American Coal Ash Association

The American Coal Ash Association (ACAA) advances the management and use of coal combustion products (CCPs). Generically, CCPs are the residuals from coal combustion, such as fly ash, bottom ash, and boiler slag, or byproducts from air emission controls. In addition to a myriad of core performance attributes in construction and industry, CCP use can conserve natural resources, reduce greenhouse gas emissions, and eliminate the need for additional landfill space. Nearly 40 percent of 123 million tons of CCPs produced annually are used beneficially.

Members of ACAA are located worldwide and include utility and non-utility CCP producers, as well as marketers, organizations, and individuals with commercial, academic, research, and other interests in CCP management. Members promote CCP use and management in ways that are environmentally responsible, technically sound, and commercially competitive. This mission is achieved through public and private sector partnerships, technical assistance, education, publications, meetings, and workshops. ACAA has developed strong partnerships with the Federal Highway Administration, Environmental Protection Agency, Department of Energy, Department of Agriculture, and others. Through these partnerships, the association helps provide information, education, and outreach to engineers, designers, specifiers, end users, and regulatory agencies.

Fly ash and cenospheres are CCPs often specified for high performance concrete in bridge decks, piers, and footings. The recently completed $531 million Arthur B. Ravenel Jr. Bridge project in Charleston, South Carolina, used more than 30,000 tons of fly ash. Caltrans, a state leader in the use of fly ash in paving projects, specified high volume fly ash mixes for the largest bridge project in its history—the San Francisco-Oakland Bay Bridge. Using innovative specifications and blending techniques, Caltrans was able to improve the workability, permeability, and hardened concrete properties. A number of engineering standards and specifications define CCP applications, thus ensuring high quality performance and products.

For more information, please visit www.acaa-usa.org.

WRI Shares Best Kept Secret—Welded Wire Reinforcement

The Wire Reinforcement Institute (WRI) is the world's leading association of manufacturers, allied industries, and professionals engaged in the production and application of structural welded wire reinforcement (WWR) and related products for concrete reinforcement.

Headquartered in Hartford, Connecticut, WRI is the concrete construction industry's leading source for timely, objective, and credible information on the uses and benefits of structural WWR and related products. WRI works closely with design firms, universities, owners, contractors, and government agencies, to ensure adherence to the most accurate, up-to-date codes, standards, specifications, and regulatory requirements.

WRI has a wealth of information about structural WWR and how it may be used to help reduce bridge and paving closing times and promote public satisfaction. Many say that WWR is the best-kept, time-saving, cost-cutting secret in the concrete reinforcement industry.

The Institute's efforts to advance the industry include technical and promotional materials and a variety of outreach programs to increase the construction industry's awareness of new structural WWR products and breadth of applications. Through the WRI Education Foundation, the Institute funds a scholarship program that annually grants over $10,000 for undergraduate and graduate level civil and structural engineering students at accredited engineering universities. Over the past two years, the Foundation has awarded over $30,000 in academic scholarships to students majoring in civil and structural engineering.

Once known as welded wire fabric, wire mesh, or fabric, WWR provides structural concrete reinforcement. It is a highly controlled, cold-worked, structural product that possesses higher yield strength than Grade 60 reinforcement. It is produced in standard and custom prefabricated sheets. High-quality welds and computer-controlled spacing eliminate the time-consuming and less precise job-site layout and tying that is typical of traditional reinforced concrete construction.

With these superior attributes, WWR offers several key benefits. It is stronger than traditional materials and, therefore, less material is needed. And less weight means easier handling and placement—over 50% less labor when compared to traditional materials.

To learn more about WRI and structural WWR, as well as to access a variety of technical publications, visit www.wirereinforcementinstitute.org or call us at (800) 552-4WRI [4974]. Outside the U.S. please call 1-860-808-3000, X356.

Spanning the Land of 10,000 Lakes—

Minnesota's Concrete Bridges

by Dave Dahlberg, Kevin Hagen, Dave Hall, Brian Homan, Keith Molnau, and Arlen Ottman, MnDOT

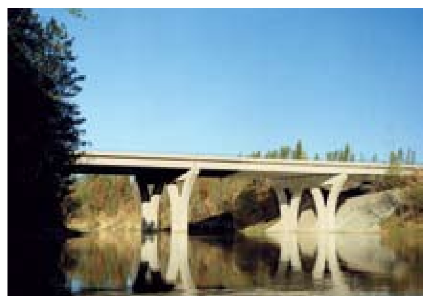
Concrete bridges have been a key component of Minnesota's transportation system for the past century. Numerous arches built in the early 1900s gracefully span the rivers of the state. While cast-in-place concrete bridges were frequently used, the advent of prestressed concrete resulted in the number of concrete bridges rising dramatically and becoming the predominant type of bridge. Today, precast, prestressed concrete and cast-in-place concrete bridges represent over 80% of the new bridges built on Minnesota's highways. Despite the severe Minnesota weather conditions, extreme temperature ranges and heavy use of deicing chemicals, concrete bridges are providing increased service lives due to improvements in materials and corrosion protection systems.

Mendota Bridge, TH 55 over the Minnesota River. (Nineteen-span cast-in-place concrete spandrel arch bridge)

Precast, Prestressed Concrete Bridges

The first prestressed concrete beam (PCB) bridge in Minnesota was built in 1957 using precast, pretensioned AASHO*-PCI Type I beam sections. This was truly the beginning of a new era in bridge design. In the almost 50 years since then, over 2,800 PCB bridges have been built in Minnesota. During this time, the PCB bridge has emerged as the preferred choice for most situations due to its economical cost and low maintenance requirements.

* AASHO was subsequently renamed AASHTO



TH 371 over the Mississippi River, near Brainerd. (Three-span prestressed concrete girder bridge)

The first prestressed concrete beams ranged in depth from 36 to 54 in. and had narrow flanges and thick webs. Until about 1970, they also had end blocks (thickened webs at the ends of the beams). In 1986, new more efficient I-beam shapes labeled the "M" series were added. These beams have depths ranging from 27 to 81 in. with wider top flanges, narrower webs, and more room for prestressing strands in the bottom flange. The new shapes increased the available span range, expanding the use of prestressed concrete beams in Minnesota.

In 2005, an even more efficient "MN" series I-beam was added with depths of 45, 54, and 63 in. The "MN" series beams are more robust and provide more area for prestressing, thus allowing for a reduced number of beams for a given span compared to the "M" series beams.

Other factors have improved precast, prestressed concrete beam efficiency. For instance, concrete quality and strength have increased. Required concrete strengths at strand release have risen from the 4500 to 5000 psi range of the early years to a current value that can go as high as 7500 psi, and design strengths have been specified as high as 10,000 psi. Prestressing steel has also changed from the original 3/8-in.-diameter stress-relieved strands to ½-in. diameter and now 0.6-in.-diameter low-relaxation strands.

Slab Spans

Concrete slab spans, have always had a place in Minnesota's bridge history. Whether it is for short slabs between spandrel beams of concrete arch bridges, voided slabs for grade separations, or the modern post-tensioned slabs capable of spanning greater distances, these spans fill a niche in the appropriate structure type for a particular location.

Arch bridges, which are rare for new construction, many times require slabs to be rehabilitated for repair and greater traffic capacity. Often historical, they must utilize some of the original construction methods to retain the key classical features.

TH 57 over the South Branch of the Middle Fork of the Zumbro River, Mantorville. (Three-span, post-tensioned slab)

Reinforced concrete slabs have evolved into post-tensioned slabs to accommodate longer spans. Normally, slab spans are chosen to provide a shallower superstructure than can be obtained with the typical beam-slab arrangement. An example is that of a bridge crossing the Zumbro River in the historical town of Mantorville. Here, the highway grade could not be raised due to its proximity to the town's main street. The river carries high flow rates during periods of fast run-off. Also, the townspeople did not want a standard utilitarian bridge to replace the hightruss spans that they had come to embrace over the years. To maintain a minimum structure depth and to provide the flexibility for aesthetics because the bridge is located adjacent to a city park, a post-tensioned, three-span slab bridge was chosen.

In 2005, Minnesota introduced its new Precast Slab Span System bridges, based on AASHTO's International Scan on Prefabricated Bridges. This Precast Slab Span System is similar in proportion to a slab-type structure, but the new system utilizes precast, prestressed inverted tee-beams to eliminate the need for falsework and forming. To further accelerate construction, precast substructures were used on one of the pilot projects. Using this innovative system, construction time was reduced by several weeks.

TH 72 over Tamarac River. (Three-span precast, prestressed inverted "tee" beam deck)

Box Girder Bridges

The Minnesota Department of Transportation (MnDOT) has completed several bridge projects utilizing various construction methods for box girder bridges. On the Highway 10 project in Blaine, the bridges were designed as multi-cell, concrete box girders, cast-in-place on falsework, and cast-in-place on fill. The Wakota Bridge is a major river crossing carrying Trunk Highway 494 over the Mississippi River in the southeast metropolitan area of Minneapolis-St. Paul. The graceful structural lines are the result of a variable depth, two-cell, box girder configuration. The main spans are 465 ft constructed using the cast-in-place, segmental, balanced cantilever method. The west end of this bridge flares considerably, which was partially achieved using variable length overhangs, and was partially constructed on falsework.

The structure type was chosen as a result of a very successful public involvement process. The final crossing includes several amenities, including a bicycle and pedestrian trail, overlooks, ornamental railings, and concrete surface treatments to give the concrete a more natural appearance. On a separate project, Minnesota is planning to construct six precast concrete, box girder bridges in the most congested segment of Interstate 35W and Crosstown Highway 62, utilizing the balanced cantilever method. The six bridges include fly-over type structures with curved 200-ft-long spans, for a total combined length of 4610 ft, or nearly 200,000 sq ft of precast segmental construction.

Wakota Bridge, I-494 over the Mississippi River. (Five-span cast-in-place segmental concrete bridge)

Land of Lakes

Minnesota's landscape includes "10,000 lakes," which contributes to the need for hundreds of small stream crossing structures. Precast concrete box culverts are often the most economical type of structure for these locations, and offer the advantage of rapid construction without the need for falsework or the curing time required with cast-in-place culverts. Minnesota has developed standard tables for culverts ranging from 6 x 4 ft up to 14 x 14 ft, for fill heights up to 25 ft. Special designs are made for precast sections up to 16-ft spans, beyond which transportation and weight of sections becomes a limitation. Local precasters have responded to MnDOT's Standard Culvert Designs, and are set up to mass-produce the precast sections to meet demand. Beyond the 16-ft span, Minnesota has utilized precast arches and precast three-sided structures for spans up to 34 ft. These types of structures have also been successfully used on small stream crossings and pedestrian trail bridges, and can be designed utilizing formliner and decorative railings on the headwalls to enhance the appearance of the portal entries.

On the local highway system, the majority of the bridges are in rural areas, have relatively low average daily traffic, and cross rivers or

TH 210 over Paul Bunyan Trail, Brainerd. (Precast concrete arch)

streams. Typically, these bridges require overall lengths less than 150 ft. Within this span length, concrete affords a number of options that are economical, durable, and adaptable to most geometric conditions.

In the past few years, over 90% of bridge spans constructed on the local system, excluding box culverts, have been prestressed concrete beam or concrete slab span bridges. Prestressed concrete beams are used for spans ranging from 30 to 150 ft. Slab spans are used for spans ranging from 15 to 60 ft.

In the last few years, the MnDOT also introduced a rectangular prestressed concrete beam section for spans ranging from 24 to 55 ft. The rectangular beam provides a more shallow structural depth than standard PCB sections and eliminates the falsework necessary for slab span structures. The rectangular beams come in 14-, 18-, and 22-in. deep sections.

Arcade Street over Channel at Spoon Lake, St. Paul. (Precast concrete arch)

Aesthetics

Aesthetic considerations have become an important design consideration in the last 20 years. The versatility of concrete has allowed Minnesota to deliver not only sustainable structures on the state highway system, but also visual assets and focal points for our communities. The MnDOT subscribes to the principles of context sensitive design and solutions as a basis for developing projects that are sensitive to the natural, environmental, cultural, and economical aspects that influence how a project will fit into a community or location. Policy and guidance in developing aesthetically pleasing bridges and structures is provided in the state's "Policy and Procedures for Cooperative Construction Projects" and the "Aesthetic Guidelines for Bridge Design," respectively.

Pioneer Trail over TH 169, West Bloomington/Eden Prairie. (Two-span prestressed concrete girder bridge)

Working with the state's district project managers and staff, the Bridge Office enters into a public involvement process that includes local government officials and staff, other state and local agencies, and representatives from the general public to develop visual quality guidance that is appropriate and mutually acceptable to all project stakeholders. Through this involvement at the early project planning and development stages of a project, the local representatives have an opportunity to participate in what will become part of their community's fabric for the next 50 to 75 years. As illustrated in the photographs, the use of concrete has offered flexibility in structural design and the opportunity for architectural enhancement in many of Minnesota's bridge structures.

36th Avenue North over TH 100, Robinsdale. (Two-span prestressed Concrete girder bridge)

For more information on Minnesota's bridges, visit www.dot.state.mn.us/bridge.