

Designer's

NOTEBOOK



SUSTAINABILITY

Sustainability Concepts

Sustainability is often defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Worldwide, people are currently using 20% more resources than can be regenerated. In particular, the U.S. population consumes more resources on a per capita basis than any other nation.

The environmental impact of constructing and operating buildings in most countries is significant. Consider that buildings consume 65% of the electricity generated in the U.S. and more than 36% of the primary energy (such as natural gas); produce 30% of the national output of greenhouse gas emissions; use 12% of the potable water in the U.S.; and employ 40% of raw materials (3 billion tons annually) for construction and operation worldwide.¹

Building materials can have a significant effect on the environmental impact of the construction and operation of a building. Some materials may have to be used in special configurations, or employ different combinations, to achieve sustainability; the inherent properties of precast concrete, however, make it a natural choice for achieving sustainability in buildings. Precast concrete contributes to sustainable practices by incorporating integrated design, using materials efficiently, and reducing construction waste, site disturbance, and noise.

Although most consumers are concerned with the present and future health of the natural environment, few are willing to pay more for a building, product, process, or innovation that minimizes environmental burdens. The concept of sustainability, however, balances sustainable design with cost-effectiveness. Using integrated design (also called holistic or whole building approach), a building's materials, systems, and design are examined from the perspective of all project team members and tenants. Energy efficiency, cost, durability (or service life), space flexibility, environmental impact, and quality of life are all considered when decisions are made regarding the selection of a building design.

Triple bottom line

The triple bottom line — environment, society, and economy — emphasizes that economic consequences are related to environmental and social consequences. Consequences to society include impacts on employees, communities, and developing countries, as well as ethics, population growth, and security. Reducing material, energy, and emissions used by buildings has impacts

¹ U.S. Green Building Council, "An Introduction to the U.S. Green Building Council and the LEED Green Building Rating System," PowerPoint presentation on the USGBC website, October 2005, www.usgbc.org.

Table 1 Integration Strategies.

INTEGRATION STRATEGY	SUSTAINABILITY ATTRIBUTE
Use precast concrete panel as interior surface.	Saves material; no need for additional framing and drywall.
Use hollow-core panels as ducts.	Saves material and energy; eliminates ductwork and charges thermal mass of panel.
Use thermal mass in combination with appropriate insulation levels in walls.	Thermal mass with insulation provides energy benefits that exceed the benefits of mass or insulation alone in most climates.
Design wall panels to be disassembled for when building function changes.	Saves material; extends service life of panels.
Use durable materials.	Materials with a long life cycle and low maintenance will require less replacement and maintenance during the life of the building.
Use natural resources such as daylight as a source for building lighting, trees for shading, and natural ventilation	Reduces lighting and cooling energy use. Increases indoor air quality and employee productivity.
Reduce and recycle construction waste.	Reduces transportation and disposal costs of wastes. Less virgin materials are used if construction waste is recycled for another project.
Use building commissioning quality control, and inspections to ensure that building standards are met.	Energy savings and indoor air quality are most likely attained during the building life if inspections are made to ensure construction was completed as designed.

far beyond those of the buildings themselves, such as:

- Using less materials means fewer new quarries are needed.
- Using less energy means fewer new power plants need to be constructed, less pollution is emitted into the air, and dependence on foreign energy sources is reduced.
- Less emissions to air means a reduction in respiratory conditions, such as asthma.
- Using less water means a reduction in demands on the infrastructure to find and deliver new sources of water.

All of these examples indicate how building energy and utility use affect the local community. These are especially important since most communities do not want new power plants, quarries, or landfills built near them.

The community can also be considered globally. Carbon dioxide (CO₂) emissions in the U.S. were reduced in 2002 for the first time; this reduction, however, was due to a decrease in manufacturing and a stagnant economy. That same year, China's production of CO₂ increased by more than the reduction realized in the U.S., but this increase was primarily due to production of materials consumed by U.S. citizens. Energy and material consumption, waste, and emissions to air, land, and water need

to be considered from a global as well as regional perspective in a global market.

Cost of building green

A sustainable design can result in reduced project costs and a building that is energy and resource efficient. Energy and water efficient buildings have lower operating costs (in the range of \$0.60 to \$1.50 versus \$1.80 per sq ft) and a higher facility value than conventional buildings.² Lower energy costs translate into smaller capacity requirements for mechanical equipment (heating and cooling) and lower first costs for such equipment. Effective use of daylighting and passive solar techniques can further reduce lighting, heating and cooling costs. Reusing materials, such as demolished concrete for base or fill material, can reduce costs associated with hauling and disposing of materials.

When sustainability is an objective at the outset of the design process, the cost of a sustainable building is competitive. Often green buildings cost no more than conventional buildings because of the resource-efficient strategies used, such as downsizing of more costly mechanical, electrical, and structural systems. Reported increases in first costs for green buildings range from 0 to 2% or more, with costs expected to decrease as project

² U.S. Green Building Council, "An Introduction to the U.S. Green Building Council and the LEED Green Building Rating System," PowerPoint presentation on the USGBC website, October 2005, www.usgbc.org.

Glossary

Admixture: material, other than water, aggregate, and hydraulic cement, used as an ingredient of concrete, mortar, grout, or plaster and added to the batch immediately before or during mixing. Chemical admixtures are most commonly used for freeze-thaw protection, to retard or accelerate the concrete setting time, or to allow less water to be used in the concrete.

Albedo: solar reflectance; see reflectance.

Building envelope: the components of a building that perform as a system to separate conditioned space from unconditioned space.

Calcination: process of heating a source of calcium carbonate, such as limestone, to high temperatures, thereby causing a chemical reaction that releases CO₂. This CO₂ is not related to the fuel used to heat the calcium carbonate.

Cement: see portland cement.

Cementitious material (cementing material): any material having cementing properties or contributing to the formation of hydrated calcium silicate compounds. When proportioning concrete, the following are considered cementitious materials: portland cement, blended hydraulic cement, fly ash, ground granulated blast-furnace slag, silica fume, calcined clay, metakaolin, calcined shale, and rice husk ash.

Concrete: mixture of binding materials and coarse and fine aggregates. Portland cement and water are commonly used as the binding medium for normal concrete mixtures, but may also contain pozzolans, slag, and/or chemical admixtures.

Emittance: the ability of the material to emit, or “let go of” heat.

Green buildings: buildings designed considering the concepts of sustainable design and reduction of environmental impacts due to site selection, water use, energy use, materials and resources, the building’s impact on the environment, and indoor air quality.

Greenhouse gas emissions: emissions that have the potential to increase air temperatures at the earth’s surface, including carbon dioxide, methane, nitrous oxide, CFCs, water vapor, and aerosols (particles of 0.001 to 10µm diameter).

Portland cement: Calcium silicate hydraulic cement produced by pulverizing portland-cement clinker, and usually containing calcium sulfate and other compounds.

Pozzolan: siliceous or siliceous and aluminous materials, like fly ash or silica fume, which in itself possess little or no cementitious value but which will, in finely divided form and in the presence of moisture, chemically react in the presence of portland cement to form compounds possessing cementitious properties.

Reflectance: the ratio of the amount of light or solar energy reflected from a material surface to the amount shining on the surface. Solar reflectance includes light in the visible and ultraviolet range. For artificial lighting, the reflectance refers to the particular type of lighting used in the visible spectrum.

Silica fume: very fine noncrystalline silica which is a byproduct from the production of silicon and ferrosilicon alloys in an electric arc furnace; used as a pozzolan in concrete.

Slag cement (Ground granulated blast-furnace slag): a nonmetallic hydraulic cement consisting essentially of silicates and aluminosilicates of calcium developed in a molten condition simultaneously with iron in a blast furnace. Slag cement can be used as a partial replacement or addition to portland cement in concrete.

Supplementary cementitious materials: materials that when used in conjunction with portland cement contribute to the properties of hardened concrete through hydraulic or pozzolanic activity or both.

Sustainability: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.¹ In more tangible terms, sustainability refers to the following: not compromising future quality of life; remediating environmental damage done in the past; and recognizing that our economy, environment, and social well-being are interdependent.

Sustainability rating systems: a set of criteria used to certify that a construction, usually a building, is sustainable, green, or energy-conserving.

Thermal mass: the storage properties of concrete and masonry that result in a reduction and shift in peak energy load for many buildings in many climates, compared to wood or metal frame structures.

Urban heat island: microclimates near urban or suburban areas that are warmer than surrounding areas due to the replacement of vegetation with buildings and pavements.

teams become more experienced with green building strategies and design.³ Generally, a 2% increase in construction costs will result in 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.

Buildings with good daylighting and indoor air quality — both common features of sustainable buildings — have increased labor productivity, worker retention, and days worked. These benefits contribute directly to a company’s profits because salaries — which are about ten times higher than rent, utilities, and maintenance combined — are the largest expense for most companies occupying office space.⁴ In schools with good daylighting and indoor air quality, students have higher test scores and lower absenteeism.

Holistic/integrated design

A key tenet of sustainable design is the holistic or integrated design approach. This approach requires coordinating the architectural, structural, and mechanical designs early in the schematic design phases to discern possible system interactions, and then deciding which beneficial interactions are essential for project success. For example, a well-insulated building with few windows that face east and west will require less heating and air-conditioning. This could impact the mechanical design by requiring fewer ducts and registers and perhaps allow for the elimination of registers along the building perimeter. Precast concrete walls act as thermal storage to delay and reduce peak loads, while also positively affecting the structural design of the building. Table 1 provides other integrated design strategies.

A holistic viewpoint will also take into account the surrounding site environment:

- Are shelters needed for people who take public transportation to work?
- Can bike paths be incorporated for those who bike to work?
- Can native landscaping be used to reduce the need for irrigation?

The eight elements of integrated design are:

1. Emphasize the integrated process.
2. Consider the building as a whole — often interactive, often multi-functional.
3. Focus on the life cycle.
4. Have disciplines work together as a team from the start.
5. Conduct relevant assessments to help determine requirements and set goals.
6. Develop tailored solutions that yield multiple benefits while meeting requirements and goals.
7. Evaluate solutions.
8. Ensure requirements and goals are met.

Contracts and requests for proposals (RFPs) should clearly describe sustainability requirements and project documentation required.⁵

3R’s – reduce, reuse, recycle

The 3R’s of reducing waste can be applied to the building industry.

Reduce the amount of material used and the toxicity of waste materials.

Precast concrete can be designed to optimize (or lessen) the amount of concrete used. Industrial wastes such as fly ash, slag cement, and silica fume can be used as partial replacements for cement with certain aesthetic (color) and stripping

¹ World Commission on Environment and Development, “Report on Our Common Future,” Oxford University Press, New York, NY, 1987.

³ Green Value, *Green Buildings Growing Assets*, www.rics.org/greenvalue.

⁴ U.S. Green Building Council, “Making the Business Case for High Performance Green Buildings,” www.usgbc.org.

⁵ Portland Cement Association, website for sustainable solutions using concrete, www.concretethinker.com

