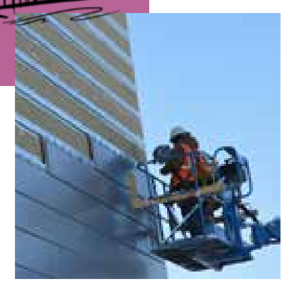
CLADDING SUPPORT SYSTEMS

Cladding Attachment Solutions

For Exterior Insulated Commercial Walls



Prepared by: **RDH Building Engineering Ltd. and RDH Building Sciences Inc.**

224 W 8th Avenue
Vancouver, BC
V5Y 1N5

Primary Author:
Graham Finch, P.Eng., Dipl.T., MASc

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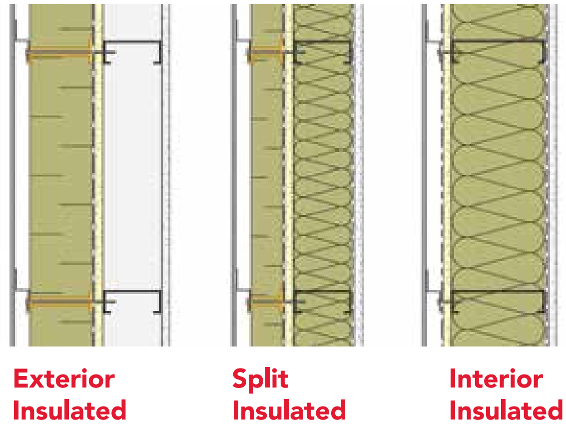
Cladding Attachment Solutions for Exterior Insulated Commercial Walls

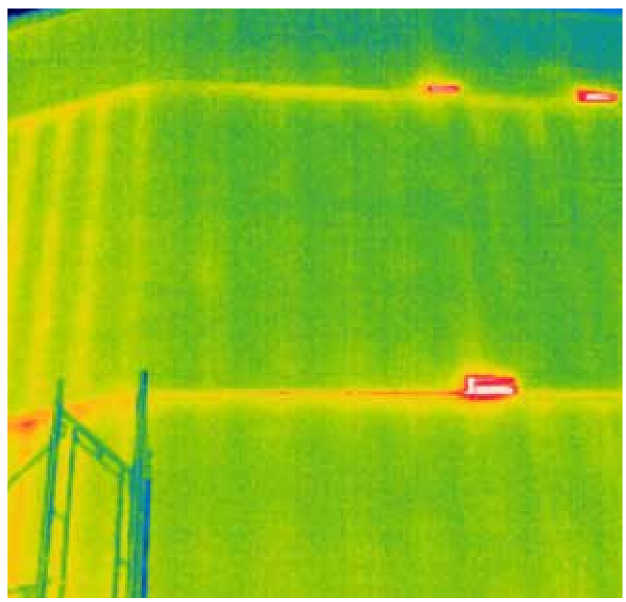
The use of exterior insulation installed outboard of wall sheathing is becoming increasingly common across North America to meet new energy code requirements. Commonly referred to as exterior insulation, this insulation is installed continuously on the outside of the primary structure and is typically more thermally efficient than insulation placed between studs or inboard of the structural system, provided that thermally efficient cladding attachments are used. Exterior insulation also has significant benefits for durability and thermal comfort as well. As a result, greater attention is being paid to the design of thermally efficient structural attachment systems, and several proprietary systems have been introduced into the market in recent years to meet this demand. Cladding attachment options include continuous girts, intermittent clip and rail systems, long screws, masonry ties, and other engineered supports.

The challenge designers and contractors face is selecting and evaluating an appropriate cladding attachment strategy for their project and understanding the implications these decisions have on effective thermal performance, installation methods, sequencing, and system costs.

This bulletin clarifies and provides guidance regarding different cladding attachment systems through exterior insulation for commercial wall applications.



Standard approaches to insulating steel-framed wall assemblies, referred to as exterior insulated, split insulated and interior insulated depending on the placement of insulation.



Thermal infrared image showing a cladding with thermally inefficient continuous vertical Z-girt cladding support system to left side of wall versus thermally efficient low-conductivity clip and rail cladding support system to right side. The insulation within the continuous girts is less than 25% effective (about R-4 for 4″ of mineral wool insulation), whereas the insulation between the intermittent clips is over 80% effective (about R-13 for 4″ of mineral wool insulation) – significantly improving the thermal performance of the wall for the same construction cost.

Energy Codes & Exterior Insulation

There are various energy codes and standards in force across North America for commercial buildings. The two most widely applicable energy codes are the International Energy Conservation Code (IECC) in the United States, and the National Energy Code for Buildings (NECB) in Canada. The most commonly referenced energy standard is ASHRAE Standard 90.1, which is referenced by building and energy codes in the majority of American states and Canadian provinces. Different versions and adaptations of these standards and codes are in effect in the provinces and states.

While different versions and adaptations of these regulations are enforced in different jurisdictions, each requires consideration for thermal bridging and effectiveness of installed insulation. Exterior insulation presents an efficient and cost-effective method to provide improved thermal performance and meet the requirements of these regulations; however, the effectiveness of this approach hinges on the selection of a thermally efficient cladding attachment strategy. The cladding attachment can be a significant thermal bridge and reduce exterior insulation performance by as little as 5-10% for high-performance systems, and as much as 80% for poor systems.

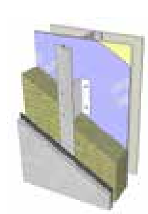
Requirements for Cladding Attachment

There are several considerations which must be made with respect to choosing a type of exterior insulation and cladding attachment strategy for a building. These typically include at a minimum:

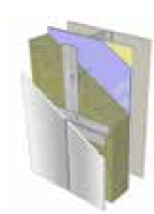
- Cladding weight & gravity loads
- Wind loads
- Seismic loads
- Back-up wall construction (wood, concrete, concrete block, or steel framing etc.)
- Attachment point back into the structure (through studs, sheathing, or slab edge)
- Thickness of exterior insulation
- Use of rigid, semi-rigid or spray-applied insulation
    - Ability to fasten cladding supports directly through the face of rigid insulation boards
    - Ability to fit semi-rigid or sprayed insulation tightly around discrete supports and ease of installation
- Effective R-value target and tolerable thermal efficiency loss from supports
- Orientation and required attachment location for cladding system (panel, vertical, horizontal)
- Details for attachment of cladding at corners, returns and penetrations
- Combustibility requirements
- Accommodation of dimensional tolerance
- Allowable wall thickness

The design of the cladding attachment system will typically be performed by a structural or façade engineer working for the architect or cladding manufacturer. Many cladding support systems have been pre-engineered and designed using load tables developed by the manufacturer.

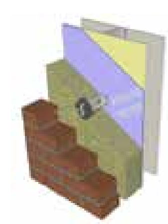
It is important that the cladding support designer understands the requirements of the project, including the thermal requirement, so that the system and spacing of supports can be optimized to make the best use of the exterior insulation. Various options exist, and will be selected based on a number of factors as discussed here.



Discrete clip and rail type cladding support with semi-rigid insulation placed between clip supports inboard of the continuous vertical rail. Cladding attached back to vertical rails on exterior of insulation.



Long screws through rigid insulation utlizing continuous vertical strapping to create a truss cladding support system. Cladding attached to strapping on exterior of insulation.



Masonry ties with semi-rigid insulation. The tie supports here provide only lateral resistance support, not gravity load (supported at the base of the veneer).

Cladding Attachment Systems

There are numerous generic and proprietary cladding support systems designed for use with exterior insulation available on the market today, and many different materials are used to make these systems including galvanized steel, stainless steel, aluminum, 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 or other engineered systems.

Systems are available to accommodate a wide range of claddings for buildings of all heights and exposures. Typically the heavier the cladding or extreme the wind load the tighter the spacing of the supports – at compromise to the effective thermal performance. The best system is one that is optimized structurally and thermally for the cladding support needs of the specific project.

An overview of ten different cladding support systems is provided in the sections below. For each of the systems a relative cost ($ - $$$), thermal efficiency (e.g. percent effectiveness of the exterior insulation), and ease of installation ranking is provided. Within all of the systems, semi-rigid ROCKWOOL CAVITYROCK® is typically appropriate except where noted. Where a more rigid insulation is required, such as where the screws through insulation cladding support system is used or in an application where a more rigid board is preferred, ROCKWOOL COMFORTBOARD™ is recommended.

All of the cladding systems can be installed with wood, steel stud, or concrete/concrete block back-up walls, with most systems lending themselves better to commercial construction rather than residential practices.

Continuous Framing

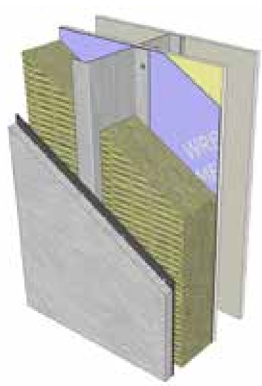
Continuous girt cladding support systems are the predecessors to the more thermally efficient clip and rail systems that have been developed in the past few years. While continuous framing systems do not perform nearly as well thermally, they are still used in some applications.

Vertical Z-Girts

RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	20-40%	

This cladding attachment consists of continuous galvanized steel framing members, typically 18 to 20 gauge Z-girt or C-channel profiles attached vertically to the back-up wall. Typically girts are spaced to line up with stud framing behind (every 16" to 24" o.c.). Cladding systems are attached directly to the outer flange of the Z-girts. Where vertically oriented cladding is used, additional horizontal sub-girts may be applied to the exterior of the verticals.

Vertical Z-girts are not a thermally efficient cladding system and are not recommended in typical applications due to the excessive amount of thermal bridging. Exterior insulation installed between vertical Z-girts is degraded significantly and is only 20-40% effective for typical applications. While thermal breaks at the sheathing level can be beneficial, the insulation is still largely bridged, making the improvement mostly to surface temperature rather than U-value. In terms of prescriptive code compliance, it is very difficult to meet effective R-value requirements with this system.



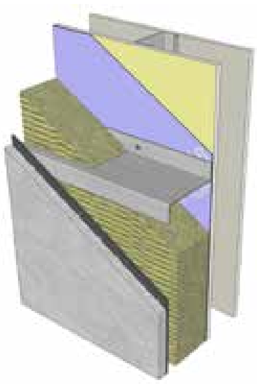
Vertical Z-girt over steel stud wall assembly. Girts are fastened to studs behind at every 16" o.c. resulting in significant thermal bridging through the exterior insulation.

Horizontal Z-Girts

RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	30-50%	

This cladding attachment consists of continuous galvanized steel framing members, typically 18 to 20 gauge Z-girt profiles attached horizontally to steel studs or a concrete back-up wall. Typically girts are attached to the back-up wall every 24" to 48" o.c. depending on cladding loads. Cladding systems are attached directly to the outer flange of the girts. Where horizontally oriented cladding is used, additional vertical sub-girts may be applied to the exterior of the horizontals.

Horizontal Z-girts are not a thermally efficient cladding system and not recommended in typical applications due to the excessive amount of thermal bridging. Exterior insulation installed between horizontal Z-girts is degraded significantly and only 30-50% effective for typical exterior insulation applications. This is only slightly improved from vertical Z-girts as less steel bridges the exterior insulation (i.e. 24" o.c. spacing vs 16" o.c.).



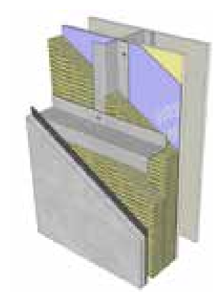
Horizontal Z-girts over a steel stud wall assembly. Girts are fastened every 36" here to reduce the thermal bridging.

Crossing Z-Girts

RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	40-60%	

This cladding attachment consists of two continuous galvanized steel framing members, typically 18 to 20 gauge Z-girt profiles attached in a crossing pattern to steel studs or a concrete back-up wall. Typically girts are spaced every 16" to 24" o.c. depending on the back-up framing and cladding loads. Cladding systems are attached directly to the outer flange of the exterior girts.

Crossing Z-girts are not a very thermally efficient cladding system and not recommended in typical applications due to the excessive amount of thermal bridging. Exterior insulation installed between crossing Z-girts is degraded significantly even though the attachment occurs intermittently and only 40-60% effective for typical exterior insulation applications. This system can be improved slightly (less than 5%) with the use of low conductivity isolation thermal breaks/washers between framing and back-up wall, or between the crossing girts.



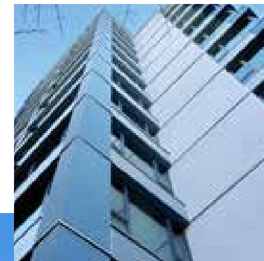
Crossing Z-girt assembly consisting of horizontal and vertical Z-girts attached at crossing points.

Crossing Z-girt cladding support system with custom punched vertical Z-girt profiles used to retain ROCKWOOL CAVITYROCK® insulation.

Clip and Rail Systems

Clip and rail systems are becoming a popular approach for a more thermally efficient cladding support system and can support all types of cladding. This includes board and lap cladding that is installed using standard nail/screw fasteners, stucco/adhered veneers, stone veneers, and a wide range of metal, glass, and composite cladding systems each with unique support conditions.

Clip and rail systems consist of vertical or horizontal girts (rails) attached to intermittent clips which are then attached back to the structure through the exterior insulation. Typically only the clips penetrate the exterior insulation; however, in some designs, the web of the rail may also cut through part of the insulation. In such a case, the web degrades the thermal performance of the system similar to the continuous vertical/horizontal girt systems and should be avoided as much as possible. The rails are typically made from galvanized steel Z-girt or hat-channel sections or aluminum extrusions. The clips are made from a range of materials including galvanized steel, stainless steel, aluminum, fiberglass, plastic or some combination of these materials together. The less conductive the clip material and the fasteners that penetrate the insulation, the more thermally efficient the system will be. This is why stainless steel or fiberglass systems perform better than galvanized steel or aluminum, and why stainless steel fasteners may be beneficial compared to galvanized steel fasteners. The strategy with all clip systems is to maximize the spacing and use as few clips as possible while meeting the structural requirements. This maximum clip spacing is typically governed by the cladding wind loads and stiffness of the rail section. Low conductivity clips are also beneficial since inevitably more clips are needed at detail locations. While this is not necessarily accounted for in current energy codes, it will likely become a consideration in the future, as thermal bridging at such locations becomes a central concern.



Galvanized Steel Clips

RELATIVE COST $$$

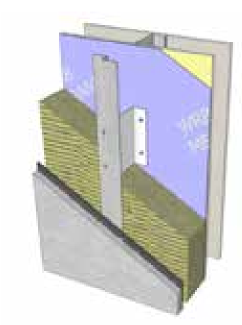
THERMAL EFFICIENCY 50-75%

CONSTRUCTABILITY

This clip and rail support system utilizes intermittent generic metal clips made of cold formed galvanized steel. The clips typically take the form of 16-20 gauge Z-girts, C-channels, or L-angles in 4-8" lengths with depth to suit the insulation and/or cladding cavity. Dimensional adjustability can come from the use of separated back to back L-brackets screwed together as they are installed or the use of plastic or metal shims installed on the wall behind the clips. The clips are attached to vertical or horizontal rails which are most often Z-girts, hat-channels or C-channels. Cladding is attached directly to these rails with short screws. The rail sections should ideally not penetrate the insulation as this will degrade the effective thermal performance of the system.

The thermal efficiency of a clip and rail system with galvanized steel is predominantly affected by the spacing, gauge, and length of the clips. Typically clips are spaced every 16" horizontally and 24-48" vertically depending on the cladding loads. Given the variables, the thermal efficiency of galvanized steel clip and rail systems can range considerably from less than 50% to as high as 75%.

In addition to the generic options available, there are some manufacturers who now produce pre-made engineered galvanized steel clips.




Intermittent galvanized steel clips with vertical girts.

Generic adjustable back to back L-angle clips.

Stainless Steel Clips

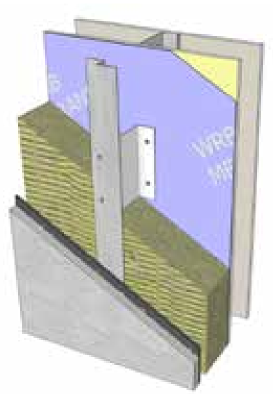
RELATIVE COST $$$

THERMAL EFFICIENCY 65-85%

CONSTRUCTABILITY

This clip and rail system is very similar to the galvanized steel clip option described previously, but instead the clips are made of stainless steel profiles (rails remain as galvanized steel). Stainless steel is more than four times less conductive than galvanized steel, and therefore more thermally efficient. Because of the lower conductivity of the clips, this system performs quite well with thermal efficiencies in the 65 to 85% range depending on spacing and clip dimensions.

In terms of installation, pre-drilling the stainless components can help with fastening onsite. In addition to the generic options available, there are a few manufacturers who now produce and sell stainless steel clips including a pre-drilled back to back L-bracket allowing for site adjustability.



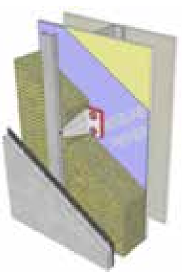
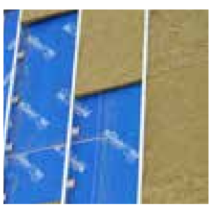

Intermittent stainless steel clips with vertical girts.

Thermally Isolated Galvanized Clips

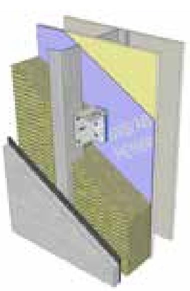
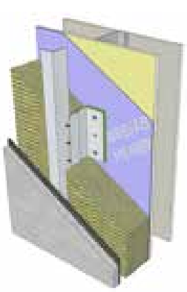
RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	60-90%	

This clip and rail system consists of proprietary heavier gauge galvanized steel clips with 1/8" to 1/2" plastic pads/washers installed between the clip and backup structure. Plastic washers may also be used at fasteners to reduce the heat transfer. Vertical or horizontal girts are attached to the clips using screws and the cladding is attached to these girts. There are currently multiple manufacturers of similar products in the market with varying thermal and structural performance.

In terms of thermal performance, the plastic components reduce the heat flow through the clip to performance levels similar to stainless steel clip systems. Again the key to maximizing the thermal performance of this system is to reduce the number of clips required. The thermal performance of this system varies between 60% and 90% depending on the manufacturer's details and spacing.

Thermally isolated galvanized steel clip attached to wall with screws through plastic isolation pad.

Additional examples of thermally isolated galvanized steel clips where low-conductivity pads are used to reduce the heat flow through each clip. Note that the best performance arises when the continuous girts attached to the clips are entirely outboard of the insulation and do not cut through it.

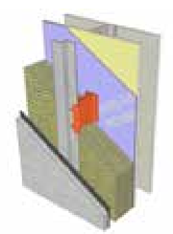
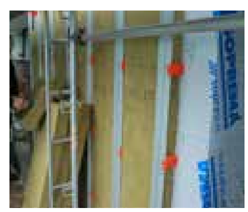
Fiberglass Clips

RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	70-95%	

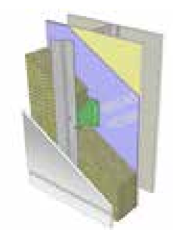
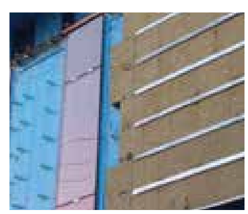
This clip and rail system utilizes low-conductivity fiberglass clips. Fiberglass is approximately 200 times less conductive than galvanized steel and improves the thermal performance significantly. One or two long screws (galvanized or stainless steel) through each clip connect the vertical or horizontal galvanized steel rail through the shear block clip back to the structure.

With this system, Z-girts or hat-channels are used as the vertical or horizontal rail elements entirely on the exterior of the insulation. The fiberglass clips are often pre-clipped to the metal girts and then screwed to the wall as one element, speeding up installation time.

There are two variants of the fiberglass clip in the market with varying structural, fire, and thermal performance characteristics. The thermal performance of a fiberglass clip and rail system is heavily dependent on the spacing of the clips and type of screw fasteners used (galvanized vs stainless) and ranges from 70% with tightly spaced clips for heavier claddings to over 90% with optimally spaced clips for lighter claddings.

Fiberglass clips with vertical Z-girt attached with screw fasteners through the fiberglass clips into the back-up wall.

Fiberglass clips (spacers) attached to wall with screws, horizontal Z-girts attached to clips with screws.

Long Screws through Insulation

RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	75-95%	

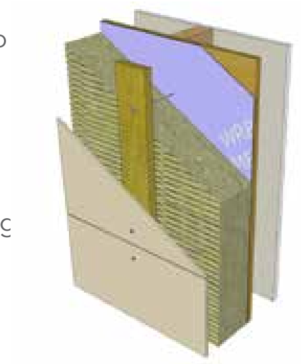
This cladding attachment system utilizes long fasteners that connect girts or strapping on the exterior of rigid insulation (ROCKWOOL COMFORTBOARD™) directly into the structure. Semi-rigid insulation is not recommended as it is too compressible in this application.

The combination of the continuous exterior strapping/ girts, long fasteners, and rigid insulation creates a truss system to support lightweight to medium weight cladding systems. Deflection is limited by the truss action and can be further limited by installation of fasteners screwed in upwards at an angle through the insulation. The only thermal bridges through the exterior insulation are the long galvanized or stainless steel screws. Claddings are attached directly to steel girts or wood strapping on the exterior surface of the insulation. Typically vertical strapping is used as it provides a vertical cavity for drainage and ventilation behind the cladding along with greater load carrying capacity; however, horizontal strapping can also be used for some claddings.

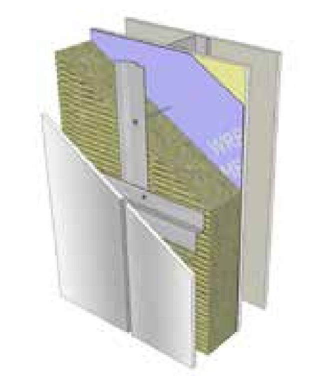
Typically 18 to 20 gauge hat-channel profiles for galvanized steel girts or minimum ¾″ plywood or dimensional lumber are used for the exterior girts/ strapping. Typically the fasteners consist of #10-#14 steel screws every 12-16″ o.c. in lengths to connect the exterior girt/strapping to the backup structure (studs, sheathing, or concrete). Typically the required screw length can be estimated by the thickness of exterior insulation plus 1 ½″ - 2″.

One challenge installers face with this system is the positive connection of the screw fasteners back to the structure. With wood framing this can be achieved by either hitting the studs or designing the plywood or OSB sheathing for the required pull-out resistance. With steel studs this requires careful alignment to hit but not strip the studs. With concrete and concrete block back-up, this requires special concrete or masonry fasteners.

The thermal performance of this system depends on the back-up wall, type of fastener and fastener spacing. For typical conditions, the insulation effectiveness will be in the range of 75% to 85% for galvanized screws in steel/ concrete backup, and up to 90-95% for stainless steel screws in wood-frame backup.




Long screws through vertical wood strapping and rigid ROCKWOOL COMFORTBOARD™ insulation on a multi-family residential project.




Long screws through horizontal metal hat tracks and rigid ROCKWOOL COMFORTBOARD™ insulation on a commercial building project.

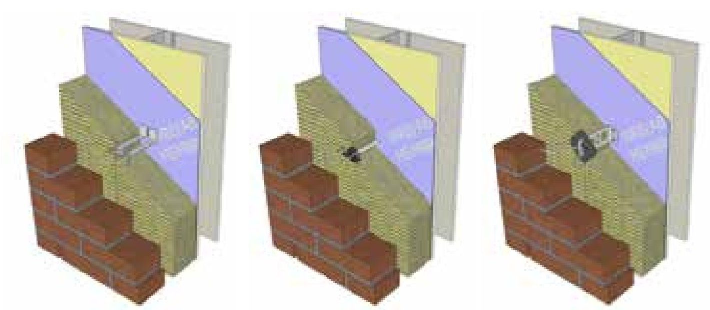
Engineered Anchors & Other Systems

Masonry Ties

RELATIVE COST	THERMAL EFFICIENCY	CONSTRUCTABILITY
$$$	40-90%	

Masonry veneer systems are supported by gravity bearing supports (shelf angles, corbels, etc.) and intermittent ties for lateral and out of plane support. Masonry ties bridge the exterior insulation similar to other cladding supports and therefore are thermal bridges. There are a range of proprietary and generic masonry tie systems available in the market and the thermal efficiency ranges from fair to excellent (approximately 40 to 90%) depending on the number of ties and type of metal used.

Examples of masonry ties installed through ROCKWOOL CAVITYROCK® insulation.

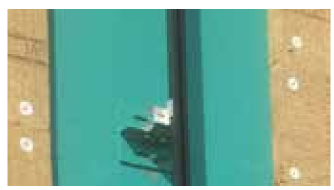


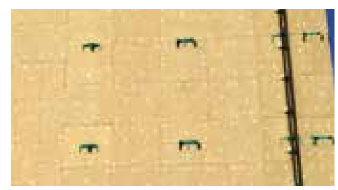
Examples of alternate masonry ties installed through ROCKWOOL CAVITYROCK® insulation.

In addition to the various cladding attachment systems presented in this bulletin, there exist many opportunities for engineered approaches and adaptations of existing systems.

Stone veneer systems have long used heavy gauge engineered clips to structurally support heavy claddings and have adapted dimensions to support through a few inches of exterior insulation. Many of these heavier gauge steel anchors will be large thermal bridges, and thermal modeling is suggested to assess opportunities for improvement, including spacing optimization or incorporation of thermal break materials.

An example of a heavy-duty engineered cladding anchor support system is shown below where large steel plates have been bolted into the concrete structure at 10 to 12' spacing. An aluminum rail system spans over top of the steel plates to support the panel cladding system.





Example of heavy-duty engineered anchor consisting of large welded steel plates and vertical rail system.

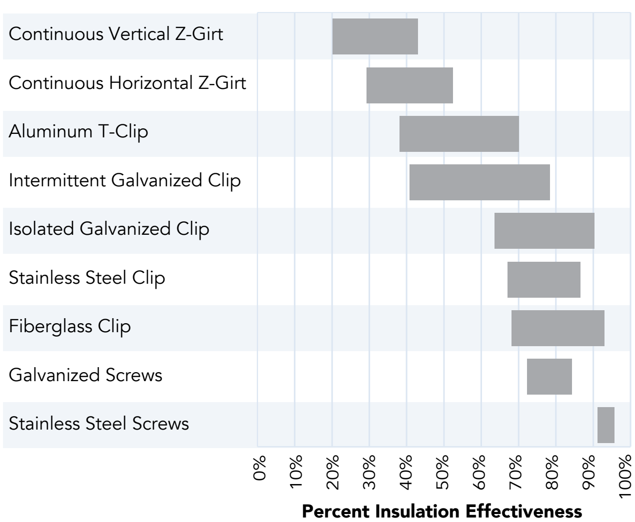
Cladding manufacturers are constantly developing new and improved support systems. The list of available cladding support systems from that covered within this bulletin will continue to grow and modifications of existing systems will become more commonplace. Such examples include the use of discrete fiberglass clips or aluminum and plastic clips to support composite metal panels (below).

Examples of thermally improved discrete cladding supports for composite metal panels.

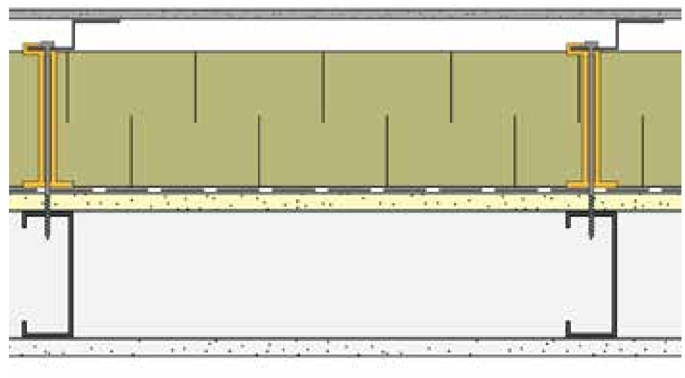
Summary Thermal Comparison of Systems

To summarize the thermal performance of the various cladding support strategies presented, the range of thermal effectiveness of the exterior insulation is shown below. These percentages can be multiplied by the R-value of the exterior insulation and added to the back-up wall R-value to determine an approximate overall effective R-value for the wall assembly.

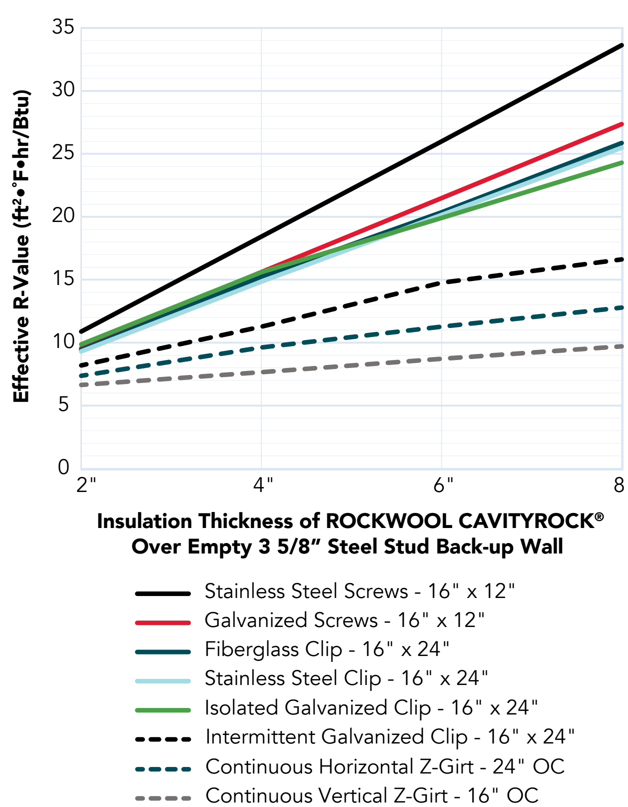
The range in values provided encompasses typical support structure spacing when attached to steel stud, concrete, and wood back-up walls for a range of typical claddings. The percent insulation effectiveness also decreases with thicker amounts of exterior insulation. The values were determined using calibrated three-dimensional thermal modeling software. Each of the systems was modeled using the same set of assumptions, boundary conditions, and material property inputs. Manufacturers will also be able to provide their own published data.



This same information can also be used to help select an appropriate thickness of ROCKWOOL CAVITYROCK® insulation over an uninsulated 3 5/8" steel stud frame back-up wall in the chart below. For example, to get to an effective R-20 with this back-up wall, 6" of CAVITYROCK® insulation is required with several different cladding support systems.



Uninsulated 3 5/8" steel stud wall with exterior insulation and cladding attachment system.



Other Considerations

In addition to the cladding supports, mechanical attachments are also needed to support and hold the exterior insulation in place where not provided by the cladding support system. These insulation fasteners are intended to retain the insulation tight to the back-up wall and the cladding supports as gaps between boards of insulation or behind the insulation will degrade the thermal performance, especially if the insulation becomes dislodged behind the cladding in-service.
These fasteners are used throughout the wall area, and in particular around details where smaller pieces of insulation are cut and fit. Acceptable fasteners include screws & washers, proprietary insulation fasteners, impaling pins, and plastic cap nails. Many of the cladding systems presented in this bulletin also are designed to retain the insulation during the installation process.

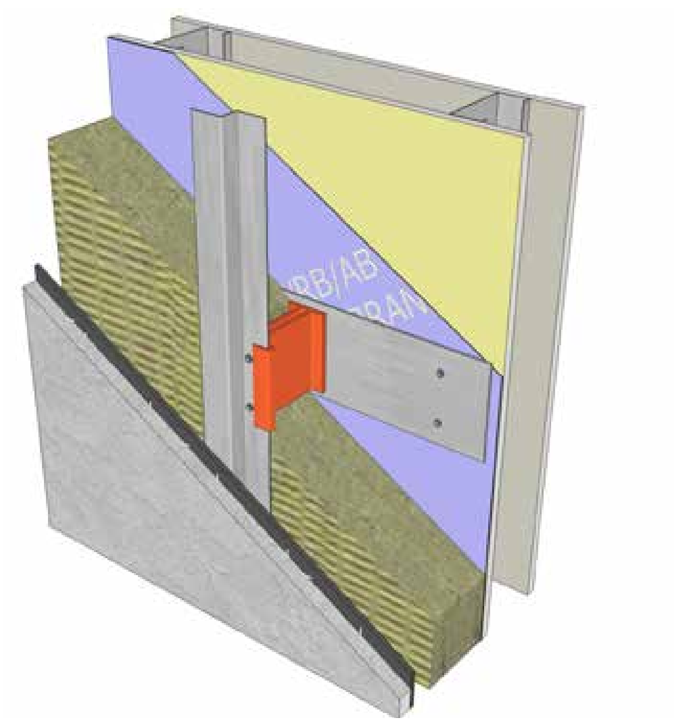
Metal insulation fasteners will create additional thermal bridging through the exterior insulation, so should be used sparingly. Fasteners will typically reduce the thermal effectiveness of the exterior insulation by <1% for plastic fasteners to up to 10% for large screws, in addition to losses due to the cladding support system.

Example of insulation retained by intermittent cladding support clips behind metal panels. The metal panel support structure overtop will further retain the insulation in the assembly here.

Example of insulation retained by mechanically attached impaling pins between vertical wood framing (adhesive stick-pins are not considered a long-term support strategy).

Example of plastic fuel-cell actuated insulation fasteners installed after insulation and girt system is installed to retain the insulation.

Each of the cladding systems presented in this bulletin requires the supports to be attached back to the structure. This is relatively simple with concrete, concrete block, and mass timber walls. With wood buildings, the cladding supports can be designed either to be supported by studs, or by the plywood or OSB sheathing, depending on the fastener pull-out requirements. With steel stud buildings and gypsum sheathing, the cladding supports must be attached back into the steel studs. This means that a steel stud needs to be positioned behind each clip or girt. This may not always be possible, especially in retrofit situations. In these scenarios 16 to 20 gauge galvanized sheet steel strips can be used to span between the studs and act as a larger target for the fasteners of the cladding support clip/girt. These strips may be required around penetrations, windows, corners, and other places where steel studs cannot be installed from the interior.



Example of the use of galvanized sheet steel strips to provide structural backer for cladding support clips away from studs.

Summary

There are many cladding support systems available in the industry that can be used to support claddings of all types through exterior insulation including ROCKWOOL CAVITYROCK® and COMFORTBOARD™. Energy codes including ASHRAE Standard 90.1 and NECB consider thermal bridging and insulation effectiveness, making an efficient cladding attachment strategy an important component of the enclosure design. Key attributes to look for are systems that provide the required structural support, minimize thermal bridging, are easy to install, and are cost effective. As this is an emerging industry – cladding support systems are constantly evolving and being developed.

Additional Sources of Information

- ROCKWOOL CAVITYROCK® Installation Guide
- ROCKWOOL CAVITYROCK® Videos
- ROCKWOOL COMFORTBOARD™ Installation Guide
- ROCKWOOL Fastener Guidelines

At the ROCKWOOL Group, we are committed to enriching the lives of everyone who comes into contact with our solutions. Our expertise is perfectly suited to tackle many of today's biggest sustainability and development challenges, from energy consumption and noise pollution to fire resilience, water scarcity and flooding. Our range of products reflects the diversity of the world's needs, while supporting our stakeholders in reducing their own carbon footprint.

Stone wool is a versatile material and forms the basis of all our businesses. With approx. 10,500 passionate colleagues in 38 countries, we are the world leader in stone wool solutions, from building insulation to acoustic ceilings, external cladding systems to horticultural solutions, engineered fibres for industrial use to insulation for the process industry and marine & offshore.

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ROCKWOOL
8024 Esquesing Line
Milton, ON L9T 6W3
Tel: 1 800 265 6878
rockwool.com