innovations in concrete

the alternatives

Research into more sustainable concrete manufacture and construction is essential as worldwide demand for and usage of concrete increases. Alternative methods of reinforcing concrete can enhance its performance in a variety of areas. Of particular interest is Ferro-cement construction, which involves reinforcing concrete with wire-mesh and narrow rebar, and can be used to make wall panels, ceiling and floor slabs and roofs. The advantages of Ferro-cement construction are that it is possible to build thinner walls and slabs, which are lighter and can be assembled by just a few of workers. Ferro-cement components can be manufactured in informal settings at low-cost and may be a good option for relief housing due to its flexural strength and lighter weight.

Apartment house under construction using ferro-cement in Dominican Republic © EcoSur

Concrete recycling is another way of reducing the environmental impacts of the material. Recycling concrete takes the aggregate left when buildings and other concrete structures such as roadways, highways and sidewalks are demolished, and uses it to replace natural aggregates like stone, sand and gravel. The advantages of using recycled concrete aggregate are that it is lighter weight and produces a higher yield per unit weight, reduces landfill waste, and often outperforms natural aggregates in concrete products.

Green Materials Technical Notes Series

UN-Habitat promotes the use of green building materials within the context of slum upgrading, large scale affordable housing, social housing, and reconstruction in developing countries and emerging economies. UN-Habitat supports the adoption of green materials in mainstream building based on affordability and capacity to uphold the 4 dimensions of sustainability. UN-Habitat also encourages governmental support for alternative building materials, which may include adaptations to building codes and providing subsidies.

contact

United Nations Human Settlements Programme
P.O. Box 30030, Nairobi 00100, Kenya
Tel: +254-20-7623120
Fax: +254-20-76234266/7
infohabitat@unhabitat.org
www.unhabitat.org

Global Network for Sustainable Housing
www.gnshousing.org

resources

Information adapted from "Going Green: A Handbook of Sustainable Housing Practices in Developing Countries". 2012 UN-Habitat: Nairobi

EcoSur
www.english.ecosur.org

Construction Materials Recycling Organization
Concrete Reccling - www.concreterecycling.org

Concrete Mix Ratio Sources:
"Sugar Cane Ash" – Niels Bohr Institute (wwwnbi.ku.dk)
"Concrete without sand?" - http://www.downtoearth.org.
"ACI Method Concrete Mix Design" - http://www.aboutcivil.org

Green Materials
CONCRETE

Concrete is the most used man-made material in the world with twice as much concrete used in construction than wood, steel, plastic and aluminum combined. Although concrete has acquired a negative image due to environmental impacts that occur at various stages of its production, sustainable use of concrete is possible by using alternative stablizers and construction techniques and restricting usage to certain building parts. Given that the use of concrete is not likely to decline, it is important that more sustainable techniques of using concrete continue to be researched and promoted.

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environmental

Concrete is an important material for constructing durable and energy efficient buildings. Since concrete looses little strength over time and is not susceptible to water damage, mold or pests, concrete structures have proven to be some of the longest lasting in the world.

On the opposite end, however, concrete's negative reputation stems primarily from the production of Portland cement, but also includes its high embodied energy from its production. Other disadvantages of concrete are that it often requires steel for reinforcement, the production of which has negative environmental impacts and has minimal insulation value (though this can be improved using lightweight concrete under the ceiling in warm climates and extra insulation in cold climates).

cultural

Using concrete in a culturally sustainable manner is rather difficult and may in fact even undermine traditional ways of building. Therefore, when working with concrete it is important to be culturally considerate in the spatial layout and design of the project.

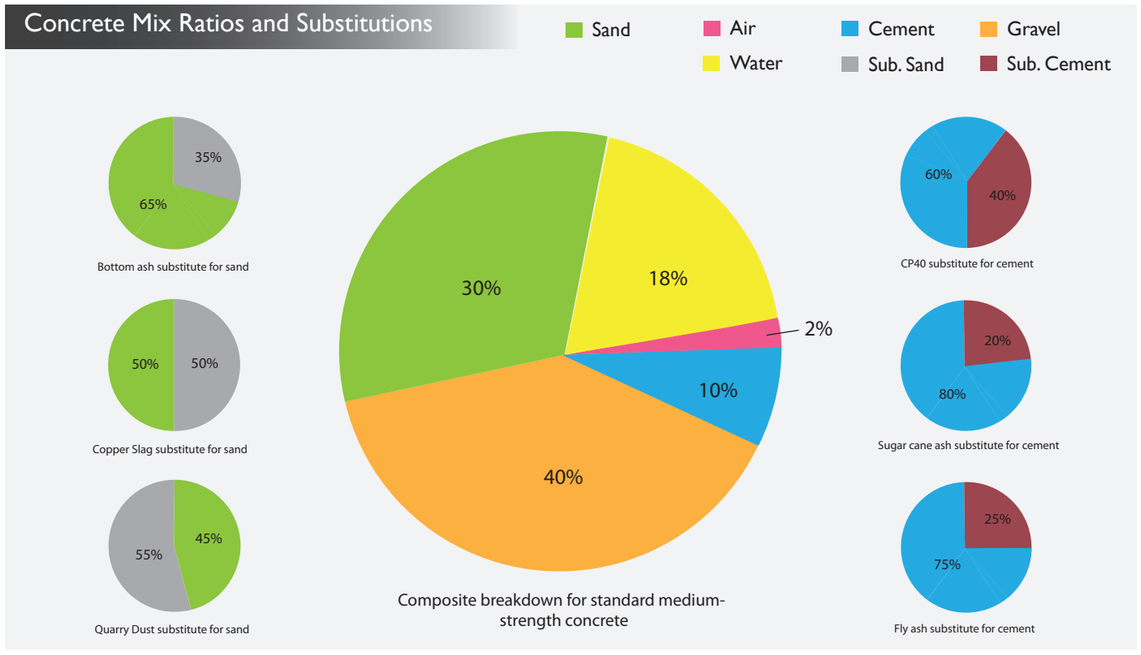
social

The making of concrete and concrete products can be an inclusive social activity. Since concrete is usually mixed on-site and needs only a few trained workers, production sites can be successfully implemented with sufficient equipment and technical training. Concrete also has an important role in sustainable development since many types of infrastructure such as roads and drainage systems usually rely heavily on the material.

economic

The production of local building materials using concrete can create opportunities for small businesses to develop in low-income communities and stimulate local economic activity. Examples of these are workshops that produce micro-concrete roofing tiles, which can enter into both formal and in formal markets, since there is great demand for quality roofing material across communities of various income levels. Durable roofs also relieve families of the cost-burden of frequenlty replacing inadequate ones.

Governments can make sustainable usage of concrete more feasible by providing subsidies for alternative stabilizers or facilitating access to industrial waste. This provides incentives to continue sustainable concrete practices by making them more accessible and less expensive.



a composite material

Concrete is a composite material made by mixing cement, sand and water, though the particular ratio of each component varies slightly between climates. While these have been the traditional ingredients of concrete both Portland cement and sand may be replaced or supplemented with substitute materials that can enhance certain properties of concrete including its environmental sustainability.

Micro-concrete roof tiles in Nicaragua. © EcoSur

cement

Portland cement has been the primary target of the criticism of concrete since its production releases numerous airborne pollutants and requires large amounts of energy. Substitute materials, however, can partially replace Portland cement and reduce its overall environmental impact. Such replacements include a mixture of lime and pozzolana (industrial waste like fly ash and foundry slag or natural materials like volcanic sands) known as CP40, which has half the embodied energy of cement and can replace it by as much as 40 percent. CP40 is ideal for smaller scale workshops since it can be produced on-site at a low market price.

fly ash

Fly ash, a by-product of coal combustion, can also partially substitute cement by up to 25%. Likewise, materials that can replace sand in cement production include bottom ash (another by-product of coal combustion) and foundry sand. These materials can make up 25%-35% of sand in cold and warm climates respectively.

A house being constructed using ferro-cement panels in Nicaragua. © EcoSur

While criticism of concrete mostly targets cement, the accelerated (and ultimately unsustainable) sourcing of sand and rock suggests that the discussion around the greening of concrete is incomplete without considering the other materials that make up 70% percent of it.

sourcing

Responsible sourcing of materials used to make concrete is another consideration that affects effects its overall sustainability. Within the past few years certification systems such as the BES 6001 Responsible Sourcing of Construction Products and the Sustainable Concrete Plant Certification Scheme, have set guidelines for responsible sourcing practices at all stages of the supply chain. These systems set frameworks for companies to assess their claims of sustainable sourcing, and also allow producers to receive third-party examination to further validate their practices.