Composite Building Materials for Green Building

Presentation prepared by:

ASHLAND®

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Learning Objectives

• Define and identify a composite material

• Recognize the benefits that composite materials have to offer for green building and construction

• Become familiar with tools to gain additional information on composite building products.
  – CompositeBuild.com
  – CompositesAndArchitecture.com
Composite Building Materials for Green Building

Why Be Concerned With Building Materials?

Course Drivers
Defining Composites
Benefits of Composites
Composite LCA
CompositeBuild.com
Composites&Arch.com
Drivers for Green Building Materials

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

![Graph showing 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.

![Image showing average savings of green buildings](image-url)

Courtesy of USGBC, 2011
Drivers for Green Building Materials

• LEED green building program
  – Leadership in Energy and Environmental Design
  – Program developed by the US Green Building Council (USGBC)
  – Provides a framework for implementing practical green building design, construction, operations and maintenance solutions

Materials are an important consideration within LEED and other 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
Composite Building Materials for Green Building

What Are Composites?

- Course Drivers
- Defining Composites
- Benefits of Composites
- Composite LCA
- CompositeBuild.com
- Composites&Arch.com
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
Examples of Polymer Matrix Composites

• Variety of applications, including:
  – Transportation
  – Marine
  – Infrastructure
  – Building & Construction

Photo courtesy: John Deere

Photo courtesy: Composites Advantage

Photo courtesy: Campion Boats
Composite Building Materials for Green Building
Composite Building Materials for Green Building

How Are Composites Useful?

Course Drivers
Defining Composites
Benefits of Composites
Composite LCA
CompositeBuild.com
Comp&Architecture.com
Benefits of Composites

- Extremely durable
- Lightweight
- Energy-saving
- Flexible in design
- LEED-enabling

BENEFITS

Durable  Lightweight  Energy-Saving  Flexible in Design  LEED-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
Durability

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 of Composites

- Extremely durable
- Lightweight
- Energy-saving
- Flexible in design
- LEED-enabling
Composites are Lightweight

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

![Graph showing the weight comparison of different materials. Steel has the highest weight, followed by Aluminum, Concrete, Brick, and Composite, with Wood being the lightest.]

- Lower transportation costs.
- Less equipment required during installation.

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

- Composites are lightweight materials that are strong and stiff.
- Composites are much stronger and stiffer than pure polymers.
- Relative to wood, composites are stronger and stiffer.
- Relative to concrete, composites offer superior strength.
- Composites can have specific strength & specific stiffness similar to steels.

**BENEFITS**

- Durable
- **Lightweight**
- Energy-Saving
- Flexible in Design
- LEED-enabling
Composites are Lightweight
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

**BENEFITS**
- Durable
- **Lightweight**
- Energy-Saving
- Flexible in Design
- LEED-enabling
Enhancing Performance of Other Building Materials

“Bridge in a Backpack” – Composite arches filled with concrete

- Smaller equipment during install
- Improved corrosion resistance
- Improved freeze-thaw performance

<table>
<thead>
<tr>
<th>Weight Savings</th>
<th>Corrosion Resistance</th>
<th>Durability</th>
<th>High Strength</th>
<th>Material Reduction</th>
</tr>
</thead>
</table>
| **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
- Energy-saving
- Flexible in design
- LEED-enabling
Minimizing Energy Consumption

Composites can help conserve energy

- **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

**BENEFITS**

- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- LEED-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>
</tbody>
</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!

BENEFITS

- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- LEED-enabling
Structural Insulated Panels

- **Structural Insulated Panels (SIPS)**
  - Lightweight
  - Easy-to-install (modular)
  - Very good insulating properties
    - Whole wall R value = 14

* Tests show that in the "worst case, commonly found of procedures for installing batt insulation" the performance drops to R-11.

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**BENEFITS**

- Durable
- Lightweight
- **Energy-Saving**
- Flexible in Design
- LEED-enabling
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
- Can contain 100% recycled fill
- More structurally-sound. Hurricane-resistant
Energy-Saving
Composite Structural Framing

- Composite frames are being used to build hurricane-resistant structures.

Weight comparison in a 2000 ft² Hurricane-built structure

Information and photos courtesy Composite Building Systems, Inc.

Energy Savings During Construction
- Transportation
- Low weight installation

Operational Energy Savings
- Low thermal bridging
- Wall panel R-values in the 20’s

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

- Extremely durable
- Lightweight
- Energy-saving
- Flexible in design
- LEED-enabling
## 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>
<td></td>
</tr>
<tr>
<td>Lay-up / Spray-up</td>
<td>Moderate mold cost</td>
<td>Tanks, building facades</td>
</tr>
<tr>
<td></td>
<td>Good for small run parts</td>
<td></td>
</tr>
<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>
</tr>
<tr>
<td></td>
<td>Complex design possible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High cost mold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid to high volume</td>
<td></td>
</tr>
<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>
</tr>
<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>
</tr>
<tr>
<td></td>
<td>Very high Capital cost</td>
<td></td>
</tr>
</tbody>
</table>
Composites Offer Flexibility in Design

Flexible Design
Aesthetics & Performance

BENEFITS
Durable  Lightweight  Energy-Saving  Flexible in Design  LEED-enabling
Composites Offer Flexibility in Design

Flexible Design
Aesthetics & Performance

Cornices
Facades
Columns
Urban Renewal

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BENEFITS
Durable Lightweight Energy-Saving Flexible in Design LEED-enabling
Composites Offer Flexibility in Design

**Color & Style Options**

**Mold/Mildew Resistance**

**Flexible Design**

Aesthetics & Performance

BENEFITS

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

- Extremely durable
- Lightweight
- Energy-saving
- Flexible in design
- LEED-enabling
Composites are LEED-Enabling

Composites products offer direct applicability to LEED under the Materials & Resources Category

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

Life Cycle Assessment of Building Assemblies & Materials
Pilot Credit 1

| BENEFITS | Durable | Lightweight | Energy-Saving | Flexible in Design | LEED-enabling |
Composite fabricators are responding to the green building industry’s need for more sustainable products.

MR Pilot Credit 53 – Prescriptive attributes for non-structural materials
Rapidly renewable materials are being incorporated.
Renewable based polymers first.

Lots of work on-going with natural fiber reinforcements.

BENEFITS
- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- LEED-enabling

USDA BioPreferred

WATERLESS
Some fabricators have produced composite materials from recycled & renewable materials. This is a growing trend!
Because of their durability, most composites are capable of being re-used.
Composites are LEED-Enabling

Composites products offer *functional applicability* to LEED under several categories and credits.

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

Daylight & Views

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

![Image of building interior](image1)

![Image of building exterior](image2)

![Image of building interior](image3)

**BENEFITS**
- Durable
- Lightweight
- Energy-Saving
- Flexible in Design
- LEED-enabling

*Courtesy: Pella*

*Courtesy: Kalwall*

*Courtesy: Kalwall*
Functional LEED Applicability

Storm Water Handling

- Durable, corrosion-resistant
- Lightweight

Courtesy: Xerxes Corp

Courtesy: Hubbell

BENEFITS

Durable  Lightweight  Energy-Saving  Flexible in Design  LEED-enabling
Functional LEED Applicability

On-Site Renewable Energy / Green Power

- High strength and stiffness
- Low weight
- Durability against impact and weathering
- Fatigue resistance
Composite Building Materials for Green Building

How Do Composites Fare From A Life Cycle Perspective?

Course Drivers
Defining Composites
Benefits of Composites
Composite LCA
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Life Cycle Analysis (LCA)

• Considers all stages of product life from raw material extraction through end of life disposal

• Compares environmental & social damages assignable to products and services

<table>
<thead>
<tr>
<th>IMPACT CATEGORIES</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Total Energy Resources</td>
<td>• Carbon dioxide</td>
</tr>
<tr>
<td>• Greenhouse Gas Emissions</td>
<td>• Carbon monoxide</td>
</tr>
<tr>
<td>• Ozone Depletion</td>
<td>• NOx</td>
</tr>
<tr>
<td>• Acidification</td>
<td>• SOx</td>
</tr>
<tr>
<td>• Eutrofication</td>
<td>• Particulates</td>
</tr>
<tr>
<td>• Heavy Metals</td>
<td>• Volatile Organic Compounds</td>
</tr>
<tr>
<td>• Carcinogens</td>
<td>• Specific Process, and Material-specific waste issues</td>
</tr>
<tr>
<td>• Summer Smog Formation</td>
<td></td>
</tr>
<tr>
<td>• Winter Smog Formation</td>
<td></td>
</tr>
<tr>
<td>• Solid Waste</td>
<td></td>
</tr>
</tbody>
</table>
Environmental Impact Review

Composites vs. Concrete

- **The Need:**
  - The Monterey Bay Aquarium new seawater tank
    - 20 year lifetime
    - Smallest environmental footprint
    - Competitive cost

- **The Candidates:**
  - Fiber-reinforced Composite
  - Steel-reinforced Concrete

- Prof. Michael Lepech and a team of graduate students at Stanford performed a process–based environmental impact review
The Results: Composite vs. Concrete

The energy consumed in the production of the concrete was the most significant contributor to differences between composite and concrete impacts.

Much smaller footprint

Composite

Concrete
Environmental Impact Review

Composites vs. Steel

- **The Need:**
  - Understand environmental impacts and initial and long term cost of railing.
    - Lowest environmental impact
    - Lowest long term cost

- **The Candidates:**
  - Fiber-reinforced Composite
  - Steel

- **Review Performed by:**
The Results: Composite vs. Steel

Comparison of Normalized Environmental Impacts

- Winter Smog
- Summer Smog
- Pesticides
- Carcinogens
- Heavy Metals
- Eutrophication
- Acidification
- Ozone Layer
- GHG

Impact (Pt)

STRONGRAIL®

Mild Steel
The Need:
- New cultural center in Baku, Azerbaijan. Building material selection.
  - 18,000 2m² panels
  - 50 yr building life span

The Candidates:
- Glass-reinforced Polymer
- Glass-reinforced Concrete

Review Performed by:
The Results:

Reinforced Concrete vs. Reinforced Polymer

The higher weight of the reinforced concrete resulted in significant impacts from transportation, especially heavy metals.
Cost of Composites vs. Other Materials

• How do the costs of composites compare to other materials?
Cost of Composites vs. Other Materials

• When purchase cost is the only factor:
  – Composites always win:
    • Tubs & showers
    • Boats & heavy truck
    • Large wind blades
  – Composites rarely win:
    • Bridges
    • Disposable / consumables
  – Composites win at certain volumes
    • Automotive body panel
Total life cycle cost analysis is similar to LCA.

Total Cost = Raw Materials & Manufacturing + Construction & Installation + Operation & Maintenance + Replacement & End of Life

- Composites can be more costly to purchase
- They are low weight, resulting in lower cost to transport and install
- Composites typically require less maintenance
- Durability results in low replacement frequency
Life Cycle Cost Comparisons from LCA

<table>
<thead>
<tr>
<th></th>
<th>Composite Tank</th>
<th>Concrete Tank</th>
<th>Composite Strongrail®</th>
<th>Mild Carbon Steel Rail</th>
<th>Polymer Composite</th>
<th>Concrete Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purchase</strong></td>
<td>$1,501,935</td>
<td>$1,836,763</td>
<td>$584.12</td>
<td>$371.14</td>
<td>$26.26</td>
<td>$31.04</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td>Included</td>
<td>Included</td>
<td>$48.00</td>
<td>$18.36</td>
<td>$0.62</td>
<td>$10.03</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Included</td>
<td>included</td>
<td>$91.00</td>
<td>$91.00</td>
<td>included</td>
<td>included</td>
</tr>
<tr>
<td><strong>Operation/Maintenance</strong></td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td>$274.00</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>End of Life Costs</strong></td>
<td></td>
<td></td>
<td>$2.86</td>
<td>Recycled</td>
<td>$0.002</td>
<td>$0.003</td>
</tr>
<tr>
<td><strong>Total LCC</strong></td>
<td>$1,509,450</td>
<td>$1,868,119</td>
<td>$725.97</td>
<td>$754.50</td>
<td>$26.88</td>
<td>$41.07</td>
</tr>
</tbody>
</table>
Composite Building Materials for Green Building

How Can I Easily Find More Information About Composites?

Course Drivers  Defining Composites  Benefits of Composites  Composite LCA

CompositeBuild.com Comp&Architecture.com
CompositeBuild.com

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
About CompositeBuild.com
CompositeBuild.com allows architects, designers, builders and others interested in composite building materials to learn about the benefits of composites and to connect with composite material fabrication and distributors.

Because of the significant interest in sustainable building, CompositeBuild.com highlights product and material characteristics of interest to green builders.

What is a Composite?
Composites are engineered products made from two or more different materials. A composite product provides a designed solution that surpasses the performance of the starting materials.

There are many variations of composite products. Some of the most common composites are fiber reinforced plastics and engineered wood composites.

Fiber reinforced plastics (FRP) are composites made of a plastic polymer matrix reinforced with fibers, such as glass, or other materials.

Composite wood panels, laminated plastic, and engineered wood flooring are formed by bonding layers of fibers, wood chips, or adhesives to

Why Composites?
Composites offer significant advantages in durability and design freedom over conventional materials. The composite designer can tailor the performance of the end product with proper selection of materials.

Benefits of Composites
FRP Composites
- Design flexibility for aesthetics and performance
- High durability with resistance to environmental effects such as rot, insect attack and corrosion
- Light-weight components that deliver high strength per unit weight
- Special properties such as cured-in-color composites for maintaining the desired appearance for a lifetime.
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

The attractive appearance of Robal Glass provides a beauty un-foreseen in the past. An endless array of design configurations are available for shower bases, wall panels and vanity tops. Robal Glass resists stains, bacteria and everyday wear and tear.

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.
Explore the CompositeBuild.com Commercial Building

See how durability and design flexibility are hallmarks of engineered composite products.

Throughout the tour you will find information on composite building products and furnishings that have attributes of interest to those involved in "green" building.
Exterior Architecture

Composites enjoy widespread use throughout exterior architectural applications. The design freedom enabled by composites combined with its outstanding weatherability and high strength-to-weight ratio make it a compelling material choice.
Case studies of composites in architecture.  
Site maintained by Kreysler & Associates

compositesandarchitecture.com

Bill Kreysler is a composite industry veteran with more than 30 years of experience in custom fabrication. His firm focuses on composite products for architecture, artists and industrial applications. Extensive experience in coordinating design, engineering, estimating and fabrication tasks to realize a wide variety of objects made of or through the use of composite materials.
**New Materials**

With its unique design, the facade is also unique in its material composition. To adapt to the special geometry, it was natural to design using new and innovative building materials and methods. If the same facade was to be built using traditional construction methods (i.e., steel frames), it would be a challenge to build each element separately and therefore difficult to keep uniformity. By contrast, by taking the decision to build completely out of fiberglass, it becomes possible to mass produce with much fewer discrepancies amongst the various building elements.
Case Study:
Sendai, Japan – FRP Facade

Designed by Atelier Hitoshi Abe and Asao Tokolo, this multi-storied building in Sendai, Japan boasts a mod FRP facade in patterned white panels that unify the intersecting boxes comprising the building’s form. Photos by Daici Ano
Case Study:
Sheraton Hotel, Spain – Seamless Shell

The Alpensa International Airport in Spain has a new hotel designed by King Roselli Architetti. At 420m long, 64m wide, 21m high, and with 436 rooms, this luxury hotel is divided into 7 rounded bays, all covered in an FRP shell. On the subject of the shell, Rosellii notes: “We were looking for a seamless shell to fold around the functional volumes of the buildings. After researching and detailing a number of alternatives - titanium zinc sheeting, Corian and similar solid surfacing, sprayed polyurethane damp-proof membranes, and waterproof concrete-resin based finishes - we finally opted for pultruded fibreglass panels. Pultrusion is a manufacturing process combining extrusion and pulling fibreglass through a die that can provide panels up to 1400mm wide and almost infinite lengths - we needed lengths of up to 25 meters. Aside from the lengths of the panels, the material has a series of qualities highly suitable for building: it is light weight, elastic, very stable in extreme temperatures (-20°C to +50°C), fireproof and waterproof. Reduced costs and construction times coupled with the inherent qualities and finish of the material have proved to be decisive in achieving the desired result in this project. This material is more often used for industrial products and so an enormous experience of precision detailing to tight tolerances has been accumulated over the years which came in very useful in the detail design of the membrane.” Read more about the shell [here](#).
Case Study:
Composite Clad Terminal at the Cerresco Airport

This relatively new terminal in Uruguay for this building was designed by architect Rafael Viñoly in the shape of a paraglider. This form, while seductive in its low lying curved profile, introduced a number of challenges due to its three axis of curvature and design suction forces of up to 1.8 kPa.

IIFC’s report states “MVC’s eventual solution was to cover the bottom surface with sandwich panels made of composite plates having a gelcoat finish and expanded polystyrene and polyurethane core. These were attached to the building’s main structure by a secondary aluminum structure so as to allow for the correction of imperfections present in the main structure. 24,000 m² of panels were supplied and assembled, without interfering with the other activities at the construction site, over a period of 9 months.” Read more here
Case Study:
London – Building Facade

More on the facade from the Walbrook: “A veil of silver colored horizontal shading elements (brise soleil) extends from roof level down to the lower levels of the building. It increases in density on the upper stories, where the office space is more exposed to sunlight. The shading reduces the amount of cooling required to the office space. These brise soleil elements are manufactured from Fiber Reinforced Polymer with a high performance and high gloss paint finish. All of the elements are easily de-mounted for maintenance repair.”

Designed by Foster + Partners, completed in 2010. Images via Walbrook.
Case Study:
Stanford University – Bing Concert Hall

Now underway at Stanford University, the construction of Bing concert hall contains engineered acoustic panels that will precisely disperse sound to the audience. Designed by Ennead Architects and aided by acoustician Yasuhisa Toyota using models and the latest technology to generate the complex curvature of the hall and panels inherent in the acoustical performance. Advanced computer programming and CNC fabrication was integral to the creation of the molds and resultant panels.

“(These) panels, a combination of glass fiber-reinforced polyester skin on top of steel-reinforced concrete, will be mounted to the walls (called sails) and ceiling (dubbed the cloud). Designed and manufactured by architectural composite fabricator Kreysler and Assoc. (American Canyon, Calif.), the panels cover most of the performance hall’s interior walls and ceiling. Their convex shapes counter the sound concentrations that could result from the hall’s concave shape. The panels disperse the sound to create a richer quality by enabling the audience to hear sounds coming from more than one direction.” - CompositesWorld.com
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