

Highland Boulevard Viaduct

Carrying traffic from West Highland Boulevard  
over the Chicago, Milwaukee & St. Paul Railroad  
Milwaukee  
Milwaukee County  
Wisconsin

HAER No. WI-26

HAER  
WIS,  
40-MILWA,  
48-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record  
National Park Service  
U. S. Department of the Interior  
P. O. Box 37127  
Washington, D. C. 20013-7127

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Location: Carrying traffic from West Highland Boulevard over the Chicago, Milwaukee & St. Paul Railroad  
Milwaukee, Milwaukee County, Wisconsin

UTM: 16.421390.4766080  
Quad: Milwaukee, Wisconsin

Dats of Construction: 1909

Present Owner: City of Milwaukee

Present Use: Pedestrian and vehicular bridge

Significance: The two-span reinforced concrete, arch bridge was designed by the well-known engineer, Claude A. P. Turner. The Neoclassical bridge allowed the extension of Highland Boulevard, one of the city's most prominent addresses to the west. Mr. Turner, based in Minneapolis, is known for his many theories on concrete construction, including the flat slab construction method. The Highland Boulevard Viaduct is one of the earliest remaining Turner-designed bridges in the United States.

Historian: Edwin Cordes  
Wisconsin Historic Bridges Recording Project  
Summer 1987

## HISTORY

The Highland Boulevard Viaduct, built in 1909, permitted the continuation of one of the city's most desirable residential areas. Designed by the renowned engineer/architect, Claude A. P. Turner, the barrel arched concrete viaduct utilizes a hooped rod system of reinforcement. Neoclassical styling, along with the permanence of concrete construction, make this span aesthetically pleasing and appropriate for its location.

## DESCRIPTION

The Highland Boulevard Viaduct consists of two 100-foot reinforced concrete arch spans and has a total length of 446 feet, including the reinforced retaining wall approaches. The structure is 75 feet wide, with a 50-foot road and two 12-foot sidewalks. The bridge is relatively level, with only a .8% grade ascending to the south. Both arches are of three centered design and rise 22 feet above the springing line. The arch rings are 20 inches thick at the crown and expand to 13 feet radically at the skewbacks.<sup>1</sup>

Neoclassical design elements are prevalent throughout the bridge. Brick and cast stone are used for ornamentation. The masonry veneer consists of a hard burned, vitrified red brick set in a Flemish bond for strength. This brick veneer composes the exterior surface of the spandrel, wing and retaining walls. The pilasters and central pier are accented with cast stone quoining and infilled with red brick.<sup>2</sup> All the stone detailing was cast by the Milwaukee firm of Hitchins and Fiske.<sup>3</sup> Cast-in-place stone veneer voussoirs emphasize the Neoclassical lines of the arch rings. Ornamental cast parapets and balustrades completed the design, but have since been replaced by a steel railing.

## CONSTRUCTION

The Milwaukee Board of Public Works awarded the design for the Highland Boulevard Viaduct to the Minneapolis firm of Claude A. P. Turner on December 9, 1907. The design was completed by the spring of 1908, and the city paid Turner \$1733.19 for his services.<sup>4</sup> The Common Council let the construction contract to B. E. Sivyver and Company, a Milwaukee contractor, on July 6, 1908, for a total sum of \$57,773. Construction and cement work on the foundations commenced in September 1908.<sup>5</sup> A contract clause stating that no concrete could be poured below 32 degrees forced work to be halted in November of that year. Both arches had been completed by this point and work was progressing on the formwork for the approach spans. Construction of the viaduct resumed in late March 1909 and was completed later that summer.<sup>6</sup> A contract for erection of a retaining wall, northeast of the span completing the final phase of the project, was awarded to S. C. Coddington in March 1910 for a total cost of \$5,323. The work was completed in June 1910. The city accepted the viaduct on June 30, 1910, for an aggregate cost of \$68,352.<sup>7</sup>

Construction of the centering and falsework for the twin arches presented some difficulty. Clearance needed to be maintained for the Chicago, Milwaukee & St. Paul Railway tracks, due to their heavy use. In order to span the railroad's right-of-way, the falsework and centering was carried on 24-inch I-beams, 36 feet long, supported 20 feet above the tracks. Additional falsework for the second arch was constructed, using traditional timber form methods.<sup>8</sup>

Concrete used in the viaduct's construction was prepared at the site using two portable Smith mixers. The use of two mixers, one on each side of the ravine, eliminated the necessity of carrying the mix across the tracks. The mixers were placed against the hill and the steep slope allowed the raw materials to be dumped directly into the mixers by hand from above. Towers and chutes were then used to funnel the concrete where it was needed. A hand-operated cableway transported the rubble stone to the construction site for mass masonry work on the foundations.<sup>9</sup> Casting of the central arches required precise timing. The mass of the central pier was not great enough to resist the outward thrust of the arches. The rings were poured simultaneously on both sides of the central pier, so that loading upon the pier and centering devices was balanced.<sup>10</sup>

#### REINFORCING

The arch rings are reinforced both longitudinally and transversely, using two woven sheets of steel rods bound together at the intersections. Two sets of 3/4-inch rods spaced ten inches on center run the length of the arch, from the center pier to a level well below the springing point at the abutments. This method insured secure anchorage. Transverse reinforcement rods of 5/8 inches were laid at the same level as the longitudinal rods and bound to each other with wire. The bottom reinforcing web is placed one inch from the intrados and the top web is located 1-3/4 inches from the extrados. Proper spacing between the two sheets was maintained by regularly spaced vertical angles that were also used to resist shear forces. Workers completed assembly of the reinforcing system for each arch before any concrete was placed. This method allowed the steel to be placed considerably more rapidly and without hindrance to the concrete work.<sup>11</sup>

#### SITE DEVELOPMENT

Highland Boulevard has long been noted as one of Milwaukee's most desirable addresses. The boulevard was created by the Milwaukee Common Council in 1896 as the city's first parkway. Soon afterward, a large number of wealthy first and second generation German businessmen began to build their residences on the street. Frederick Miller of beer brewing fame and Frederick Ueinger, the sausage maker, both located there. The boulevard's Germanic orientation eventually earned it the nickname 'Sauerkraut Boulevard.' The majority of the homes were variations of the Romanesque revival, Classical revival and English Tudor styles. Large mansions were often interspersed with somewhat smaller residences owned typically by middle income merchants and business executives.<sup>12</sup>

Although the arsa surrounding the street was annexed by the city as early as 1885, significant building did not occur until shortly before the turn of the century. Original boundaries for the boulevard were Washington Avenue to the east and Western Avenue or N. 35th Street to the west. A housing boom continued until the beginning of World War I and, by 1907, had reached a point that expansion of the street westward was deemed necessary.<sup>13</sup> In the fall of that year, the city engineer, Charles Poetsch, began contacting engineering firms regarding the project. A sizable bridge would be needed to span the steep ravine containing the two main tracks of the Chicago, Milwaukee and St Paul Railway. The Board of Public Works choose reinforced concrete as the material, since it offered the best choice for both durability and aesthetic beauty.<sup>14</sup>

#### C. A. P. TURNER

The Highland Boulevard Viaduct is one of the earliest remaining examples of reinforced concrete bridge design by the well-known Minneapolis engineer, Claude A. P. Turner. Many improvements in reinforced concrete construction are attributed to Turner. The engineer is associated with the development of the concrete flat slab construction method in the United States and was granted a patent for his innovations in 1908. Flat slab construction made possible the erection of long span plate girder bridges and large warehouse-type buildings requiring overhead space and heavy loading capacities. Flat slab design principles were first applied to bridge construction in 1908, when Thomas Greene chose this method for the Lafayette Avenue Bridge over the Soo Line tracks in Minneapolis. This system was advantageous in situations which required restricted overhead clearance because it eliminated thick girders.<sup>15</sup>

C. A. P. Turner is also known for his design of a steel, three hinged railroad bridge for the Soo Line over the St. Croix River near New Richmond, Wisconsin. The three-hinged arch design is most often found in lighter highway structures due to its inherent weakness over two hinged designs. Turner's delicate rib arch span is remarkable for its ability to carry the heavy railway loads. The engineer designed the central hinge to slide into a rigid locked position under loading temporarily transforming the ribs into a two-hinged arch.<sup>16</sup>

#### DESIGN CONTROVERSIES

Milwaukee Common Council proceedings contain two letters written to the city engineer, Charles Poetsch, in October 1907, by engineering firms interested in the project. Letters were received from Claude A. P. Turner of Minneapolis and from The Concrete-Steel Engineering Company of New York, which, six months earlier, had been awarded first prize in the Grand Avenue Viaduct design competition.<sup>17</sup>

The Concrete-Steel Engineering Company was the successor to the Melan Arch Construction Company which held the patent rights to the Melan beam concrete reinforcing system. The company was headed by Edwin Thacher and William

Mueser, who both also held important patents for innovations in concrete reinforcing. The New York firm, which specialized in bridge and viaduct construction, had used the Melan reinforcing system in their winning Grand Avenue Viaduct design. Although the Grand Avenue Viaduct was not completed until 1911, the competition was staged before the contract was let to Turner for the Highland Boulevard project.

C. A. P. Turner's engineering firm was awarded the second place design in the Grand Avenue competition. Turner's competition entry employed the newer, more radical hooped rod method of reinforcing. This type of reinforcing would eventually be used in the Highland Avenue project and involved the concentration of smaller rods of steel in the areas of tension. While this system, called the Considere system after its inventor, had been used extensively in Europe as early as the 1880s, it failed to gain acceptance in American engineering circles for some time thereafter. The Grand Avenue contest judges called Turner's design "rather bold" and "far in advance of current American technology." This is probably one reason the engineer's design did not win.<sup>18</sup>

The acceptance of Turner's design for the Highland Boulevard Project so soon after the rejection of his Grand Avenue scheme leads one to believe that a critical evolution in construction technology had taken place. City officials, who had just a short time earlier rejected Turner's plans, now saw merit in construction of a bridge which could truly be called concrete. The opposing Melan system used such a great quantity of steel that the result was basically a metal bridge with a concrete cover. Turner's design was not the only Milwaukee bridge which employed innovative reinforcing methods, (the 1905 Kahn bar reinforced Lake Park pedestrian bridge is another example), but it was the first large scale project to use the hooped rod system. The Highland Boulevard Viaduct can be seen as the decisive large scale bridge project in the city of Milwaukee, in terms of acceptance of the newer, more economical reinforcing technologies.

FOOTNOTES

- 1 "The Highland Boulevard Viaduct, Milwaukee." The Engineering Record. Vol. 59, No. 24, June 12, 1909, pp. 747-748.
- 2 Plans - A 1938 W.P.A. tracing of the original Turner 1908 Highland Boulevard Viaduct elevation, along with several historical photographs, can be found at the Milwaukee Bureau of Bridges and Public Buildings.
- 3 "Highland Boulevard Viaduct," p. 748.
- 4 "Annual Report of the Department of Public Works," Milwaukee: Edw. Keogh Prese, 1910.
- 5 "Highland Boulevard Viaduct," p. 748.
- 6 Ibid.
- 7 "Annual Report DPW - 1910."
- 8 "Highland Boulevard Viaduct," p. 747.
- 9 Ibid.
- 10 Ibid.
- 11 Ibid, p. 748.
- 12 Built in Milwaukee - An Architectural View of the City, Milwaukee: City of Milwaukee Department of City Development Publications, 1983. An architectural survey of the city, completed by Landscape Research, Inc., for the city of Milwaukee's mayor's office.
- 13 Ibid.
- 14 "Specifications for the Highland Boulevard Viaduct over the Chicago, Milwaukee & St. Paul Tracks." Original copy of C. A. P. Turner's design specifications can be found in Highland Boulevard Viaduct file at the Milwaukee Bureau of Bridges and Public Buildings.
- 15 Condit, Carl W. American Building. Chicago and London: The University of Chicago Press, 1982.
- 16 Ibid.

- 17 A file containing the two original letters, along with copies of the original specifications for the Highland Boulevard Viaduct, can be found at the Bureau of Bridges and Public Buildings in Milwaukee.
- 18 "Competitive Designs For a Reinforced-Concrete Viaduct in Milwaukee, Wis.,"  
Engineering News, Vol. 57, No. 7, February 14, 1907, p. 180.

BIBLIOGRAPHY

- "Annual Report of the City Engineer." Milwaukee: Edw. Keogh Press, 1908-1909.
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- Built in Milwaukee - An Architectural View of the City. Milwaukee: City of Milwaukee Department of City Development Publications, 1983. An architectural survey of the city, completed by Landscape Research, Inc., for the city of Milwaukee mayor's office.
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- Plans - A 1938 W.P.A. tracing of the original Turner 1908 Highland Boulevard Viaduct elevation, along with several historical photographs, can be found at the Milwaukee Bureau of Bridges and Public Buildings.
- "Proceedings" of the Milwaukee Common Council, 1907-1909. A microfilmed copy of City Common Council proceedings can be found in the Milwaukee City Records Center.
- "Specifications for the Highland Boulevard Viaduct over the Chicago, Milwaukee & St. Paul Tracks." Original copy of C.A.P. Turner's design specifications can be found in Highland Boulevard Viaduct file at the Milwaukee Bureau of Bridges and Public Buildings.
- "The Highland Boulevard Viaduct, Milwaukee." The Engineering Record. Vol. 59, No. 24, June 22, 1909, pp. 747-748.
- Turner, Claude A. P. 'Advance in Reinforced-Concrete Construction: An Argument for Multiple-Way Reinforcement in Floor Slabs.'" Engineering News. Vol. 61, No. 7, February 18, 1909, pp. 178-181.

ADDENDUM TO:  
HIGHLAND BOULEVARD VIADUCT  
Spanning Railroad Tracks on West Highland Boulevard  
Milwaukee  
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Wisconsin

HAER WI-26  
*HAER WIS, 40-MILA, 48-*

PHOTOGRAPHS

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1849 C Street NW  
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