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Thermafiber® THE NAME IN MINERAL WOOL®

The Benefits of Mineral Wool as Continuous Insulation

The Benefits of Mineral Wool as Continuous Insulation

Presented By: Thermafiber, Inc.
3711 Mill Street
Wabash, IN 46992

Description: Provides an overview of mineral wool, its manufacture and use, and its contribution to sustainable buildings as a continuous insulation.

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The Benefits of Mineral Wool as Continuous Insulation

by AEC Daily Corporation

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Learning Objectives

At the end of this program, participants will be able to:

- recall the advantages and implications of using continuous insulation
- discuss the changes in ASHRAE R-value requirements from 2007 to 2010
- describe the raw materials used in the manufacture of mineral wool, its manufacturing process, and where the recycled content comes from
- list three benefits of mineral wool as a continuous insulation, and
- describe three types of rainscreen walls.

Table of Contents

Click on title to view

Mineral Wool Continuous Insulation was used in the Fort Belvoir Community Hospital, Fort Belvoir, VA.

Continuous Insulation

Insulation Choice

Choosing the right insulation and putting it in the right location is becoming one of the most important decisions in design, construction and retrofit, as insulation has a dramatic impact on the energy efficiency of a building.

In order to design energy efficient buildings that will meet current and future energy codes, the use of continuous insulation (ci) construction systems on the exterior of the building is critical. ASHRAE 90.1 defines continuous insulation as:

"*insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior, exterior, or is integral to any opaque surface of the building.*"

Continuous Insulation

Use of continuous insulation eliminates thermal bridging. This is the type of heat loss which occurs when heat flows through the building envelope via a continuous path, like through wood, or more commonly, highly conductive steel framing members. Thermal bridging dramatically affects whole wall R-value. For instance, a steel stud wall assembly with batt insulation will lose 75% of its R-value through thermal bridging.

Having the insulation outboard of the structure has advantages. Air and vapor barriers can be installed as a single material adjacent to wall sheathing, allowing for continuity of the barriers. Placing the insulation in this location will also move the dew point closer to the outer face of the wall, reducing the potential for condensation within the wall. The location of the moisture barrier within the wall is critical.

Continuous Insulation Requirements

ASHRAE Standard 90.1 is one of two primary baseline building energy codes that may be adopted by states and local jurisdictions to regulate the design and construction of new buildings. 90.1 is limited to commercial buildings, while the International Energy Conservation Code® (IECC), addresses both residential and commercial buildings.

The mandatory installation of ci over steel stud framing was first incorporated in the ASHRAE 90.1-1999 edition. Both residential and non-residential steel-framed walls in zones 3–8 required continuous insulation.

The recently DOE-approved ASHRAE standard, 90.1-2010, requires states to be certified by 2013.

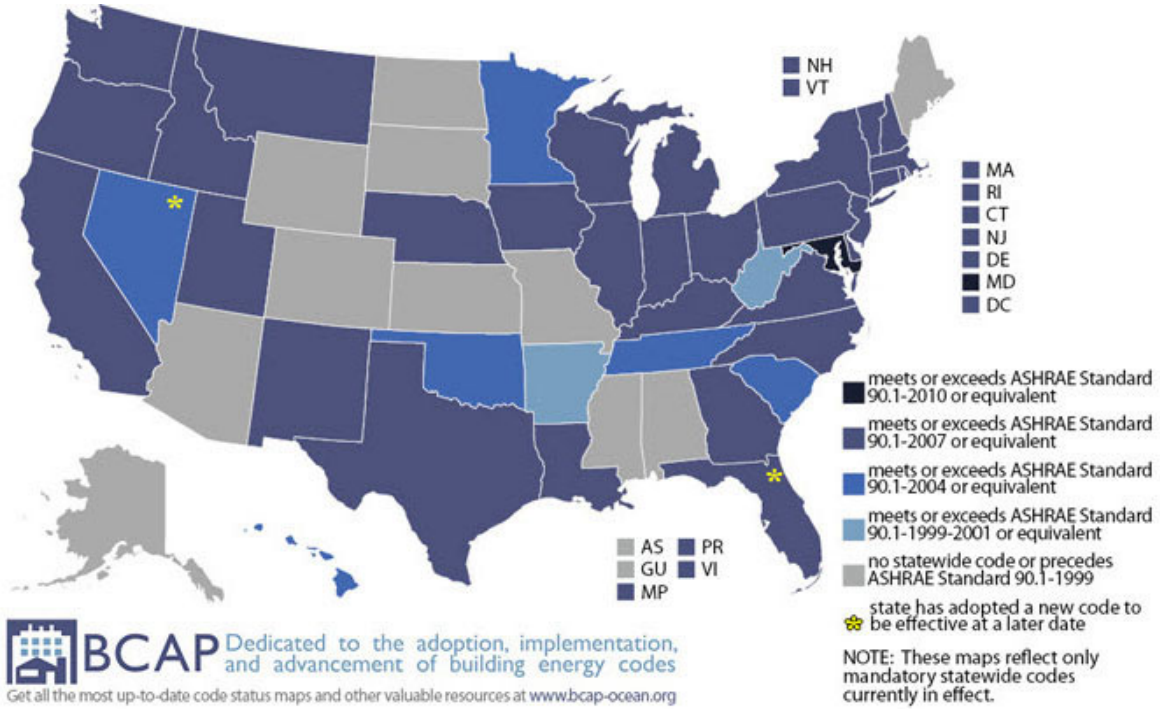
Continuous Insulation Requirements

Certification will confirm that they have reviewed the provisions of their commercial building code regarding energy efficiency, and updated their code to meet or exceed Standard 90.1-2010.

States may request extensions of this deadline from DOE if a state can demonstrate that it has made a good faith effort to comply with this code update.

This standard calls for continuous insulation in all zones for steel frame construction and metal-framed buildings.

Commercial State Energy Code Status



Code	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
2012 IECC	R-13 + 5 ci	R-13 + 5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci
ASHRAE 90.1 2010	R-13	R-13	R-13 + 3.8 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci
2009 IECC	R-13	R-13	R-13 + 3.8 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci
ASHRAE 90.1 2007	R-13	R-13	R-13 + 3.8 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci	R-13 + 7.5 ci

Source: http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/graphic/973

ASHRAE R-Values

Summarized below are the changes in ASHRAE R-value requirements from 2007 to 2010.

Zone	Building Type	Changes in ASHRAE Requirements 2007-2010
Zones 1 & 2	Metal Buildings	23% increase in R-value
Zones 3 & 4	Metal Buildings	46% increase in R-value
Zone 5	Metal Buildings	New requirement added for continuous insulation
Zone 5	Wood-Framed Buildings	Decrease in continuous insulation
Zone 6	Metal Buildings	New requirement for continuous insulation
Zone 7	Metal Buildings	46% increase in overall R-value; 57% decrease in ci R-value requirement
Zone 7	Wood-Framed Buildings	57% decrease in ci R-value requirement
Zone 8	Metal Buildings	46% increase in overall R-value of wall
Zone 8	Wood-Framed Buildings	57% decrease in ci R-value requirement

Beyond the Code

Another important factor in increasing energy efficiency in buildings is reducing greenhouse gas emissions.

In the 2007 McKinsey study titled *Reducing U.S. Greenhouse Gas Emissions: How Much and at What Cost,* new commercial and residential building envelope improvements (including increased insulation levels) are identified as a negative marginal cost item—meaning that this option would generate "positive economic returns over its lifecycle."

Many feel that the insulation requirements set out in state adopted codes are not enough to save energy and reduce greenhouse gas emissions. They look beyond the code initiatives, to USGBC's LEED® rating system, ASHRAE Standard 189 or Architecture 2030.

Museum of the Moving Image, Astoria, NY

Mineral Wool Benefits

Continuous Insulation Choices

There are a number of choices when it comes to choosing a continuous insulation (ci) product.

Two of the most common options are mineral wool and foam (rigid, spray, or poly-iso).

When comparing insulation products with sustainable design in mind, identify the raw materials used in their creation (waste, blast furnace slag, naturally occurring minerals or petrochemical), embodied energy and operational performance. Look into whether the creation of the product has any global warning potential (GWP) or ozone depleting potential (ODP).

For instance, in an 2009 *Environmental Building News* article, a comparison was made between the GWP of the insulation (based on its embodied energy) and the greenhouse gases saved in the use of the insulation.

Continuous Insulation Choices

Although all insulation materials reduce GHG emissions, those products that were produced with HFC's had much longer "payback periods."

To explain, foam insulations encompass a greater amount of embodied energy—meaning that the sum of energy inputs, such as fuels, power, and materials, that are used to make a product are significantly higher than the embodied energy of mineral wool insulation.

Therefore, its payback period, or the rate of energy investment to energy savings, is much higher than the mineral wool insulation's.

Mineral Wool

Mineral wool does not use any HFC or blowing agents in its production. It was originally created using natural rock. The industry has changed their processes to reduce the negative impact on the environment that comes from the mining and harvesting of the raw materials. Over the years, the availability of low-cost by-products with similar chemical make-up as mined rock have been made available. One such raw material is a by-product of the steel industry called blast furnace slag, which is made up of spent iron ore and limestone.

Natural Rocks

Slag

Raw Materials

The slag content in mineral wool ranges from 70–90+%. This is one of the highest recycled contents among all the continuous insulation products.

Foam products are only available with up to 40% recycled content.

Every year the mineral wool industry recycles millions of tons of waste slag.

Mineral Wool: Manufacturing Process

The production of mineral wool is a somewhat energy intensive process. In its production, the rocks and slag are melted in cupola furnaces at temperatures exceeding 2600° F. Next, the molten lava is spun into fibers using compressed air and high-speed spinning wheels. This process may leave mineral wool with a high embodied energy status, but this is balanced by the energy saved in the material's use phase. After only one month of use, one pound of mineral wool insulation saves the same amount of energy used in its manufacture.

Rocks are melted in cupola furnace

Lava is spun into fibers

Non-Combustible & Fire Resistant

Mineral wool is non-combustible. In the event of a fire, mineral wool insulation will not burn or release harmful smoke and hot gases. Mineral wool continuous insulation helps protect buildings and improves life safety by preventing fire and smoke from spreading. Smoke protection can be especially critical in high-occupancy buildings, such as schools and hospitals.

Most foam products are combustible and will become a fuel source in a fire, releasing toxic smoke and hot gases. In high-occupancy buildings like schools, hospitals and offices, the safety of building occupants is an important consideration. As per ASTM E 84 test results, rigid foam rates the worst score possible (450) while mineral wool receives ratings of zero—the best score possible—for both flame spread and smoke developed.

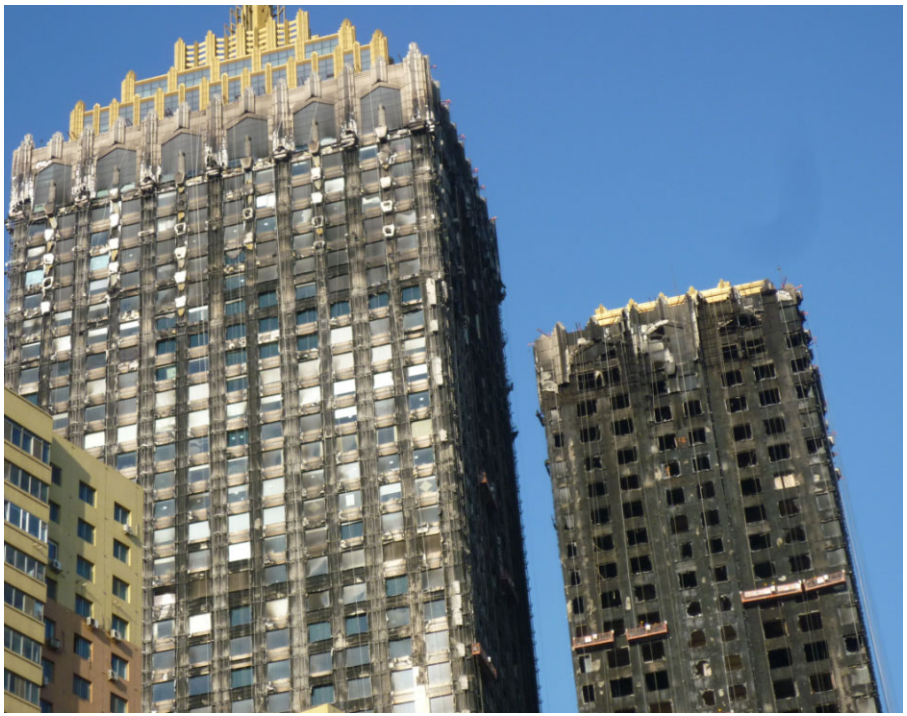
ASTM E 84 Test Results	Rigid Foam	Mineral Wool
Flame Spread #	50 (Class B)	0 (Class A)
Smoke Developed #	450 (Class B)	0 (Class A)

Non-Combustible

For decades, mineral wool has been recognized and used for fire containment in multi-story buildings.

China's building industry is dominated by foam products; as a result, they have had several high profile and deadly fires directly attributed to the use of combustible insulation. Consequently, China has changed their building code to mandate the use of mineral wool in structures over 26 meters tall.

This is a photo taken in 2011 of the Sheraton Hotel buildings in Shenyang, China. You can see the fire burned both of these building completely.



Risk of Fire

This is another photo of the Sheraton Hotel; you can still see the façade hangers on the side of the building. The foam insulation used to insulate this façade contributed to the spread of the fire and total destruction of the building.

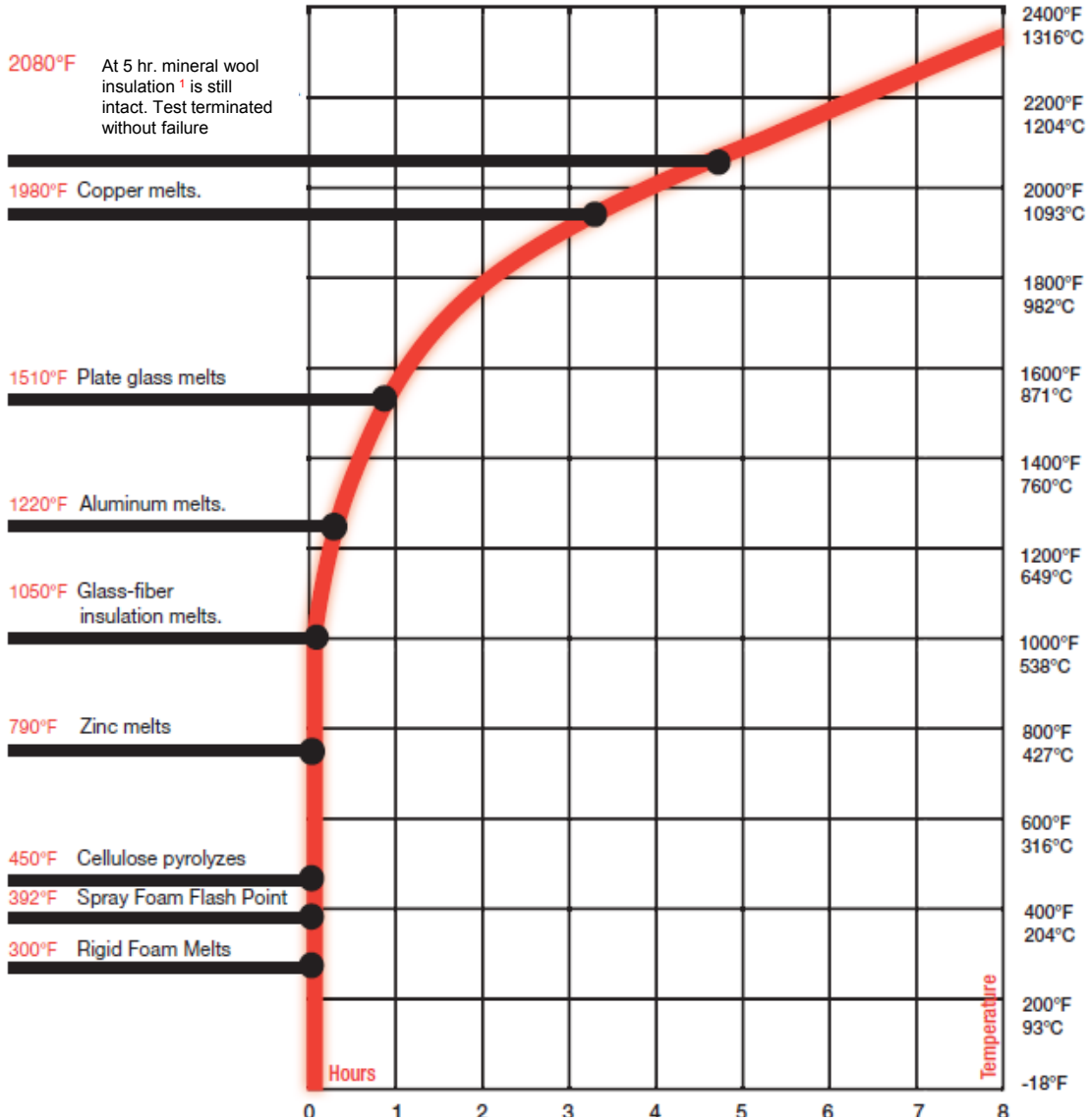
Risk of Fire

This photo is of a fire that happened in Shanghai. The exterior façade of this 28-story apartment building was being replaced and insulated with combustible insulation when a welding spark ignited the insulation. The entire building went up in flames, and 53 people lost their lives.

ASTM E 119

ASTM E 119 is a fire performance standard that tests building materials. The E 119 test is based on the time and temperature of a fire. Fires ramp up in temperature over time, and this curve illustrates how different building products perform.

This chart compares a number of insulation products. You can see the foam products reach their melting point and combust minutes into a fire. At the very top of this chart, you can see that after five hours and temperatures over 2000 degrees, the test was stopped and the mineral wool insulation is still intact.



[1] Not for service operation at this temperature. Refer to the appropriate manufacturer's recommended maximum service temperature limits of individual products. Time-temperature curve from "Standard of Methods of Fire Tests of Building Constructions and Materials" (ASTM E 119-81)

Mineral Wool Energy Conservation

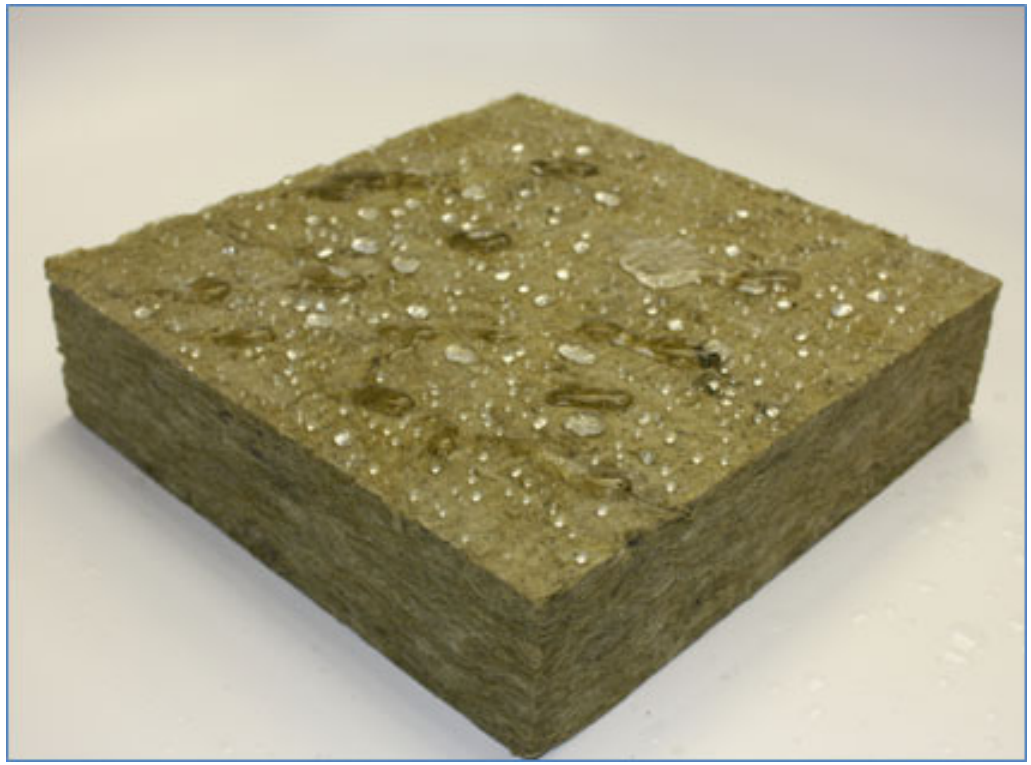
Mineral wool insulation reduces the transfer of heat (and cold) through building structures or envelopes by providing a thermal resistance of 4.2 per inch (k-value 0.24).

Mineral wool is also the most cost effective continuous insulation product; for the same R-value, mineral wool costs 40–60% less per square foot than a comparable foam product.

Foam products offer R-values ranging from 5–6 per inch of thickness. For an R-10 continuous insulation, a 2"-thick rigid foam product or a 2.5"-thick mineral wool continuous insulation would meet that requirement.

Moisture Resistance

Mineral wool is engineered to repel and drain moisture in continuous insulation applications. It is designed to handle condensation, driving rain, and other moisture that may be introduced into the wall assembly.



Indoor Environmental Quality: VOC

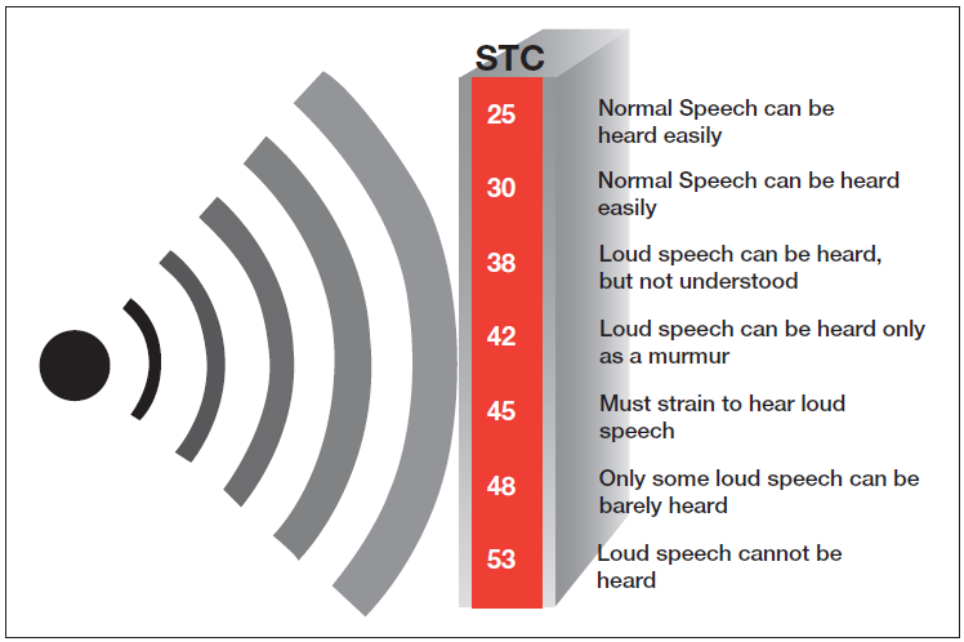
Mineral wool uses very small amounts of phenol formaldehyde in the binder system, the glue that holds the fibers together to form a blanket.

Even with this trace amount, blankets are cured in a high-temperature oven that virtually eliminates the “free formaldehyde.”

Indoor Environmental Quality: Acoustics

Another attribute that mineral wool products provide is sound attenuation. All mineral wool insulation blocks and absorbs sound passing between partition walls and floor/ceiling applications.

Assemblies which include mineral wool are capable of providing sound transmission coefficients (STCs) that improve the indoor environmental quality for the occupants of a structure.



Indoor Environmental Quality: Acoustics

Using insulation with sound control properties on the exterior of the building can help to improve the indoor environmental quality by reducing the amount of noise coming in from outside the building.

The chart below describes the noise reduction coefficient of different thicknesses of a typical mineral wool. The NRC is a number used for rating how a particular material absorbs sound. It is determined through laboratory testing. The number ranges from zero (perfectly reflective) to 1 (perfectly absorptive), and some materials can test above 1.

Coefficients at Frequencies Per ASTM 423							
Thickness	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
1 ½"	.22	.44	.96	1.06	1.05	1.05	.90
2"	.30	.69	1.08	1.01	1.00	1.03	.95
3"	.70	1.07	1.24	1.13	1.07	1.08	1.15
4"	1.03	1.25	1.20	1.05	1.05	1.08	1.15

Durability

Mineral wool continuous insulation products are UV resistant and repel water. These properties make mineral wool the ideal product for open joint façade construction.

In a testament to the durability of mineral wool, this photo of the Museum of the Moving Image was taken after this insulation had been left exposed for over four months through the New York winter. This insulation has been exposed to UV rays, rain, sleet, snow and ice, yet it remains intact and in great condition.

Foam continuous insulation products also repel water but cannot be left exposed to UV for extended periods of time.

Durability

This is another photo of the Museum of the Moving Image that shows the metal façade panels. This is considered an open joint façade system.

Retains R-Value

When mineral wool remains exposed to the weather and is saturated, insulating value is reduced; however, if the insulation is dried and not mechanically changed in form, the thermal properties return to their original level.

Tests were conducted for thermal conductivity ratings per ASTM C 518 on a dry piece of insulation. The insulation was then submerged in water for a time period (88 hours) that allowed the material to become completely saturated. The insulation was then allowed to dry. When dry, the material was again tested for thermal conductivity ratings.

The two ratings were compared and the results were identical. In conclusion, the thermal properties remain intact after exposure to moisture, rain, etc., when allowed to dry by either natural or accelerated means.

Aesthetics

Many foam board products are white, pink, or blue in color; however, mineral wool continuous insulation is available in a dark fiber. This dark fiber is used in open joint façade systems to create a shadowing effect. The dark fiber camouflages the open joint and will not detract from the aesthetics of the building.

Vapor Permeable

Mineral wool, as a continuous insulation, lets your building “breathe.”

As it is air/vapor permeable, it provides better control over humidity, condensation and air quality—plus, its flexibility facilitates positioning the vapor barrier. Mineral wool has a permeance rating of 50.

Unlike mineral wool, rigid foam blocks airflow, making it more difficult for the building to breathe.

Overview: LEED® Certification

The U.S. Green Building Council (USGBC) is a 501(c)(3) non-profit organization composed of leaders from every sector of the building industry working to promote buildings and communities that are environmentally responsible, profitable and healthy places to live and work. USGBC developed the LEED (Leadership in Energy and Environmental Design) green building certification program, the nationally accepted benchmark for the design, construction, and operation of high performance green buildings.

LEED credit requirements cover the performance of materials in aggregate, not the performance of individual products or brands. Therefore, products that meet the LEED performance criteria can only contribute toward earning points needed for LEED certification; they cannot earn points individually toward LEED certification.

For detailed information about the council, their principles and programs, please visit www.usgbc.org.

LEED Contribution

Mineral wool continuous insulation is capable of contributing to a number of LEED credit categories:

Energy & Atmosphere Credit 1: Optimize Energy Performance

Mineral wool helps to minimize the amount of energy needed to heat and cool a building, resulting in reduced greenhouse gas (GHG) emissions. Mineral wool continuous insulation is only one component of the building envelope. Points are awarded based on energy efficiency above ANSI/ASHRAE/IESNA Standard 90.1-2007.

Materials & Resources Credits 2.1 & 2.2: Construction Waste Management

Mineral wool insulation products can be diverted from the waste stream by removing undamaged material and re-installing it in new projects.

50% recycled or salvaged - 1 point

75% recycled or salvaged - 1 additional point

LEED Contribution

Materials & Resources Credits 3.1 & 3.2: Materials Reuse

Mineral wool insulation can be removed from demolition projects and reused in new construction.

Materials & Resources Credits 4.1 & 4.2: Recycled Materials

With up to 90% recycled content, mineral wool offers an extremely high level of recycled content.

Materials & Resources Credits 5.1 & 5.2: Regional Materials

Mineral wool is manufactured in the U.S. Check with manufacturers to see if your project qualifies for these credits.

Indoor Environmental Quality Credits 3.1 & 3.2: Construction Indoor Air Quality, Management Plan During Construction

Many mineral wool products have been evaluated by a third party independent laboratory to certify that emissions are below containment concentration thresholds established by LEED.

LEED Contribution (For Schools Only)

Indoor Environmental Quality Credit 9: Enhanced Acoustical Performance

Mineral wool sound attenuation products absorb sound passing between partition walls and floor/ceiling applications. In wall assemblies, mineral wool continuous insulation products help provide sound transmission coefficients (STCs) that improve indoor environmental quality.

Innovative Design Credit 1:

Mineral wool products allow LEED design teams the opportunity to achieve exceptional performance above the requirements set by the LEED rating system.

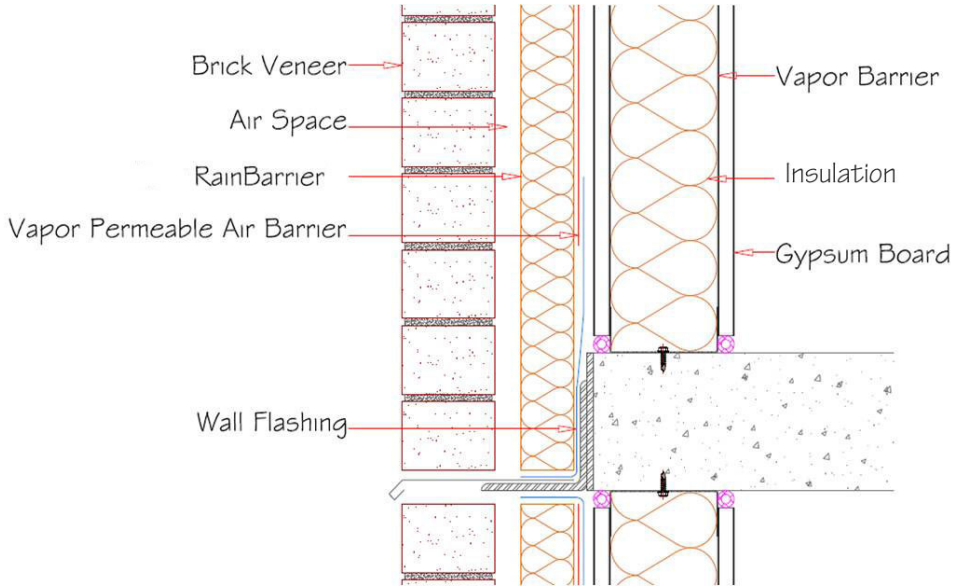
Please remember the **exam password PARTITION**. You will be required to enter it in order to proceed with the on-line examination.

Installation and Use

Rainscreen & Cavity Wall Assemblies

One of the prime uses of mineral wool insulation is in rainscreen and cavity wall designs. Commonly used in Europe, these assemblies create an air/drainage cavity which prevents water ingress and allows pressure equalization.

There are a number of options for mineral wool insulation use in a rainscreen design. It can be used in both permeable and non-permeable assemblies. At right is a vapor permeable design.

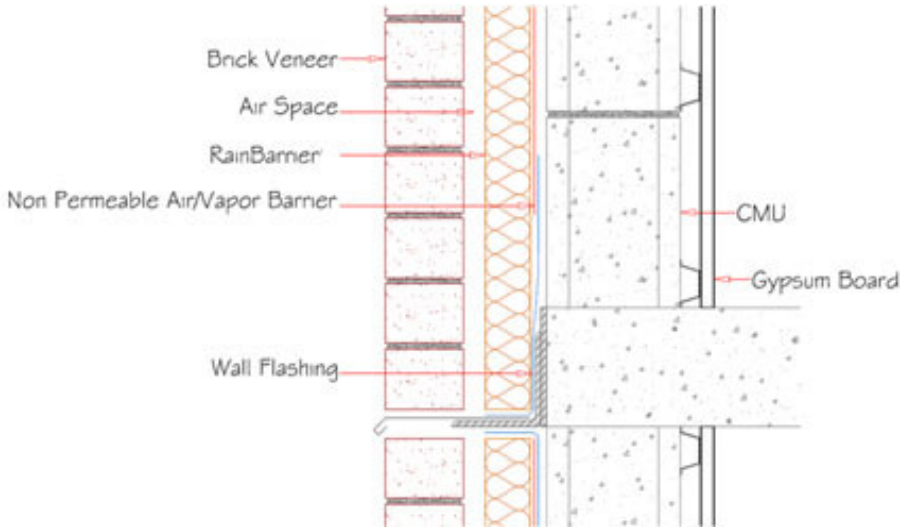


Rainscreen & Cavity Wall Assemblies

This is an example of a vapor non-permeable assembly. Vapor retarder, air barriers and moisture control are elements that are essential to the proper design and construction of buildings.

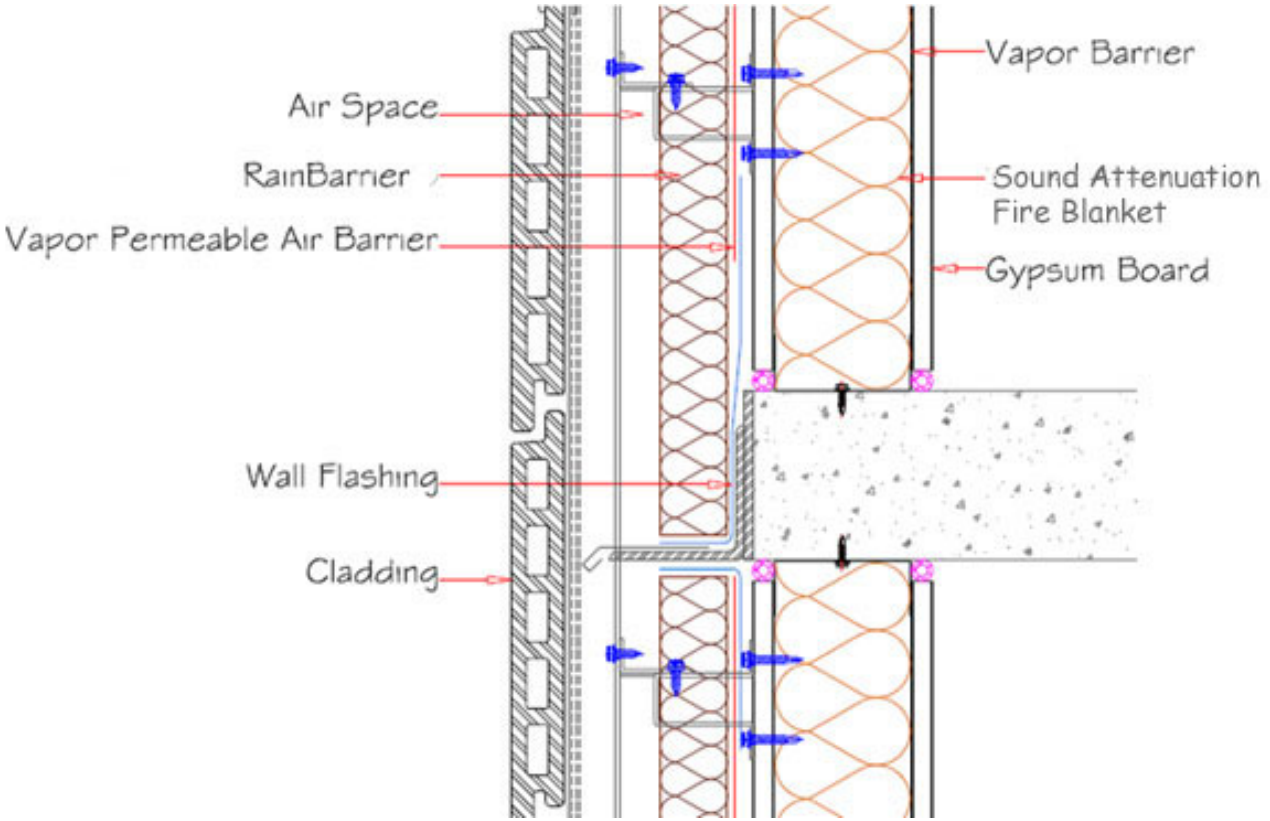
The need for, and proper placement of, the vapor/air barrier and moisture control must be determined by a qualified professional engineer/architect. Critical considerations include the inside and outside climatic and air pressure conditions of the building.

Penetrating the vapor/air barrier with mechanical insulation pins must be approved by the air/vapor barrier manufacturer.



Open Joint

This is an example of an open joint assembly. Here, the use of UV resistant mineral wool ensures the durability of the assembly and no loss of R-value.



Installation

Mineral wool is a semi-rigid product that is easy to cut and install. Its flexibility allows it to conform to building shapes and construction irregularities. It comes in standard-sized sheets and is easily cut with a serrated knife.

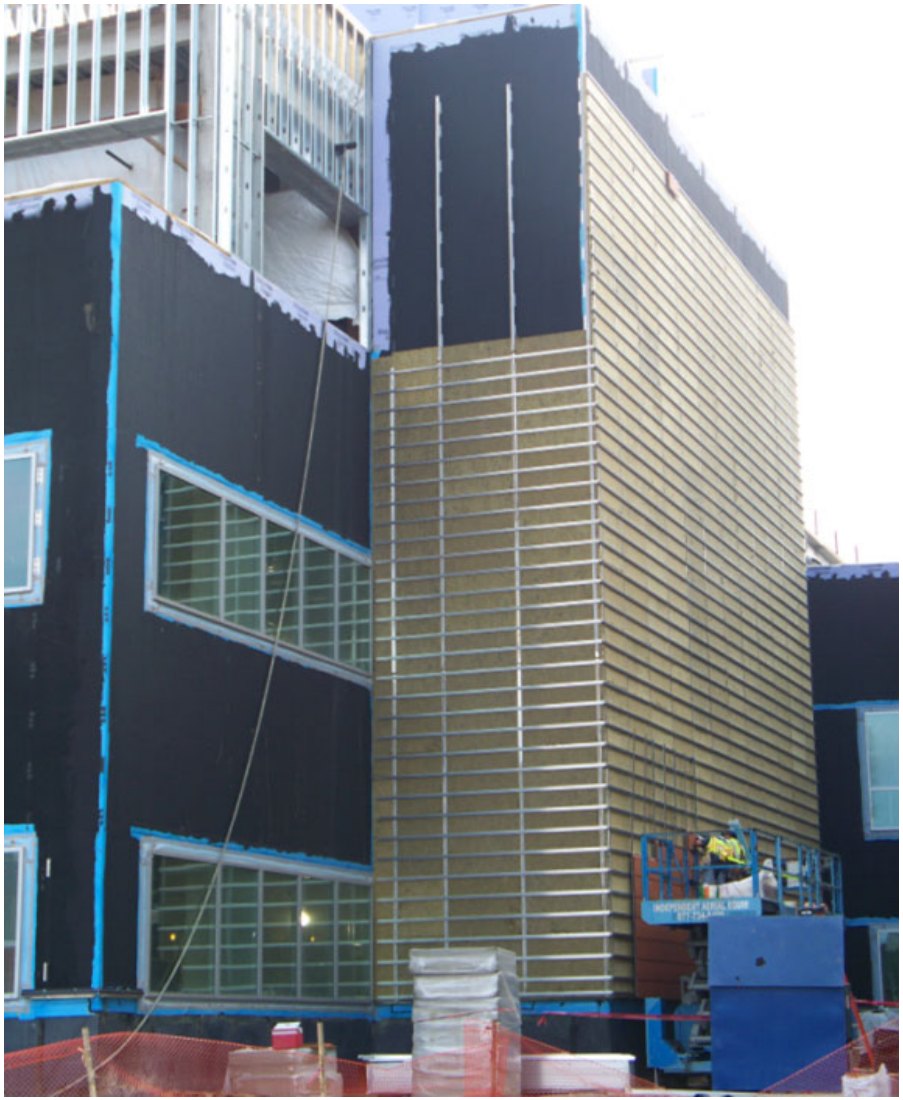
Rainscreen and cavity wall systems vary greatly from types of hangers to how they are installed. Generally, mineral wool insulation is installed with abutted joints and mechanically secured and attached to the building substrate. Note that the joints do not need to be taped.

Unlike rigid foam, mineral wool flexes for a better fit on curved walls and other surfaces. Mineral wool leaves a clean, straight edge when cut.

Installation

Here, we see mineral wool being installed in a steel stud and gypsum board exterior construction.

The mineral wool is being installed behind the grid structure that will hold the terra cotta façade panels.



Fort Belvoir Community Hospital, Fort Belvoir, VA

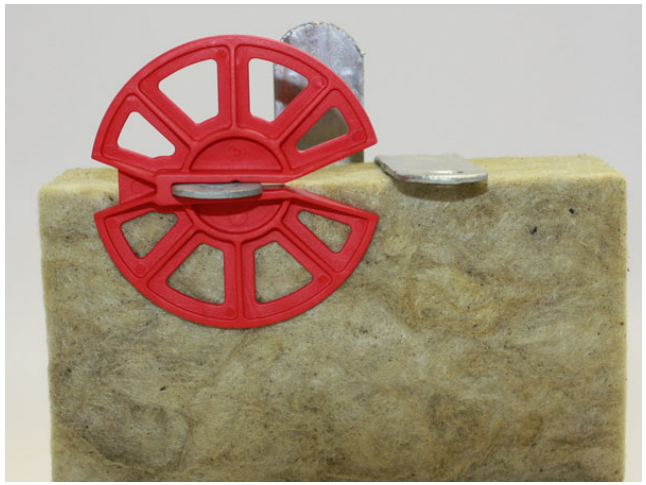
Installation

This is the same Fort Belvoir Community Hospital project where the workers are installing the terra cotta façade panels over the mineral wool insulation.

Installation

Insulation is friction-fitted between the wall ties in masonry applications, as shown in the top image. After installing the insulation, secure with a clip, utilizing the center notches to secure directly on the tie as shown.

If using a flange or flat-style hanger, installation of insulation is friction-fit between ties, forming a seam (a typical size is 16" on center).



Installation

The North Quad project on the University of Michigan campus in Ann Arbor, Michigan is a typical masonry cavity wall construction. In this photo, you can see the masons installing the mineral wool insulation in the masonry cavity and securing it with retaining clips that fasten to the masonry wall ties.

Installation

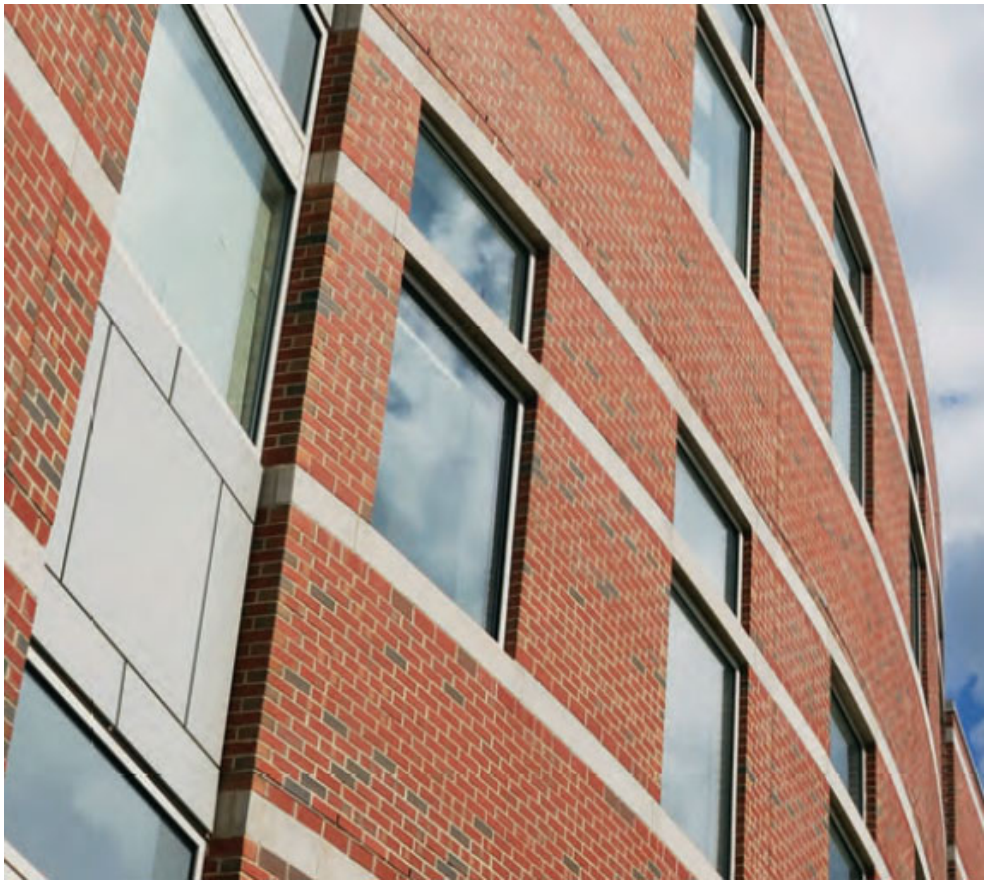
Here, the insulation is fully installed. It can be seen through the unfinished openings below the windows.

Safety of Installation

Mineral wool is manufactured in sizes that are safe and easy to handle on the jobsite.

It can be safely installed with regular construction scaffolding or mechanical lifts.

Additionally, mineral wool does not pose any health or safety threats to the insulation installers.



Summary

Important Points

- ASHRAE 90.1 defines continuous insulation as: "*insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior, exterior, or is integral to any opaque surface of the building.*"

- The recently approved ASHRAE standard, 90.1-2010, by the DOE, requires states to be certified by 2013. Certification will confirm that they have reviewed the provisions of their commercial building code regarding energy efficiency and updated their code to meet or exceed Standard 90.1-2010.

- Use of continuous insulation eliminates thermal bridging and can have a dramatic impact on the energy efficiency of a building.

- The slag content in the mineral wool fiber (ranging from 70–90+%) is the highest recycled content among all the continuous insulation products.

Important Points

- Foam insulations encompass a greater amount of embodied energy than the embodied energy of mineral wool insulation.
- Mineral wool is the most cost effective continuous insulation product.
- Mineral wool continuous insulation is durable, moisture resistant, flexible, UV resistant, non-combustible with a melt point above 2000°F, and air/vapor permeable.
- Mineral wool is a semi-rigid product that is easy to cut and install, and it can be used in both permeable and non-permeable assemblies.
- Assemblies which include mineral wool are capable of providing sound transmission coefficients (STCs) that improve the indoor environmental quality for the occupants of a structure.
- Mineral wool continuous insulation is capable of contributing to a number of LEED credit categories.

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  "Framed Exterior Wall Thermal Performance"
  http://www.conspectusinc.com/downloads/Documents/Conspectus%20Tech%20Tips%20B2010%20Framed%20Exterior%20Wall%20Thermal%20Performance.pdf
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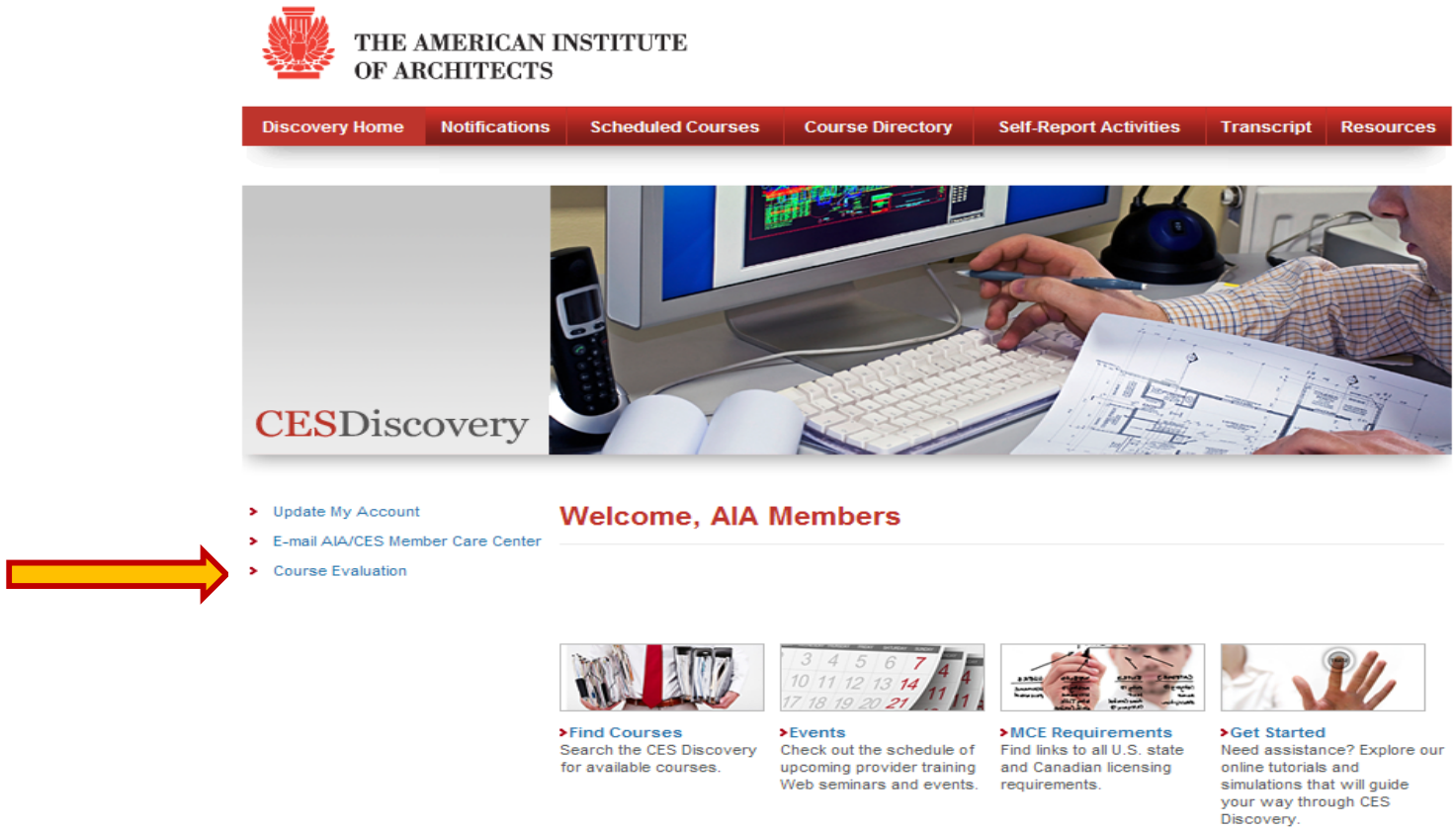

Conclusion

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