



SUSTAINABILITY

Social Benefits of Concrete Bridges— How Green is Our Valley?

by Kevin R. Eisenbeis

Is sustainability merely a fad or a concept whose time has come? At every turn, we are exposed to print media, industry dialog, political stumping, and even Hollywood celebrities promoting sustainability and the value of going green. What is this all about, and how does the concrete bridge industry relate? And perhaps of greater significance, why should we care?

This issue of *ASPIRE*[™] focuses on the social benefits of sustainable concrete bridges. Social benefits, including life-safety issues, accelerated bridge construction, context-sensitive designs, and aesthetics are just one aspect of the overall theme of sustainable design as it relates to highway bridges. Future issues of *ASPIRE* will delve into the economic and ecologic aspects of sustainable concrete bridges.

In this article, we will examine the social benefits of sustainable concrete bridges and how we can balance the impact of our choices on society.

What is a Sustainable Structure?

For a better understanding of the subject, some definitions are in order. To the casual observer, a sustainable structure will last a long time and have minimal negative impact on our environment. However, to the environmental advocate,



Rehabilitation of the Benton Boulevard Bridge in Kansas City, Mo., allowed preservation of an existing arch bridge originally constructed in 1923.

Photo: Harrington & Cortelyou Inc.

The excellent fire and seismic resistance characteristics of these structures further ensures the public well-being.

sustainability connotes a much deeper intent. To be truly sustainable, all aspects associated with a structure including design, location, materials utilized, construction techniques, maintenance, impact on the environment, overall energy consumption, and effect on future generations must be considered. All elements should be coordinated in a manner to benefit society. The consequences of our decisions now may affect our children's future. To put it another way, a sustainable bridge design accomplishes our needs now without compromising the ability of future generations to meet their own needs.

Much of the concern in the field of going green relates to carbon emissions in the atmosphere. A reported three-fold increase in carbon dioxide in the atmosphere since 1977 prompts the global warming concern. One aspect of sustainability is the minimization or elimination of carbon emissions to reduce the portion of climate change that may be caused by this phenomenon. Locating bridges where drive times and travel distances are minimized can reduce overall carbon emissions from vehicles.

Social Benefits of Sustainable Concrete Bridges

Society is the benefactor when our industry provides safe, long-term, durable structures. Even more so when economical, attractive, and low-maintenance describes our bridge. Sound familiar? Additional benefits occur when construction minimizes site disruption, environmental impact, and traffic congestion, again, all common benefits inherent to current bridge construction.

Let's look at various social benefits of concrete bridges as they relate to sustainability.

Life Safety

Concrete bridges, with their typically redundant structural systems, are safe bridges. The excellent fire and seismic resistance characteristics of these structures further ensures the public well-being. In seismic zones, confinement and corresponding ductile behavior in plastic hinge regions provides for minimal earthquake damage, low repair costs, and immediate post-earthquake use. With accelerated bridge construction, rapid replacement of other bridges that may have been damaged is also beneficial. Concrete bridges also demonstrate outstanding performance when exposed to fire as illustrated by other articles in this issue. The necessity of safe bridges is fundamental to our industry.

Accelerated Bridge Construction

Precast components allow rapid construction of bridges to occur. With the advancement of rapid construction techniques, construction time previously measured in weeks and months is now measured in hours and days. Minimal lead times, locally manufactured products, and standard shapes make this method economically feasible. Deck formwork for cast-in-place concrete can be eliminated when adjacent precast members are used. Combined with the reduced disruption to traffic, shorter detour times, and minimal site impact afforded, the social benefits are significant.

Context-Sensitive Design

A context-sensitive design utilizes a



Aesthetic requirements played a key role in selecting the type of bridge for the 27th Street Bridge, Kansas City, Mo.
Photo: Harrington & Cortelyou Inc.

collaborative approach involving all key stakeholders when considering the total setting in which a project will exist. Concrete structures adapt well to various physical settings often preserving scenic, aesthetic, historic, and environmental resources. The advantage of concrete bridges is apparent in the number of communities improved by their use.

Aesthetics

Concrete bridges blend well with their surroundings. The simple, clean shapes provide attractive spans in individual or multiple arrangements. Low span-to-depth ratios create slender lines and enhance their graceful appearance.

Long Service Life

Another key aspect of sustainability is longevity. When maintenance requirements are minimized, the amount of effort and energy required to repair the bridge in the future is minimized.



The Route 100 precast box beam bridge provides a shallow structure depth over I-44 near St. Louis, Mo. Photo: MoDOT.

Recent advancements in the use of higher strength concretes combined with prestressing provide for extremely durable concrete structures. Where corrosion of reinforcement is reduced, future maintenance requirements diminish accordingly. Durable concrete bridges are long-term structures, minimizing the cost of future repairs and life-cycle energy consumption.

Where Do We Go from Here?

We should first answer the question, why do we care? Regardless of personal feelings about global warming, carbon credits, LEED certifications, or any of a myriad of “green” terms, it is important to realize our decisions have consequences, and our actions can make a difference. It seems safe to say we all want to preserve or improve our environment, and we want our children and our grandchildren to have a better environment than we enjoy. As practitioners in our industry we can take steps that may make a difference.

With a few minor variations in current mindset and practice, we can continue to improve on our bridge sustainability. Advocates for sustainability promote designing, building, and maintaining with overall energy consumption in mind. For example, providing solar powered lighting can reduce power requirements

while still meeting safety needs. Many traffic signals and message signs utilize this technology, why not bridge lighting? Lowering the power consumption for the life of the bridge, including energy used in fabrication, distribution, installation, and maintenance, reduces its “footprint” in the realm of carbon dioxide emissions. Designing with “local” in mind can cut transportation costs and fossil fuel consumption in shipping materials and products. This aspect often comes into play now resulting in lower costs for construction, but what about on a macro level. Should we consider the consequence in carbon emissions for shipping a product a long distance, from overseas for instance, just because it had the lowest initial cost? Remember, our decisions have consequences. A reasonable balance between economy and environmental concern is in order.

As summarized above, concrete bridges provide many social benefits. From fire-resistant and seismic-resistant structures, to rapid construction and attractive, long-term installations, concrete bridges provide sustainable solutions that benefit society. In our quest for continual improvement, we should ask ourselves: Can we do more? Because our decisions have consequences, we can decide to make our children’s valley greener as we continue to realize the benefit of sustainable concrete bridges.

PRESTRESSED CONCRETE BRIDGES

serving the public's best interest

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Prestressed Concrete Association of Pennsylvania
www.pcap.org



Central Atlantic Bridge Associates
www.caba-bridges.org

Advantages of Prestressed Concrete Bridges:

Simple Design

A variety of components can accommodate various load-carrying capabilities and span potentials. Connections between elements are simple – carefully planned details result in economy.

Low Initial Costs

Prestressed concrete bridges are economical as well as provide for minimum downtime for construction. Carefully planned details speed the total construction process and result in overall economy.

Fast, Easy Construction

Construction is fast with prestressed concrete. As the beams are factory produced, site preparations can proceed. Prestressed concrete is ideal for limited access locations and where speed of erection is crucial.

Widely Used and Accepted

While prestressed concrete is a relatively new product – the first use of prestressed concrete in the United States was in a bridge, built in the early 1950s in Philadelphia, Pennsylvania – today, about a third of all bridges built use prestressed concrete beams.

Assured Quality

The quality of prestressed concrete bridges is controlled under factory conditions. Because of such protected conditions, weather can't affect the result of casting. Unlike cast-in-place concrete, precast concrete offers greater consistency and more options for high quality finish.

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Post-tensioning is being utilized on bridges in increasingly varied ways, including cable stays for long-span applications, segmental construction, bridge decks, strengthening, and on spliced girders to extend the capabilities of precast elements. Post-tensioning offers some unique advantages that have led to rapid growth in its usage around the world.

Post-tensioned bridges have performed extremely well, but reliability and performance are dependent on quality construction and good design. Education and training is one of PTI's strategic goals. PTI's initiatives to assist designers and to help assure a high quality workforce, include the following:

Bonded Post-Tensioning Certification

This 3-day training workshop is a comprehensive course on all aspects of bonded post-tensioning installation. It is intended for construction personnel, inspectors, and construction managers. Attendees are certified following successful completion of the training and subsequent examination. The next course is planned for May 28-30, 2008, in Gainesville, Fla.

2008 PTI Technical Conference

The 2008 conference will be held May 4-6, 2008, in St. Louis, Mo., and will feature technical sessions, committee meetings, and PTI's 2008 Design Awards. It will be held jointly with the NCBC's Concrete Bridge Conference—PTI registrants can attend all the bridge sessions.

Design Guides

The updated 5th Edition of PTI's *Stay Cable Recommendations* is now available. In addition, PTI's Bridge Committee is working on two design guides: 1) update of PT Bridge Manual, and 2) Guide for PT Bridge Decks. Post-tensioned bridge decks offer potential benefits such as reduced cracking and improved durability, lighter superstructures, and fewer girders.

For more information, contact PTI or visit our website at www.post-tensioning.org.

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