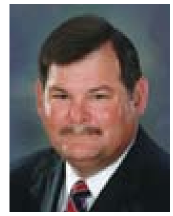
SUSTAINABILITY



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Get In, Get Out, and Stay Out

Several years ago, even before sustainable development was the important topic it is today, the American Segmental Bridge Institute (ASBI) acknowledged the following phrase as an organization goal—get in, get out, stay out.

Cliff Freyermuth, who was then ASBI director, wrote in 2003 that this concise statement summed up ASBI's mission of "… reducing project construction time and reducing the need for project maintenance activities following construction."

What does that have to do with sustainability? Plenty, if you consider sustainability more than an issue for environmentalists and ecologists. Sustainable Measures, a consulting firm dedicated to promoting sustainable communities, says sustainability can be measured by whether the "economic, social, and environmental systems that make up the community are providing a healthy, productive, meaningful life for all community residents, present and future."

That's a lot bigger than using energy-saving bulbs in the lighting plan.

At its core, sustainable development offers all kinds of short- and long-term benefits to a community—whether it's the residential community, the driving public, or the environment.

With recent advances made in post-tensioned segmental concrete bridge construction, we're making significant strides toward achieving higher levels of sustainability in our projects as an industry. Specifically, new grouting material specifications and new approaches to grouting tendons, improvements in epoxy technology, innovation in post-tensioning systems, and new developments in concrete mix designs resulting in better, higher-strength concretes are improving our ability to get in, get out, and stay out.

By using ground-based crane erection of precast segments, construction does not require the use of large gantries on site. Photos: Finley Engineering Group Inc.

National grouting standards and a certification program have contributed to improved performance. Photo: American Segmental Bridge Institute.

Grout and Epoxy Improvements

The Florida Department of Transportation (FDOT), in its *Post-Tensioning Tendon Installation and Grouting Manual*, states: "Good corrosion protection of post-tensioning is essential for structural integrity and long-term durability. Over the years, occasional failures have been detected that were attributed to inadequate grouting and lack of overall protection."

Grout originally had two roles in post-tensioned bridge projects—to bond the tendon to the surrounding concrete via corrugated ducts and to fill the duct and prevent corrosion caused by contaminants. However, problems arose related to grouting. With no set standards for uniformity, grouting systems tended to bleed water, incur installation voids, and leak at ducts and deviation pipes. Other issues included lack of cap protection, chemical issues for set and hardening, and duct cracking.

In recent years, the development of national grouting standards and specifications, a grouting certification program, and more intensive training have dramatically improved performance. Now, with virtually no grout issues, bridges require less inspection and maintenance, and they last longer.

Early epoxy was also sometimes problematic, failing to properly cure, not providing the necessary waterproofing to the deck; and variations in thickness of the epoxy affected the segment geometry. As an industry, we learned that a one-size-fits-all approach to epoxy technology would not work, so we developed a variety of different formulations to address project variables such as extreme temperatures and set times.

Unlike the grouting improvements, which were driven by ASBI and the Precast/Prestressed Concrete Institute (PCI) in cooperation with the states, the evolution of epoxy mixes was driven by manufacturers competing to improve a product that as originally introduced, was inadequate.

In both cases, but in different ways, the industry's innovations reinforce the notion that good construction practice, and the sustainability that accompanies it, are evolutionary.

Improvements in post-tensioning techniques are also reaping performance and durability rewards on major bridge projects. These include low-relaxation strand, improved analysis techniques and design software, the use of unbonded tendons in extruded sheathing, encapsulated anchors, diabolos, and development of prepackaged, non-bleed grouts for bonded post-tensioning.

An effort is currently underway to establish a national standard for post-tensioning; just as such standards were achieved for grouts and grouting. Proponents of this standard (including the writer) are reviewing and adapting state codes into a single national standard for post-tensioning, with a goal of 12 to 18 months for implementation.

Longitudinal view of Bridge 22 on Road 431 in Israel, built in precast segmental cantilever construction. Photo: Finley Engineering Group Inc.

Aerial view of the Ein Ha'kore Interchange of Road 431. Precast concrete segmental bridges offer insights into how durability and sustainable construction intertwine. Photo: Danya-Cebus.

Road 431 in Israel

The introduction of external post-tensioning tendons has also helped change the nature of the corrosion protection system, as illustrated by the Road 431 project in Israel.

Time was the most compelling reason to use precast segmental construction with external tendons on the Road 431 Ein Ha'kore Interchange Bridges in Israel. With a very limited design and construction schedule, and several other aspects of the overall roadway project dependent on prompt completion of the interchanges, the project team needed to perform quickly.

Deviation segment featuring post-tensioning tendon diabolos in the foreground. Photo: Finley Engineering Group Inc.

The external post-tensioning system reduced the segment cross-sectional area, including narrower web width and bottom slab thickness. This resulted in lower superstructure weight and foundation loads, and better utilization and effectiveness of the post-tensioning system. With smaller sections, the same post-tensioning force achieved higher compressive stress in the concrete and reduced cracking potential, meaning lower cost and better performance.

Also, external tendons meant that fewer segments required post-tensioning embedments and associated details, so segment casting was faster and more efficient. The system reduced post-tensioning operations in the field as there were fewer tendons to install, less anchorage hardware, and fewer stressing operations. The continuous duct also reduced the number of connections.

When considered collectively, these factors positioned the Road 431 project as a model of sustainability.

Because Road 431 is a build-operate-transfer project, contractor/concessionaire Danya-Cebus was particularly sensitive to durability issues and conscious of inspection and maintenance of the infrastructure. Since it is a toll road, any shutdown for inspection or maintenance would reduce income. So staying out was equally as important as getting in and getting out.

Because external tendons are not encased in concrete, maintenance teams can ensure that all strands remain protected against harmful exposures by simple visual inspection of the tendon ducts. External tendons can be inspected for nearly their entire length and repair teams can repair any defect from inside the box girder. Such defects would include grout voids, split ducts, and tendon damage.

Conclusion

By focusing on getting in, getting out, and staying out, a bridge design and construction team can contribute greatly to sustainability goals. Less construction time usually means fewer traffic problems and, as a result, reduced smog, faster commute times, and an overall improvement in qualify of life. A more durable bridge means less down time for inspection and maintenance, a higher level of safety, and a longer-lasting structure.

In the United States, with billions of dollars from the stimulus bill likely to be spent on bridge construction and reconstruction, and an industry wisely focused on increasing sustainability in all areas, we should continue our quest for innovation and improvement in our construction processes and techniques. This way, our country's investment in bridge infrastructure will be rewarded with highly efficient, rapidly built, and low-maintenance structures that do their job and do it for a long, long time.

For more information on this or other projects, visit www.aspirebridge.org.