Elevating Building Envelope Sustainability and Performance with Self-Sealing Fasteners and Anchors

TRUFAST®

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Contents.

INTRODUCTION

To minimize the risk of moisture and air intrusion, a building needs sustainable, high-performance walls. These walls require multiple, individual control layers all fastened or attached in some way. The fastener or anchor specified to attach these layers plays a significant role in the effectiveness of the wall system yet is typically overlooked. In many cases, subcontractors supply the fasteners, which means fastener selection often comes down to whatever is readily available.

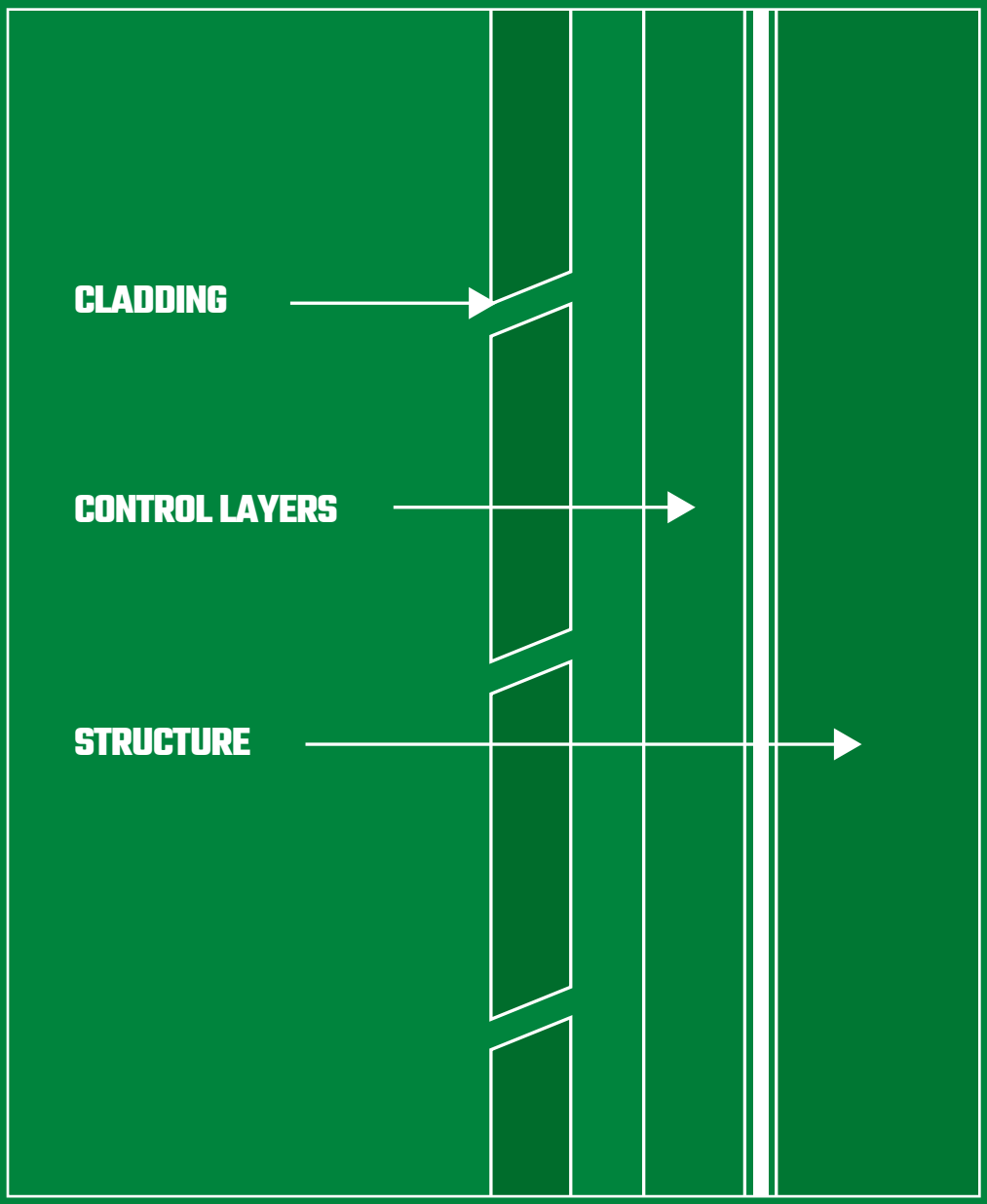
Understanding the impact of fasteners is critical to long-term sustainability both in terms of durability and energy performance. In this paper, we will explore the various layers and components of a sustainable wall system and discuss why it is important to consider the types of fasteners holding everything together.

THE “PERFECT WALL”

Leading building envelope scientist Joseph Lstiburek defines the perfect wall as having three layers. First, there is the cladding, which serves a design function. Next, there are the control layers, which are responsible for water, air, thermal, and vapor control. Last, there is the structure, which supports the building against dead and dynamic loads.

The perfect wall has three layers:

01. Cladding
02. Control layers
03. Structure



The key functions of a wall:

01. Structural support
02. Climate control
03. Aesthetic appearance

Each of these layers corresponds to one of the three primary purposes of a wall, with the most important function being structural. Structural support means that the foundation is able to support the structure’s weight, and the walls are load-bearing.

The second function pertains to the energy use and climate control abilities of the structure. The building envelope protects occupants and contents from the elements and helps ensure that conditioned air remains inside, while the outside air remains outside.

The third function of a wall is to give the building its aesthetic appearance. This aspect is more than just selecting a color or cladding type. Various types of cladding materials can define the cultural identity and character of a building.

Aesthetic appearance:

Aesthetics & cultural identity: Walls enhance a building’s look and cultural significance, reflecting its character.

Defining personality: Walls shape a building’s vibe, showcasing tradition, modernity, or distinctiveness.

Reflecting setting: Walls harmonize with surroundings, echoing the environment’s character or culture.

EXAMINING THE LAYERS

After a structure is framed, typically some sort of sheathing is attached. There are many types of sheathing, all serving different, project-specific purposes—structural support, rack and shear resistance, or fire, vapor, and water resistance. The common types of sheathing are wood, exterior gypsum, cement board, and magnesium oxide.

Common practice is to attach structural sheathing mechanically, usually with simple fasteners like standard bugle-head screws. Some sheathing, like magnesium oxide or cement board, requires structurally rated screws with a larger head diameter. Regardless, it's important to note that, at this point, fastener penetrations become a consideration.

The next layer is the weather-resistive barrier (WRB). It is intended to shed bulk water that penetrates through exterior finishing, yet it allows water vapor to escape. The WRB is usually a building paper or wrap, but can also be a self-adhered or fluid-adhered wrap.

Following the weather-resistive barrier is the air barrier. The air barrier requires a systems approach to control air leakage into and out of the building envelope. The integration of multiple components and areas must be considered—above the walls and below-grade—to provide a continuous path of air resistance.

Next comes continuous insulation. Historically, insulation has been installed between framing members, allowing much of a building's heat to be lost via thermal bridging through the steel or wood studs and framing members. Today, however, energy codes across North America often require a continuous layer of insulation that spans over framing members to reduce the effects of thermal bridging. Continuous insulation, too, often requires mechanical attachment.

The final layer is cladding. Most cladding types require fasteners or anchors to mechanically attach the control layers to the structure.

Fastener penetrations in each successive layer must be considered—sealing holes only in the outermost layer is not sufficient. In most building projects, there are multiple subcontractors working on different layers of the building envelope, who may or may not be considering the effects of their actions on the previous layers, therefore leading to leaks. The solution to this problem is utilizing fasteners, washers, and anchors that have been designed and tested to self-seal the blind-fastener penetrations. This helps preserve the integrity of air and water control layers, thereby maintaining the energy performance and sustainability of the entire building envelope.

Types of Continuous Insulation:

Expanded polystyrene (EPS)—Inexpensive; relatively low R-value; vapor-permeable; commonly used in EIFS.

Extruded polystyrene (XPS)—Moisture-resistant; can be flammable, so code considerations are required regarding building applications; commonly used below-grade.

Polyisocyanurate (polyiso)—Can double or triple as air, water, and thermal barrier; commonly used in walls when foil-faced and on roofs when paper-faced.

Mineral wool—Highly flame-resistant; vapor-permeable; allows for active drying of the weather-resistive layers behind; commonly used in rainscreen systems.

After a structure is framed, a specific layer structure typically follows.

01. Sheathing
02. WRB
03. Air barrier
04. Continuous insulation
05. Cladding

SHEATHING.

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WRB.

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AIR BARRIER.

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CONTINUOUS INSULATION.

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CLADDING.

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THE IMPACT OF FASTENERS AND ANCHORS

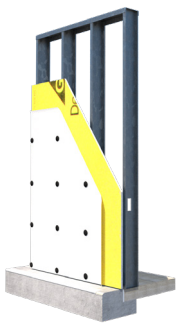
The historical challenge to attaching all the layers outlined above is the order in which each layer is added: the WRB and air barrier are always buried behind the cladding and often behind the thermal control layer or CI—leaving the WRB or air barrier susceptible to inevitable penetrations.

To understand the impact of adding fasteners and anchors during the application of each of the aforementioned layers without treating the penetrations they make, let's quantify the number of holes created in a standard 4' x 8' section of sheathing throughout its construction.

92

FASTENERS

The first layer, gypsum sheathing, is in most cases, attached about every 4" along the edge and 8" in the field. This layer accounts for 92 fasteners per 4' x 8' section.



28

FASTENERS

Next is mechanically attaching the building wrap or air barrier. It's typically attached in a 16" x 16" pattern. That means 28 fasteners can be expected for a 4' x 8' section of this layer.

28

FASTENERS

For the continuous insulation, this layer will see an additional 28 fasteners for a 4' x 8' section.

36

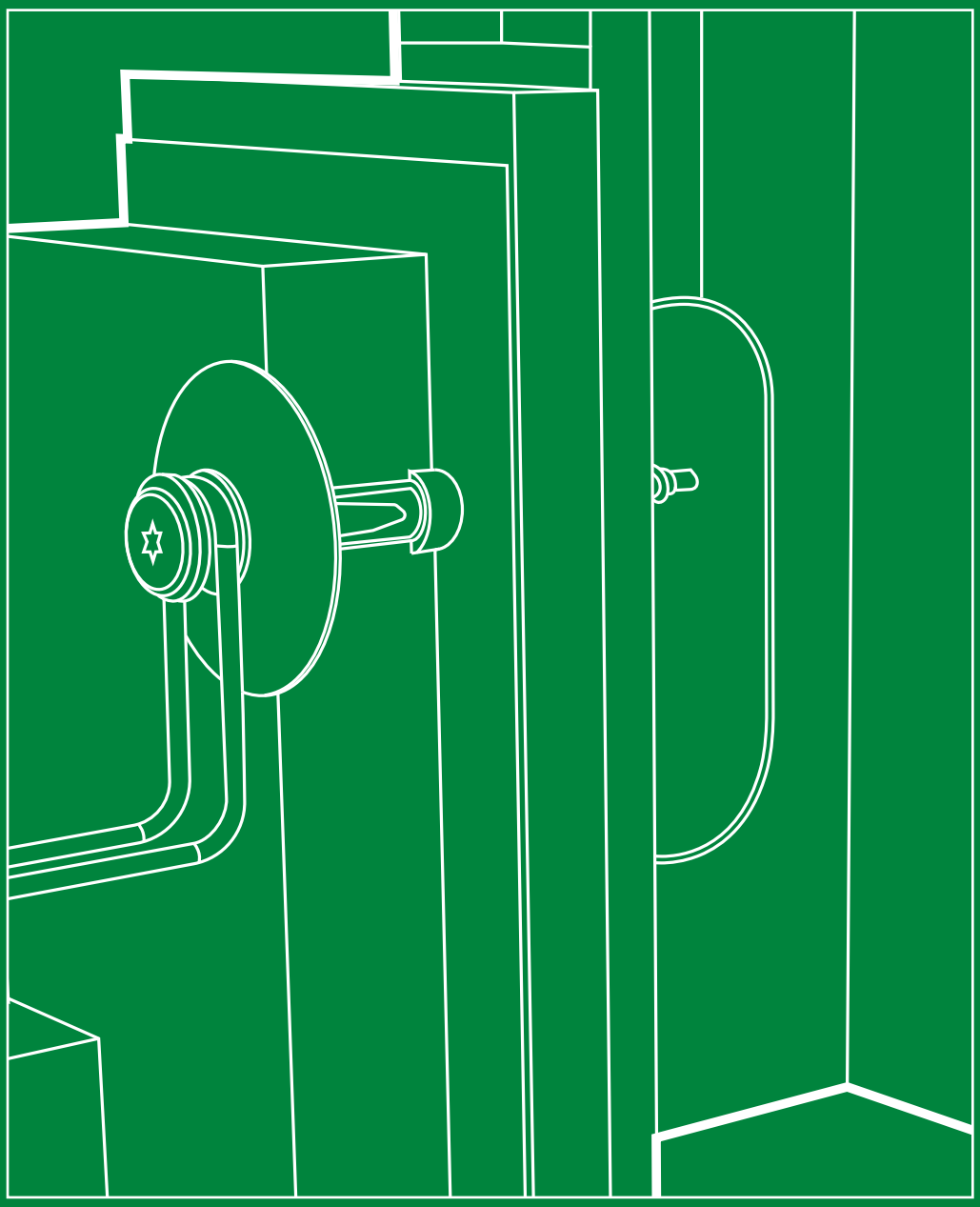
FASTENERS

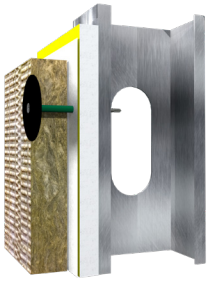
The last layer, the hat channel based ventilated rainscreen system, will require 36 fasteners for a 4' x 8' section.

So let's do the math. Our hypothetical 4' x 8' wall assembly ends up with a total of 184 fasteners penetrating through the air, water, and thermal control layers. This example demonstrates why there should be concern about fastener performance and how they affect a building envelope.

INNOVATION IN FASTENER TECHNOLOGY

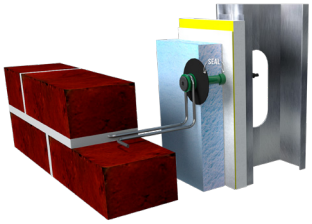
Luckily, there have been developments in fastener technology to help alleviate these issues. TRUFAST, for example, has worked extensively to develop its TubeSeal™ fastener technology, which leverages a semi-rigid tube around the outside of the screw that compresses against the surface of the underlying air barrier/WRB, creating a seal against air and moisture intrusion.





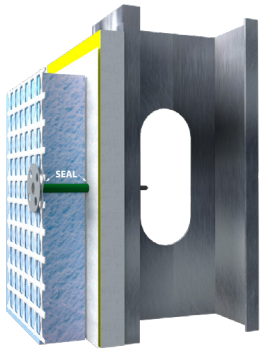
Tube seal fastener: Combines a screw, washer, and tube for an air barrier/WRB application.

TRUFAST has developed innovative TubeSeal™ solutions for various component attachments. **For continuous insulation over an air barrier/WRB, a TubeSeal fastener that combines a screw, washer, and tube will aid in sealing blind-fastener penetrations of the air barrier and WRB behind the insulation.** The fastener's tube inserts through the insulation while the screw inside spins and drills through the layers without any tearing action. Without the sealing tube, every penetration of the air barrier or WRB is susceptible to leakage.

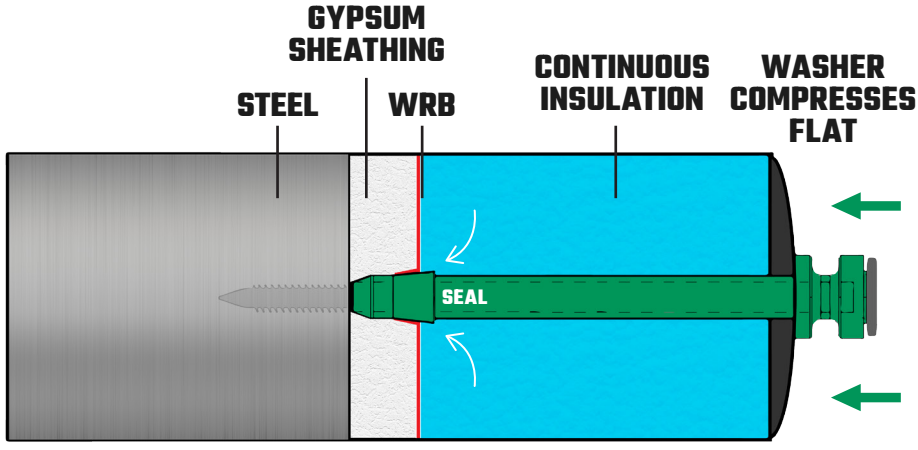


Tube seal or barrel-style options: Exist for masonry veneer anchors.

Similar **TubeSeal or barrel-style options exist for masonry veneer anchors**, whether for steel studs, wood studs, or masonry substrates. They are suitable for assemblies 1"-4" thick, and the wire ties allow for a 1"-2" air gap. The polycarbonate tube punches through the layer of insulation and even through the gypsum sheathing to make positive contact with a stud. The anchors are designed to minimize thermal bridging by separating the screw and wire tie with the polycarbonate tube. The large-diameter screw head also creates a redundant fire-safety feature by retaining the wire in the event of a fire in the wall cavity.



Tube seal fastener: An effective solution for lath attachment.



A TubeSeal fastener is also a fix for lath attachment. In these applications, the tube inserts through the lath and insulation and then compresses on the surface of the hidden air barrier/WRB, effectively creating a seal against air and moisture penetration. The galvanized lath washers are designed with keyholes for proper embedment and bonding of the cementitious base coat. These fasteners are available preassembled with various screw types for steel and wood substrates, and with varying lengths of screws and tubes for insulated assemblies ranging in thickness from 1" to 4."

Importance of Testing:

When specifying fasteners, it's important to have a proven product that has been tested to adhere to all relevant building codes. TRUFAST fasteners undergo an array of tests to ensure their performance against industry codes and standards. These include:

Multicomponent Assembly Testing—A dynamic test of the water and air barrier performance, which follows the standards of ASTM E331, "Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference," and ASTM E2357, "Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies." Many air barrier and WRB manufacturers test their barriers per these standards, but not all add the insulation or the cladding outboard. This extra layer of testing helps to determine if there will be any issues in the future.

Full-Scale Assembly Testing—This test includes varying combinations of air barriers, WRBs, insulation, fasteners, and anchors per ASTM E331 and E2357 standards. This test simulates the wall's performance over multiple decades and temperatures.

Blower Door Test—Based on ASTM E1827, "Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door," this test evaluates the entire building envelope and measures the amount of air that is escaping.

TubeSeal fasteners are also an innovative solution for attaching hat channels in rainscreen systems. In addition to creating an air- and watertight seal at the face of the air barrier/WRB, the tube also separates the steel screw from the hat channel, which reduces thermal bridging in the rainscreen assembly.

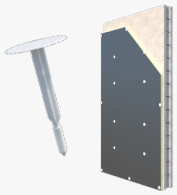
OTHER INNOVATIVE APPROACHES TO ATTACHING WALL COMPONENTS

COMMERCIAL BUILDING WRAP ATTACHMENT

Used for mechanically attaching commercial building wrap; design allows for seals against air and water; resilient during high-wind events; UV-resistant.

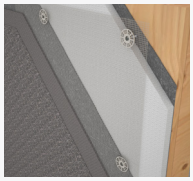
CONTINUOUS INSULATION ATTACHMENT

Used for rigid insulation and mineral wool attachment into a steel or wood stud; a combination of energy performance and labor-saving benefits.



CONTINUOUS INSULATION ATTACHMENT TO MASONRY SUBSTRATE

Used for attaching continuous insulation or mineral wool to concrete or masonry; minimizes thermal bridging; easy-to-install.



CONTINUOUS INSULATION RECESSED FASTENER

For attaching rigid insulation and mineral wool to concrete, masonry, and precast walls; fast, labor-saving installation.

CONCLUSION

Moisture and air penetration in a building project are undoubtedly a major concern, impacting sustainability efforts, building envelope performance, and occupant health. These issues can be mitigated by careful planning during the specification process of a project. However, the specification of building envelope fasteners is often overlooked, with subcontractors typically left to supply them. Consequently, cheap and untested fasteners are commonly used, posing a substantial risk of problematic leaks, given that projects have hundreds of thousands of fasteners. Without a sealing solution, every penetration of the control layers is susceptible to leakage. Specifying self-sealing TubeSeal fasteners is a proven solution to ensure the lasting performance and sustainability of the entire building envelope.

TRUFAST®

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