Composite Building Materials for Green Building

Bob Moffit
Product Manager
Learning Objectives

• Define and identify a composite material

• Recognize the benefits that composite materials offer in building products

• Become familiar with tools to gain additional information on composite building products
  • CompositeBuild.com
  • Compositesandarchitecture.com
Why Be Concerned With Building Materials?
Drivers for Green Building Materials

• Buildings consume a large amount of natural resources to construct and operate

U.S. Building Impacts:

- 12% water use
- 39% CO₂ emissions
- 65% waste output
- 71% electricity consumption

Courtesy of USGBC, 2011
Drivers for Green Building Materials

• **Green building** is the practice of minimizing the impact a building has on the environment

![Diagram showing average savings of green buildings]

*Courtesy of USGBC, 2011*

Materials are an important component of green building programs
Drivers for Green Building Materials

• All materials: Performance & Aesthetic requirements

• Green Materials
  – Energy Savings
  – Durability
  – Low Maintenance
  – Healthy Indoor Environment
    • Air Quality
    • Daylighting
    • Air handling

Composite materials provide many of these benefits
What is a Composite?
What Is A Composite?

**Composite**

Engineered or naturally-occurring materials made from two or more constituent materials with significantly different physical or chemical properties

*At a microscopic level, the constituent materials remain distinct within the finished structure.*
Composites We Are All Familiar With

Wood is a natural composite of cellulose fibers in a lignin matrix.

There are many man-made composites:

- Early civilization houses were composites of mud and straw.
- Disc brake pads are composites of hard ceramic particles embedded in soft metal.
Focus for this Presentation

Polymer Matrix Composites

A composite made from a polymer and a reinforcing and/or particulate material

The polymer binds the reinforcement & particulate together.

Reinforcement material
- Glass fibers
- Natural fibers
- Carbon fibers

Particulate material
- Sand, talc and other fillers
- Color chips
- Recycled glass

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Where Are Composites Found?

- Variety of applications, including:
  - Transportation
  - Marine
  - Infrastructure
  - Building & Construction
Composite Building Materials
What Benefits Can Composites Provide?
Benefits of Composites

• Extremely Durable
• Light Weight
• Energy-Saving
• Flexible in Design
• Green Building Enabling
Composites are Durable

• Polymer matrix composites are extremely durable, long-lasting materials

• Require low maintenance

• Increased service life vs. conventional materials

• Re-use opportunities
Composites are Durable

Composites have very good environmental durability relative to wood.

- Do not swell, warp, rot
- Very good resistance to animals and insects
Composites are Corrosion Resistant

- Composites offer very good corrosion resistance relative to metals and concrete.
- They find widespread use in corrosive environments.
  - Pipes and tanks
  - Ductwork
  - Cladding for roofs & walls
  - Seawalls

BENEFITS
- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- GB-enabling
Benefits of Composites

- Extremely Durable
- **Light Weight**
- Energy-Saving
- Flexible in Design
- Green Building Enabling
Composites are Lightweight

- Composites are lighter than steel, aluminum, concrete and brick.

![Graph showing weight comparison between materials](image)

Functionally equal comparisons are more important.

**BENEFITS**
- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- GB-enabling
Composites Have a High Strength to Weight Ratio

- Composites offer superior performance vs. the individual components that make up the composite.
- Composites are stronger and offer more stiffness than wood.
- Composites offer higher strength than concrete.
- Composites have specific strength & stiffness similar to steels.

Composites

Concrete

PMMA

PP

Nylon

Glass

Specific Stiffness (Modulus/Density)

Specific Strength (Strength / Density)
Taking Advantage of High Strength to Weight

Prototype Investigation

• Replace failing masonry cladding in high rise building
• The **low weight composite** allows floor space to be added
• Uses existing building structure and foundations

<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>Durable</th>
<th>Lightweight</th>
<th>Energy-Saving</th>
<th>Flexible in Design</th>
<th>GB-enabling</th>
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<tbody>
<tr>
<td>CRAFT Engineering Studio</td>
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</table>
Enhancing Performance of Other Building Materials

Hybrid Composite Beams
Composite skins with concrete and composite re-bar

- 33% lighter than all concrete beam
- High strength
- Improved corrosion resistance
- Estimated 100+ year life span
Benefits of Composites

- Extremely Durable
- Lightweight
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- Flexible in Design
- Green Building Enabling
Minimizing Energy Consumption

- **Construction Energy**
  - Lightweight, easy to transport and install

- **Operational Energy**
  - Offer low thermal conductivity and reduce thermal bridging

- **Embodied Energy**
  - Materials can be designed to be
    - Reusable
    - More durable
    - Manufactured with recycled and rapidly renewable

**Composites can help conserve energy**

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**Benefits**
- Durable
- Lightweight
- **Energy-Saving**
- Flexible in Design
- GB-enabling
Composites Are Energy-Saving

**Composites are insulating**

Composite frames offer high thermal insulation

<table>
<thead>
<tr>
<th>Material</th>
<th>U-Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (no thermal break)</td>
<td>1.9 - 2.2</td>
</tr>
<tr>
<td>Aluminum (thermal break)</td>
<td>1.0</td>
</tr>
<tr>
<td>Aluminum clad wood/reinforced vinyl</td>
<td>0.4 - 0.6</td>
</tr>
<tr>
<td>Wood and vinyl</td>
<td>0.3 - 0.5</td>
</tr>
<tr>
<td>Composite</td>
<td>0.2 - 0.3</td>
</tr>
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</table>

**Composites are dimensionally stable**

Composites have a very low coefficient of thermal expansion (CTE)

They are not prone to expansion & contraction with swings in temperature.

*No cracks!*
Composites are Energy-Saving

Composite Structural Insulated Panels

• Conventional SIPs have a sandwich construction
  – Wood – Insulating Foam Core – Wood

• Polymer matrix SIPs also are a sandwich
  – Composite – Insulating Layer – Composite

  • More mold, mildew & insect resistant
  • Does not require additional weather protection
  • Structurally sound – can be utilized in hurricane areas
Benefits of Composites

- Extremely Durable
- Light Weight
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# Composites Offer Flexibility in Design

<table>
<thead>
<tr>
<th>Process</th>
<th>+ / -</th>
<th>Types of Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casting</td>
<td>Design flexible, shape and color</td>
<td>Sinks, tubs, counters</td>
</tr>
<tr>
<td></td>
<td>Non-structural parts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low cost molds, appropriate for small run parts</td>
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<tr>
<td>Spray-up</td>
<td>Moderate mold cost</td>
<td>Tanks, building facades</td>
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<tr>
<td></td>
<td>Good for small run parts</td>
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<tr>
<td></td>
<td>Complex designs possible</td>
<td></td>
</tr>
<tr>
<td>Infusion / RTM</td>
<td>Consistent part</td>
<td>Boat parts, car parts</td>
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<tr>
<td></td>
<td>Complex design possible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High cost mold</td>
<td></td>
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<tr>
<td></td>
<td>Mid to high volume</td>
<td></td>
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<tr>
<td>Continuous Panel</td>
<td>Continuous flat sheet</td>
<td>Light panels, building panels</td>
</tr>
<tr>
<td></td>
<td>High volume</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limitations on physical design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Options for surface / color</td>
<td></td>
</tr>
<tr>
<td>Pultrusion</td>
<td>Continuous shape parts</td>
<td>I-beam, ladder rail, window lineals</td>
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<tr>
<td></td>
<td>High volume</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate design flexibility</td>
<td></td>
</tr>
<tr>
<td>Press Molding</td>
<td>Very high volume</td>
<td>Car/truck panels, appliance bodies</td>
</tr>
<tr>
<td></td>
<td>Very consistent part</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complex shape possible</td>
<td></td>
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<tr>
<td></td>
<td>Very high Capital cost</td>
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**BENEFITS**

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Composites Offer Flexibility in Design

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**Aesthetics & Performance**
Composites Offer Flexibility in Design

BENEFITS
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- Lightweight
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Cornices
Facades
Detailed Replications
Columns
Urban Renewal

Courtesy: Kreysler & Associates

Terminal Tower – Cleveland, OH

High & Goodale – Columbus, OH

Courtesy: Architectural Fiberglass
Composites Offer Flexibility in Design

- Color & Style Options
- Mold/Mildew Resistance

Function & Style

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Composites & Green Building

Composites products offer direct applicability to material categories of green building standards.

- Recycled Content
- Rapidly Renewable Materials
- Regional Materials
- Material & Building Re-use

BENEFITS: Durable, Lightweight, Energy-Saving, Flexible in Design, GB-enabling
Recycled Content

Composite fabricators are responding to the green building industry’s need for more sustainable products.
Rapidly Renewable Materials

Rapidly renewable materials are being incorporated.
Renewable based polymers first.

Lots of work on-going with natural fiber reinforcements.

BENEFITS
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Recycled Content & Rapidly Renewable Materials

Some fabricators have produced composite materials from recycled & renewable materials. This is a growing trend!
Composites and Green Building

Composites products offer functional applicability relevant to green building standards.

- Storm Water Handling
- Daylight and Views
- On-site Renewable Energy & Green Power
- Storage & Collection of Recyclables
- Mold Prevention
Daylight & Views

- Roof panels
- Curtain walls
- Lineals for windows/doors

BENEFITS
- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- GB-enabling
Storm Water Handling

- Durable, corrosion-resistant
- Lightweight
On-Site Renewable Energy / Green Power

- High strength and stiffness
- Low weight
- Durability against impact and weathering
- Fatigue resistance
How Can I Find Out More About Composites?

CompositeBuild.com

COMPOSITES and ARCHITECTURE
Purpose

• Increase awareness of composite building materials

• Enable the design/build community to:
  – Learn about the benefits of composites
  – Easily connect with composite material fabricators & distributors
Explore the CompositeBuild.com Residential Home

Take a tour of the CompositeBuild.com residential home and see how engineered composite materials can be used to meet your everyday needs.

Throughout the tour we will spotlight products that have attributes of interest to those involved in green building and living.
Bath

Engineered composite materials provide limitless design options for the bath.

TUBS, SHOWERS & SPAS
Solid Surface
Robal Glass
Acrylic/Gelcoated

Select a specific Material type
Robal Glass is manufactured using 100% post consumer recycled glass and a resin binder containing rapidly renewable content.

ADA accessible showers and tubs can be designed with Robal Glass.

ANSI 2124 tested and approved.
Connecting To CompositeBuild.com

- Free to register
- More products / more choices means more useful to end user
- Contact: rlmoffit@ashland.com
Resources

• Compositebuild.com
  – Connect design/build industry to composite products and fabricators

• Compositesandarchitecture.com
  – Further innovation and inspiration in the world of architecture, design, digital fabrication and composite technology

• ACMAnet.org
  – American Composite Manufacturer’s Association

• ICPA-hq.org & MasterCast.biz
  – International Cast Polymer Association

• Composites in Construction
  – Linked-In group
Thank You!!