Beneficial Use Case Study

Hoover Dam Bypass

Coal Combustion Product Type
Class F Fly Ash

Project Location
Lake Mead National Recreation Area, Clark County, Nevada; Mohave County, Arizona

Project Participants
HDR Inc., T.Y. Lin International, Sverdrup Civil Inc., Headwaters Resources, Obayashi Corporation, PSM Construction USA Inc., Casino Ready Mix, Federal Highway Administration, Arizona Department of Transportation, Nevada Department of Transportation, RE Monks Construction, Vastco Inc., Edward Kraemer & Sons Inc.

Project Completion Date
2010

Project Summary
The Mike O'Callaghan–Pat Tillman Memorial Bridge is a concrete arch bridge spanning the Colorado River between Arizona and Nevada. Located 1,500 feet downstream of the Hoover Dam, the bridge rerouted US 93 from its previous location along the top of dam. The bridge incorporates the widest concrete arch in the Western Hemisphere and, at 900 feet above the canyon floor, is the world's highest concrete arch bridge.

Project Description
As with the construction of the nearby Hoover Dam itself three-quarters of a century earlier, building the Mike O'Callaghan–Pat Tillman Memorial Bridge carried a number of design challenges. The remoteness of the build site, the strength requirements for the concrete arches, the size of the placement, and the hot desert conditions all contributed to challenges in mix design, thermal control, concrete delivery, and placement.

Designers specified that concrete would need to achieve compressive strength of 10,000 psi in 56 days and thermal control to minimize cracking. Strength requirements were further addressed by use of a material content of 200 lbs. of fly ash to 800 lbs. of cement per cubic yard—and a very low water-to-cement ratio of under 0.31. The mixture typically achieved strengths of 4000 psi in a little more than a day and over 12,000 psi in 56 days.

A challenge associated with this mix was that, in its natural curing condition, it would reach temperatures in excess of 190° F—well above the 155° F limit of the design specifications. Further, the usual mitigation methods—such as chilled batch water or ice chips, shading the aggregate stockpiles, and pouring at night—were deemed to be insufficient to reduce the maximum curing temperature to within the desired range.

Ultimately, liquid nitrogen was used to precool the concrete to temperatures that would allow a maximum peak curing temperature of under 155° F. Use of liquid nitrogen dropped the batched temperature of 85° F to a predelivery temperature of 40° F—allowing temperatures at the point of placement to be in the 60° F range with peak curing temperatures of less than 150° F.

The finished bridge's twin concrete arches are made of 106 pieces—53 per arch—mostly 24-foot cast-in-place sections. The arch was constructed from both sides of the bridge concurrently, supported by diagonal cable stays strung from temporary towers. Construction required hoisting both workers and up to 50 short tons of materials 890 feet above the Colorado River using 2300-foot-long steel cables held aloft by a "high-line" crane system.