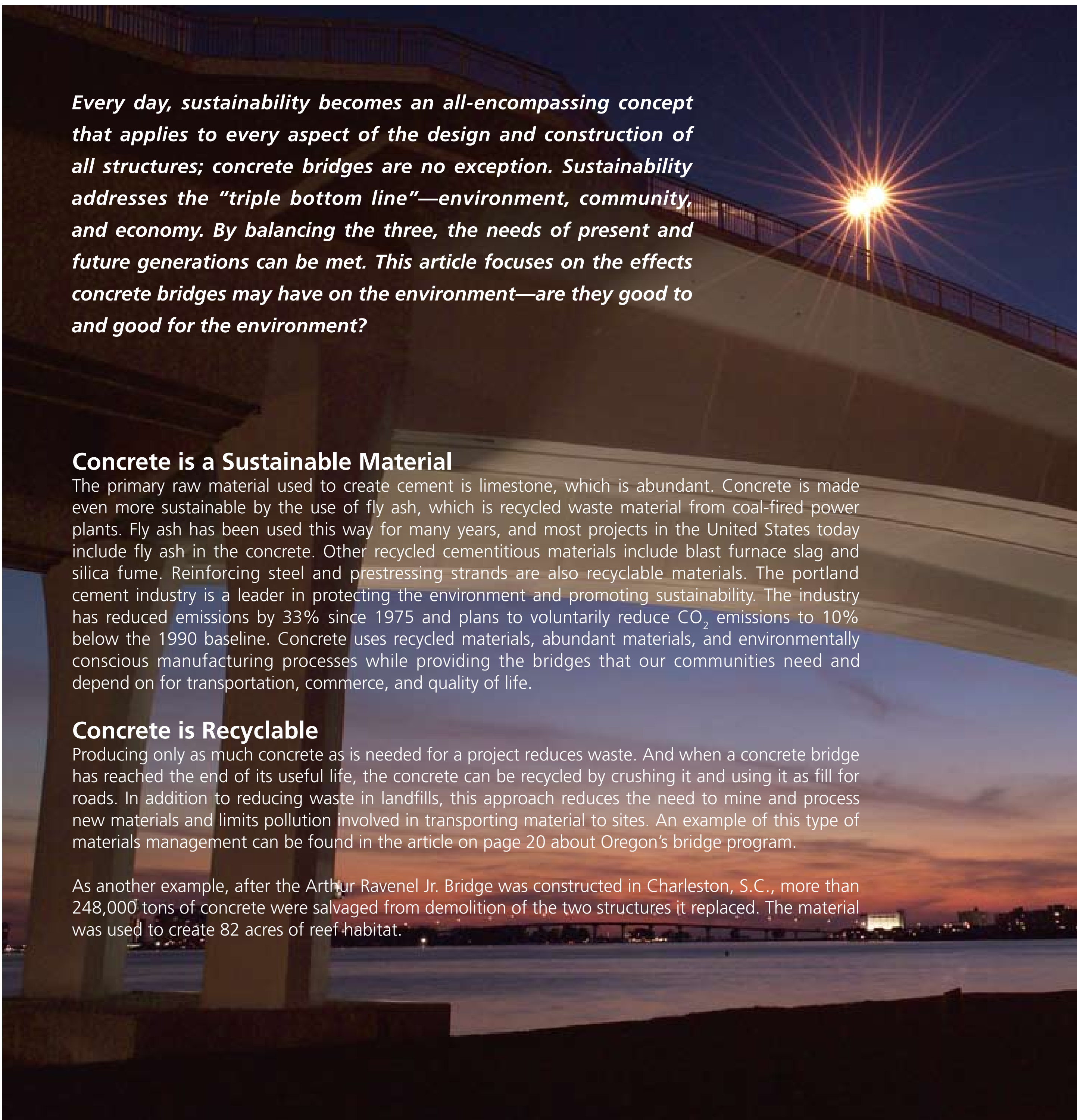
ENVIRONMENTAL Benefits of Concrete Bridges



Every day, sustainability becomes an all-encompassing concept that applies to every aspect of the design and construction of all structures; concrete bridges are no exception. Sustainability addresses the "triple bottom line"—environment, community, and economy. By balancing the three, the needs of present and future generations can be met. This article focuses on the effects concrete bridges may have on the environment—are they good to and good for the environment?

Concrete is a Sustainable Material

The primary raw material used to create cement is limestone, which is abundant. Concrete is made even more sustainable by the use of fly ash, which is recycled waste material from coal-fired power plants. Fly ash has been used this way for many years, and most projects in the United States today include fly ash in the concrete. Other recycled cementitious materials include blast furnace slag and silica fume. Reinforcing steel and prestressing strands are also recyclable materials. The portland cement industry is a leader in protecting the environment and promoting sustainability. The industry has reduced emissions by 33% since 1975 and plans to voluntarily reduce CO_2 emissions to 10% below the 1990 baseline. Concrete uses recycled materials, abundant materials, and environmentally conscious manufacturing processes while providing the bridges that our communities need and depend on for transportation, commerce, and quality of life.

Concrete is Recyclable

Producing only as much concrete as is needed for a project reduces waste. And when a concrete bridge has reached the end of its useful life, the concrete can be recycled by crushing it and using it as fill for roads. In addition to reducing waste in landfills, this approach reduces the need to mine and process new materials and limits pollution involved in transporting material to sites. An example of this type of materials management can be found in the article on page 20 about Oregon's bridge program.

As another example, after the Arthur Ravenel Jr. Bridge was constructed in Charleston, S.C., more than 248,000 tons of concrete were salvaged from demolition of the two structures it replaced. The material was used to create 82 acres of reef habitat.

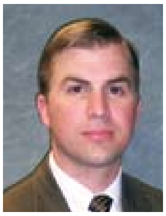


Photo: Scott Dobry.

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Concrete Creates Long-Lasting Structures

Concrete can withstand a wide range of environmental challenges, from temperature extremes to corrosive environments. Concrete is made even stronger through the use of the previously mentioned recycled cementitious materials. As a result, concrete bridges can have service lives approaching or exceeding 100 years.

The concrete industry is continually improving material quality and capabilities, and bridge designers are finding new and innovative ways to use these materials. For example, the advent of high-performance concrete (HPC) has resulted in longer spans, taller towers, better decks, and safer, more durable structures. With these improvements, even more sustainable solutions can be developed.

The use of prestressed concrete is a longstanding practice in the bridge industry. This technology improves the performance and longevity of concrete bridges by maximizing what concrete does best—resisting loads via compression. Pre-tensioned and post-tensioned concrete bridges are extremely resilient to deterioration, even when subjected to the harshest environments. Longer spans and better, more sustainable bridges are created with the use of prestressing technologies.

The curved architecture of the new Memorial Bridge in Clearwater, Fla., reflects the sunset to accent its scenic setting along the Intracoastal Waterway. Photo: HDR Inc.

Concrete from the Arthur Ravenel Jr. Bridge in Charleston, S.C., was given new life as artificial reef habitat. Photo: HDR Inc.

Fiber reinforced plastic (FRP) reinforcement is becoming more available and brings the potential to further enhance the performance of concrete bridges. Trading the traditional steel reinforcement bar for an FRP bar eliminates the expansion that comes with corrosion of an embedded steel reinforcing bar. This is the most common form of distress and deterioration observed in reinforced concrete bridges. As the use of FRP bars increases, the reputation of concrete as an already great sustainable material is sure to grow even more.

From the outset, the concrete industry, including concrete producers, designers, contractors, and precasters, has continually aspired to find new and better ways to use and improve this material. From plain concrete to the development of reinforced concrete to the use of HPC with prestressing and FRP bars, the efforts continue. More advancement is sure to come and will further improve the longevity and sustainability of concrete bridges. For example, the Massachusetts Institute of Technology has been applying nanotechnology to concrete to determine whether it's possible to both improve concrete performance and reduce carbon-dioxide emissions during its production.

The use of 183-ft-long precast, prestressed concrete beams across the Union Pacific Railroad tracks eliminated the need for intermediate bents. A similar design was used for the 162.5-ft-long Alder Creek Bridge to eliminate foundations in the water. Photo: HDR Inc.

Improvements in Technology Enhance Environmental Mitigation Efforts

Minimizing environmental impacts during construction is nothing new. What is new is that innovations in concrete are making this easier to accomplish. Issues such as minimizing stream disruption and wetland displacement, accommodating seasonal migratory patterns, and reducing side slope erosion are all possible with concrete bridge structures.

Furthermore, concrete makes it possible to facilitate accelerated construction; thereby, reducing greenhouse gas emissions caused by traffic delays and construction equipment operation. The Federal Highway Administration's Highways for LIFE program supports this initiative by contributing funds for accelerated construction projects. Prefabricated concrete components are the heart of the accelerated bridge construction trend as illustrated by the following examples.

One of the projects in the Oregon Transportation Investment Act III State Bridge Delivery Program involved U.S. 26 at Alder Creek. The contractor used 162.5-ft-long beams to create a single-span structure over the creek. This design approach eliminated the need for foundations in the water, causing less disruption to the natural setting. Using the big-beam technology also reduced the time needed for construction, speeding up the return to normal traffic operations. By reducing environmental impacts and saving time and money, this use of a concrete design addressed all components of the triple bottom line.

For the project to replace the 24th Street Bridge over I-80/I-90 in Council Bluffs, the Iowa Department of Transportation had to consider the effect lengthy closures would have on the surrounding business corridor. Retail, casino, lodging, and recreational businesses in the area depend on traffic entering and exiting via the 24th Street interchange. A precast concrete deck system accelerated the schedule and made it possible to stage construction to allow at least three lanes of traffic to remain open at all times. As a result, the community will benefit from reduced impacts to traffic and the economic well-being of the local businesses.

Concrete is a Compatible Material

While much attention goes to the natural environment, the built, historic, and cultural environments must be considered. Compatibility may be expressed in terms of aesthetic value, community acceptance, or historical significance. Some concrete bridges are viewed as landmarks in their communities and include architectural ornamentation that adds drama and interest. Advancing technologies create new opportunities for concrete bridges to add to the built and historic fabric of our communities.

The new Clearwater Memorial Bridge in Florida employs a curved architecture to reflect the sunset from the structure and accent its setting. Additionally, the chosen alignment through downtown allowed efficient traffic movement while supporting continued economic development—again providing social and economic sustainability benefits.

Summary

Bridge designers face a new set of parameters today. Beyond the question of economics and functionality, they must ask themselves whether their designs will be long-lasting; do they help protect the natural environment; can they complement the built and cultural environments; and can they help reduce the carbon footprint?

When it comes to concrete bridges, the answer to these questions is "Yes."


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