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GRAND AVENUE VIADUCT
(Gordon Avenue Viaduct)
Iowa Bridges Recording Project II
Over the Chicago & North Western Railroad
& Stockyard on U.S. Highway 20
Sioux City
Woodbury County
Iowa

HAER No. IA-87

BLACK & WHITE PHOTOGRAPHS

WRITTEN HISTORICAL & DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Department of the Interior
P.O. Box [illegible]
[illegible] D.C. 20013-7127

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HISTORIC AMERICAN ENGINEERING RECORD

GRAND AVENUE VIADUCT
(Gordon Avenue Viaduct)

HAER No. IA-87

Location:	U.S. Highway 20, Business and State Highway 12. Spanning the Chicago and North Western Railroad and Stockyard in Sioux City; Woodbury County, Iowa UTM: 14.714765.4707225 USGS: Section 34, Township 89 North, Railroad 47 West
Date of Construction:	1936
Designers:	Ash, Howard, Needles and Tammen, Kansas City, Missouri
Builders:	C.F. Lytle Company, Sioux City, Iowa
Fabricators:	Unknown
Present Owner:	Iowa Department of Transportation
Present Use:	Highway viaduct
Significance:	Extending for over three-quarters of a mile, the Grand Avenue Viaduct is Iowa's longest grade separation and the state's longest bridge except for the Mississippi River structures.
Historians:	Richard Vidutis, James Hippen
Project information:	This document was prepared as part of the Iowa Historic Bridges Recording Project performed during the summer of 1996 by the Historic American Engineering Record (HAER). The project was sponsored by the Iowa Department of Transportation (IDOT). Preliminary research on this bridge was performed by Clayton B. Fraser of Fraserdesign, Loveland, Colorado.

EVENTS SCHEDULE

1935 - work begins on viaduct plans as Sioux City takes advantage of Hayden-Cartwright Act funds to solve serious traffic problems in its Floyd River section of town.

March 17, 1936 - Iowa Highway Commission Chief Engineer, Fred White, hires firm of Ash-Howard-Needles and Tammen for $18,000 to prepare detailed plans for the proposed viaduct on Grand Avenue.

June 1936 - bids are solicited for bridge contract.

June 30, 1936 - bridge work contract awarded to C.F. Lytle Company, Sioux City, for $783,932.01.

July 1936 - work begins on the Grand Avenue Viaduct.

November 1936 - work on the viaduct completed.

INTRODUCTION

The Grand Avenue Viaduct carries a city street over an industrialized section of the Floyd River Valley congested with businesses and railroads. A multiple-span steel deck girder structure, the Grand Avenue Viaduct extends over three-quarters of a mile through the downtown district. Built during the Depression in order to create jobs and solve one of Sioux City's biggest traffic problems, the Grand Avenue Viaduct is distinguished as Iowa's longest grade separation and the State's longest bridge other than the Mississippi River structures.

I. REGIONAL HISTORY

The first authentic account of white men passing through the area of what would become Sioux City was the Lewis and Clark expedition of 1804. But the first settlers did not arrive until 1848 and 1849. In 1854 John K. Cook, who was under government contract to survey a part of northwest Iowa, was so impressed with the area of Sioux City that he located a claim and set about laying out Sioux City in December of that year. Even at that early date, the unique position of Sioux City was clear to see. The valleys of the Missouri, the Sioux, the Floyd and other smaller streams merged at this point; the soil was excellent; and beyond the corn belt, the west lay open with its vast stretches of prairie all the way to Montana and Wyoming. It quickly developed into a gateway to the West becoming a great outfitting point for the Dakotas and Montana shipping large amounts of freight for the mines.[1] The prairies offered opportunities for grazing and settlers soon had large herds of cattle, hogs, and sheep. Thus Sioux City became a trading center for a large territory producing wheat, corn, oats, hay, cattle, hogs, sheep, horses, and dairy products.[2]

The railroads played a very important role in developing the many industries in Sioux City and probably was the single most important event in the history of the city. The first railroad was the Sioux City & Pacific which ran for the first time on March 9, 1868, from Missouri Valley to Sioux City. This line was

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[1]William J. Petersen, Iowa: The Rivers of Her Valleys (Iowa City: State Historical Society, 1941), p. 223.

[2]Polk's Sioux City (Iowa) Directory, 1929, Vol. XLIV (Kansas

a forerunner of a network of roads that was to make Sioux City a center of rail traffic, river traffic, and, eventually, motorized traffic.[3]

By the 1930s Sioux City had six trunk railroads with a total of about 20 distinct lines extending in every direction to every corner of the country. The railroad companies were: Chicago & Northwestern; Illinois Central; Chicago, Milwaukee, St. Paul & Pacific; Great Northern; Chicago, Burlington & Quincy; and the Chicago, St. Paul, Minneapolis & Omaha. This great collection of railroads served a city whose chief industries were in manufacturing, agriculture, distributing, meat-packing and milling. It had a population of 80,000 working in 103 establishments producing goods to the value of $54,386,895 in 1936, the year the Grand Avenue Viaduct was built.[4]

II. HISTORY OF THE GRAND AVENUE VIADUCT

The expansion of Sioux City followed the flat lands along the Floyd River. In 1887, Sioux City was experiencing its greatest economic boom in its history largely served by the Missouri River and four railroads. Geographically, the location of the city did not allow for easy expansion--steep hills rose to the north and west from the river and along the Floyd River Valley to the east, the area, known as Morningside, was stuffed with packing plants, cattle pens, railroad lines and stock yards. This array of establishments, which included 84 railroad crossings, created a crossing problem no one could solve. Prior to 1887 Sioux City was served by only a few scattered surface lines with cars drawn by horses, cable, or powered by steam, but no one could overcome the problem of easily traversing the Morningside area. In 1885 the Sioux City Rapid Transit Company was organized to provide a double tracked elevated railway to go from Third and Jones streets in the business district and then connect to a single-tracked surface line on Leech Street in Morningside. The system ran through World War I[5] and was the first large scale attempt to provide a service which was eventually solved on a grand scale by the Grand Avenue Viaduct in 1936.

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[3]Ibid.

[4]Polk's Sioux City (Woodbury County, Iowa) Directory, 1936, (Kansas City: R.L. Polk and Co., Publishers, 1936), p. 10.

[5]William Thompson, Transportation in Iowa: A Historical

In 1934 Congress passed the Hayden-Cartwright Act allowing federal monies to be used for road and bridge construction within municipalities. The impetus behind the Act was to provide jobs during the Depression. Sioux City took advantage of the opportunity to get a share of the $200,000,000 of unmatched funds and grants allocated to the States[6] and requested the IHC to design plans for a viaduct. Work began on the plans in 1935. But instead of the commission designing the bridge, Chief Engineer Fred White was instructed (March 14, 1936) by the Iowa Highway Commission to enter into an agreement with outside engineering consultants Ash-Howard-Needles and Tammen, from Kansas City, for the preparation of detailed plans for the proposed viaduct on Grand Avenue in Sioux City. The price to be paid the firm for the plans was $18,000, slightly less than three percent of the preliminary estimated cost of the viaduct.[7]

Bids were solicited by IHC for the Grand Avenue Viaduct in June 1936.[8] On June 30, 1936, a bridge construction contract was awarded to C.F. Lytle Company of Sioux City for $783,932.01.[9] Work commenced in July, although an agreement with the city of Sioux City relative to the construction of a proposed viaduct on Grand Avenue was not approved by the IHC Board until September 15, 1936.[10] Work continued until completion November of 1936. When finished, the viaduct extended from Court Street to South College Street having consumed almost 13,000 cubic yards of concrete, 1.1 million pounds of reinforcing steel and 6.2 million pounds of structural steel.[11]

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[6]William Thompson, Transportation in Iowa: A Historical Summary (Ames: Iowa Department of Transportation, 1989), p. 179.

[7]Iowa Highway Commission Minutes (March 17, 1936); the original estimate for the Grand Avenue Viaduct had to have been in the neighborhood of $600,000.

[8]Iowa State Highway Commission, *Weekly Letting Report* 24:25 (June 17, 1936).

[9]Ibid., IHC Minutes, July 7, 1936.

[10]Ibid., September 15, 1936.

[11]Fraserdesign, Iowa Historic Bridge Inventory, Inventory Report, Vol. VIII. (1269 Cleveland Avenue, Loveland, Colorado, 1993-94), p. WOOD01, FHWA: 052830.

By 1936 the Grand Avenue Viaduct was built not only to cross the industrial valley of the Floyd River but also to expedite traffic on Highways 20, 50, and 77 east and west through the city and to speed truck and other heavy traffic in the stockyards and industrial areas by providing a clear passageway for passenger and through traffic. But because construction of the whole structure, including approaches, was not completed all at once, the Public Works Administration project--costing $800,000--was seen by some as a great waste of public money. The viaduct was constructed under the mayoral term of W.D. Hayes. The viaduct became a political issue in the 1938 campaign when challenger David F. Loepp, a local attorney, singled out the viaduct as an example of waste in government and proclaimed that the bridge "began nowhere and ended nowhere." Hayes lost his attempt at an unprecedented fifth term.[12]

III. DESIGN AND TECHNOLOGY OF THE GRAND AVENUE VIADUCT

Two major types of bridges are used extensively in Iowa in the late twentieth century for medium and large spans. These are the continuous steel girder and the precast, prestressed concrete girder. The prestressed girder has come into use since World War II, but the continuous bridge has a long history. The Grand Avenue Viaduct represents an important step in the emergence of this technology from experimental to common use.

The continuous beam, girder, or truss bridge has the advantage over simply supported structures in a saving of material and greater stiffness.[13] This was demonstrated on a grand scale by Robert Stephenson's Britania Bridge, completed in 1850.[14] American engineers, however, were slow to adopt the idea of continuity in a bridge, considering it impractical both because of its vulnerability to the effects of any pier settlement and

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[12]Scott Sorensen and B. Paul Chicoine, Sioux City: A Pictorial History, (Norfolk/Virginia Beach, Virginia: Donning Company, Publishers, 1982), p. 182.

[13]The principle of continuity is clearly explained in Harry Parker, Simplified Design of Reinforced Concrete (New York: Wiley, 1943), chapter 3, and later editions of the same work.

[14]Charles Singer, et al. A History of Technology, 5 The Late

the difficulty of calculating the stresses involved.[15] Some very few examples were built in North America, and the theory found its way into textbooks, but the attitude of the great majority of engineers was summed up, and fortified, by J.A.L. Waddell (the pontifex maximus of the profession) who concluded "few American engineers will countenance the building of continuous girder bridges."[16] In 1917, the next year, Gustav Lindenthal completed the great Sciotoville, Ohio, continuous truss, and engineers began a slow realization of the practical possibilities in the continuous approach.[17]

In Iowa, as in the profession generally, engineers approached the previously condemned idea with care. In trusses and in girders the nearest thing to a continuous structure is a cantilever. For major bridges, such as crossings of the Mississippi and Missouri rivers, cantilever trusses had been used for decades. The first large continuous truss was the Nebraska City bridge over the Missouri, built in 1929.[18] Others were built in the 1930s over the Mississippi, the Missouri, and the Des Moines rivers.

Of wider importance throughout the state was the gradual acceptance of continuous bridges for moderately large crossings. The first, so far as is known, was designed by the highway commission to replace a Luten patented arch that had collapsed in Ames. Built to carry the Lincoln Highway over Squaw Creek, the bridge was a three-span steel through plate girder, and it was continuous. The inflammatory word "continuous" was not used, however, in describing the bridge. The captions to published photographs merely call attention to the beauty of the "continuous curve" of the camber of the bridge, "instead of a series of lines breaking at the pier points."[19] Also noted is the fact that the three girders are "permanently connected to each other end to end," thus saving in the number of supports needed

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[15]George A. Hool and W.S. Kinne, Movable and Long-Span Steel Bridges, 2nd ed. (New York: McGraw-Hill, 1943), pp. 199-201.

[16]Bridge Engineering I (New York: Wiley, 1916), p. 482.

[17]Carl W. Condit, American Building Art: The Twentieth Century (New York: Oxford University Press, 1961), pp. 92-100.

[18]Sverdrup & Parcel, Engineering Projects (St. Louis: 1946).

[19]Iowa State Highway Commission, Service Bulletin 9 (March-

on the top of the piers.[20] If this seems to press the issue of disguising the new a bit far, it is well to note that when the state highway system was established two years earlier, "so great was the opposition to the word 'state' and a state-controlled road system, that legislators, fearing for their political futures, names it the 'Primary Road System'."[21]

The cantilever design was also used first with regard to concrete structures. As early as 1905 a concrete cantilevered girder was built for the street railway in Marion.[22] The highway commission experimented with reinforced concrete cantilever girders, beginning with one at Woodbine (also on the Lincoln Highway) in 1917. Others followed, noted in the bridge design section of the commission's Annual Reports.[23] In 1926 the commission reported the design of a "monolithic concrete girder" that "makes use of the cantilever principle."[24] This was the Winnebago River bridge (HAER No. IA-78) just north of Mason City.

But things began to change more rapidly. Other states were also introducing the continuous bridge.[25] By 1929 an editorial in the Engineering News-Record proclaimed that "structural views have made distinct progress since the days when continuous bridges were considered bad practice."[26] Iowa began to regularly construct continuous bridges, usually of the steel plate girder

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[20]Ibid., p. 5.

[21]William Thompson, Transportation in Iowa: A Historical Summary (Ames: Iowa Department of Transportation, 1989), p. 73.

[22]This may have been the first such bridge in the nation. Carl Condit, American Building (Chicago: University of Chicago Press, 1968), p. 257.

[23]Those listed in Fraserdesign, Iowa Historic Bridge Inventory (1993), are Herrold, 1921 (POLK13), Goldfield, 1921-22 (WRIG27), Okoboji, 1929 (DICK01), and Spirit Lake, 1939 (DICK02).

[24]Iowa State Highway Commission, Annual Report for 1926, p. 15.

[25]Oregon State Highway Commission, Eighth Biennial Report...1926...1928 (Salem, Oregon: 1929), p. 71.

[26]Ibid., January 17, 1929, p. 89.

variety.[27] Those that were built in the 1930s are remarkable examples of innovative design in response to the demands of the age of automobiles and highways.

The Grand Avenue Viaduct is difficult to describe, even to comprehend, because it is both large and complex. It is called on the plans a "continuous beam and girder structure of deck type with approaches between retaining walls."[28] The length of open structure is 3970'-6". There were, when built in 1936-1937, 58 spans,[29] which comprised 18 continuous beam or girder bridges and 2 simple spans. The continuous sections extended from three to five bents, and ranged in length from 126' to 327'. The simple spans were 40' each. Where the continuous bridges were longest, at the Floyd River crossing and two other places, they were formed of riveted plate girders, curving downward at the center bents to increase their strength. The other continuous sections are rolled beams, all of 36' WF section, but of varying weights. The combinations of spans in each continuous beam section were adjusted so that it was economical to use the same height of beam throughout.[30]

Ned Ashton, well-known Iowa City engineer who designed such noteworthy structures as the Centennial Bridge and the Julien

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[27]The conclusion that few concrete continuous bridges were built is tentative. The Iowa Historic Bridge Inventory rarely identifies continuous structures, so it is of little value in checking among the surveyed items for this structural type. From an economic point of view, concrete continuous girders, due to cost of formwork, would usually be more expensive, thus less common. The concrete bridge really came into its own with the introduction of prestressed beams after World War II.

[28]Design 236, Woodbury County, Ash-Howard-Needles & Tammen consulting engineers, for Iowa State Highway Commission, Iowa Department of Transportation, title + 36 sheets.

[29]The completion date, 1937, is from Howard, Needles, Tammen & Bergendorff, Bridges and Expressways (Kansas City: 1950).

[30]Ned L. Ashton, Comments on Design and Construction of Various Mississippi River Bridges, lecture at Davenport, Iowa, April 6, 1944, 14. There are other levels of detail in such a bridge. The beam sections used were all nominally 36", but they actually varied up to 7/8" depending on the weight per foot, 150 lbs. to 230 lbs. United States Steel, Pocket Companion (Pittsburgh: 1934), 10-11.

Dubuque Bridge, was one of the engineers at Ash-Howard-Needles & Tammen who did the Grand Avenue viaduct. Although he was always at the cutting edge of bridge design, he was also keenly interested in esthetics. In the Grand Avenue bridge, he was pleased to point out that the ends of the bents were shaped to a modest classical profile, with a molding at the base and capital of the vertical and at the beam end. He thought it a fine example, "showing the simple beauty that can be gained in ordinary rolled beam viaduct construction by adding a little architectural concrete treatment to the substructure."[31]

The viaduct has experienced two major changes. In 1963 the river crossing spans were relocated to near the center of the viaduct when the course of the Floyd River was changed.[32] This resulted in the installation of some rather plain new girders and the elimination of the old variable depth curved girders at the former river crossing. Then three years later, the viaduct was widened by installing a three-girder wide addition on the south, supported on concrete "T" piers.[33] For all these changes, much of the original detail--ornamented bents, variable depth girders--is still visible. And, the grand conception of a way to carry city and highway traffic over a river and a maze of streets and railroad tracks is still evident. So is the versatility and simple efficiency of the continuous beam and girder. This bridge is a classic example from the 1930s, the years when this technology became so important to the highways of Iowa.

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[31]Ashton, Comments, pp. 13-14.

[32]Sioux City Journal, August 8, 1963.

[33]Ibid., March 2, 1966; June 29, 1966.

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APPENDIX A Bridge Designs for the Grand Avenue Viaduct

Microfilm files located at the Iowa Department of Transportation, Ames, Iowa. Filed under: File 21809, File 10834, Design 663, and Design 236.

1. *State of Iowa State Highway Commission Design for Grand Avenue Viaduct, Sioux City, Iowa*. U.S. Works Program Highway Project No. W.P.G.M. 604. Woodbury County. Ash-Howard-Needles and Tammen, Consulting Engineers, Kansas City and New York. Date 5-29-36. [36 sheets]

2. *State of Iowa State Highway Commission Design for Bridge Remodeling. Primary Road System. Project No. U-604(3), Woodbury Co. Gordon Drive Viaduct*. Design 663. Design for Widening Gordon Drive Viaduct. Approved by R.M. Tutton, Deputy Chief Engineer, IHC. May 1965 in Letting of June 22, 1965. [135 sheets]

APPENDIX B List of Illustrations

Fig.1 From bridge design: *Design for Grand Avenue Viaduct...1936.*

Fig.2 Shell tourist map showing position of Grand Avenue Viaduct in local road infrastructure, 1947(?).

Fig.3 Profile Sketch of Grand Avenue Viaduct. James Hippen, 1996.

Fig.4 USGS Map. Sioux City South Quad., 1963. 7.5 min. series (topo.).

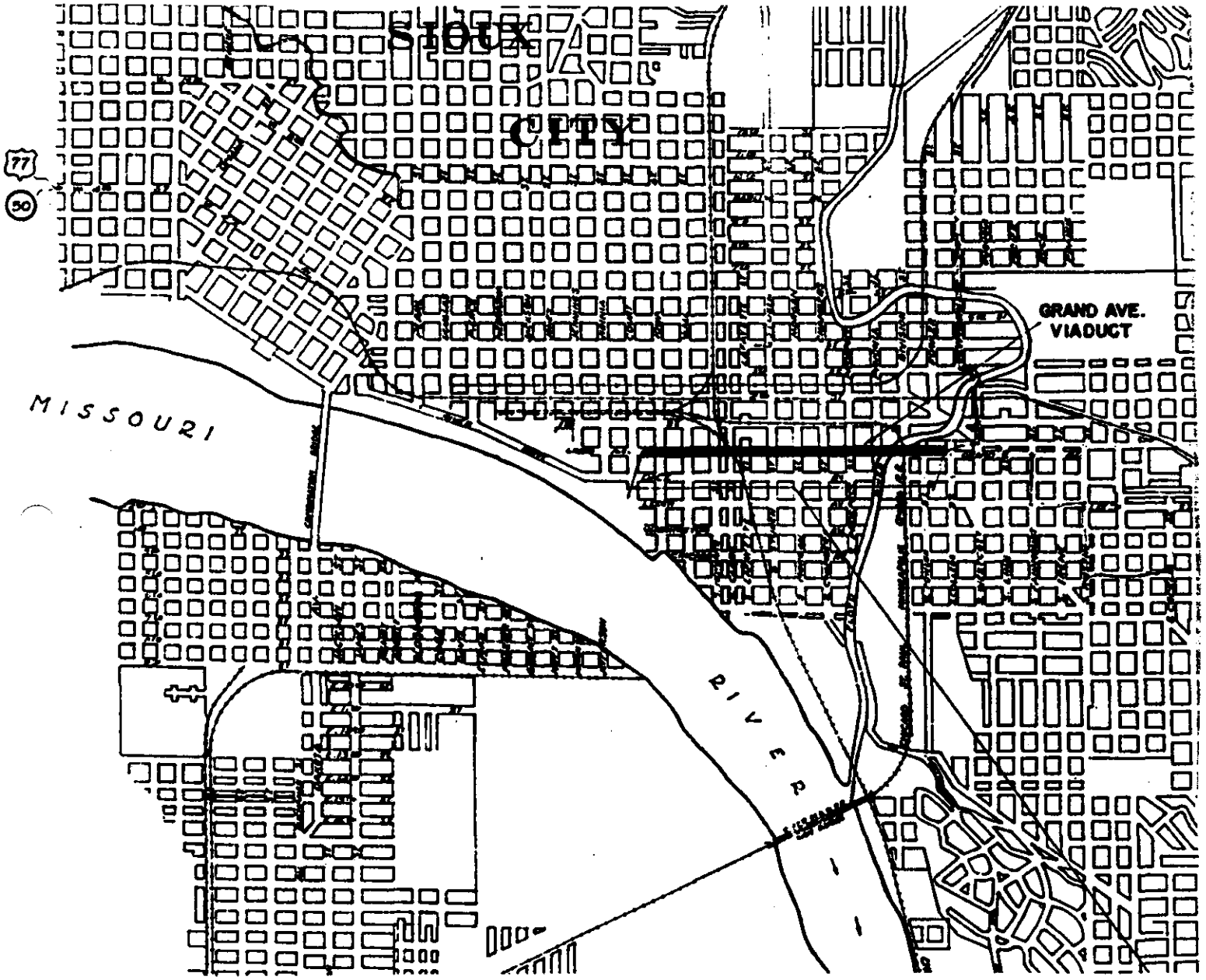

Fig.1 From bridge design: *Design for Grand Avenue Viaduct...1936.*

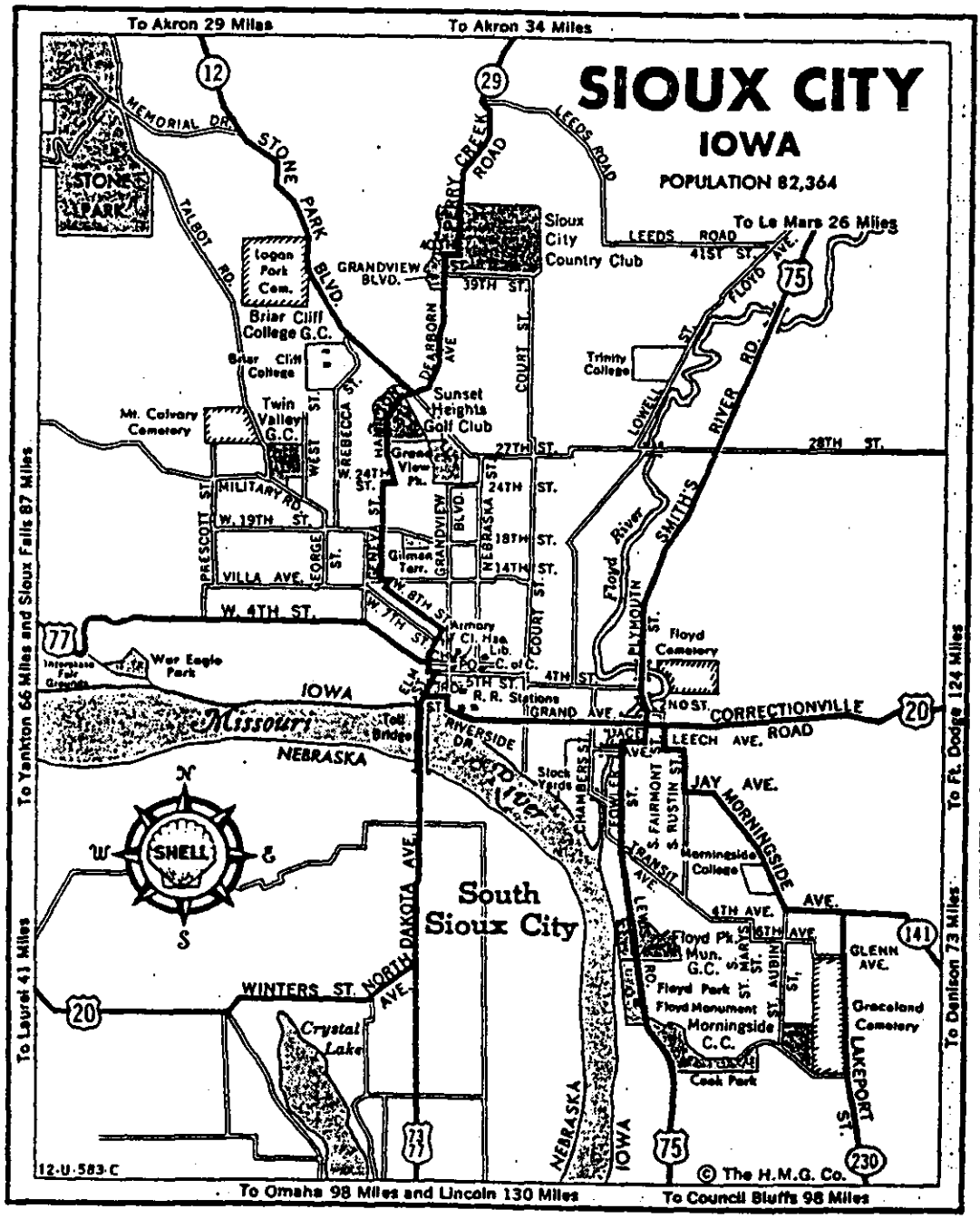

Fig.2 Grand Avenue Viaduct in local road infrastructure

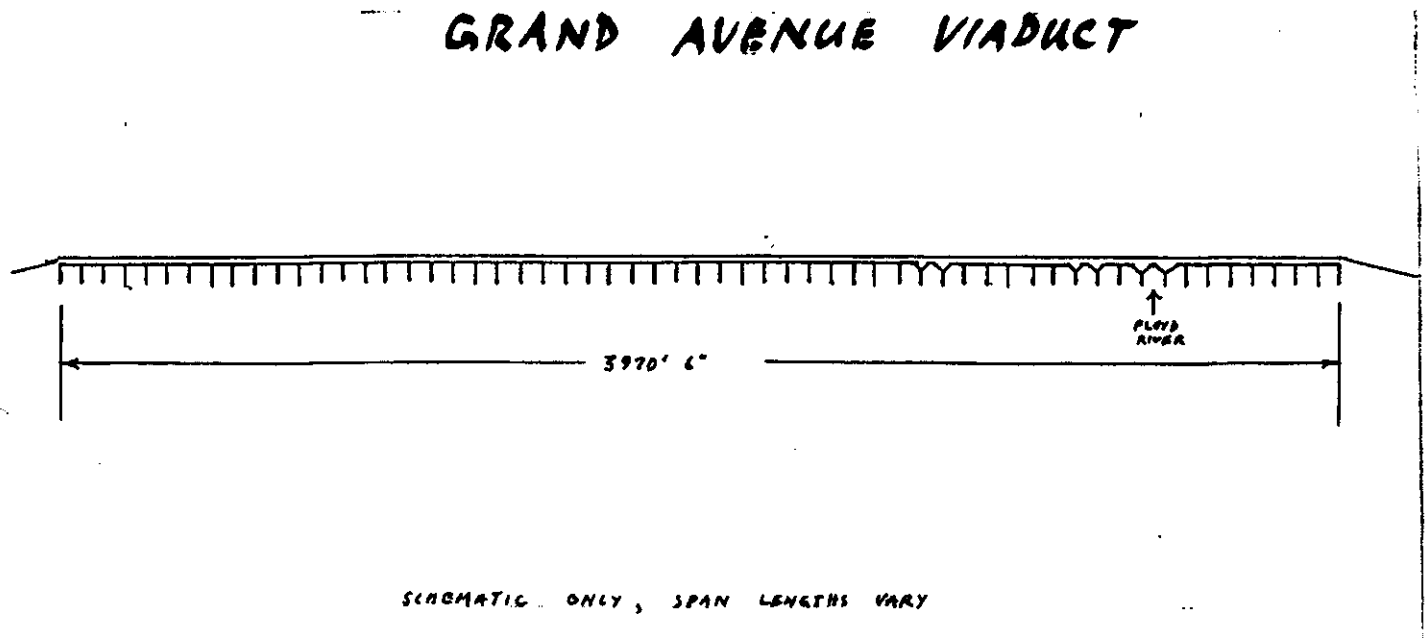

Fig.3 Profile Sketch of Grand Avenue Viaduct. James Hippen, 1996

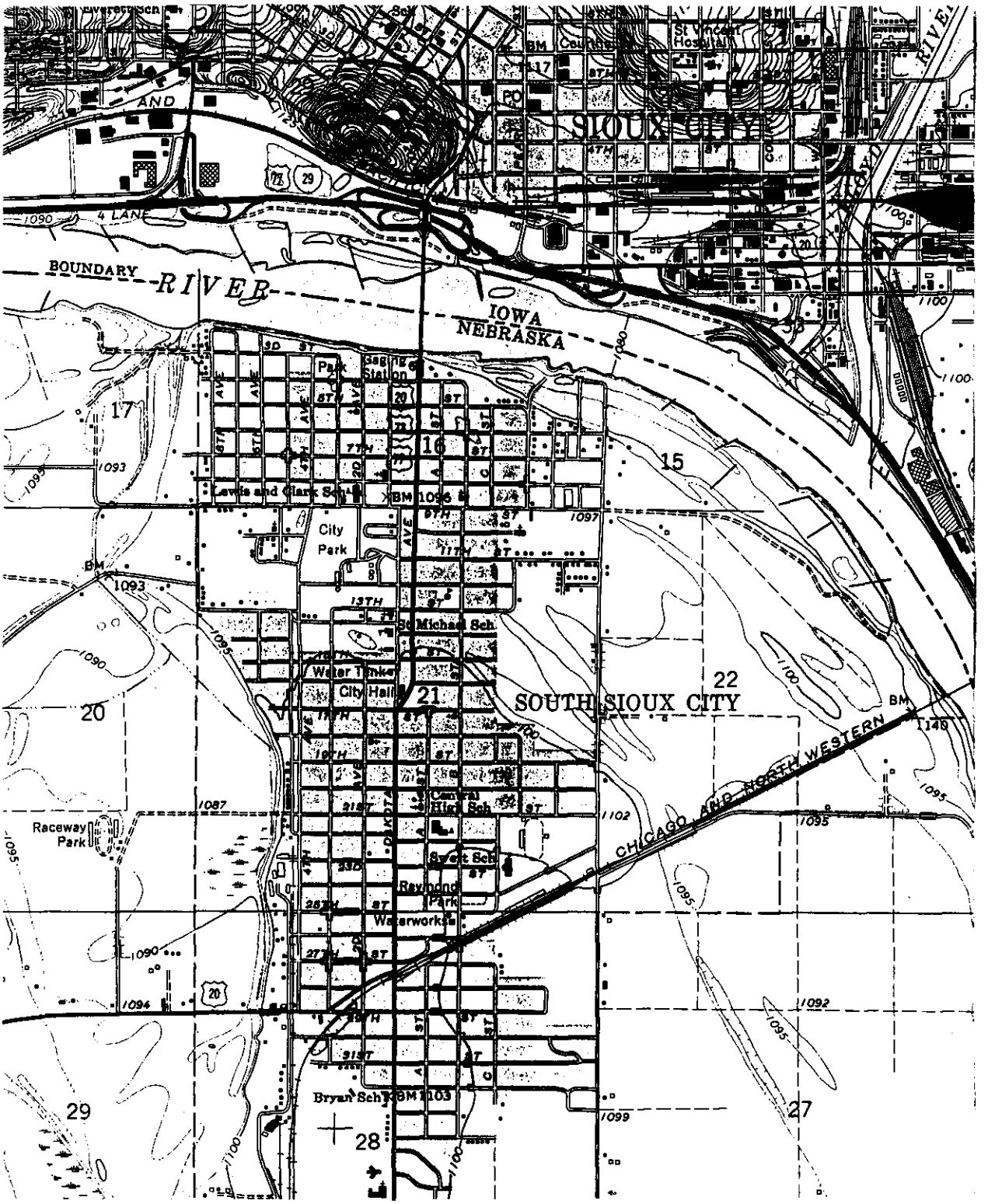

Fig.4 USGS Map. Sioux City South Quad., 1963. 7.5 min. series (topo.).

APPENDIX C Research Statement

Research Limitations

No historic photographs were found during the course of document research.

ADDENDUM TO
GRAND AVENUE VIADUCT
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This appendix is an addendum to a 19-page report previously transmitted to the Library of Congress.

APPENDIX: ADDITIONAL REFERENCES

Interested readers may consult the Historical Overview of Iowa Bridges, HAER No. IA-88: "This historical overview of bridges in Iowa was prepared as part of Iowa Historic Bridges Recording Project - I and II, conducted during the summers of 1995 and 1996 by the Historic American Engineering Record (HAER). The purpose of the overview was to provide a unified historical context for the bridges involved in the recording projects."