Open Spandrel Bridge
(Hawkeye Avenue Bridge)
Fort Dodge
Webster County
Iowa

HAER No. IA-17

HAER
IOWA,
94-FTDO,
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Rocky Mountain Regional Office
Department of the Interior
P.O. Box 25287
Denver, Colorado 80225

HISTORIC AMERICAN ENGINEERING RECORD
OPEN SPANDREL BRIDGE
(HAWKEYE AVENUE BRIDGE)
FORT DOOGE, WEBSTER COUNTY, IOWA

Location: Carries Hawkeye Avenue over the Des Moines River

UTM: East End: 15.401158.4707109
West End: 15.401081.4707120

Quad: Fort Dodge North, Iowa

Present Owner: City of Fort Oodge, Iowa

Present Use: Vehicular and Pedestrian Bridge

Date of Construction: 1919

Significance: The Hawkeye Avenue Bridge is a well-preserved example of an open spandrel reinforced concrete arch bridge. The bridge was designed by the Fort Dodge City Engineer, C. H. Reynolds, and constructed by Koss Construction Company of Des Moines, Iowa.

Project Information: The Hawkeye Avenue Bridge was documented by Dennett, Muessig, Ryan & Associates, Ltd., Iowa City, Iowa for the City of Fort Oodge in 1985. Hans Muessig served as the Historian and Photographer.

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Historical Background

Increasing settlement of the Iowa territory in the late 1840s brought with it the fear of Indian attacks. As the result of pressure from settlers, an army fort, Fort Clark, was established in August 1850 on the banks of the Des Moines River. The fort was later renamed Fort Dodge and finally abandoned in mid-1853. The post trader and postmaster purchased the fort and its buildings in January 1854 and surveyed a townsite, which was called Fort Dodge.[1]

In 1856 Fort Dodge was designated the county seat of Webster County, contributing to its survival as a viable community. In addition to fertile farmland, the area surrounding the town encompassed abundant coal and gypsum deposits. By 1900 the city had a thriving economy based on gypsum and plaster, coal mining, and the city's position as a regional farm and market center.

The first crossing of the Des Moines River in the northern part of Fort Dodge, known to many as Bobtown, was a two-span iron truss bridge built in 1876. The bridge served its purpose well until perhaps the second decade of the twentieth century. By this time the amount of traffic over the bridge prompted many residents of Bobtown to begin agitating for a new structure.

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[1] H. M. Pratt, History of Fort Dodge and Webster County Iowa. (Chicago: The Pioneer Publishing Company, 1913), pp. 151, 153.

In August 1917 the residents of Bobtown submitted a petition with seventy-five signatures to the city council requesting a new bridge. The residents argued that the bridge was too narrow and unsafe for automobile traffic. Several mothers claimed that their children had been nearly run down by speeding automobiles and had been forced to cling to the sides of the bridge, as the old bridge did not have any sidewalks. The city council took the petition seriously and instructed the city engineer, C. H. Reynolds, to study the possibility of adding a sidewalk to the existing bridge and report back at the next meeting.[2]

At the 4 September 1917 meeting, Reynolds gave his report on improving the Bobtown bridge. Evidently he did not favor any improvements, for the council recommended that he prepare plans for a new reinforced concrete bridge.[3] The choice of reinforced concrete rather than steel was probably dictated by three factors. First, due to the continuing war in Europe, steel was in short supply and difficult to obtain in quantities sufficient for a truss bridge. Second, the cost of reinforced concrete bridges was usually less than a comparable steel truss. Finally, arch bridges were considered more desirable aesthetically.

The cost of building a new bridge apparently stalled the project until January 1919. At the 28 January meeting of the city council,

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[2] "[City Council] Minute Book, City of Fort Dodge," City Clerk's Office, Fort Dodge, Iowa. Book 14, pp. 90, 94 (Minutes of the August 21, 1917 meeting). Fort Dodge Messenger and Chronicle, 22 August 1917, p. 1.

[3] "[City Council] Minute Book, City of Fort Dodge," Book 14, p. 104.

Reynolds was again instructed to prepare plans for a "reinforced concrete bridge." The bridge was to have a 30-foot roadway and two 6-foot sidewalks. The estimated cost of the bridge was $60,000. Construction on the bridge was to begin as soon as practical in the same location as the old Bobtown bridge.[4]

At the 4 March 1919 city council meeting, Reynolds presented plans and specifications for the new bridge, which were then accepted. The council instructed the city clerk to advertise for bids for the construction of the bridge, and to accept bids until 1 April 1919. The advertisement appeared in the Fort Dodge Messenger and Chronicle on 7 and 8 March. Prospective bidders were required to submit a $25 deposit for a copy of the plans and specifications, and a bond check equal to ten percent of their bid.[5]

The city clerk reported at the April 1 council meeting that four bids had been received. The bidders were Koss Construction of Des Moines, Iowa; N. M. Stark; C. E. Larson; and the Omaha Structural Steel Bridge Company. Koss' bid was the lowest, at $49,999.00, while Omaha's

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[4] "[City Council] Minute Book, City of Fort Dodge," Book 14, p. 337. Fort Dodge Messenger and Chronicle, 29 January 1919, p. 1.

[5] "[City Council] Minute Book, City of Fort Dodge," Book 14, pp. 352-3. Fort Dodge Messenger and Chronicle, 7 March 1919, p. 11.

was the highest at $66,500.00. The contract was formally awarded to Koss Construction by the city council at their 8 April 1919 meeting.[6]

By 1919 the choice of a reinforced concrete arch bridge was not particularly unusual. This bridge type was developed in Europe in the late 1880s, with the first such span designed by a Frenchman, Jean Monier. Monier originally was a landscape architect and used wire mesh to strengthen concrete pots and urns. Subsequently he turned to arch bridges, imbedding a layer of mesh near the intrados of the arch. Although Monier probably did not entirely understand the importance of the mesh in improving the strength of the arch, nearly two hundred bridges were built in Europe based on his patent.[7]

Meanwhile, several engineers in the United States had been experimenting with various methods of reinforcing concrete. W. E. Ward showed, in 1871-72, that concrete beams could best resist tension if iron rods were placed at the bottom of the beam. In 1881 S. Bissel received a patent for a bar-reinforced concrete arch bridge, but there is no record of any bridges ever being built on his system. Three years later, Ernest L. Ransome developed the now universal method of twisted-bar reinforcing. The first bridge built using this system was Ransome's

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6"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 364. Bids of Koss Construction Company and the Omaha Structural Steel Bridge Company on file at the city clerk's office, Fort Dodge, Iowa. "[City Council] Minute Book, City of Fort Dodge," Book 14, p. 378. Nothing is known about the Koss Construction Company.

7David Plowden, Bridges: The Spans of North America. (New York: The Viking Press, 1974), p. 298. Edwin Thacher, "Concrete and Concrete-Steel in the United States," Transactions, American Society of Civil Engineers, Part E 54: (1905) 438.

Alvord Lake Bridge in San Francisco's Golden Gate Park, completed in 1889.[8]

Credit for improving on Monier's reinforced arch goes to another Frenchman, Joseph Melan, who patented a system using I beams in 1892. Two years later the first Melan arch built in the United States was erected in Rock Rapids, Iowa. During the following decade nearly three hundred spans were built in the United States employing Melan's system or improvements to the system.[9]

One center of concrete arch bridge construction was Iowa. A number of significant bridges of this type were built in the state, including the Sixth Street Bridge over the Des Moines River in Des Moines, several bridges in Cedar Rapids and Iowa City, and the 586-ft. (178.61 M.) seven-span bridge over the Cedar River in Waterloo.[10] Perhaps the major encouragement for this activity was the research carried out by the faculty and students at Iowa State College in Ames. One faculty member, Conde B. McCullough, later became a bridge engineer for the Oregon Highway Department, where he designed some of the best known and most impressive concrete arch bridges in the world.

Most of the concrete arch bridges built in the two decades following the Rock Rapids bridge were closed-spandrel bridges, that is they consciously or unconsciously were designed to appear like stone

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[8]Plowden, p. 298.

[9]Thacher, p. 439.

[10]Ibid.

arch bridges. Indeed, many of the early bridges were faced with stone or imitation stone. But starting in 1915 perhaps, a number of significant highway bridges were built with open spandrels. Most of these bridges were located in Minneapolis and were designed by C. A. P. Turner and Frederick W. Cappelen.

Although neither the selection of a concrete design nor the particular rendition for the Bobtown or Hawkeye Avenue Bridge is unusual, it is to Reynolds' credit, as a self-educated engineer, that he was able to design both an attractive and functional reinforced concrete arch bridge.

Construction on Reynolds' bridge began about the middle of April, 1919 (this was a condition of the contract with Koss). A week later the local paper noted that the old bridge had been closed and that a foot bridge for pedestrians had been constructed.[11]

The only clues regarding the contractor's progress on the bridge following this initial newspaper article are the monthly work summaries contained in the requests for progress payments submitted to the city. These are summarized below:

6 May 1919: Koss submitted a bill for $1,334.50 for work completed on the bridge. This included 730 cubic yards of excavation - presumably

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[11] Fort Dodge Messenger and Chronicle, 24 April 1919, p. 5.

for the abutments - and $422.50 for the materials for falsework and the pedestrian bridge.[12]

6 June 1919: During May, an additional 900 cubic yards of earth was excavated for the abutments, as well as 30 cubic yards of rock for the abutment footings. The old truss bridge was completely removed and Koss completed 35 percent of the work in removing the old abutments and pier. One arch center was completed and 298 cubic yards of concrete were poured (presumably for the piers or the abutments).[13]

8 July 1919: During June, Koss completed one abutment and backfilled the earth around it. The old abutments and pier were now 40 percent removed.[14]

15 August 1919: During July and the first weeks of August, Koss continued to work on the abutments and piers. A second arch center was completed and the forms for the spandrels were finished on the the first arch. The old abutments and pier were now 85 percent removed. A total of 627 cubic yards of concrete had been placed.[15]

9 September 1919: During the remainder of August, Koss completed the excavation for the second abutment and began pouring concrete for that abutment. The forms for the second arch were finished and the pier and

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12"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 414.

13"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 453.

14"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 497.

15"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 517.

abutments for the old bridge were completely removed.[16] The local newspaper reported that only the forms for one arch and the roadway were still to be completed, along with the bridge railing.[17]

7 October 1919: Koss completed the third arch center and forms during September. Since the previous progress report an additional 900 cubic yards of concrete had been placed, indicating that the arches, spandrels, and deck were probably finished.[18] A week later the local paper reported that only the sidewalk and railing were unfinished and that, except for the lights, the bridge would be completed in late October.[19]

On November 11, 1919 the city council approved the final payment for the bridge. Koss was still having difficulty obtaining the lamp posts, and a portion of the final payment was withheld until the lamps were installed. On June 8, 1920 the city council accepted the bridge as complete and paid Koss the withheld amount.[20]

The Hawkeye Avenue Bridge will be replaced during the 1986 construction season.

16"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 533.

17*Fort Dodge Messenger and Chronicle*, 11 September 1919, p. 12.

18"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 555.

19*Fort Dodge Messenger and Chronicle*, 14 October 1919, p. 6.

20"[City Council] Minute Book, City of Fort Dodge," Book 14, p. 589; Book 15, p. 92.

Engineering Description

The Hawkeye Avenue Bridge is an open spandrel reinforced concrete arch bridge with three spans. The center span has a clear span of 85 ft. 6 in. (26.06 M.); the other two spans have a clear span of 83 ft. 3 in. (25.38 M.). Counting the abutments and the river piers, the bridge is 312 ft. (95.10 M.) long and 42 ft. (12.80 M.) wide between the handrails. The bridge contains two 6 ft. (1.83 M.) sidewalks and a 30-ft. (9.14 M.) roadway. The roadway is located at 103 ft. 6 in. (31.55 M.) above datum, or 26 ft. 6 in. (8.08 M.) above low water on the Des Moines River (which is 77 ft. (23.47 M.)). The roadway is slightly crowned to allow for water drainage and the entire bridge itself is also crowned. The roadway at either abutment is slightly over 2 ft. lower than the roadway at the center. The bridge is entirely symmetrical in construction details and dimensions about its center, except for the varying depths of the abutments and two river piers, and the extension of the south handrail on the west end of the bridge.[21]

The foundations of the bridge rest on bedrock, which is limestone in the Fort Dodge area. C. H. Reynolds, in the drawings for the bridge, estimated that the bedrock was located at 70 to 74 ft. (21.34 M. to

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[21] All dimensions and descriptions of construction details are from the original construction drawings of the bridge. "Reinforced Concrete Bridge over the Des Moines River. Ft. Dodge, Iowa. Engineering Depart[ment] C. H. Reynolds, City Eng[ineer]. Feb[ruary] 1919. Bridge No. 3" City Engineer's Office, Fort Dodge, Iowa. (Three sheets, ink on vellum). These drawings have been copied photographically and are part of this documentation project, HAER IA-17-15 through HAER IA-17-17.

22.56 M.) above datum, or about 3 to 7 ft. (.91 M. to 2.13 M.) below low water. The abutment foundations consist of reinforced concrete placed directly on cleaned and roughened bedrock. Both abutments are keyed into the bedrock to effectively transfer the compressive forces of the arches to the stone. The drawings are unclear as to exactly how the two pier foundations are to be tied to the bedrock. The specifications for the bridge simply state that:

> The foundations shall be concrete down to the depth shown on the plans or to such depth as will in the opinion of the engineer, insure perfect stability of the structure.[22]

It is very likely that a keyway was excavated into the bedrock to some depth for the pier foundations. Koss Construction billed the city for a total of 98 cubic yards of "wet rock excavation".[23] Given the footprint of the two abutments and two piers this amount of rock excavation would amount to an average depth for the keyways of 1 ft. 8-1/2 in. (.52 M.).

The two abutments are shaped roughly like an open-topped earth-filled box with one side missing. The base of the abutment - the bottom of the box - is reinforced concrete approximately 3 to 4 ft. (.91 M. to 1.22 M.) thick. The front wall of the abutment tapers upward from the base. At the base the front wall is 2 ft. 9 in. (.84 M.) and at the top

[22] "Specifications for a Reinforced Concrete Bridge," Typescript, city clerk's office, City of Ft. Dodge, Iowa, p. 2. Note that these specifications are reproduced as Appendix 1 of this report.

[23] "[City Council] Minute Book, City of Ft. Dodge," Book 14, p. 555. The minutes of the October 7, 1919 city council meeting include Koss's next to final estimate and bill for work completed on the bridge.

1 ft. 3 in. (.38 M.) thick. The two side walls are also tapered: 4 ft. 3 in. (1.30 M.) at the base and 1 ft. 3 in. (.38 M.) at the top. The reinforcing in the walls consists of 1/2 inch- and 3/4-inch square steel bars laid horizontally and vertically, and wired together at all intersections. The front and side walls are tied into the base by vertical reinforcing bars. Within the abutment additional triangular-shaped concrete buttresses have been placed to transfer the compressive forces of the arches to the base of the abutment. Each abutment also has four short butts that form the spring points for the arch ribs. Each butt is tied to the abutment and the triangular reinforcing buttress by twelve 7/8-inch square reinforcing rods that also extend into the arch itself. (There is a construction joint at these butts. The arches themselves were formed and poured after the abutments and piers were completed.) Each abutment was probably completed in one pour, i.e. all of the concrete needed to make up the abutment was mixed and placed in the abutment form in one operation. The drawings and a visual inspection of the abutments show no construction joints.

The two piers are essentially unreinforced concrete monoliths except for the butts that form the spring points for the arch ribs. It is likely that each monolith was completed in one pour, although the specifications did allow "Horizontal joints in the piers provided keyways at least six inches deep and not closer than twelve inches from any face are left in the concrete."[24] At the cap of each pier eight butts were formed to serve as the spring points for the arch ribs.

[24]"Specifications...," p. 4.

Twelve 7/8-inch square reinforcing bars are anchored in the pier and extend from the butt into each arch rib. A series of reinforcing bars (called dowel bars) also were embedded in the pier to serve as an anchor for the spandrel walls above the pier.

Each span consists of four arch ribs. Each rib is 5 ft. (1.52 M.) wide, 1 ft. 6 in. (.46 M.) at the crown, and 2 ft. 9 in. (.84 M.) thick at the butt at a pier or abutment. The arch ribs are properly described as "three-centered arches," that is, the crown portion has a different radius than do the two haunches. The crown of the center span has an intrados (the radius to the inside, or soffit, of the arch) of 66 ft. (20.12 M.) and an extrados (the radius to the top of the arch) of 73 ft. 9 in. (22.48 M.). The haunches of the center span arch have an intrados of 68 ft. 7 in. (20.90 M.) and an extrados of 77 ft. 7 in. (23.65 M.). The crown of the two side arches have an intrados of 63 ft. 3 in. (19.28 M.) and an extrados of 70 ft. 8-1/2 in. (21.55 M.). The haunches of the side spans have an intrados of 72 ft. 1 in. (21.97 M.) and an extrados of 81 ft. 10 in. (24.94 M.). The use of three centers for the arch and different radii for the intrados and extrados of the arch ribs results in the ribs which taper in thickness from the spring to the crown.

The arch ribs were poured in forms placed on centering, a scaffolding designed to hold the forms and also give them their arch shape. Once the centering and forms were in place, the reinforcing bars for the entire rib were placed in the form. Each rib was then poured in five segments in order to equalize the stresses on the centering.[25] The first segment poured was the crown of the rib, followed by the two haunch segments from the butt on the pier or abutment to 8 ft. from the crown segment. Finally the two gaps between the crown and the haunch segments were poured.[26] At the points where the spandrel walls join the arch ribs, horizontal construction joints (essentially a concrete-concrete platform) were formed around the dowel rods previously placed in the ribs.

Each span of the bridge has eight spandrels per arch rib. These spandrels are concrete reinforced with 1/2-inch square steel bars. They are 15 inches (.38 M.) thick. The spandrels over the outer ribs are 4 ft. 8 in. (1.42 M.) wide; those over the inner ribs are 5 ft. (1.52 M.) wide. The arch spandrels and the paired spandrels over the piers were poured following the completion of all of the arch ribs. Horizontal construction joints were left at the top of the spandrels and extra reinforcing bars were left exposed to tie the spandrels to the floor beams.

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[25]Reynolds also specified that all the arch ribs were to be poured for all of the spans before the centering was struck under any span to further equalize the stresses on the centering. "Specifications ...," p. 4.

[26]A detailed discussion of the construction of reinforced concrete arch bridges, including the use of centering and the sequence of pouring arches, can be found in Webster, George S. and Henry H. Quimby, "Walnut Lane Bridge, Philadelphia," <u>Transactions</u>, American Society of Civil Engineers 65: (1909) 423-461. It is very likely that Reynolds, himself a member of the American Society of Civil Engineers, read and utilized the information in this article as well as many others published by the American Society of Civil Engineers.

C. H. Reynolds designed the bridge so that the deck and the floor beams were integral units, constructed in three sections to allow for expansion. This provided more overall strength to the structure than if the floor beams had been separate from the deck. The floor beams are located on top of each spandrel and consist of four 1/2-inch square reinforcing bars that run along the bottom side of the beam and are tied up onto the tops of the spandrel walls. The beams are all 15 inches wide and 18 inches tall. A series of reinforcing bars extend from the beam up into the deck. The deck is a 9-inch thick slab reinforced with 3/4-inch square bars laid longitudinally on 9-inch centers and 1/2-inch square bars laid transversely also on 9-inch centers.

The center four floor beams and deck were the first to be poured on each span. This was followed by the two floor beams and deck located over the haunches of each span. The deck of these portions rested on top of the abutment walls or the pier spandrel walls at one end and on a portion of the floor beam poured as part of the crown section. This arrangement produced four expansion joints per span.

The bridge has a reinforced concrete hand railing on each side of a simplified spindle and banister style. This railing is similar to the original railing which was replaced at sometime. At each end of the railing and above each pier electric light fixtures provide illumination for automobiles and pedestrians.

Underneath each sidewalk Reynolds designed a pipe alley for an 18-inch water main. At the time the bridge was constructed water mains were not installed, and it is not known whether pipes ever were put in place.[27]

The paving of the bridge was not included in Koss' contract and there is no information about the original paving. The current pavement is a bituminous surface.

[27] "Specifications ...," p. 4.

Biographical: Charles Henry Reynolds 1874 - 1929

C. H. Reynolds served as the city engineer for Fort Dodge from 1898 until his death in 1929. During that time he designed and supervised the erection of at least four bridges, as well as the new city water works, which was under construction at the time of his death. As city engineer, Reynolds was also involved in more mundane affairs, such as laying of the first permanent brick sidewalk, and paving the many miles of city streets. "Another improvement which took place under his direction and of which he was exceptionally proud, was the selection of numbers for city streets in place of the names which they formerly had."[28]

In addition to his duties as city engineer, Reynolds served for twelve years as the county surveyor of Webster County, and as principal drainage engineer for Webster and surrounding counties. He also did freelance engineering work for nearby towns.

Reynolds was born on 3 December 1874 near Manchester, Iowa. At the age of two, his family moved to Fort Dodge where he resided for the following fifty years. Reynolds attended the public schools of Fort Dodge and graduated with a high school diploma. Following graduation he began working as assistant city engineer, apprenticing under Mr. Easley, the then current city engineer. Reynolds "later took a correspondence

[28]C. H. Currie, "Memoir of Charles Henry Reynolds," Transactions, American Society of Civil Engineering 94 (1930): 1705.

course in Engineering, which he completed with a very high standing."[29] He also undoubtedly corresponded with and visited the faculty and staff in the Engineering Department at the Iowa State College, and with the Iowa Road Commission, both in Ames.

Reynolds was appointed city engineer in 1898 and was reappointed repeatedly during the next thirty-one years, despite numerous changes in local politics and city government. In 1919 he was accepted as an Associate Member[30] of the American Society of Civil Engineering. Reynolds was also very active in the local fraternal organizations of the city. He was a Past Exalted Ruler and Past District Deputy Grand Exalted Ruler of the Elks Lodge and Past Commander of the Calvary Commandery of the Masonic Lodge. He was also a member of the Knights Templars, the Eastern Star, Shepherds of the White Shrine, and Za-Ga-Zig Shrine.[31]

Reynolds died on 1 November 1929 after a protracted illness. He was survived by his wife of thirty-two years, two daughters, and a son.[32]

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[29] Ibid.

[30] The highest honor accorded an engineer without a formal engineering degree.

[31] Currie, "Memoir ...," p. 1705.

[32] Fort Dodge Messenger and Chronicle, 2 November 1929, p. 1.

SPECIFICATIONS

FOR

A REINFORCED CONCRETE BRIDGE.

WORK TO BE DONE.

These specifications and plans entitled "Reinforced Concrete Bridge over the Des Moines River, City of Fort Dodge, Iowa," and marked Sheets No. 1 to 3 inclusive, are to be considered as co-ordinate parts of one document, the two together mutually explaining each other, and forming the complete specifications for the structure.

Whenever the plans are referred to herein, it is understood that the above mentioned plans are meant.

LOCATION OF STRUCTURE.

The structure is located on a street crossing the Des Moines river just north of the Illinois Central Railroad Bridge. The site is now occupied by a steel bridge consisting of two spans resting on stone abutments and pier. The relative positions of the old and new structure are shown on the plans.

The new structure will consist of three reinforced concrete arch spans.

SCOPE OF CONTRACT.

This contract will include the furnishing of all materials and labor necessary to build and fully complete the structure, and to do all other work outlined in these specifications or the accompanying plans. The work to be done will include the removal of the present steel bridge and the pier to elevation 77.00 and the abutments to elevation 85.00. The contractor will be required to construct and maintain properly lighted a temporary bridge six feet wide for foot traffic only, during construction of the new bridge.

The old steel bridge inclusive of the wooden floor becomes the property of the contractor and may be disposed of as he sees fit, excepting that it must be removed from the site at the completion of the work.

The contractor shall fill in abutments at the ends of the bridge and around the outside of the end walls to the slope shown on sheet No. 1. This filling shall be done at the time and in the manner directed by the Engineer.

The contract does not include the paving of the bridge.

It is intended that the contractor shall supply all tools, labor and materials to fully complete the structure notwithstanding any omissions in the plans or specifications.

MATERIALS.

No cement shall be used except established brands of Portland cement which will successfully pass all tests recommended by the American Society for Testing Materials, Aug. 16, 1909.

Each bidder shall name in his tender at least three standard brands of cement which he proposes to use and in the event of his securing the contract the cement he selects shall be one of these.

The sand shall be clean river sand, well graded in sizes up to that retained on a ¼" screen, and shall be free from mud, clay, and all foreign matter.

The stone used shall be hard clean crusher run of the sizes specified for the different mixtures but no stone passing a ¼" screen shall be used.

Screened pebbles may be used in place of broken stone. These must be free from all foreign matter and be retained on a ¼" screen and pass a 1½" screen.

The contractor may use the stones in the old pier and abutments in the new piers below the spring line providing each stone is surrounded by not less than 6" of concrete and no stone is closer than 6" to the face of a pier, or he may crush the stone for use as coarse aggregate of the size specified. section and shall be of medium ~~grade and shall be~~ manufactured by the open hearth process. In all other respects they shall meet the requirements of the specifications for concrete reinforcement bars adopted by the Association of American Steel Manufacturers.

FOUNDATIONS.

The foundations shall all be concrete down to the depth shown on plans or to such other depths as will in the opinion of the engineer, insure perfect stability of the structure.

The engineer retains the right to make such changes in the footing design as he may deem advisable and desirable. The bidder shall name a price per Cu. Yd. for additional concrete and per pound for additional reinforcing steel in the foundations.

MIXING AND PLACING CONCRETE.

The concrete shall be composed of cement, sand and broken stone, or screened gravel, mixed with clean water in the proportions hereinafter mentioned. All concrete specified herein shall be based upon the assumption that one barrel of Portland cement is equivalent to 4 cubic feet and all proportioning must be done by means of carefully gauged wheelbarrows or other apparatus of capacity which will be determined by the engineer.

All mixing shall be done by machinery, excepting that for the handrail, which may be mixed by hand. Mixing shall be done by means of a revolving batch mixer.

The mixture shall be made of a consistency to suit the engineer. Concrete shall be placed in position immediately after mixing and before the initial set shall have taken place.

No retempering of concrete shall be allowed. The mixing and placing of concrete shall be, so far as possible, a continuous operation and when it is necessary to make a joint in monolithic concrete it shall preferably be made by means of a stop board placed in a vertical position and containing a key on the side next the concrete first placed. When these boards are removed the exposed surface of concrete shall be wet and carefully dusted with neat cement before continuing the work.

In placing concrete it shall not be dropped from a height greater than eight feet. When it is required to place concrete from a greater height than eight feet it shall be done by means of chutes or other devices satisfactory to the engineer. This applies particularly to the arch ribs and transverse spandrel walls. In placing the concrete in these, openings shall be left in the back forms of the arch ribs and in the forms for the transverse spandrel walls through which the concrete is to be placed. The concrete shall be deposited in such a manner as will permit the most thorough compacting and shall be thoroughly spaded and puddled next the forms so as to bring the water to the face. The contractor will be required to replace any concrete which, upon removal of the forms shows a separation of the aggregate.

CONSTRUCTION JOINTS.

Construction joints shall be avoided wherever practicable but when they are necessary they shall be located at such sections as will least effect the structural strength and shall be made at right angles to the direction of principle compressive stresses. In addition to the construction joints shown on the plans joints may be made as follows:

Horizontal joints in two piers provided keyways at least six inches deep and not closer than twelve inches from any face are left in the concrete.

Joints which are parallel to the skew backs in the abutments and that part of the piers above the spring line.

Horizontal joints between the transverse spandrel walls and floor beams.

No construction joint will be permitted between the floor beams and the roadway slab.

Construction joints at other points will be permitted only upon the consent of the engineer.

FORMS AND CENTERS.

The contractor shall build an unyielding falsework of a type, for the arch ribs, to be approved by the engineer.

All forms shall be constructed of sufficient strength to obtain the rigidity necessary to prevent any motion of the forms while the concrete is being poured.

Forms shall be as nearly watertight as practicable and shall be surfaced on the side next to all surfaces of concrete which shall be exposed in the finished work. Forms shall be wet before concreting and shall be true to line and grade. Forms which are used more than once shall be cleaned carefully after each usage. Forms for the arch ribs, slabs and girders shall be given sufficient camber so that after the forms are removed the different parts of the structure occupy the proper vertical position as shown on the plans.

In general, forms shall not be removed in less than fourteen days in summer and twenty-eight days in winter, except in the case of vertical surfaces, the forms for which may be removed from three to six days.

The arch ribs shall be poured for all spans before the centering is struck under any span. Should the contractor choose to strike the centers under the arch ribs before pouring the super structure, the super structure shall be poured in such parts and in such order as shall be directed by the engineer.

PLACING STEEL.

All reinforcing steel shall be bent and placed with great care. All abrupt bends shall be avoided except where one steel member is bent around another.

Steel reinforcing shall be secured against displacement during the pouring of concrete and shall be subject to rigid inspection immediately prior to the placing of concrete.

All reinforcing shall be wired together at every intersection and splices shall be at least 30 diameters in length, unless otherwise indicated on the plans.

GRADES OF CONCRETE.

All concrete below the spring line of piers shall be composed of 1 part Portland Cement, 2½ parts sand and five parts broken stone or screened gravel passing through a two inch screen.

All other concrete, excepting hand rail and top one-half inch of sidewalk slab shall be composed of 1 part Portland cement, 2 parts sand and 4 parts broken stone or screened gravel passing a 1½" screen.

The upper one-half inch of the sidewalk slab shall consist of mortar composed of 1 part Portland cement and two parts of well graded sand. This top layer shall be placed before the concrete in the slab has reached an initial set. The surface shall be straight edged thoroughly and finished according to the standard specifications of the City of Fort Dodge for sidewalks.

The concrete for handrails, spindles and posts shall consist of 1 part cement and 2½ parts sand.

LAMP POSTS.

The contractor shall furnish and install eight single globe lamp posts of a design approved by the engineer and provide conduits and wiring and switch boxes for lighting the same.

Provision is made for space for the placing of an 18" water main under each sidewalk at some future time. The contractor shall fill this space with cinder concrete mixed in the proportion of 1 part cement to 10 parts of cinders.

ELEVATIONS AND LINES.

The engineer will furnish the contractor all lines and elevations necessary for the proper placing of forms and location of piers.

abutments and other parts of the structure so as to conform to the plans.

INTERPRETATION OF SPECIFICATIONS AND PLANS.

Should any disagreement arise as to the true meaning of the plans and specifications in any point, the decision of the engineer shall be final and conclusive and binding on all parties to the contract. In these specifications wherever the term "Engineer" is used it shall mean the City Engineer of Fort Dodge, Iowa, or his authorized agents and the term "City" shall mean the City of Fort Dodge, Iowa.

CONTRACTOR.

Unless a contractor can prove to the City Council by satisfactory evidence that he has built a structure of similar character to the one proposed, his bid will not be considered.

RESPONSIBILITY FOR ACCIDENTS AND DAMAGE.

The contractor shall repair all damages to any existing structure occasioned by his operations. He shall provide watchmen, red lights, fences and other precautionary measures necessary to the protection of property and persons.

The contractor will be held responsible for all accidents to men, animals, property and materials until the final completion and acceptance of the structure, and must indemnify and save harmless the city against all claims and demands of all parties whatsoever for damages or compensation for injuries arising from or caused by his operations.

The contractor shall employ no superintendent who has not had experience on a structure of similar character. He shall employ only competent foremen and experienced mechanics, laborers, and shall discharge immediately, whenever required to do so by the engineer, any man considered by the engineer as incompetent, or who refuses to obey the instructions of the engineer as given to the contractor or his superintendent and shall not again employ said person on the work.

REMOVAL OF DEBRIS.

All staging, falsework, rubbish and other obstructions created or caused by the contractor must be removed so that the site upon completion of the contract will be left in a neat and clean condition;

INSPECTION.

All materials and workmanship are to be subject at all times to the inspection of the engineer or his representative. Upon final inspection, any defects or omissions noted must be made good by the Contractor without extra charge notwithstanding any previous inspection or acceptance.

The contractor upon being so directed by the engineer, shall remove, rebuild or make good without extra charge any work which the engineer may consider to be defective.

EXTRA WORK.

No extra work will be paid for or allowed unless the same was done upon the written order of the engineer. Extra work so ordered will be paid for according to the schedule of prices in the contractor's bid. All claims for extra work must be made to the city council in writing 30 days after the work shall have been performed.

ESTIMATES.

The contractor will on about the first day of each month, receive from the engineer a monthly estimate based upon 80% of the value of the part of the contract completed, materials which become a part of the finished structure, delivered on the site and all labor furnished. He shall also receive a final estimate for the full value of the contract price showing balance due within fifteen days after the satisfactory completion of the contract and the acceptance of the structure by the engineer and the city council.

CONTRACTOR'S BOND.

The successful bidder will be required to furnish the city a satisfactory surety bond in a sum equal to 50% of the contract price for the faithful performance of the contract according to plans and specifications, and all the terms and conditions therein contained, and for the prompt payment for all materials and labor used on the structure, and to protect and save harmless the city from all damages or claims for damage to persons or property caused by the operations of the contractor in performing the work herein outlined.

INSTRUCTIONS TO BIDDERS.

Each bidder must submit with his bid an unconditional certified check for 10% of his bid, on some Fort Dodge bank and made payable to the City Treasurer of Fort Dodge, Iowa.

This check will be forfeited to the city should the bidder be awarded the contract and fail to sign the same within ten days after contract is awarded, and fail to furnish the city a satisfactory surety bond in a sum equal to 50% of the contract price.

Unsuccessful bidders will have their checks returned.

The city reserves the right to reject any and all bids.

Parties desiring to bid upon the work may obtain plans and specifications from the city engineer upon written application therefor and the payment of $25.00 which sum will be refunded if plans and specifications are returned within 30 days after contract is awarded, providing parties receiving plans submit a bid. Should bids not be received from the parties receiving the plans the $25.00 will not be refunded.

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