The concept of sustainability in construction has been undergoing constant redefinition.

Originally, much of the debate about sustainable building products revolved around the environmental friendliness of the manufacturing process. Where did the raw materials originate? Were they virgin materials or recycled? How much energy was used in their manufacture and transport to the job site? And how much waste was generated during production and installation? continued
The concept quickly evolved to encompass how the product or system performed to reduce energy usage in a building or reduce the building’s operating carbon footprint. Would the products lower energy draw and use? Utilize less water? Enhance daylighting? Reduce VOCs, improve indoor air quality and enhance worker productivity?

The added philosophy of “resilience” has now moved to the forefront. Not only must a building product be manufactured in a sustainable manner and provide environmental benefits once a building is commissioned, it must deliver those benefits over an extended period of time — with the impact of maintenance factored in. For example, a building system that promises to reduce a building’s carbon footprint 25% over an expected 50-year service life will probably be less “sustainable” than a more durable system that reduces the carbon footprint 20%, but has a 100-year lifespan and can survive extreme weather or seismic events.

The bottom line is that sustainability — no matter what you call it — is not going away. Building trends come and go. But reducing environmental impact is not a trend. It is an integral and essential part of responsible business culture. And let’s not forget the bottom line: if reducing energy usage and maintenance can reduce costs, you can rest assured that building owners will want to find ways to translate the benefits of sustainability into enhanced profitability and ROI. In fact, all of the guidelines set forth by the U.S. General Services Administration can be advanced by the proper selection of construction products:

- Optimize site potential
- Minimize non-renewable energy consumption
- Use environmentally preferable products
- Protect and conserve water
- Enhance indoor environmental quality
- Optimize operational and maintenance practices

Factory-formed precast wall panels can minimize site disruption and footprint while improving overall enclosure quality.

The Statue of Liberty Museum is raised to avoid damage from storm water and uses solid materials such as CarbonCast in the exterior for long-term durability.
The GSA continues: “Utilizing a sustainable design philosophy encourages decisions at each phase of the design process that will reduce negative impacts on the environment and the health of the occupants, without compromising the bottom line. Such an integrated approach positively impacts all phases of a building’s lifecycle, including design, construction, operation and decommissioning (www.gsa.gov/sustainabledesign).

Let’s examine some of the key sustainability features of conventional precast and CarbonCast insulated sandwich walls, which feature carbon fiber grid as a wythe connector and occasionally as secondary reinforcement in the panel face for crack control. CarbonCast was introduced to the construction market in 2004 by innovative and progressive precasters in North America and since that time has enjoyed phenomenal growth and acceptance as an enclosure system. More than 2,000 projects worldwide have been made using CarbonCast.

### Life Cycle Analysis of CarbonCast vs other exterior systems

- **Transport impact (kgCO2e)**
- **Framing impact (kgCO2e)**
- **Reinforcement impact (kgCO2e)**
- **Wall face meshing impact (kgCO2e)**
- **Shear meshing impact (kgCO2e)**
- **Interior finish impact (kgCO2e)**
- **Insulation impact (kgCO2e)**
- **Mortar impact (kgCO2e)**
- **Brick impact (kgCO2e)**
- **Block impact (kgCO2e)**
- **Finishing impact (kgCO2e)**
- **Main material impact (kgCO2e)**

Source: Verus Carbon Neutral study, 2013
Embodied energy

The calculation of the embodied energy of a building system is important to determining how sustainable it is. For example, the energy embodied in a building envelope is 8-10 times (800%–1000%) more than the annual energy used to heat and cool the building. That’s a big initial energy premium to consider. Building systems that last longer will allow a structure to avoid incurring the high embodied energy costs of a replacement system. Precast walls can perform 100 years or more, allowing you to amortize the initial energy premium longer than most wall systems in use today. Precast concrete is made from materials harvested within 500 miles of the precast plant — and often closer. (Many plants have their aggregate supply adjacent to the manufacturing facility.) Precast sandwich wall panels do use a high-carbon-footprint material: Portland cement, which is a large contributor to greenhouse gases.

Fortunately, there are ways to reduce cement usage. The first is through admixtures made from reclaimed waste materials such as silica fume or blast furnace slag. They can replace a good portion of the cement in the mix design. The use of C-GRID® wythe connectors in CarbonCast technology for insulated wall panels can further limit the use of cement. CarbonCast wall panels use insulation to replace between 20 and 33 percent of the concrete in a solid panel, with a corresponding decrease in cement use. Further, CarbonCast panels typically utilize full composite design, which means they can be made thinner and lighter (with less concrete) than conventional precast insulated sandwich wall panels that use traditional non-composite design. (See Figure 1).

PCI and CPCI have developed and issued environmental products declarations (EPDs) to offer transparency when it comes to embodied energy. They can be viewed at www.pci.org/PCI/Design_Resources/Sustainability_Resources/Environmental_Product_Declarations.aspx. On the surface, precast might not look as sustainable as more trendy alternatives. But with cement-reduction options improving each year, new technologies and a long service life, it can be argued that precast deserves a spot near the top of the sustainability list, especially when other attributes and product benefits are fully considered.

Transport to the job site

Precast concrete panels can be heavier than other exterior wall systems such as metal panels or rain screen alternatives, but weigh about the same as tilt-up or brick and block with some exceptions. Insulated CarbonCast panels can significantly reduce weight for transport and may permit more panels on a truck, leading to fewer trips to the job site. Lighter panels can also be made larger, translating into fewer connections, seams and joints depending on structural requirements.
Erection

Precast wall panels greatly minimize jobsite disruption and waste. They arrive ready to be lifted into place and installed. The potentially lighter weight of CarbonCast products can result in a smaller, less costly, downsized crane that requires less energy for operation. And the speed of erection — a fraction of site-built systems — reduces on-site labor, site congestion and commutes to and from the job site every day.

Fire Resistance

As a construction material, precast has inherent fire protection. Concrete is not a combustible material and cannot ignite and burst into flame like wood or other natural materials. Precast should be the top choice for material selection for fire and life safety. Precast can help contain fires into a controlled space, an approach called compartmentation. Precast also provides passive fire protection meaning it does not have to rely on any other systems to take action. Fire is a significant cause of loss and financial burden. Precast construction can reduce insurance premiums compared to combustible materials like wood. With precast comes peace of mind for the building owners and occupants.

Wood-framed apartment fires across the United States in cities including Boston, Raleigh, Houston, Denver, Santa Clara, and more starkly illustrate the grave life-safety risks of building with combustible wood stick and frame elements — especially in dense urban areas where fire can easily move from structure to structure.

Energy savings, thermal performance, moisture performance

Most CarbonCast Enclosure Systems feature continuous insulation to meet and exceed ASHRAE 90.1 code requirements. Additional inches of insulation can significantly reduce energy consumption to heat and cool buildings. The more vertical a building is — or the higher the ratio of exterior wall area (less windows) to roof area — the greater the potential savings. The use of carbon fiber grid as a wythe connector virtually eliminates thermal transfer through the panel, allowing the insulation to deliver its full effective R-value. When it comes to the building envelope, more insulation is the most efficient way to save money in today’s buildings.

Additionally, a wall’s thermal mass heat capacity is determined by the building materials used. Thermally efficient buildings absorb energy more slowly and then hold it longer, effectively reducing indoor temperature fluctuations and reducing overall heating and cooling requirements. Precast concrete exterior wall panels are an excellent source of thermal mass heat storage capacity and provide complementary thermal benefits. ASHRAE 90.1 acknowledges the thermal mass benefits of concrete walls in specifying lower minimum insulation R-values and higher maximum wall U-factors for mass (concrete) wall construction in specific geographic areas.

To prevent dew point temperature-driven condensation, a wall must be designed so it is free of thermal bridges with the dew point temperature of the cross-section occurring within the insulation body where free air is not present. (See Figure 2). If the dew point hits or occurs anywhere else in the wall assembly, damage via condensation and moisture accumulation can result. Properly designed CarbonCast walls can greatly mitigate the potential for condensation. Insulated precast, walls when properly designed, tend to perform very
favorably in WUFI® and other computational analyses that allow realistic calculation of heat and moisture transport in walls and other multi-layer building components exposed to weather and extreme temperature and climactic fluctuations.

**Durability**

The core of the word “sustainability” is “sustain,” which means “to endure.” Products that reduce environmental impact during production and their service life but don’t last very long are not very sustainable. They provide short-term benefits but in the long run might degrade our environment rather than help it. That’s one of the main areas where precast offers significant benefits, which are amplified by CarbonCast technology.

And as climate change turns our attention to the possibility of increasingly likely natural disaster situations, resilient design serves to remind us to design for durability over time. Few products, if any, can match the durability of precast concrete and high performance insulated sandwich walls.

Precast prestressed concrete is inherently resistant to weather events such as hurricanes and tornadoes and the high winds, storm surge and flying debris that can accompany them. Precast is often used in call centers, data centers and security complexes. It is commonly specified by FEMA for its shelters as well as other structures such as gymnasiums and auditoriums in storm-prone areas to create buildings with safe spaces that can withstand severe storms and natural disasters.

**Earthquake Resistance**

Precast is used in seismic regions all over the globe and has been proven to do well during major seismic events. Precast offers design solutions that provide a cost-effective response to significant seismic events including hybrid post-tensioned precast frames, pretensioned precast frames, and shear wall systems. Furthermore, precast concrete can be recycled back into other concrete or utilitarian products should the building need to be decommissioned.

**Blast Resistance**

Certain buildings, such as government facilities, data centers, and financial and military facilities require added protection including blast resistance. Precast is an economical construction material that can support antiterrorism/force protection (AT/FP) design. Precast panels and other precast components can be designed to support the necessary blast loads expected while protecting the people inside from both the blast and its debris.
Conclusion

Sustainability has gone from a buzzword to an everyday consideration in architecture and construction. The ability of a building system to reduce a structure’s embodied energy and operational energy usage has been augmented by the concept of resilience, which takes into account the service life of a building system and its ability to withstand the tests of time, weather, natural disasters, and everyday wear and tear.

Additional innovations to lower cement’s carbon footprint, reduce its use in concrete, or even embed carbon dioxide in the production process hold promise to make precast concrete even greener in the coming years.

The evolution of energy codes has resulted in a greater focus on long-term system performance. Precast insulated wall panels with carbon fiber grid offer many benefits that wholly embrace the concept of resilience. Their long-term performance will provide a lifetime of benefits and fulfill the evolving scope of sustainability for decades to come.

For more information, go to altusprecast.com and learn how CarbonCast® can deliver resilience for your project as well as lasting performance that generate positive ROI.

Call us today to speak with a technical representative or request a lunch-and-learn program.

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