Carbon Fiber Reinforced Precast Systems for Multi-Unit Residential Structures
It All Started Here….

Thomas Edison with a model of his prototypical all-concrete house (c. 1910). Courtesy of the Portland Cement Association.
And Evolved Into a Complete Precast System for Housing...
Carbon Fiber Reinforced Multi-Unit Residential Precast Products

- Foundation Panels
- Exterior Wall Panels
- Demising Panels
- Floor and Roof Decks
- Modules & more….
Types of Residential Systems

- Roof Decks
- Floor Decks
- Exterior Wall Panels
- Foundation Panels

Bath Module
Enabling Technology

- Carbon Fiber Grid
  - 1 mm thick
  - 5X stronger than steel
  - Lighter and easier to handle than steel
  - Non-corrosive
  - Non-magnetic
  - Thermally non-conductive
  - Used for:
    - Shear transfer
    - Face reinforcing in corrosive environments
Appearance Options
Wall Panel Appearance Options
Appearance Options
<table>
<thead>
<tr>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight</td>
</tr>
<tr>
<td>No footing required in most soils</td>
</tr>
<tr>
<td>Add Insulation to achieve R 10</td>
</tr>
<tr>
<td>Typically 10” thick</td>
</tr>
<tr>
<td>Internally ribbed waffle design accepts</td>
</tr>
<tr>
<td>any opening and can be furred out</td>
</tr>
<tr>
<td>Walls can be load bearing</td>
</tr>
<tr>
<td>Walls can be factory furred with wood</td>
</tr>
<tr>
<td>or steel for easy drywall finish</td>
</tr>
<tr>
<td>High STC rating &amp; thermal efficiency</td>
</tr>
<tr>
<td>Highly mold/mildew &amp; pest resistant</td>
</tr>
<tr>
<td>Paperless drywall applied at factory</td>
</tr>
<tr>
<td>All weather installation</td>
</tr>
</tbody>
</table>
Foundation Panels
Foundation Panel Casting

C-Grid bands
(with foam cores or waffle pans)
Accelerated Occupancy

Unload off the trailer

Erecting into place
Accelerated Occupancy

Erecting perimeter walls

Erecting demising wall
Wall Panels

- Lighter than conventional systems
- Insulation has an R value of R13-R19
- Typically 6-8” thick – fire rated
- Windows can be pre-installed
- Load bearing, high STC rating
- Thermal efficient & mold resistant
- Open back for wiring/plumbing access
- Walls can be factory furred with wood or steel for easy drywall finish
Wall Panels Prior To Finishing

Cast flat on liners w/ composite trim added as desired
Factory-Applied Windows, Trim and Shutters
Horizontal or Vertical Studding
Manufacturing Process
Wall Panel Weights

Comparison

- Residential Lightweight Panel-
  - Wall panel weighs 25 psf
  - (9’ tall x 32’ long) equals (7,200 lbs)
  - This allows six per load
  - 1728 sf of wall area per truck

Residential sandwich wall-
  - Wall panel weighs 58 psf
  - (9’ tall x 32’ long) equals (16,704 lbs)
  - This allows two per load
  - 576 sf of wall per truck
Floor and Roof Decks

- 12” deep
  - 1” flange
  - Legs: 24”- 32” apart
  - Spans to 32’@ 12”d

- Open bottom
  - Enables access for HVAC, wiring & plumbing

- Furring with wood or steel

- Finish with drywall
  - Residential look & feel
  - Smooth ceilings
  - 1-hour rating possible w/1” flange
Floor Panel Weights

Comparison

• Stem-Decks weigh 30 psf 8’ wide x 30’ long panel) (7,200 lbs)
• Per load you get six panels
• 1440 sf of floor per shipment

• 8” typical hollow core slabs weigh 60+ psf 8’ x 30’ area (14,400 lbs)
• Per load you get three panels
• 720 sf of floor per shipment
Manufacturing Process

• Long line production
• Split bulkheads w/ magnetic bases
• Bulkheads fitted with 3” tapered oval rubber hole voids
• Tapered pans w/ 1-1/2” voids at sides for transverse utilities
• C-GRID rolled out and pressed in after flange is poured
• Final finish with vibratory roller screed
Bath Modules
Accelerated Occupancy
LEED Friendly

A carbon cast architectural precast wall can be a key building component in qualifying for LEED Certification ...

- **Sustainable Sites**
  - Reduced site disturbance
  - Reduced heat island effect if light colors selected

- **Energy & Atmosphere**
  - Outstanding energy efficiency

- **Materials & Resources**
  - Regionally manufactured product
  - Building re-use
  - Construction waste
  - Recycled content
  - Recyclable materials
  - Regionally extracted materials

- **Indoor Environmental Quality**
  - Construction IAQ Management plan during construction

- **Innovation & Design Process**
  - Less concrete usage: Much less energy consumed in manufacturing, hauling & erection, plus less raw material used
  - Load bearing structural/architectural wall
  - Thin brick usage: Much less energy consumed in manufacturing, hauling & erection, plus less raw material used
LEED: Precast Concrete Project Checklist

### Sustainable Sites

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Site Development, Protect or Restore Habitat</td>
<td>1</td>
</tr>
<tr>
<td>5.2</td>
<td>Site Development, Maximize Open Space</td>
<td>1</td>
</tr>
<tr>
<td>7.1</td>
<td>Heat Island Effect, Non-Roof</td>
<td>1</td>
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</tbody>
</table>

### Energy & Atmosphere

<table>
<thead>
<tr>
<th>Prereq</th>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>Minimum Energy Performance</td>
<td>Required</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Optimize Energy Performance 15% to 60%</td>
<td>2-10</td>
</tr>
</tbody>
</table>

### Materials & Resources

<table>
<thead>
<tr>
<th>Prereq</th>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inventories. The credit 1.1 requires a minimum of 75% of existing walls, floors, and roofs to be reused.</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 inventories. The credit 1.2 requires a minimum of 95% of existing walls, floors, and roofs to be reused.</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1</td>
<td>Construction Waste Management, Divert 50% from Disposal</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>Construction Waste Management, Divert 75% From Disposal</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4.1</td>
<td>Recycled Content, Use 10% (Post-Consumer + Half Pre-Consumer)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>Recycled Content, Use 20% (Post-Consumer + Half Pre-Consumer)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5.1</td>
<td>Regional Materials, 10% Extracted, Processed and Manufactured Regionally</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5.2</td>
<td>Regional Materials, 20% Extracted, Processed and Manufactured Regionally</td>
<td>1</td>
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</tbody>
</table>

### Indoor Environmental Quality

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Construction IAQ Management Plan, During Construction</td>
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</tr>
</tbody>
</table>

### Innovation & Design Process

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Innovation in Design, Use of High Volume supplementary Cementitious Materials.</td>
<td>1</td>
</tr>
<tr>
<td>1.2-1.4</td>
<td>Apply for other credits demonstrating exceptional performance</td>
<td>+3</td>
</tr>
<tr>
<td>2.1</td>
<td>LEED™ Accredited Professional</td>
<td>1</td>
</tr>
</tbody>
</table>

The credits are organized under the following categories: Sustainable Sites, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, and Innovation & Design Process. Each credit is assigned a certain number of points, with a total of 1-10 points required for each category.
THANK YOU!

Questions?