Sustainable Precast concrete construction

1. What is sustainability and why is it important?

- The United Nations defined sustainable development "Sustainable development is that which meets the needs of the present without compromising the ability of future generations to meet their own needs."
- A growing global population is straining the finite resources available on the planet.
- Sustainability seeks to balance the economic, social, and environmental impacts, recognizing that population growth will continue.
- Sustainable development brings this evaluation to the design and construction industries, which have significant potential to reduce the negative impact of human activities on the environment.

2. Why is there demand for sustainable development?

- According to the U.S. Green Building Council (USGBC), buildings in the United States alone consume nearly 10% of the world's energy.
- With energy costs increasing, and concerns about environmental impact growing, need is to adopting green building programs. In addition, an increasing number of countries are offering tax benefits for green public buildings, and large corporations are moving toward sustainable design for their facilities to reduce operations and maintenance costs.


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3. What is a green building?

- The green buildings can be defined as those that:
- demonstrate the efficient use of energy, water, and materials
- limit impact on the outdoor environment
- provide a healthier indoor environment
- Studies show that green buildings offer improved air quality and more access to daylight in addition to energy and cost savings. The USGBC estimates that green buildings cost 8% to 9% less to operate, and have a 7.5% greater building value.

4. What is the cost premium for a green building?

- The studies cites an initial cost premium of anywhere from 0% to 2% for green buildings.
- As project teams become more experienced with building green, these costs should decrease. Generally, a 2% increase in construction costs will deliver a savings of 10 times the initial investment in operating costs for utilities (energy, water, and waste) in the first 20 years of the building's life.

5. What is the payback for a sustainable building project?

- The financial payback of green building practice is measured in operating and maintenance savings over time offsetting initial costs of sustainable features. The payback varies from project to project, depending on the implemented sustainable features and other factors such as availability of materials and expertise of the design team. However, experienced design professionals maintain that green buildings do not have to cost more than non-green buildings.
- Guidebook to Sustainable Design

6. How can I measure the costs and benefits of sustainable design?

- Most project teams perform a comprehensive life-cycle cost assessment (LCC) prior to defining their sustainable goals for the project. The LCC predicts how long it will take to recoup additional first cost.

Sustainability and Precast Concrete

1. Is precast concrete a green building material?

- Precast concrete contributes to green building practices in significant ways.
- The low water-cement ratios possible with precast concrete -0.36 to 0.38- mean it can be extremely durable.
- The thermal mass of concrete allows shifting of heating and cooling loads in a structure to help reduce mechanical-system requirements.
- Because precast concrete is factory-made, there is little waste created in the plant (most plants employ exact-batching technologies) and it reduces construction waste and debris on site, reducing construction IAQ concerns.
- The load-carrying capacities, optimized cross sections, and long spans possible with precast concrete members help eliminate redundant members, and concrete readily accommodates recycled content.

2. What makes precast concrete so durable?

- The primary ingredients of concrete -sand, gravel, and cement- are mineral based. When mixed with water, the cement chemically reacts to create a crystalline matrix with a high compressive strength. This matrix binds the sand and gravel together, creating concrete. Unlike other construction materials that can rust, rot, or otherwise degrade when in the presence of moisture, concrete can actually get stronger if there are unhydrated cement particles available to react with the water.

3. Is precast concrete different from other types of concrete?

- Precast concrete is different because it is made in a factory by highly experienced personnel who apply stringent quality-control measures. In the factory environment,
- precasters are able to achieve consistency in temperature and moisture and low watercement ratios that are not possible in field-fabricated concrete. Precast concrete can easily attain strengths of 5000 psi to 7000 psi or more, with densities that minimize permeability.

4. Is precast concrete energy-efficient?

- The thermal mass of precast concrete absorbs and releases heat slowly, shifting air conditioning and heating loads to allow smaller, more efficient heating, ventilating, and air conditioning (HVAC) systems.
- Insulation is often used in architectural panels and sandwich wall panels to increase thermal efficiency, with continuous insulation (ci) in walls being possible. The resulting savings are significant up to 25% on heating and cooling costs.

5. Does precast concrete contain recycled materials?

- Precast concretes fresh and in-place performance can improve when several common industrial byproducts are added. Fly ash, slag, and silica fume, which would otherwise go to landfills, can be incorporated into concrete as supplementary materials.
- These by-products can also reduce the amount of cement that is used in concrete.
- Reinforcement is typically made from recycled steel. (Steel is one of the most recycled building materials, and can be reused again and again.) Insulation and connections within the precast concrete also contain recycled content.

6. Can precast concrete members be reused?

- Precast concrete members are unique in that they are individually engineered products that can be disassembled. Designers can easily plan future additions to buildings, because the precast concrete components can be rearranged. Once removed, precast concrete members may be reused in other applications.
- Precast concrete is also friendly to down cycling, in which building materials are broken down, because it comes apart with a minimum amount of energy and retains its original qualities.
- An example of down cycling would be the use of crushed precast concrete as aggregate in new concrete or as base materials for roads, sidewalks, or concrete slabs.

Manufacturing

1. How is precast concrete made?

- Precast concrete is made in a factory, where a dedicated batch plant produces a specially designed concrete for precast products such as structural beams, columns and double tees, architectural cladding, and wall systems. Aggregates usually come from nearby quarries, and cement and other ingredients are often supplied by local manufacturers.
- The mixed concrete is placed into a form around reinforcement and, often, prestressing strands that provide load-resisting camber to the finished precast concrete member. After the member is cured, the precast concrete product is stripped from the form and moved to the precasters yard for finishing and storage prior to shipping to the jobsite.

2. What steps are precast operations taking toward sustainability?

- PCI Producer Members meet local and state ordinances and emissions requirements. Initiatives within the industry include:
- Use of local materials in all mixtures; local aggregate resources
- Water reclamation and recycling
- Reducing cement requirements by lowering watercement ratios
- Admixtures such as hardening accelerators to eliminate applied heat in curing
- Use of self-consolidating concrete (SCC) for quicker placement, no vibration, and reduced surface defects
- Use of environmentally friendly thin brick in place of conventional brick in precast concrete systems
- Carbon-fiber reinforcement that allows lighter and larger concrete sections with less embedded energy and no corrosion
- Use of supplemental cementitious materials (SCMs) to reduce cement consumption; participation in Cool Climate Concrete
- Enclosed sandblasting facilities with 100% process-waste control
- Standardizing wood form parts for multiple reuse; recycling discarded forms into mulch or fuel
- Recycling all scrap steel and reinforcement
- Reducing and reusing product packaging received in facilities

3. How much cement is in precast concrete?

- Typical concrete contains approximately 10% to 12% cement by volume. The cement chemically reacts with water to bind together the aggregates and other ingredients of the concrete. According to the Department of Energy (DOE), cement production contributes between 1% and 2% of global carbon dioxide emissions through the burning of fossil fuels and process-related emissions.
- The amount of cement used in precast concrete may be reduced by up to 60% through substitution by supplementary cementitious materials (SCMs). The amount of cement substitution possible is affected by the mixture design requirements, the products and processes of individual precast concrete manufacturers and plants, and the local availability of materials.

4. What is being done about CO2 emissions during the cement-manufacturing process?

- Since 1975, the cement industry has reduced CO2 emissions by 33%. Today, cement production accounts for less than 1.5% of carbon dioxide emissions, well below other sources such as electric generation plants for heating and cooling the homes and buildings we live in (33%) and transportation (27%).
- In 2000, the cement industry created a new way to measure CO2 emissions. Recently introduced guidelines will allow for greater use of limestone as a raw material in cement, ultimately reducing CO2 by more than 2.5 million tons per year. By the year 2020, plans call for further reduction of CO2 emissions to 10% below the 1990 baseline through investments in equipment, improvements in formulations, and development of new applications for cements and concretes that improve energy efficiency and durability.

Precast Concrete Contributions to Sustainability

1. How does precast concrete contribute to Sustainability

- Precast concrete:
- minimally disrupts the site (area and time)
- reduces damage to drainage paths and natural habitats
- increases open area when multi-level parking structures are used
- reduces the heat-island effect because of concrete's light color
- improves energy efficiency and thermal comfort
- reuses and recycles formwork, keeping materials out of the landfill
- uses recyclable concrete and steel
- can be reused or recycled
- can use waste and recycled materials such as slag, fly ash, and silica fume
- is generally made from materials that are extracted and manufactured regionally
- does not off-gas, and does not need to be sealed or painted


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2. How can precast concrete reduce the heat-island effect

- Sustainable Sites reduce heat islands,
- meaning the thermal gradient difference between developed and undeveloped areas. The heat-island effect is partially attributed to the dark surfaces of roofing and paving, and the additional heat in developed areas increases HVAC loads and contributes to the creation of smog.
- Reducing heat islands minimizes impact on microclimate and human and wildlife habitat.
- Precast concrete parking structures that place at least 50% of the spaces under cover (for example, underground, under a building, or under a deck or roof) can reduce this effect. Any roof used to shade or cover parking must have a solar reflective index (SRI or albedo) of at least 29. In addition, high-albedo vertical precast concrete wall surfaces reduce the heat-island effect.

3. How can precast concrete contribute to Innovation and sustainable Design

- Projects earn Innovation and Design when they demonstrate exemplary performance in a recognized area, or bring new approaches and technologies such as carbon-fiber reinforcing that reduce weight and embedded energy and advance sustainable design. Because of its inherent green characteristics, precast concrete offers an excellent platform on which creative project teams can base their sustainable design plans.

4. How does precast concrete contribute to the underlying sustainability concept of "Reduce, Reuse, Recycle"?

- By reducing the amount of materials and the toxicity of waste materials
- Precast concrete can be designed to optimize (lessen) the amount of concrete used in a structure or element
- As one example, the use of carbon-fiber reinforcement or insulation can reduce:
- Amount of concrete needed in a precast concrete panel
- Weight of a precast concrete panel

- Transportation cost of precast concrete panel
- Amount of energy used to erect a precast concrete panel
- Precast concrete generates low amounts of waste with low toxicity
- 2% of the concrete at a precast plant is waste
- 95% of the waste is used to manufacture new panels
- By reusing products and containers and repairing what can be reused
- Precast concrete panels can be reused when buildings are expanded or dismantled

- Concrete pieces from demolished structures can be reused to protect shorelines
- Wood or fiberglass formwork used to make precast concrete products is generally reused 40 or more times
- Concrete and steel have practically unlimited service lives
- By recycling as much as possible, including buying products with recycled content
- Industrial wastes (fly ash, slag, and silica fume) can be used as partial replacements for cement
- Wood and steel forms are recycled when they become worn or obsolete
- Virtually all reinforcing steel is made from recycled steel
- Insulation contains partially recycled material
- Concrete in most urban areas is recycled as fill or road base


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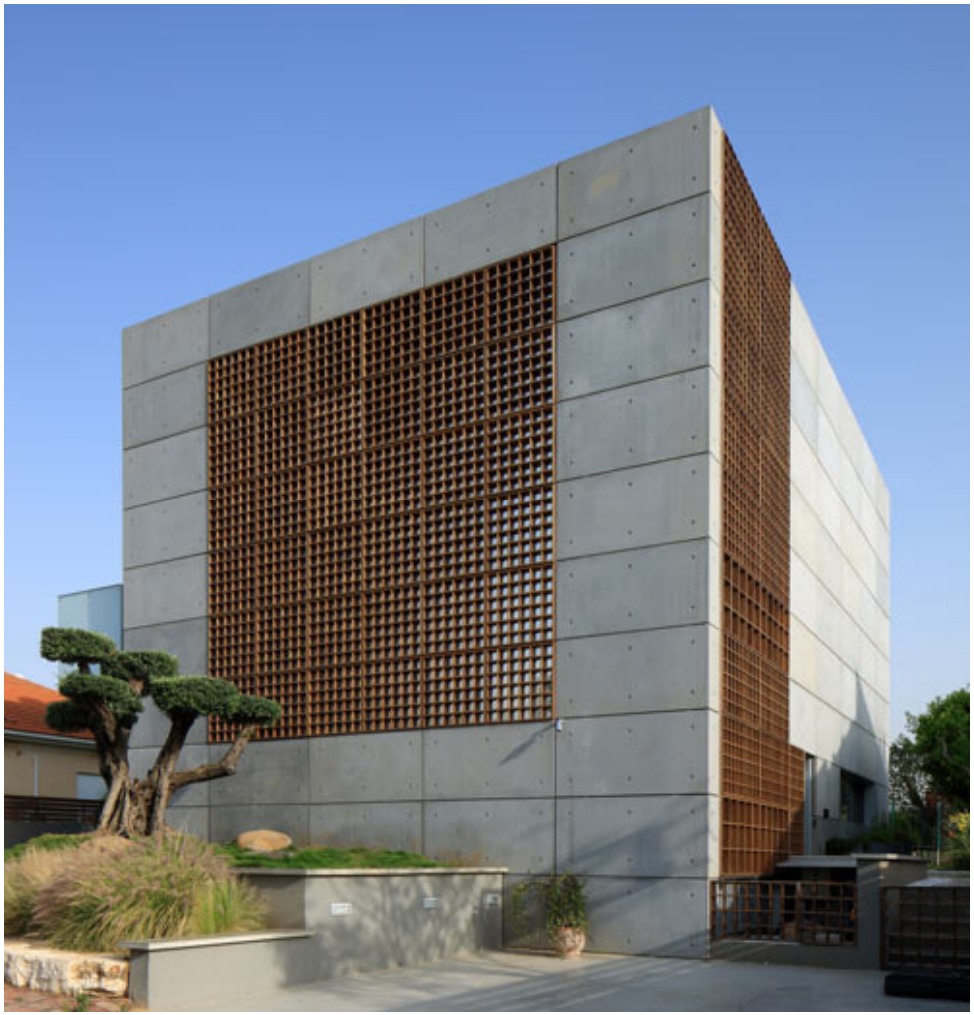

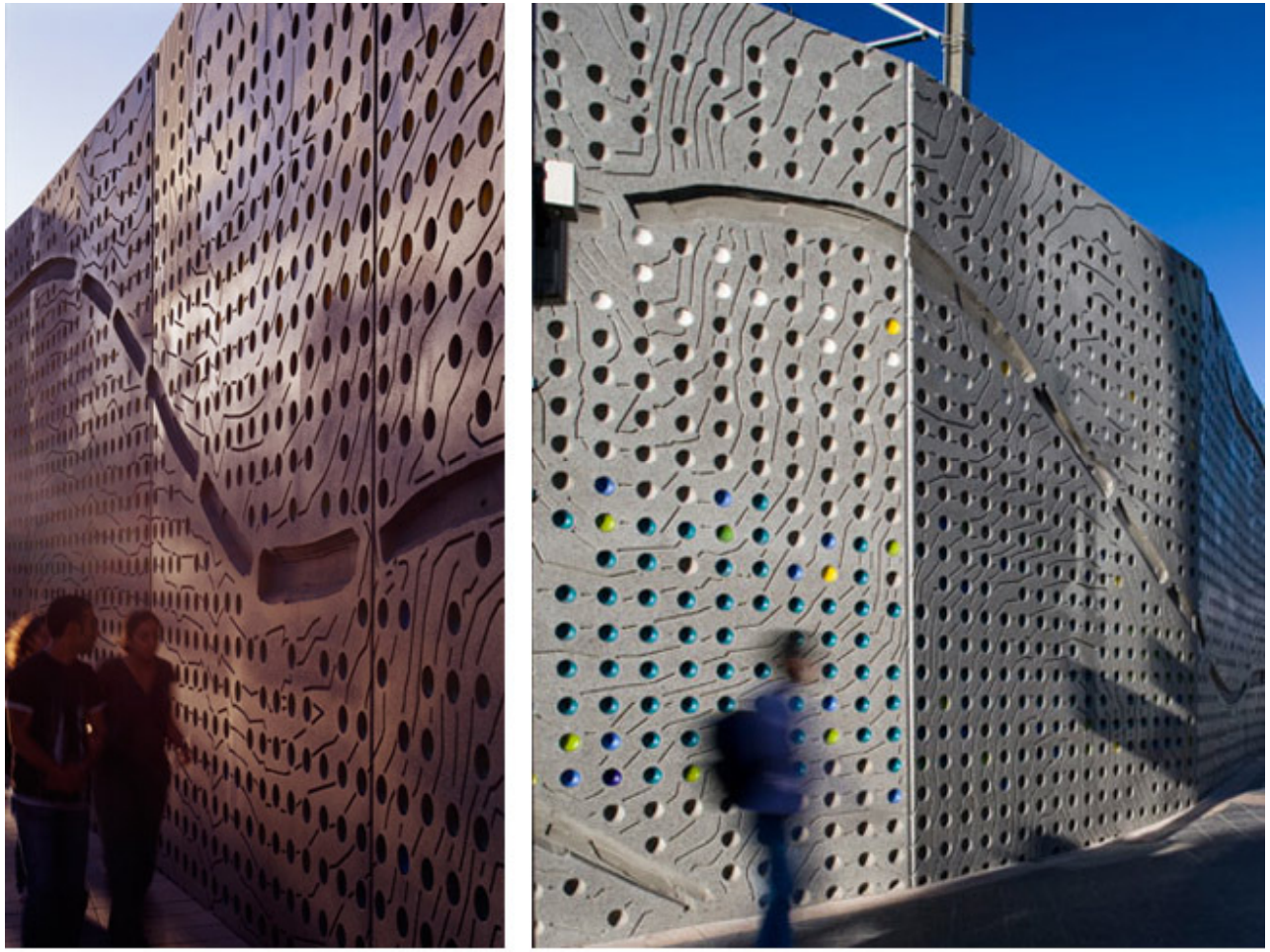

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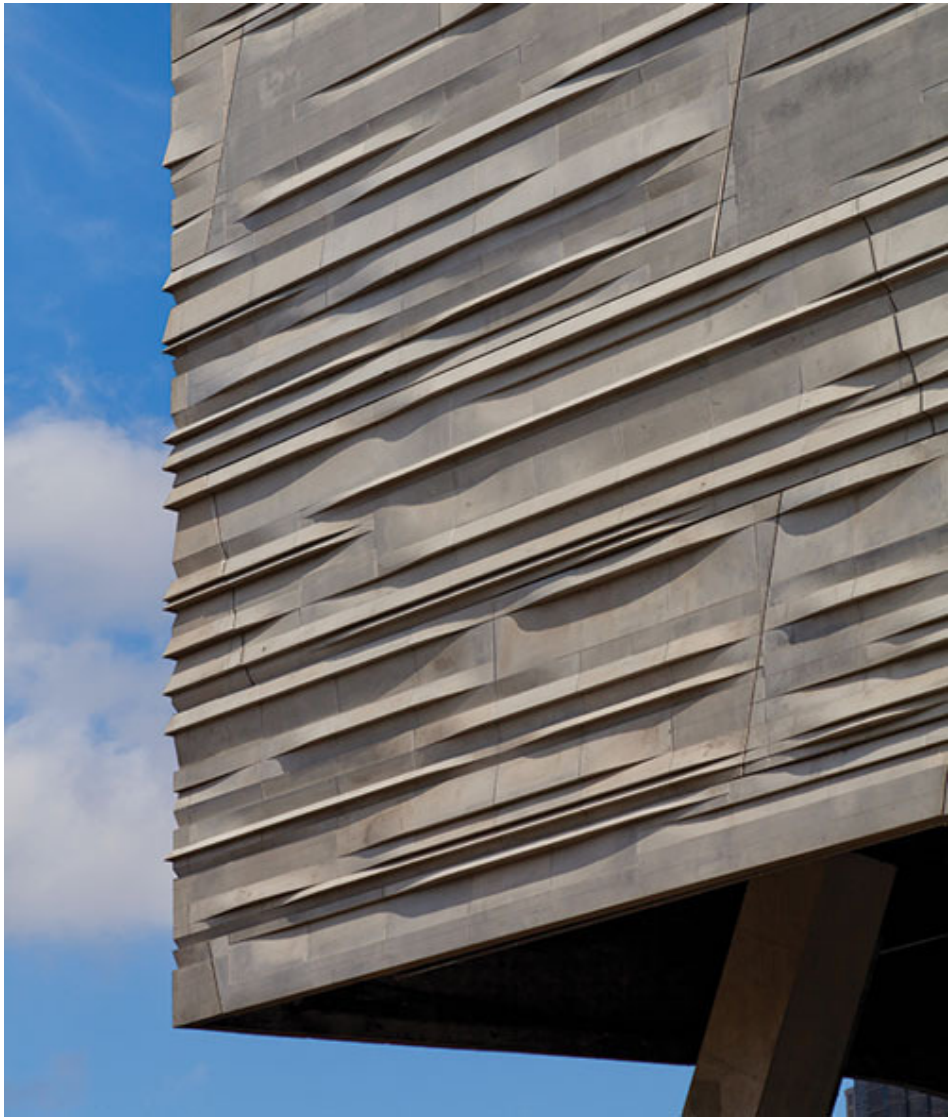

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