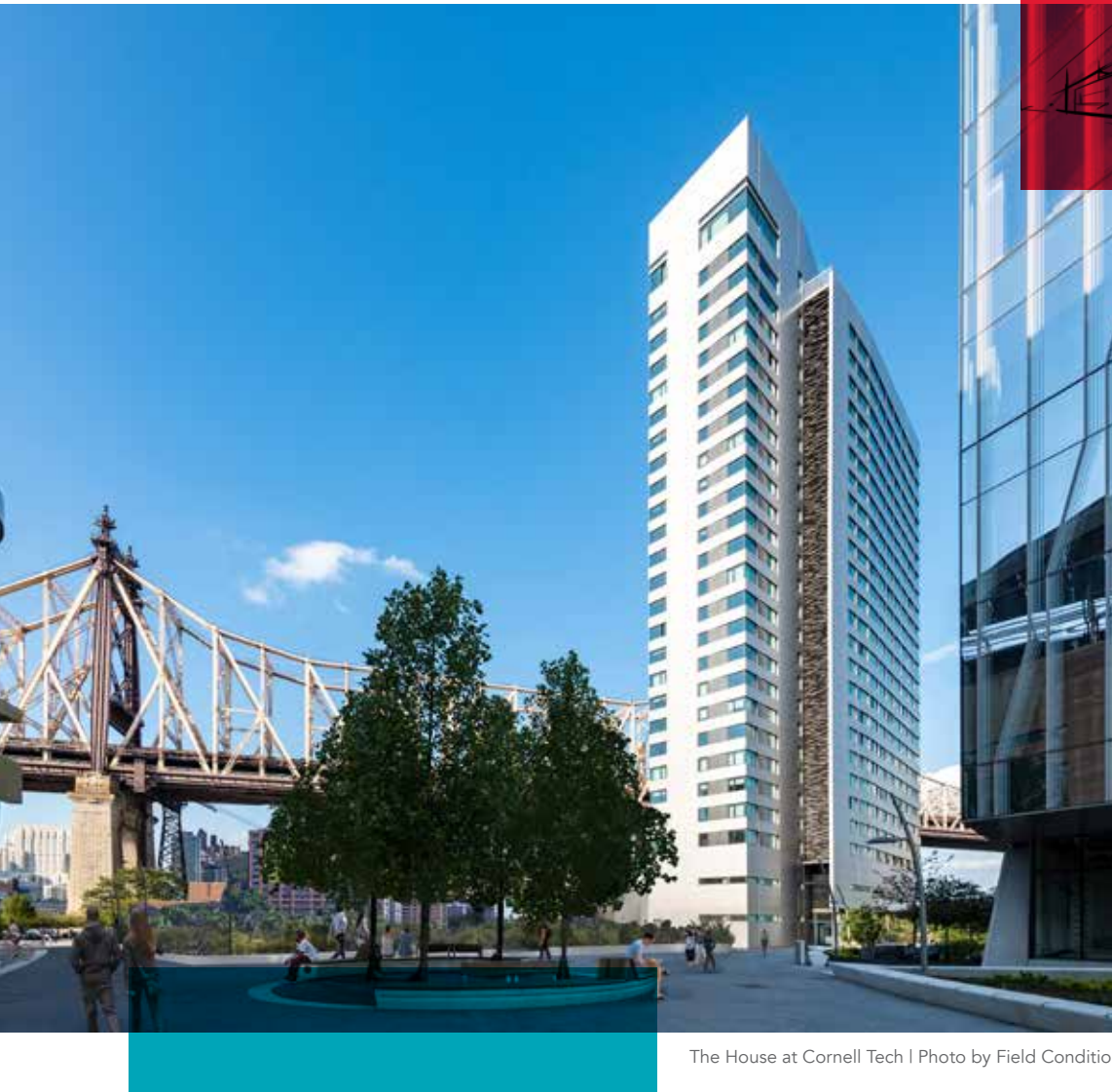


# Passive House Solutions Guide

Achieve superior energy efficiency and occupant comfort with stone wool insulation



The House at Cornell Tech | Photo by Field Condition

# Introduction

Passive House is a voluntary standard for buildings where the primary goals are to achieve superior energy efficiency and occupant comfort. It is an enclosure first “passive” approach that encompasses all aspects of high energy performance, sustainability and resiliency that can be applied to all types of buildings, in all types of climates.

In North America Passive House Requirements are set out by two organizations:

1. International Passive House Institute (PHI) in affiliation with NA Passive House Network (NAPHN)
2. Passive House Institute US Inc (PHIUS) in affiliation with Passive House Alliance US (PHAUS)

ROCKWOOL has two wall enclosure systems certified by PHI: Mass Wall and Steel Frame Wall. The system and details, as outlined in this guide, can be directly incorporated into your project.

For further assistance with your Passive House project, visit [www.rockwool.com/passivehouse](http://www.rockwool.com/passivehouse)

A Passive House is a building, for which thermal comfort (ISO 7730) can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air.

- Passive House Institute



Disclaimer: ROCKWOOL™ has exercised due care to ensure that the data and information contained in this document is accurate. However, this document is intended for general reference only. While the specific enclosure systems and details have been certified by Passive House Institute, actual results may vary depending on a number of independent factors specific to the given end-use application including, but not limited to, design, workmanship, materials, geographic, environmental, and other specific or unique end use conditions. The end-use application is a determination that must be made independently by the architects, engineer and/or consultant in their own professional judgement. ROCKWOOL fully disclaims any liability for any of the content contained herein whether such liability be premised on a theory of contract, tort, or otherwise.

# Why Passive House?

## Energy Efficiency

Energy efficiency is the primary goal for Passive House. Taking a building enclosure first approach, the high R-value requirements reduce the energy demand of buildings up to 90% in comparison to existing buildings and 70% in comparison to typical new constructions. The low energy demand of Passive House designs promote the use of passive solar heating and daylighting as well as smaller mechanical systems which further increases the energy efficiency of a building. Consequently, in comparison to typical buildings where heating and cooling energy is dominant, the energy consumption to power electricity and the total embodied energy of the construction materials used in Passive House buildings becomes more significant.

## Occupant Comfort

Passive House buildings are often described as quiet and comfortable. With most of our day spent indoors, occupant comfort is a critical consideration when designing for high performance. The high performance enclosure in combination with stringent demands for mitigating thermal bridging and air leakage increases interior surface temperatures while reducing the risk of cold draughts and potential for condensation that can lead to poor indoor air quality and occupant comfort. Furthermore, a highly insulated building enclosure helps to improve indoor acoustics creating a productive work environment and a healthy home.

## Sustainable and Resilient

The Passive House standard is often adopted when aspiring to achieve net zero energy buildings. The low energy demands make it easier to incorporate renewable energy sources. Additionally, in times of climate change and severe weather occurrences, high thermal autonomy and resiliency in buildings is critical. A high-performance building enclosure increases the thermal autonomy of a building where the building can passively maintain comfortable conditions without the use of active systems.



**70-90%**

Reduction in Energy Demands of Buildings.

# Passive House Principles

Passive House is a voluntary performance based standard, governed by five fundamental design principles, that promote the use of passive measures prior to the incorporation of active systems.

## Highly Insulated Walls

A highly insulated building enclosure is the key component to achieving Passive House. With high R-value walls, considerations for moisture transport and drying potential as well as fire codes and life safety is critical. The thickness and location of the thermal insulation is dependent on the type of structure, with optimal performance achieved when using all (or mostly) continuous exterior insulation (c.i.).

## Thermal Bridge Free

A thermal bridge is a localised area or component of the building enclosure with a higher thermal conductivity than the surrounding materials, creating a path for heat transfer. Thermal bridges result in an overall thermal resistance reduction leading to cold spots on the interior side of the assembly and risks of condensation within the enclosure.

There are three types of thermal bridges: repeated, linear and point thermal bridges.

A repeated thermal bridge, is often found within the structural component of the enclosure and is taken into account in the overall U-Value calculation. For example, wood studs and/or steel studs.

A linear thermal bridge, expressed as a Psi Value ( $\Psi$ ), is found along the length of the enclosure occurring mainly at component joints, edges and transitions within the building enclosure. For example, a window to wall connection or slab edge are considered linear thermal bridges. Linear thermal bridges are calculated separately using 2D thermal modelling software.

A point thermal bridge, expressed as a Chi Value ( $\chi$ ), occurs at isolated points within the enclosure. For example, insulation attachments and/or fasteners. Point thermal bridges are calculated separately using 3D thermal modelling software.

Along with thermal bridging calculations, the temperature factor,  $FR_{si} = 0.25m^2K/W$ , must be met at the weakest point at the interior side of the detail (i.e. the coldest point on the interior side).

## High Performance Windows

Windows and doors are typical weak points within the thermal enclosure. The use of triple pane high performance windows that are Passive House certified are required for compliance. Window to wall ratios are calculated and determined based on the orientation, glazing type and shading mechanism to take maximum advantage of passive solar daylight.



## Airtight Enclosure

A leaky building enclosure leads to excess heat transfer, cold spots and potential for condensation. To achieve a continuous airtight enclosure, close attention to detail is required at all joints and penetrations. The airtightness of a Passive House is measured by means of an air pressure test of the building.

## Heat Recovery Ventilation

Appropriate mechanical and ventilation systems are critical to ensure clean and fresh air intake and occupant comfort. High performance energy recovery systems (ERV), required for Passive House, help reduce energy losses by taking advantage of heat energy from extract air.



# Building Enclosure Requirements

## 1. U-Value Recommendations:

Opaque Wall and Roof U-Value  $\leq 0.15 \text{ W/m}^2\text{K}$   
( $0.14 \text{ BTU/h}\cdot\text{ft}^2\cdot^\circ\text{F}$ )  
Fenestration (Triple-pane Windows) Ug-Value  $\leq 0.80 \text{ W/m}^2\text{K}$   
( $0.14 \text{ BTU/h}\cdot\text{ft}^2\cdot^\circ\text{F}$ ) and g-value: 0.5 - 0.62

## 2. Thermal-bridge Free:

Linear thermal bridge =  $\Psi_e \leq 0.01 \text{ W/mK}$   
Point Thermal Bridge =  $X \leq 0.005 \text{ W/m}^2\text{K}$

## 3. Airtightness $\leq 0.6 \text{ ACH @ 50Pa}$

## PHI Certification Criteria

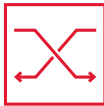
Space heating demand  $\leq 15 \text{ kWh/m}^2\text{yr}$  or Peak heating load  $\leq 10 \text{ W/m}^2$

Space cooling demand  $\leq 15 \text{ kWh/m}^2\text{yr}$  or excess temperature frequency ( $T > 25^\circ\text{C}/77^\circ\text{F}$ )  $\leq 10\%$

Primary energy demand  $\leq 120 \text{ kWh/m}^2\text{yr}$  or primary energy renewable  $\leq 60 \text{ kWh/m}^2\text{yr}$

Airtightness  $\leq 0.6 \text{ ACH@50Pa}$

Heat Recovery Ventilation



Highly Insulated Walls



High Performance Windows



Airtight Enclosure



Thermal Bridge Free



# Benefits of using Stone Wool Insulation

ROCKWOOL™ products meet the call for higher energy efficiency, sustainability, durability and better overall performance in buildings.

## Continuous Insulation

Above-grade wall assemblies can be installed using either only exterior continuous insulation or in combination with interior insulation depending on the construction type. For steel framed applications, ROCKWOOL COMFORTBATT® stud wall cavity insulation can be friction fit between studs. Semi-rigid ROCKWOOL CAVITYROCK® and rigid ROCKWOOL COMFORTBOARD™110 continuous insulation boards for cavity walls and rainscreens are water repellent yet vapor permeable that can be installed on the exterior side of a wall assembly for steel framed and mass wall types.

High density ROCKWOOL TOPROCK® DD and ROCKWOOL MULTIFIX™ can be installed in low sloped roof application, above deck (concrete or steel), providing superior acoustic and fire performance.

## Fire Resistance

With Passive House requirements calling for higher insulating values and the use of continuous insulation, designing with fire resistance and life safety in mind is essential. ROCKWOOL stone wool insulation is extremely resilient to fire. Made of non-combustible material, stone wool insulation has a melting point of approximately 1177°C (2150°F) and it works to contain fire and prevent its spread. At the same time, it does not contribute to the emission of significant quantities of toxic smoke even when directly exposed to fire. This provides a critical line of defense, keeping occupants safe and reducing property damage in the event of a fire.

## Optimal Thermal Performance

A stable building enclosure can dramatically reduce heating, cooling, and ventilation costs, and reduce a building's carbon footprint. The R-value of ROCKWOOL insulation will not change over time because stone wool is not produced with blowing agents, which can off-gas and result in lower thermal performance. Not only is the thermal performance of stone wool insulation maintained over its lifetime, but the wall's thermal performance remains consistent because stone wool products are dimensionally stable. ROCKWOOL insulation will not expand or contract due to temperature variances within the enclosure. These attributes result in optimal thermal performance of a building envelope.



### **Vapor Permeability**

Insulation products, membranes and other building materials all have varying levels of vapor permeability and can potentially act as a vapor retarder. When designing enclosures with thick insulation levels, consideration with regards to the appropriate use of vapor retarders is critical. Depending on the climate location of the building, the vapor retarder profile should be either on the interior or exterior side of the enclosure.

For Passive House buildings, in combination with a vapor permeable water resistive barrier membrane, the use of ROCKWOOL vapor permeable exterior insulation allows for increased potential for drying without trapping moisture in the assembly. Additionally, the use of transient vapor retarders on the interior side, also known as smart membranes”, enables drying potential to the interior when necessary, further enhancing the durability of the enclosure.

### **Acoustic Control and Comfort**

Considering the acoustical performance of every assembly on the building envelope is critical when designing for a high performance system. Noise will travel through the weakest sections of the building envelope, and the effectiveness of a high performing wall or roof system may be reduced when the rest of the building is not equally designed for. When a component of wall and roof assemblies, ROCKWOOL stone wool insulation can reduce external noise creating a comfortable and healthy living space. It's the unique stone wool characteristics found within our products that make them efficient at reducing noise.

### **Efficient Cladding Attachment Systems**

There are numerous generic and proprietary cladding support systems designed for use with exterior insulation available in the market today. Many different materials are used to make these systems including galvanized steel, stainless steel, aluminium, fiberglass, and plastic. While each system is different, the approaches can generally be classified as: continuous framing, intermittent clip and rail, long fasteners and masonry ties or other engineered systems. Systems are available to accommodate a wide range of claddings for buildings of all heights and exposures. Thermally efficient cladding attachment systems are critical for Passive House buildings to mitigate thermal bridging.

#### **Links - For More Information**

- [Building Envelope Acoustic Solutions Guide](#)
- [ROCKWOOL Cladding Attachment Guide](#)
- [Vapor Diffusion Guide](#)

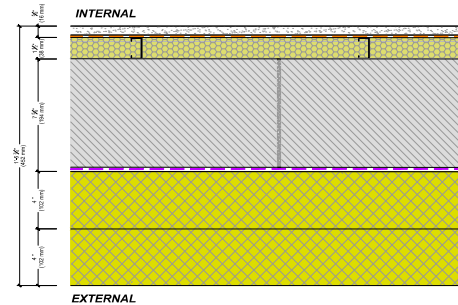
# ROCKWOOL™ PH Certified Mass Wall - ID: 1274cs03

This enclosure system is concrete masonry unit (CMU) substrate using the following vapor permeable stone wool products: ROCKWOOL CAVITYROCK®, ROCKWOOL COMFORTBOARD™ 110, ROCKWOOL TOPROCK® DD and ROCKWOOL MULTIFIX™

The exterior insulation on the walls is fastened using thermally broken fiberglass clip system with stainless steel fasteners (or equivalent alternative).

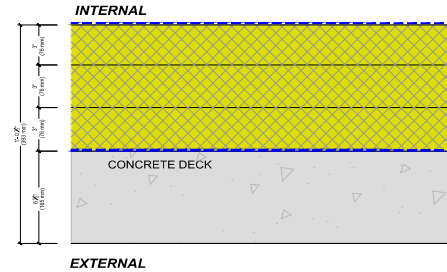
The primary airtight layer is a fully adhered vapor permeable, air and water-resistive barrier, installed on the exterior side of the CMU. Depending on the climate zone requirements, an optional interior vapor control layer can be installed on the interior side and serve as a secondary airtight layer if necessary.

## External Wall



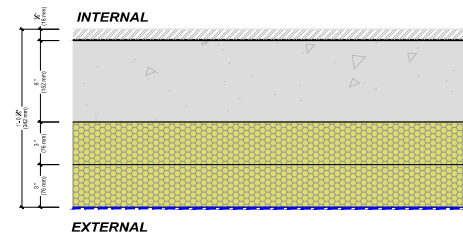
<b>Installed R-Value</b>	7.11 m <sup>2</sup> k/W	(40.40 ft <sup>2</sup> -hr-F°/BTU)
<b>Effective R-Value</b>	7.14 m <sup>2</sup> k/W	(40.56 ft <sup>2</sup> -hr-F°/BTU)
<b>Overall U-Value</b>	0.140 W/m <sup>2</sup> k	(0.024 BTU/ ft <sup>2</sup> -hr-F°)

## Flat Roof



<b>Installed R-Value</b>	6.02 m <sup>2</sup> k/W	(34.20 ft <sup>2</sup> -hr-F°/BTU)
<b>Effective R-Value</b>	6.67 m <sup>2</sup> k/W	(37.86 ft <sup>2</sup> -hr-F°/BTU)
<b>Overall U-Value</b>	0.150 W/m <sup>2</sup> k	(0.026 BTU/ ft <sup>2</sup> -hr-F°)

## Slab



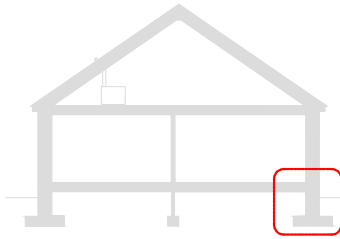
<b>Installed R-Value</b>	4.23 m <sup>2</sup> k/W	(24.00 ft <sup>2</sup> -hr-F°/BTU)
<b>Effective R-Value</b>	4.46 m <sup>2</sup> k/W	(25.35 ft <sup>2</sup> -hr-F°/BTU)
<b>Overall U-Value</b>	0.224 W/m <sup>2</sup> k	(0.039 BTU/ ft <sup>2</sup> -hr-F°)

Detail No.	Description	Page No.
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FSIW01	Floor Slab to Interior Load-bearing Wall	10
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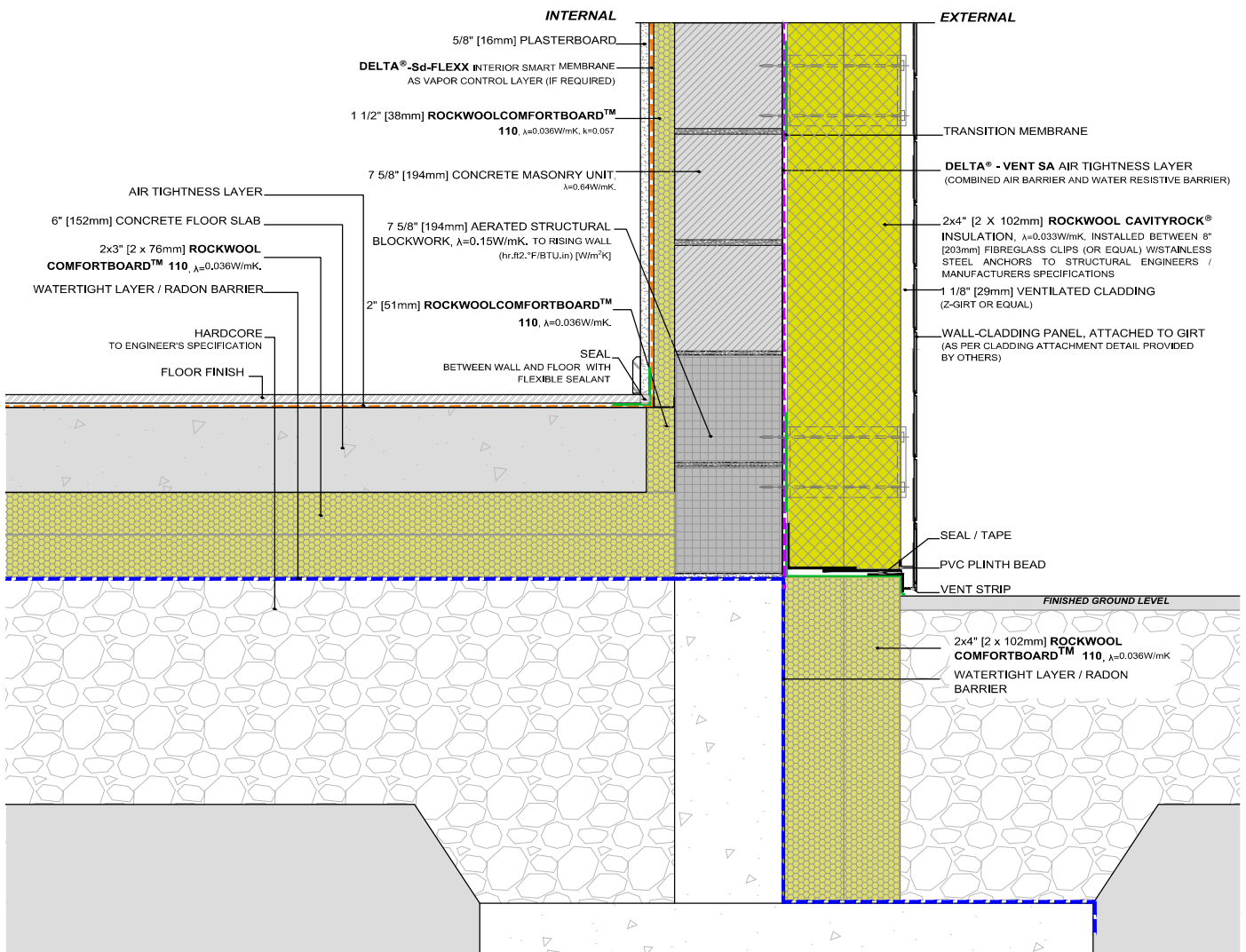


# FSEW01 – Floor Slab to Exterior Wall

Psi = 0.002 (W/mK) | FRsi = 0.93

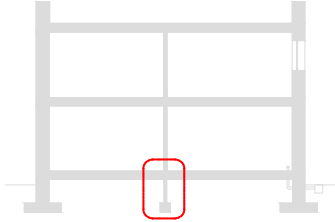


- ROCKWOOL CAVITYROCK®**
- ROCKWOOL COMFORTBOARD™**
- DELTA® VENT SA**, Air tightness layer & water resistive barrier
- DELTA® -Sd-FLEXX**, optional secondary air tightness / vapor control layer
- Transition membrane
- Watertight layer

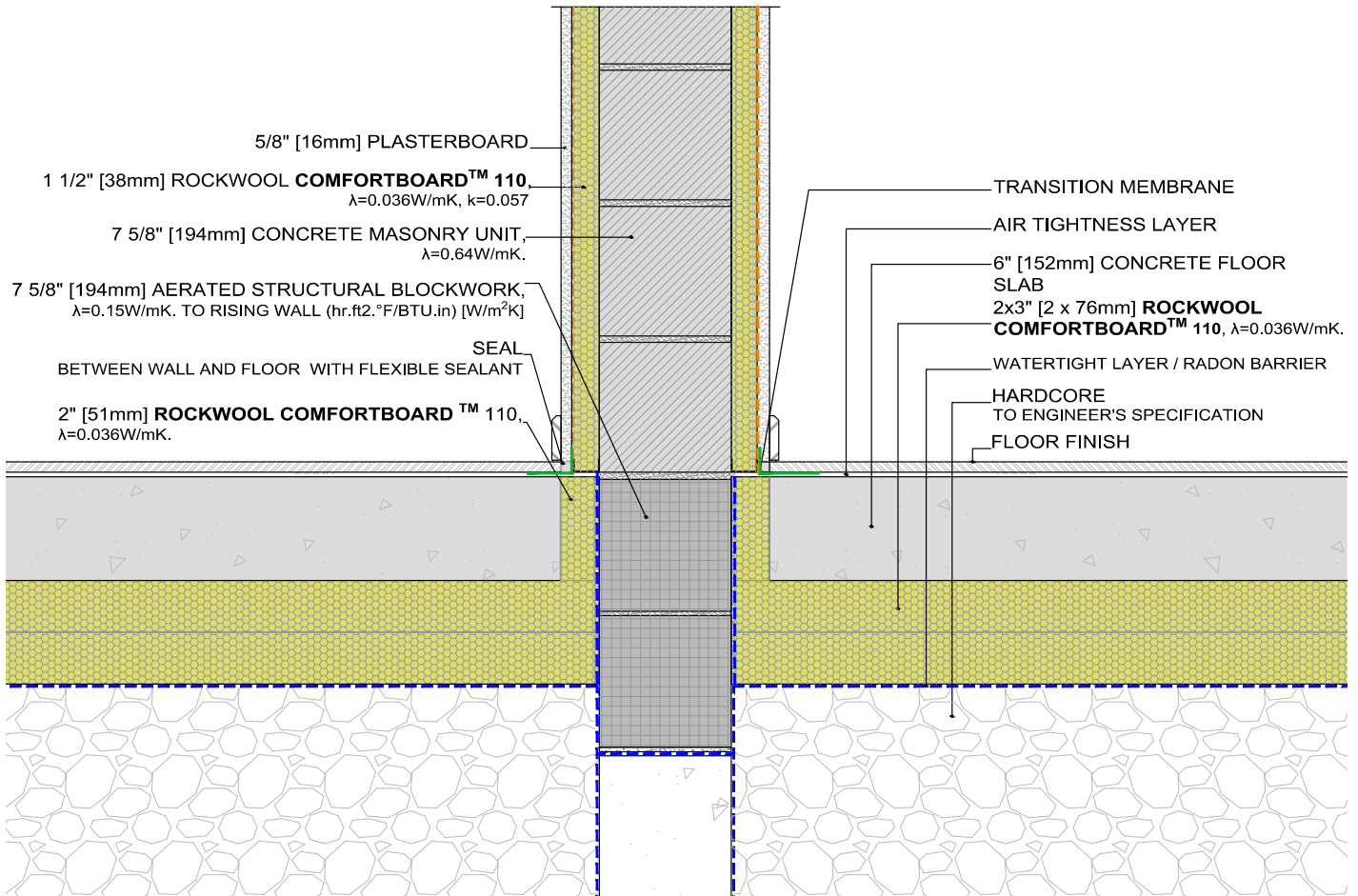


# FSIW01 – Floor Slab to Interior Load-bearing Wall

Psi = 0.009 (W/mK) | FRsi = 0.95

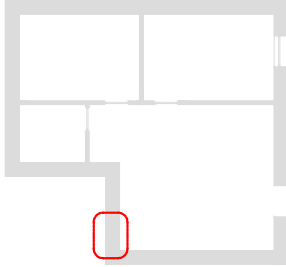


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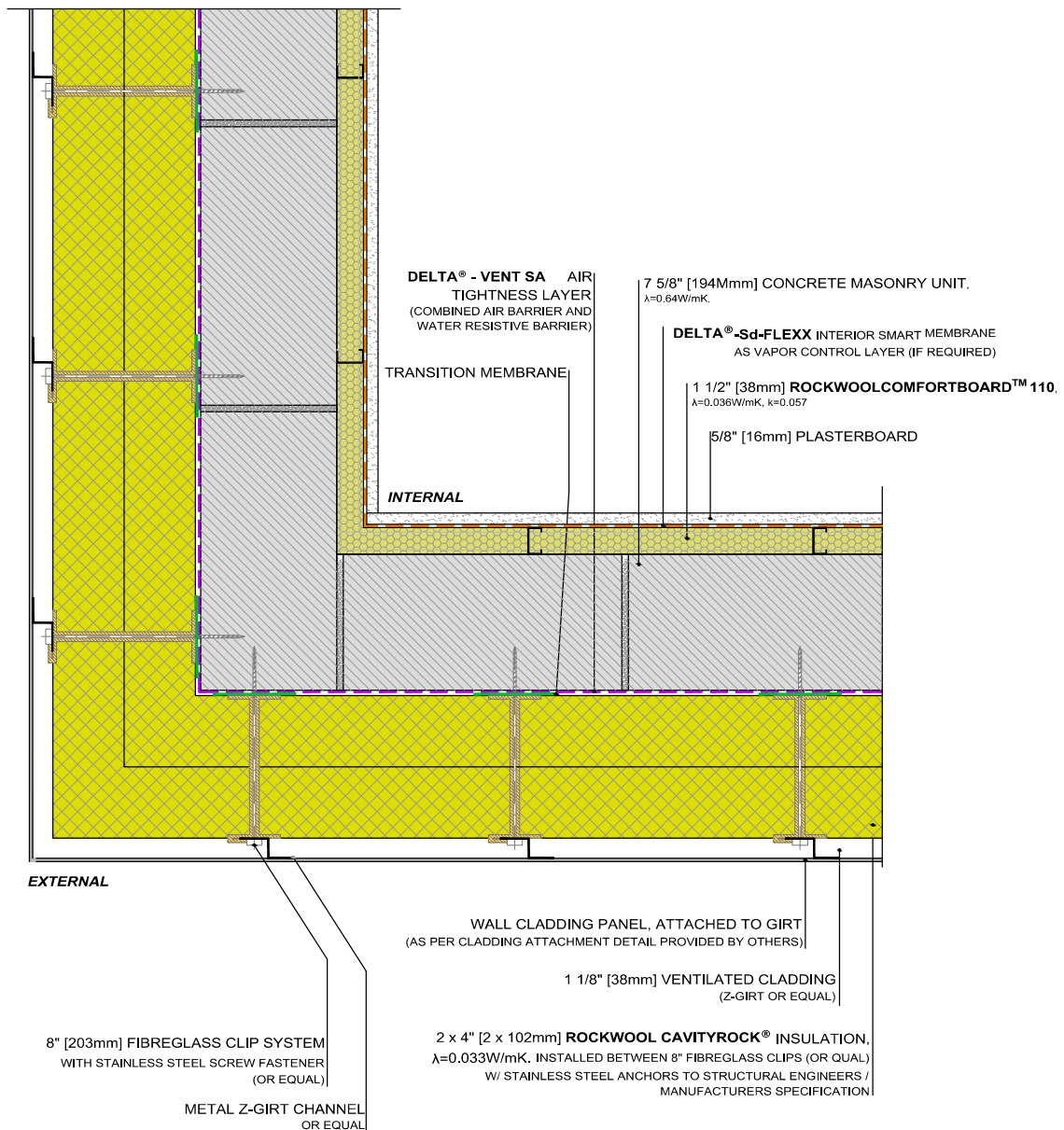


# EWEC01 – Exterior Wall - Exterior Corner (plan)

Psi = -0.058 (W/mK) | FRsi = 0.93

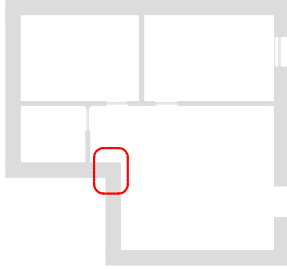


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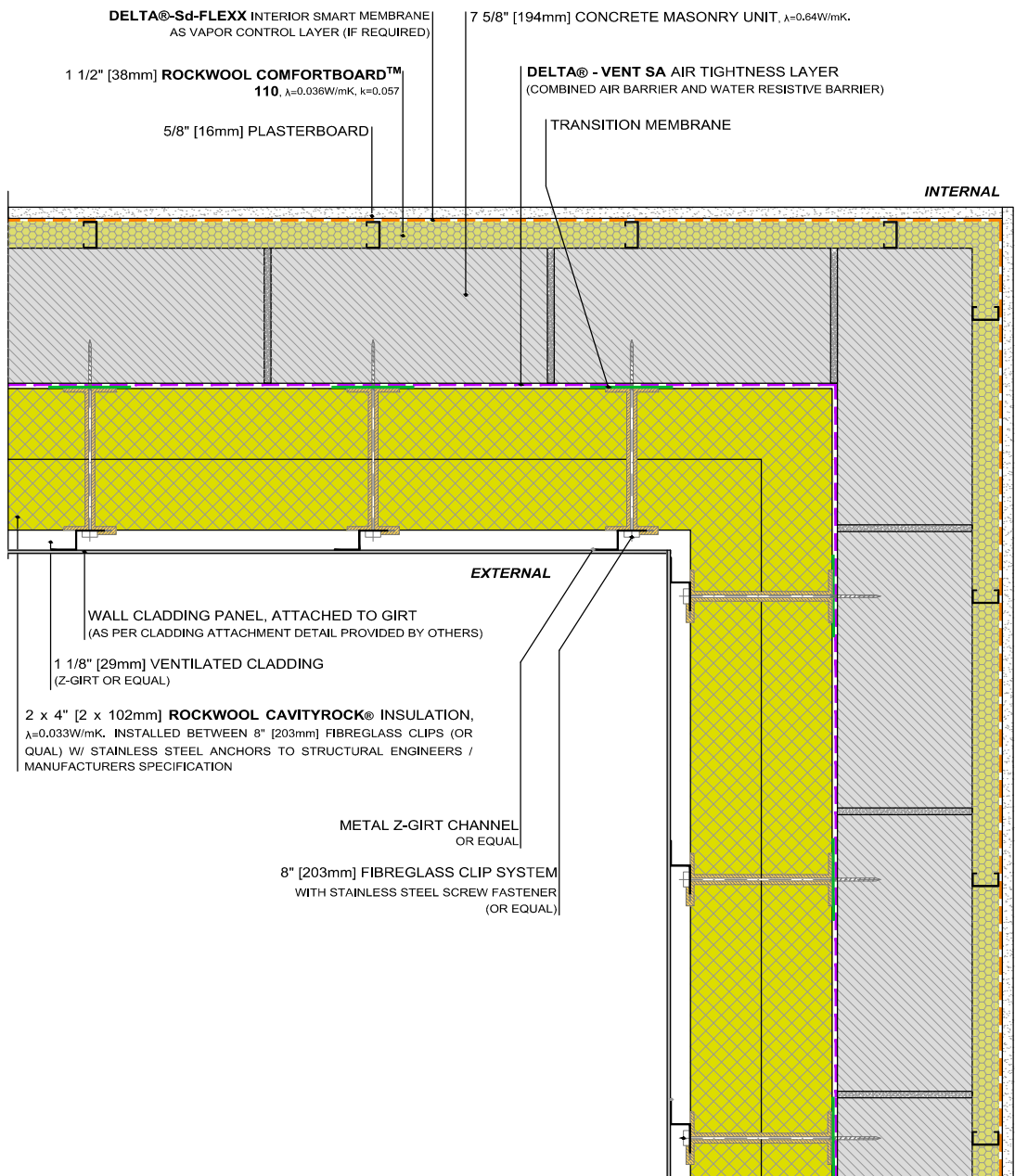


# EWIC01 – Exterior Wall – Interior Corner (plan)

Psi = 0.022 (W/mK) | FRsi = 0.97

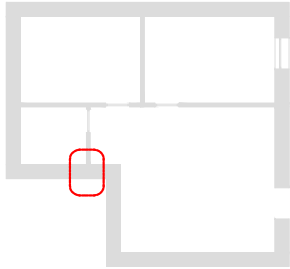


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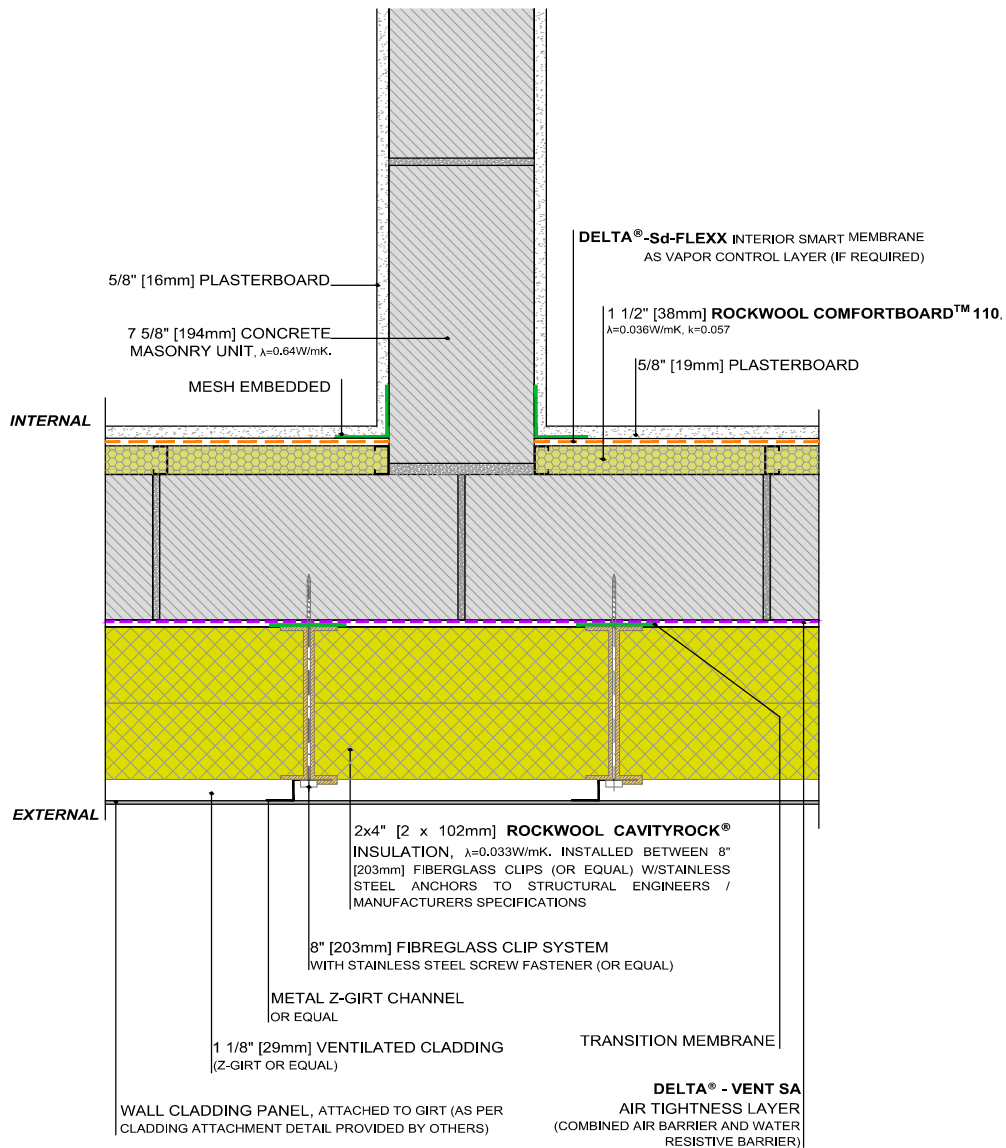


# EWIW01 – Exterior Wall to Interior Wall Junction (plan)

Psi = 0.008 (W/mK) | FRsi = 0.94



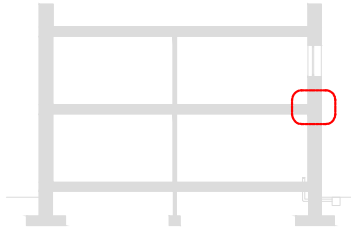
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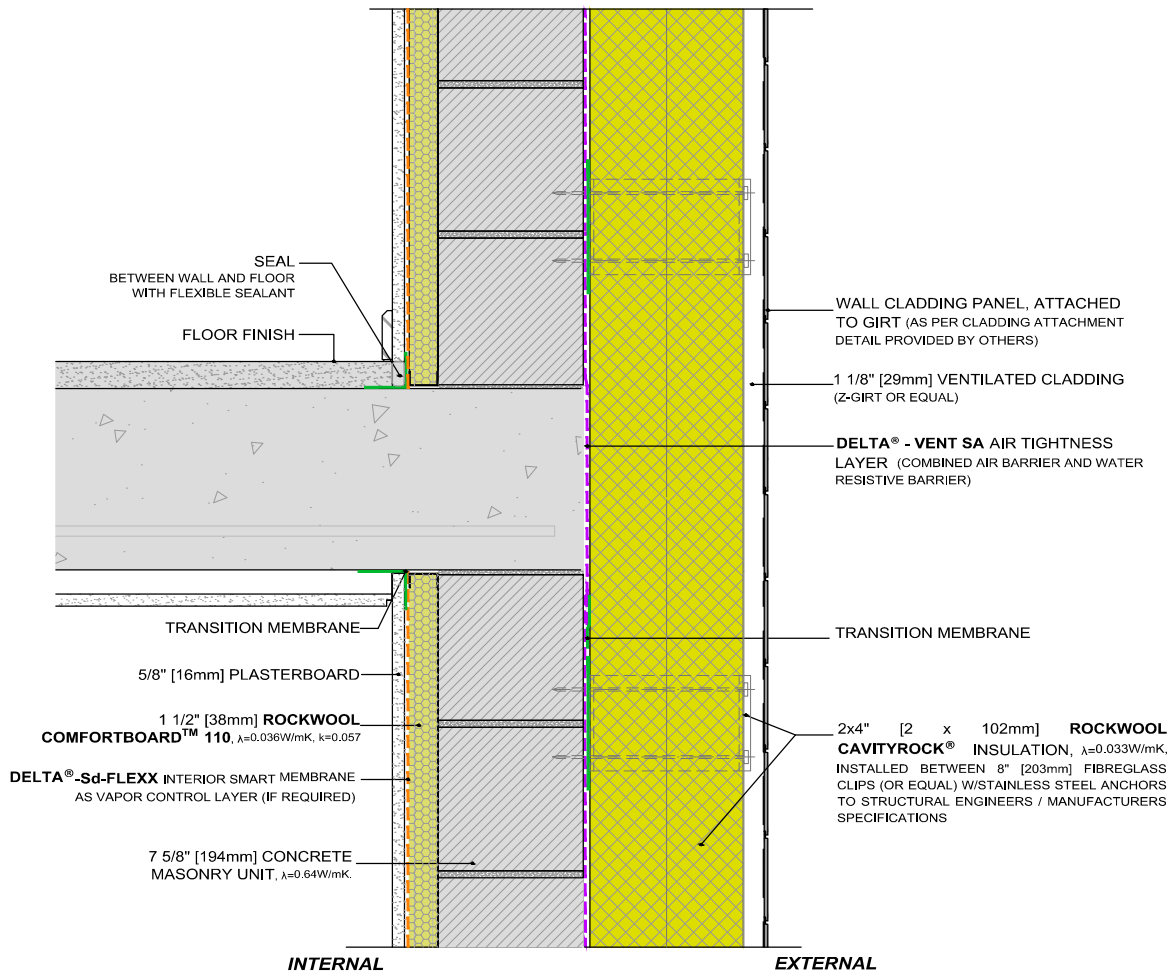


# EWCE01 – Exterior Wall to Ceiling

Psi = 0.010 (W/mK) | FRsi = 0.96

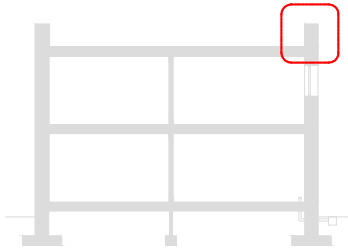


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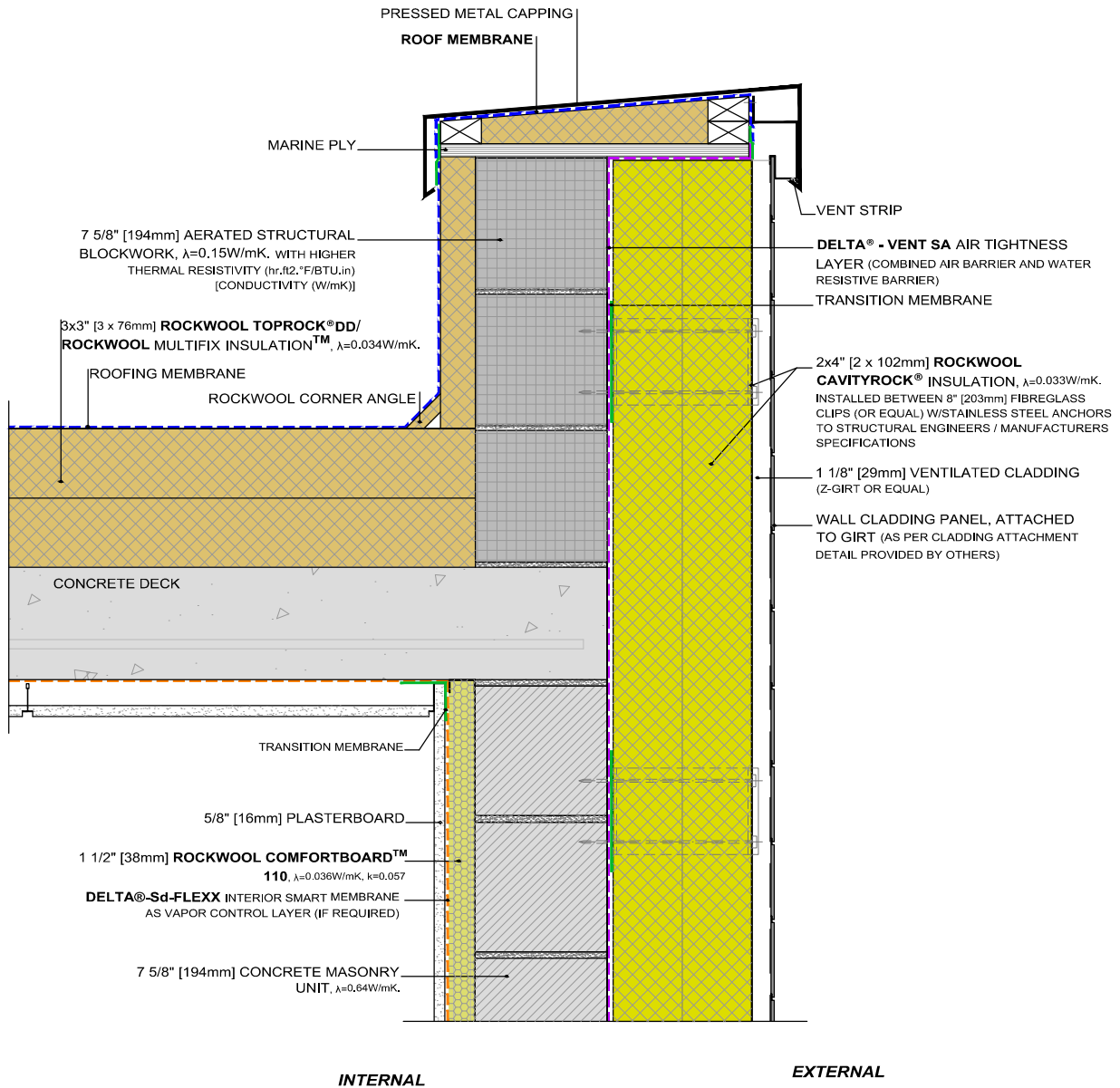


# FRRP01 – Flat Roof Parapet

Psi = -0.011(W/mK) | FRsi = 0.97

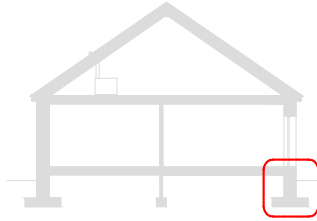


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- ROCKWOOL TOPROCK® DD
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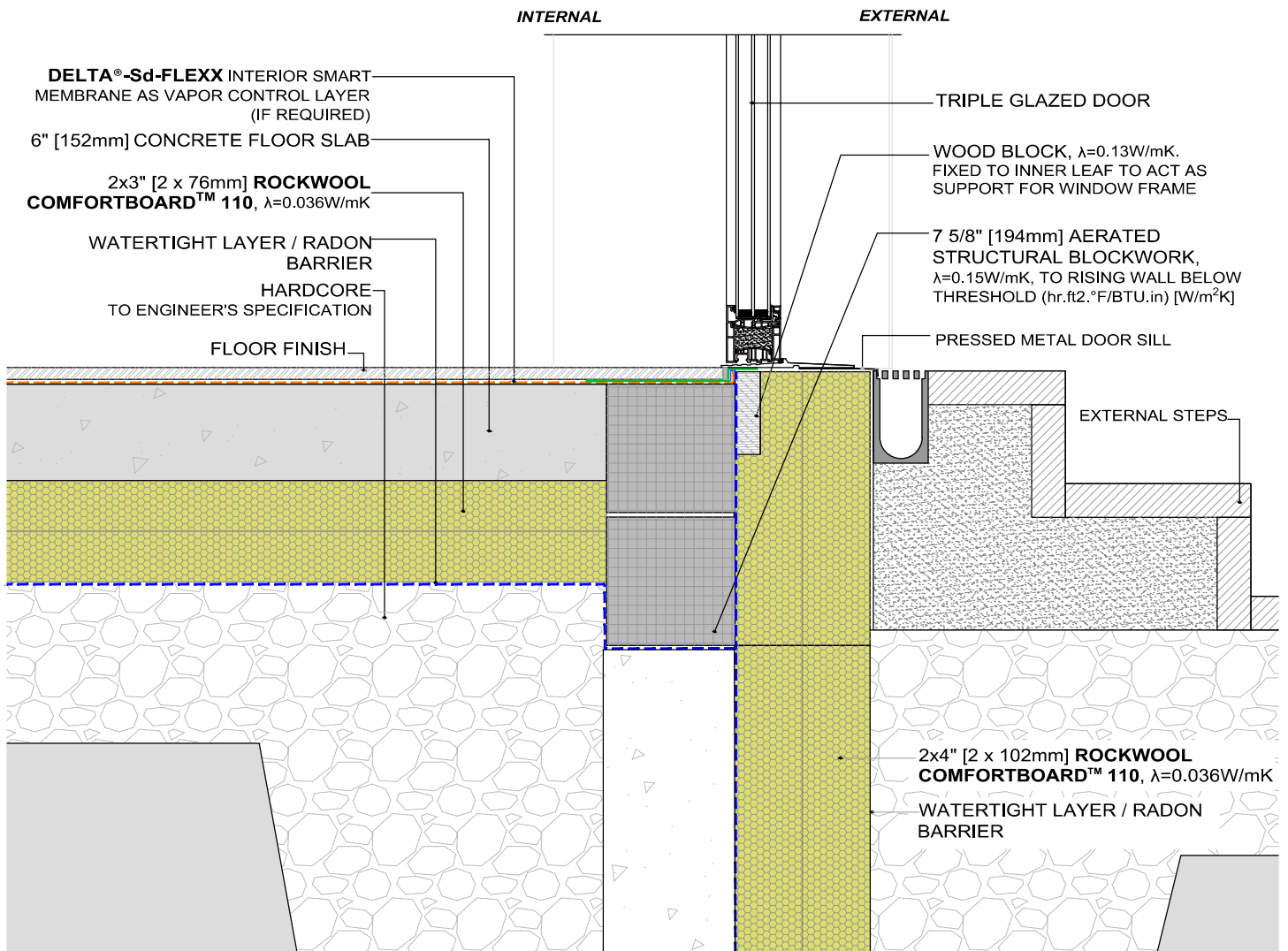


# WITH01 – Door Threshold

Psi = 0.057 (W/mK) | FRsi = 0.71

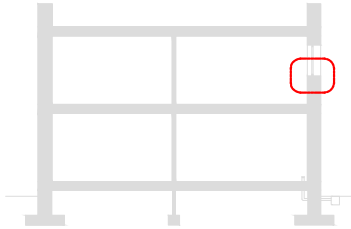


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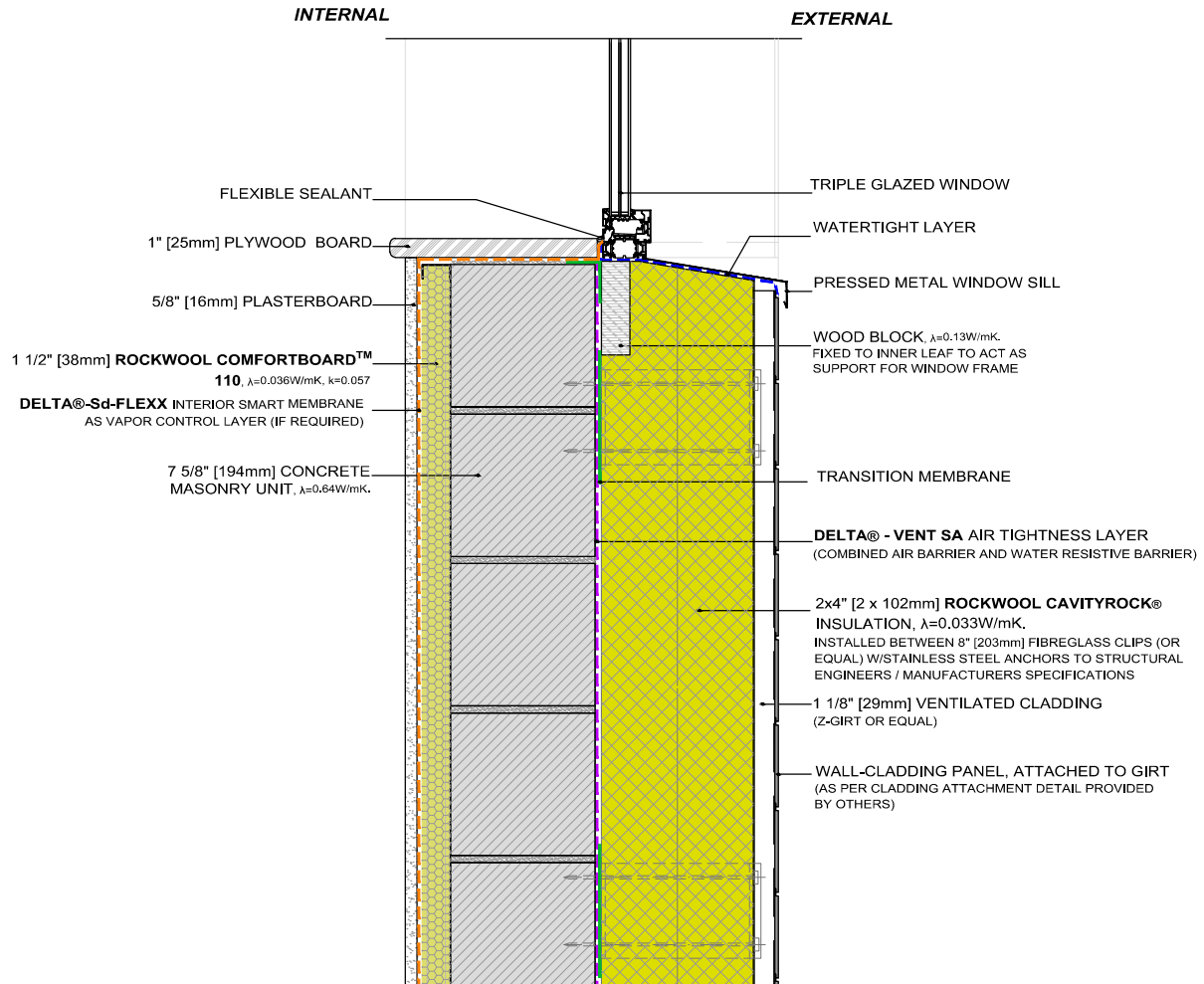


# WIBO01 – Window Sill

Psi = 0.027 (W/mK) | FRsi = 0.76

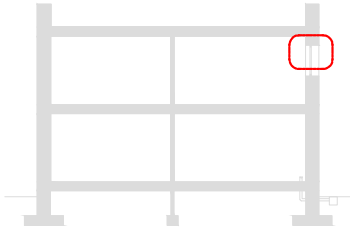


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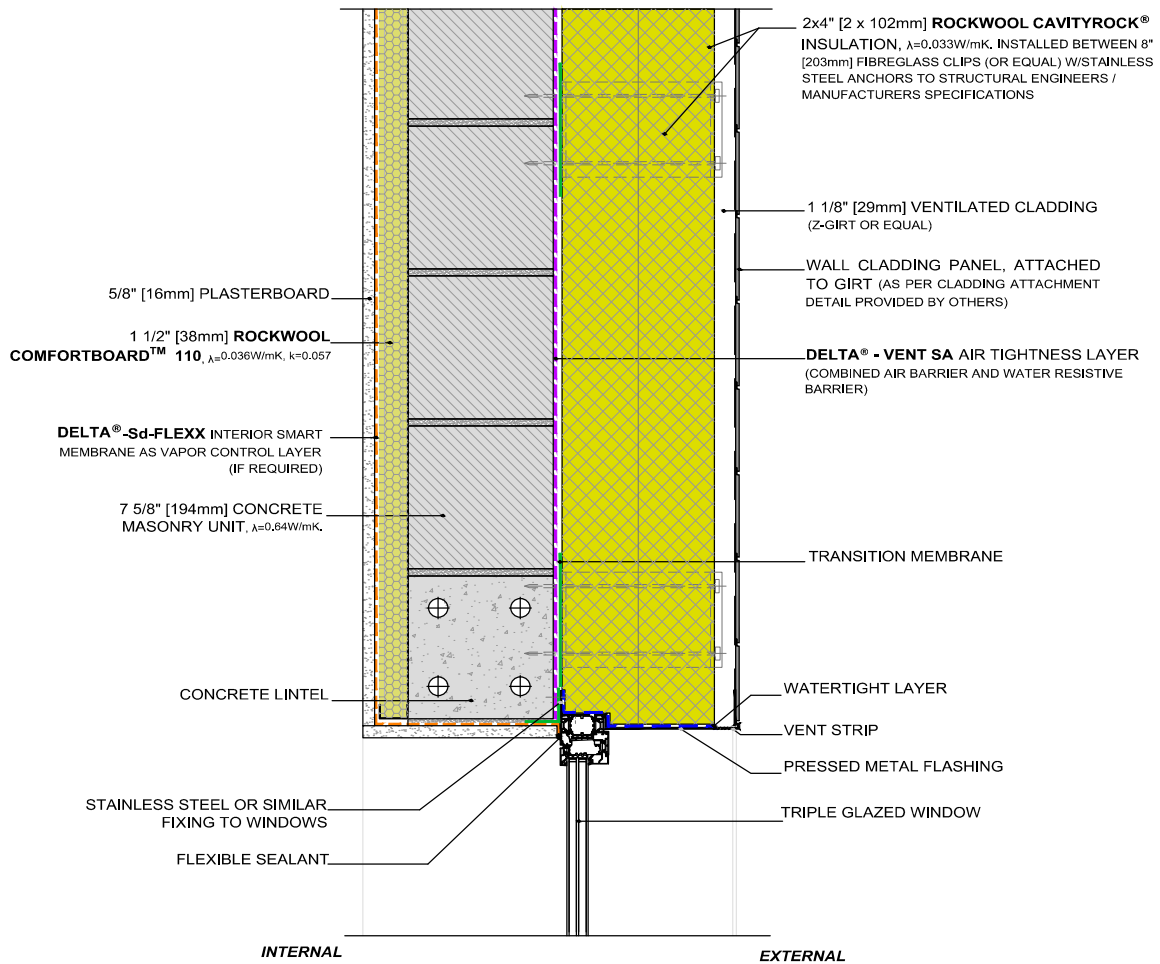


# WITO01 – Window Head

Psi = 0.014 (W/mK) | FRsi = 0.76



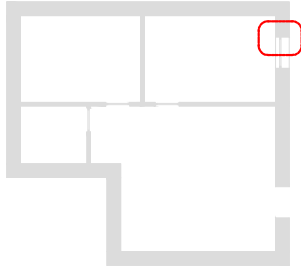
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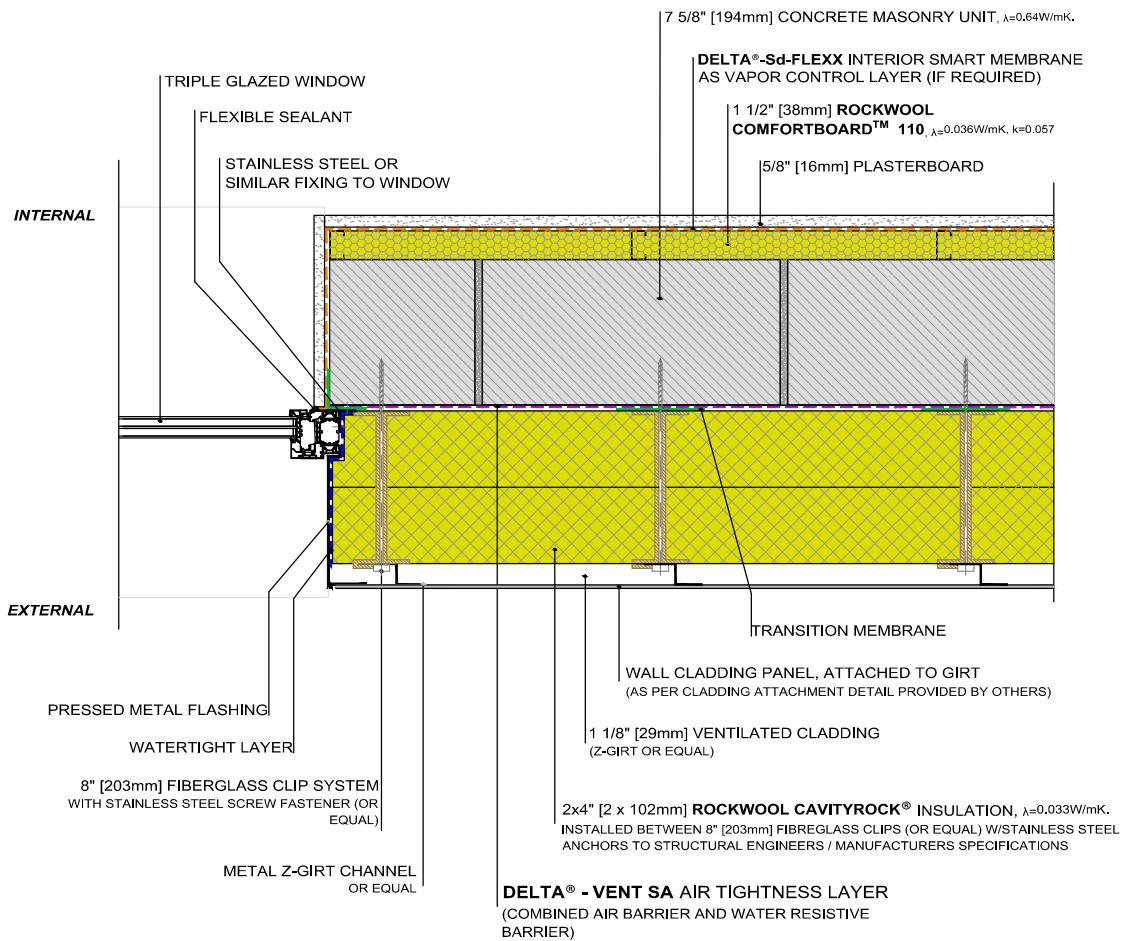


# WISI01 – Window Jamb

Psi = 0.013 (W/mK) | FRsi = 0.76



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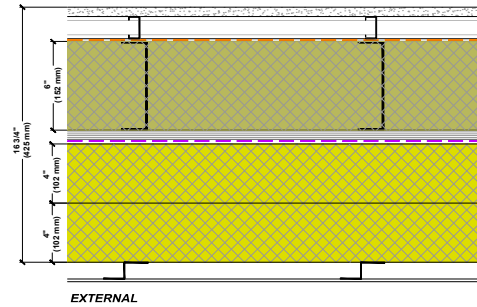
# ROCKWOOL™ PH Certified Steel Frame Wall - ID: 1411cs03

This enclosure system is steel frame substrate using the following vapor permeable stone wool products:  
**ROCKWOOL CAVITYROCK®**,  
**ROCKWOOL COMFORTBOARD™ 110**,  
**ROCKWOOL TOPROCK® DD** and  
**ROCKWOOL MULTIFIX™**

The exterior insulation on the walls is fastened using thermally broken fiberglass clip system with stainless steel fasteners (or equivalent alternative).

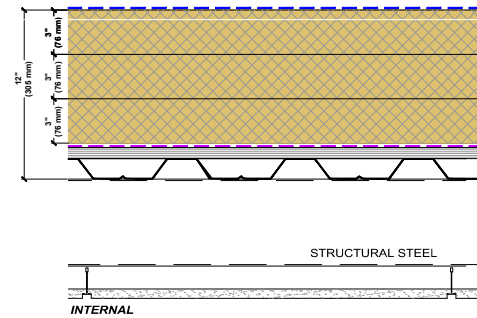
The primary airtight layer is a fully adhered vapor permeable, air and water-resistive barrier, installed on the exterior side of the exterior sheathing. Depending on the climate zone requirements, an optional interior vapor control layer can be installed on the interior side and serve as a secondary airtight layer if necessary.

## External Wall



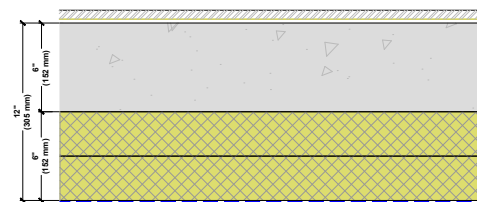
<b>Installed R-Value</b>	10.28 m <sup>2</sup> k/W	(58.40 ft <sup>2</sup> ·hr·F°/BTU)
<b>Effective R-Value</b>	7.69 m <sup>2</sup> k/W	(43.68 ft <sup>2</sup> ·hr·F°/BTU)
<b>Overall U-Value</b>	0.130 W/m <sup>2</sup> k	(0.023 BTU/ ft <sup>2</sup> ·hr·F°)

## Flat Roof



<b>Installed R-Value</b>	6.02 m <sup>2</sup> k/W	(34.20 ft <sup>2</sup> ·hr·F°/BTU)
<b>Effective R-Value</b>	6.45 m <sup>2</sup> k/W	(36.63 ft <sup>2</sup> ·hr·F°/BTU)
<b>Overall U-Value</b>	0.155 W/m <sup>2</sup> k	(0.027 BTU/ ft <sup>2</sup> ·hr·F°)

## Slab

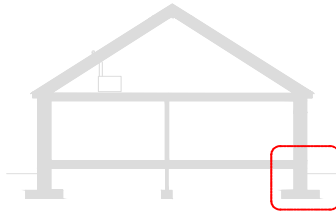


<b>Installed R-Value</b>	4.23 m <sup>2</sup> k/W	(24.00 ft <sup>2</sup> ·hr·F°/BTU)
<b>Effective R-Value</b>	4.46 m <sup>2</sup> k/W	(25.35 ft <sup>2</sup> ·hr·F°/BTU)
<b>Overall U-Value</b>	0.224 W/m <sup>2</sup> k	(0.039 BTU/ ft <sup>2</sup> ·hr·F°)

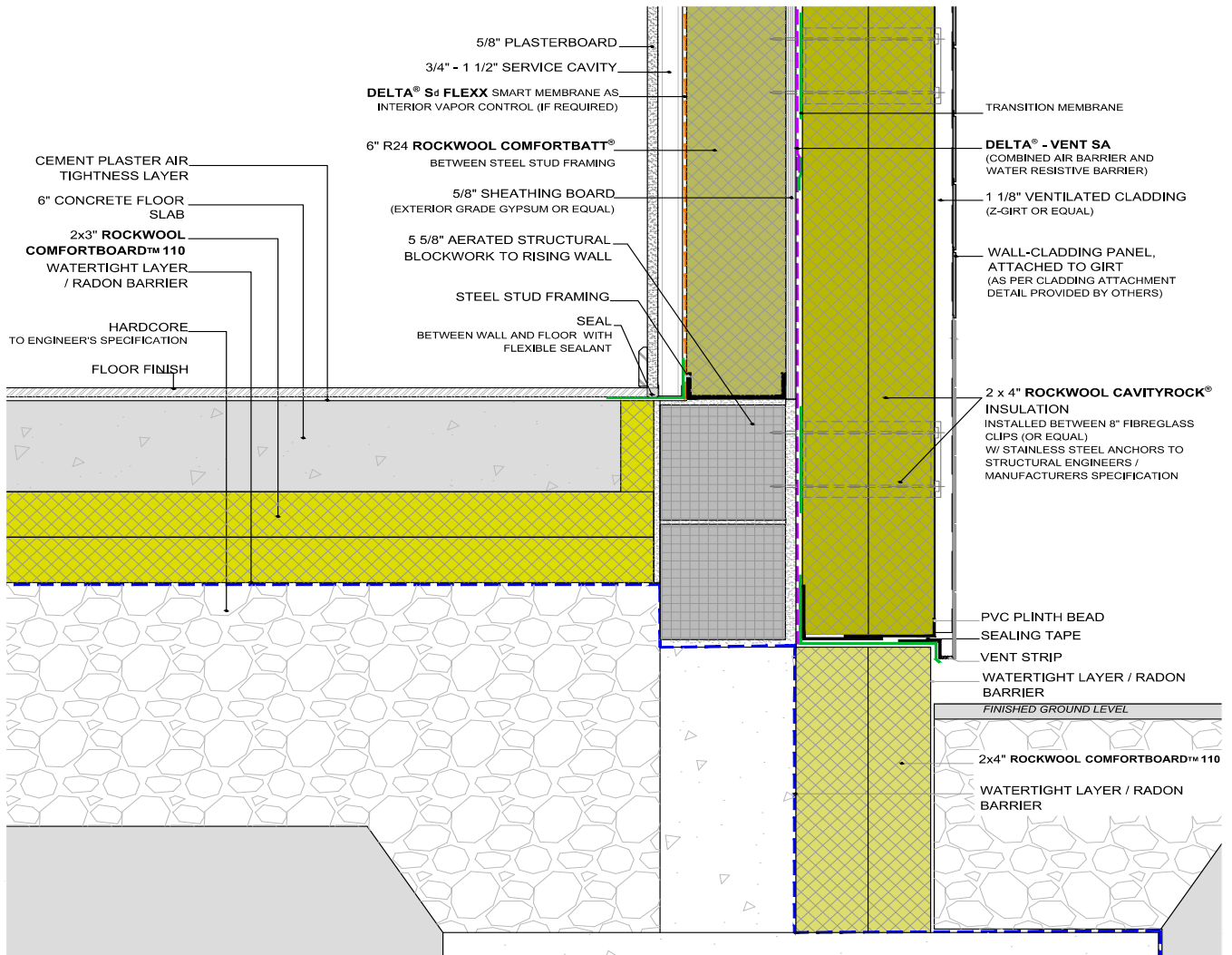
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# FSEW01 – Floor Slab to Exterior Wall

Psi = 0.003 (W/mK) | FRsi = 0.90

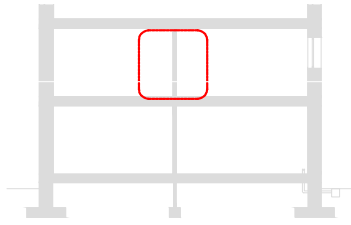






- ROCKWOOL CAVITYROCK®** Exterior insulation
- ROCKWOOL COMFORTBATT®** Batt insulation
- ROCKWOOL COMFORTBOARD™ 110** Board insulation
- DELTA® VENT SA** Air tightness layer & water resistive barrier
- DELTA® Sd FLEXX** Optional secondary air tightness layer/vapor control
- Transition membrane**
- Watertight layer**

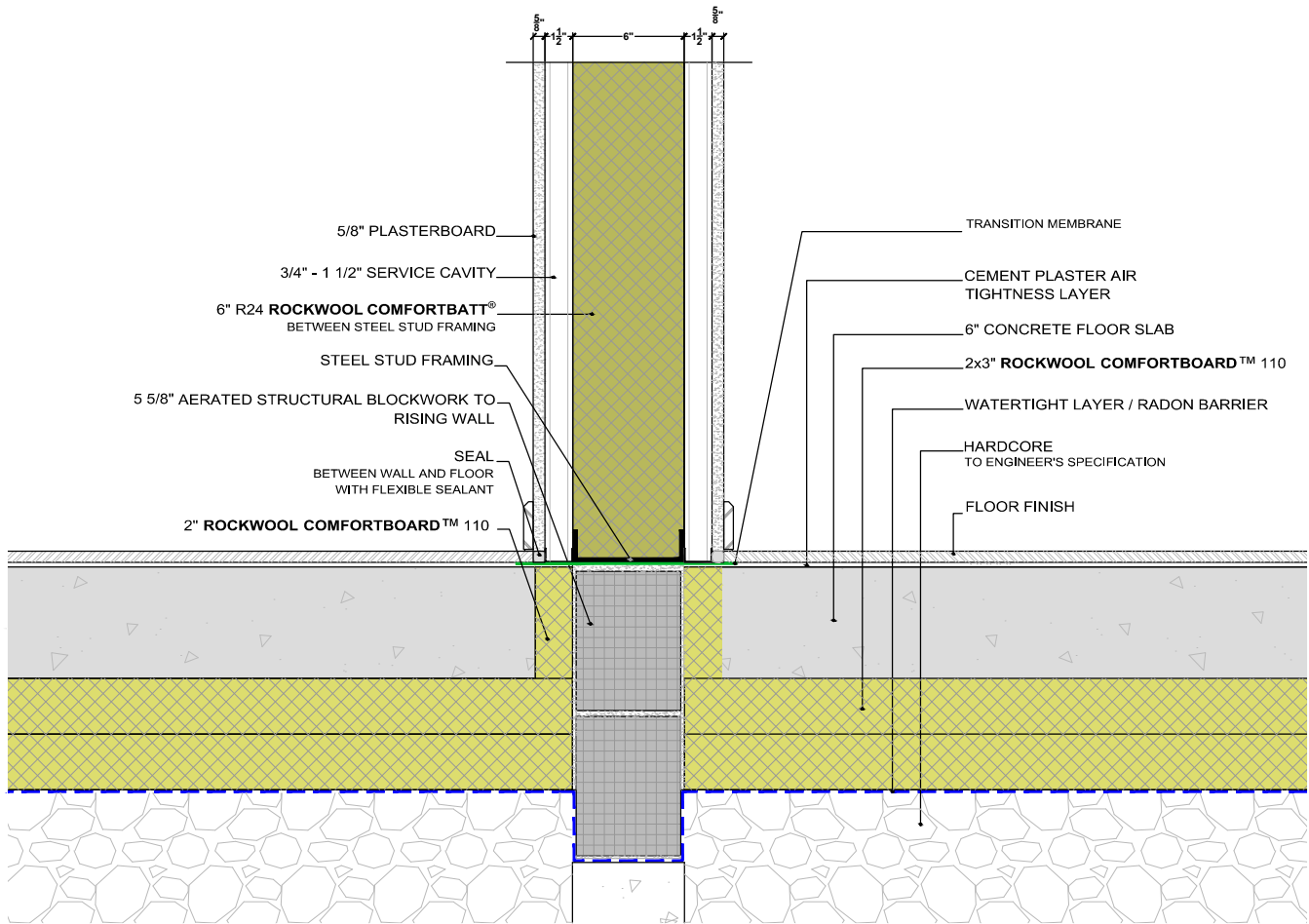


# FSIW01 – Floor Slab to Interior Load-bearing Wall

Psi = 0.009 (W/mK) | FRsi = 0.96

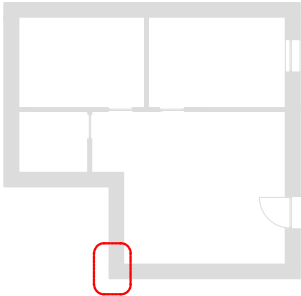


-  ROCKWOOL COMFORTBATT® Batt insulation
-  ROCKWOOL COMFORTBOARD™ 110 Board insulation
-  Transition membrane
-  Watertight layer

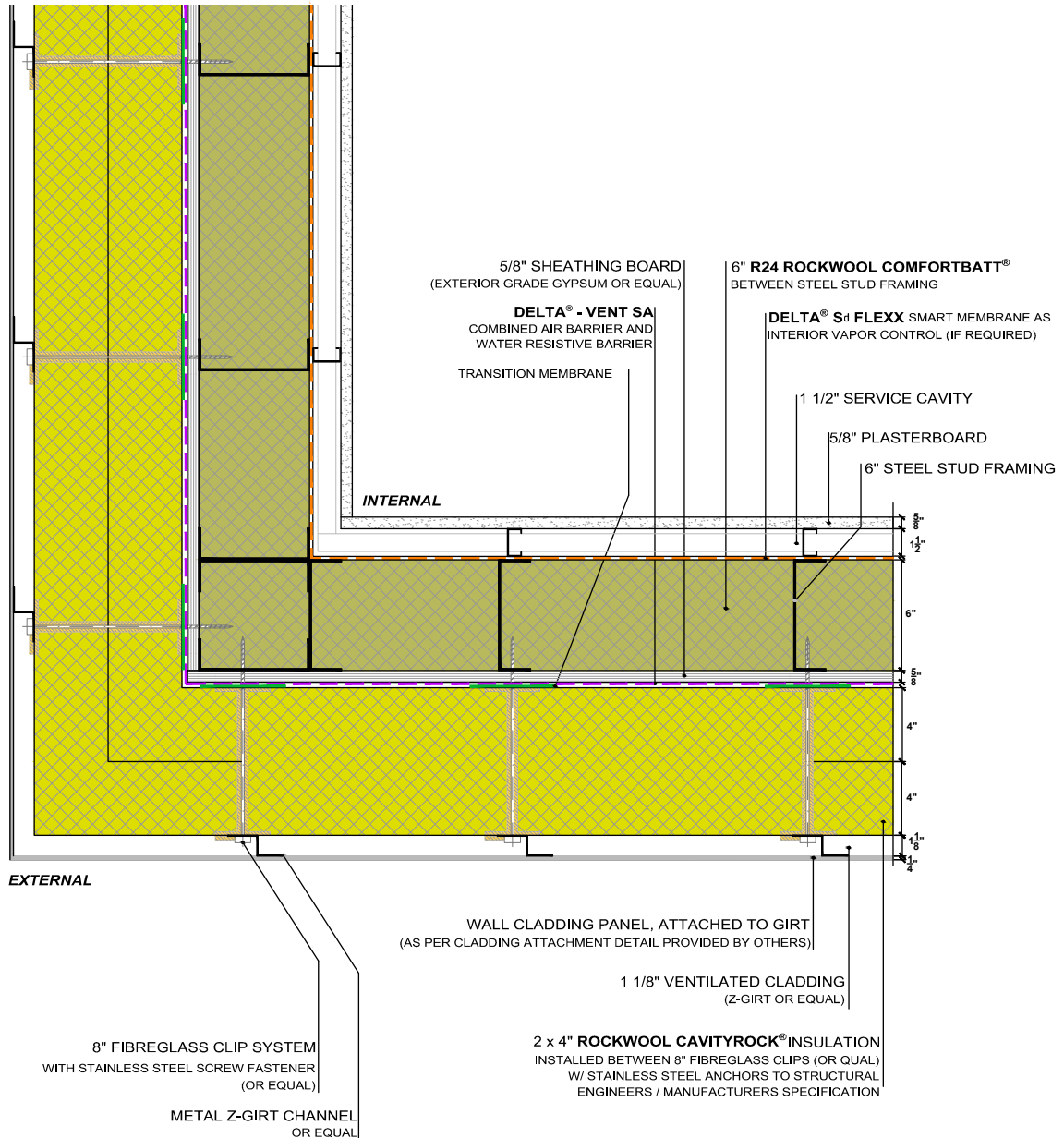


# EWEC01 – Exterior Wall - Exterior Corner (plan)

Psi = -0.056 (W/mK) | FRsi = 0.87



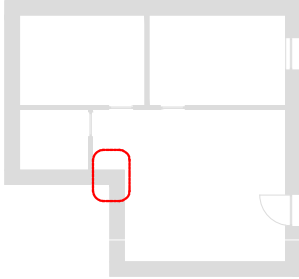
-  **ROCKWOOL CAVITYROCK®** Exterior insulation
-  **ROCKWOOL COMFORTBATT®** Batt insulation
-  **DELTA® VENT SA** Air tightness layer & water resistive barrier
-  **DELTA® Sd FLEXX** Optional secondary air tightness layer/vapor control
-  Transition membrane
-  Watertight layer



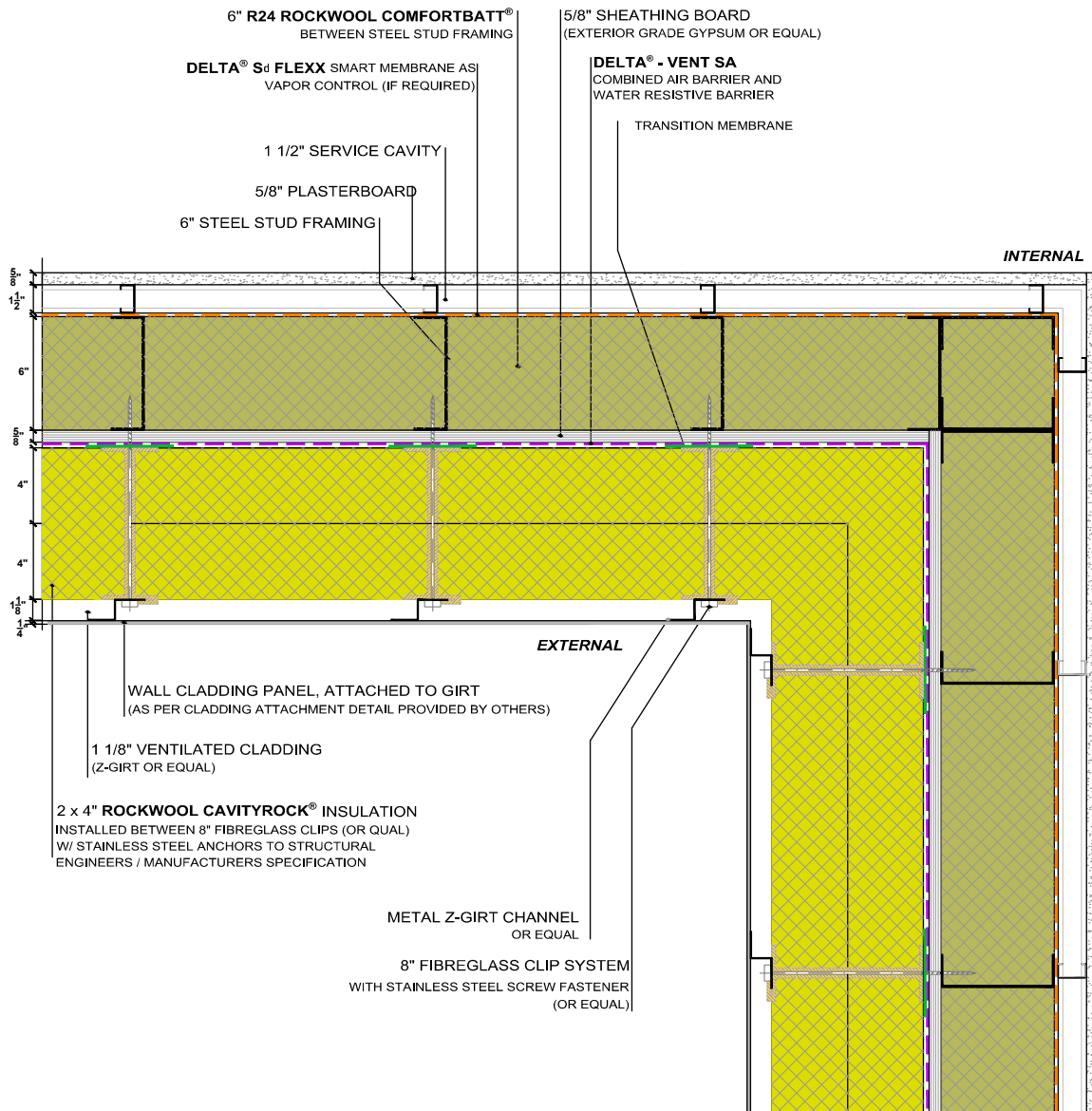


# EWIC01 – Exterior Wall – Interior Corner (plan)

Psi = 0.020 (W/mK) | FRsi = 0.94

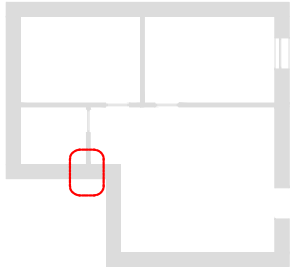


- ROCKWOOL CAVITYROCK®** Exterior insulation
- ROCKWOOL COMFORTBATT®** Batt insulation
- DELTA® VENT SA** Air tightness layer & water resistive barrier
- DELTA® Sd FLEXX** Air Optional secondary air tightness layer/vapor control
- Transition membrane
- Watertight layer

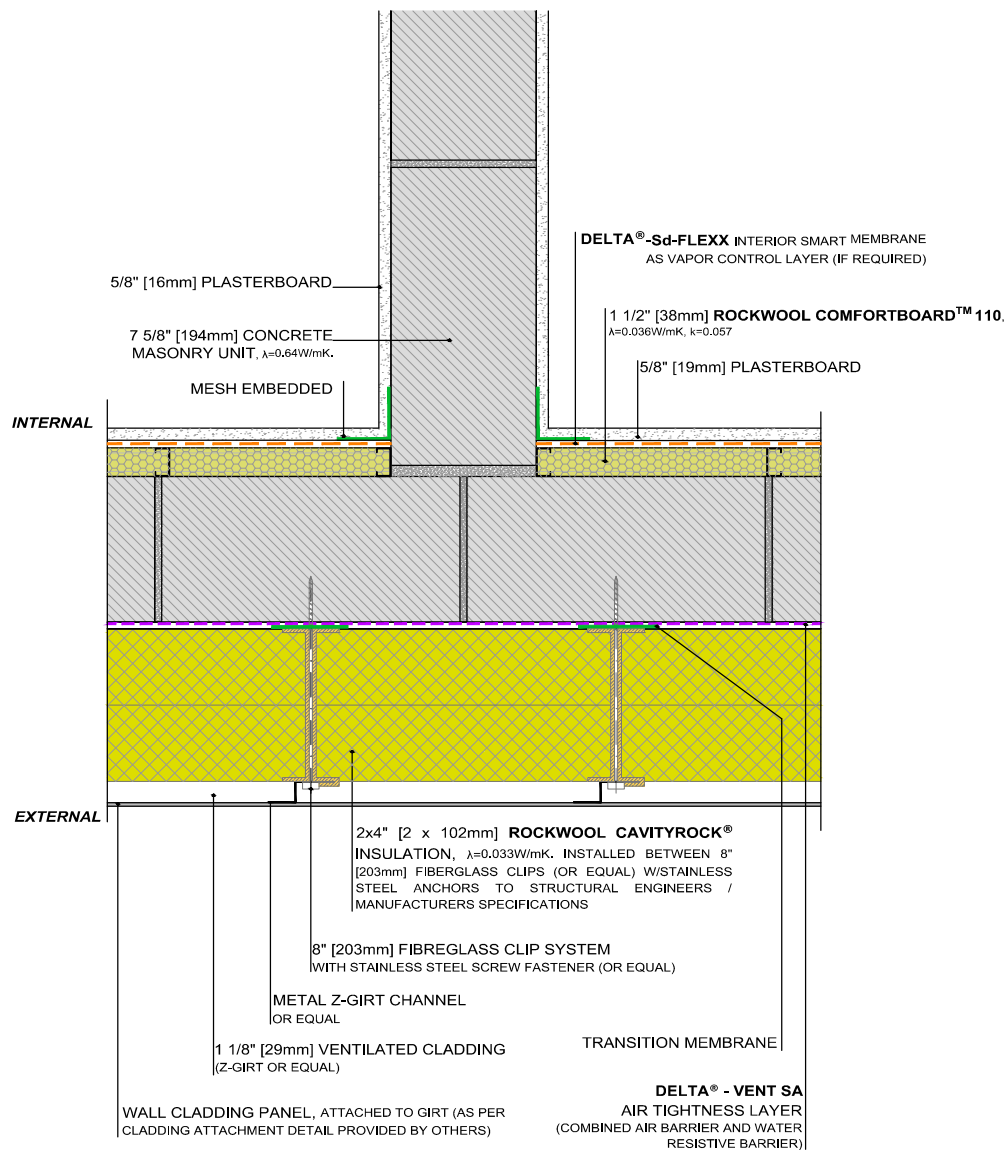


# EWIW01 – Exterior Wall to Interior Wall Junction (plan)

Psi = 0.003 (W/mK) | FRsi = 0.94

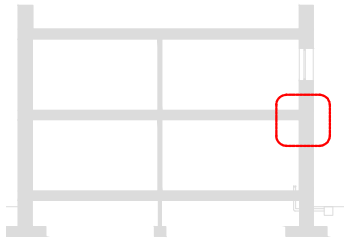


-  ROCKWOOL CAVITYROCK®
-  ROCKWOOL COMFORTBOARD™
-  DELTA® VENT SA, Air tightness layer & water resistive barrier
-  DELTA® -Sd-FLEXX, optional secondary air tightness / vapor control layer
-  Transition membrane
-  Watertight layer

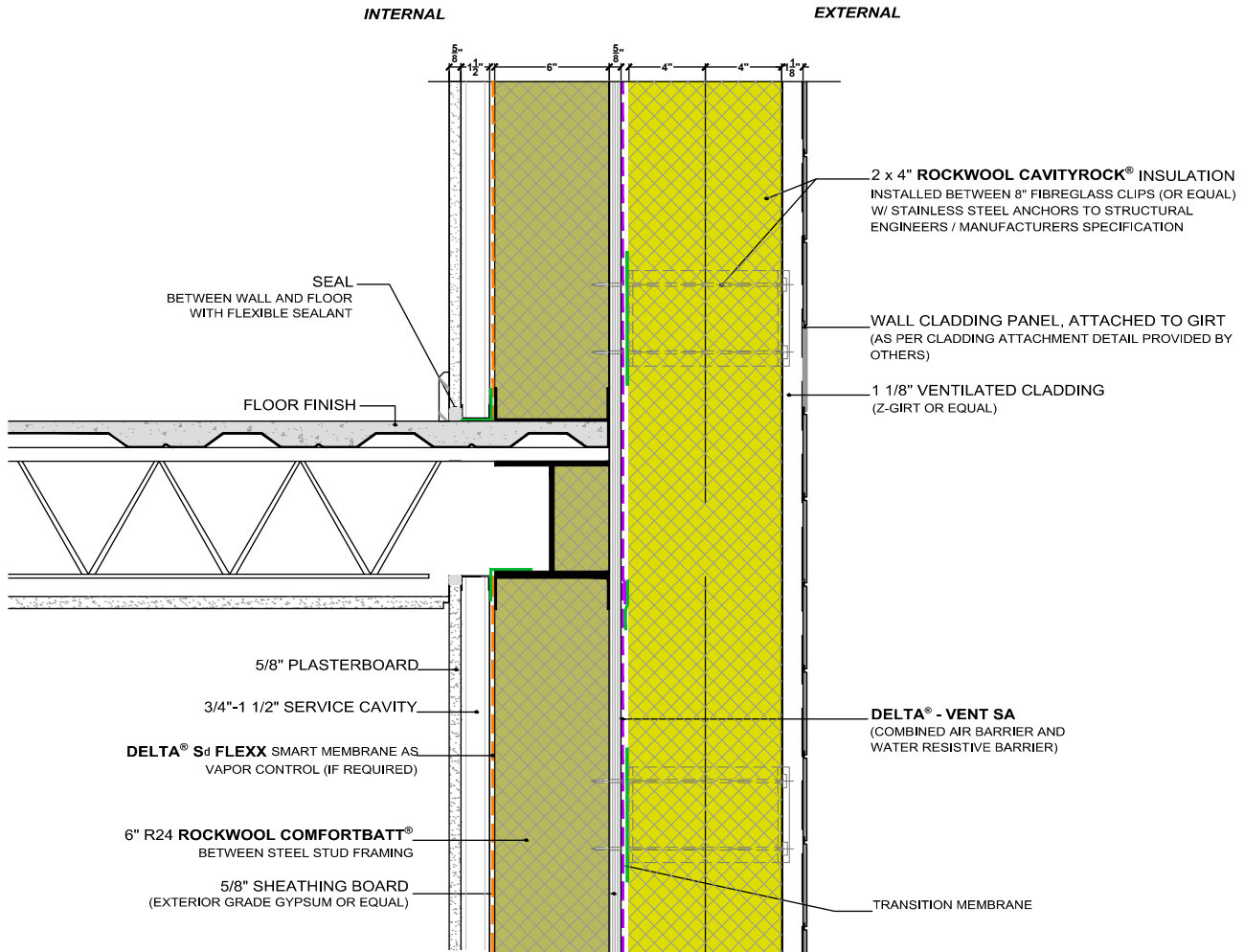


# EWCE01 – Exterior Wall to Ceiling

Psi = 0.016 (W/mK) | FRsi = 0.96

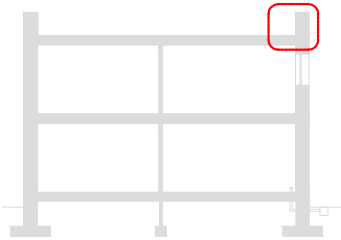


-  **ROCKWOOL CAVITYROCK®** Exterior insulation
-  **ROCKWOOL COMFORTBATT®** Batt insulation
-  **DELTA® VENT SA** Air tightness layer & water resistive barrier
-  **DELTA® Sd FLEXX** Air Optional secondary air tightness layer/vapor control
-  Transition membrane
-  Watertight layer

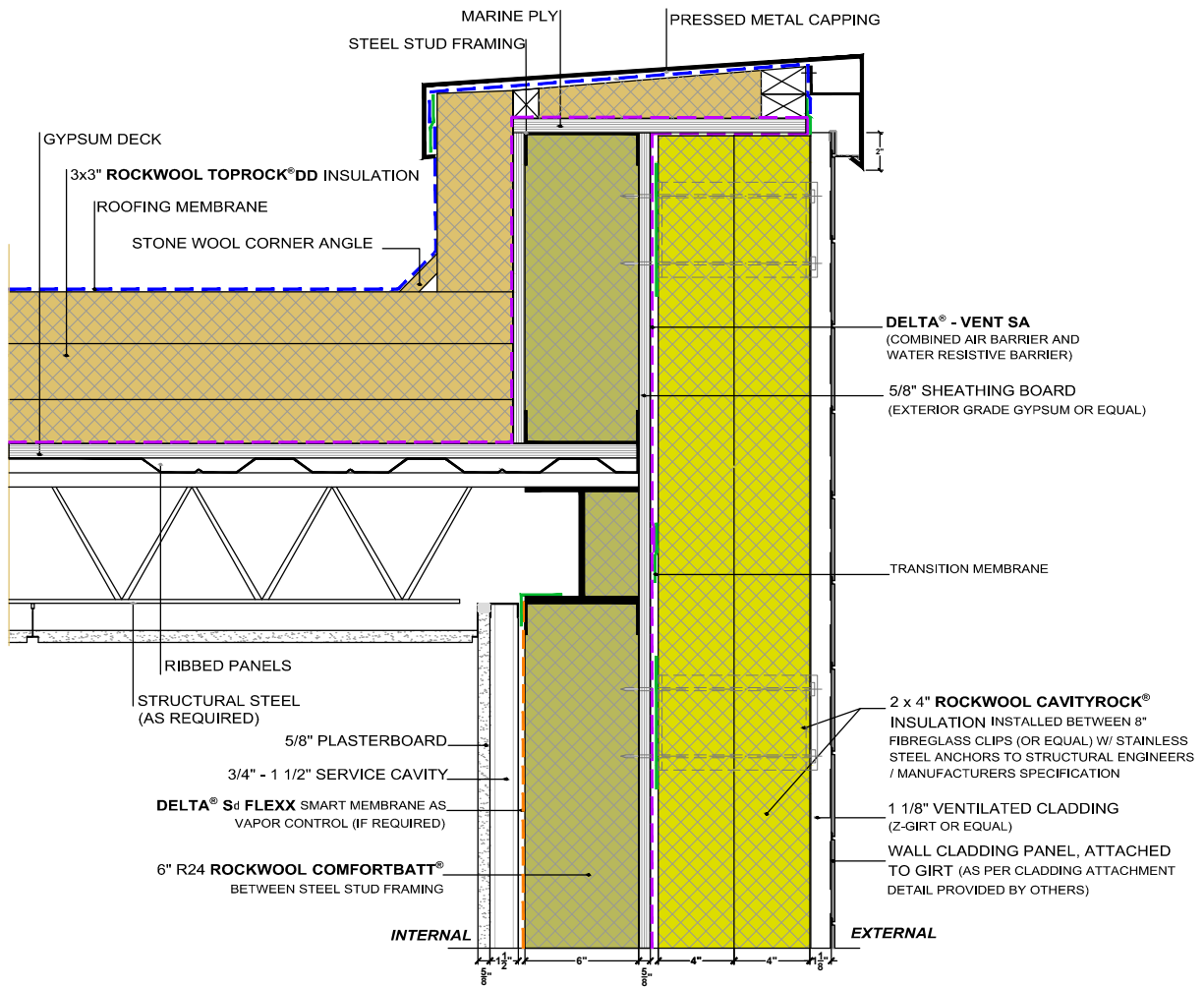


# FRRP01 – Flat Roof Parapet

Psi = 0.010 (W/mK) | FRsi = 0.88

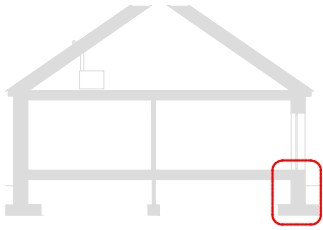





- ROCKWOOL CAVITYROCK®** Exterior insulation
- ROCKWOOL COMFORTBATT®** Batt insulation
- ROCKWOOL TOPROCK® DD** Flat roof insulation
- DELTA® VENT SA** Air tightness layer & water resistive barrier
- DELTA® Sd FLEXX** Air Optional secondary air tightness layer/vapor control
- Transition membrane
- Watertight layer

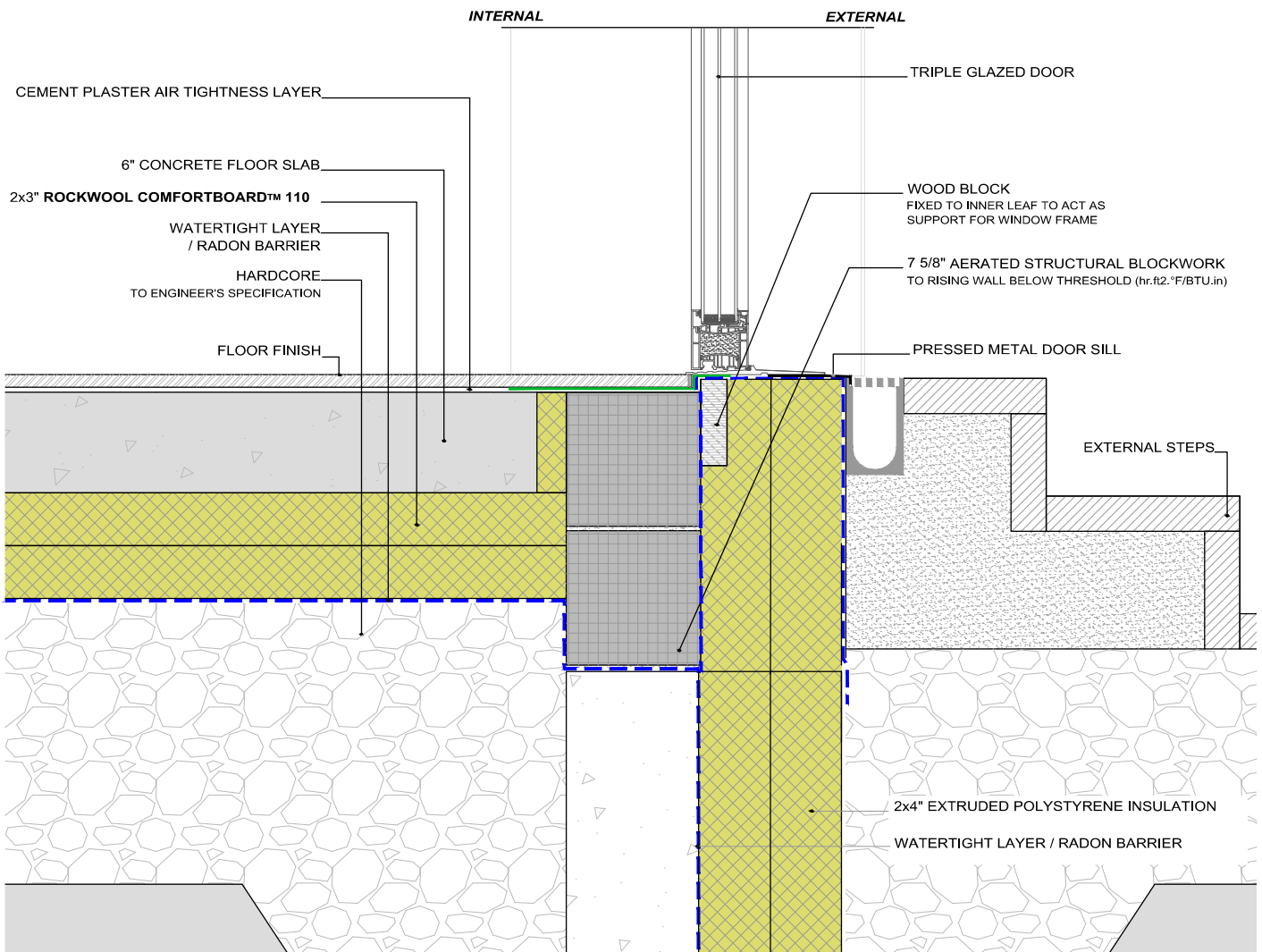


# WITH01 – Door Threshold

Psi = 0.034 (W/mK) | FRsi = 0.70



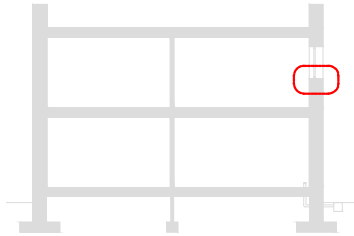
-  **ROCKWOOL COMFORTBOARD™110** Board insulation
-  Transition membrane
-  Watertight layer



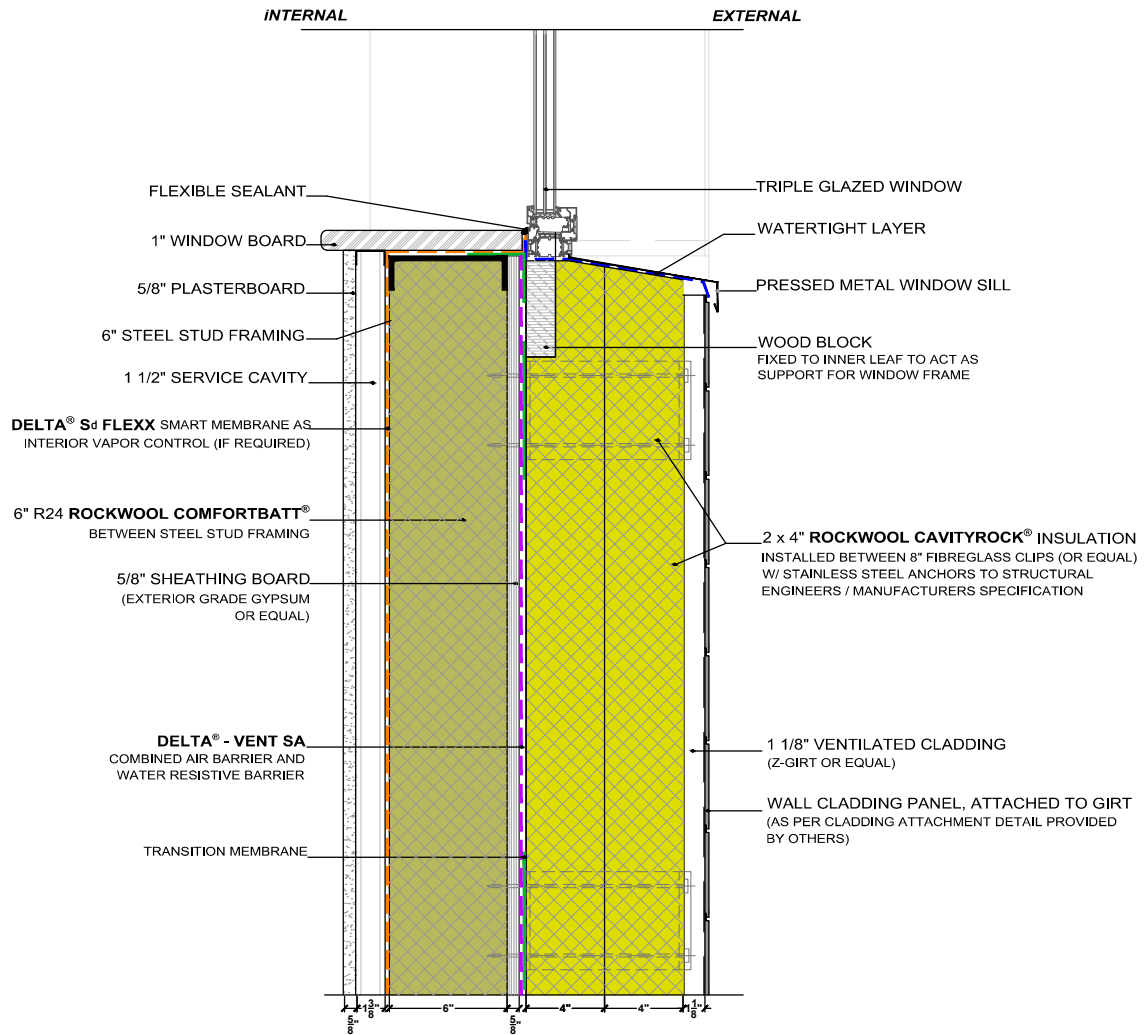


# WIBO01 – Window Sill

Psi = 0.028 (W/mK) | FRsi = 0.76

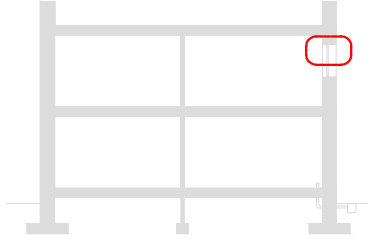


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-  **ROCKWOOL COMFORTBATT®** Batt insulation
-  **DELTA® VENT SA** Air tightness layer & water resistive barrier
-  **DELTA® Sd FLEXX** Optional secondary air tightness layer/vapor control
-  Transition membrane
-  Watertight layer

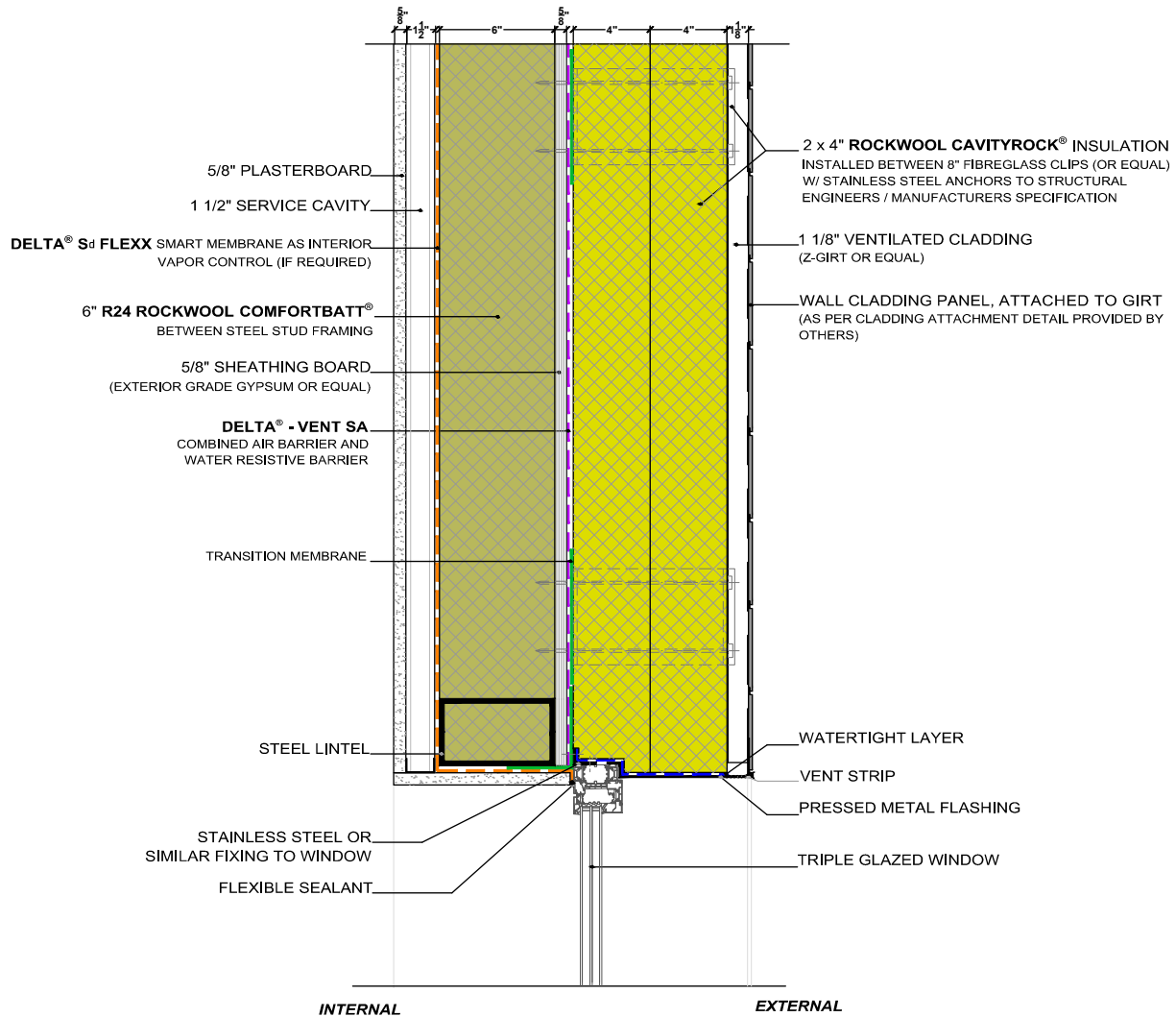


# WITO01 – Window Head

Psi = 0.014 (W/mK) | FRsi = 0.76

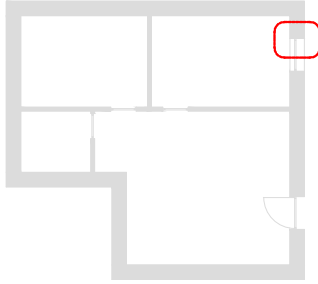


-  **ROCKWOOL CAVITYROCK®** Exterior insulation
-  **ROCKWOOL COMFORTBATT®** Batt insulation
-  **DELTA® VENT SA** Air tightness layer & water resistive barrier
-  **DELTA® Sd FLEXX** Optional secondary air tightness layer/vapor control
-  Transition membrane
-  Watertight layer

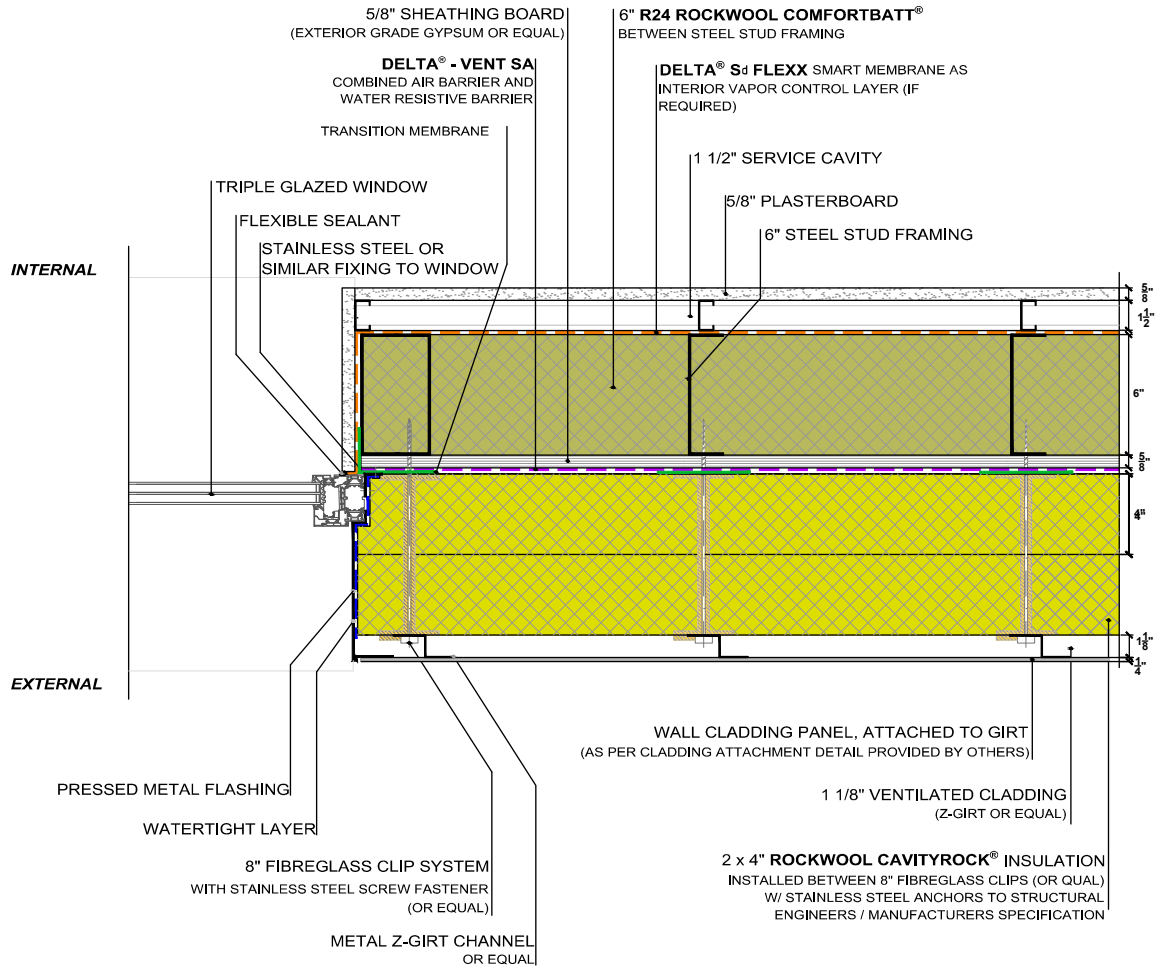


# WISI01 – Window Jamb

Psi = 0.013 (W/mK) | FRsi = 0.76



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-  **ROCKWOOL COMFORTBATT®** Batt insulation
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-  **DELTA® Sd FLEXX** Optional secondary air tightness layer/vapor control
-  Transition membrane
-  Watertight layer



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