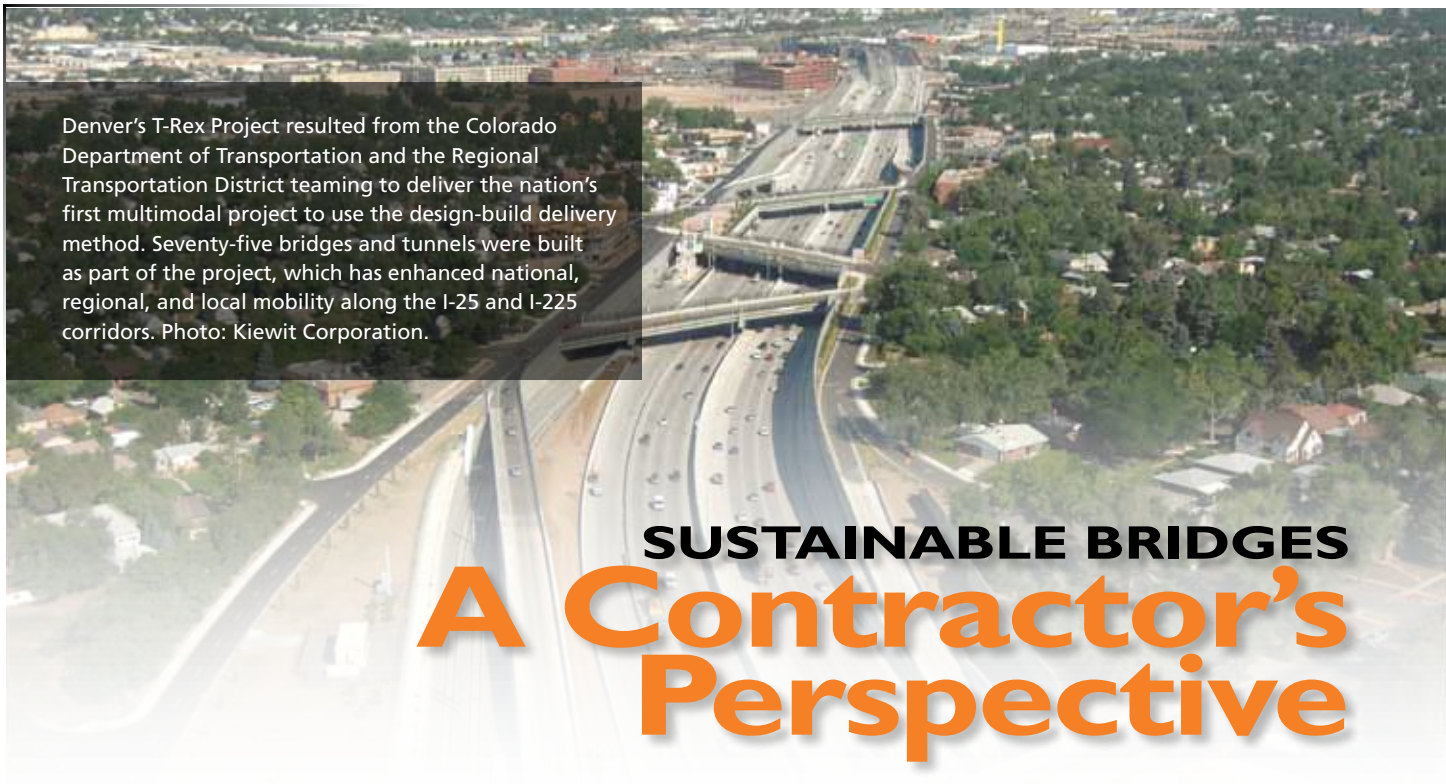

Denver's T-Rex Project resulted from the Colorado Department of Transportation and the Regional Transportation District teaming to deliver the nation's first multimodal project to use the design-build delivery method. Seventy-five bridges and tunnels were built as part of the project, which has enhanced national, regional, and local mobility along the I-25 and I-225 corridors. Photo: Kiewit Corporation.

SUSTAINABLE BRIDGES
A Contractor's Perspective

The entire construction team must do its part to ensure sustainable design is effective

by Raymond Paul Giroux,
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For generations, building good bridges has proved to be a moving target, as design criteria and standards evolve to meet society's changing needs. Recently, designs have been further complicated by society's increasing demands on bridge infrastructure in the face of dwindling resources. As a result, we hear more and more about the need for "sustainable solutions" in the bridge market. To achieve this goal, all on the construction team must do their part.

Those efforts are complicated by the lack of a generally accepted definition of a "sustainable bridge" or a simple litmus test to determine if a bridge design is sustainable. Criteria for sustainable bridges have proven to be somewhat complicated, vague, and at times controversial. Yet sustainable bridge development is essentially about stewardship of our resources and making smart bridge decisions that not only meet society's current needs but also their needs in the future.

We face the challenge of maximizing transportation funding in difficult economic times, with an ever-aging bridge inventory and a growing demand for infrastructure. While bridges are built locally, each plays a role in the bigger picture of strategic regional and national infrastructure planning. Accordingly, proper management of our bridges is essential to achieving sustainable bridge solutions on a national, regional, and local level.

We all need to be aware of the big picture, but we each can do more to achieve the final goal. First and foremost, everyone involved must stress "life-cycle" costs and economy as the primary goal in bridge design.

Sustainable Examples Abound

We are beginning to see this "big-picture strategic" thinking around the country. Denver's I-25 Transportation Expansion provides an excellent example of sustainable infrastructure development. Known as the "T-Rex" project, it used a unique collaboration between the Colorado Department of Transportation and the Regional Transportation District to become the nation's first multimodal project to use the design-build delivery method.

Completed in 2006, the $1.28-billion Kiewit Corporation-led joint venture reconstructed 17 miles of I-25 and I-225 and constructed 19 miles of double-track, light-rail transit lines, 13 light-rail stations, three parking structures, eight interchanges, and more than 75 bridges and tunnels. All construction was performed to minimize disruption to the public and the environment.

Missouri's "Safe and Sound" initiative, an ambitious upgrade to the state's 10,000-plus bridges, focuses on approximately 1100 structures in poor to serious condition. With an emphasis on safety, mobility, efficiency, and value, Missouri Department of Transportation officials packaged 554 bridge replacements into a single design-build contract. The $487-million contract was awarded in May 2009 to KTU Constructors, comprising Kiewit Corporation, Traylor Bros. Inc., United Contractors Inc., HNTB Corp., and The LPA Group Inc.

More and more we see owners placing emphasis on sustainable solutions as part of a well planned infrastructure program. In planning Honolulu's new 20-mile-long elevated rail line that will connect West Oahu with downtown Honolulu, the City and County of Honolulu placed an emphasis on sustainable solutions. In Kiewit Pacific's 2009 winning design/build proposal, concrete piers and precast concrete guideways provided many sustainable elements and opportunities for aesthetic treatments.

Concrete: A Green Solution

Materials used in bridges need to be continually evaluated and researched to create improvements. In this regard, concrete proves to be a "green" bridge material by almost any measure:

- The use of supplementary cementitious materials such as fly ash, slag, and silica fume
- Carbon dioxide (CO_2) sequestration capability (ability to absorb CO_2)
- The energy cost of production (reinforced concrete is 2.5 Gigajoules/metric ton (GJ/t); steel: 30 GJ/t)
- Low solar reflectance compared to asphalt, creating reduced heat-island effect in urban areas
- The recyclability of concrete and reinforcing steel

Other advanced bridge materials may also improve the sustainability of our bridges:

- Ultra-high-performance concrete (UHPC), offering 25,000 to 30,000 psi with correspondingly high tensile strength
- Self-consolidating concrete and lightweight concrete
- Improved reinforcing steels (high strength and corrosion resistant)
- Carbon dioxide-absorbing materials
- Recycled materials and recyclability of materials

Improvements in sustainability will also come from improving means and methods to build our bridges, which will reduce environmental impacts and road-user impacts. Some of these methods will include the use of erection trusses, balanced-cantilever methods, prefabricated assemblies, and self-propelled modular transporters (SPMTs).

Focus on Life Span

Bridges currently provide an average life span of 40 to 45 years, with decks replaced every 20 years. Doubling this life span would dramatically improve the overall sustainability of bridges. Extending service life will start with adoption of various options for improved design details:

- Simplification of details
- Adaptable substructure designs
- Consideration for bridge inspection, monitoring, and maintenance
- Allowance for future modifications and retrofitting mass transit
- Consideration of utility corridors along bridge alignments
- Focus on context-sensitive solutions

The City and County of Honolulu placed an emphasis on sustainable solutions for Honolulu's new 20-mile elevated rail line. Concrete offered many advantages to meet the needs of the project. Preliminary rendering: Kiewit, HNTB, and FIGG.

Extending service life will start with adoption of improved design details.

Key Questions to Answer

The February 2009 issue of *Civil Engineering* featured a special section suggesting "Guiding Principles for Critical Infrastructure." The authors noted, "We tend to take our infrastructure for granted until something goes wrong—often terribly wrong." To that end, it suggested some hard questions for all of us to consider:

- Have we ignored the need to manage and communicate risks?
- Have we failed to consider critical infrastructure as part of a complex system?
- Have we neglected to call for upgrades as conditions have changed?
- Have we allowed the intertwined pressures of cutting time from schedules and reducing costs to prevail over the principle purpose of our built infrastructure—to protect the safety, health, and welfare of the public?

Improving the sustainability of our bridges will not come from one change in federal regulations, nor from one new structural analysis, one new super bridge material, one new design detail, one new construction method, nor one new maintenance procedure. Clear vision and improved sustainability for bridge projects will come from all of us in the bridge industry working toward a common goal.

This article was taken from a more detailed paper presented by the author at the Construction Research Congress, "Building a Sustainable Future," held in Seattle, Wash., April 5-7, 2009. The full paper can be downloaded from the ASPIRE™ website: www.aspirebridge.org, click on "Resources" and select "Referenced Papers."

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