ARLINGTON AVENUE BRIDGE
(Bridge No. 6579)
Spanning Interstate 35E (I-35E) at Arlington Avenue
Saint Paul
Ramsey County
Minnesota

HAER MN-121
HAER MN-121

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD
ARLINGTON AVENUE BRIDGE (BRIDGE NO. 6579)

HAER No. MN-121

Location: Carries Arlington Avenue over Interstate 35E (I-35E) at Arlington Avenue, Saint Paul, Ramsey County, Minnesota.

The Arlington Avenue Bridge (Bridge No. 6579) is located at latitude 44.984618, longitude: -93.088949. The coordinate represents the center of the bridge. It was obtained in 2010 by plotting its location. The location has no restriction on its release to the public.

Present Owner/ Occupant: Minnesota Department of Transportation.

Present Use: Vehicular and pedestrian traffic.

Significance: The Arlington Avenue Bridge is significant as an early representative example of a prestressed concrete girder bridge in Minnesota. At the time of construction in 1959, prestressed concrete was emerging as a significant technological advancement in bridge design. At this same time, the Minnesota Interstate Highway system was under development and a large number of bridges were required to span and carry the new highway in the greater Twin Cities metropolitan area and throughout the state. The availability and economy of prestressed concrete as a bridge building material facilitated the development of the Interstate Highway system in the Twin Cities and throughout the country by providing the main materials for the construction of a large number of similar bridges in a short time at a very competitive cost. The Arlington Avenue Bridge also represents the development of Elk River Concrete, a regional company that collaborated with the Minnesota Highway Department (MHD) and other engineers to develop a system for prestressed concrete beam fabrication that further facilitated the state's bridge construction and Interstate and highway development during this period.

The bridge exhibits minor physical alterations; however, it retains its historic integrity of location, design, materials, workmanship, setting, feeling, and association. It was determined eligible for listing in the National Register of Historic Places (National Register) under *Criterion C* in the area of *Engineering* at the state level of significance.

Historian(s): Megan Ruiz, Architectural Historian; Katie Kaliszewski, Historian; Emily Pettis, Senior Historian; Amy Squitieri, Senior Historian; and Robert M. Frame, Senior Historian; Mead & Hunt, Inc.; August 2013.

Project Information: This documentation was prepared as mitigation for the proposed replacement of the Arlington Avenue Bridge. The Minnesota Department of Transportation (MnDOT) is the project sponsor and retained Mead & Hunt, Inc. (Mead & Hunt) to prepare this document. It was written by architectural historian Megan Ruiz, historian Katie Kaliszewski, and senior historians Emily Pettis, Amy Squitieri, and Robert M. Frame. Dietrich Floeter was responsible for photography.

Part I. Historical Information

A. Physical History:

1. Date(s) of construction: 1958.

2. Engineer: E.L. Gardner, Ellerbe & Company (Ellerbe & Company) of St. Paul, Minnesota.

Ellerbe & Company, an architectural and engineering firm, was led by Franklin Ellerbe and his son Thomas F. Ellerbe, Sr. The firm served transportation, institutional, and corporate clients nationwide. Within Minnesota, notable Ellerbe & Company projects include the state's first prestressed concrete bridge, constructed in 1957 (Bridge No. 9053) in Bloomington; the MHD State Highway Building (now the MnDOT Central Office), constructed in 1958 in Saint Paul; and the Mayo Clinic Diagnostic Building in Rochester, constructed in 1953-1954.[1] E.L. Gardner, the firm's Chief Structural Engineer, was responsible for the final plans for Trunk Highway 35 (later I-35E) in St. Paul, of which the Arlington Bridge is a part.[2]

3. Builder/Contractor/Supplier: Elk River Concrete Products, of Elk River, Minnesota, drafted and fabricated the prestressed concrete beams. Ashbach Construction Company, based in Minnesota, served as the contractor. St. Paul Foundry & Manufacturing Company, based in St. Paul, Minnesota, provided metal parts, while Paper, Calmenson & Company, also based in St. Paul, provided bearings.[3]

4. Original plans and construction: The original plans, prepared by Ellerbe & Company, are dated March 31, 1958.[4] Construction was completed in 1960.[5] The bridge was constructed as part of the overall I-35 Interstate Highway project through St. Paul.

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[1] "Biographical and Historical Notes," Ellerbe Architects Papers, 1914-1959, University of Minnesota Libraries, Northwest Architectural Archives, Manuscript Division, http://discover.lib.umn.edu/cgi/f/findaid/findaid-idx?c=umfa;cc=umfa;rgn=main;view=text;didno=naa004, Accessed 13 December 2013."

[2] Ellerbe & Company, Bridge No. 6579 Plan Drawings, Trunk Highway No. 35, State of Minnesota Department of Highways, 31 March 1958; According to the Preliminary plans for Bridge 6579, it was to be along Trunk Highway 10; at a later time the highway's number was changed.

[3] Construction documents that list all companies that were a part of the design, fabrication and construction of the Arlington Bridge can be found at Bridge 6579 Record, Minnesota Department of Transportation Central Files, St. Paul, Minn.

[4] Ellerbe & Company, Bridge No. 6579 Plan Drawings, Trunk Highway No. 35, State of Minnesota Department of Highways, 31 March 1958.

[5] Minnesota Highway Department, "Structural Metals Inspection Report," Minnesota Highway Department, Available at Bridge 6579 Records, Minnesota Department of Transportation Central Files, St. Paul, Minn.

The original plans called for a four-span bridge with prestressed concrete girders designed in accordance with American Association of State Highway Officials (AASHO) specifications.[6] The plans called for a bridge width of 30' with two traffic lanes and two 5' sidewalks. The east and west abutments were built on treated timber pilings. The original rail was aluminum. Notes in the final plans recommended that the skew for the bridge be 1 degree 57.' The bridge reflects the original design and dimensions.

5. Alterations and additions: Concrete crash struts were installed between the pier columns in 1986. In 1993 the bridge underwent minor alterations, including joint and deck reconstruction, scarifying and resurfacing the deck, and replacing expansion joints. A chain-link fence was added outside the railings along the edge of the deck in 1995.

B. Historical Context:

Development of prestressed concrete

Prestressed concrete first achieved widespread use as a bridge construction material in the middle of the twentieth century and was subsequently used for a large number of bridges. Prestressed concrete was developed in the late 1920s in Europe as a method for overcoming concrete's natural weakness in tension. It was considered innovative because it allowed for longer spans and elements than reinforced concrete, which was the preferred concrete bridge construction material at the time.

Prestressed concrete is best defined in *A Context for Common Bridge Types*:[7]

> In prestressed concrete bridges, the tensile forces caused by the application of loads are reduced in the main structural members by inducing internal compressive forces by means of high tensile strength wires, cables or (occasionally) bars. The compressive forces may be applied during fabrication of the member by stretching the steel reinforcement prior to casting and curing of the concrete. After the concrete has cured, the tension on the steel is released, thus transferring the load to the concrete. The concrete is in direct contact with the steel so that bonding of the two materials can occur. When external loads (traffic and the weight of the deck and other bridge components) are applied to the member, tensile forces that are thus created are counterbalanced by the internal compressive forces induced by the pre-tensioning of the steel. This method of pre-stressing is called pre-tensioning.
>
> Another method of pre-stressing, called post-tensioning, involves placing sleeves or ducts in the concrete member during fabrication, into which steel reinforcement is placed after curing of the concrete. The reinforcement is then stretched (stressed) by jacking, and locked in place by anchor plates or other locking devices. If bonding is desired, grout may be injected into the sleeves. In some cases, however, a protective covering is applied to the steel to de-bond it from the concrete in order to control cracking in end sections. Occasionally, though usually in more modern bridges that have not yet achieved "historic age," a combination of pre-tensioning and post-tensioning is used. But, whatever the method employed, when compressive forces are properly calculated and proper fabrication methodology is followed, the prestressed bridge members will not develop stress cracks.

[6] Ellerbe & Company, Bridge No. 6579 Plan Drawings.

[7] Parsons Brinckerhoff and Engineering and Industrial Heritage, *A Context for Common Bridge Types*, NCHRP 25-25, Task 15 (prepared for the National Cooperative Highway Research Program, October 2005), 3-101.

Unlike reinforced concrete, prestressed beams require specialized tensioning or casting beds for their manufacture, meaning that they cannot be produced just anywhere or by anyone, or at the bridge site itself. The design and construction of the beds were technological achievements in their own right in the early years of prestressed concrete usage, thus limiting manufacture of prestressed concrete to those precasters who made the investment in beds and could provide transportation of the beams to the bridge site. Precasting of prestressed concrete units also allowed for cost savings, as large quantities of beams could be mass produced at plants and then delivered to construction sites, allowing for reuse of forms.[8] Historian Carl Condit describes the importance of precast beams: "The precasting and prestressing of girders for concrete bridges have brought their construction as close to the methods of mass production as the building arts have yet come."[9] The ability to quickly produce large volumes of prestressed concrete bridge components allowed for fabrication and use on a large scale.

With the introduction of precasting concrete units in large quantities, it was quickly considered an ideal bridge construction material. The ability to use prestressed concrete to span longer lengths without adding weight also contributed to its popularity. Between 1951, when the first prestressed concrete bridge was constructed, and the mid-1950s, when the material was widely used in bridge building, information was readily disseminated on prestressed concrete to a wide audience. The Prestressed Concrete Institute (PCI), established in in 1954 in Tampa, Florida, became influential in the formulation of code provisions for prestressed concrete. The PCI, along with other organizations such as the American Concrete Institute (ACI), promoted the use and benefits of prestressed concrete in bridge construction. These groups disseminated information about prestressed concrete to bridge engineers and contractors through conferences, symposiums, and publications, such as the *PCI Journal* and *ACI Journal*. Articles written by bridge designers, fabricators, manufacturers, and university professors touted the advantages of this material, and the Bureau of Public Road's (BPR) 1954 *Criteria for Prestressed Concrete Bridges* provided codified standards.

The first prestressed concrete bridge constructed in the United States was the Walnut Lane Memorial Bridge in Philadelphia, it was replaced by a new prestressed concrete bridge in 1989.[10] The bridge was designed by a Belgian engineer, Gustave Magnel, and opened to traffic in 1951.[11] Magnel began working on the theory of prestressed concrete in the 1920s at the University of Ghent in Belgium and promoted the idea during a lecture series around North American universities in 1946. His book *Prestressed Concrete,* published in 1948, was significant as one of the first books on prestressed concrete in

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[8] Tung Y. Lin, *Design of Prestressed Concrete Structures* (New York: John Wiley & Sons, Inc., 1955) 31; Tung Y. Lin and Felix Kulka, "Fifty-Year Advancement in Concrete Bridge Construction," Journal of the Construction Division, Proceedings of the American Society of Civil Engineers 101, no. CO3 (September 1975): 494-495.

[9] Carl W. Condit, *American Building: Materials and Techniques from the First Colonial Settlements to the Present, 2d ed.* (Chicago: University of Chicago Press, 1982), 257.

[10] George D. Nasser, "The Legacy of the Walnut Lane Memorial Bridge," *Structure Magazine*, October 2008, 31.

[11] Joseph H. Wierbicki, P.E., A.G. Lichtenstein & Associates, Inc. "Walnut Lane Bridge, HAER No. PA-125," Historic American Engineering Record, Northeast Field Area, National Park Service, March 1988, http://www.loc.gov/pictures/collection/hh/item/pa1791/ (accessed 12 December 2013).

English.[12] Magnel was ultimately responsible for carrying the knowledge of Europe's prestressed concrete methods to the United States.

Walnut Lane Memorial Bridge was a three-span prestressed concrete bridge supported by 13 concrete girders in each span. The girders were prestressed by using four post-tensioned wire cables embedded in the concrete.[13] The main span was 160', long even by today's standards. Following the successful completion of the Walnut Lane Memorial Bridge, other states began exploring prestressed concrete as a building material for bridges. By 1955, when construction began on the Lake Pontchartrain Causeway outside New Orleans, Louisiana, engineers were comfortable enough with prestressed concrete construction to build the 24-mile-long bridge. At the time of construction, it was the longest precast, prestressed concrete bridge in the world.[14]

Interstate development in Minnesota and the Twin Cities metropolitan area

The rise in widespread prestressed concrete bridge construction coincided with the end of World War II (WWII) and the initiative to develop a national interstate highway system. In April 1944 President Franklin D. Roosevelt received the final report of the National Interregional Highway Committee, a task force convened in 1941 to make plans for a federal highway construction program that could be implemented after the war to offset anticipated unemployment. The committee's report, entitled *Interregional Highways*, called for the construction of 39,000 miles of Interstate express highways, including 5,000 miles constructed in and around major cities. The roads were to follow new alignments, with right-of-way selected cooperatively by federal, state, and local governments. To ensure a smooth flow of traffic, the new Interstates were to have limited access and grade separations, or bridges, to eliminate intersections. *Interregional Highways* formed the basis for the Federal Aid Highway Act of 1944, which called for the creation of a 40,000-mile Interstate system that would "connect principal metropolitan areas…industrial centers…serve the national defense, and connect…with routes of continental importance in the Dominion of Canada and the Republic of Mexico."[15]

When World War II came to an end in August 1945, it seemed as though road and bridge building would immediately emerge as a domestic priority. The need for improvements was clear. In Minnesota and other states, road construction slowed during the war. Shortages of materials and funding had caused even routine maintenance to be deferred. Meanwhile, major highways had been used heavily by an ever-expanding fleet of large trucks that transported raw materials and equipment for the war effort. As trucks

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[12] Charles C. Zollman, "Magnel's impact on the advent of prestressed concrete," *Journal of Prestressed Concrete,* Vol. 23, No. 3, (May – June 1978) 29-31.

[13] Nasser, 27.

[14] Nasser, 30.

[15] Patricia Cavanaugh, *Politics and Freeways: Building the Twin Cities Interstate System* (Minneapolis, Minn.: University of Minnesota Center for Transportation Studies/Center for Urban and Regional Affairs, 2006), 7; Bruce E. Seely, *Building the American Highway System: Engineers as Policy Makers* (Philadelphia: Temple University Press, 1987), 177-182.

increased in size and number, it became clear that many of the state's existing bridges were no longer sufficient to carry the heavy new loads.[16]

As a result of the need for new roadways and bridges, government leaders began to chart a course for nationwide road-building projects. The Federal-Aid Highway Act of 1944 provided funds for planning and surveys, and facilitated cooperation between federal, state, and local governments. However, it was not until the Federal-Aid Highway Act of 1956, with the increased funding it provided, that rapid development of the Interstate Highway system occurred. When the 1956 Act was enacted, the MHD announced plans to proceed with a $66 million road and bridge construction program, and construction started in earnest. The undertaking was described by *Minnesota Highways* as "a record shattering" effort representing the "biggest twelve-month's contract" in the state's history. Among other things, the program enabled the MHD to improve 530 miles of state trunk highways and construct 41 new bridges, including 22 grade separations and 19 stream crossings on this system.[17] Many of these efforts upgraded major trunk highway routes to expressway standards. Both expressways and freeways were designed to provide fast and safe mass transportation within and between metropolitan areas.

Within Minnesota, in addition to updates to the Trunk Highway system, three Interstate routes were proposed to pass through the state, covering some 900 miles and corresponding closely to the eventual alignments of I-35, I-90, and I-94.[18] I-35 was designed as a north-south route entering the state from Iowa and terminating in Duluth. I-90 was designed as an east-west route across the southern portion of the state from the border with La Crosse, Wisconsin, to Sioux Falls, South Dakota. I-94 was planned as an east-west route entering the state from Hudson, Wisconsin, and running northwest through St. Paul and Minneapolis to the border with Fargo, North Dakota.

The Twin Cities metropolitan freeway system eventually included four Interstate routes: I-35, including I-35W through Minneapolis and I-35E through St. Paul; and I-94, including its outer beltline comprised of I-494 encircling the southern and western portions of the greater metro area and I-694 encircling the northern and eastern portions of the metro area. From the beginning, the MHD planned to divide I-35 into east and west sections to facilitate movement to both the state capitol in St. Paul and the business center in Minneapolis. Early plans for the Twin Cities freeway system included approximately 50 bridges in St. Paul and 80 bridges in Minneapolis, with limited access to the freeways provided by on and off ramps at half- to one-mile intervals.[19] The Arlington Avenue Bridge is one such bridge that was constructed to span I-35E during this early period of Minnesota Interstate development.

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[16] Automotive Safety Foundation, "Highway Transportation in Minnesota: An Engineering Analysis," St. Paul, Minn., September 1954, 78; Michael T. Morris, "Before the Interstate: The Minnesota Highway Department from 1921-1956" (M.A. University of Wisconsin, River Falls, 1990), 96-97.

[17] "6-Month Program Covers 530 Miles," *Minnesota Highways* 6, no. 4 (February 1957), 1.

[18] District Nine Resource Section - Minnesota Highway Department, "History of the Interstate System at the National Level," 1975, 19.

[19] Cavanaugh, 12; "135 Miles of Freeways Planned for Twin Cities," *Minnesota Highways* 5, no. 8 (June 1956), 1, 4.

Minnesota's prestressed concrete bridges

With the implementation of the Federal-Aid Highway Act of 1956, Interstate and highway construction projects flourished in Minnesota. The need for Interstate bridges prompted the construction of specialized facilities to manufacture prestressed concrete beams, an undertaking that required substantial investment. Prestressed concrete quickly emerged as an important material for Interstate and non-Interstate bridges. It was used for 57 percent of Minnesota's Interstate bridges between 1956 and 1970.[20]

Prestressed concrete was first used by the MHD in 1957, a year after the implementation of the Federal-Aid Highway Act of 1956. In only 13 years the MHD constructed more than 450 prestressed concrete structures on both Interstate and non-Interstate routes. Ellerbe & Company designed the first state-owned prestressed concrete bridge in 1957. Bridge No. 9053 (extant) was constructed as part of the I-35W project and carries 94th Street over the Interstate in the suburban community of Bloomington. Prestressed concrete was selected over steel as the construction material because it was the less expensive option, a result of using precast, prestressed concrete produced in large quantities. In addition, steel deliveries would not meet the expedited timing conditions for the project.[21]

Use of prestressed concrete in MHD bridges significantly increased after its first use in the 94th Street Bridge. In 1958 the Walter Butler Company recommended using prestressed concrete for four bridges along a portion of the I-94 corridor through St. Paul. The company cited prestressed concrete's economy over steel. Their designs followed the standards codified in the 1954 *Criteria for Prestressed Concrete Bridges*, published by the BPR.[22] At about this time, the MHD retained Ellerbe & Company to prepare final plans for a portion of I-35E, following Mississippi Street, north of downtown St. Paul and the Capitol Interchange, which included bridges crossing the corridor. Early segments completed by Ellerbe & Company using prestressed concrete include the Arlington Avenue Bridge, the Wheelock Parkway Bridge (Bridge No. 6511, built in 1959, extant), and the Larpenteur Avenue Bridge (Bridge No. 6514, built in 1960, extant). Within the first three years of prestressed concrete usage on the Trunk Highway system in Minnesota, 70 bridges were built and contracts were let for 14 more.

In addition to Interstate projects, the MHD consistently used prestressed concrete in bridge construction, particularly for structures less than 500' in length and for spans of less than 100 feet. According to professionals working in the bridge construction business at the time, the AASHO and PCI standard

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[20] Minnesota Department of Transportation, *Bridge Inventory Database*, 2009.

[21] Ellerbe & Company. "Final Design and Estimate: Bridge No. 9053, 94th Street/T.H. 65 for State of Minnesota Department of Highways." 1957. Available at Bridge 9053 Records, Minnesota Department of Transportation Central Files, St. Paul, Minn.

[22] Walter Butler Company. "Preliminary Design Report for S.P. 1982-08, 6280-23 & 6280-25, Interstate Route 35E." St. Paul, Minn. 1959. Available at Minnesota Department of Transportation, St. Paul, Minn.

sections were followed for spans up to 100 feet.[23] During the period from late 1950s through 1970, the MHD also developed an innovative 40-inch section in addition to AASHO 27-, 36-, and 45-inch sections. The MHD left the decision to pre-tension or post-tension concrete beams up to the prestressed beam fabricator. Although AASHO specifications only required end blocks for post-tensioned prestressed concrete beams, the MHD required that all prestressed concrete beams have end blocks to provide an anchorage zone for the prestressed strands, and the MHD continued using end blocks through the 1970s.[24]

The MHD and Minnesota's prestressed concrete industry collaborated significantly regarding the use and development of prestressed concrete bridge members. Area manufacturers, such as Elk River Concrete Products. Company, were active in urging the MHD to permit innovations in prestressed concrete fabrication, such as alterations to concrete mixtures, in order to improve concrete quality. They also promoted the incorporation of accelerants to cure concrete and speed the manufacturing time, and adopted methods for increasing the strength of the prestressed concrete beams. The collaboration between the MHD and manufacturers was a mutually beneficial relationship for both the state and privately owned companies.[25]

Elk River Concrete Products was uniquely equipped to produce prestressed concrete bridge members during this early period of use and development. Founded in 1917 by L.D. Bailey and D.W. Longfellow, Elk River Concrete was the first of several companies in the Midwest that would comprise Cretex Companies, Inc.[26] By the 1950s Elk River Concrete had eight plant locations across Minnesota, including a concrete pipe plant and bridge fabrication department. The bridge department, located in Elk River itself, manufactured precast reinforced concrete bridge members. When the company incorporated prestressed concrete production, many employees were already trained in precasting bridge members. It was under the leadership of L.D. Bailey's son, Albert, that Elk River entered the prestressed concrete market under the technical guidance of engineer Charles C. Zollman.[27]

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[23] Donald Flemming, interview by Mead & Hunt, Inc., Oakdale, Minn., 4 February 2008; Robert McFarlin, Sr., phone interview by Mead & Hunt, Inc., 4 February 2008. The term "standard section" or "section" is referring to shapes and depths of girders that could be produced by concrete suppliers.

[24] Jim Nystrom, interview by Mead & Hunt, Oakdale, Minn., 28 January 2008; "Concrete is 'Squeezed' to Extend its Use," *Minnesota Highways* (April 1960), n.p.; Ellerbe & Company, "Final Design and Estimate: Bridge No. 9053, 94th Street/T.H. 65 for State of Minnesota Department of Highways," n.p.; American Association of State Highway Officials, *Standard Specifications for Highway Bridges, 9th ed.* (Washington, D.C.: American Association of State Highway Officials, 1965), 79. End blocks are thicker sections of concrete at each end of a prestressed girder that were used to prevent cracking in the early years of prestressed concrete production.

[25] Mead & Hunt, Inc., 88.

[26] Don Stolz, *Cretex Times* (Edina, Minn.: Beaver's Pond Press, 1997), 51.

[27] Stolz, 104.

Zollman, born 1916 in the Netherlands, studied under Gustave Magnel at the University of Ghent before immigrating to the United States in 1941.[28] Following World War II, the two men renewed their correspondence, out of which grew a professional relationship. During Magnel's North American lecture series, Zollman acted as his representative, making arrangements for the tour. After the tour was complete, Zollman worked with Magnel to translate chapters of what would become *Prestressed Concrete* into English.[29] It was Zollman who proposed Magnel's design for the Walnut Lane Memorial Bridge to the City of Philadelphia. Zollman's employer, the Preload Corporation located in Garden City, New York, was also chosen to fabricate the prestressed concrete beams, and Zollman acted as a supervisor for the design.[30] After completion of the Walnut Lane Memorial Bridge, Zollman emerged as one of the America's engineering experts on the design, fabrication, and installation of prestressed concrete beams.

Albert Bailey had studied the prestressing process, but needed further advice on the techniques and installation for the new, and expensive, casting and tensioning beds. In the mid-1950s he reached out to Zollman, as well as Zollman's coworker Morris Schupack, to act as a consultants for designing and constructing the new prestressed concrete area in the plant at Elk River. Later, Zollman would remark:

> The wise potential investor, the intelligent producer is the one who is willing to assume that he doesn't know anything about it [prestressed concrete fabrication] – most likely an understatement – but who then surrounds himself with competent men and lets them carry the ball.[31]

Zollman applied his expertise garnered while working on the Walnut Lane Memorial Bridge and developed a complex pattern for building casting beds, just one facet of the significant infrastructure required to manufacture, transport, and erect prestressed concrete beam bridges.[32] In 1957, with Zollman's guidance, Elk River Concrete built two casting beds at its Elk River location and began producing prestressed concrete members, primarily for MHD Interstate bridges, through the 1960s.[33] At the same time, Zollman acted as a design consultant for Elk River Concrete on MHD bridge projects and developed alternate designs for stringers in order to reduce construction costs of casting for non-standardized, prestressed bridge sections.[34] With their combined knowledge and skill, Bailey and Zollman "gave Cretex its leading position in bridge construction using prestressed products."[35]

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[28] Zollman, "Magnel's impact on the advent of prestressed concrete," 28.

[29] Zollman, "Magnel's impact on the advent of prestressed concrete," 31.

[30] Nasser, 27.

[31] Charles C. Zollman, "Planning and Design of Installations of Today's Pretensioned Requirements," *Journal of Prestressed Concrete* 2 (March 1958), 74.

[32] Jim Nystrom, interview by Mead & Hunt, Inc., Oakdale, Minn., 28 January 2008. Nystrom was an employee at Cretex, which is still in operation.

[33] Dennis Voight, Roy Barthel and Jim Nystrom, interview by Mead & Hunt, Inc., Elk River, Minn., 17 September 2009.

[34] Charles C. Zollman Consultants, "Alternate Stringer Design, 1958," Minnesota State Highway Department, Available at Bridge 6579 Records, Minnesota Department of Transportation Central Files, St. Paul, Minn.

[35] Stolz, 104.

In addition to Elk River Concrete, Minnesota's burgeoning prestressed concrete bridge construction industry attracted attention from several construction firms. Recognizing the potential market for large numbers of prestressed concrete bridges in association with the burgeoning Interstate system, companies like Guaranteed Gravel and Sand Company of Mankato, Minnesota, invested significant amounts of capital into developing manufacturing systems in advance of bidding on structures. Demonstrating the urgency of getting manufacturing processes up and running and the investment at stake, Guaranteed Gravel and Sand wrote to the MHD in January 1957 regarding the future contract letting of Bridge No. 9053: "At the present time we are in the process of installing a 20' flat bed which will be 295' long between the buttresses…It is our hope that we will be in a position to offer a prestressing service which will conform in every respect to the high standards which your department sets up." Guaranteed Gravel and Sand also urged the MHD to share the plans for Bridge No. 9053, the state's first prestressed concrete bridge, in order to determine the best way to install devices for draping tensioning strands.[36]

As prestressed concrete bridges were built in rapid succession, changes were necessary in the construction process. New trucking systems were required to deliver beams as they became longer. After arriving at the bridge construction site, prestressed beams were hoisted into place with large-scale machinery, such as cranes. Contractors' cranes were small and inadequate during the MHD's early foray into prestressed concrete bridge building. Contractors eventually acquired larger equipment, such as the 50-ton crane, which could handle the prestressed bridge components.[37]

Construction of Arlington Avenue Bridge

The Arlington Avenue Bridge was constructed as part of the State Trunk Highway No 35, later I-35E Interstate Highway project through St. Paul. Preliminary plans first suggesting the use of prestressed concrete were completed in 1956 by E.L. Gardner, the Chief Structural Engineer for Ellerber & Company.[38] Final plans were approved by MHD on March 31, 1958, only one year after Ellerbe had designed the first prestressed concrete bridge in the state (Bridge No. 9053). Due to delays in right-of-way acquisition, construction did not begin until summer of 1958.[39] A number of local companies were involved in the construction process. Elk River Concrete Products fabricated the beams, probably under the guidance of Zollman, as he was designing alternate prestressed girders for their projects during this

[36] Frank Balcerzak, "Frank Balcerzak, Guaranteed Gravel and Sand Company, to A.E. LaBonte, Minnesota State Highway Department, Letter, January 26, 1957," n.p.

[37] Donald Flemming, interview by Mead & Hunt, Inc.

[38] "Ellerbe & Company, "Preliminary Design and Recommendations Bridge No. 6579 Arlington/Trunk Highway 10 for State of Minnesota 20 Ft. Roadway H20-S16 Loading," Minnesota Highway Department, Available at Bridge 6579 Record, Minnesota Department of Transportation Central Files, St. Paul, Minn.

[39] E.J. Rowland, "Right of Way Certificate from E.J. Rowland, Engineer of Lands & Right of Way to A.I. Overbee, Division Engineer" Minnesota State Highway Department, Letter, 2 July 1958, Available at Bridge 6579 Records, Minnesota Department of Transportation Central Files, St. Paul, Minn.

time.[40] The St. Paul Foundry & Manufacturing Company provided some of the metal parts, and Paper, Calmenson & Company provided the bearings. Ashbach Construction Company served as the contractor for the bridge, which was complete by the fall of 1960.[41]

Alterations to Arlington Avenue Bridge

Although the Arlington Avenue Bridge has experienced several alterations, it retains a high degree of integrity and reflects its historic appearance. Concrete barrier walls (also termed "crash struts") were installed between the pier columns in 1986, and minor alterations were completed in 1993 when the deck joints were updated and the deck reconstructed. A chain-link fence was added outside the railings along the edge of the deck in 1995. The Arlington Avenue Bridge is scheduled for removal in 2014.

[40] Charles C. Zollman Consultants, "Alternate Stringer Design, 1958" Minnesota State Highway Department, Available at Bridge 6579 Records, Minnesota Department of Transportation Central Files, St. Paul, Minn.

[41] Minnesota Highway Department, "Structural Metals Inspection Report," Minnesota Highway Department, Available at Bridge 6579 Records, Minnesota Department of Transportation Central Files, St. Paul, Minn.

Part II. Structural/Design Information

A. General Statement:

1. Character: The Arlington Avenue Bridge (Bridge No. 6579) exemplifies the early use of prestressed concrete for bridge construction in Minnesota.

2. Condition of fabric: Good.

B. Description: The Arlington Avenue Bridge (Bridge No. 6579) carries Arlington Avenue on an east-west axis over a north-south segment of I-35E in the City of St. Paul. It is a four-span prestressed concrete girder bridge with a total structure length of 185', 4", including two center 55.7' spans and two 35' side spans. Within the out-to-out deck width of 42.3', the bridge carries a 30', undivided, two-lane, two-way roadway and a 5' sidewalk on each side. The superstructure is skewed at two degrees relative to the underlying roadway. The vertical clearance beneath the spans is 15.2'. The roadway beneath the bridge is 102' wide and includes two 51' double lanes divided by a 6' median.

The center spans (spans 2 and 3) are each comprised of nine precast prestressed (pretensioned) I-section concrete girders, 54" deep, 11-3/8" in length, spaced at 4.6' on centers. The side spans (spans 1 and 4) are comprised of five precast, prestressed (pretensioned), I-section concrete girders, 34', 9-1/2" deep, spaced at 9.0' on centers. The girders for spans 2 and 3 are Type 1; the girders for spans 1 and 4 are Type 2. Each girder has concrete end blocks on both ends. The girders rest on expansion bearings at the abutments and center (median) pier 2, and fixed bearing assemblies at the two side piers (piers 1 and 3). Concrete diaphragms are located between the beams on all four spans. The deck is constructed of cast-in-place concrete, as are the sidewalks.

The substructure is comprised of two reinforced concrete abutments on pilings and three reinforced-concrete piers on spread footings. The piers are aligned perpendicular to the underlying roadway. Each pier has three square columns separated by angular arched openings. Concrete crash struts were added between the pier columns in 1986. The columns are fluted on the outside (highway) faces, with the recess of the fluting deepening at the top of the column to create a shadow. The abutments are also perpendicular to the underlying roadway, but the U-form wingwalls are aligned to match the skew of the superstructure. Each wingwall unit is designed with adjacent three walls that extend from grade to above the deck in a stepped arrangement to become form a railing with a modern architectural stylistic element. Precast concrete-block slope protection is located between each abutment and side pier.

The railings, which extend the length of the four spans and terminate at the wingwall extensions, are comprised of two horizontal aluminum pipes supported by curved metal posts that are bolted atop a 1.5' curb. An 8' tall chain-link fence along the edges of the deck and outside of the railings was added in 1995. An "Arlington Avenue" road sign is mounted at the centers of the north and south sides of the bridge. A bronze bridge plate is mounted on the northeast railing, but was obscured by a metal guard rail added at an unknown date. An additional bronze bridge plate is mounted on the south column of the east pier column facing the roadway.

C. Site Information: Arlington Avenue Bridge spans I-35E in St. Paul, Minnesota. It is located in an urban area.

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