roofs
- Durable, easy to handle, cut and install
- ASTM E84 Class B <75 Flame <450 Smoke spread without additional flame retardants

TimberBatt

TimberBatt is a flexible, press-fit cavity insulation composed of refined wood fiber with added binders and flame retardant. Its dense, high R-value per inch helps achieve Grade I installations. It outperforms other batt products as a safe, convenient, thermal and acoustic solution. TimberBatt can increase room comfort by buffering and managing indoor humidity as well as unwanted moisture accumulation within walls.

Key Attributes

- Low thermal conductivity and high heat capacity—insulation for all seasons R-4/in
- Sized for 16”o.c. and 24”o.c.wood and steel cavities: 3”; 3.5”; 5.5”; 6” and 7.25” thicknesses
- Manages and redistributes moisture, borates protect against mold and mildew (ASTM C739)
- Durable, easy to handle, cut and install
- ASTM E84 Class A (<25 Flame <450 Smoke spread)

TimberFill

TimberFill offers exceptional and debris-free installs contractors appreciate, using the same machines and methods familiar to all fiber applications. Attic applications resist wind washing, and full-fill wall applications eliminate convective loops. Closed cavity applications can be installed at lower densities without risk of settling, resulting in cost and time savings, as well as exceptional sound and airflow reductions.

Key Attributes

- Low thermal conductivity and high heat capacity—insulation for all seasons
- R-60 attic: ~12 sq ft per 25# bag. 2x6 Wall: R-21 20 sq ft per 25# bag
- Manages and redistributes moisture, borates protect against mold and mildew (ASTM C739)
- Easy to handle and install
- ASTM E84 Class A (<25 Flame <450 Smoke spread)

MADE IN USA

Wood Fiber Insulation, Made in America

Introduction

This guide focuses on residential and light commercial construction using TimberHP products and systems, however, the principles and physics apply to all types of construction. In specific cases, especially with TimberBoard applications, a design professional should be consulted. Dry-process wood fiber insulation is new to North America. Building codes need to be updated to recognize wood fiber insulation applications. As TimberHP looks to innovate and expand TimberBoard, please, understand that some designs in this guide will require specific Board lines possibly still under development. The information in this guide is intended to be compliant with the International Residential Code (IRC) most recent edition (2021) and the International Building Code (IBC) most recent edition (2021). In all cases, the authority having jurisdiction should be consulted prior to using the information in this guide for code compliance purposes.

The guide contains two sections: Part I – Principles and Part II – Practices. The principles and associated physics form the basis for the specific construction details and methods presented in the second section – the practices part of the guide.

Additional TimberHP product information and web links are contained in the Appendices.

Part I - Principles

1.0 What is a Building?

The basic requirement for buildings is to create an indoor environment different from the outdoors. In this regard, buildings are environmental separators. They allow the regulation of temperature, air movement, humidity, rain, snow, light, dust, odors, noise, vibrations, insects and vermin. They must accomplish this in a safe, healthy and durable manner.

In order to function as an environmental separator the following must be met:

- control of heat flow
- control of airflow
- control of water vapor flow
- control of rain
- control of ground water
- control of light and solar radiation
- control of noise and vibrations
- control of contaminants, environmental hazards and odors
- control of insects, rodents and vermin
- control of fire
- provide strength and rigidity
- be durable
- be aesthetically pleasing
- be economical

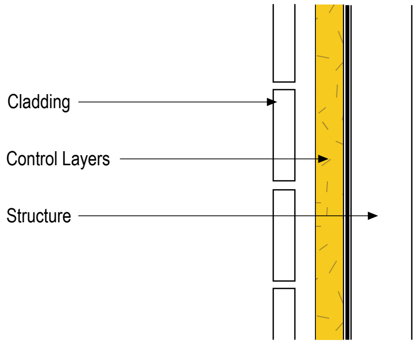
Control of heat flow, airflow, water vapor flow, rain and ground water are hygrothermal factors that are key to providing a durable enclosure. The hygrothermal factors are controlled with four principal control layers: a water control layer, an air control layer, a vapor control layer and a thermal control layer. Each control layer will be discussed in the following sections.

1.1 Control Layers

The building enclosure or building envelope must have four principal control layers as overlays to the structure. They are presented in order of importance and each will be discussed in the order of importance:

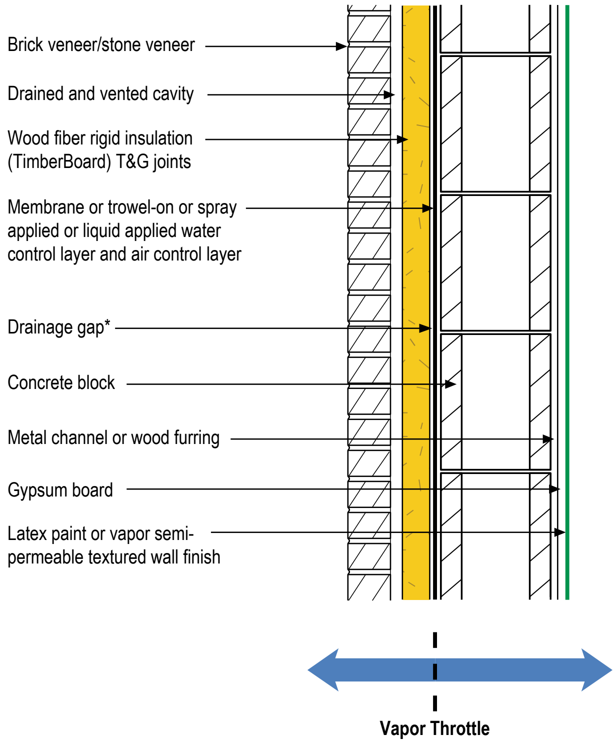
- water control layer
- air control layer
- vapor control layer
- thermal control layer

Figure 1.1
Ideal control layer configuration

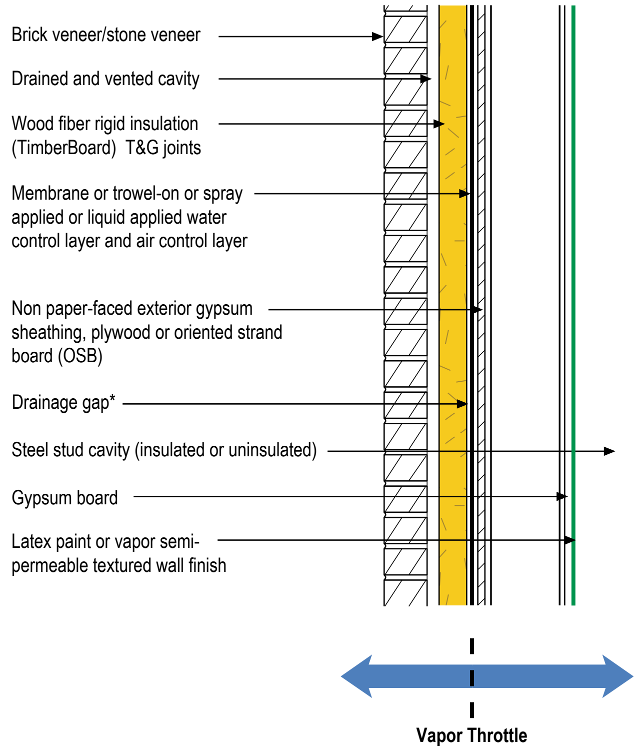


The best place for the control layers is to locate them on the outside of the structure in order to protect the structure. The optimum configuration is presented in Figure 1.1 However, many configurations are possible for wood frame, steel frame and concrete assemblies. The most common examples of configurations of control layers are presented in Figure 1.2 for concrete, steel frame and wood frame assemblies. Additional wood frame assemblies control layer options are presented in Figure 1.3. Please note the need for a 1/16" capillary break or drainage gap between TimberBoard and vapor throttle (control layer) in the referenced figures.

Concrete Assembly



Steel Frame Assembly



Wood Frame Assembly

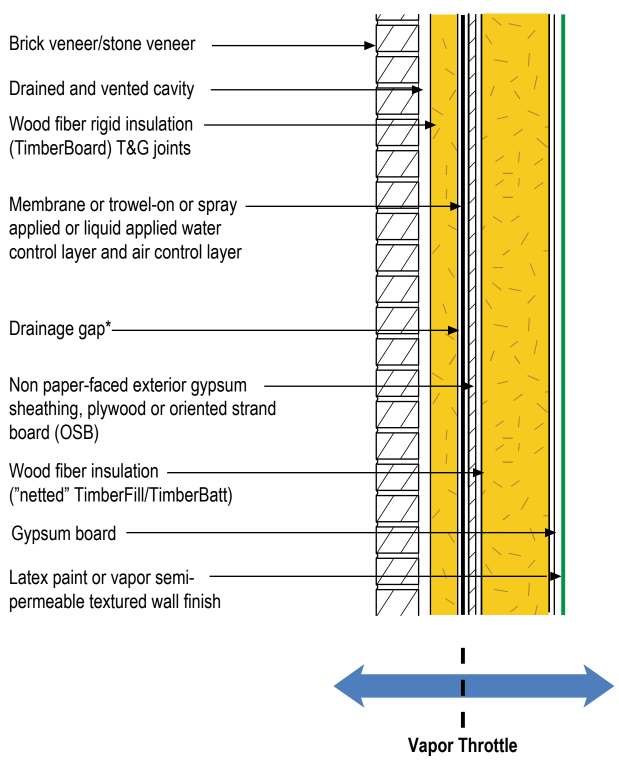


Figure 1.2
Concrete, steel, and wood framed assemblies.
Note the drainage gap required in each assembly. This 1/16" gap can be done with a textured impression on some versions of TimberBoard or with a textured WRB

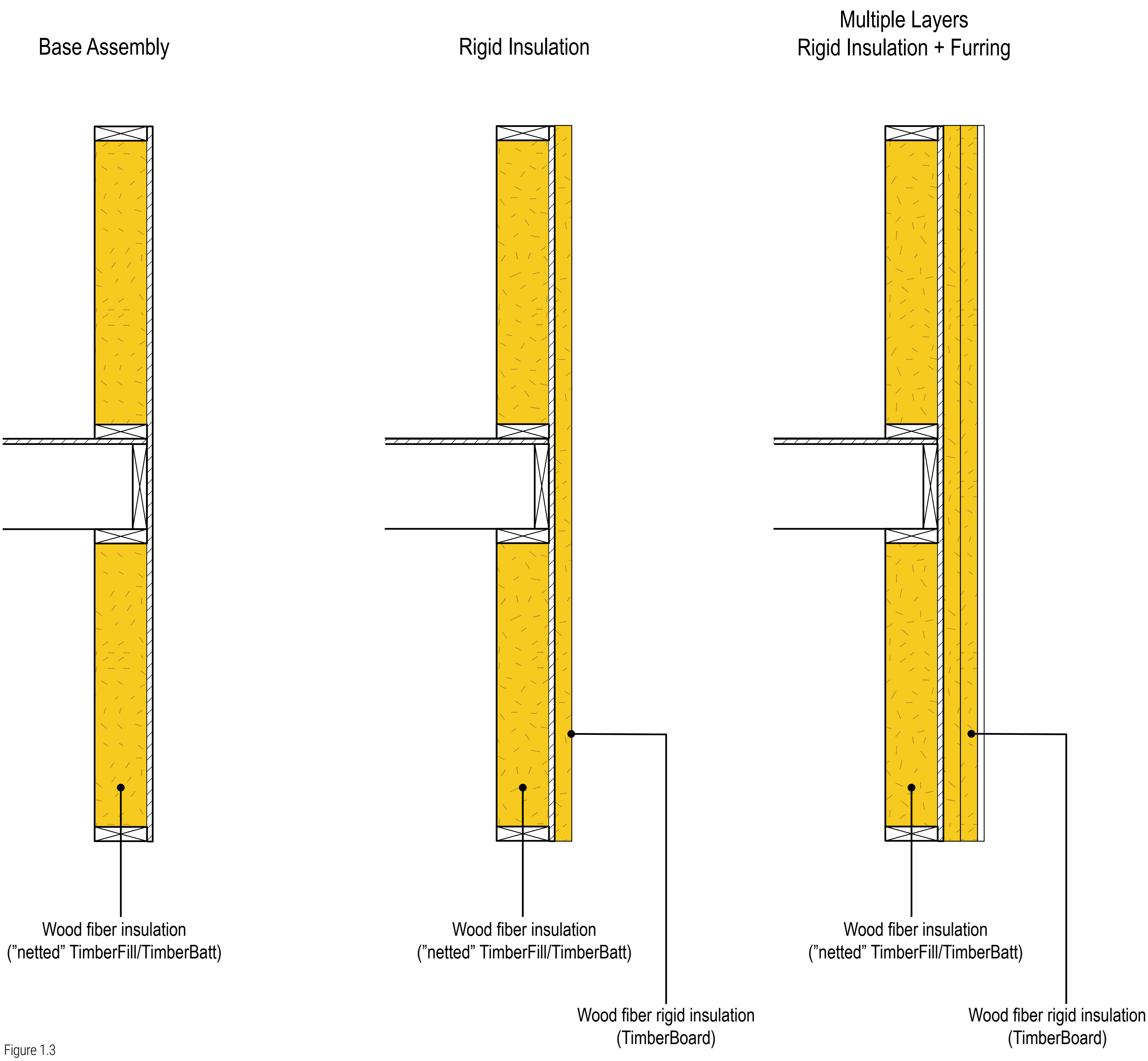
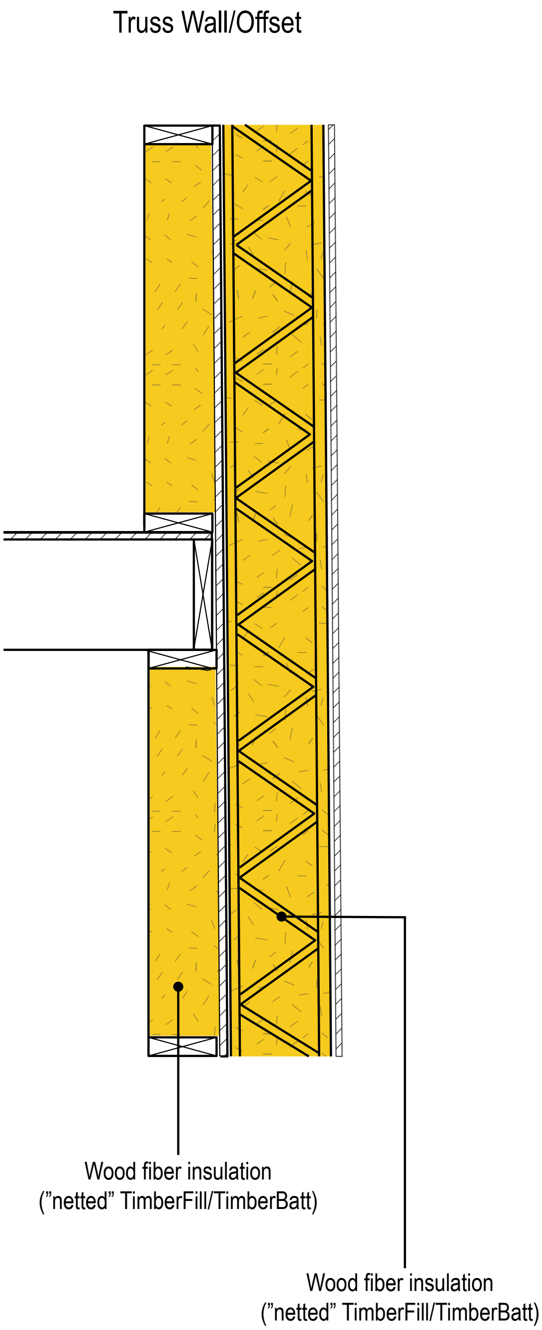


Figure 1.3
Additional wood frame assemblies control layer options



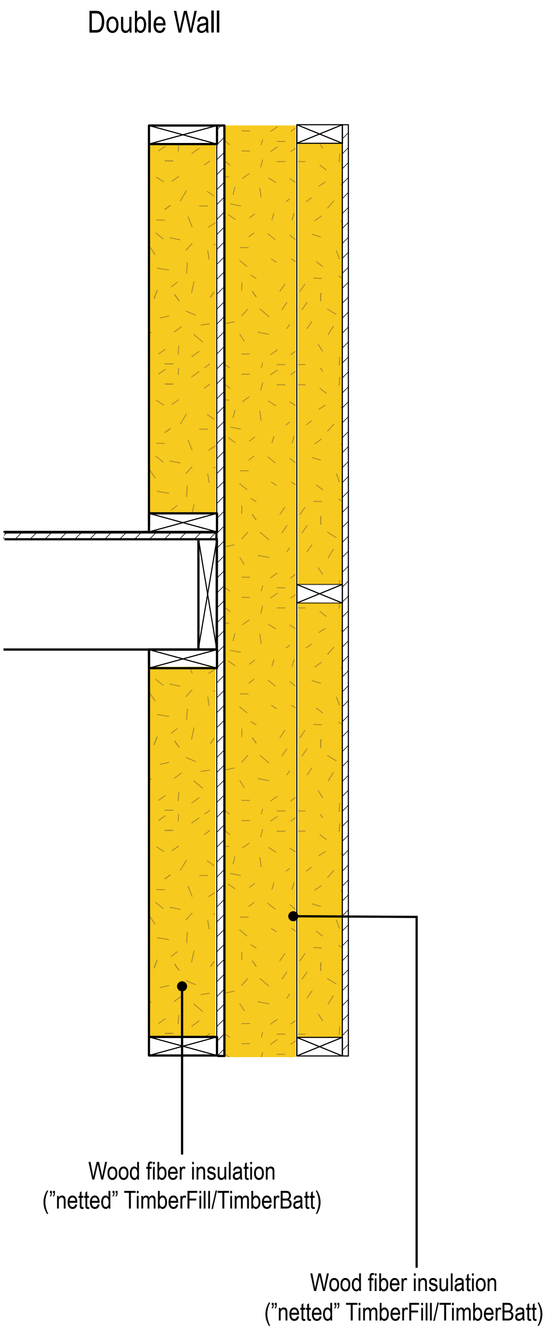


Figure 1.3
Additional wood frame assemblies control layer options

The most important factor to consider when dealing with control layers is their continuity. Figure 1.4, Figure 1.5, Figure 1.6 and Figure 1.7 show that these control layers need to be continuous around the entire perimeter of the building enclosure.

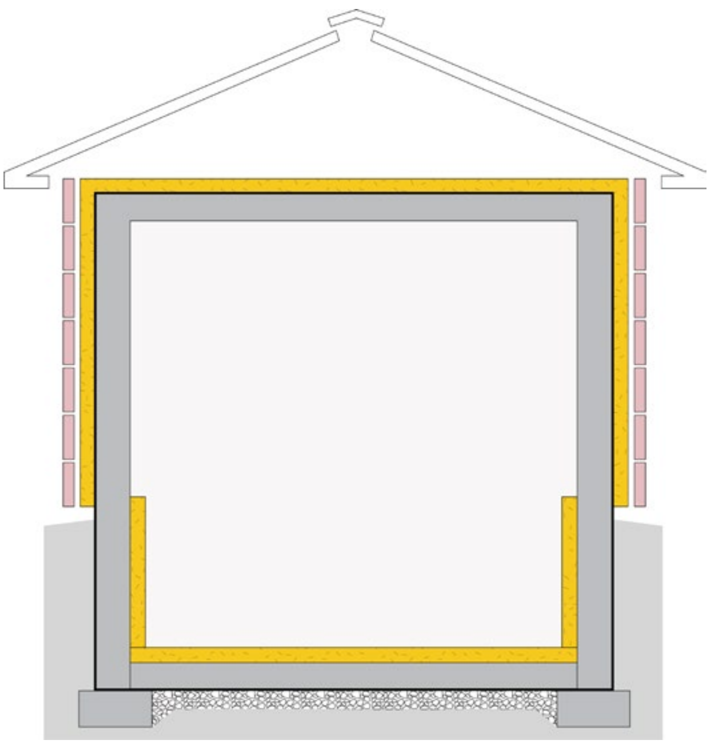


Figure 1.4
Control layer alignment with a flat attic. Note: below grade layers are interior and extend past the exterior layer

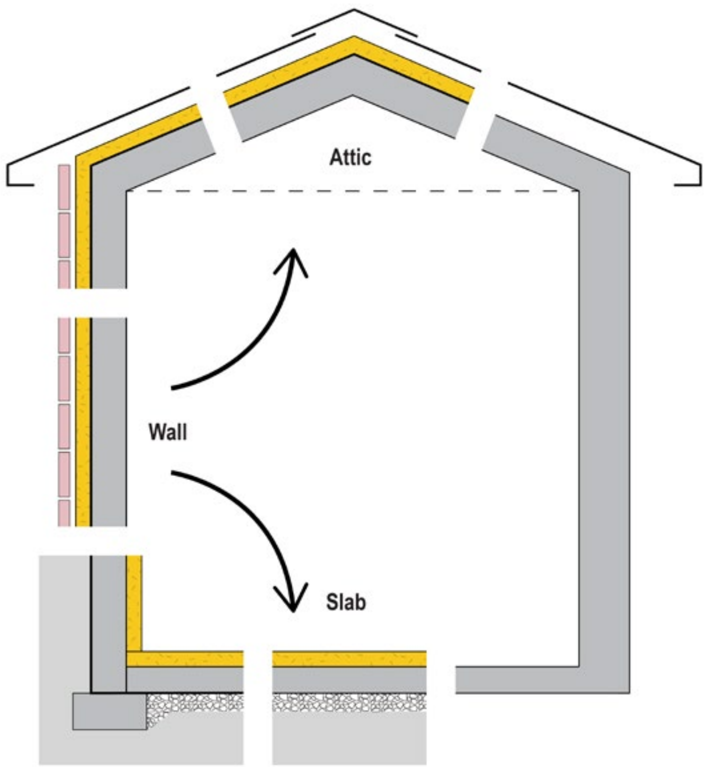


Figure 1.5
Control layer alignment with a vented roof assembly

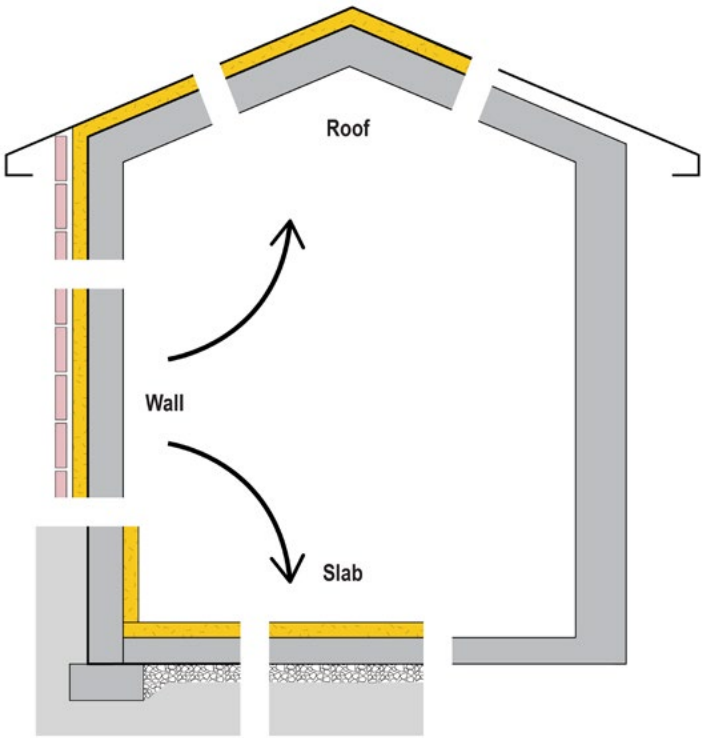


Figure 1.6
Control layer alignment: unvented roof

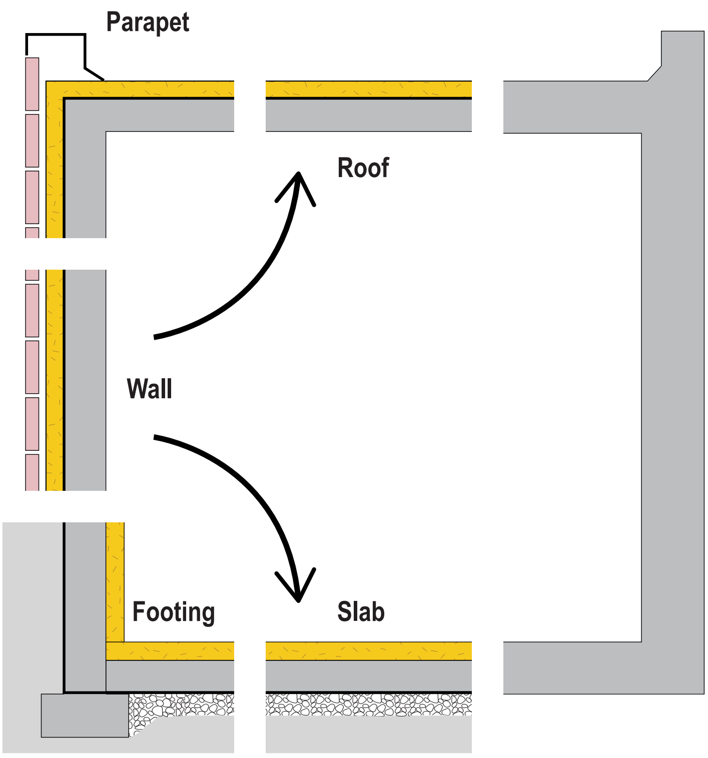


Figure 1.7
Control layer alignment: flat roof

1.2 Water Control Layer

Controlling rain and ground water is the single most important factor in the design and construction of durable buildings. Water control layers are used in the design and construction of building enclosures to control rain and ground water.

All exterior claddings pass some rainwater. Siding leaks, brick leaks, stucco leaks and stone leaks. As such, some control of this penetrating rainwater is required. In most walls, this penetrating rainwater is controlled by a water control layer that directs the penetrating water downwards and outwards.

Water control layers are water repellent materials (sheet membranes and liquid applied coatings) that are located behind the cladding and are designed and constructed to drain water that passes through the cladding. They are interconnected with flashings, window and door openings, and other penetrations of the building enclosure to provide drainage of water to the exterior of the building. The materials that form the water control layer overlap each other shingle fashion or are sealed so that water drains down and out of the wall. The water control layer is often referred to as the "drainage plane" or "water resistant barrier" or WRB.

Water control layers can be created by sealing or layering water resistant sheathings. Water control layers can also be created using fully adhered sheet membranes, or trowel, paint and spray applied coatings applied over sheathings such a plywood, OSB, non-paper-faced exterior gypsum sheathing or concrete block or cast concrete.

Water control layers can be vapor permeable or vapor impermeable depending on climate, location within the building enclosure or required control function.

1.3 Rain Control

The fundamental principle of rainwater control is to shed water by layering materials in such a way that water is directed downwards and outwards out of the building. The key to this fundamental principle is drainage.

Gravity is the driving force behind drainage. The "down" direction harnesses the force of gravity and the "out" direction gets the water away from the building enclosure assemblies, openings, components and materials. In general, the sooner water is directed out the better. Sooner, may not always be practical – such as at window openings where draining a window into a drainage space behind a cladding is often more practical than draining them to the exterior face of the cladding.

A "screen" or "cladding" is installed over the exterior elements of the building enclosure elements to provide aesthetics, rain water control and to provide protection from ultra-violet radiation and mechanical damage. UV protection is also necessary for TimberBoard. In gapped siding, the exterior board insulation should be covered with a dark membrane to prevent long term exposure. Drainage occurs behind the cladding and on the exterior of the water control layer.

Exterior wood fiber rigid insulation (TimberBoard) can act as an effective (secondary) control layer by virtue of the T&G joints. The non T&G joints can be made continuous with mastic or tapes. This exterior wood fiber rigid insulation is additionally "drained" at its back textured surface where it intersects the primary water control layer. Additional drainage gaps can be provided by installing a draining building wrap (WRB) over the water control layer. Note that this draining building wrap is in addition to the water control layer – it does not replace the water control layer.

1.4 Drainage and Ventilation

In order for drainage to occur, a space must be provided between the cladding and the water control layer this could be a membrane or sheathing or TimberBoard in some applications. The width of this space varies depending on cladding type and function. This drainage space also provides ventilation and facilitates the redistribution and removal of absorbed water.

Effective drainage of rainwater can occur in drainage spaces as small as 1/16 to 1/8 inch (2 or 3 mm). Effective ventilation can occur in the drainage space if it is increased to ¼ inch (6 mm).

Some claddings act as reservoirs – materials that store water. When and if the reservoirs get wet, the stored water can migrate elsewhere and cause problems. The most common reservoir cladding is a brick veneer although wood siding, fiber cement siding and stone also can be significant reservoir claddings. TimberBoard can act as a reservoir as well. It manages moisture well because of this but should be integrated into designs that accommodate and excel at this.

"Back ventilating" a reservoir cladding or TimberBoard uncouples or disconnects the reservoir cladding from the rest of the wall assembly. The greater the reservoir, the greater the moisture load, and the greater the ventilation required. While not often a reservoir cladding, roof systems, given the exposure and higher bulk water load, will have impermeable layers to uncouple moisture from the interior structure. A reservoir cladding can also be uncoupled by providing a condensing surface such as an impermeable fully adhered sheet membrane or fluid applied layer that is also impermeable (i.e. also a vapor barrier). It is also possible to control the "inward vapor drive" from a reservoir cladding by "throttling" the flow with semi-permeable layers such as oriented strand board (OSB) sheathing and semi-permeable membranes and fluid applied layers.

Wood siding should be installed over a spacer strip or furring creating a drained (and vented) air space between the drainage plane and wood siding. Back priming wood siding and trim helps to uncouple a reservoir cladding from the rest of the assembly. Typical vinyl and aluminum siding profiles provide a functional drainage space and furring or a space strip is not necessary.

With stucco claddings a drainage mat is recommended to provide a clear continuous drainage space.

With brick veneers, the width of the drainage space is based more on tradition than physics. A 1-inch (25 mm) airspace is more-or-less the width of a mason's fingers, hence, the typical requirement for a 1-inch (25 mm) airspace. However, historical experience with stucco and other cladding systems show spaces as small as 1/16 inch (2 mm) drain. However larger spaces must be couples with a functional control layer.

1.5 Drain the Opening

Water control layers should be integrated with window and door openings as well as the windows and doors themselves.

The seal between a window or door component and the water control layer is rarely perfect – and even if it is perfect at the time of installation it certainly will not be perfect forever.

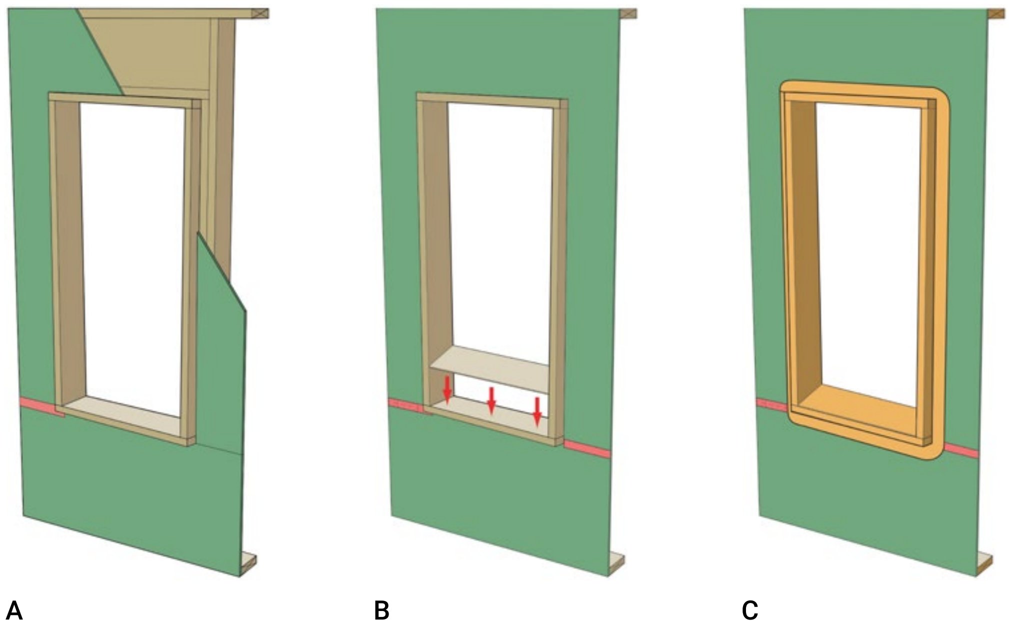


Figure 1.8
Installation sequence for an "outie" or flanged window additional description and detailing can be found in our install best practices. Refer to our technical library.

Furthermore, the window or door component within the opening is rarely perfect – it can and often does leak. This leakage should be managed in the same manner leakage is managed in the plane of the assembly - by drainage to the outside.

Window and door openings should be drained to the exterior using the same principles used in the design and construction of wall assemblies in general.

Pan flashings, membranes lining openings, precast sills with seats extending under window and door units, formable flashings and liquid applied flashings are all methods of providing drained openings.

These techniques allow for sealants to be installed imperfectly or for sealants to age without resulting in catastrophic failure of the assembly. A leak is not truly a leak if it leaks back to the exterior without wetting a water sensitive material. A common method for integrating windows is presented in the series of sequenced images presented in Figure 1.8.

To use a non-flanged window, consider using a 3/4" OSB Buck flashed back to the WRB. This will allow you to step the window into any desired position within the wall.

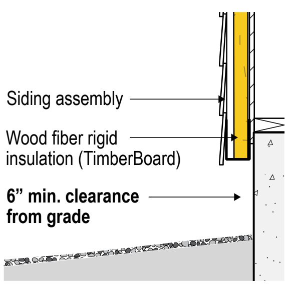
D E F G

1.6 Drain the Building Enclosure

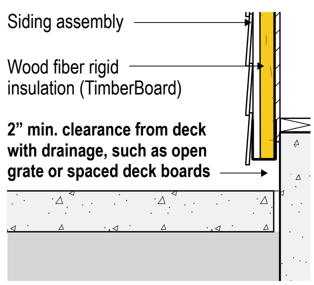
The water control layer and drainage logic should encompass the entire building enclosure. Deck, balcony and railing connections should be designed and constructed to shed or drain water to the exterior. Roof-wall connections and roof dormer connections should be designed and constructed to shed or drain water to the exterior. Garages, decks, and terraces should be sloped to the exterior and drained. And sites should be graded to shed or drain water away from building perimeters. And finally foundation assemblies should be designed and constructed to drain.

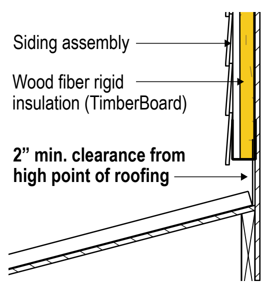
Where TimberBoard is used in exterior applications, proper clearances must be maintained to ensure the long-term durability of the insulation and the buildings on which they are installed. Failure to provide the proper clearances, as specified in figure 1.9 may affect performance of the building system or violate building codes. Check with a design professional and local building officials to ensure that the chosen details are correct for their intended purpose and location.

▼ Figure 1.9
Minimum clearances TimberBoard may need additional protections in these applications. Insect screening, flashing and WRB details can be found in our install guides.

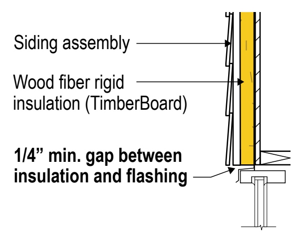


A 6 inch minimum clearance must be maintained between exterior TimberBoard siding assemblies and the ground.





A 2 inch minimum clearance must be maintained between exterior TimberBoard siding assemblies where they meet roofs, decks, paths, steps, driveways or any other solid surfaces.



A 1/4 inch minimum clearance is necessary between exterior TimberBoard assemblies and any horizontal flashing. Ensure that all horizontal flashing is positioned with a positive slope to encourage effective drainage and prevent trapping of bulk water.

1.7 Keeping the Groundwater and Contaminants Out of Foundations

The fundamentals of groundwater control date back to the time of the Romans: drain the site and drain the ground. Today that means collecting the run off from roofs and building surfaces using gutters and draining the water away from foundation perimeters. Roof and facade water should not saturate the ground beside foundations. Grade should slope away from building perimeters and an impermeable layer should cover the ground adjacent to buildings (Figure 1.10).

A free draining layer of backfill material or some other provision for drainage such as a drainage board or drainage mat should be used to direct penetrating groundwater downward to a perimeter drain. The perimeter drain should be located exterior to the foundation and wrapped completely in a geotextile ("filter fabric"). A crushed stone drainage layer under the basement slab should be connected through the footings to the perimeter drain to provide drainage redundancy and to provide a temporary reservoir for high groundwater loading during downpours if sump pumps fail during electrical outages (if gravity drainage to daylight is not possible).

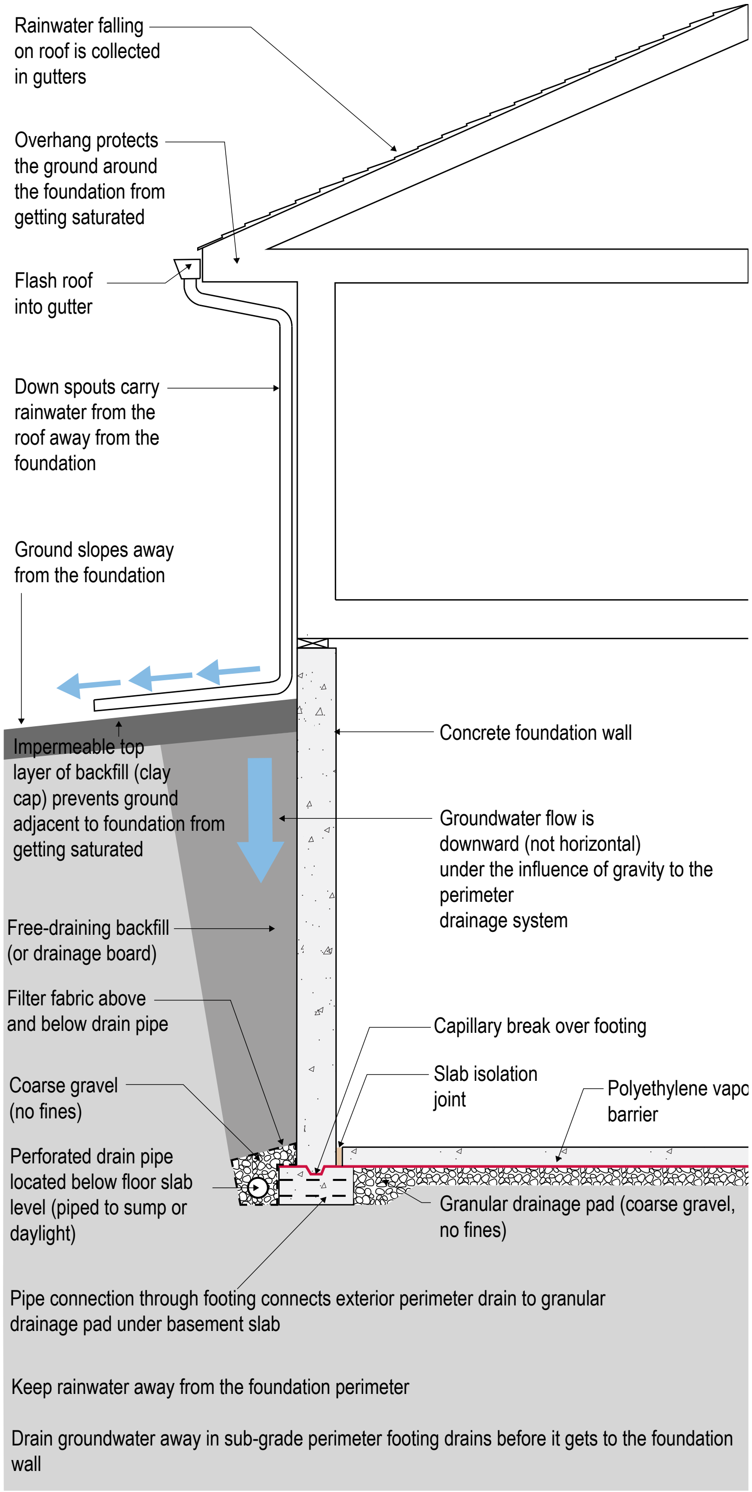


Figure 1.10
Groundwater management at and below grade

The basement wall should be damp-proofed and vapor-proofed on the exterior and a capillary break installed over the top of the footing to control “rising damp”. Damp-proofing and vapor-proofing in these locations is often provided by a fluid applied coating of bitumen. In the past, capillary breaks over footings were not common. They were not needed when basement perimeter walls were uninsulated and unfinished on the interior because these conditions permitted inward drying of the migrating moisture. For finished basements they are an important control mechanism. Without them, moisture constantly migrates through the foundation, and then into the interior insulation layer.

A capillary break and vapor barrier should also be located under concrete basement floor slabs. Crushed stone or coarse gravel acts as an effective capillary break and sheet polyethylene in direct contract with a concrete floor slab acts as an effective vapor barrier. The concrete slab should be sealed to the perimeter basement wall with sealant (the concrete slab becomes the air control layer or “air barrier” resisting the flow of soil gas).

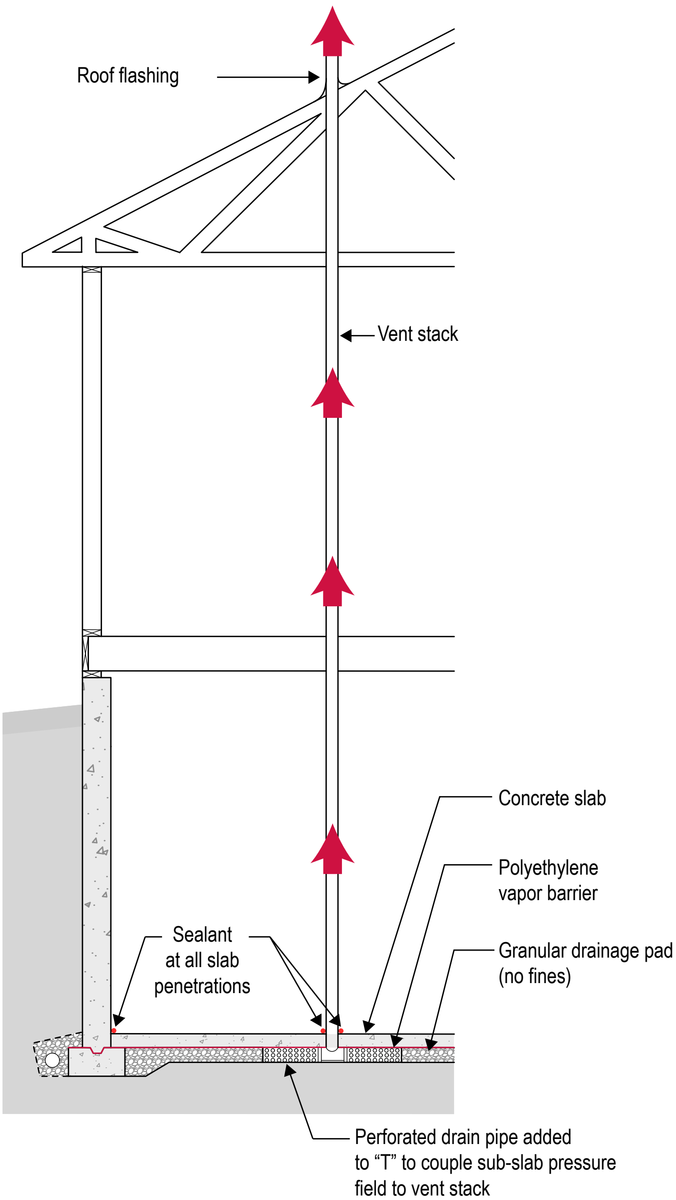


Figure 1.11
Mitigate soil gases by venting drainage layer

The crushed stone drainage layer under the basement concrete slab should be vented to the atmosphere to control soil gas (Figure 1.11). Atmospheric air pressure changes are on the order of several hundred Pascal's so that the soil gas vent stack is in essence a "pressure relief vent" or "soil gas bypass" to the atmosphere. Perforated pipe should be attached to the vent stack to extend the pressure field under the slab to the foundation perimeter and to the drainage layer outside the walls. Pipe connections through the footing extend the pressure field further to the exterior perimeter drain (as well as providing drainage redundancy as previously noted).

The traditional approach to basement water control has been to place the water control layer on the outside and then allow drying to the inside. Drainage, damp-proofing or water-proofing and vapor control layers have historically been located on the outside of basement perimeter walls and crushed stone layers and plastic vapor barriers have been located under concrete slabs. The operative principle has been to keep the liquid water out of the structure and locate vapor barriers on the outside – and allow inward drying to the basement space where moisture can be removed by ventilation or dehumidification.

Most interior insulation and finish systems are constructed with moisture sensitive materials (i.e. paper faced gypsum board) and are unable to tolerate even minor groundwater leakage, therefore requiring builders to be "perfect" in controlling groundwater – an impossible requirement. These systems also can prevent inward drying (i.e. when batt or blanket insulation is covered with plastic vapor barriers). This is an issue with moisture of construction, capillary rise and ground water leakage. To address the "impossible requirement" of "perfect" groundwater control and the moisture of construction, basement water control should allow inward drying.

Simply leaving off interior vapor barriers or vapor retarders will not avoid problems because interior water vapor will migrate outward from the basement conditioned space. Then it will condense on the interior surface of the foundation wall providing moisture for mold growth and other problems. Rather than installing a typical plastic vapor barrier that is always “impermeable” a “variable permeance vapor control layer” should be used (Figure 1.12). These layers are often referred to as “smart membranes”. Alternatively, acrylic latex paint installed over a standard latex primer over standard gypsum board also acts as a “variable permeance vapor control layer” (Figure 1.13). The interior “strapped wall” in both Figure 1.12 and Figure 1.13 acts as a “service chase” to facilitate wiring, plumbing and other services avoiding penetrating the membrane or sheet variable permeance vapor control layer allowing it to also act as an air control layer.

The structural elements of below-grade walls are cold (concrete is in direct contact with the ground) – especially when insulated on the interior. The main problem with below-grade walls comes during the summer when warm moist air comes in contact with basement cold surfaces that are below the dewpoint of the interior air. The “variable permeance vapor control layer” and air control layer control this interior moisture.

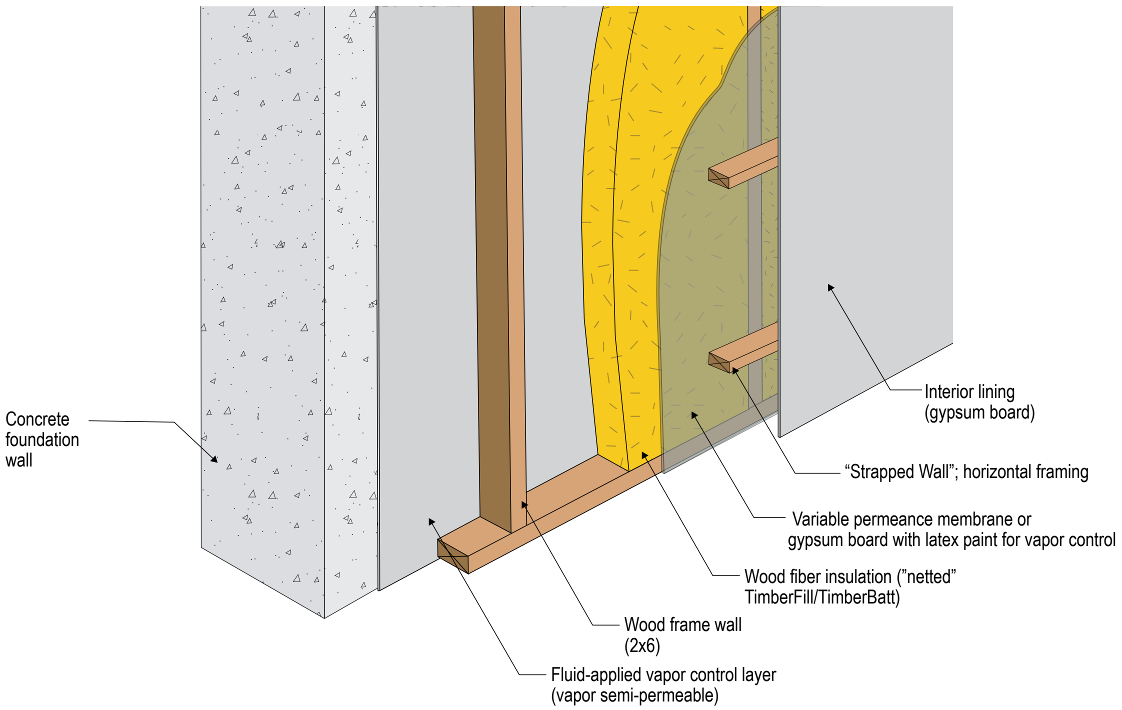


Figure 1.12
To allow for inward drying, a variable permeance layer at foundation wall is preferred

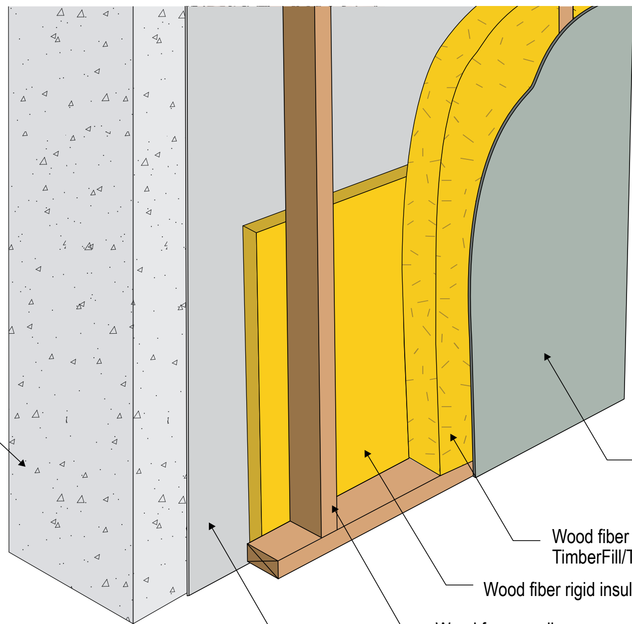


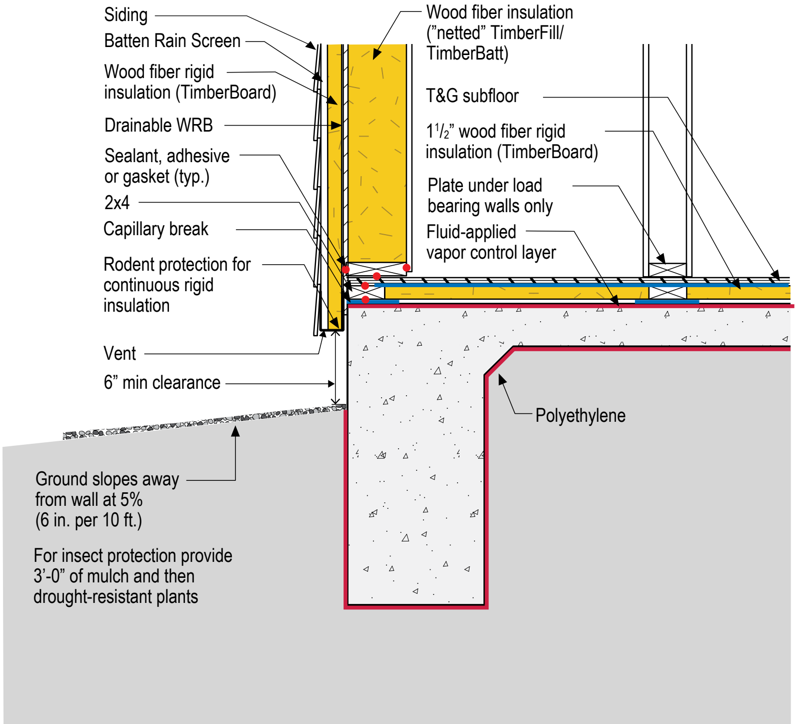
Figure 1.13
A variable permeance layer at foundation wall with TimberBoard

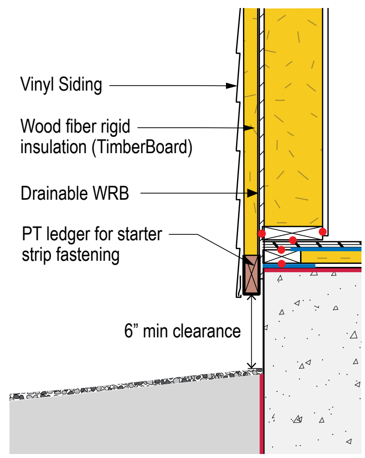
As noted earlier the foundation wall assembly should be constructed so that it is able to dry. It can't dry outwards because the ground is wet. It can obviously dry inwards. It can also dry upwards and then out above grade.

In cooling dominated climates CZ1-3, concrete basement floor slabs are best insulated over their top surface with TimberBoard (that includes borates) insulation. A sheet polyethylene vapor barrier should be located under the concrete basement floor slab direct contact with the concrete slab. Additionally, a fluid applied vapor control layer should be applied over the top of the concrete slab to control the initial moisture in the concrete when the concrete is first placed. The addition of a dimple mat to control capillarity between the slab and TimberBoard is also recommended.

Slab on grade foundations follow the same principles as basement foundations (Figure 1.14 and Figure 1.15).

Existing basement floor slabs and slab on grade foundations are treated in the same manner as Figure 1.14 and Figure 1.15. Note that existing slabs may not have a sheet polyethylene vapor barrier located under them. As such the top surface fluid applied vapor control layer acts as the primary vapor control layer. Sheet polyethylene should not be installed over the top of existing slabs unless it is continuously adhered – no air pockets – as the non-fully adhered approach can result in odors. Insulated slab details below are acceptable for climate zones 1-3. Additional measures need to be taken for colder climates due to the potential for condensation.





◄ Figure 1.14a
Slab on grade treated similar to basement. Wall assembly detailed for clapboard siding

▲ Figure 1.14b
Variation on wall assembly for vinyl siding with a PT 2x4 starter strip

Slab floor insulation currently limited to CZ 3 or less.

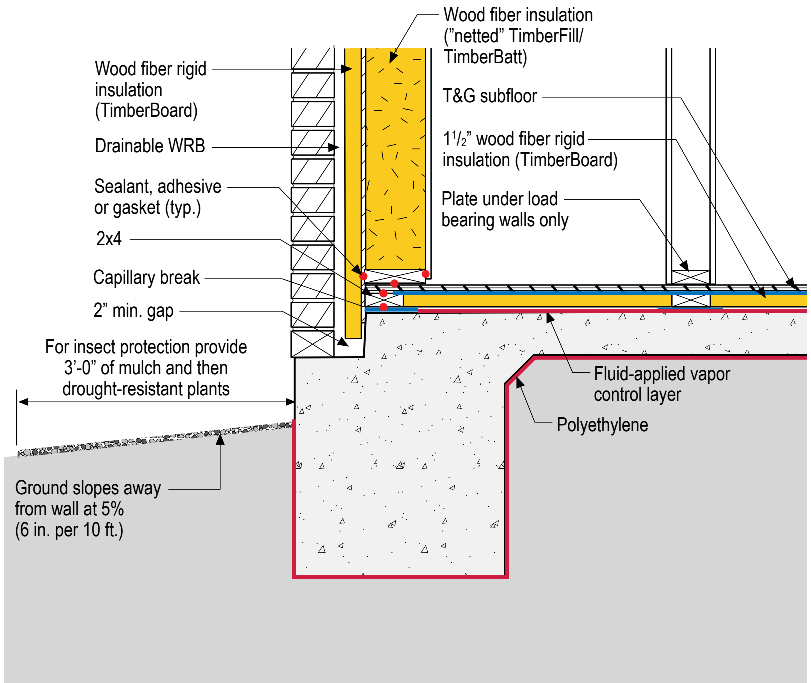


Figure 1.15 ►
Slab on grade with stepped foundation for masonry cladding

1.8 Mass Walls and Stucco on Concrete Blocks : cooling climates

Some traditional assemblies do not rely on drainage for the control of rain water that penetrates claddings. They rely on absorption, storage, redistribution and drying. The most common assembly that relies on this approach is a stucco rendering applied directly to the exterior surface of a concrete block wall (Figure 1.16). These assemblies are common to hot humid climates and have a long history of successful performance.

Stucco passes very little rain water through its face – but it does pass some rain water nevertheless. This penetrating rain water is stored in a non-water sensitive material, in this case concrete block, until it is able to dry either to the exterior or interior or both by the process of vapor diffusion and evaporation. It is common to coat the exterior of the stucco rendering with a vapor permeable layer such as acrylic paint to further reduce rain water entry.

Additionally, the inward vapor flow out of the CMU "block wall" needs to be reduced or "throttled". This can be accomplished by installing an interior coating sheet membrane on the interior surface of the CMU "block wall". This interior coating should be less than 5 perms "wet cup".

It is also recommended that a "seat" in concrete slab at the perimeter to address any penetrating rainwater draining down the CMU block cores (Figure 1.17). The "seat" acts as flashing directing the rainwater to the exterior of the wall.

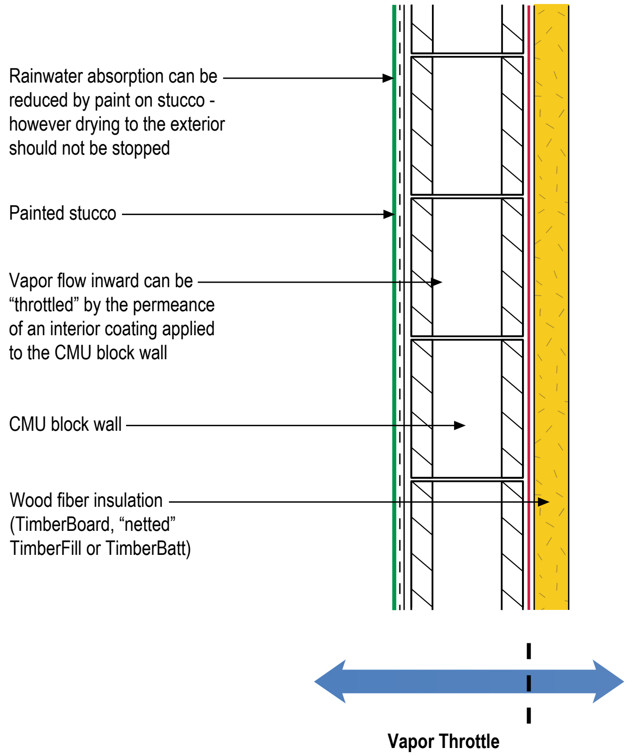


Figure 1.16
Exterior stucco with vapor throttle on interior

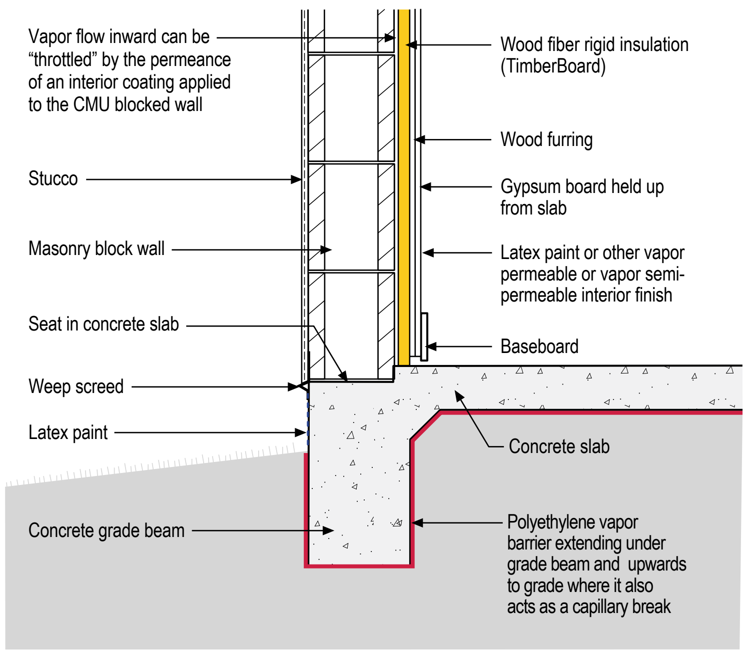


Figure 1.17
Block wall on slab with seat

2.0 Air Control Layer

Controlling airflow in a building enclosure is important because of its influence on heat and moisture flow. Airflow carries moisture that impacts a material's long-term performance (serviceability) and structural integrity (durability). Airflow also affects building behavior in a fire (spread of smoke and other toxic gases, supply of oxygen), indoor air quality (distribution of pollutants and location of microbial reservoirs) and thermal energy use. One of the key strategies in the control of airflow is the use of air control layers.

Air control layers are systems of materials designed and constructed to control airflow between a conditioned space and an unconditioned space. The air control layer is the primary air enclosure boundary that separates indoor (conditioned) air and outdoor (unconditioned) air. In multi-unit/townhouse/apartment construction the air control layer also separates the conditioned air from any given unit and adjacent units.

The air control layer also separates garages from conditioned spaces. In this regard, the air control layer is also the "gas barrier" and provides the gas-tight separation between a garage and the remainder of the house or building to control the migration of typical contaminants found in a garage.

2.1 Approaches

Air control layers are intended to resist the air pressure differences that act on them. Rigid materials such as gypsum board, exterior sheathing materials such as plywood, OSB or exterior gypsum board, and supported flexible barriers such as building wraps or housewraps are typically effective air control layers if joints and seams are sealed. Fully adhered membrane systems and liquid applied systems supported by exterior sheathing also are effective.

Air control layers keep outside air out of the building enclosure or inside air out of the building enclosure depending on climate or configuration. Sometimes, air control layers do both.

Air control layers can be located anywhere in the building enclosure – at the exterior surface, the interior surface, or at any location in between. In cold climates, interior air control layers control the exfiltration of interior, often moisture-laden air. Whereas exterior air control layers control the infiltration of exterior air and prevent wind-washing through cavity insulation systems.

Air control layers should be:

- Impermeable to air flow
- Continuous over the entire building enclosure or continuous over the enclosure of any given unit
- Able to withstand the forces that may act on them during and after construction
- Durable over the expected lifetime of the building

The significant advantage of exterior air control layers is the ease of installation and the lack of detailing issues related to intersecting partition walls and service penetrations.

An additional advantage of exterior air control layers is the control of wind-washing that an exterior air seal provides with insulated cavity frame assemblies. TimberBoard with T&G or sealed square edge seams acts as an effective layer to reduce wind-washing.

The significant disadvantage of exterior air control layers is their inability to control the entry of air-transported moisture into insulated cavities from the interior. As a result, most exterior air control layers are insulated on their exterior side with rigid or semi-rigid insulations that are not sensitive to wind-washing.

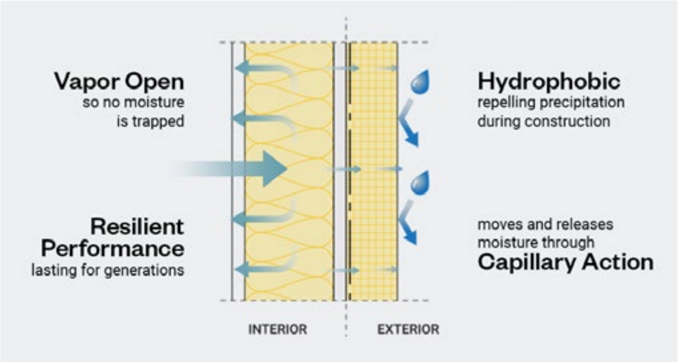
An advantage of interior air control layers over exterior systems is that they control the entry of interior moisture-laden air into insulated assembly cavities during heating periods. The significant disadvantage of interior air control layers is their inability to control wind-washing through cavity insulation and their inability to address the entry of exterior hot-humid air into insulated cavities in hot-humid climates.

Installing both interior and exterior air control layers can address the weakness of each TimberBoard can be an effective exterior solution.

Air control layers can be provided with properties which also class them as vapor control layers. An example of this are self-adhered modified bituminous membranes and sheet polyethylene which can be used as both an air control layer and a vapor control.

Keep in mind however, sheet polyethylene on the inside of building assemblies in cold, mixed-humid, marine, hot-dry and hot-humid climates is not generally a good idea; drying of building assemblies in these climates needs to occur to the inside during air conditioning periods. Despite the code allowance for a class I layer on the interior in a number of climates, we do not generally recommend this and feel flow though assemblies that allow for drying in both directions, are generally more durable and effective.

Additionally, interior drying is necessary in air conditioned enclosures. In other words, interior vapor barriers such as polyethylene and vinyl wall coverings should never be installed in air conditioned buildings – even ones located in cold climates.



3.0 Vapor Control Layer

The function of a vapor control layer is to retard the migration of water vapor. Where it is located in an assembly and its permeability is a function of climate, the characteristics of the materials that comprise the assembly and the interior conditions. Vapor control layers are not typically intended to retard the migration of air. That is the function of air control layers.

Confusion on the issue of vapor control layers and air control layers is common. The confusion arises because air often holds a great deal of moisture in the vapor form. When this air moves from location to location due to an air pressure difference, the vapor moves with it. This is a type of migration of water vapor. In the strictest sense, air control layers are also vapor control layers when they control the transport of moisture-laden air.

Incorrect use of vapor control layers can lead to an increase in moisture related problems. Vapor control layers were originally intended to prevent assemblies from getting wet. However, they often prevent assemblies from drying. Vapor control layers installed on the interior of assemblies prevent assemblies from drying inward. This can be a problem in any air-conditioned enclosure, as well as in any below grade space. Finally, this can be a problem when there is also a vapor control layer on the exterior – the "double vapor barrier" problem. Most foams are vapor barriers and using them as continuous insulation increases the risk for a double barrier. Great caution should be used in designing these assemblies.

3.1 Principles

The fundamental principle of control of water in the vapor form is to keep it out and to let it out if it gets in. It can get complicated because sometimes the best strategies to keep water vapor out also trap water vapor in. This can be a real problem if the assemblies start out wet because of rain or the use of wet materials.

It gets even more complicated because of climate. In general, water vapor moves from the warm side of building assemblies to the cold side of building assemblies. This is simple to understand, except we have trouble deciding what side of a wall is the cold or warm side. Logically, this means we need different strategies for different climates. We also have to take into account differences between summer and winter.

Finally, complications arise when materials can store water. A cladding system, such as a brick veneer, can act as a reservoir after a rainstorm and significantly complicate wall design. Alternatively, wood framing or masonry can act as a hygric buffer as well as wood fiber insulation absorbing water lessening moisture shocks.

There are three principle control approaches to dealing with water in the vapor form. The first is to let the water vapor pass through the assembly from the inside out and from the outside in. Where a wall assembly is concerned, it is a wall that can dry to both sides. We call these types of assemblies "flow-through" assemblies.

The second is to locate a distinctive vapor control layer to retard the flow of water vapor into the wall assembly from either the inside or from the outside. We call these types of assemblies "vapor control layer" assemblies. The most common location for a vapor control layer is on the inside "warm in winter" side of the thermal insulation.

The third is to control the temperature of the surfaces where condensation is likely to occur by raising the surface temperature with insulation. The most common method of doing this is to use rigid insulation on the exterior of assemblies. We call these types of assemblies "control of condensing surface temperature" assemblies.

TimberHP products work as components in all three assembly types.

The added benefit of using TimberBoard as a continuous insulation to control dew point is that it is also vapor open and hygroscopic. TimberBoard can absorb 15% of its weight in water and still retain its full R-value.

4.0 Thermal Control Layer

The function of the thermal control layer is to control the flow of heat from both the inside to the outside and from the outside to the inside. As with the other control layers the most important factor to consider when dealing with the thermal control layer is its continuity.

4.1 Thermal Bridges

Gaps and openings in the thermal control layer are called thermal bridges. Some thermal bridges are not as significant such as wood framing as wood is not highly thermally conductive. However, thermal bridges that occur with highly thermally conductive materials such as concrete and steel can be very significant to the thermal performance of the building and can affect heating and cooling costs, occupant comfort and building durability if condensation occurs on them. Examples of significant thermal bridges are uninsulated exposed concrete foundation slabs, steel beams that penetrate the building enclosure and steel framing in general.

Wood frame building cavities are typically insulated with cavity insulation ("netted" TimberFill/TimberBatt). Wood is not highly thermally conductive and the combination of wood framing and cavity insulation is effective. The framing portion of the typical "opaque" portion of the building enclosure when framing on 16 inch centers (not including windows and doors) is approximately 30 percent and the insulated cavity portion of the building enclosure is 70 percent. This is often expressed as a "framing factor" of 30 percent.

With wood frame buildings a framing factor of 30 percent results in a reduction of the effective thermal performance of the cavity insulation by approximately 10 percent. With steel frame buildings a similar framing factor results in a reduction of the effective thermal performance of the cavity insulation by approximately 70 percent due to the high conductivity of steel relative to wood. Hence, the practice and need to insulate steel frame buildings on the exterior with continuous rigid insulation (wood fiber rigid insulation - TimberBoard).

Framing factors can be reduced to 15 percent or less using efficient framing techniques often called “advanced framing”. These techniques are referenced and accepted by the model building codes and involve “stack framing”, framing on 24 inch centers rather than 16 inch centers, single top plates, two stud corners and elimination of “jack studs” and “cripples”. To provide structural equivalency, this is done with 2x6 framing not 2x4 framing.

For cavity insulation to be effective, it should not permit airflow through it or around it, and it must completely fill the cavity. Higher density cavity insulations, such as TimberBatt and TimberFill, reduce the threat of such airflow. Assemblies incorporating air permeable cavity insulations (anything other than closed-cell spray foam) should always be coupled with a designated air control layer.

Exterior continuous rigid insulation (wood fiber rigid insulation - TimberBoard) should be added to both wood frame buildings and steel frame buildings and most concrete buildings. As mentioned previously, exterior continuous rigid insulation is essential to steel frame buildings because of the significance of the thermal bridging of the highly conductive steel framing elements.

Concrete masonry block walls – the concrete blocks are often called concrete masonry units or CMU’s - are also highly conductive and are best insulated on the exterior with continuous rigid insulation. It is possible to insulate CMU wall assemblies on the interior but the thermal bridging of floor systems and floor slabs must be accounted for.

4.2 Thermal Inertia or Heat Protection

R-value (resistance and its inverse, conductivity) tells us how well an insulation resists heat flow at steady state, but often fails to tell the whole story about a materials ability to keep heat out of a building a set period of time. Some insulations take longer than others to reach steady state, this can have significant impact on comfort and utility bills.

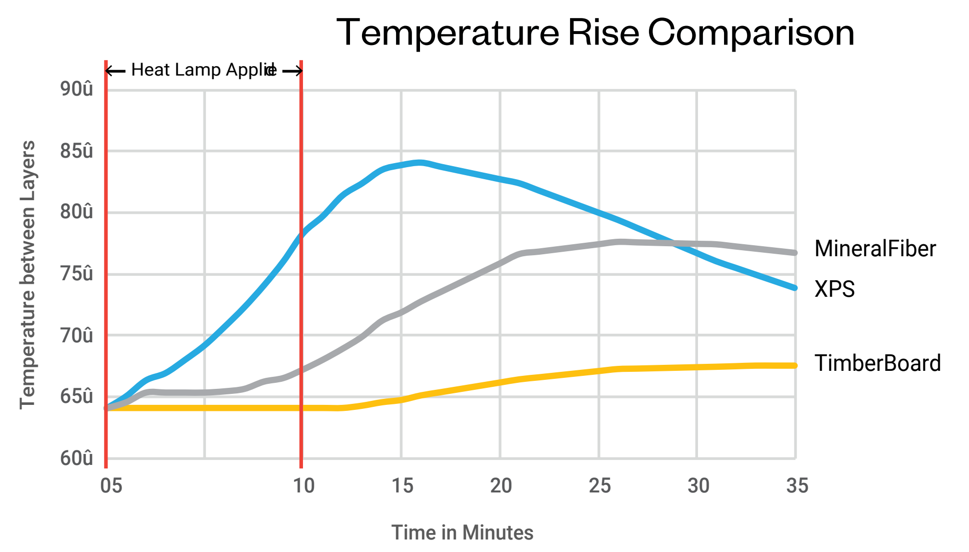
On warmer days when outside temperatures rise and then cool overnight, wood fiber insulation, in particular denser and continuously installed TimberBoard, excels in stabilizing conditions in our buildings like no other product. It delays internal heat gains during the hottest part of the day, until late in the evening. This reduced or eliminated temperature swing leads to increased comfort and reduced cooling costs.

A material or assembly’s specific heat capacity, combined with its density and conductivity, express how big of a “bucket” that material has to hold heat before it “spills over” or passes through. The material or assembly can also be seen as a sponge (insulation) and its ability to absorb moisture (heat) before reaching saturation. A lighter and less absorptive sponge (lighter density and lower specific heat capacity) will take up water, but not be able to take and hold the water for any time at all.

Wood has one of the highest specific heat capacities of all building materials and hits a sweet spot between density, conductivity, and heat capacity resulting in the lowest thermal diffusivity. High diffusivity material reaches equilibrium on both sides faster than low diffusivity. In other words high diffusivity materials are not good heat sponges.

The benefit of WFI over other insulation materials comes when steady state heat flow through the envelope is delayed long enough until there is a natural drop in temperature outside (evening) minimizing and reducing heat gains internally, even allowing built up heat within the envelope to cool to the outside.

While there are numerous ways to add mass to a building, TimberBoard is a cost effective way to do so while also increasing R-value. Find additional information in our technical library



The graph shows temperature rise between layers of each material in the display with 10 minutes of heat applied and then shut off.

The wood fiber "internal" temp is unaffected the entire time heat is applied and remains lower (best attenuation ratio of all three) due to the low diffusivity values, resulting in delaying internal gains (longest phase shift).

▲ View the Summer Heat Protection display in our technical resource library

5.0 Strength and Rigidity

Walls, roofs and foundations also must provide the necessary strength and rigidity for the building enclosure to address wind, snow and seismic loads. These issues are regional and a detailed discussion of these loads is beyond the scope of this guide. For specific guidance professionals should be consulted and local codes followed. However, some general points can be made.

Resistance to shear loads due to wind must be provided. One of the most effective ways of providing load resistance to these forces is to provide shear panels. The most common shear panels used are plywood or OSB. Plywood and OSB are often referred to as "structural sheathing", additional methods include engineered hardware which may allow for the elimination of shear panels.

5.1 Exterior Wood Fiber Rigid Insulation

Exterior wood fiber rigid insulation – TimberBoard - does not provide shear resistance to exterior walls and must be used with structural sheathing. The amount of structural sheathing, type of structural sheathing and connections of the structural sheathing to the structural frame depend on the expected loads. These loads are established by local codes and building practices.

It is common to install exterior wood fiber rigid insulation – TimberBoard - over structural sheathing. Eliminating the structural sheathing is possible if TimberBoard is installed in conjunction with alternate shear methods approved by a licensed structural engineer, such as cross-bracing or other design elements.

5.2 Cladding Attachment

There are practical and structural limits to the attachment of cladding directly through exterior wood fiber rigid insulation to the structural frame or structural bracing. Cladding fasteners must be installed directly into framing members.

Many cladding manufacturers limit the thickness of exterior rigid insulation that their products can be installed over. These limits are typically between 1 inch and 1.5 inches and they vary from manufacturer to manufacturer and between product types. Vinyl siding requirements/limits are typically different than fiber cement siding requirements/limits. Individual manufacturers guidelines should be followed.

When thicker layers of exterior wood fiber rigid insulation are used, structural furring is used to transfer the wind loads to the structural frame. This furring is typically nominal 1x4 or 1x3 dimensional wood for most wind load areas. Cladding is typically attached to the furring with ring shank nails in place of smooth shank nails due to their greater withdrawal strength.

Furring strips should be fastened through the exterior rigid insulation with corrosion-resistant screws. Furring strips do not need to be treated lumber as they easily dry to both sides into the air space they create. Should treated lumber be used for furring then stainless steel screws will be necessary due to the corrosive nature of treated lumber. Spacing of these screws and their gauge is determined by the local wind load and the spacing of the furring strips (16 inch centers vs. 24 inch centers).

In higher wind load areas, ¾ inch thick “marine grade” plywood strips are used in place of 1x4 dimensional wood strips due to their significantly higher nail withdrawal strength. In coastal regions in Florida, 2x4’s installed “flat” directly over masonry are often used as a base for cladding attachment as their greater “thickness” allows for longer fasteners and higher withdrawal strength respectively.

In all cases, local codes should be followed and professionals consulted as necessary.

6.0 Fire Resistance

There are two main types of fire issues: fires emanating from the interior of a building and fires emanating from the exterior of a building.

The single most important design consideration for fire safety relating to interior fires is discovery of the fire and getting out of the building quickly and safely. Smoke detectors, carbon monoxide detectors and egress are central to this approach.

The two most important design consideration for fire safety relating to exterior fires focuses on the spread of fire by vegetation to a building and on not spreading fire from the exterior of one structure to another. Please refer to our technical library for 1 and 2 hour fire-rated assemblies with cavity and continuous TimberHP insulations.

6.1 Fires Emanating From the Interior

The main objective to limiting fire spread is to slow air (oxygen) from feeding a fire. The most common approaches to limiting fire spread are firestopping, fire-blocking, draft-stopping, thermal barriers and ignition barriers.

Firestopping is used to seal openings and joints in fire-resistance rated wall and floor assemblies. Fire-blocking is used to resist the free passage of flames or other products of combustion to other areas through concealed spaces. Draft-stopping is used to restrict the movement of air within open spaces of concealed areas. It is often used in open floor truss assemblies to break the open areas down to smaller compartments – typically less than 1,000 square feet.

Solid materials such as dimensional wood and gypsum sheathing are considered effective firestopping, fire-blocking and draft-stopping materials. TimberFill, installed at the correct density as well as TimberBatt are an effective and code-compliant firestop material. Note that local code acceptance may vary.

A thermal barrier is intended to protect an element in an assembly in a fire exposure by limiting the temperature rise at the surface of the element being protected. Most codes define a thermal barrier as a layer that limits the temperature rise to not more than 250 degrees F in a 15-minute time period. The 15-minute period is considered to be sufficient time for occupants to escape from a building. Foam plastics could be protected by TimberHP products depending on the application. Refer to our ESR.

Most model codes recognize ½ inch gypsum board as an effective thermal barrier.

Ignition barriers are different from thermal barriers. Ignition barriers prevent the ignition of the element being protected from a spark, or from direct heat, but does not protect from direct flame. TimberFill and TimberBatt meet ASTM-E84 Class-A Fire and Smoke Performance, allowing them to serve as fire blocks in some applications. TimberBoard can also be incorporated into fire rated assemblies.

6.2 Fires Emanating From the Exterior

Two major concerns exist with fires emanating from the exterior - the spread of fire by vegetation to a building ("wildfires") or not spreading fire from the exterior of one structure to another.

With respect to wildfires, the issue is burning embers. Roofs are particularly prone to burn ember exposure – both from the perspective of the roof covering and from the perspective of roof venting.

Entry of burning embers is a concern in urban regions with higher risk of wildfire occurrence. Homes built in regions designated as Urban Wildland Interface Zones are at a high risk for fire exposure. Wildfires burn with speed and intensity that often lead to a high percentage of homes lost in these communities. However, the ignition of homes is typically not caused directly by flames but rather by ignited embers becoming airborne.

Wildfires tend to occur in regions with plenty of fuel source including leaves, pine needles, ground debris, grasses and shrubs. Burning embers generated in these fires are transported through the air and become deposited on roofs of homes or can be drawn into the attic through the openings in roof vents. Embers drawn through roof vents will ignite the combustible materials in the attic. Embers deposited on roofs may also ignite debris on roof tops and in gutters such as leaves, pine needles and branches. Embers drawn through roof vents will ignite the combustible materials in the attic. Roof ventilation may be prohibited by local jurisdictions within Urban Wildland Interface Zones. Where roof ventilation is allowed, fire resistance rated vents are required.

Unvented roofs can be constructed if the appropriate thermal and moisture control requirements are followed.

When there is less than 5 feet between buildings such as is common with zero lot line construction the model codes require that walls be rated from the exterior for fire resistance purposes.

The most common requirement is a "one hour fire-resistance rating" from the exterior. Ratings are often provided by testing laboratories – the most common being Underwriters Laboratory (UL). This can be achieved with all 3 TimberHP products -- TimberFill, TimberBatt, and TimberBoard -- refer to ICC ESL and the Appendix.

Roof assemblies can become exposed to direct flames particularly with zero lot line construction. Roof coverings may have Class A, B and C fire resistance classification. Roof covering products carrying "Class A" fire resistance classification have been subject to most severe fire exposure standards.

Claddings serve several important functions among which are contributing to rainwater control and fire resistance – where fire resistance includes more robust wildfire resiliency and the spread of fire from the exterior of one structure to another.

In wildfire events one of the most common means of homes catching fire is the entry of airborne embers/cinders behind vented cladding assemblies. Vented claddings should have screens that prevent the entry of airborne embers/cinders. Additionally, vented claddings should have minimal vent spaces – ¾ inch or less to limit fire propagation.

The main objective to limiting fire spread is to slow air (oxygen) from feeding a fire. The most common approaches to limiting fire spread are firestopping, fire-blocking, draft-stopping, thermal barriers and ignition barriers.

The approaches to fire resistance are climate independent – they work in all climates.

Part II - Practices

Designing and Constructing Buildings

Buildings should be suited to their environment. Design and construction should be responsive to wind loads, snow loads and seismic loads. It should also be responsive to soil conditions and frost depth, orientation and solar radiation. Finally, design and construction should consider temperature, humidity, rain and interior conditions.

Building enclosures and mechanical systems should be designed for a specific hygro-thermal region (Figure 2.1), rain exposure zone (Figure 2.2) and interior climate in addition to the structural requirements already mentioned.

The interior climate for this guide is assumed to be residential or commercial. Interiors are assumed to be conditioned to 70 degrees F in the winter and 75 degrees F in the summer. Relative humidities are assumed to be limited to 35 percent (no higher) during the coldest month in winter and 65 percent (no higher) in the summer. These conditions also form the basis for the requirements delineated in the model building codes.

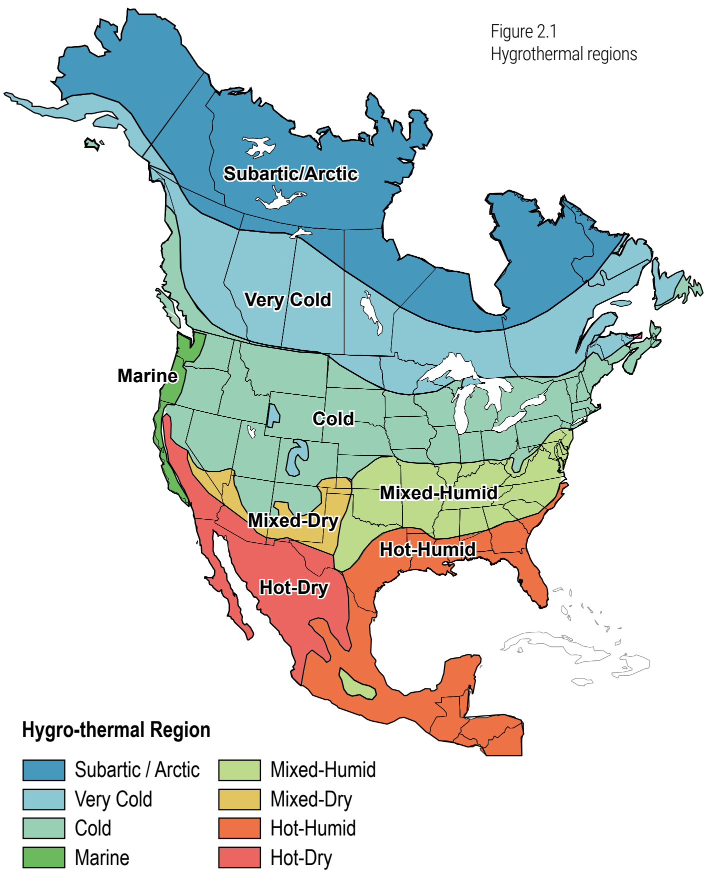


Figure 2.1
Hygrothermal regions

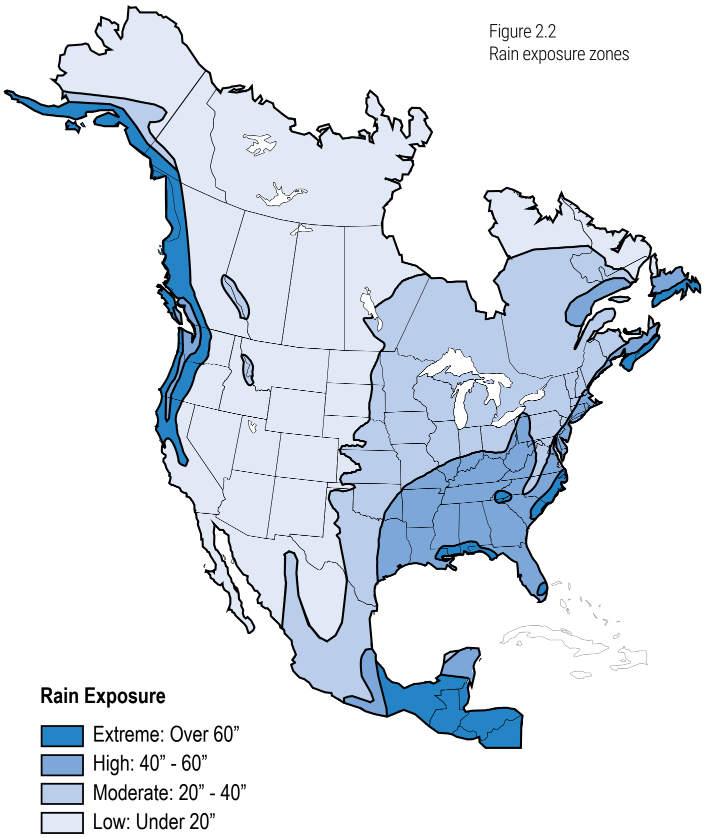


Figure 2.2
Rain exposure zones

* Based on information from the U.S. Department of Agriculture and Environment Canada

High occupant loadings can lead to high interior relative humidities during winter months. High interior relative humidities due to high occupant loading should be controlled by dilution ventilation. The greater the occupant density the greater the dilution ventilation rate required.

This guide does not address high occupant loadings or special use buildings that have high interior levels of moisture such as buildings with spas, indoor swimming pools or buildings that are humidified beyond 35 percent relative humidity during the coldest months in the winter.

The model building codes are also based on the hygro-thermal regions noted in Figure 2.1. The model codes further subdivide the regions for energy conservation purposes. Specific "code" climate zones are referenced in 2021 IRC, IBC and the IECC (Figure 2.3). The practices described in this guide are designed to meet the hygro-thermal requirements and interior conditions for each IRC, IBC and IECC zone noted for each practice.

The model building codes provide limited requirements regarding rain exposures. However, the wall designs presented in this guide are all designed to work in all rain exposure zones – except where noted.

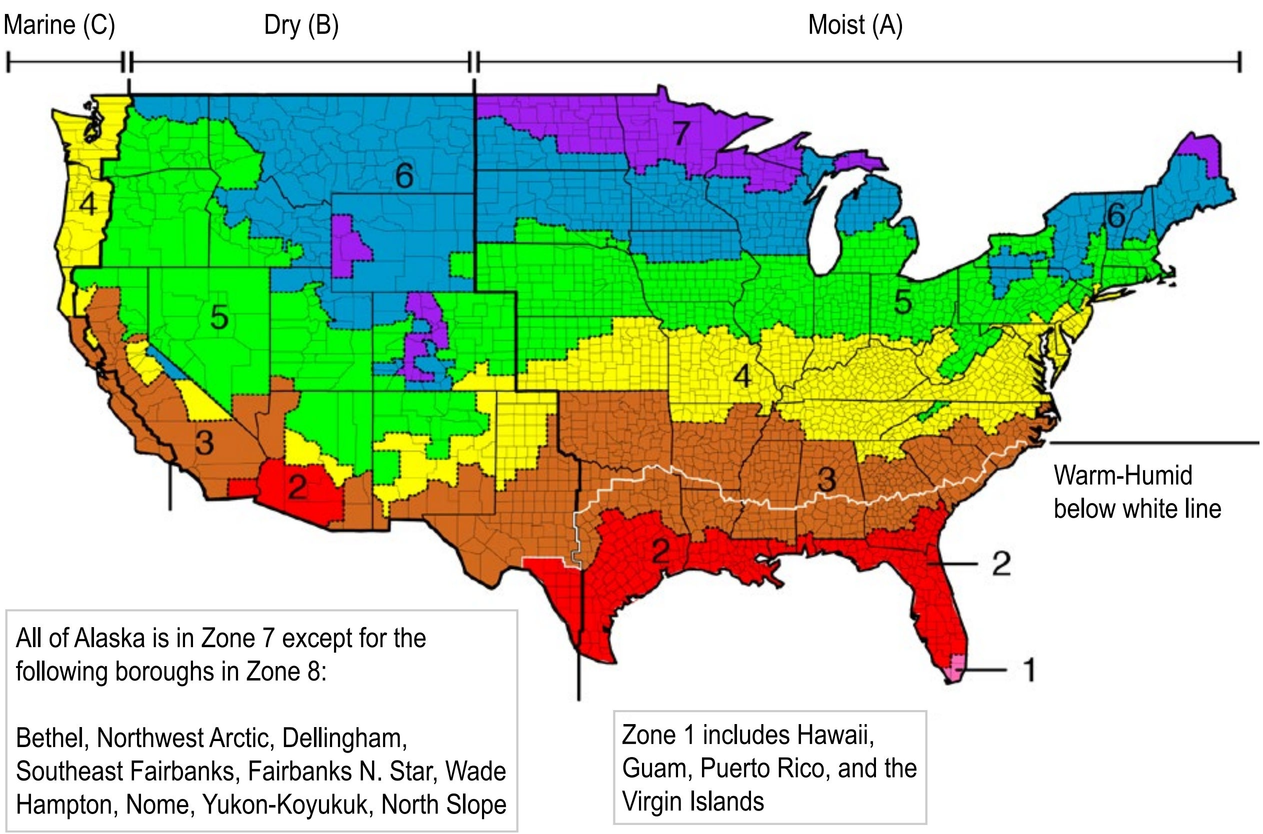


Figure 2.3
Climate zones per IBC and IRC codes

Climate Zones 1&2

Buildings constructed in these two zones are principally constructed on slab foundations and crawl-spaces due to lack of frost penetration and high ground water.

Where slab foundations are used they are typically uninsulated due to the lack of heat loss and heat gain through these assemblies due to the climate and due to concerns about insect migration. Exterior rigid insulation is often avoided for insect control reasons and constructibility, although there are termite resistant barriers that can be used.

Walls are a combination of wood frame, steel stud and concrete block – concrete masonry units (CMU). In Florida, CMU construction is common for first floor assemblies and wood frame for second floor assemblies from Orlando south. From Orlando north wood frame and steel stud assemblies predominate as well as throughout the remainder of Climate Zone 2.

Roof construction is typically a mixture of vented attics and unvented roof assemblies. Unvented roof assemblies perform better in these climate zones with respect to moisture control, hurricane wind load resistance and wild fire resistance.

Foundations

Figure 2.4 is the recommended slab foundation detail for CMU construction in South Florida. Note the "seat" in the slab to receive the CMU wall. This seat provides a continuous flashing around the entire perimeter of the building. Also note that the stucco does not extend into the ground. Extending the stucco into the ground is bad practice that results in wicking of moisture into the assembly and provides a pathway for insects. Further note that the under slab polyethylene vapor barrier wraps the grade beam.

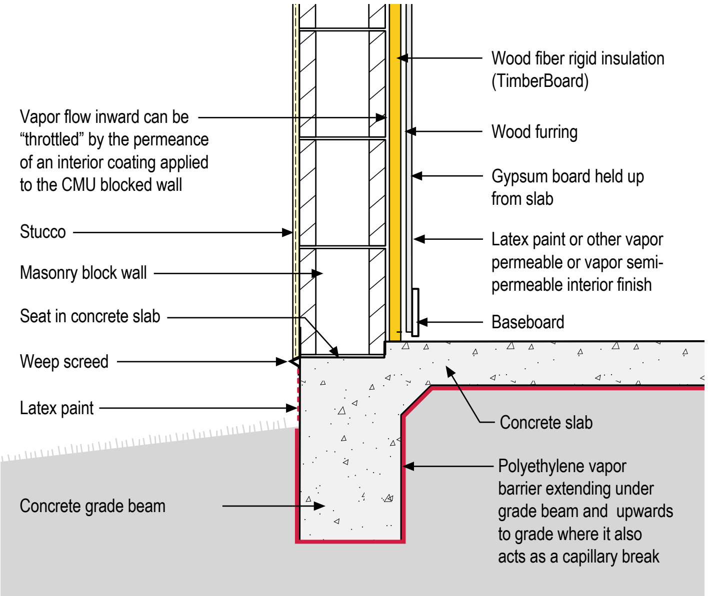


Figure 2.4
CMU assembly for Climate Zone 1&2

Climate Zones:

1

2

Crawl spaces and pier foundations are common in the Gulf coast regions of Climate Zone 2. Where crawl spaces are constructed, they typically are constructed as “vented” crawl spaces and elevated above grade due to high water tables and flooding issues. Figure 2.5 is an example of recommended vented crawl space construction. Note the continuous rigid insulation on the underside of the floor framing. This rigid insulation’s primary function is to protect the floor assembly from moisture. Exterior wood fiber rigid insulation – TimberBoard should be coated with a fluid applied vapor barrier or appropriate sheet membrane needs to be incorporated into this system as it acts as the primary vapor control layer of the assembly. Additionally, the exterior wood fiber rigid insulation should be protected with protection board from fire, insects and vermin. It is appropriate to include fluid applied vapor barrier to the protection board. Per our TimberBoard ESR, some areas of the country with wood destructive insects will require a treated board to address certain applications.

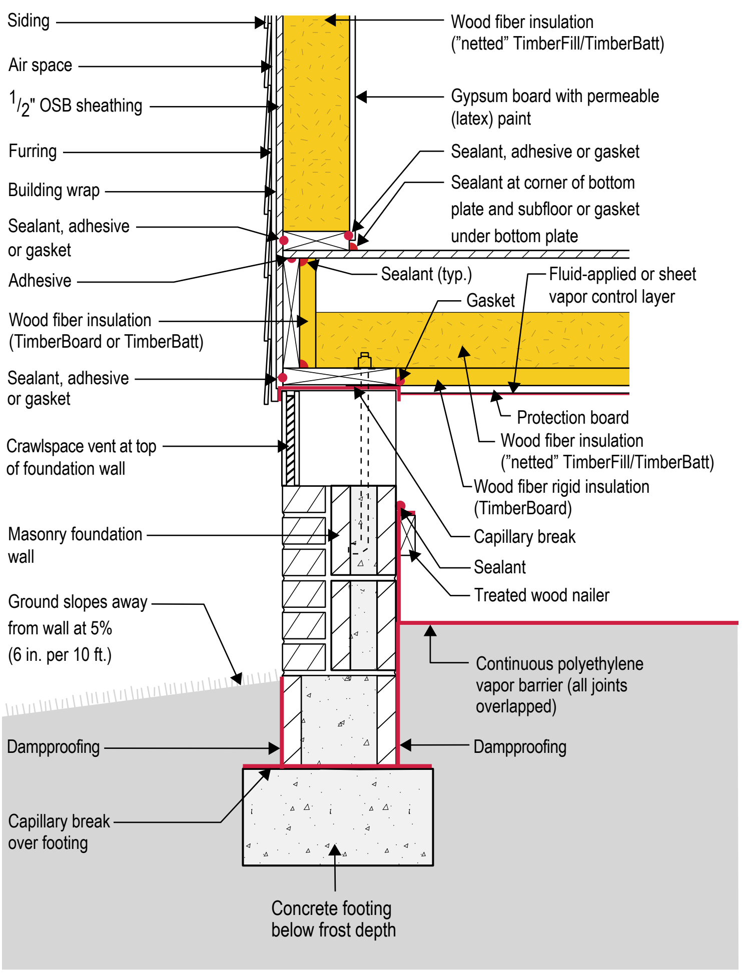


Figure 2.5
Vented crawlspace detail

Unvented crawl spaces should be only considered where flooding is not a concern. Figure 2.6 is a recommended approach to constructing conditioned crawl spaces. Note the protection board on the rigid insulation protecting the rigid insulation from fire. Also note the fully adhered membrane barrier for insect control.*

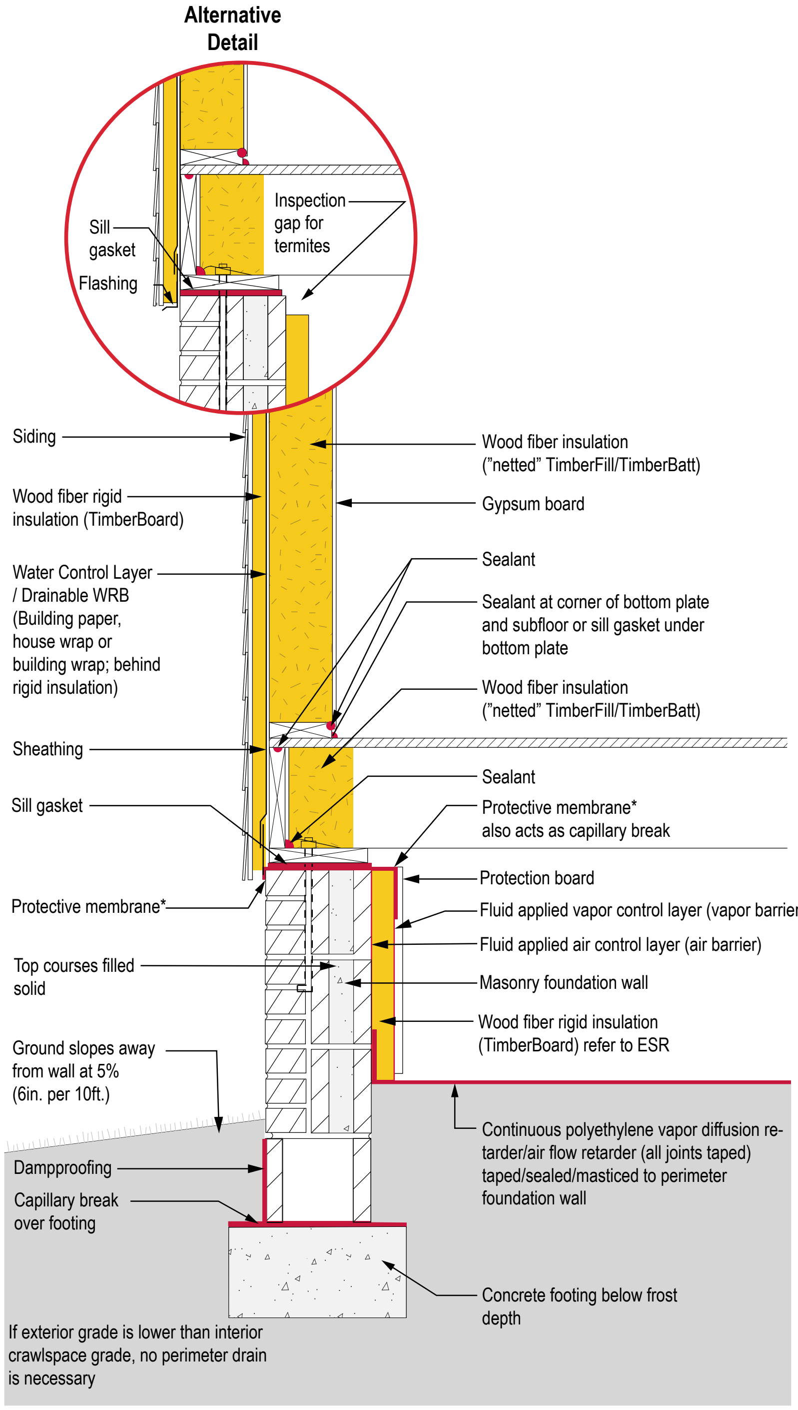


Figure 2.6
Unvented, conditioned crawlspace

Climate Zones:

1

2

Pier foundations are common in shore areas where flooding is a concern. Figure 2.7 is a recommended approach to constructing pier foundations. Again, as in vented crawl space construction, note the continuous rigid insulation on the underside of the floor framing. This rigid insulation's primary function is to protect the floor assembly from moisture. Exterior wood fiber rigid insulation – TimberBoard should be coated with a fluid applied or sheet vapor barrier as it acts as the primary vapor control layer of the assembly. Additionally, the exterior wood fiber rigid insulation should be protected with protection board from fire, insects and vermin.

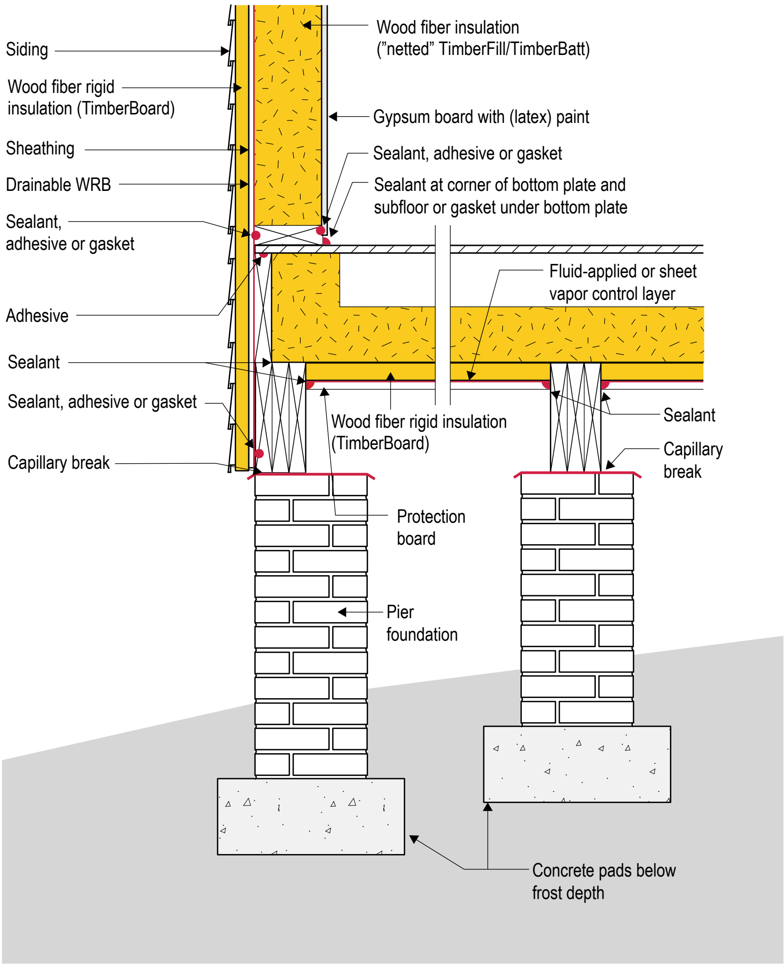


Figure 2.7
Pier foundation detail

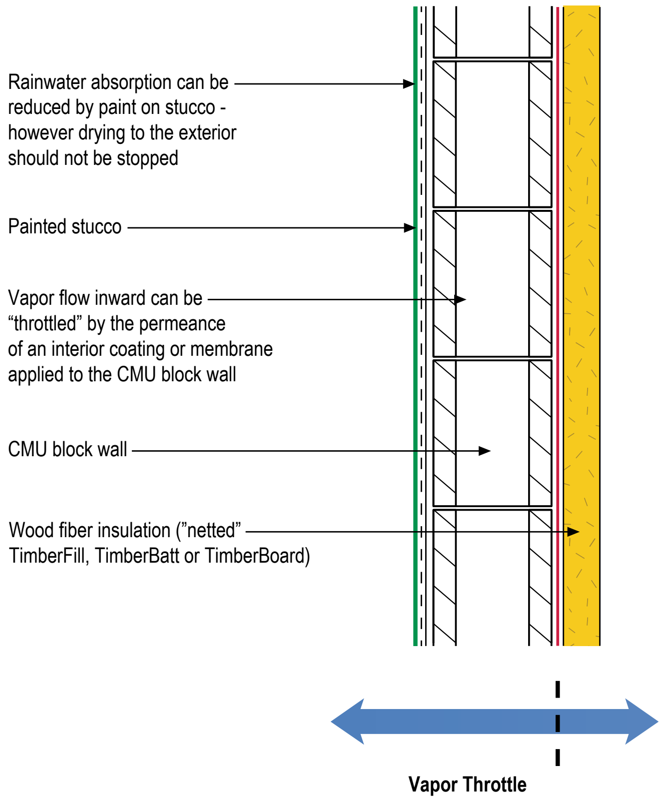
Climate Zones:

1

2

Walls

Figure 2.8 illustrates the common approach to construct CMU walls. A common approach to construct wood frame walls is illustrated in Figure 2.9. The key elements of this wall is the gap between the cladding and the water control layer used to control hydrostatic pressure. Wood frame building cavities are typically insulated with cavity insulation ("netted" TimberFill/TimberBatt).



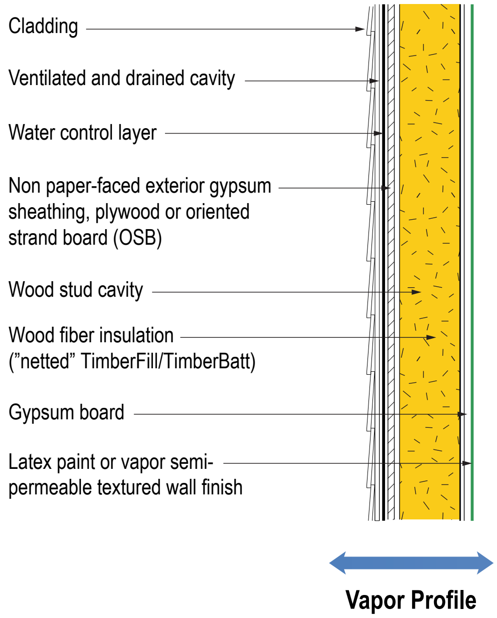


Figure 2.8
CMU Wall

Figure 2.9
Wood Framed Wall

Climate Zones:

1

2

Roofs

Unvented roofing assemblies are illustrated in Figure 2.10 and Figure 2.11. The amount of rigid insulation above the roof deck relative to the amount of insulation under the roof deck in Figure 2.11 is specified by the IRC and the IBC to control condensation (SEE APPENDIX. For a vapor diffusion option, see figure 2.16.)

The same approach can be used with flat roofs (Figure 2.12).

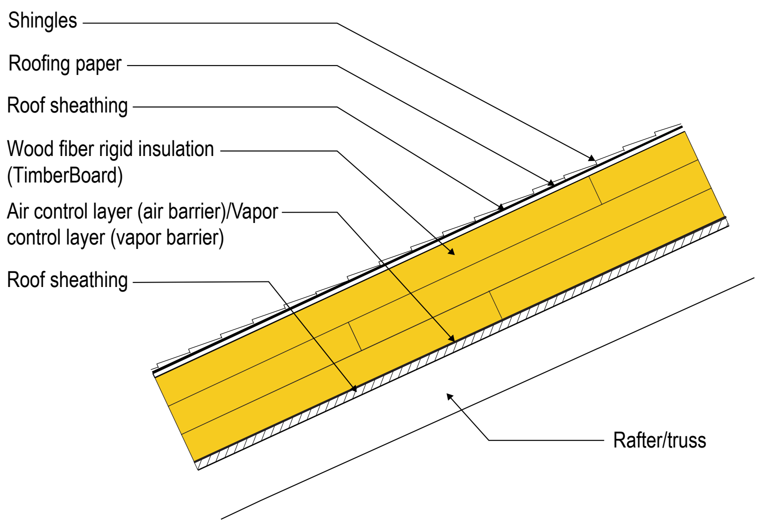


Figure 2.10
Roof detail with an all-exterior above deck insulation option. See vapor diffusion port 2.14-2.16

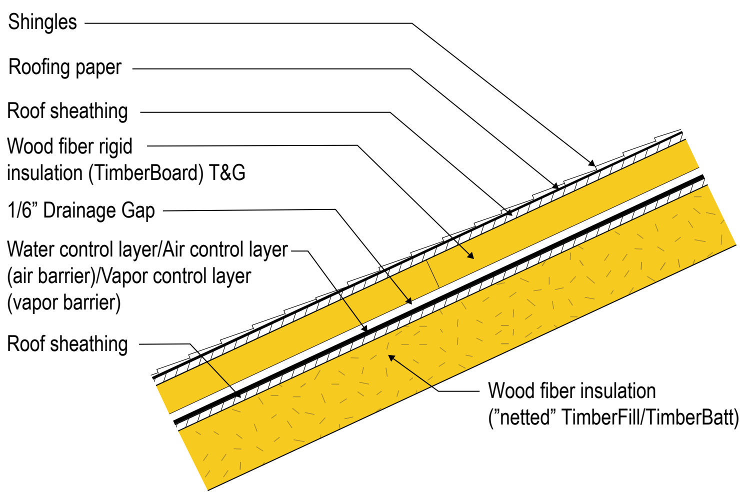


Figure 2.11
Roof detail with above-deck and cavity fill option

Climate Zones:

1

2

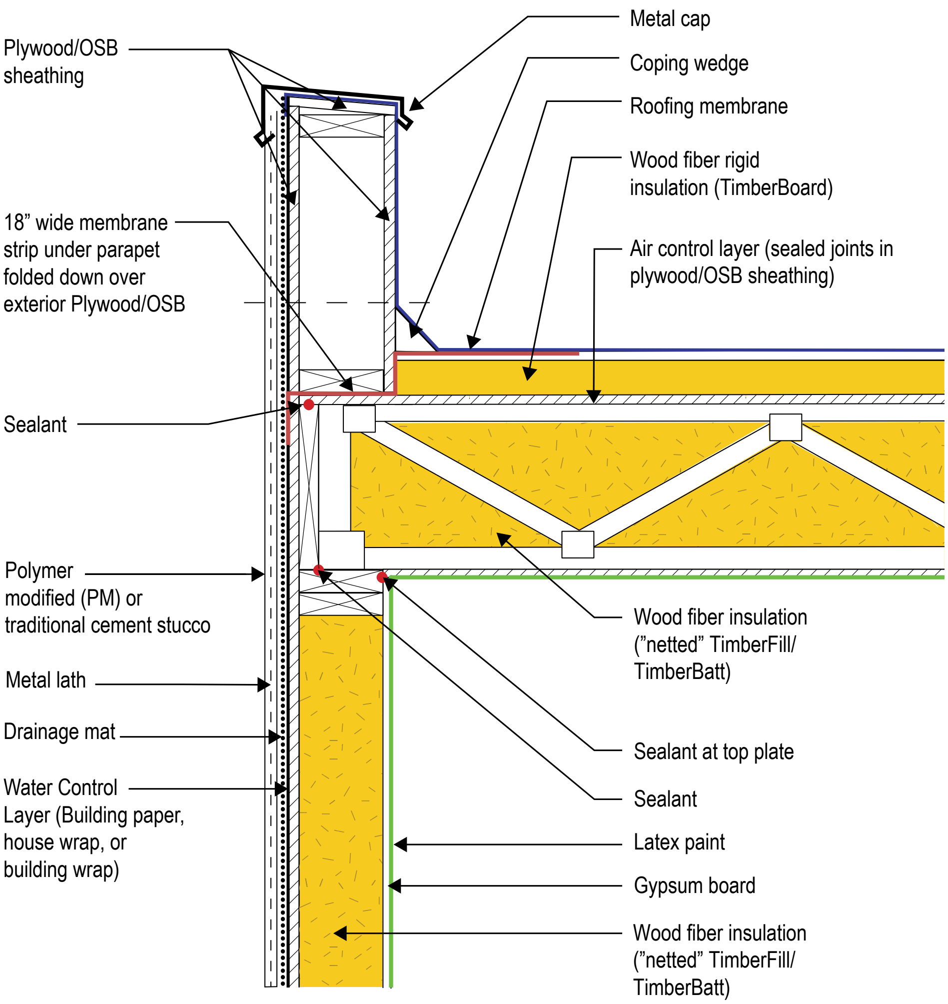


Figure 2.12
Flat roof detail. In this application excess moisture occurring in the roof deck insulation would diffuse through the wall assembly. Membranes and wraps should be vapor open and act as a throttle.

Climate Zones:

1

2

Figure 2.13 is an unvented attic approach that can only be used in hot dry climates (Climate Zone 2B). Note that the roofing tiles provide a vented space allowing the roof sheathing to dry. However, this drying is only possible if the roofing membrane is vapor open (Class III vapor retarder).

This approach can be adapted in hot humid climates and mixed humid climates with the use of vapor diffusion ports (Figure 2.14; Figure 2.15 and 2.16)

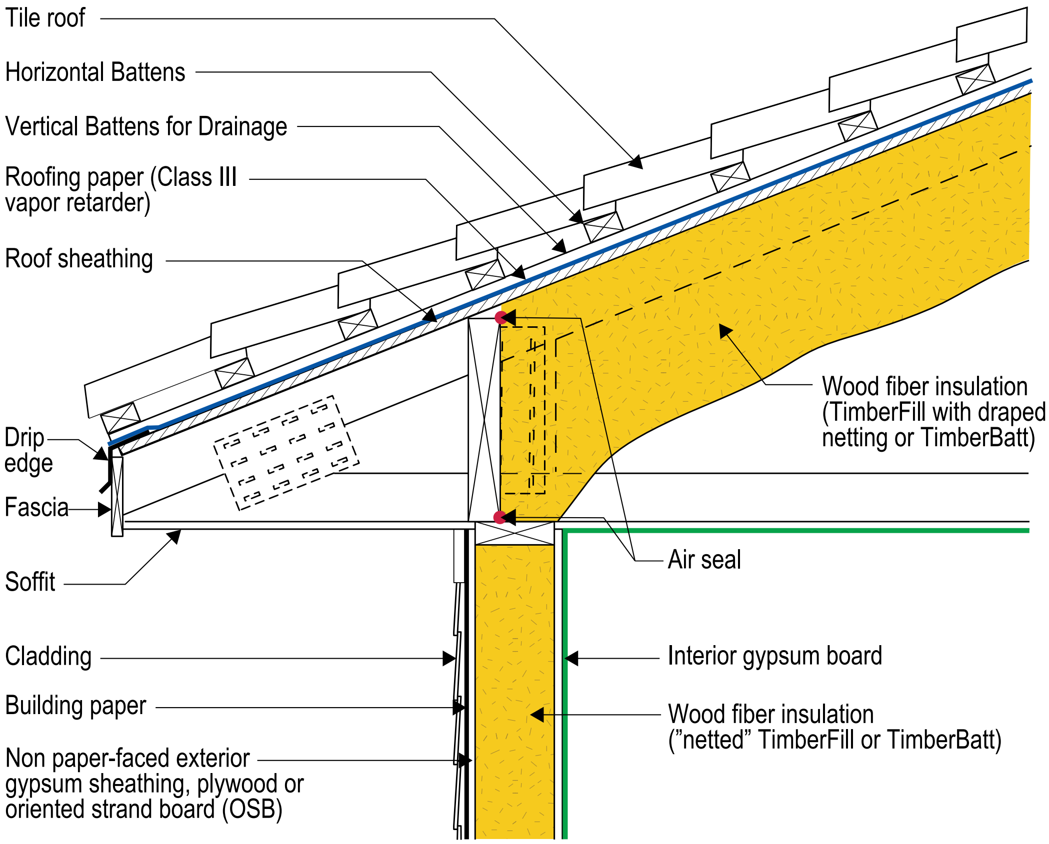


Figure 2.13
Hot dry climate option with clay tile

Climate Zones:

1

2

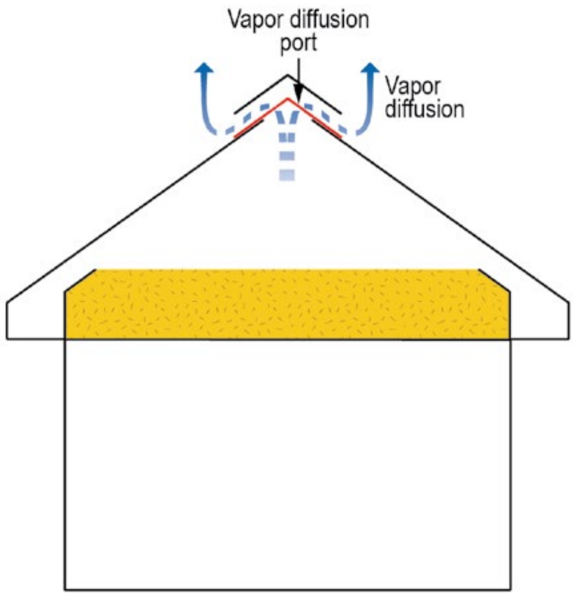


Figure 2.14
Unconditioned unvented attic with Vapor Diffusion Port

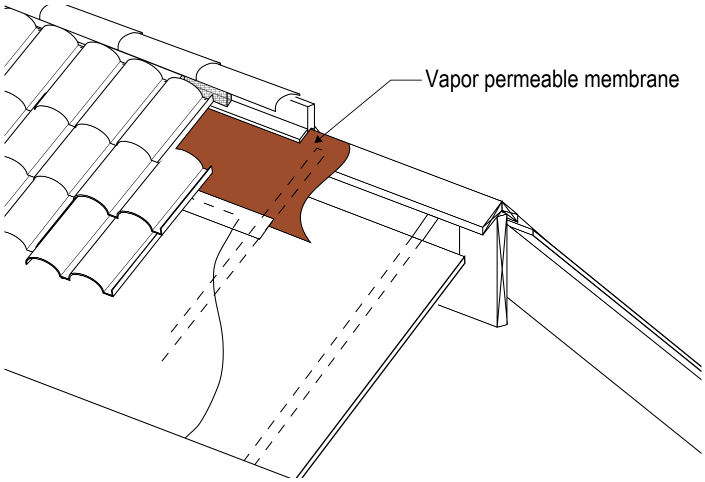


Figure 2.15
Diffusion port with clay tile

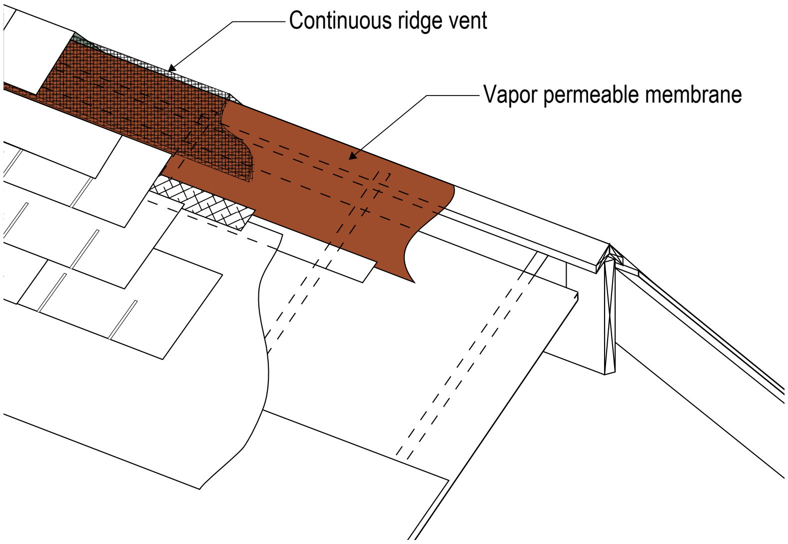


Figure 2.16
Diffusion port with continuous ridge vent

Climate Zones:

1

2

Case Studies

A typical section for Orlando is presented that meets or exceeds the 2021 IECC as well as meeting the requirements for environmental separation (Figure 2.17).

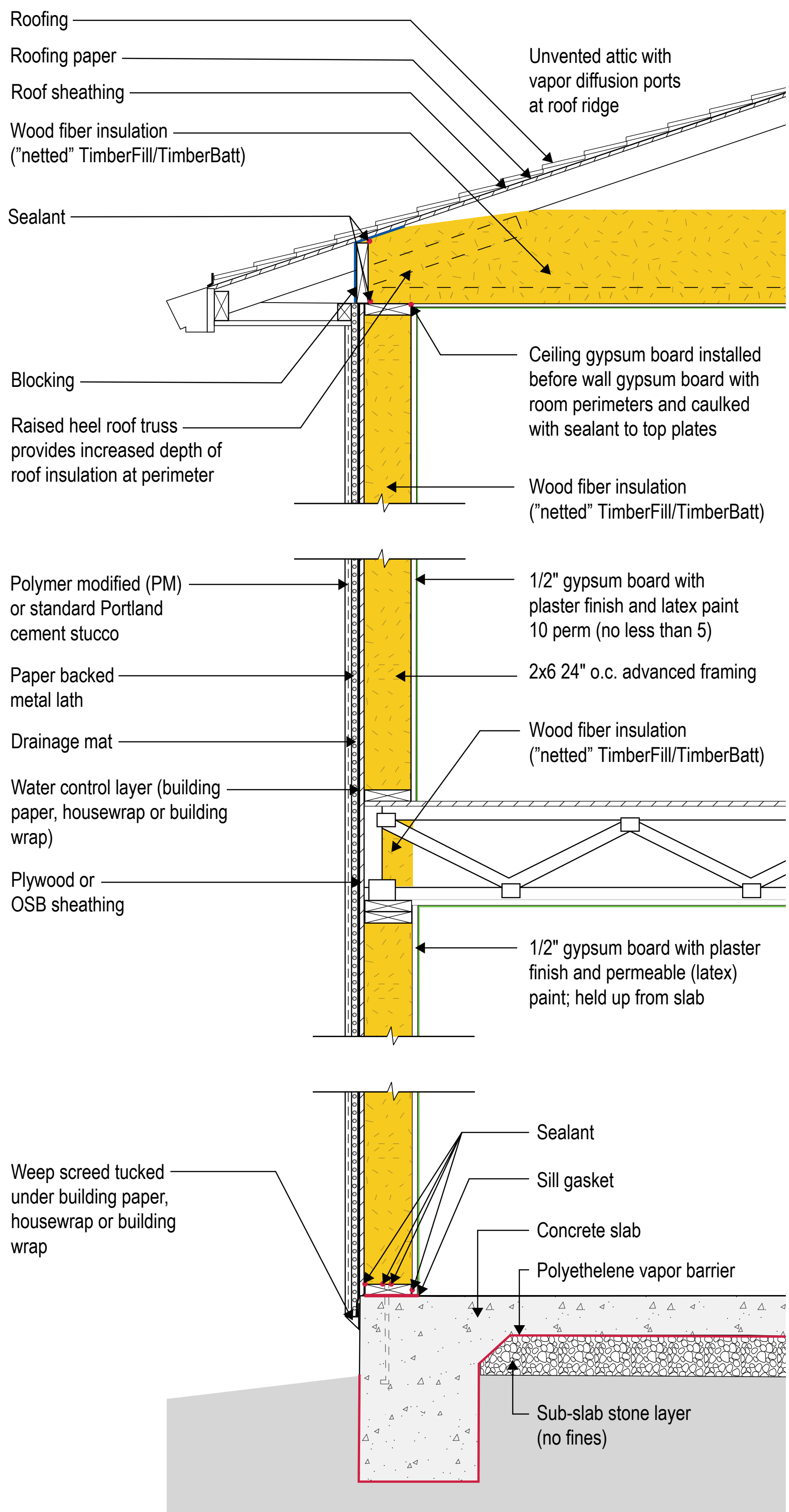


Figure 2.17
Case study with a dry slab foundation

Climate Zones:

3

4

5

Climate Zones 3, 4 and 5

Buildings constructed in these three zones are constructed on each of the three typical foundation types: slab foundations, crawlspaces and basements.

Where slab foundations are used, they are insulated, as are basement foundations.

Walls are a mixture of wood frame, steel stud and concrete assemblies. Where wood framing is used both 2x4 and 2x6 framing are common.

Roof construction is predominately vented attics. Some unvented roof assemblies are being constructed, but they are not common.

Foundations

Figure 2.18 is an effective means for providing a "dry" slab that is also insulated on its top surface. Additionally, a fluid applied vapor barrier should be applied over the top of the concrete slab to control the initial moisture in the concrete when the concrete is first placed. Ground treatment for insect control is also recommended.   The building wrap installed directly under the subfloor and over the top surface of the slab insulation is optional to control wetting of the assembly from minor spillage of interior water.

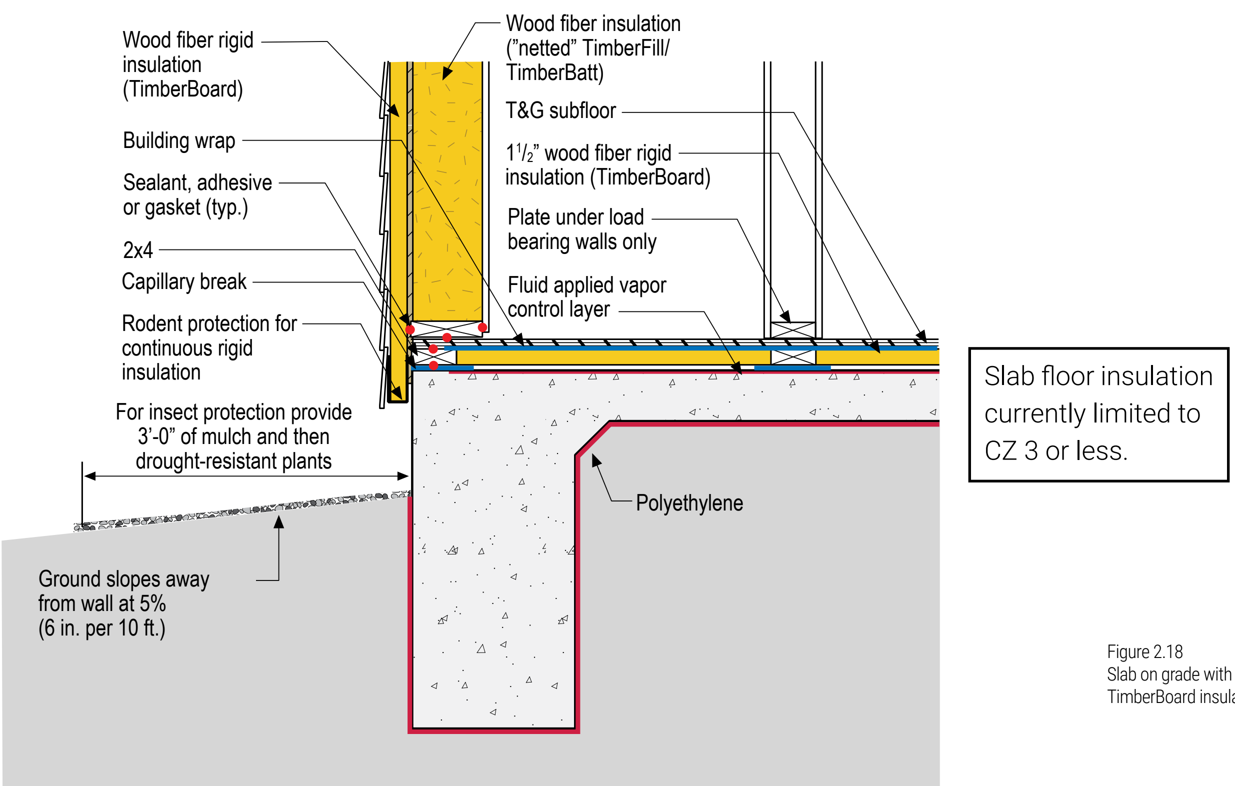


Figure 2.18
Slab on grade with TimberBoard insulation

Climate Zones:

3

4

5

Crawl spaces are typically constructed as “vented” crawl spaces and elevated above grade when high water tables and flooding issues are a concern. Figure 2.19 is an example of recommended vented crawl space construction. Note the continuous rigid insulation on the underside of the floor framing. This rigid insulation’s primary function is to protect the floor assembly from moisture. Exterior wood fiber rigid insulation – TimberBoard or the protection board applied to it should be coated with a fluid applied vapor barrier as it acts as the primary vapor control layer of the assembly. Sheet vapor barriers could be incorporated instead of fluid applied, and should be placed between TimberBoard and protection board. The protection board in necessary to add resistance to fire, insects and vermin.

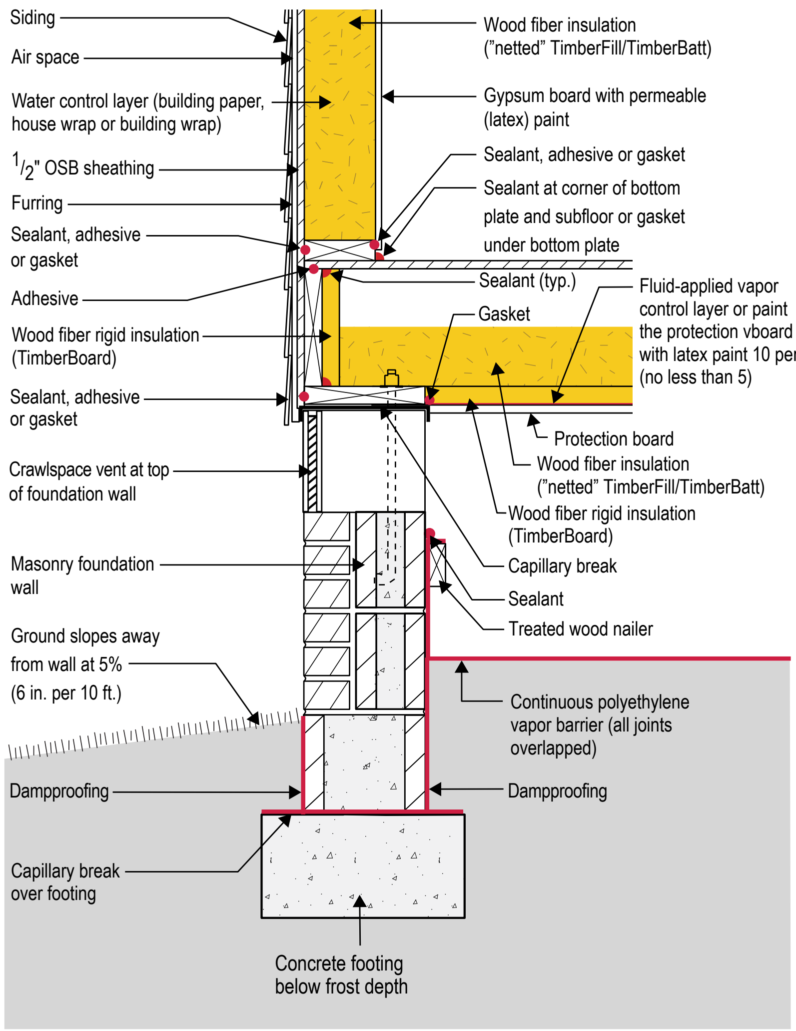


Figure 2.19
Vented crawlspace with continuous insulation

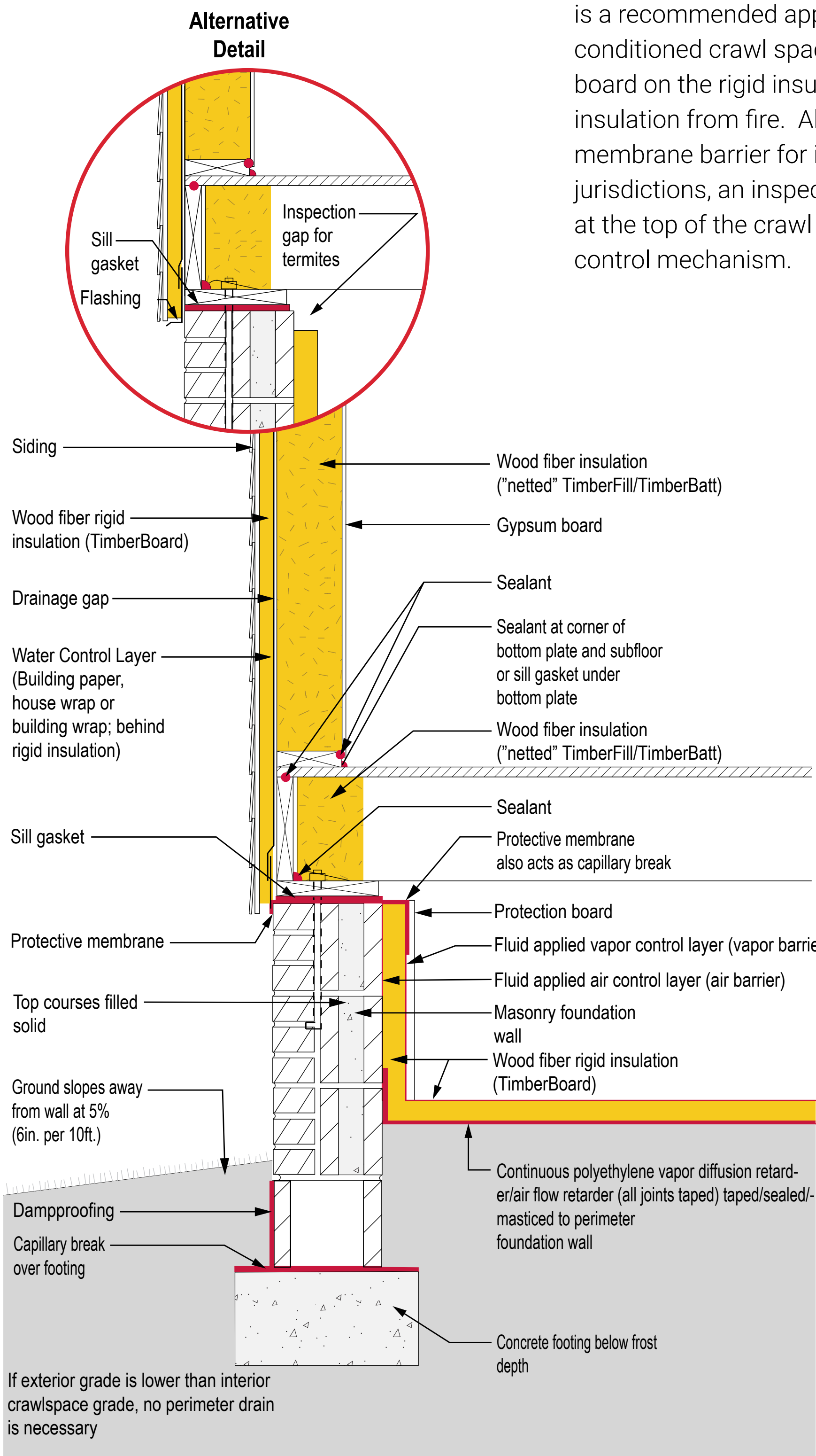
Climate Zones:

3

4

5

Unvented crawl spaces should be only considered where flooding is not a concern. Figure 2.20 is a recommended approach to constructing conditioned crawl spaces. Note the protection board on the rigid insulation protecting the rigid insulation from fire. Also note the fully adhered membrane barrier for insect control. In some jurisdictions, an inspection strip or gap is required at the top of the crawl space wall as an insect control mechanism.



Insulation at grade currently limited to CZ 3 or less.

Figure 2.20
Unvented crawlspace

Climate
Zones:

3

4

5

Basement foundations are often insulated from the interior due to constructibility issues, thermal bridging issues with brick veneer construction, insect control and vermin issues and cost issues.

Figure 2.21 and Figure 2.22 illustrate means of constructing insulated basements.

Figure 2.21
Insulated basement with semi-permeable vapor control

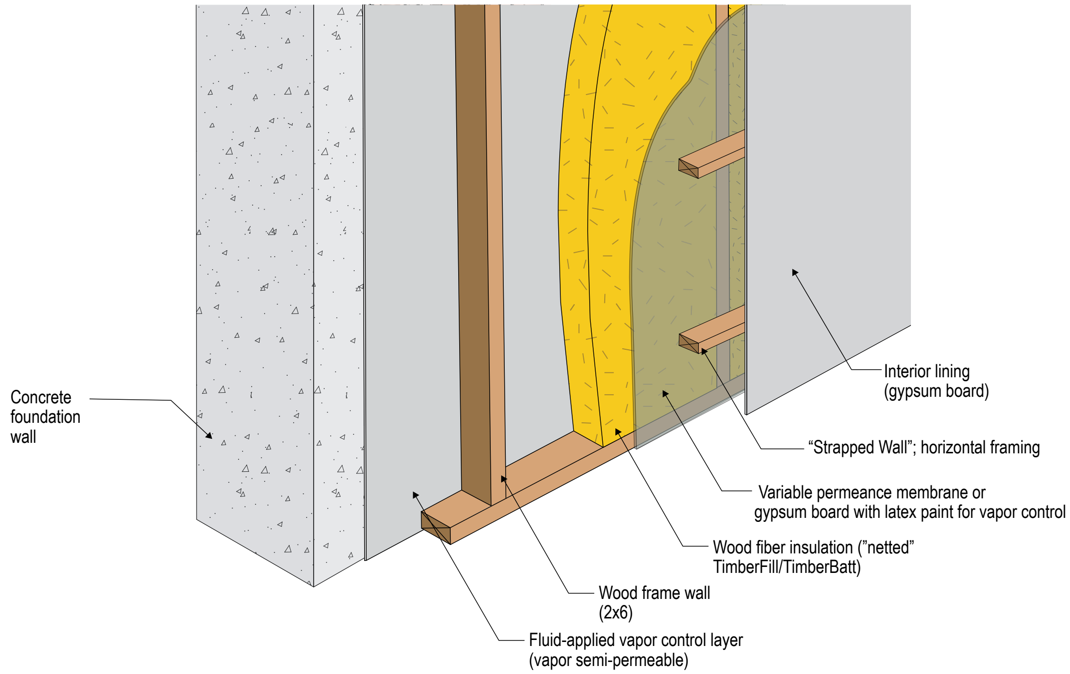
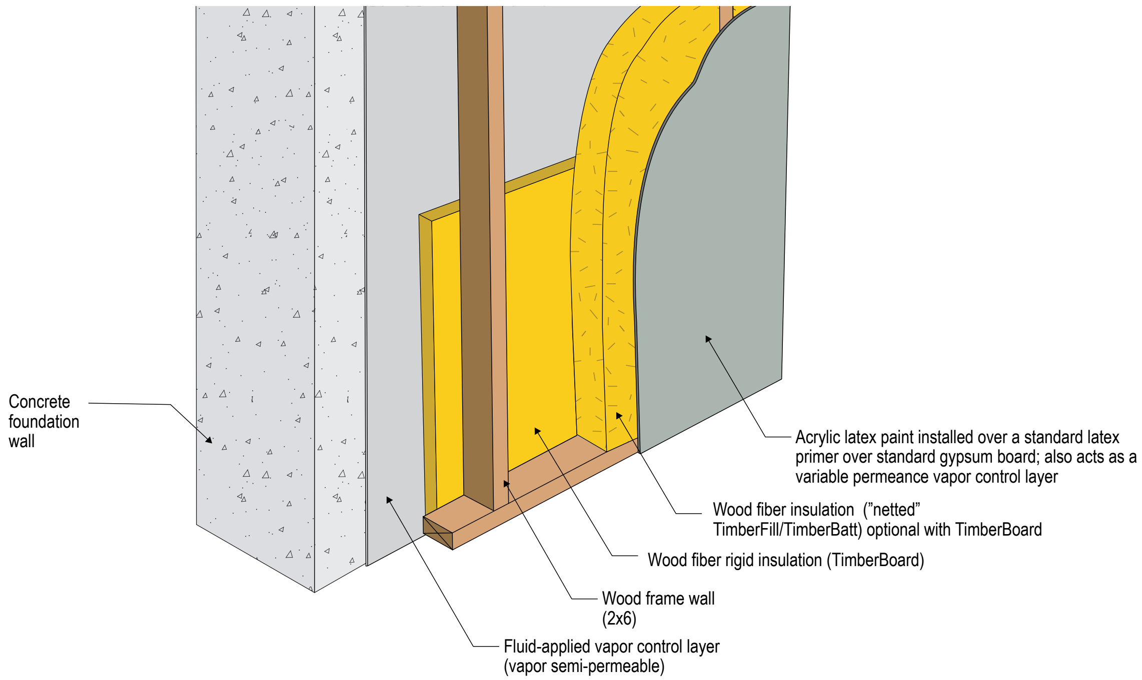


Figure 2.22
Insulated basement with secondary vapor control layer with TimberBoard



Climate Zones:

3

4

5

Walls

A common approach to construct wood frame walls is illustrated in Figure 2.23. The key elements of this wall is the gap between the cladding and the rigid insulation used to control hydrostatic pressure. Wood frame building cavities are typically insulated with cavity insulation ("netted" TimberFill/TimberBatt) and externally insulated with exterior wood fiber rigid insulation – TimberBoard.

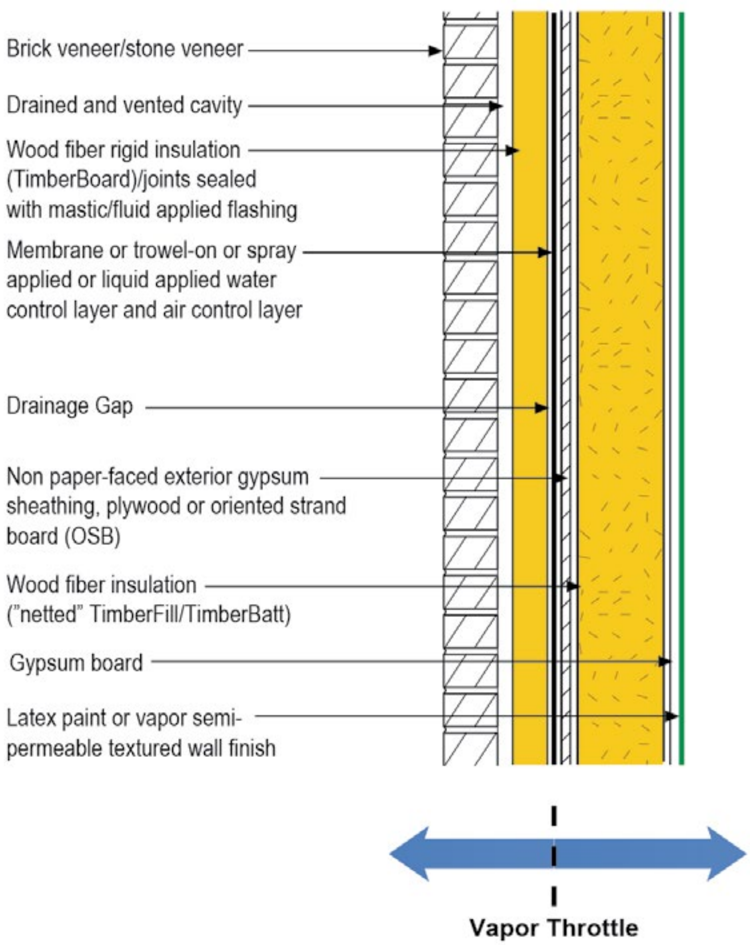


Figure 2.23
Wood framed wall with vented cladding

Climate Zones:

3

4

5

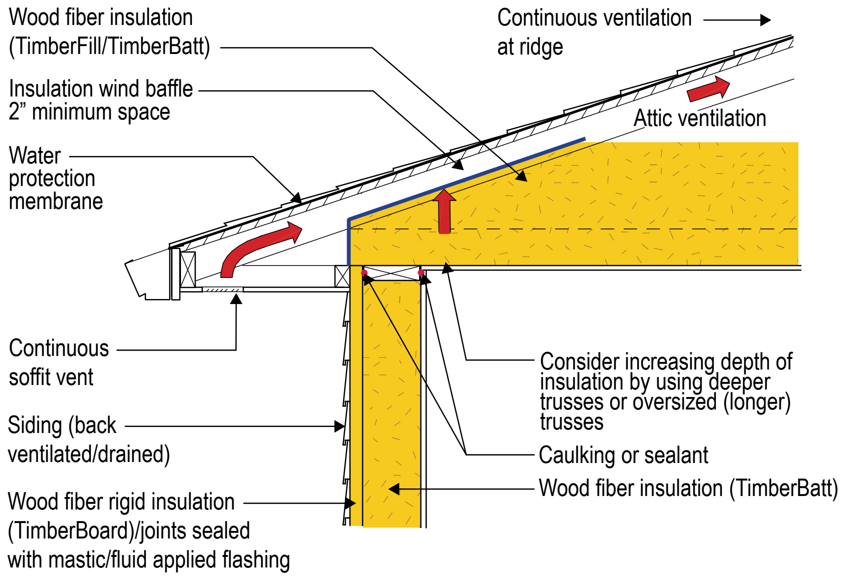


Figure 2.24
Roof Assembly with Vented Attic

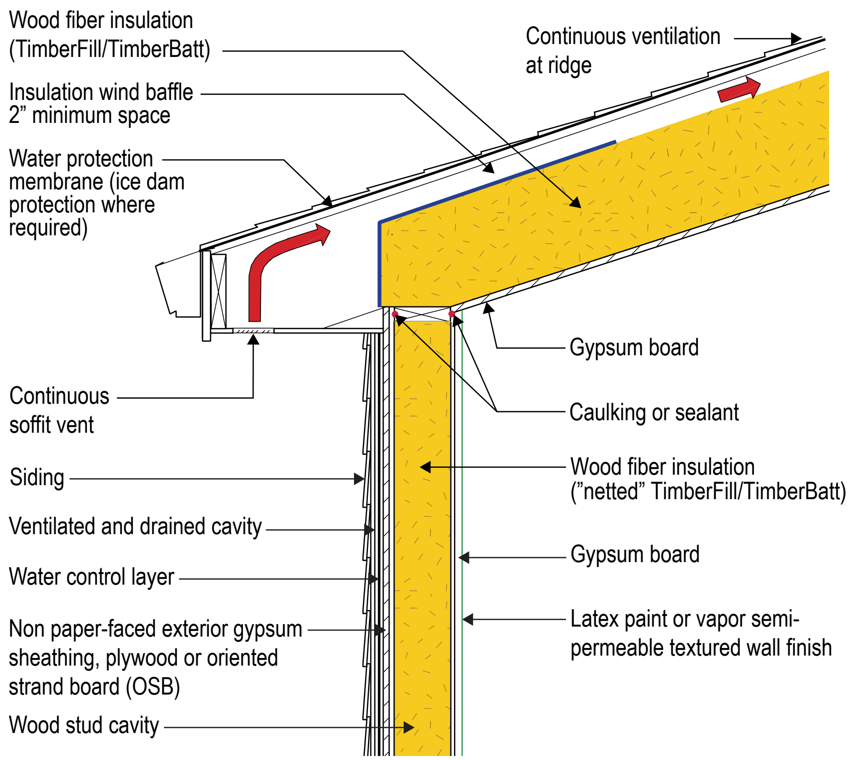


Figure 2.25
Vented roof assembly with sloped ceiling and baffle vents

Climate Zones:

3

4

5

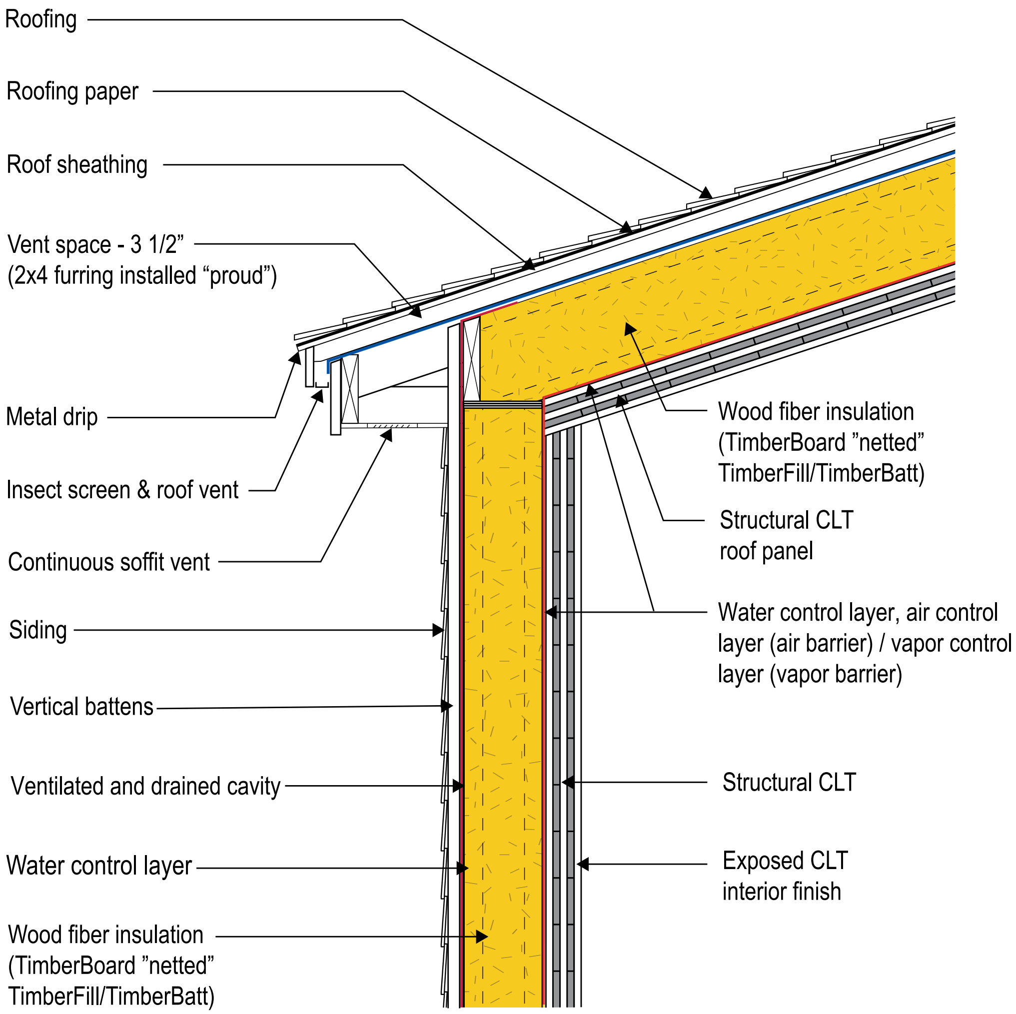


Figure 2.26
Vented-over-roof assembly
with furring strips

Climate Zones:

3

4

5

Roofs

The most common approach to roof construction in these climate zones is a vented attic. Figure 2.24; Figure 2.25 and Figure 2.26 illustrate the recommended approaches to constructing vented attics.

TimberBoardHD FOR ROOF APPLICATIONS, can be used in unvented roofing assembly construction is illustrated in Figure 2.27; Figure 28 and Figure 29. The amount of rigid insulation above the roof deck relative to the amount of insulation under the roof deck in Figure 2.28 and Figure 29, is specified by the IRC and the IBC to control condensation.

The same approach can be used with flat roofs (Figure 2.30).

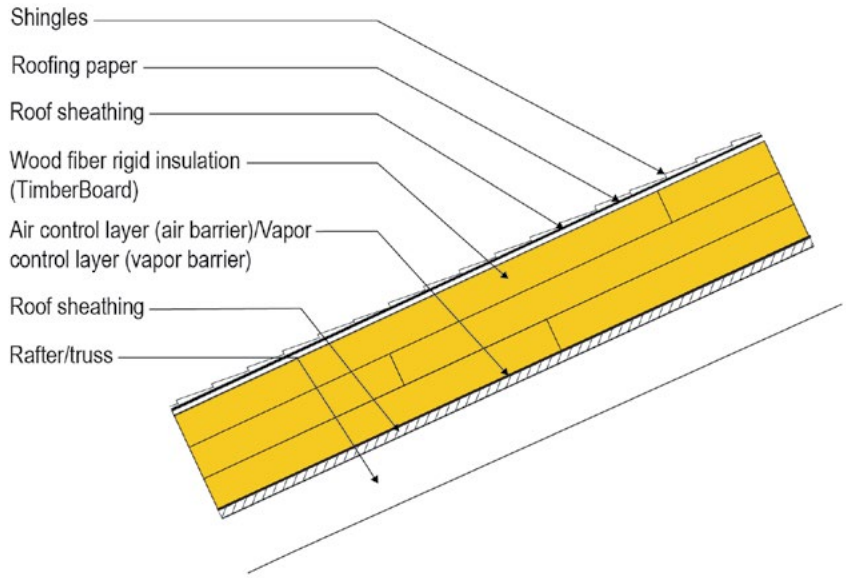


Figure 2.27
Unvented roof assembly with continuous exterior insulation to be used in combination with diffusion port at ridge shown in figure 2.29

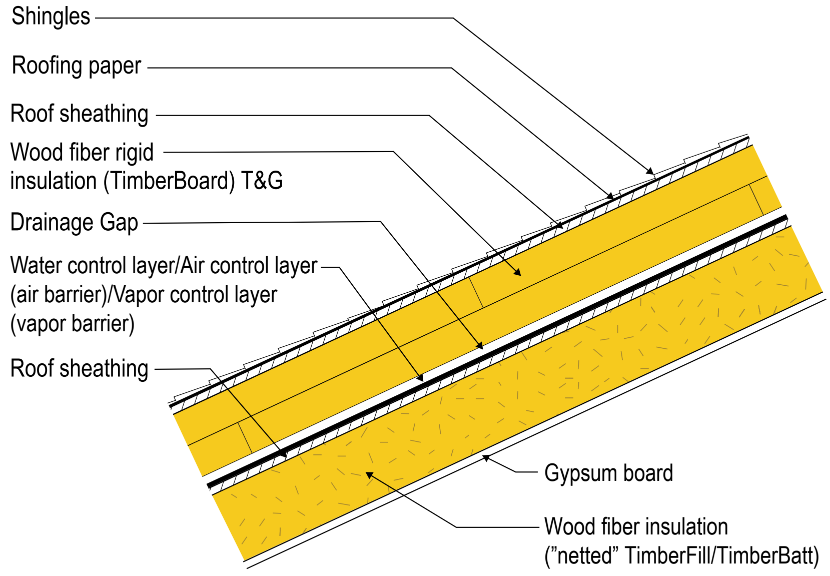


Figure 2.28
Unvented roof assembly with continuous exterior insulation and interior cavity insulation to be used in combination with diffusion port at ridge shown in figure 2.29

Climate Zones:

3

4

5

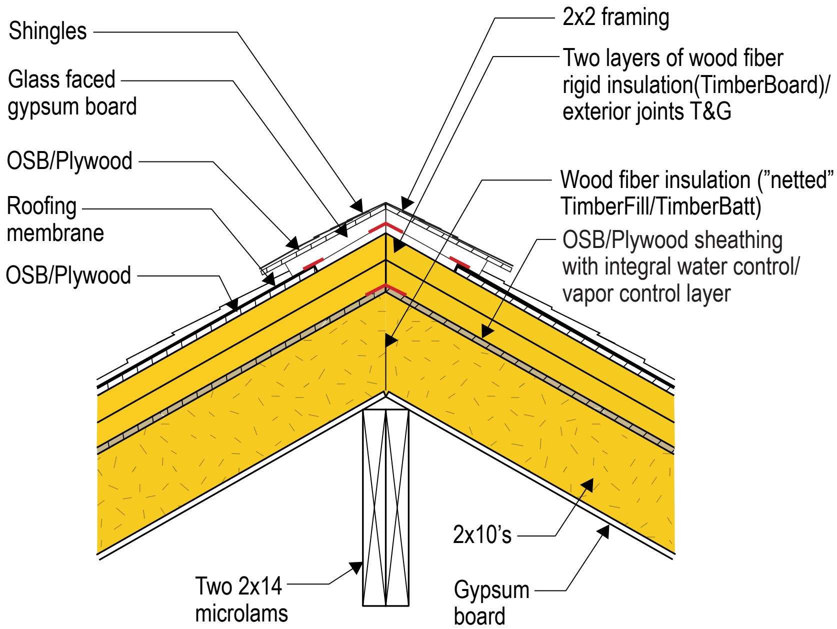


Figure 2.29
Diffusion port for unvented roof assembly

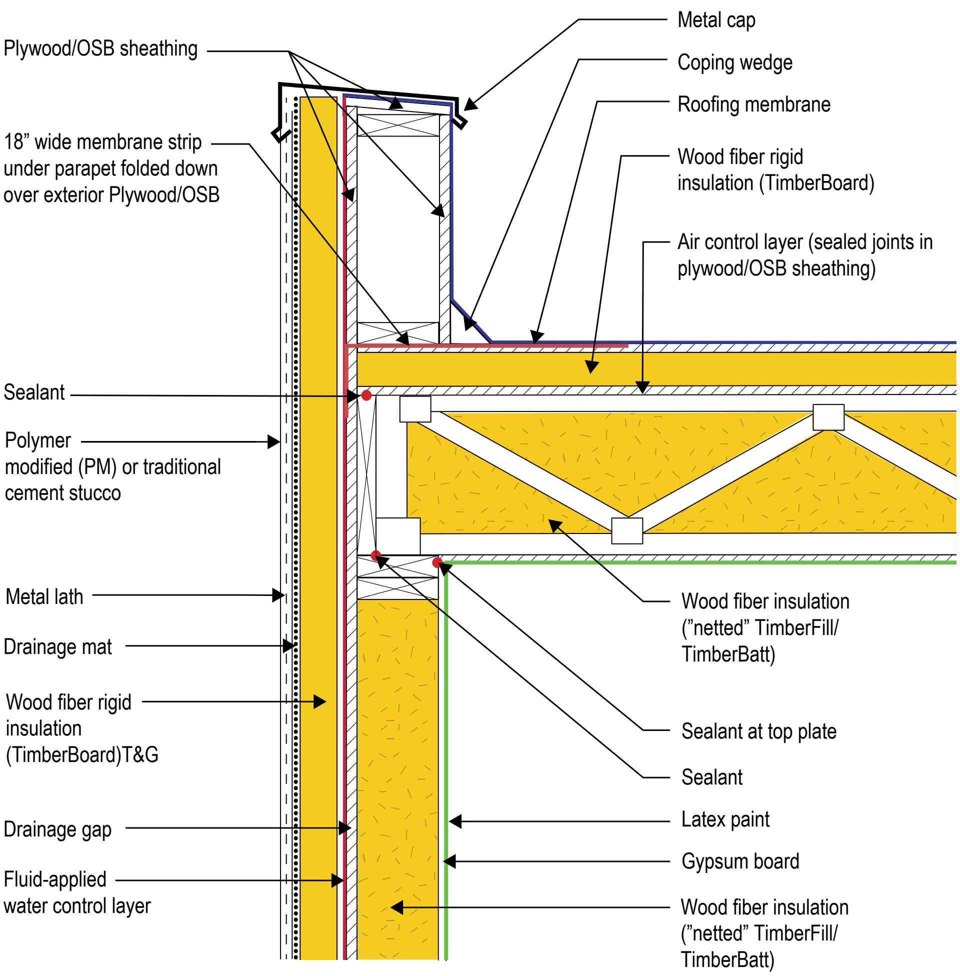


Figure 2.30
Unvented flat roof

Climate Zones:

3

4

5

In areas where the ground snow load exceeds 50 lb/ft2 only vented roofs should be constructed in order to address ice-dam issues. In some applications, a "vented over roof" is installed over an "unvented under roof" to address ice-dam issues (Figure 2.31, Figure 2.32 and Figure 2.33).

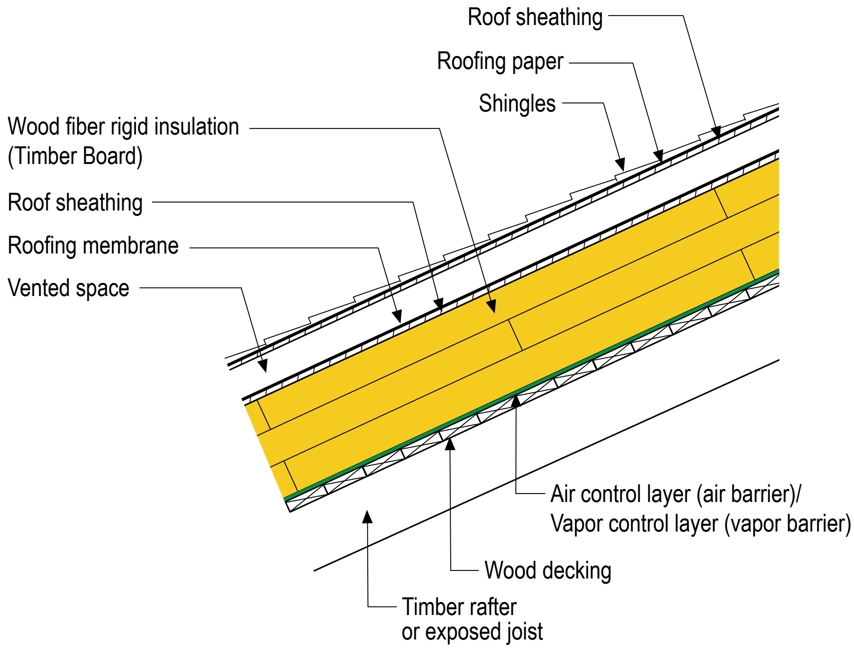


Figure 2.31
Vented over roof

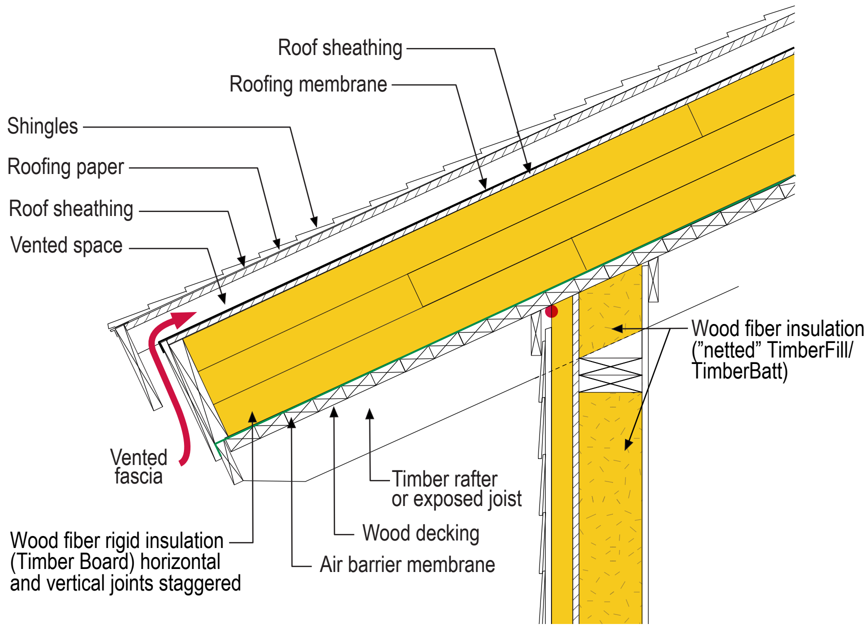


Figure 2.32
Vented over roof fascia detail

Climate Zones:

3

4

5

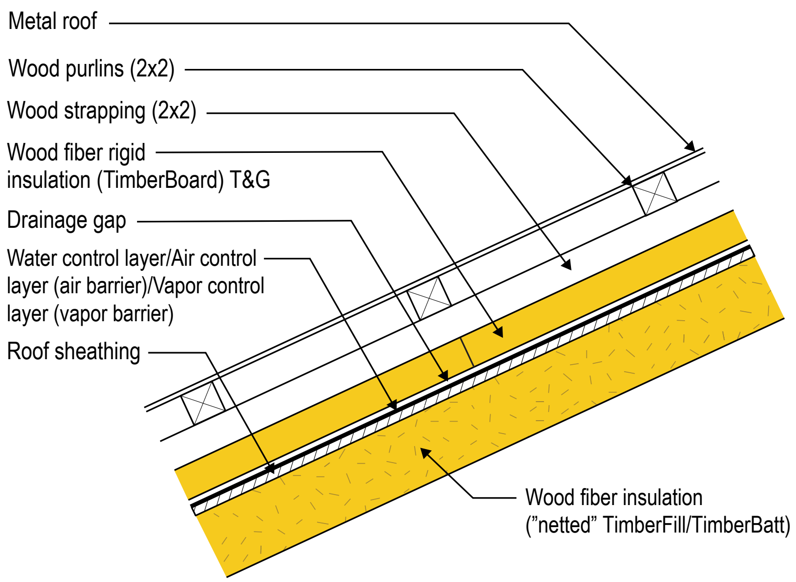


Figure 2.33
Strapping and purlin detail for some vented-over roofing applications

Climate Zones:

3

4

5

Case Studies

A typical section for Chicago is presented (Figure 2.34) that meets or exceed the 2021 IECC as well as meet the requirements for environmental separation.

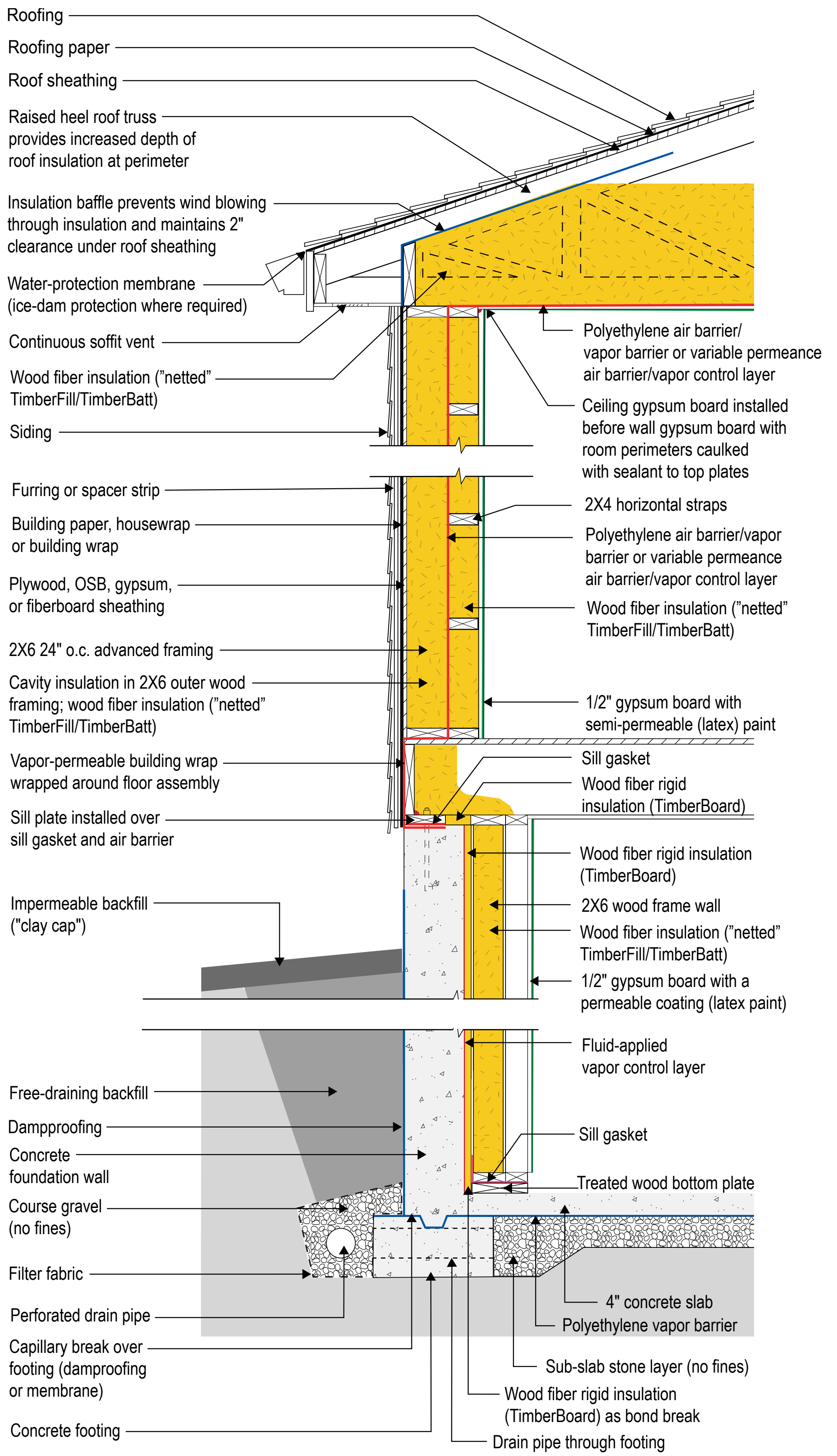


Figure 2.34
Typical Options for climate zones 3,4 & 5

Climate Zones 6, 7, and 8

Climate Zones:

6

7

8

Buildings constructed in these climate zones are constructed principally with basement foundations due to ground frost penetration concern.

Walls are a mixture of wood frame, steel stud and concrete assemblies. Where wood framing is used 2x6 framing is the most common. Continuous exterior rigid insulation is generally used.

Roof construction is predominately vented attics. Some unvented roof assemblies are being constructed, but they are not common.

Basement foundations are often insulated from the interior due to constructibility issues, thermal bridging issues with brick veneer construction, insect control and vermin issues and cost issues.

Foundations

Figure 2.35 illustrates a means of constructing insulated basements.

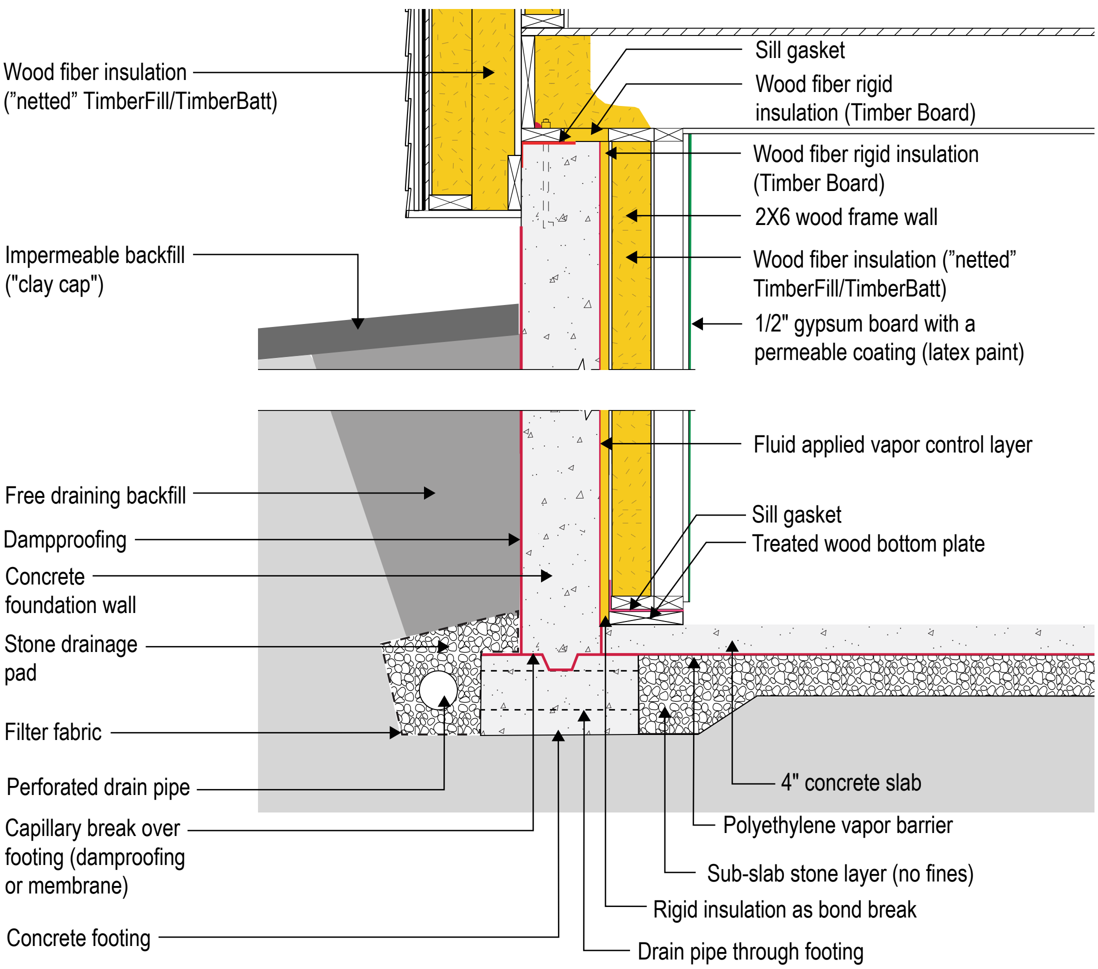


Figure 2.35
Insulated basement

Climate Zones:

6

7

8

Walls

A common approach to construct wood frame walls is illustrated in Figure 2.36. The key elements of this wall is the gap between the cladding and the rigid insulation used to control hydrostatic pressure.

Wood frame building cavities are typically insulated with cavity insulation ("netted" TimberFill/TimberBatt) and externally insulated with exterior wood fiber rigid insulation – TimberBoard.

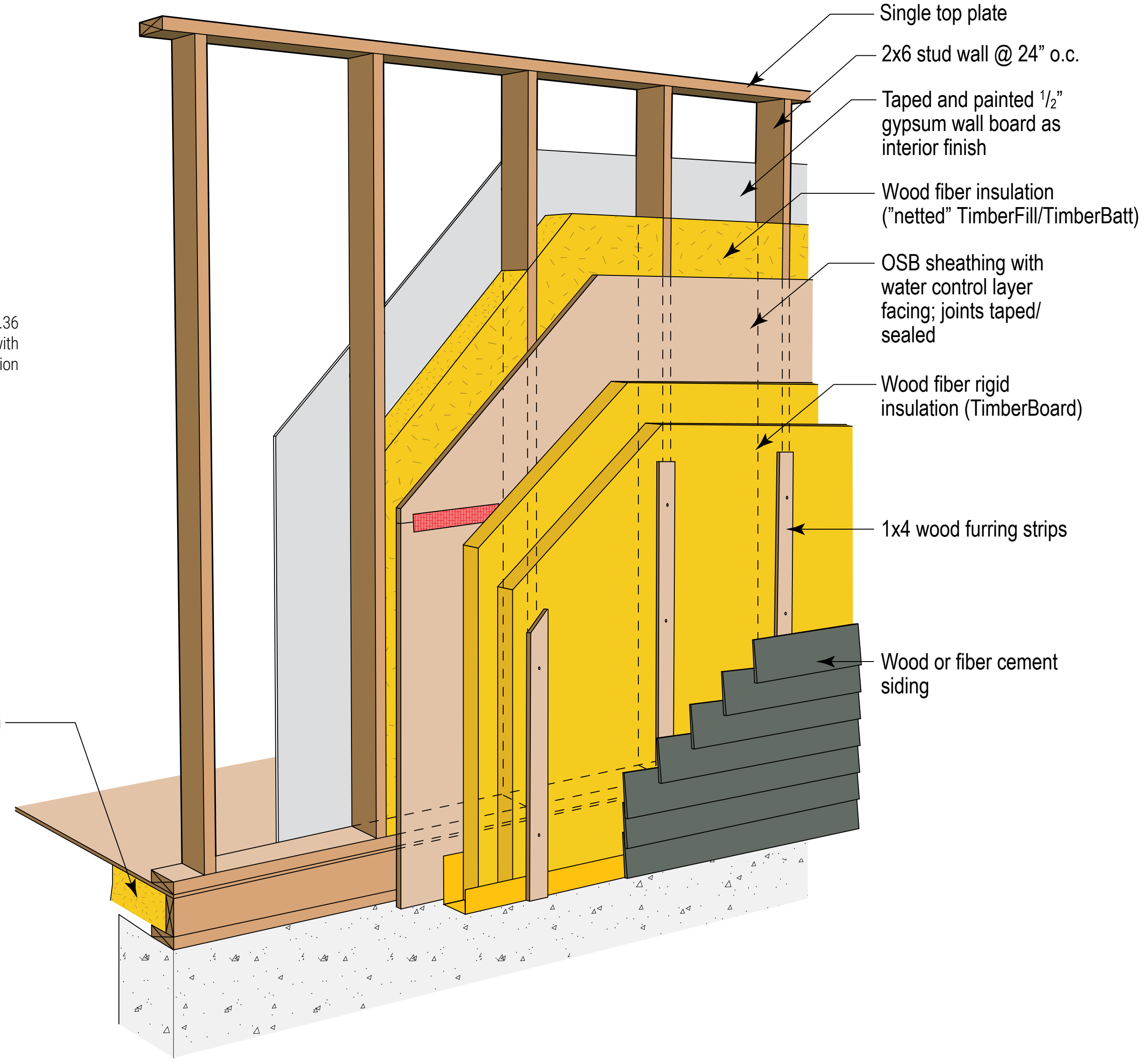


Figure 2.36
Wood framed wall with continuous insulation

Climate Zones:
6
7
8

Roofs

The most common approach to roof construction in these climate zones is a vented attic. Figure 2.37, Figure 2.38 and Figure 2.39 illustrates the recommended approaches to constructing vented attics.

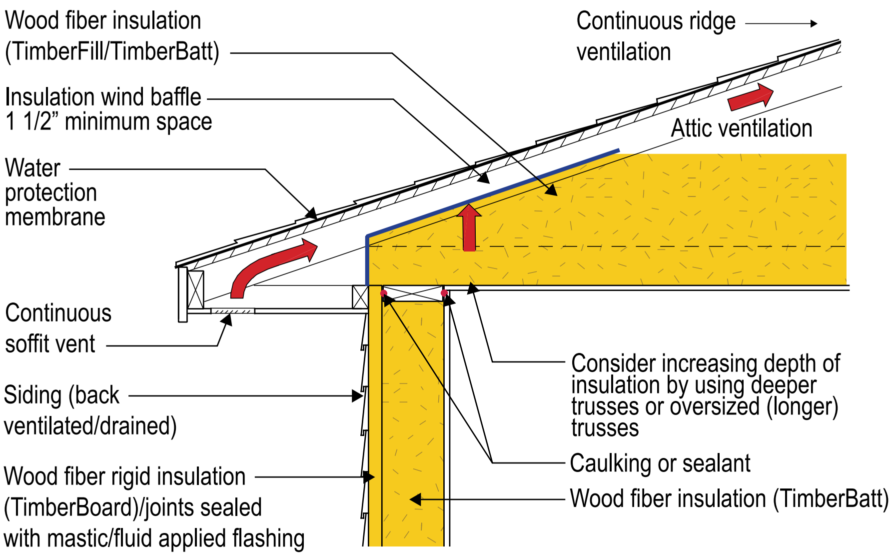


Figure 2.37
Roof Assembly with Vented Attic

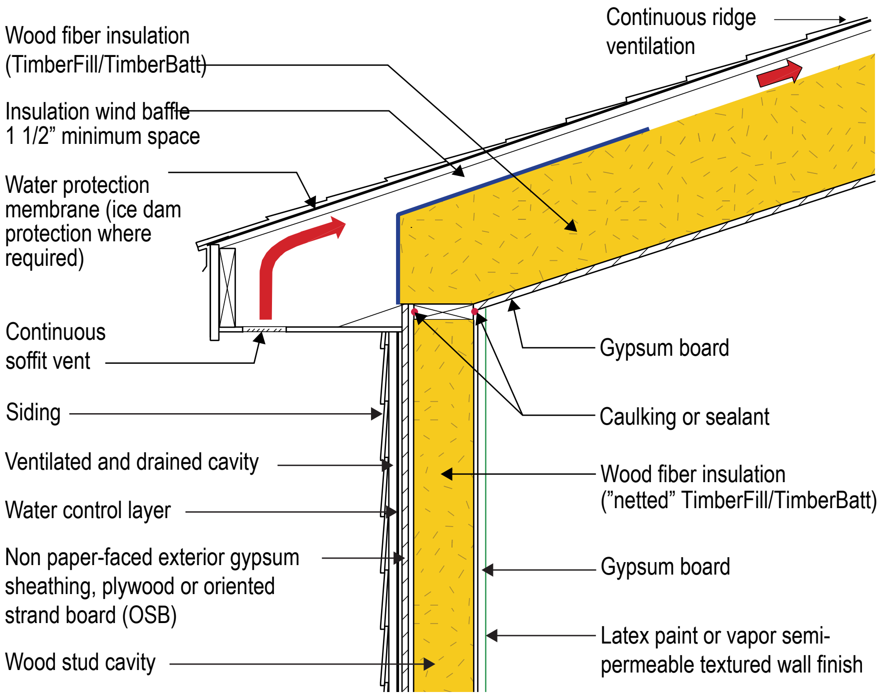


Figure 2.38
Vented roof assembly with sloped ceiling and baffle vents

Climate Zones:

6

7

8

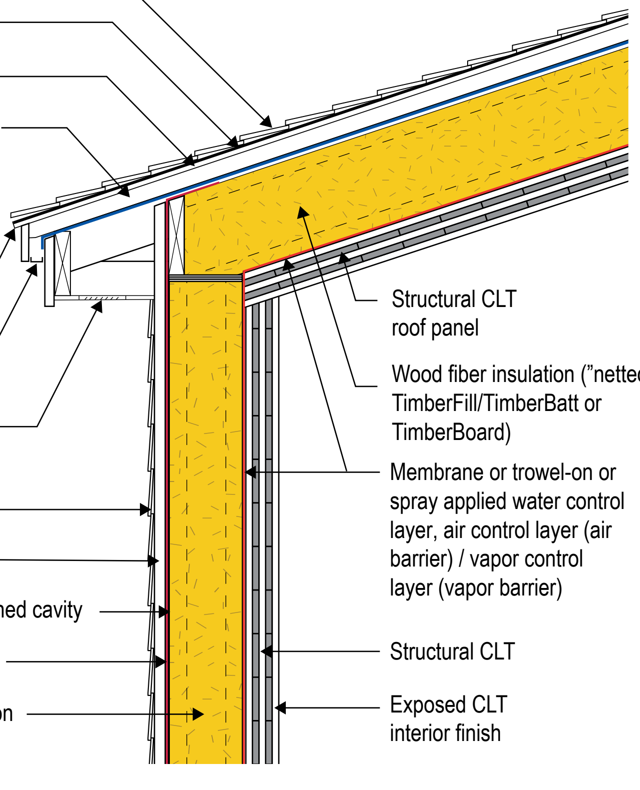


Figure 2.39
Vented-over-roof assembly with furring strips

Unvented roofing assembly construction is illustrated in Figure 2.40, Figure 2.41 and Figure 2.42. The amount of rigid insulation above the roof deck relative to the amount of insulation under the roof deck in Figure 2.41 and Figure 2.42 is specified by the IRC and the IBC to control condensation. These unvented assemblies work depending on snow load. Please see overvented details following where snow loads exceed 50 lb/ft^2.

Climate Zones:

6

7

8

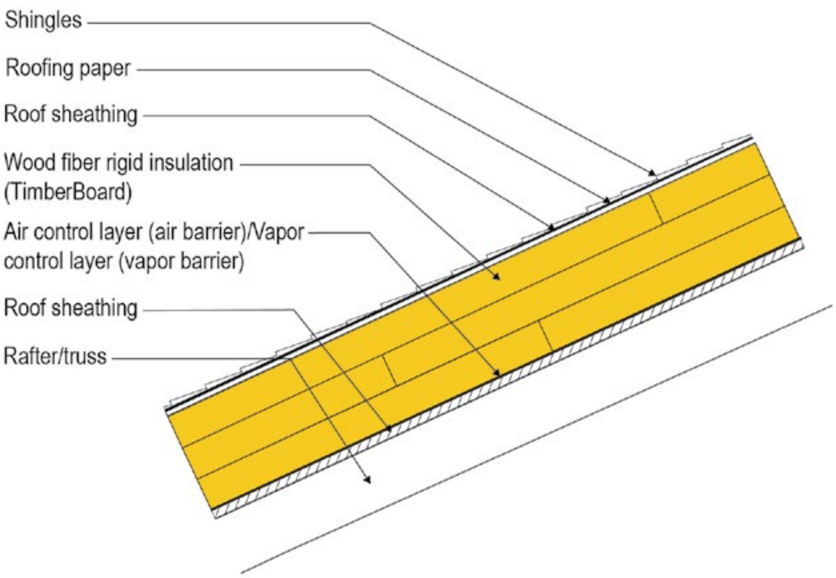


Figure 2.40
Unvented roof with all exterior TimberBoard

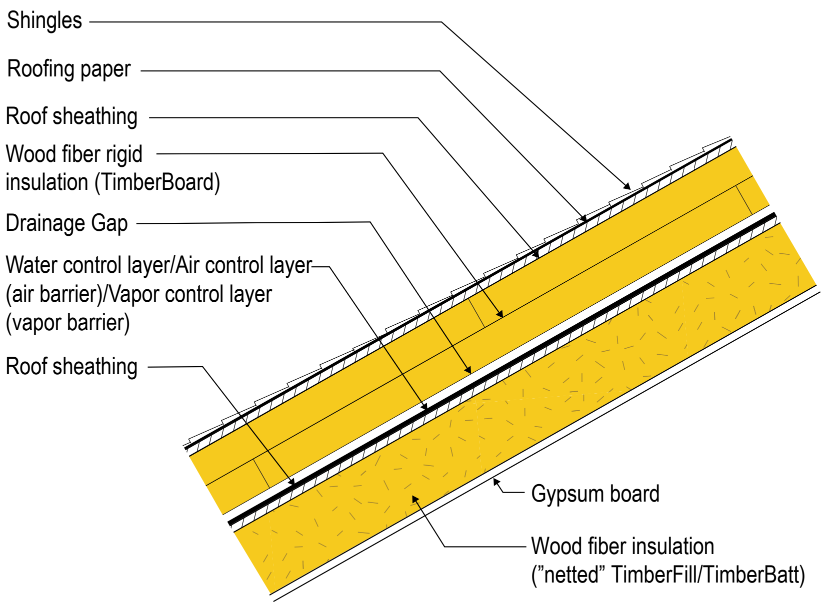


Figure 2.41
Unvented roof with TimberBoard continuous exterior insulation combined with TimberFill or TimberBatt interior insulation.

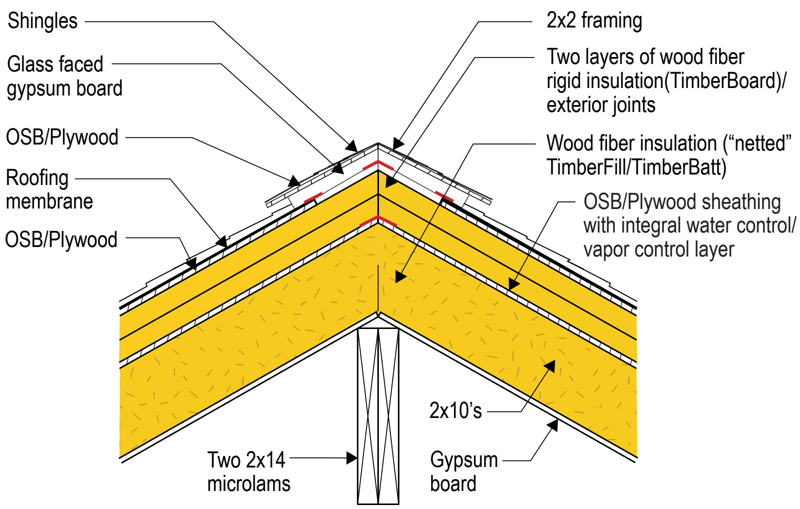


Figure 2.42
Diffusion port at ridge in unvented roof

Climate Zones:
6
7
8

The same approach can be used with flat roofs (Figure 2.43).

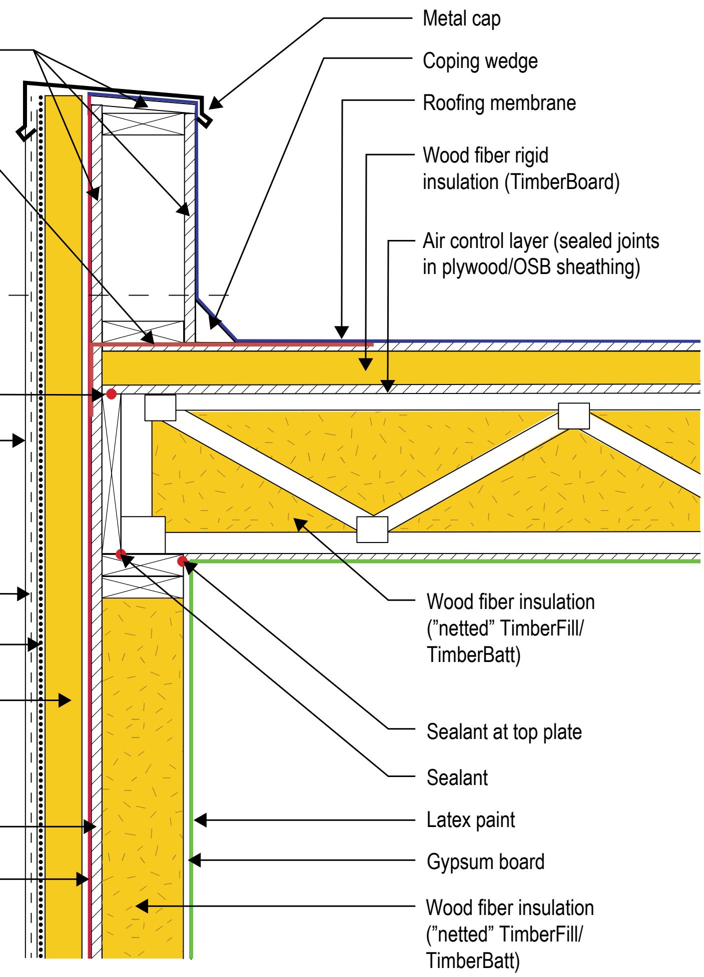


Figure 2.43
Flat roof detail

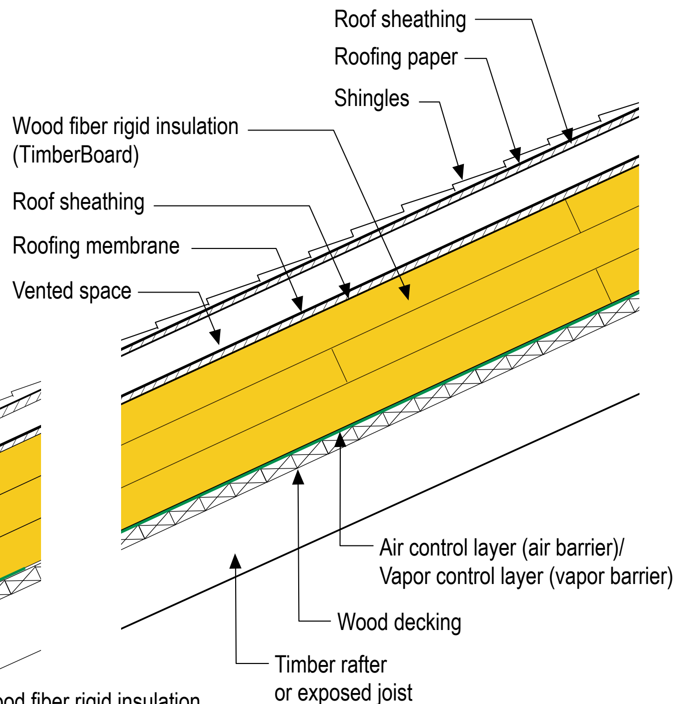
Climate Zones:

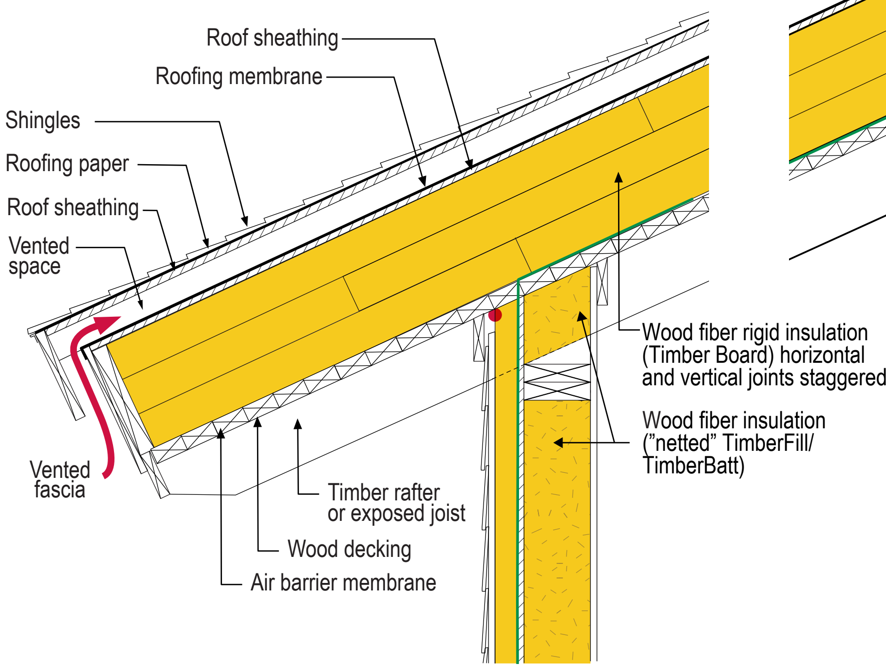
6

7

8

In areas where the ground snow load exceeds 50 lb/ft^2 only vented roofs should be constructed in order to help prevent ice-dam issues. In some applications a "vented over roof" is installed over an "unvented under roof" to address ice-dam issues (Figure 2.44, Figure 2.45 and Figure 2.46).





▲ Figure 2.44
Over-vented roof to address higher snow loads

◄ Figure 2.45
Fascia detail for over-vented roof

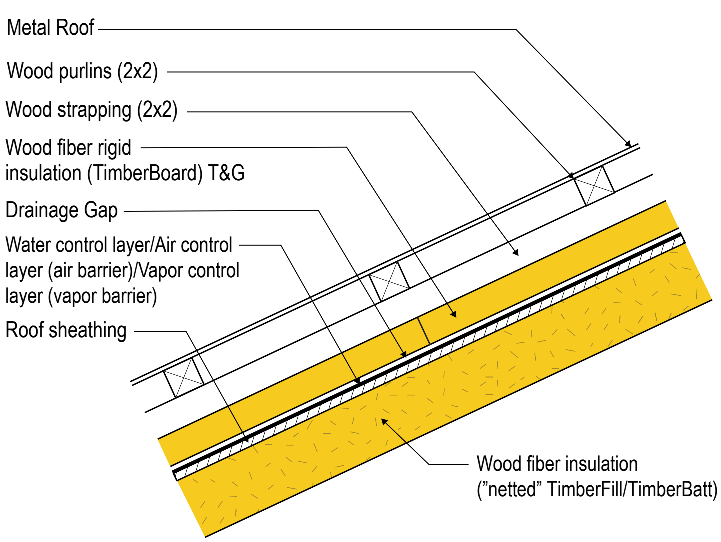


Figure 2.46
Over-vented roof with strapping and purlins

Climate Zones:

6

7

8

Case Studies

A typical section for Minneapolis (Figure 2.47) is presented that meets or exceed the 2021 IECC as well as meet the requirements for environmental separation

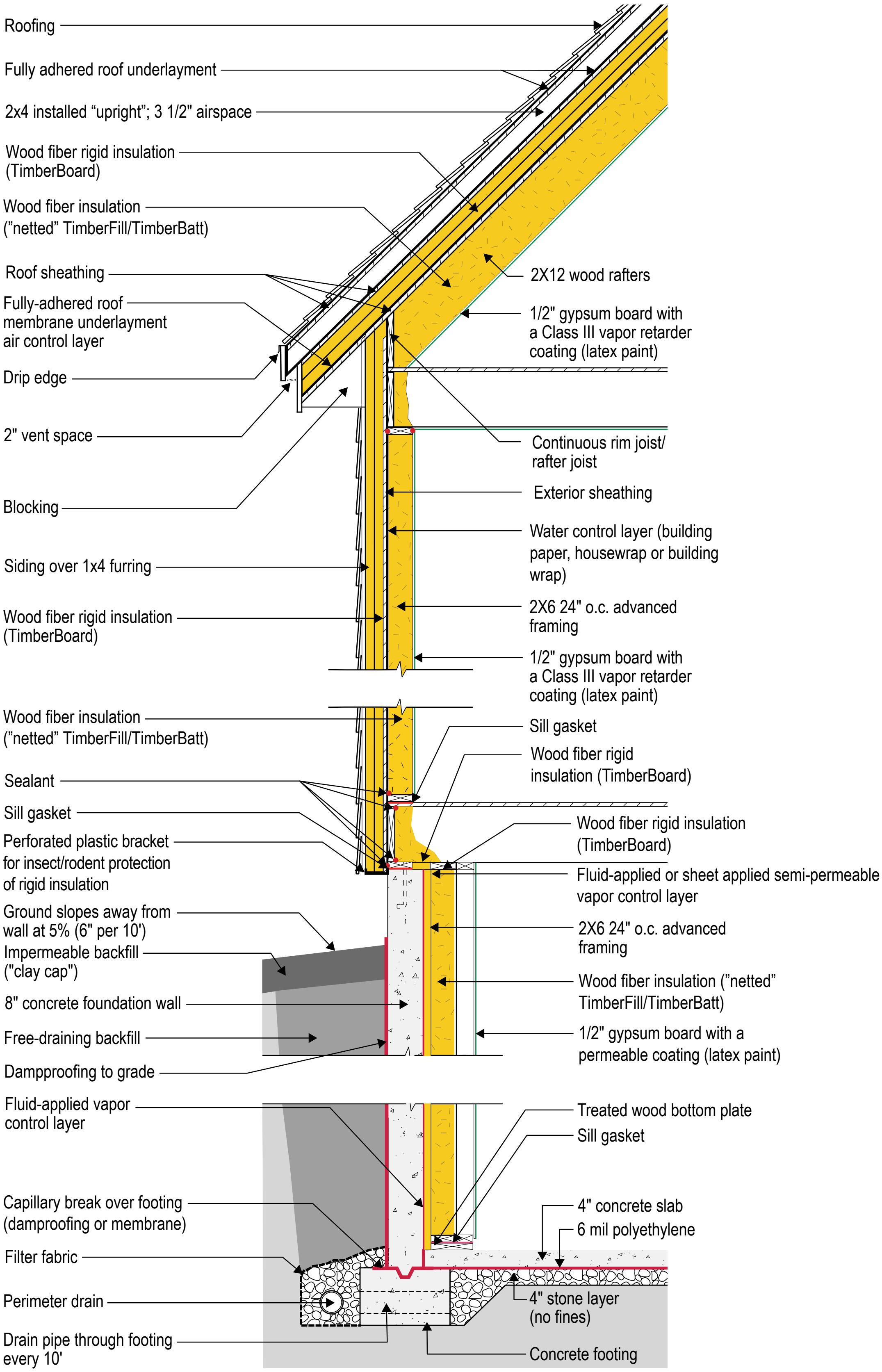


Figure 2.47
Typical Options for climate zones 6,7,8

Appendix

Acoustic Testing Data

TimberBoard Cut Sheet

TimberBatt Cut Sheet

TimberFill Cut Sheet

TIMBERHP

INSULATE BETTER. LIVE BETTER.™

ACOUSTIC TESTING DATA

Assembly	STC*	OITC	RAL #
3-5/8" Metal Studs 16" o.c. TimberBatt acoustic, RCSD on Source Side, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	53	34	TL23-007
3-5/8" Metal Studs 16" o.c. TimberBatt acoustic, Single Layer of 5/8" Type X Gypsum Board on Both Sides	46	30	TL23-008
3-5/8" Metal Studs 24" o.c. TimberBatt acoustic, RCSD on Source Side, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	53	32	TL23-009
3-5/8" Metal Studs 24" o.c. TimberBatt acoustic, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	49	30	TL23-010
2x4 Wood Studs Studs 16" o.c. TimberBatt, RCSD on Source Side, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	50	31	TL23-012
2x4 Wood Studs Studs 16" o.c. TimberFill, RCSD on Source Side, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	50	32	TL23-013
2x6 Wood Studs Studs 16" o.c. TimberBatt, RCSD on Source Side, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	55	37	TL23-015
2x6 Wood Studs Studs 16" o.c. TimberFill, RCSD on source side, Single Layer Of 5/8" Type X Gypsum Board on Both Sides	53	38	TL23-017

*STC (Sound Transmission Class), and OITC (Outdoor Indoor Transmission Class), ratings for metal and wood framed assemblies insulated with TimberHP Batt and Fill products.
STC ratings are an assembly's ability to reduce sound decibel levels transmitted through that wall, ceiling or floor.

Material Details

Product Name	Thickness	NRC**	RAL #
TimberFill	5-1/2 inch	1.15	A22-003
TimberBatt	5-1/2 in	1.15	A22-007
TimberBoard (Single layer)	1-1/2 inch	0.85	A22-004
TimberBoard (Two layers)	3 inch	0.85	A22-005
TimberBoard (Single layer)	5-1/2 inch	1.00	A22-006

**The NRC (Noise Reduction Coefficient) represents the percent of sound directed at the surface that is absorbed by the wood fiber insulation. Anything over .80 is very effective.

Manufactured by:
TimberHP ™
1-855-755-1359 • www.TimberHP.com
1 Main St Madison, ME 04950

MADE IN USA

INSULATE BETTER. LIVE BETTER.™

PRODUCT DATA SHEET

TimberBoard by TimberHP

Product Description

Manufacture of TimberBoard begins with softwood chips produced from FSC-certified forests, adhesive and Paraffin. Compressing the mixture creates a single-ply continuous insulation ideal for addressing thermal bridging and improving overall performance of the building envelope. Boards range in thickness from 1" to 9.25" at widths of 24" and 48" with lengths up to 8', and can deliver R-3.4 to 3.7 per inch. The continuous tongue and groove detailing of TimberBoards creates an excellent wind-resistant assembly that remains vapor open, while the composition of the board delivers a hydrophobic surface to repel water.

Applications

TimberBoard is an ideal continuous insulation for roofs and above-grade walls. The rigidity and density of wood fiber board products make them easy to handle, cut, and install. Traditional wood cutting tools work well.

Market Position

TimberBoard replaces foam board insulations, such as expanded polystyrene (EPS), extruded polystyrene (XPS), and polyisocyanurate (PIR) in above-grade applications. Continuous foam board insulations can trap moisture in wood frame structures, leading to mold, mildew, and rot. TimberBoard is highly vapor permeable, allowing indoor humidity to escape. Wood fiber, through low thermal conductivity and high heat capacity, balances temperature swings in conditioned spaces to reduce both heating and cooling loads. TimberBoard offers high compressive strength, increasing the speed and precision of cladding installation. Wood fiber continuous insulation meets residential fire standards and is superior to most foam products in flame tests. TimberBoard does not release toxic emissions related to burning petroleum-based products. The product line is recyclable, non-toxic, and arrives at the jobsite with a negative carbon footprint.

TECHNICAL DATA

Description	Rigid Wood Continuous Insulation
Full Declaration	Softwood Fibers, PMDI (bonding), Paraffin Wax (waterproofing)
R-Value	3.4 to 3.7 / inch
Vapor Permeability	40 perm @ 1 inch
Compressive strength	10-20 psi
Fire Protection	Class B ASTM E84

DIMENSIONS

Edge Profile	Tongue & Groove | Square Edge
Board Thickness	1"(R3.6); 1.5"(R5+); 2"(R7); 2.5"(R9); 3.5"(R13); 4"(R15); 5.5"(R20); 7.25"(R26); 9.25"(R34)

Key Attributes

- R-3.4 to R-3.7 per inch
- Continuous insulation solution for walls and roofs to reduce energy loss and prevent thermal bridging
- Windproof, water-resistant, vapor open material that manages moisture instead of trapping it
- Carbon storing, renewable/sustainable, recyclable, no dangerous off gassing
- Durable, easy to handle, cut and install
- ASTM E84 Class B Flame and Smoke Spread without the addition of flame retardants
- Resists temperature fluctuations in conditioned spaces
- Industry-leading acoustic performance

TimberHP
1 Main Street
Madison, Maine 04950
www.timberhp.com
1-855-755-1359

MADE IN USA

INSULATE BETTER. LIVE BETTER.™

PRODUCT DATA SHEET

TimberBatt by TimberHP

TECHNICAL DATA

Description	Press Fit Batt Insulation for wood frame and steel stud cavities
Full Declaration	Wood fibers, polyamide fibers, boric acid
R-Value	4.0 / inch
Vapor Permeability	46 perm @ 1 inch
Fire Protection	ASTM E84 Class A Flame / Smoke

DIMENSIONS

Batt Thickness	3” ; 3.5” ; 5.5” ; 6” ; 7.25”
Batt Width	15” and 23” (wood stud); 16” and 24” (steel stud)
Batt Length	47” (wood stud), 48” (steel stud)

Product Description
TimberBatt is a flexible, press-fit batt insulation composed of refined FSC-certified softwood fiber treated with borate. Borate is a flame retardant that also inhibits mold growth and mildew. TimberBatt offers R-4 per inch with a density and composition that reduces air infiltration for vapor-open assemblies with industry-leading sound dampening.

Applications
TimberBatt is an ideal thermal and acoustic insulation to replace fiberglass and mineral wool batts. Batts come in 3”; 3.5”; 5.5”; and 7.25” thicknesses for wood assemblies framed at 16” and 24” on center. TimberBatt also comes in widths for steel stud framing at thicknesses of 3”; 3.5”; and 6”.

Market Position
TimberBatt, with its high R-value per inch and density, excels as both a thermal and acoustical solution. Its high heat capacity and low thermal conductivity make it a better insulation for all seasons. TimberBatt’s vapor-open characteristics and safe formulation work to create healthy indoor air and support resilient assemblies. Fully recyclable and possessing a negative carbon footprint, wood fiber batts are a scalable, environmentally-responsible solution.

Key Attributes

- R-4 per inch
- Press-fit, easy and safe handling, cutting, and install
- No irritating fibers or toxic off-gassing
- Resists temperature fluctuations in conditioned spaces due to high density, low thermal conductivity, and high heat capacity—insulation for all seasons
- ASTM E84 Class A Flame and Smoke Spread
- Carbon storing, renewable/sustainable, recyclable
- Air flow resistant, yet vapor open
- Effectively reduces cavity windwashing
- Industry-leading acoustic performance
- Liquid applied borate inhibits mold / mildew (ASTM 739)

TimberHP
1 Main Street
Madison, Maine 04950
www.timberhp.com
1-855-755-1359

MADE IN USA

INSULATE BETTER. LIVE BETTER. ™

PRODUCT DATA SHEET

TimberFill by TimberHP

Product Description

TimberFill blown-in insulation is made of FSC-certified softwood chips refined into a loose-bodied fiber and then blended with borate. Borate is a flame retardant that also inhibits mold and mildew growth. The product is packed in 25lb poly bags and stacked 48 or 42 bags per pallet.

Applications

TimberFill is ideal for both new construction and renovation. Both professionals and do-it-yourselfers can install the product with ease in attic spaces and dense pack in wall, floor, and ceiling cavities using traditional insulation blowers.

Market Position

The size and shape of fibers prevent settling over time, resulting in assemblies with stable, effective R-values. Introducing flame retardant to wood fiber during wet-phase processing results in consistent and long-term fire performance of TimberFill. TimberFill is a universal blown-in solution and is environmentally responsible and safe to install.

LOOSE FILL APPLICATIONS

R-Value at 75° F Mean Temp	Settled Thickness (inches)	Max Sq. Ft./ Bag
13	4.0	56.5
19	5.7	37.7
22	6.6	32.3
26	7.8	27.1
30	8.9	23.3
32	9.5	21.8
38	11.3	18.3
40	11.9	17.3
45	13.4	15.3
48	14.2	14.4
49	14.5	14.1
60	17.8	11.4

TECHNICAL DATA

Description	Wood Fiber Blown-In Insulation
Fire Protection	ASTM E84 Class A Flame / Smoke (Borate)

Key Attributes

- Low thermal conductivity and high heat storage
- Resists settling in dense-pack applications due to interlocking wood fibers
- ASTM E84 Class A <25 Flame and <450 Smoke spread
- Pure, consistent feedstock with no toxins or plastic contaminants
- Industry-leading acoustic performance
- Manages moisture - hydroscopic and vapor open
- Renewable and recyclable
- Carbon-storing
- Liquid applied borate inhibits mold / mildew (ASTM C739)
- Click Here for the 3-part spec

DENSE-PACK APPLICATIONS

Sidewall and Floor Coverage Chart at 3lbs / ft^3

Framing	Installed Thickness (inches)	Thermal Resistance (R value)	Minimum Wt Per Sq. Ft (lb / ft^3)	16 inch o.c. ft^2 / Bag	24 inch o.c. ft^2 / Bag
2 x 4	3.5	13	.88	32.9	31.4
2 x 6	5.5	21	1.38	20.9	20.0
2 x 8	7.25	28	1.81	15.9	15.2
2 x 10	9.25	35	2.31	12.4	11.9

TimberHP
1 Main Street
Madison, Maine 04950
www.timberhp.com
1-855-755-1359

MADE IN USA

TimberHP's Guide for Builders
Roof and Wall Details and Best Practices for Building Better

Send us feedback and submit questions here:

timberhp.me/GFB-feedback

TimberHP
1 Main Street
Madison, Maine 04950
1-855-755-1359

www.timberhp.com

INSULATE BETTER. LIVE BETTER. ™