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# Designing with MgO Structural Insulated Panels



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# Promotional Statement Slide

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# Course Description

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In this course, the design professional will discover how High-performance MgO Insulated Structural panels are a part of an energy-efficiency design strategy that can improve energy efficiency and performance with small to medium size projects. Designers will also learn about the unique properties of SIPs such as high fire ratings, greater R-Values and superior structural integrity that make the system out perform traditional building methods. In learning these things designers will take away the knowledge that not only are SIPs a strong, environmentally friendly building material, but also a cost effective way to build.

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# Learning Objectives

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## After completing this course you will be able to:

1. Describe and define MgO SIPs panel construction and design.

*Such as Fire Ratings / R-Values / Sustainable Design*

1. Explain energy-efficiency design strategies with MgO SIPs panels and how they improve energy efficiency and indoor air quality.
  2. MgO SIPs uses and applications.
  3. Describe how MgO SIPs panels are installed using current industry assembly standards.
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# Course Outline

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## 1. Describe and define MgO SIPs construction & design.

- History of SIPs
- Types of SIPs
- Construction & Uses
- Fire Ratings
- Advantages & Limitations
- Sustainable Design

## 2. Explain energy-efficiency design strategies with MgO SIPs panels and how they improve energy efficiency and indoor air quality.

- Design Strategies
- R-Values
- Thermal Characteristics
- Air & Energy Quality Improvement
- Energy Code Compliance
- Cost Effectiveness

## 1. MgO SIPs uses and applications.

- Systems
- Applications

## 4. Describe how MgO SIPs panels are installed using current industry assembly standards.

- Qualifications of Installers
  - Delivery & Installation
  - Sealing
  - Connections
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## Learning Objective #1

Describe and define MgO SIPs construction & design.

*In this section we will be focusing on:*

Fire ratings

R-Values

Sustainable Design

# SIPs History

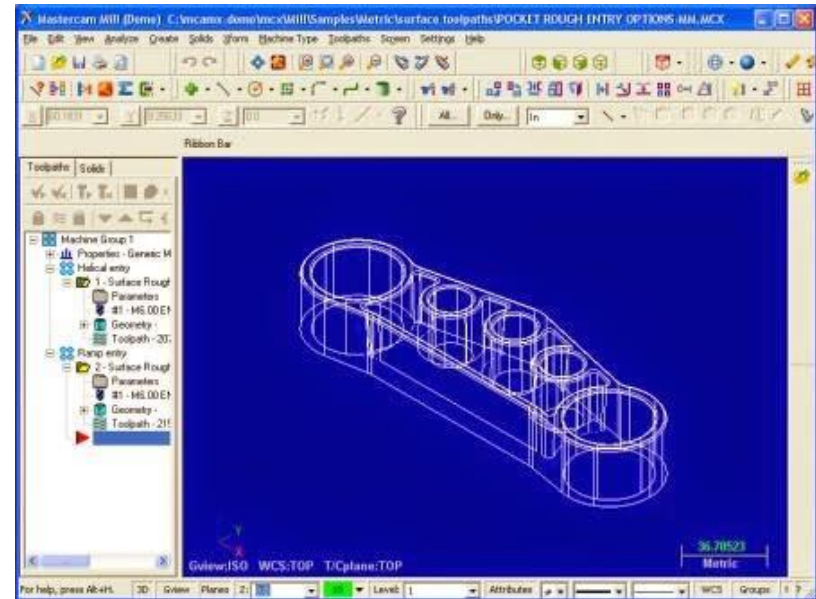
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- SIPs were developed nearly 75 years ago.
  - Frank Lloyd Wright was exceptionally innovative and explored the idea of SIPs to incorporate beauty and simplicity into cost-effective homes.
  - Alden B. Dow, an architecture student of Frank Lloyd Wright, experimented further with the concept of structural panels. He had concerns about energy efficiency and was fearful over depleting natural resources. Thus he sought to create a structural panel with an insulated core and is generally credited with creating the first structural insulated panel.
  - The first foam core SIPs were created in 1952
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# SIPs History

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- In the early 1990's advanced computer-aided manufacturing (CAM) technology was developed that allowed cutting machines to fabricate SIPs to match a building's specific design.



- Today, SIPs offer a high-tech solution for residential and low-rise nonresidential buildings, with a great potential for multistory building applications.
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# What are SIPs?

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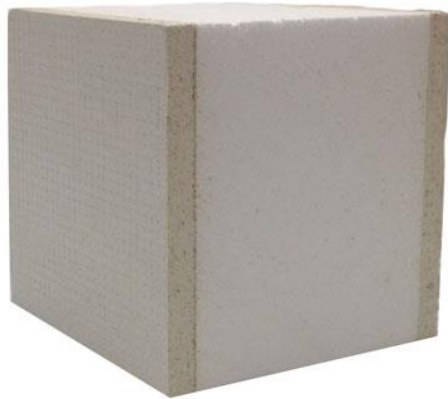


- High-performance composite building panels used in floors, walls, and roofs for residential and light commercial buildings.
  - Panels consist of an insulating foam core sandwiched between two structural facings.
  - These panels are fabricated in a factory and shipped to a construction site, where they can be quickly assembled to form a tight, energy-efficient building envelope.
  - Building with SIPs will save you time, money and labor.
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# Types of SIPs

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**MgO SIPs**



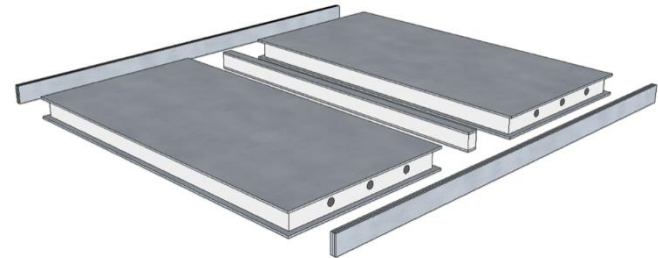
**Cement Fiber**



**Oriented Strand Board (OSB)**



**Metal**



This course will focus on MgO SIPs because of their resistance to fire, mold and mildew.

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# Other Types of SIPS Panels

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## Plywood SIP Panel



Plywood SIP panels 4' wide by up to 24' long. These panels are manufactured with ½" CDX plywood, ¾" pressure treated plywood or other plywood material

## Nail Base SIPS Retro Fit



Energy efficient nail base and retro-fit SIP panels save contractors and building Owners time and money

## ABS/Plywood Panel



ABS and Foam Board panels have a verity of uses in the building industry. The high impact ABS and Foam Board material can be custom printed with any design or photo image.

## Specialty Laminations



Some manufacture can create custom composite panels and can laminate almost any skin material including phenolic fiberglass, FRP, PVC, ABS, carbon fiber, steel, bullet resistant materials, foam board and more.

## Phenolic Fiberglass SIP Panel



Phenolic skin SIPs in varying skin and core thickness to meet the specific needs of our clients. Phenolic skins are highly fire resistant, water proof, dimensionally stable

## Cork SIPS

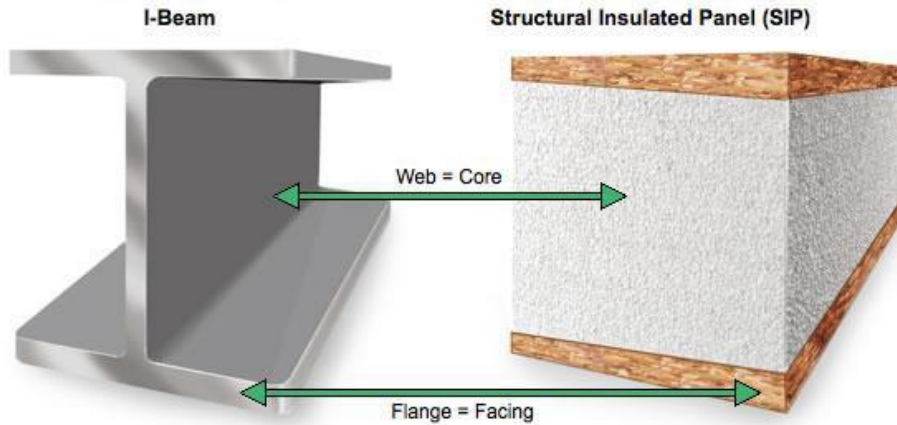


Cork may be a new building material to many in the United States, but this sustainable material has been used for home and commercial construction projects in other parts of the world for centuries

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# MgO Panel Construction

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- Rigid foam core
- Two layers of structural board
- Structural adhesive
- They share the same structural properties as an I-beam or I-column.

MgO SIPs are structural insulated panel with Magnesium Oxide Cement skin on one side and common Plywood or OSB sheathing on the other.

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# MgO Panel Construction

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## The Face: What Is Magnesium Oxide (MgO)?

MgO is prized as a refractory material, i.e. a solid that is physically and chemically stable at high temperatures. It has two useful attributes: high thermal conductivity and low electrical conductivity.

Magnesium oxide is a versatile mineral that when used as part of a cement mixture and cast into thin cement panels under proper curing procedures and practices can be used in residential and commercial building construction. As an environmentally friendly building material, magnesia board has strength and resistance due to very strong bonds between magnesium and oxygen atoms that form the magnesium oxide molecules (chemical symbol MgO).

It is a principal fireproofing ingredient in construction materials. As a construction material, magnesium oxide wallboards have several attractive characteristics: **fire resistance, termite resistance, moisture resistance, mold and mildew resistance, and strength.**

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Source: [wiki/Magnesium oxide](https://en.wikipedia.org/wiki/Magnesium_oxide)

Source: [wiki/Magnesium oxide wallboard](https://en.wikipedia.org/wiki/Magnesium_oxide_wallboard)

# MgO Panel Construction

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## Adhesives

Adhesive performance must be considered when choosing the best type of SIPs panel to use in order to meet the required building design or perform well under different climates. Any adhesive used in the construction of a SIP must comply with International Code Council [Acceptance Criteria AC05](#).

Adhesives in SIPS help bond the facings to the core as well as:

- **Resist Forces:** The adhesive joint must transfer the design loads (in order to have the proper tensile and shear strength). They must resist buckling and racking forces.
  - **Thermal stresses:** A frequent cause of debonding in SIPS that causes catastrophic failure of a panel is due to thermal stress.
  - **Moisture Penetration:** The adhesive must be able to withstand any moisture penetration into the joint without delamination or bond failure.
-

# MgO Panel Construction

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## Core Materials

The core, usually made of Expanded Polystyrene (EPS) is responsible for providing the following to MgO Panels.

- Thermal insulation.
- Counteracts shear and transverse forces.
- Resists moisture penetration because of the millions of tiny air filled pockets it is composed of.
- Increasing environmental impact.

The material is molded into large blocks and cut to the proper shapes for use in SIPs.

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7 Zenkert, pg. 23.

8 This chart was compiled using a list of minimum values for each material, taken from ASTM C 578, ASTM D 1622, ASTM D 1621, ASTM C 203, ASTM D 1623, ASTM C 273, ASTM E96, ASTM C 27, and ASTM D 2126.

9 Morley, Michael. Building With Structural Insulated Panels. Pg. 23.

# MgO Panel Sizes

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Panels can be optimized to the specific design needs of any project.

- MgO SIPs walls are commonly between 4' and 6'
  - Roof panels are generally thicker (often up to 12 inches, depending on climate conditions)
  - MgO SIPs with cementitious facings are typically cut to 4' x 8'.
  - MgO SIPs may be as large as 9' by 28' with OSB facings.
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# Magnesium Oxide SIPS panels (MgO)

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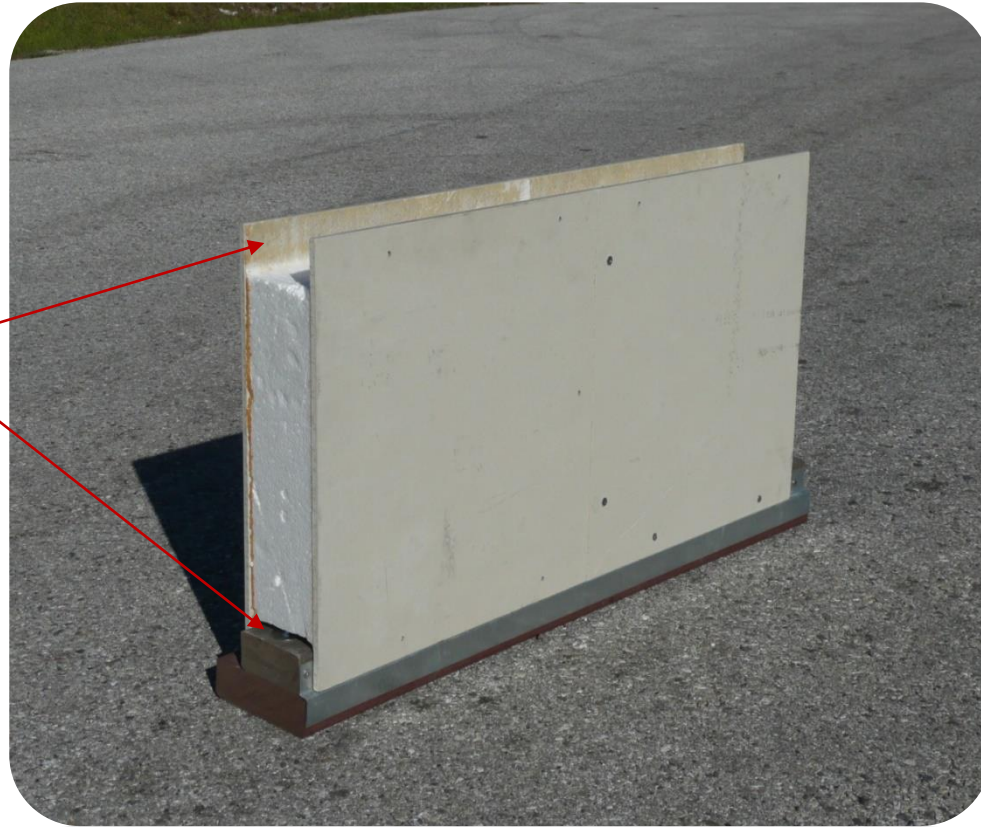
- Magnesium Oxide SIPS panels (MgO) are the next generation of SIPs having a superior fire rating to traditional fiber cement and OSB SIPs panels.
  - MgO panel skins are available in thickness of 6 mm to 30 mm.
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# MgO SIPs Details

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Spline

Recess top &  
bottom plate



MgO SIPs panels are recessed at the top and bottom of each panel to allow for easy connection to floor plates or connecting panels.

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# MgO SIPs Details

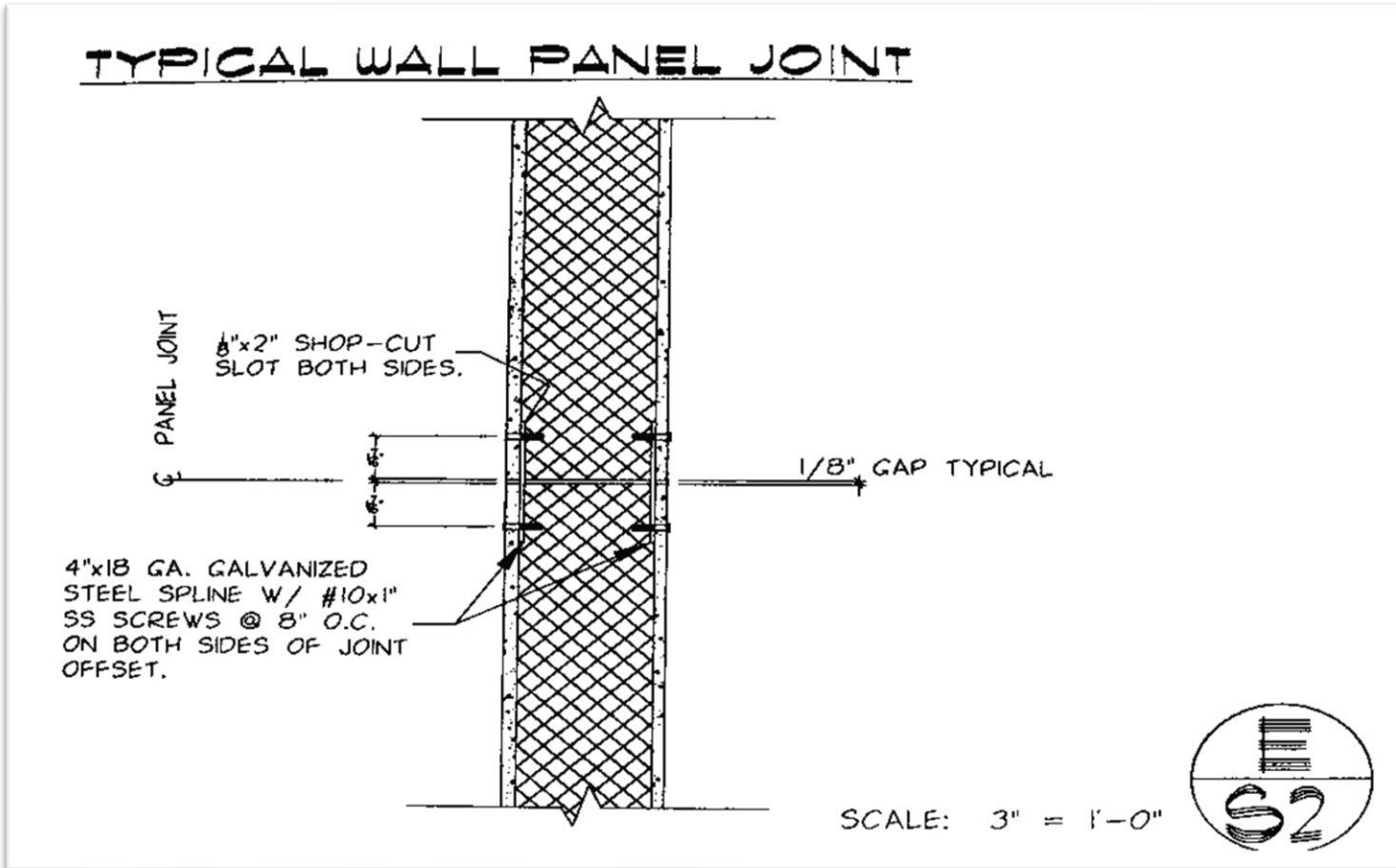
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This is an example of a corner detail with a roof panel installation.

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# MgO SIPs Details



This drawing is a typical panel joint.

Panel joints are used to reduce air infiltration

# SIPs Uses

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**MULTIFAMILY**



**BUILDING**



**COMMERCIAL**



**HOUSING**



**EDUCATIONAL**





# Advantages and Limitations of SIPs

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- When approaching a project with new materials and building methods, one will often find advantages and limitations between both methods of construction. The following slides have a list that shows the strengths and limitations of designing with SIPs.



# Advantages of SIPS

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The Panels are

- Mold Resistant
  - Fire Resistant
  - Water Resistant
  - Impact Resistant Properties
  - Have Superior Acoustic Values
  - 100% Environmentally Friendly
  - Zero Carbon Impact on Construction
  - Energy Efficient (*qualify for LEED and Green Building certifications.*)
-

# Advantages of SIPS *Cont.*

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- Faster to build than most building methods
  - Factory prebuilt, resulting in cost reduction and speed of building
  - Superior insulation values compared to wood framing with fiberglass insulation
  - Superior weather performance
  - Superior structural performance compared to wood framing
  - Superior environmental performance through less waste generated by SIPs building and less HVAC needs from superior insulation
  - Proven performance in extreme conditions, documented observations shows that SIP buildings withstood earthquakes in Japan, and storms/tornadoes in the US better than framed buildings.
  - Reduction of need for skilled laborers
  - Reduction in the need of high quality raw materials. Engineered wood production does not need high quality lumber.
  - Tighter tolerances in building due to it being an engineered product.
  - Tight control of material usage
-



# Limitations of SIPS

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- Need to have a sub-contractor that is familiar building with SIPS.
  - Restrictive in design due to modularity.
  - More involved mechanical systems planning may be required.
  - Changes to things such as electrical may be hard to implement on site.
  - Limited use in larger scale buildings such as high rises.
  - Need for special tools if on-site modification of materials are required. For example, a circular power saw can't easily cut through a SIP wall panel.
  - Weatherproofing is important, as a compromise in it structural system from weather may result in a more disastrous situation than frame based construction.
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# Fire Ratings

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Residential codes typically require the application of a 15-minute fire-resistant thermal barrier on the interior for all residential structures, accomplished by applying 1/2-in. thick gypsum board or a material of equivalent thermal performance.

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# Fire Ratings

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**NEED TO ADD FIRE RATING INFORMATION**

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# Sustainable Design

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- An airtight MgO SIPs building will use less energy to heat and cool, allow for better control over indoor environmental conditions, and reduce construction waste.
- MgO SIPs contain no organic solvents, heavy metals, asbestos, oils or other toxic ingredients and are classified as a “Green Building Material.”
- Qualify for (LEED) Rating System.
- MgO SIPs panels are mold, fire, insect, water and impact resistant. They also provide superior acoustic values.



## Learning Objective #2

Explain energy-efficiency design strategies with MgO SIPs panels and how they improve energy efficiency and indoor air quality.

# Energy Efficient Design Strategies

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- Meets a variety of design opportunities.
  - MgO SIPs are energy wise to benefit the design.
  - Can withstand climate & weather conditions that a typical building could not.
  - Can allow for a vaulted ceiling with no added insulation.
  - Can be placed over a steel frame.
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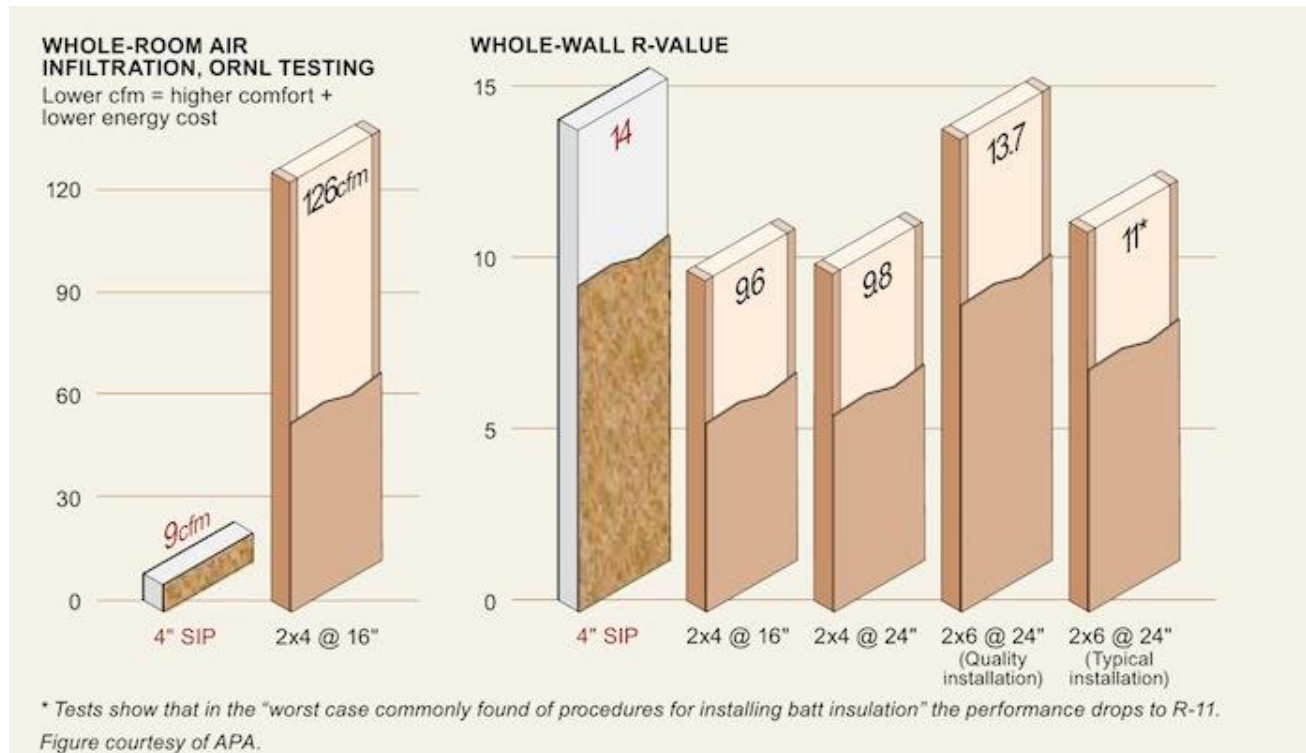
# Energy Efficient Design Strategies

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- Insulation is one of the most important components in the design of a residential or commercial building. Choosing the right insulation can save thousands of dollars in utility bills over the life of a building.
  - Insulation is rated using R-Values, which measure a material's thermal resistance to external forces. Typically the higher the R-Value the better the building will perform. Insulation with a high R-Value acts as a thermal barrier and keeps the cold or hot air inside a building.
  - High levels of insulation provide an energy efficient system, minimizing heat transfer between the inner and outer faces of the building. By providing an airtight building enclosure and well-insulated panels.
-

# Energy Efficient Design Strategies

In the real world there are factors that will influence how well a building will perform. If you consider factors such as air infiltration, high temperatures and thermal bridging, a field installed fiberglass system can lose over half of its R-Value. Research has proven that a SIPs system can retain its R-Value therefore making a SIPs system outperform traditional fiberglass insulated systems.





# Energy Efficient Design Strategies

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Building with SIPs creates a superior building envelope with high thermal resistance and minimal air infiltration.

- Oak Ridge National Laboratory(ORNL) Whole-wall R-value studies show that a 4-inch SIP wall (nominal) rated at R-14 outperforms a 2x6 stick framed wall with R-19 fiberglass insulation.
  - ORNL blower door tests reveal that a SIP test room is 15 times more airtight than its stick framed counterpart with fiberglass insulation.
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# R Values

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Structural Insulated Panels (SIP) have been third party tested and proved to outperform Fiberglass Insulation R-Values.

The Oak Ridge Laboratories study state thermal analysis of SIP panels has been accepted by many states, including Florida for energy code compliance.

The whole wall performance value of SIP panels as indicated on the following slide, can be used to meet the requirements of the Florida Energy Code. The Structural Insulated panels discussed in this course are manufactured with Green Building materials and can qualify for LEED and Green Building certifications.

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# R Values / Energy Information

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Based on Test Results: Whole Wall Rating Label for Structural Panel: Steady – State Thermal Analysis. June 4, 1999, Oak Ridge National Laboratory. Also refer to Federal Trade Commission 16 CFR Part 460, labeling of home insulation.

PANEL THICKNESS	SIP PERFORMANCE VALUE ****
4 ½"	R-25
6 ½"	R-38
8 ¼"	R-50
10 ¼"	R-62

When tested by Oak Ridge National Laboratories, an 8 X 8 SIPS Box tested 15 X tighter than a stick framed box! Because air-tightness and thermal mass are properties that are inherent with SIPS, they can out-perform their given R-Values in comparison to fiberglass insulation.

**\* All R-Values included inside and outside with covering plus infiltration barrier (House Rap)**

**\*\* Performance values have been accepted by permitting agencies throughout the following states:  
NC, SC, FL, GA, TN & MS.**

**\*\*\* All R-Values meet or exceeds the standards as required by IECC 2006.**

**\*\*\*\* Performance values apply to wall & roof panels.**

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# Thermal Bridging

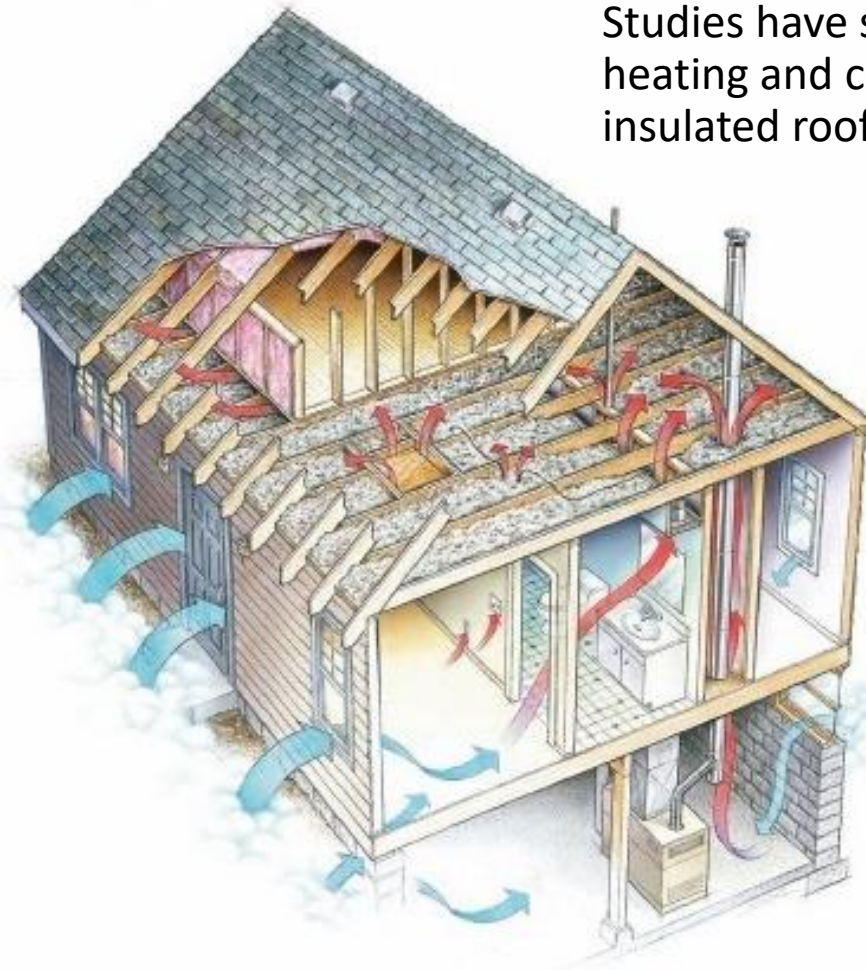
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- Thermal bridging in buildings can reduce a building's energy efficiency and can allow moisture and thermal comfort problems. Any moisture that enters a building can result in indoor air quality problems and the deterioration of a building.
  - Wood frame buildings rely on wood studs or dimensional lumber for structural support. As you already know wood is a very poor insulator and acts as a bridge allowing heat inside of a building through the process of conduction.
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# Thermal Characteristics

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Studies have shown that more than 25% of the heating and cooling cost can be lost from a poorly insulated roof system.



MgO SIPs provide an unmatched insulated roof system that is air tight. SIPs incorporate well with ICF structures to provide a high performance energy efficient building envelope.

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# Air Quality Improvement

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- A MgO SIP home or commercial building has better control of indoor air quality because they make the building more air tight.
- Controlled ventilation filters out contaminants and allergens, and also allows for incoming air to be dehumidified, reducing the possibility for mold growth.
- MgO SIPs do not contain any VOCs or measurable amounts harmful chemicals and meet some of the most stringent standards for indoor air quality.



# Environmental Impact

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- SIPs assist in reducing energy consumption because of their ability to be more air tight thus reducing the building's energy use
- SIPs also save resources in production and use less forest acreage to produce than conventional wood framing.
- Factory fabrication also helps reduce the amount of waste at the construction site.



# Energy Code Compliance

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- MgO SIPs create a more airtight system thus reducing a building's heat loss due to air leakage by 40%.
- SIPs have demonstrated amazingly low blower door test results when properly sealed. Based on the reliable performance of SIPs, ENERGY STAR chose to eliminate the required blower door test for SIP homes to meet ENERGY STAR standards.





# Cost Effective

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- SIPs can reduce framing labor by as much as 55% over conventional wood framing.
- SIPs panels can be installed on most buildings in a fraction of the time as concrete block keeping pace with even the most aggressive project schedules. Panels can be assembled on the ground and flown up and set in place similar to precast concrete construction.



# Cost Effective

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- Builders can also expect decreased jobsite waste disposal costs and savings on HVAC equipment.
- Can be used for the final interior and exterior finishes. This saves clients time and money.



## Learning Objective #3

**MgO SIPs uses & applications**

# SIPs Systems

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- The use of MgO SIPs has increased substantially the past five years as end users are demanding more energy efficient structures.
- MgO SIPs can be installed on trusses of an attic or without trusses, eliminating the attic for maximum energy efficiency.
- Eliminating the attic space in hot weather climates follows healthy house standards and provides the home with a flat or vaulted ceiling making the home feel larger and more open.



# MgO SIPs Wall Systems

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- Zero Carbon Impact on Construction.
  - Energy Efficient (*qualify for LEED and Green Building certifications.*)
  - Faster to build than most building methods
  - Factory prebuilt, resulting in cost reduction and speed of building
  - Superior insulation values compared to wood framing with fiberglass insulation
  - Superior structural performance compared to wood framing
  - Tighter tolerances in building due to it being an engineered product.
  - Tight control of material usage
  - Exterior panels can be painted or finished with a variety of exterior finishes such as stucco, brick or stone veneer, and siding
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# SIPs Roof Systems

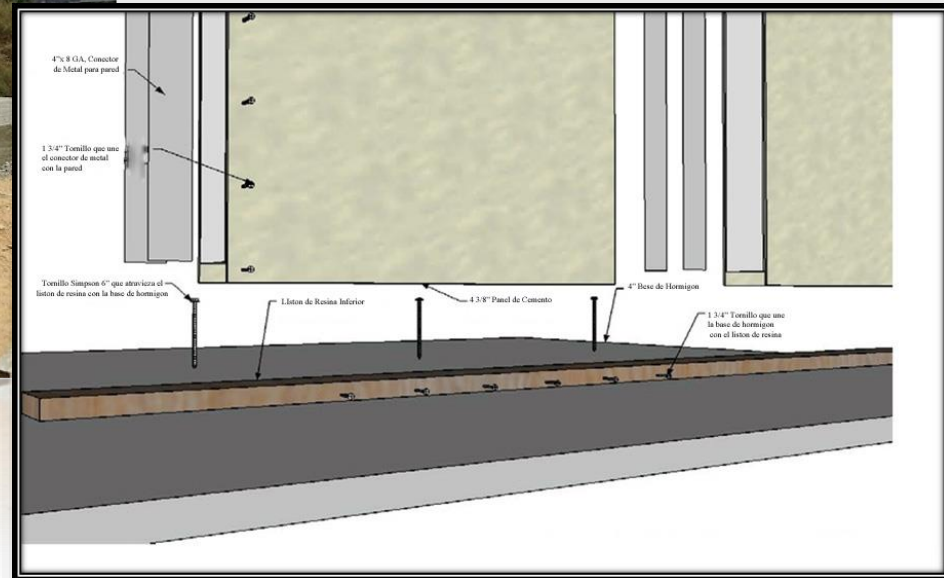
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- Impact Resistant Properties
  - Superior environmental performance through less waste generated by SIPs building and less HVAC needs from superior insulation
  - Superior Acoustic Values
    - Pre-insulated
    - Pre-engineered
  - Pre-Insulated vaulted ceilings
    - Less HVAC needs from superior insulation
  - Greater spans than stick framing
  - Minimal air infiltration
  - Panel thicknesses is sized to accept dimensional lumber, making panels easier to install.
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# Flooring Systems



MgO SIPs kits can be installed on a concrete slab or framed wood deck



# SIPs Application

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SIPs panels are very versatile and can be used in a variety of different applications such as:

- Single and multi-family homes
  - Light commercial buildings
  - Specialty buildings such as pool bars
  - Garages
  - Agricultural and farm building structures
  - Pump houses.
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# SIPs Application

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MgO SIPs are strong and can be engineered for wind loads in excess of 200 mph



*Tornado with documented winds of over 200 mph that damages 80 homes*



The only damage to the MgO SIPs home was two cracked impact windows and damage to the vinyl siding

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# SIPs Application

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*This SIPS home proved exceptionally resilient when Hurricane Charley struck Florida in August, 2004. Conventionally constructed homes in the same neighborhood were devastated by Charlie*

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# SIPs Application

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# SIPs Application

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Low Income Housing

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# SIPs Application

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HIP MGO SIP House

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# SIPs Application

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HIP MGO SIP House

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# SIPs Application

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HIP MGO SIP House

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# SIPs Application

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Coraflex Finish on MGO SIP

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# SIPs Application

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# SIPs Application

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*This SIPs home was painted to achieve a high quality exterior finish*

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# SIPs Application

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HIP MGO SIP House

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# SIPs Application

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Miami Seaquarium



# SIPs Application

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MGO Floor Plate Layout

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# SIPs Application

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Floor Plate Installation

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# SIPs Application

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MGO SIP Gable Wall

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# SIPs Application

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Panel Installation

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# SIPs Application

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Hot Iron to Clean SIP Sub-fascia

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# SIPs Application

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Roof Panel Installation

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## Learning Objective #4

**Describe how MgO SIPs panels are installed using current industry assembly standards**

# Who Can Build With MgO SIPS?

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- Any licensed contractor with residential or commercial building experience should be able to construct your building with little difficulty. A crew of four workers, each with a power screwdriver and common carpenters tools, can do all the work.
  - A sturdy movable scaffold (or two) is helpful. A fork lift is also helpful for lifting the roof panels into position.
  - On larger homes, the roof panel spans may be greater requiring the use of a LULL or crane for hoisting the panels into position. Installation cost vary depending on the difficulty of the design, the structural wind rating and any earthquake rating or seismic design considerations. It is recommended that Contractors that are not experienced SIP installers reference installation documents from the manufacturer.
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# What To Look For in MgO SIPS Manufacturers

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- Look for manufacturers who will provides on-site factory training for builders and others requiring assistance.
  - Look for product manufacturers who offers a complete training and certification program for contractors.
  - If installing a kit always ask the manufacturer to provide you with an easy to understand training manual showing you exactly how to install the kit.
  - Look for manufacturers who can provide all the tools required for the installation. Most carpenters already have all of the tools required in their tool box.
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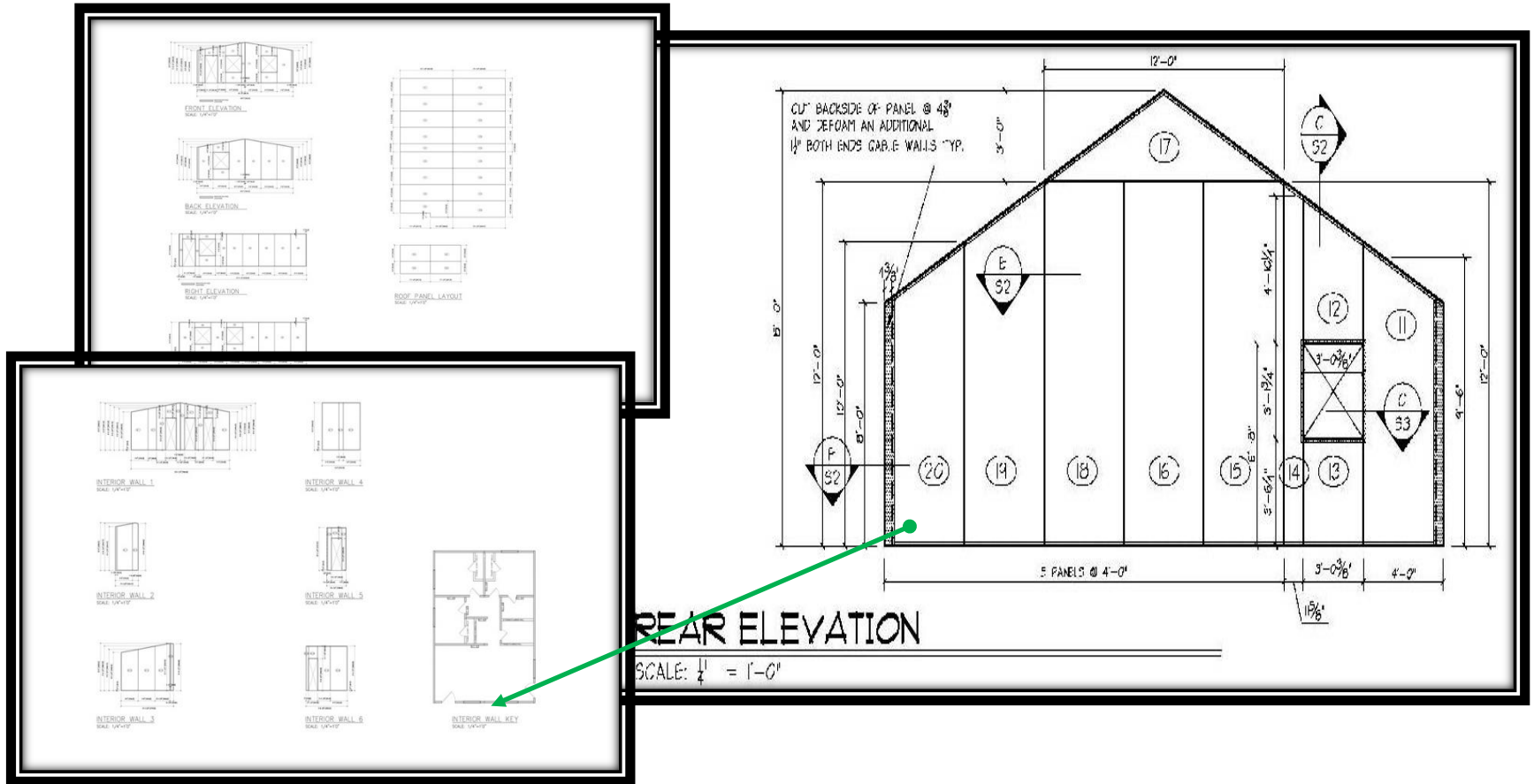
# Delivery

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- Your kit should come to you with all parts numbered for easy identification. Please inspect all parts of your building kit during the unloading process.
  - Panels should be neatly stacked on dunnage out of the way until needed for installation so as not to be damaged.
  - Panels should be covered and protected from the elements until installed. Cover and protect all Wood members from the elements. If the wood gets wet, it will swell, warp and twist causing problems in getting the Wood to fit inside the SIP system.
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# Installation



Panels are installed by panel numbers displayed on the plans



# Installation

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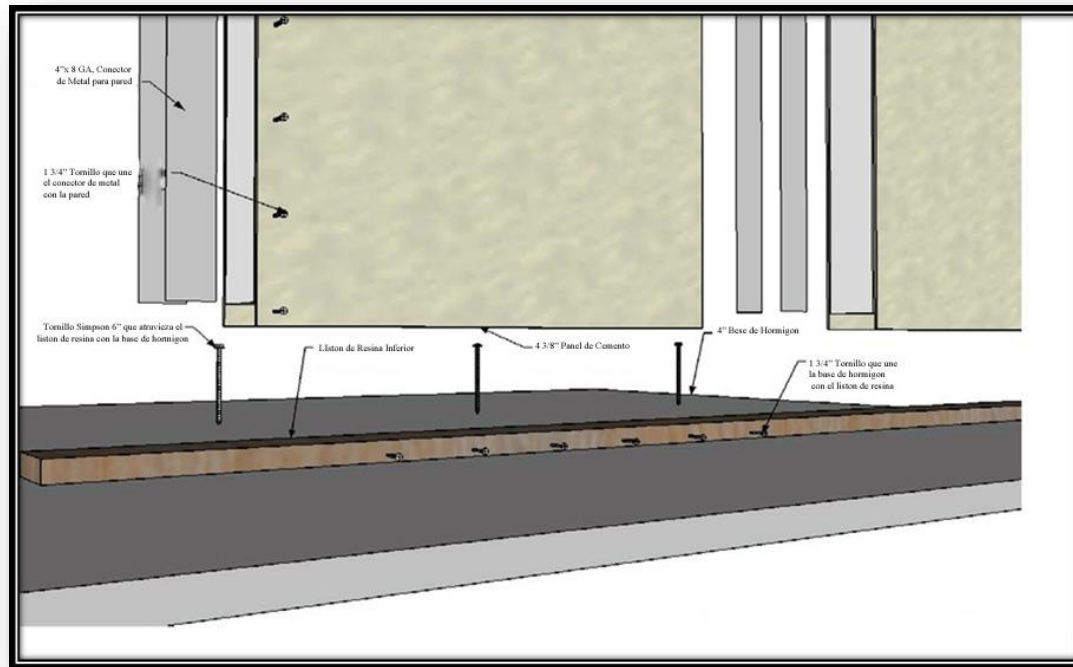


- Kit comes with the appropriate screws for the project.
  - SIP screws are designed to go through the panels, into structure.
  - Screws can be pre-started at the ground but need to be flush with the skin once installed
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# Floor Plate Connections

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- Panel to Panel connection / panel to floor plate connection
  - Floor plate needs to be properly installed
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# Sealing

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- Proper sealing is key to preventing gaps or voids in the system
- Proper sealing ensures a watertight seal



# Panel Connection

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- MgO SIPs panels are tilted back and pressed against the connection pane
- To prevent air from escaping they are placed where the splines align



*This model shows how the panel is tilted back to align the splines and panel on the floor plate before installation.*

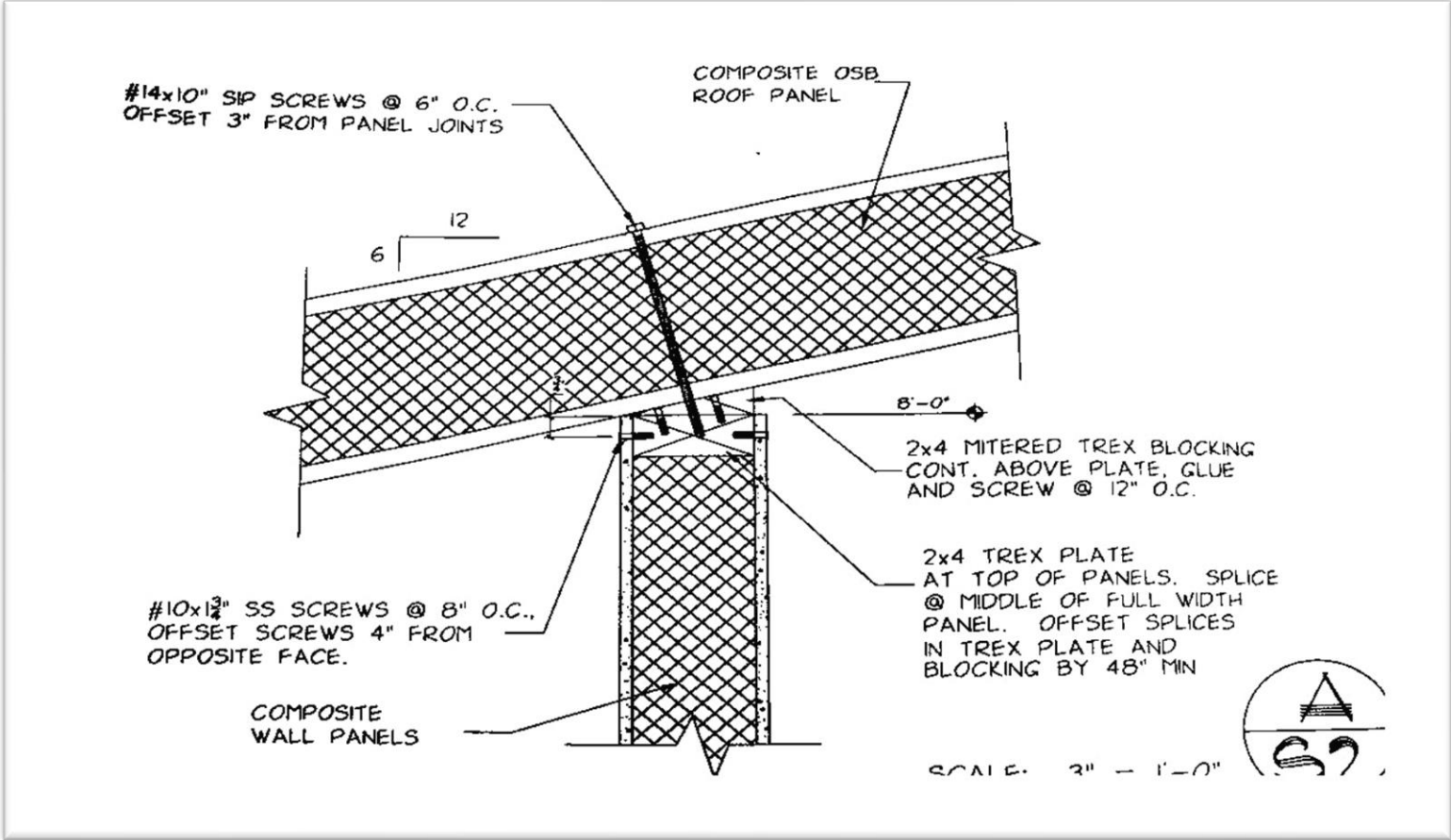
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# Roof Connection

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- NEED TO DESCRIBE ROOF CONNECTION
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# Roof Connections



# Multi Level Connection

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SIPs can be used in construction up to three stories



*With multi-story buildings, additional straps will be required at the floor plate as shown in this image.*

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# So Why Use MgO SIPS?

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- ✓ MgO SIP Walls will stop fires from spreading from interior to exterior and exterior to interior walls for added safety to the end user.
  - ✓ Highly energy efficient, reducing power consumption cost 30% to 70%
  - ✓ Solid durable construction system that results in fewer thermal breaks
  - ✓ Using MgO SIPS means a smaller HVAC system which will lower utility costs
  - ✓ MgO SIPs are mold mildew resistant
  - ✓ MgO SIPs are extremely low in VOC emission building material (no offgassing)
  - ✓ Fast, simplified construction means reduced labor cost and equipment cost for construction
  - ✓ A green building technology—less waste on the job sit
  - ✓ Reduced carbon footprint construction system
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# So Why Use MgO SIPS? *Cont.*

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- ✓ Excellent performance in cold weather conditions
  - ✓ Interior panels are taped and finished with drywall joint compound
  - ✓ Exterior panels can be painted or finished with a variety of exterior finishes such as stucco, brick or stone veneer, and siding
  - ✓ Available in various thicknesses to suit the needs of almost any project
  - ✓ Electrical wire chases are provided in the panels for easy installation of electrical wiring in the field
  - ✓ The SIPS can qualify for Leed or Florida Green building Certification
-

# What did you learn?

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- This concludes the course material.
  - The following ten minutes will be for taking a short exam. You must complete the exam with an 80% or higher in order to receive credit.
  - Please make sure and print your certificates of completion either for AIA/CES or for state MCE credit. Remember if you are an AIA member Architect-Forum will report credits to the AIA CES on your behalf.
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# Course Summary

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By now the participants should have gained a basic understanding of:

1. Describe and define MgO SIPs panel construction and design.

*Such as Fire Ratings / R-Values / Sustainable Design*

2. Explain energy-efficiency design strategies with MgO SIPs panels and how they improve energy efficiency and indoor air quality.
  3. MgO SIPs uses and applications.
  4. Describe how MgO SIPs panels are installed using current industry assembly standards.
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# Course Handout as PDF

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If you would like to save an Adobe PDF copy of this course

- [Click here](#) to access it.

Reasons why you might want a copy of this program:

- To reference the material at a later date.
- Great way to review the material while you take the test.
- If when working on a project with your team and you need to review the material.

Note: We recommend you create a folder on your computer and save all of Architect-Forum handouts for future reference.

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# *Designing with MgO Structural Insulated Panels*



**This concludes the continuing education program.**

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