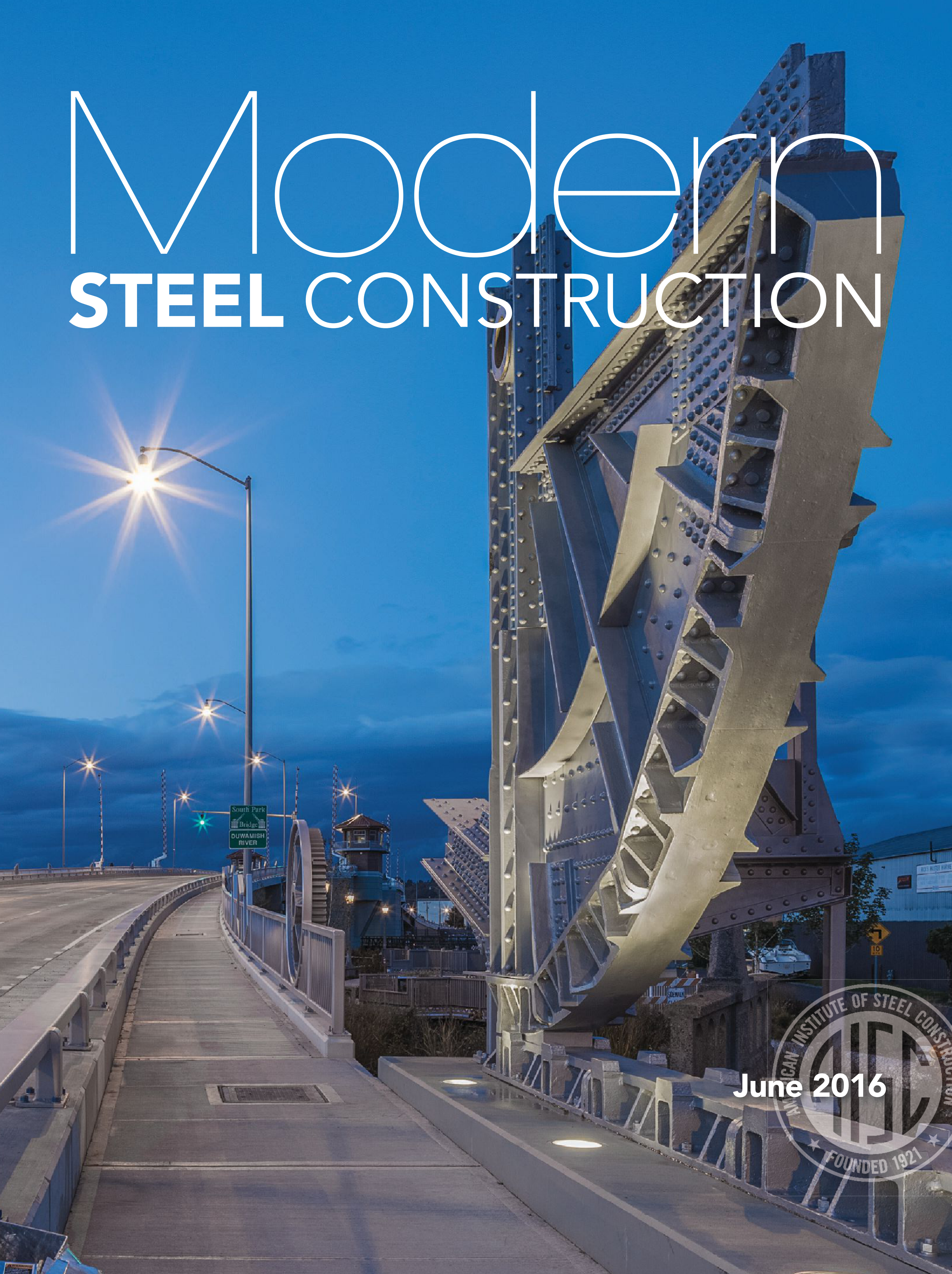
Modern STEEL CONSTRUCTION



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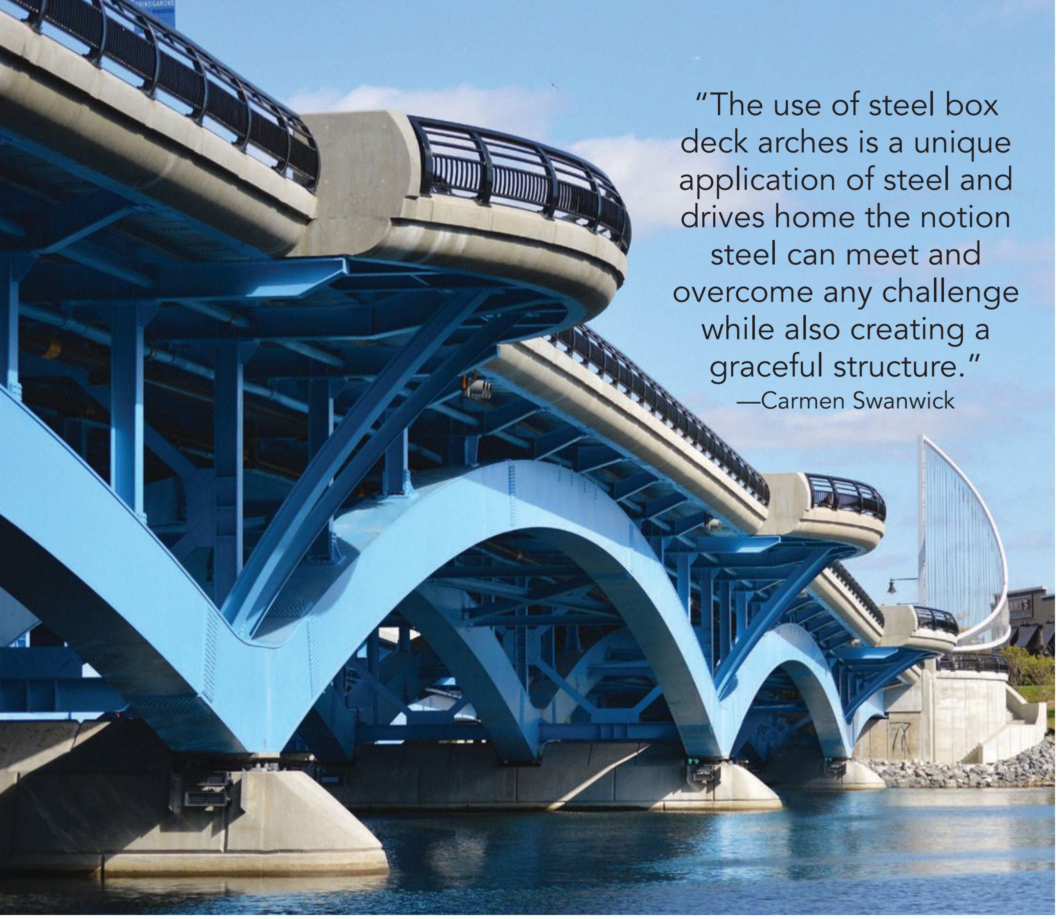

"The use of steel box deck arches is a unique application of steel and drives home the notion steel can meet and overcome any challenge while also creating a graceful structure."
—Carmen Swanwick

PRIZE WINNER: MEDIUM SPAN
Kenneth F. Burns Memorial Bridge, Worcester/Shrewsbury, Mass.

AFTER NEARLY A CENTURY OF USE, the Kenneth F. Burns Memorial Bridge had run its course.

The multi-span concrete deck arch was an appreciated part of the landscape, but it had become too narrow for modern traffic needs and was deteriorating and due for retirement. Replacing it are two separate bridges, carrying eastbound and westbound traffic, that reflect on the old bridge's grace, but with a modern update using sweeping, sleek, steel box deck arches in place of concrete framing.

Construction staging required maintaining traffic flow on the original bridge, which carries Route 9 over Lake Quinsigamond between Shrewsbury and Worcester, while the new bridge was built around it. The design team developed a unique solution for the new low-rise arch spans: full-bridge-length post-tensioned arch ties. The bridge was designed and constructed as a tied deck arch. Tension ties were placed at the deck level and included full-length bridge post-tensioning, with two ducts per steel box beam. Post-tensioning was performed twice during construction to balance moments and compression forces.

To reduce impacts at the approaches in Worcester and Shrewsbury, vertical grade changes on Route 9 were minimized, which led to a relatively low rise. The resulting arch structures behaved as hybrid arch/continuous beams structures. The team optimized the design by balancing moments, axial compression and tension, using the post-tensioning to reduce maximum moments and carefully coordinating and iterating the analysis with construction staging.

The piers are comprised of steel pipe piles, with a precast soffit and cast-in-place concrete formed above the soffits. The construction of perched piers largely out of the water avoided the need for difficult and expensive sheeting and dredging in Lake Quinsigamond, and improved requirements for environmental permitting in the lake, resulting in better water quality and less disruption for boaters.

The design team developed a complex construction staging model using CSI Bridge, augmented by customized pre-processors and post-processor programs and sheets developed specifically for the project. The staging model matched construction means and methods and was frequently called upon to evaluate conditions in real time during construction. The model was verified during construction by matching predicted deflections with actual measurements at various stages of the work. In addition to the global model, detailed finite element models of complex steel connections were prepared to evaluate special conditions and framing.

Animation was used extensively to evaluate bridge aesthetics. For example, the team was concerned that the post-tensioning ducts on the fascia box beams might look like hanging utility pipes. It was initially thought that shadows from the overhanging decks might minimize the problem, but an animation with sunlight angles estimated from the end of December (with the most direct southern light) clearly showed otherwise. Based on this result, the team moved the ducts up onto the fascias, requiring special steel framing details but greatly improving the appearance of the bridge.

Owner
Massachusetts Department of Transportation, Worcester

Designer
Stantec, Boston (formerly FST)

Contractor
The Middlesex Corp, Littleton, Mass.

Steel Fabricator
Casco Bay Steel Structures, Inc., South Portland, Maine