THE

KEOKUK & HAMILTON BRIDGE

Keokuk, Iowa - Hamilton, Illinois

An Historic American Engineering Record
Documentation Project

Prepared by

Dennett, Muessig & Associates, Ltd.
Iowa City, Iowa

for

Howard Needles Tammen & Bergendoff
Kansas City, Missouri

Iowa Department of Transportation
Ames, Iowa

Illinois Department of Transportation
Springfield, Illinois

1982

HISTORIC AMERICAN ENGINEERING RECORD
Keokuk & Hamilton Bridge
Keokuk, Lee County, Iowa

Location:	Spanning the Mississippi River between Keokuk, Iowa and Hamilton, Illinois, below Lock and Dam 19.
UTM:	East end: 15/638410 4472100; West end: 15/637780 4472310.
Quad:	Hamilton, Illinois; Keokuk, Iowa.
Dates of Construction:	Superstructure erected 1915-1916 on piers built 1869-71. Piers rejacketed 1915-1952. Hamilton approach rebuilt and steel mesh roadway installed 1956. Pivot pier protection incorporated in guardwall of lock 1957.
Owner:	City of Keokuk, Iowa.
Use:	Railroad, vehicular and pedestrian bridge.
Significance:	The Keokuk & Hamilton Bridge is one of three remaining in Iowa that were designed by Ralph Modjeski, one of this country's premier early 20th century bridge engineers. The eleven-span, double-deck steel superstructure was built in 1915-1916 on piers retained from an earlier (1869-1871) structure, to meet greater loading requirements from railroads that operated across the Mississippi at this point.

The Keokuk & Hamilton Bridge Company was incorporated in 1868 to further railroad and commercial development in Keokuk and in Hancock County, Illinois. The firm's president until 1914 was Andrew Carnegie, who had interest in the railroads participating in the venture. The first Keokuk & Hamilton Bridge was built by Carnegie's Keystone Bridge Co. from designs by Thomas Curtis Clarke, later a founder of Clarke, Reeves & Co. (which is best known under its subsequent name, Phoenix Bridge Co.). This structure stood until 1915, when pressure from Keokuk businessmen and the threatened erection of a competing bridge forced the Keokuk & Hamilton Bridge Co. to reconstruct its span.

The replacement structure remained in corporate ownership until January 1949, when it was turned over to the city of Keokuk. Although the city intended that there should be no tolls for vehicular traffic, the span remained "free" for only three years. Tolls were reimposed in 1952, in order to finance maintenance and also major repairs to the piers, which were rejacketed with reinforced concrete in 1951-1952.

Project Information: The Keokuk & Hamilton Bridge was documented by Dennett, Muessig & Associates, Ltd. (Iowa City, Iowa) for Howard Needles Tammen & Bergendoff (Kansas City, Missouri), the Iowa Department of Transportation, and the Illinois Department of Transportation in 1982. The project team consisted of Hans Muessig, Robert A. Ryan and Sarah J. Dennett, Photographers; and Martha H. Bowers and Hans Muessig, Historians.

TABLE OF CONTENTS

ACKNOWLEDGMENTS

We would like to express our appreciation to the following people, whose varied assistance in the course of this project has proved invaluable: Robert E. Felsburg, Joseph J. Scherrer, Charles Angier and H. Eugene Waldner, of Modjeski & Masters, Consulting Engineers, Mechanicsburg, Pennyslvania; Walt Heavin, Manager of the Keokuk & Hamilton Bridge, Keokuk; Jack Taylor, John Briley and Allen Beaudine, Bridge Tenders; Jerry Hare, Director of Public Works, Keokuk; and William Talbot, Lee County Historical Society, Keokuk.

ENGINEERING DESCRIPTION

The Keokuk and Hamilton Bridge was designed as a "combined" bridge: that is it was designed to carry rail, streetcar, pedestrian, and automobile traffic. A single railroad/streetcar track is located within the trusses on the floorbeams, while the 18' (5.49 M.) roadway and 4' (1.22 M.) pedestrian walkway are mounted on top of the top chords of the spans. The bridge consists of eleven spans plus the Keokuk and Hamilton approaches. The spans, numbered from the Keokuk shore, consist of a 377' 1 1/2" (114.95 M.) rim bearing swing span (Span 1), two 254' 5 1/2" (77.56 M.) Parker through trusses (Spans 2 and 3), and eight Pratt through trusses ranging in length from 148' 11 7/8" (45.41 M.) to 162' 8 5/8" (49.60 M.) in length (Spans 4 through 11). The total length of the bridge, excluding approaches, is 2,194' 2 15/16" (668.81 M.). The superstructure of the bridge is entirely steel and, except for eyebar connections which are pinned, is of riveted construction. All eleven spans are skewed 17° 15'.[1]

The bridge was designed to standard specifications for railroad loading, using Coopers E-50 loading for trusses and track floor. Modjeski did not consider any highway loading in designing the bridge. This omission was justified because steel used in the bridge was of a high grade and well capable of carrying a highway load of 1500 pounds per linear foot.[2]

The substructure of the bridge consists of abutments at either end of the bridge and eleven river piers. These piers are the same ones that were built in 1869-71 for the first Keokuk and Hamilton Bridge. All but five of these piers rest directly on the rock bottom of the river, only 8 to 10 feet below low water (elevation 497.81' Cairo Datum). The remaining five rest on shallow timber grillages resting on the rock bottom. The pier masonry is quarry faced ashlar local limestone, except for the upstream nose-stones, which are hammer dressed. The masonry was probably laid up with a utica cement and backed with large stones laid at random in spalls and mortar. The pivot pier is a hollow structure with a solid center pier connected by four radial walls to an outer masonry ring.[3] During the reconstruction all of the piers were shortened by 5' (1.52 M.) and capped with reinforced concrete.

The eight riveted Pratt spans (with pinned end shoe connections) each have seven panels. The center five panels of each Pratt are of equal length ranging from 22' 1/4" (6.71 M.) (Span 7) to 23' 11 3/4" (7.31 M.) (Span 11) depending on the length of the span. The end panels on the left side of the Pratts (standing on an end floor beam and looking toward the center of the spans) are 5' 1 7/8" (1.57 M.) shorter than those on the right side which are the same length as the center panels. In this way the Pratts can rest on the skewed piers. The trusses are 29' (8.84 M.) high (center of lower chord to center of upper chord), and 16' 7" (5.05 M.) wide (center to center). The clear distance between the two trusses is 14' 6" (4.42 M.).

The two Parker spans have nine panels. Eight of the nine panels are 28" 11 3/4" (8.33 M.) long. The end panels on the left side of each span are 6' 4 1/2" (1.94 M.) shorter. The trusses are 31' (9.45 M.) high at the endposts and 43' (13.11 M.) high at the center panel (center to center). The trusses are 20' 6" (6.25 M.) apart with a clear distance of 17' 6" (5.33 M.). The center five panels of the bottom chord are pin connected eyebars as is the diagonal between the top of the endposts and the second panel point on the lower chord. With these exceptions these spans are riveted.

The swing span consists of two arms of equal length and a center tower. The arms are connected at their lower chords to the drum and at their upper chords by eyebars to the tower. Each arm is composed of a long truss and a short truss (because of the skewed piers). The short truss is 175' 1 1/2" (53.38 M.) long, the longer one 181' 6" (55.32 M.). The two trusses of each arm have six panels, five of which are 30' 3" (9.22 M.) long and a sixth one either 23' 10 1/2" (7.28 M.) (left truss) or 30' 3" (9.22 M.) (right truss). The center tower is 48' (14.63 M.) high, with a 20' 6" (6.25 M.) panel. The truss depth at the intermediate hip of each arm is 38' 6" (11.73 M.) and at the outer hip 31' 6" (9.60 M.). The distance between the trusses is 20' 6' (6.25 M.) with a clear distance of 17' 6" (5.33 M.).

The lower deck consists of 50" (1.27 M.) plate girder floorbeams connected to the truss posts and the lower chord. Between the floorbeams run two 43" (1.09 M.) plate girder track stringers set 7' (2.13 M.) apart. The track is laid on 8" x 8" (20 cm.) ties, 12' (3.66 M.) long, set on the track stringers. Elevation of the rail base is 531.19' (Cairo datum). Above the railroad track a blast plate was installed to protect the steel and the wooden roadway. The blast plate was removed in 1967.

The original roadway consisted of 3" (8 cm.) wooden blocks laid on a subfloor of roofing felt and tar over 3" (8 cm.) tongue and groove planks. The planks were supported by 4" x 10" (10 x 25 cm.) wood joists on the steel floorbeams. On the eight Pratt spans the floor beams rest directly on the top chord, with every third one extending over the top chord on the south side for the walkway. On the swing span and the two Parker spans, where the trusses rise above the level of the roadway, the floorbeams are framed between the truss posts, and the sidewalk is cantilevered outside on brackets. The wooden roadway was replaced with a steel open-grate floor in 1956. Elevation of the roadway is 560.43' (Cairo datum).

The swing span pivots on and is supported by 40 cast steel rollers running on two circular tracks. The lower track consists of eight cast steel tread segments resting on and bolted to eight cast steel support sections. These support sections are in turn bolted to the masonry of the pivot pier. The upper track consists of eight cast steel treads bolted to the lower flange of the drum. The rollers are 18" (46 cm.) in diameter and 18" (46 cm.) wide. The general design of the tracks and rollers follows that widely used for rim-bearing spans:

> All rollers, and the faces of the upper and lower tracks which are in contact with the rollers, are ... turned smooth to the forms of right frustums of cones the vertices of which intersect at the center of the drum, so that the rollers will have perfect contact with the tracks throughout their travel around the entire circumference.[4]

The rollers are secured between two concentric rings called wheel frames. The inner frame is rigid and is connected by eight radial struts to the center cone; the outer frame is a lighter, flexible ring. The roller shafts are simply short axles connecting the inner and outer rings.

The drum itself is 5' 4 3/8" (1.64 M.) high and 28' 11 7/8" (8.84 M.) in diameter, with eight radial struts. The bottom chords of the trusses pass directly over the top flange of the drum and the load of the inside endposts and the tower posts are transmitted directly through the bottom chords to the drum.

The turning mechanism is a rack and pinion system. The rack is built of sixteen cast steel segments bolted to the lower track supports. There are two pinion gears located at opposite points on the rack driven by a single 35 hp. alternating current motor. The original 14 hp. gas engine that provided an alternate power source is long since gone. Because of the skewed alignment of the bridge, the swing span can only open counter-clockwise.

At the ends of the swing span are lifting/locking jacks operated by a power shaft from the center of the span. These jacks serve to center the span and raise the track and roadway on the swing span up to the level on the approaches when the span is closed. The same motor that operates the rack and pinion also operates the jacks. The railroad tracks also have a set of rail locks at either end of the swing span. These locks consist of a pair of sliding rails on the swing span that in the closed position fit into a pair of guides at the stationary portions of the rails. The rail locks were originally operated by the same shaft that operated the jacks. This shaft was connected to the rail locks and the jacks through a set of clutches and an automatic shifting system to operate the jacks and the locks in the proper sequence. This system evidently did not work well and at some point a set of compressed air cylinders was installed to operate the rail locks. The positions of both the rail locks and the jacks can be observed indirectly by the bridge tender by a set of indicators in the tender's house (see photograph IA-3-23). These indicators are operated by means of cables connected through pulleys to the jacks and locks.

The tender's house is a two story frame structure (aluminium sided) located outside the trusses on the south side of the swing span at its center. The first story houses the air compressor for the rail locks as well as electrical equipment. The gas engine was originally located here. The second floor contains the tender's room with the controllers, switchboard, clutch levers, and mechanical indicators for the jacks and the rail locks. There originally was a third floor to accommodate the watchman who closed the gates on the roadway.

Because the bottom of the river channel is bare rock it was considered unsafe to get power to the swing span by an underwater cable. Electrical power is therefore carried to the swing span by cables strung to a pole atop the center tower. The pole has a series of collector rings to transfer power to the swing span.

The opening and closing of the swing span is a rather complex (and for the tender, a tiring) operation. The tender is in constant radio communication with boats on the river and with the lock tenders and therefore knows approximately when the span will need to be opened. The first step in the opening of the span is telephoning a local radio station so the public can be forewarned. Then three to five minutes before the span actually opens, the tender climbs the stairs to the highway deck. There he watches the traffic and starts the warning sirens to clear the highway traffic off the swing span. Once the traffic is cleared, he drops the barricades (see photograph IA-3-32) on the roadway to prevent automobiles from driving onto the swing span. Returning to the tender's house, the rail locks are opened using the air valve, and confirmed by looking at the indicators. The actual timing of the opening depends on the river stage. When the water is high there is not enough clearance for barges and therefore the bridge must be open before the barges are under it. For barge tows coming downstream the bridge is usually opened as soon as the tow begins to move out of the lock; for tows coming upstream the bridge is swung before they reach the downstream fender. During lower water, swinging of the bridge is delayed as long as possible by letting several barges in the tow pass under the bridge before opening it finally for the tow boat itself. The actual swinging consists of engaging the clutch for the end lift jacks and starting the motor until the jacks are raised. The clutch is then shifted, and the motor is again started, this time to drive the pinion gears and swing the span. The actual time to swing the span is less than a minute.

In closing the span the procedure is reversed. Most of the experienced tenders can close the span and get it lined up very well without resorting to the brake. All of them use the resistance of the drive gearing and the electric motor to slow the span and stop it. Any slight error in alignment is taken care of by the end lifting jacks which also center the bridge.

The bridge can be open from fifteen minutes to nearly an hour depending on the river stage, size of the tow, and the direction it is traveling. The shortest time is for a tow going downstream during low water; the longest for a tow coming upstream during high water. In recent years the bridge has opened 5,000 to 6,000 times a year.

FOOTNOTES

[1] All dimensional information is from the original design documents.

[2] "Reconstruction of the Mississippi River Bridge at Keokuk," Engineering News 74 (1916): 260; see also original drawing sheets 3, 4, 5, 9, 16.

[3] E. E. R. Tratman, "Depreciation of an Old Mississippi River Bridge," Chicago, 1915. (Typewritten.)

[4] J. A. L. Waddell, Bridge Engineering (New York: John Wiley & Sons, 1915), p. 1714.

HISTORICAL BACKGROUND

The Keokuk & Hamilton bridge spans the Mississippi River between Hamilton, Illinois and Keokuk, Iowa. Its steel superstructure was erected in 1915-1916, on the piers of a bridge built in 1869-1871.

Hamilton is located in Hancock County, which was organized in 1825. The town, laid out in 1852, was incorporated in 1854. Across the river, Keokuk's first lots were offered for sale in 1837. The community became Lee County seat in 1847, with formal incorporation occurring the following year.

Until after the Civil War, the Mississippi River was the upper midwest's principal artery of transportation and commerce. The hub of this commerce was St. Louis, which received agricultural products from Iowa, Illinois, Wisconsin and Minnesota, and in turn supplied these areas with manufactured goods. By the 1850's, steamboats dominated the upper Mississippi, laden with bulk commodities, manufactured items and travelers of all kinds, including settlers seeking new homes on the prairies and in the towns of the upper midwest.

Navigation on the upper Mississippi was complicated by two sets of rapids: the upper, or Rock Island, rapids between LeClaire and Davenport, Iowa; and the lower, or Des Moines, rapids between Montrose and Keokuk. Negotiation of these rapids generally required that heavily-laden steamers be unloaded, the freight then transferred to keelboats, flatboats or steam towboats of shallower draft. Once the rapids were passed, the steamers would be re-loaded to continue their journeys as before.[1]

A measure of Keokuk's early growth derived from the community's location at the foot of the Des Moines rapids. The break in navigation here encouraged establishment of service facilities, such as wharves, warehouses and hotels for the cargo, passengers and crews of the river steamers. By the mid-19th century, Keokuk had also become an important service center for agricultural areas in northeast Missouri and southeast Iowa. Its merchants handled a variety of local commodities, including meat, grain and coal. Later in the century Keokuk developed a lumber milling industry that benefitted from extensive cutting in Wisconsin and Minnesota pine forests. The city's influence extended into central Iowa as well, due to its location at the mouth of the Des Moines River.[2]

The Mississippi River, however, discouraged extension of Keokuk's commercial influence into Illinois, as the only way to cross the river was by ferry. Ferries there were, of course, the first at the lower rapids having been established by Peter Williams of Warsaw, Illinois, in 1825.[3] This mode of transportation, however, was not necessarily reliable, and it was difficult to ship large amounts of goods or raw materials in the relatively limited cargo space of most ferries.

Until the 1850's however, Keokuk businessmen remained largely content to develop promising markets west of the river. This began to change in 1856, with construction of the first railroad bridge over the Mississippi at Davenport, Iowa. The bridge not only demonstrated that the river could be spanned, but also inaugurated a new phase in the development of transportation systems in the upper midwest, in which Chicago would play the dominant role.

THE FIRST BRIDGE

Construction of the Davenport bridge had its effect downriver as well. Soon businessmen on both sides of the lower rapids began to seriously consider how they might make, or at least encourage, major improvements in transportation both on and over the river between Keokuk and Hamilton. One improvement, promoted in St. Louis as well, was construction of a canal to bypass the rapids and thereby facilitate steam navigation on the river. The canal, suggested by Lieut. Robert E. Lee as early as 1832, was begun in 1867 and completed ten years later. Ironically the canal, which had been so eagerly sought by both Hamilton and Keokuk, produced something of a decline in the latter community's economy. With navigation at the rapids unimpeded, there was no longer the need to break the journey at Keokuk. As a result steamers passed by without stopping, to the detriment of wharf and warehouse operators and local hoteliers.[4]

Along with promotion of the canal, however, Keokuk and Hamilton businessmen in the mid-1860's applied themselves to the problem of crossing the Mississippi. Extension of railroad lines west from Chicago produced no little competition among Iowa cities along the river (such as Clinton, Burlington, Ft. Madison and Keokuk) to obtain those critical rail connections that would not only link them directly to the industrial and manufacturing centers of Chicago and further east, but would also facilitate competition with Davenport for a share of markets to the west. In light of these great hopes, the existing Keokuk-Hamilton ferry service was clearly inadequate. Various schemes were proposed for a river crossing, one of the more ambitious being construction of a tunnel beneath the river, with roadways for both rail and wagon traffic, that would be inclined toward the main channel so as not to impede navigation.[5]

More practical was the proposal of the Hancock Bridge Company, organized in 1865 with authorization from the Illinois state legislature to build a railroad and wagon bridge across the Mississippi from Hancock County. The following year, the Keokuk & Hamilton Mississippi River Bridge Co. was established in Keokuk. The two organizations merged, to become in 1868 the Keokuk & Hamilton Bridge Co., incorporated under Iowa law.[6]

Plans for a bridge were not by any means simply a matter of local concern. Prime movers in the project were four railroads: the Columbus, Chicago and Indiana Central (a leased line of the Pennsylvania railroad); the Toledo, Wabash and Western; Toledo, Peoria and Warsaw (all of Illinois); and the Des Moines Valley line (Iowa). Behind these companies was Andrew Carnegie, whose extensive interests in railroads were conveniently combined with interests in iron manufacture and bridge building. As a result, construction of a bridge at Keokuk became a Carnegie affair: he was president of the Keokuk & Hamilton Bridge Co.; railroads in which he had interest would use the bridge; and it would be erected by his Keystone Bridge Company of Pittsburgh.[7]

Location surveys were conducted, first by Col. Otley of the Des Moines Valley railroad, and again under Toledo, Peoria & Warsaw auspices by Joseph S. Smith, an engineer working under Thomas Curtis Clarke. Clarke, then designer and engineer in chief for the Quincy (Illinois) Bridge Co. (built 1866-1868), prepared plans and specifications, and on 6 December 1868 the Keokuk & Hamilton Bridge Co. contracted with the Keystone Bridge Co. for construction.[8]

Clarke's eleven-span, pin-connected iron through truss bridge was fabricated by Union Iron Mills of Pittsburgh, which often provided material to Keystone at discount.[9] It was basically a series of skewed Whipple trusses, with Carnegie octagonal columns for end and intermediate posts. All had parallel chords except the draw span, which had a slightly arched top chord and was 380' long. From west to east, the structure consisted of the draw span, two 250' fixed spans, three 162' 9" spans, one 151' 4" span, and four 164' 7" spans. They were erected on piers of limestone supplied by the Sonora Quarry Co.[10]

The piers were set at a slight skew with the bridge,and the bridge itself was inclined 17° 15' from right angle to the channel. Averaging about 35 feet in height, the piers included a pivot pier with a 32' diameter, 9 piers 6' x 29' (top) and 10 x 51.9' (bottom), and one (at the extreme western end) measuring 7' x 29' (top) and 10' x 51.9' (bottom). The superstructure was 2192' long, with a 200' masonry approach on the Keokuk side and a 700' earthen embankment approach on the Illinois side. The trusses, spaced approximately 20' center to center, supported a single line of track between two wagon roadways, with pedestrian walkways cantilevered 5' out from the trusses on each side.[11]

The bridge was begun in late 1869. Those in charge of the work included Joseph S. Smith, resident engineer in charge of the substructure; Walter Katle, in charge of overall erection of the bridge; F. S. Kaufman, foreman of the ten permanent spans; H. M. Shotts, foreman of the draw span; and Frank Reeder, machinist and foreman of the steam-engine and hydraulic works. On 19 April 1871, it was opened to traffic, but the first locomotive to cross crushed the pivot center of the draw span. A replacement was supplied "in a few days" by Sample, Armitage and Co.'s Buckeye foundry in Keokuk.[12]

With completion of the bridge, Keokuk businessmen could well believe their city was ready for a major period of growth and commercial expansion. Keokuk was now in a better position to compete against other Iowa river communities with a bridge that connected the city directly with rail lines to Chicago. In addition, Keokuk was "the only wagon bridge over the Mississippi River, above

St. Louis,"[13] a factor that for a time enhanced the city's role as an outfitting point for settlers traveling to southern and western Iowa. And with the now easy river crossing, Keokuk merchants were at last able to "secure ... a large trade from Illinois".[14]

The potential of the Keokuk bridge, and also other crossings on the upper Mississippi to alter traditional patterns of commerce was illustrated by concerns raised in St. Louis when plans for the Keokuk span were announced. In June 1869, the St. Louis Board of Trade conducted an investigation of the project. Seizing upon the 17° 15' angle at which the bridge was to cross the channel, the Board pronounced the planned structure "obstructive" and "highly dangerous to navigation."[15] More to the point, perhaps, was the Board's fear that extension of railroad lines across the upper midwest would allow Chicago merchants to dominate what had heretofore been almost exclusively St. Louis' commercial domain. The subsequent history of transportation and commerce in the region was to prove these fears well-founded. As the Daily Gate City stated in 1871, "the trade-lines of the country are undoubtedly mainly East and West,"[16] and with its new bridge, Keokuk stood ready to make the most of it. As it happened, however, the nationwide financial panic of 1873 created a temporary check on railroad expansion, and although growth soon resumed, Keokuk was unable to attract major lines. In addition, the railroad bridge over the Mississippi at Burlington, Iowa, completed just as Keokuk's was begun, made the former one of eastern Iowa's premier rail centers, again to the detriment of Keokuk.[17]

Although its construction did not produce quite the ambitious results originally anticipated, Thomas Clarke's bridge served the Keokuk and Hamilton communities for over 40 years. After the embarassing collapse of the center pivot on opening day, the bridge functioned without further structural mishaps. In 1881 however, the steamer War Eagle collided with the bridge, taking out one of the fixed spans. Until it could be replaced, a wooden, covered span was substituted. This span was subsequently reused over a slough on the earthen Hamilton approach (later called Old Dike Road).[18] A few years later, the 17° 15' angle of the bridge relative to the current became a minor issue once again. The 1885 Rivers and Harbors Act was to have allocated funds for a pier on the outer wall of the Des Moines Rapids Canal, but the allocation was tied to the bridge's having been built in conformance with certain provisions of that Act. Correspondence among the Army Corps of Engineers, the Secretary of War, and Andrew Carnegie (as president of the Keokuk & Hamilton Bridge Co.) eventually confirmed the appropriateness of Clarke's design.[19]

THE SECOND BRIDGE

In 1913, the Keokuk & Hamilton Water Power Co. began its last year of construction on a powerhouse, dam and locks at the foot of the Des Moines rapids, which was to be the largest hydroelectric development of its time in the U.S. and for many years thereafter.[20]

Coincident with this important project, there arose local interest in replacing the Keokuk-Hamilton bridge. The structure had been designed to carry engines of up to 35 tons, and carloads to 13 tons. As engines and cars began to exceed these limits in the early 20th century, "longer and heavier timbers" were added to the floor system so that loads could be "distributed over several panels."[21] This was considered but a temporary solution, however, and Keokuk businessmen began to consider alternatives.

The Keokuk & Hamilton Bridge Co. on the other hand, was satisfied with the existing span, and was at first disinclined toward change. The issue was seriously joined in 1912, when the Intercity Bridge Company, whose president, C. R. Joy, was also head of the Keokuk Industrial Association, proposed that a new bridge be built on top of the dam and across the upper end of the powerhouse, both of which were then under construction. In order to do this, however, Congressional authorization was required, and House Resolution 26672 was proposed to that end.

Hearings before the Committee on Interstate and Foreign Commerce in January 1913, focussed on several issues: the inadequacy of the existing bridge, the practicality of the bridge-on-the-dam proposal, and the exclusivity of the franchise awarded the Keokuk & Hamilton Bridge Co. (through the Hancock Bridge Co.) to erect a span in the first place. The question of competition and the prospect of diminished revenues dominated the Keokuk & Hamilton Bridge Company's case, presented by its Secretary, Theodore Gilman. He cited the original authorization, noted Congress' policy of limiting the number of interstate bridges in the interests of navigation, and warned of bankruptcy for his company should a second bridge of any kind be erected at Keokuk.[22]

"Stripped of corporate names, [the bridge controversy] was really a fight between the business interests and people of Keokuk and that canny Scot [Andrew Carnegie]." Following an official site visit in late 1913, the Interstate and Foreign Commerce Committee chairman, George Adamson of Georgia, resolved the fight by deciding that either the Keokuk & Hamilton Bridge Co. would reconstruct its bridge, or he would recommend passage of House Resolution 26672, although he was "not entirely pleased" with the scheme to build a bridge on top of the dam."[23]

In January 1914, the Keokuk & Hamilton Bridge Co. contracted with Ralph

Modjeski to prepare an analysis of the existing bridge and recommendations for future work.[24] In mid-February, Modjeski paid a visit to Keokuk, and his report was ready by early March. In essence, it stated that the existing bridge, while performing to the specifications of its original design, was overstressed for rail traffic and incapable of safely carrying modern loads. Although addition of a third rail to facilitate railroad and streetcar traffic was possible, Modjeski believed that neither reinforcing the structure nor adding a separate roadway would be feasible. He offered two options: a single track bridge with roadway above; or another bridge much like the first but with greater load-bearing capability.[25]

Although the bridge company first seized on the notion of adding a third rail to the existing structure,[26] the final decision, reached in May 1914, was to reconstruct the span along the lines of Modjeski's first option. Plans were finished by late October of that year, and invitations for bids issued on 10 November.[27]

Modjeski's double-deck design permitted a single track at the level of the original roadway, with two lanes for wagon and auto traffic on the upper deck, all within the approximately 20-foot limit imposed by the width of the existing piers. Eight of the eleven steel spans would be riveted Pratt trusses from 142' to 168' long, spaced 16' 7" center to center. Two longer fixed spans were to be 254' 6" Parker trusses, with both pin and riveted connections. The 380' draw span, its two trusses hung by pin-connected eyebar ties from a central tower, was to be riveted. The trusses of these three longer spans were to be spaced 20' 6" center to center. Reuse of the masonry piers required they they be cut down about 5 feet, and given new caps and bridge seats of concrete.[28]

According to the specifications, Modjeski planned to replace the draw span during the winter of 1914-15. However, Strobel Steel Construction submitted an alternative in which the draw span would be one of the last to be rebuilt, a proposal which was accepted in mid-February, 1915.[29] On 30 April 1915 George Hinckley, Modjeski's resident engineer, arrived in Keokuk. A crew from Hoeffler & Co. (contractors for the masonry) was already present, and work began immediately.[30]

The new superstructure was erected from east to west as far as the westernmost of the eight shorter fixed spans (Nos. 4-11). Work then shifted to the first main channel span (No. 2) and the draw span. The latter was opened for its first trial run in late March, 1916. After a year of almost wholly uninterrupted effort, high water in spring of 1916 delayed erection of the second channel span (No. 3) for several weeks. George Hinckley returned to New York in September of that year, the bridge for all intents and purposes complete.[31]

Like the original structure, the "new" bridge was supported financially through a system of rents (from rail and streetcar lines) and tolls (from wagon and automobile traffic). This system worked reasonably well through the 1930's, but then became a source of local discontent. In 1938, the city of Keokuk appointed a committee to explore methods of obtaining a free bridge crossing. The group's first effort was to investigate the possibility of purchasing the existing bridge from the Keokuk & Hamilton Bridge Co. Royal Edsell, then president of the company, offered to sell for $1,143,000, plus an additional amount to cover the company's ten thousand shares of $100 par common stock. These figures were unacceptable to the city, which made a counter-proposal of $500,000.[32]

When this offer was rejected, the Keokuk committee turned to consideration of a new structure. In November 1940, the city contracted with Sverdrup & Parcel of St. Louis to prepare plans for a new bridge, and that same year the U. S. House of Representatives approved a bill authorizing construction. The bill did not get through the Senate, however, so a new bill was proposed there in early 1941.[33]

Meanwhile, the Keokuk & Hamilton Bridge Company had been experiencing significant economic problems, perhaps because income from rail and roadway users was insufficient to support bridge maintenance and repair. The bridge was refinanced around 1940, through a transfer of property from the Keokuk & Hamilton Bridge Co. to Keokuk & Hamilton Bridge, Inc. (again headed by Royal Edsell), with offices only in Keokuk, rather than in New York as well.[34]

Given these financial difficulties, the new company would have considered the now-likely possibility of a new, free bridge at Keokuk with no little dismay. Thus, as the U.S. Senate moved to consider the second bill for new construction at Keokuk, Edsell made a "gift proposal" to the city. Under its terms, Keokuk would claim full ownership of the Keokuk-Hamilton Bridge once $775,000 in bonds had been paid off.[35]

On 6 December 1948, the Keokuk Bridge Commission was organized to take over the Keokuk-Hamilton Bridge. On 13 January 1949, with ceremonies, "Bridge Week Specials" at local stores, and a "Free Bridge Issue" of the Daily Gate City, the structure became the toll-free Keokuk Municipal Bridge (although railroads would continue to pay rent).[36]

Despite the rhetoric that accompanied the occasion, the Keokuk bridge was not to remain "free" for very long. Reimposition of tolls in May 1952 was required not only to finance general maintenance, but also to underwrite the considerable cost of reinforcing the piers in 1950-1951. As early as 1922, Ralph Modjeski expressed concern about the condition of the piers, and recommended that they be cofferdammed, "unwatered", and given reinforced concrete jackets extending well above normal water level.[37] In November 1922, a bid was recieved from F. W. Adgate of the Foundation Company (successor firm to the noted Sooysmith & Co.) for the work but it was apparently never carried out. Instead, unreinforced concrete was applied in 1927. The job proved only temporarily effective, and the piers were rejacketed, essentially along the lines of Modjeski's original recommendations, during 1950-51.[38]

Other major work on the bridge included rebuilding the Hamilton approach to avoid the slough road, the old covered bridge span there having been considered a particular problem as early as the mid-1940's. This was finally accomplished in 1956. The following year, the old wooden roadway was replaced with a steel mesh flooring. In addition, construction of a new 1200-foot lock (completed 1957) proved beneficial: the city arranged with the Army Corps of Engineers to have the old timber cribbing that had had long protected the pivot pier removed, and subsequent protection provided by having the new lock's guide wall extended downstream (incorporating the pivot pier within its mass), thereby saving the city some $150,000.[39]

Although Ralph Modjeski's reconstructed span proved more than adequate for railroad use and remains in excellent condition, he did not perhaps forsee the possibility that the bridge would be unable to handle modern truck and auto traffic. The narrow upper deck and sinuous curve of the western approach, while suitable for wagons and early automobiles, constituted something of a safety hazard for larger vehicles, semi-trailer trucks in particular. A new bridge planned for Keokuk will solve present problems related to vehicular traffic.

* * * *

In the decade following the Civil War, American railroad companies extended their lines west from Chicago to the rapidly developing frontiers of the plains and far West. Along with laying thousands of miles of track and bringing new towns into existence all along the way, the railroads also built many bridges, some across rivers that were important avenues of transportation and commerce. The first of these, on the way west from Chicago, was the Mississippi, where the first railroad bridge to Iowa was erected in 1853-56. By 1876 there were four more bridges to Iowa, among them the Keokuk & Hamilton bridge completed in 1871. Some of these, such as the Clinton (1864), Dubuque (1868), and Burlington (1868) crossings served only railroad traffic. A few others, including the second Davenport (1872) and Keokuk bridges, also had roadways for wagons and pedestrians.

These multi-span iron bridges, many utilizing double-intersection Lineville or Whipple-Murphy trusses and invariably featuring a draw span and one or more long navigation channel spans, were built well enough to meet the transportation needs of their day. Neither the designers nor, perhaps, their railroad company clients, however, anticipated the significant increases in the size and weight of rolling stock and volume of freight that occurred during the next few decades. As a result, beginning in the early 1890's, all these bridges, and later spans as well, had to be replaced. These replacements, or "reconstructions" as they were commonly called, generally meant that a new superstructure was erected on piers remaining from the original construction. There was seldom a need to relocate a bridge: the initial location was usually satisfactory, and relocation would have required expensive realignment of approaches as well. Existing piers were also found to be on the whole sufficient, even if the trusses they originally supported were too lightly-designed to accommodate turn-of-the-century loading requirements. Thus, Iowa's Mississippi River bridges were reconstructed one by one: Clinton in the 1880's and again in 1909, Dubuque piecemeal in the 1890's, Davenport in 1894-5, Burlington in 1890-93, the 1886 Iowa Central Railroad bridge at Keithsburg, Illinois in 1910, the Keokuk & Hamilton Bridge in 1915-16.

Major differences between the old and new structures included use of steel, rather than iron, and abandonment of the Lineville-type truss in favor of Pratt, Pennsylvania and Parker trusses, with heavier members to meet greater loading needs. Piers were often modified--raised or lowered as new superstructure designs required, and reinforced concrete for strengthening and new copings came into common use. In addition, the new spans tended to be riveted, rather than pin-connected, although pins continued in use for eyebar bottom chords and other tension member connections.

The history of the Keokuk & Hamilton bridge corresponds closely to this general pattern of railroad bridge building over the Mississippi to Iowa. Erected in 1869-71 for a group of regional rail lines, the original structure featured iron Lineville/Whipple trusses on limestone piers. Perhaps the most unusual feature of the bridge was its skewed alignment with respect to the current, likely a function of the nature of the topography on one or both sides of the river. This span performed successfully for over 40 years, and was still carrying the loads for which it had been designed, until it was replaced. A 1915 study by E. E. R. Tratman, then editor of Engineering News, determined that the old bridge was structurally sound; the problem lay in the larger and heavier rolling stock of the early 20th century. To solve the problem, a new superstructure was erected on the existing piers--a solution which by 1915 was well established for Mississippi River crossings.

Of the ten railroad crossings established over the Mississippi to Iowa in the 19th and early 20th centuries, only one, the Davenport, Rock Island and Western's "Crescent" Bridge (1900-1901) is an "original" structure, all the rest having been reconstructed, or, in a few cases, completely removed for new spans. The oldest of the reconstructed bridges appears to be George S. Morison's Chicago, Burlington & Quincy Railroad bridge at Burlington (opened October 1893), followed by Ralph Modjeski's Government Bridge of 1894-5 at Davenport. The last replacement occurred in 1927 when the Santa Fe Railroad replaced its 1887-8 bridge at Fort Madison.

FOOTNOTES

[1] Nelson C. Roberts and S.W. Moorhead, eds., Story of Lee County, Iowa (Chicago: S. J. Clarke, 1914), pp. 231-232.

[2] J. A. Dull, "The City of Keokuk and Its Advantages," (pamphlet, 1881).

[3] Charles J. Scofield, ed., Historical Encyclopedia of Illinois and Hancock County (Chicago: Munsell Publishing Co., 1921), Vol. II, pp. 679.

[4] Roberts and Moorhead, Story of Lee County, p. 243; Keokuk Industrial Association, "A Survey of the City of Keokuk, Iowa," (typescript, 1914), 6.

[5] Scofield, Historical Encyclopedia, p. 872.

[6] Keokuk Daily Gate City, 11 January 1949, p.15.

[7] Scofield, Historical Encyclopedia, p. 873.

[8] Keokuk Daily Gate City, 11 January 1949, p.15.

[9] James Howard Bridge Inside History of the Carnegie Steel Company (New York: Aldine Book Co., 1903), p. 44.

[10] "Reconstruction of the Keokuk Bridge,"Railway Age Gazette 61(July, 1916): 97; E. E. R. Tratman, "Depreciation of an Old Mississippi River Bridge," Chicago, 1915. (Typewritten.)

[11] Tratman, "Depreciation..."; History of Lee County, Iowa (Chicago: Western Historical Co., 1879), p. 627.

[12] History of Lee County, p. 627.

[13] Keokuk Daily Gate City, 22 August 1877 (Bickel Scrapbooks).

[14] Roberts and Moorhead, Story of Lee County, p. 150.

[15] Keokuk Daily Gate City, 24 June 1869 (Bickel Scrapbooks).

[16] Keokuk Daily Gate City,11 April 1871, p. 2

[17] U.S. Congress, House, Bridges at Keokuk, Iowa. Hearings before the Committee on Interstate and Foreign Commerce on Bills HR 26559 and HR 26672, 62 Cong. 3 Sess., 17 January 1917, p. 12

[18] Hancock County Board of Supervisors History of Hancock County, Illinois (privately printed, 1968), pp. 105-106.

[19] Keokuk Daily Gate City, 11 January 1949, p. 15.

[20] "World's Greatest Water-Power Plant," Electrical World 61(1913): 1157-1168.

[21] Scofield, Historical Encyclopedia, p. 874.

[22] U.S. Congress, House, Bridges at Keokuk, Iowa. Hearings ..., pp. 5ff.; Keokuk Constitution-Democrat, 5 February 1914, p. 1.

[23] Keokuk Constitution-Democrat, 10 November 1916 (Keokuk-Hamilton Bridge File, Keokuk Public Library).

[24] Ralph Modjeski to Theodore Gilman, 23 January 1914, General Letter Book, 21 May 1913 to 31 December 1914, Modjeski & Masters, Mechanicsburg, Pennsylvania, p. 389. (Hereafter GLB)

[25] Ralph Modjeski to Theodore Gilman, 7 March 1914, GLB, p. 497A.

[26] Ralph Modjeski to Theodore Gilman (telegram), 18 March 1914, GLB, p. 585.

[27] Keokuk Constitution-Democrat, 5 February 1914, 14 May 1914 (Keokuk-Hamilton Bridge File, Keokuk Public Library); Ralph Modjeski to Theodore Gilman, 13 May 1914, GLB, p. 578, and 27 October 1914, GLB, p. 843; W.A. Angier to Theodore Gilman, 10 November 1914, GLB, p. 876.

[28] Ralph Modjeski Keokuk & Hamilton Bridge Co.: Specifications for Rebuilding the Bridge Across the Mississippi River between Keokuk, Iowa and Hamilton, Illinois, 1915.

[29] Edward Haupt to Ralph Modjeski, 27 November 1914, General Letter Files, Keokuk & Hamilton Bridge, Modjeski & Masters, Mechanicsburg, Pennsylvania. (Hereafter GLF)

[30] George Hinckley to Ralph Modjeski, 3 May 1915, GLF.

[31] See section on construction chronology. See also correspondence between George Hinckley and Ralph Modjeski, 3 May 1915 - 23 September 1916 GLF.

[32] Keokuk Daily Gate City, 31 December 1948, pp. 1,7.

[33] Ibid.

[34] Ibid.

[35] Ibid.; Keokuk Daily Gate City, 10 January 1949, p. 2.

[36] Keokuk Daily Gate City, 11 January 1949, pp. 1,6,12,15.

[37] Theodore Gilman to Ralph Modjeski, 22 May 1922, GLF Keokuk Daily Gate City 22 May 1952 (Bickel Scrapbooks).

[38] Keokuk Daily Gate City, 22 May 1952 (Bickel Scrapbooks).

[39] Keokuk & Hamilton Bridge - Illinois Approach: Maintenance Files

(Modjeski & Masters); Keokuk Daily Gate City, 1 May 1957, p. 3.

CONSTRUCTION METHODS

Rebuilding the eleven spans of the Keokuk-Hamilton bridge was achieved with a remarkable degree of efficiency. Beginning at the easternmost fixed span (No. 11), work progressed without major interruption through reconstruction of all the shorter, Pratt-truss fixed spans (Nos. 11-4). The direction of the work was then reversed, with rebuilding of the trusses of the draw span and those of the westernmost Parker truss span (No. 2). High water, beginning in late January 1916, precluded work on the final span (No. 3) until March.[1]

The method of reconstruction was basically the same for all eleven spans, with some variation in dealing with the draw and two Parker trusses.

The first preparatory step was erection of falsework. For the shorter spans (Nos. 4-11), this consisted of seven six-post bents, connected by longitudinal struts, the end pairs tied together with diagonal bracing. The two longer fixed spans (Nos. 2 and 3) required twelve bents braced together in pairs, the end bents parallel to the piers and the remaining ten set at right angles to the bridge. At the draw span, eight bents were placed under each arm, again braced in pairs to form short towers. Because the river bottom beneath the bridge was limestone bedrock, it was impossible to drive piles. Each bent post was therefore driven to a "firm bearing" and cut off at the proper height. For spans 4-11, falsework was built beneath three spans at a time. When the easternmost span was erected and riveted, its falsework was moved past the other two spans and placed under the next to be reconstructed.[2]

Once falsework was in place beneath a span, installation of falsework stringers followed. At spans 4-11 and one of the Parker truss spans, plate-girder stringers for the two long spans were employed as falsework stringers. On the other long fixed span, old floor beams were used instead. Falsework stringers for the draw span consisted of 15-inch beams, plus six old floor beams.

The first step in reconstruction was to cut slots in the old floor and insert new floor beams. Then the old wood stringers were removed and new steel stringers set in place. With stringers and beams in position, the entire span was wedged up onto the falsework, and the old trusses dismantled, panel by panel, from east to west. For this work, a 25-ton four-wheel locomotive crane was used, with materials removed or brought forward by a dinkey locomotive.[3]

Erection of new trusses was again from east to west, panel by panel, followed by addition of upper floor beams, portals and lateral bracing, and finally the hangars and plates of the smoke-protection system. During erection, the truss members were held together with bolts. Then the span was riveted up, beginning with lower chord points and floor stringer connections, finishing up with the upper chord points. The two Parker-truss spans were treated in a slightly different manner, because their bottom chords consisted of pin-connected eyebars. For these spans (Nos. 2 and 3) the ends of the chord members were supported on blocking built up from the falsework while the pins were driven. The trusses were then riveted up in the usual way.

Because each span was raised on falsework, it was unnecessary to construct it from the fixed-shoe end to the expansion-shoe end. As work progressed at a span, the corresponding piers were cut down and concrete poured through the floor. Once the concrete had hardened, the finished span, from which the end shoes were suspended, was "swung" from the falsework onto the newly-refurbished piers.

When a new span was in place on its piers, the falsework was moved three spans west to the next span to be worked on. Each new span then received two coats of paint. Decking the upper floor, again moving from east to west, was in a sense an operation separate from the erection process, in that it did not begin until steel of spans 8-11 was up and riveted.

These steps were executed in a continuous movement out from the Illinois side so that each group of three spans would be in various stages of dismantling and reconstruction. For example, as span 10 was being riveted, steel for span 9 would be in process of erection, and at span 8 the old trusses would be coming down.

The draw and two long fixed spans (Nos. 1, 2, 3) were reconstructed in basically the same manner, except that the work progressed from west to east. Work on the draw span was complicated by a delay in delivery of the drum; the two pairs of trusses were erected first, the bottom chords then jacked up so that the treads, rollers and drum could be slipped underneath, and the towers built afterward.[4] Riveting of the draw and two long fixed spans also varied from the earlier pattern, in that upper chord connections were riveted first.

Throughout reconstruction, both rail and wagon/auto traffic moved freely across the bridge, this accomplished by leaving the lower deck flooring in place even as the beam and stringer systems were being replaced. Electric streetcar service was accommodated by removing the electric crane and clearing the bridge every half hour, for a ten-minute break between work stoppage and resumption. Lower deck flooring was not replaced until the upper deck was complete and open to traffic.

FOOTNOTES

[1] Letters of George Hinckley to Ralph Modjeski, 3 May 1915-23 September 1916, General Letter File, Keokuk & Hamilton Bridge, Modjeski & Masters, Consulting Engineers, Mechanicsburg, Pennsylvania.

[2] "Reconstruction of the Mississippi River Bridge at Keokuk," Engineering News 75 (April, 1916): 690.

[3] Ibid., pp. 691-692.

[4] "The Reconstruction of the Keokuk Bridge," Railway Age Gazette 61 (July, 1916), p. 100.

CONSTRUCTION CHRONOLOGY

The Keokuk-Hamilton bridge was reconstructed over a period of seventeen months, beginning in May 1915. The progress of the work was reported in weekly letters from George Hinckley, resident engineer, to Ralph Modjeski. They are preserved, along with many other documents, in the files of Modjeski & Masters, Consulting Engineers, Mechanicsburg, Pennsylvania. The letters form the basis of the following construction chronology, which is organized by month.

May 1915: George Hinckley arrived in Keokuk on April 30, having been shortly preceded by crews from Hoeffler & Co., contractors for the masonry and concrete work. Foundation excavation for the Keokuk approach was completed, the abutment foundation block poured, and excavation for concrete pedestals at bents 9, 10, and 11 largely accomplished.

June 1915: Pedestals for bents 9, 10, and 11 of the Keokuk approach were poured, as were the required 22 reinforced concrete piles for the Hamilton approach. At the latter, planking on the railroad track was installed to accommodate vehicular traffic during construction, and footings for the abutment and north retaining wall poured. Toward the end of the month, the superintendent from Strobel arrived.

July 1915: Activity concentrated at the Hamilton approach, where the abutment concrete was poured and forms set for portions of the retaining walls. Eight piles were poured for the Keokuk approach. On the bridge, Strobel crews removed poles and telegraph wires, and most of the sidewalk and handrail from the upstream side. Four falsework bents were raised beneath span 11, but this work was then stalled due to delay in delivery of timber and stringers.

August 1915: At the Hamilton approach, several sections of the retaining walls were poured. By month's end, falsework bents were positioned beneath spans 10 and 11, span 10 was wedged onto the falsework and two bents had been erected beneath span 9.

September 1915: During this month, Hoeffler & Co. poured the last concrete on the Hamilton approach abutment and retaining walls. Strobel crews dismantled the trusses of spans 10 and 11, each requiring less than a week. A sudden rise in the river on the 10th pushed the falsework bents under span 9 about 10 feet out of line, but they were reset the following week. September also saw completion of masonry work on piers 10 and 11, which involved cutting down the tops about 5 feet and covering them with new reinforced concrete copings. Erection of new trusses on span 11 also required about one week, once new floor beams and stringers had been inserted beneath the existing floor.

October 1915: By the end of October, steel on spans 10 and 11 had been completely erected, riveted, and was ready for paint. Most of the steel of span 9 was in place, and lower chord points and floor connections riveted. Work on the piers correspondingly progressed, No. 9 joining the two completed in September. With erection of the first three spans, preliminary activity began at spans 8 and 7. Both were by this time on falsework and the old trusses completely removed from the former and partly from the latter.

At the Keokuk approach, all masonry for the highway viaduct was completed by the 23rd, the last work having been the pouring of pedestals at bents 1, 2, 3, 4, and 5. The only work at the Hamilton approach was placement of sand filling in the completed double retaining walls.

During this month too, workmen laboriously removed - by hand - the old stone and timber from the downstream protection crib at the pivot pier, and made a start on similar dismantling of the upstream crib.

November 1915: At the Hamilton approach, the abutment and retaining walls were made ready for paving, with filling completed at the latter. At the draw span, worked progressed on the shore fence (opposite the draw protection crib) with the building of seven stone-filled timber cribs. Dismantling of the old cribs of the upstream nose of the draw protection continued.

Most of the steel for span 8 was erected the first week of November, with that of span 7 in place by the 20th. On the 27th, Hinckley was able to report that spans 7 through 11 were up and riveted, span 6 largely dismantled, and span 5 on falsework and partly dismantled. Pier work continued in concert with reconstruction of the spans, with piers 7 to 11 finished and 6 cut down and ready for new coping. In addition, four bents of falsework were in place beneath the west arm of the draw span.

December 1915: On the 4th, the "last boat of the season passed the draw". The Mississippi was thus closed to navigation at Keokuk, permitting work on the draw span to proceed without interruption through the winter. On Christmas Day, Hinckley reported that spans 5 and 6 had been completely erected, and span 4 and the draw span were on falsework and partly dismantled. Construction of the upper deck, which began in mid-November and progressed, like the rest of the work, from east to west, was by late December completed to the west end of span 7. Spans 6 to 11 had been painted, and piers were remodeled through No. 5.

Since completion of the masonry work on the Keokuk approach, no work had been done there. At the Hamilton approach, the concrete base for the road and sidewalk on the retaining wall was completed by the 11th. By the end of the month, the shore fence west of the draw had been largely finished. Crews were still removing debris from the old draw protection's upper nose, but on the downstream side excavations had been made for six new timber cribs.

January 1916: During January, the shore fence was creosoted, but high water prevented setting timber for the draw protection cribs. Piles and foundation blocks for bents 1, 2, and 3 were placed at the Hamilton approach viaduct, and erection of bents at the Keokuk approach began. On the bridge proper, the top of the pivot pier was cut down and new coping poured. New floor beams, stringers and part of the bottom chord were installed on the drawspan. Trusses of the westernmost of the shorter fixed spans (No. 4) were erected and riveted, and the first Parker truss (No. 2) was up on falsework. Two bents of falsework were placed beneath no. 3; the rest would be delayed by high water for several months.

February 1916: February saw erection of only two spans on the Keokuk approach (Nos. 11 and 12) and almost no progress on the Hamilton approach. On the bridge itself, however, steel for both arms of the draw span were erected, top chords and about two-thirds of the lower chord points riveted, and most of the smoke protection panels installed. Lower floor beams were set for span No. 2 (the first of the Parker trusses), and work began on the lower chord and panels at the west end. Work also progressed on the draw protection, where the upstream nose was built to elevation 514'.

March 1916: During March, the draw span received rollers, track, treads, center and live ring, and the drum was erected, enabling construction of the tower from which the two arms would hang when the span was open. Using a hoisting engine, since the swing and lift machinery had not yet arrived, Hinckley supervised a successful trial opening of the span during the week of the 25th. Almost all the steel for span no. 2 was erected during this period, but high water continued to prohibit any work at all on the falsework for span no. 3.

This month concluded with four more spans (7-10) in place on the Keokuk viaduct, completion of pedestals at the Hamilton approach, and near-completion of the upper nose of the draw protection.

April 1916: Within the first week of April, almost all the steel bents and stringers were in place at the Hamilton approach. By the 22nd riveting was completed and much of the structure painted. Similar progress occurred at the west approach, so that by month's end the Keokuk viaduct was erected, painted and partly floored on the upper deck. High water continued to delay work on span No. 3. Work on the draw span (still lacking swing machinery) was limited to laying upper deck timber. Span No. 2 was fully erected, and the polygonal top chord and floor connections riveted.

May 1916: By the end of May both highway approaches were complete to the point of having most of their wood block paving in place, and crews began to upgrade the west railroad approach. Other work included construction of most of the operating house and upper deck timbering on the drawspan, and completion of riveting on span No. 2.

June 1916: Early in June, the Mississippi floodwaters finally receded, and the month's efforts were concentrated on the long-idle span No. 3. By the 17th all falsework was in place under the span, and within a week the old trusses were completely removed. With placement of this span on falsework, it was also possible to remodel the remaining piers, Nos. 3 and 4. New concrete copings were also poured for the crosswalls of the Keokuk railroad approach.

July 1916: By the end of July, the last span of the new Keokuk and Hamilton Bridge was in place and mostly riveted. The entire substructure was by that time completely overhauled, except for some pointing and repair of masonry on pier 3. All that remained to accomplish on the highway approaches was rolling the block paving to fix it firmly into its sand bed, some railing on the downstream side, and tower-bracing at spans 2 and 4 of the Keokuk approach.

August 1916: With all the bridge spans in place, and the approaches nearly complete, much of August's work centered on replacing the lower (railroad) deck. The level of the river had by this time reached a "stationary" stage 4, permitting work to resume on the lower draw protection cribs, where work had been delayed since early spring. Rebuilding of the west railroad approach was also largely finished in August.

September 1916: The last report from Keokuk was written on the 23rd by M. B. Case, who had taken over the final stages of construction from George Hinckley earlier in the month. In his two reports to Modjeski, Case was able to report the building and floating into place of eight timber cribs for the downstream draw protection, and also installation of the long-delayed swing and end-lift machinery for the draw span -- the two major tasks remaining in the project. Toward the end of the month, the Keokuk & Hamilton Bridge Company's president, Theodore Gilman, arrived to view the first operation of the swing machinery by electric motor. Case was no doubt quite pleased to report that "Everything worked very smoothly," and, perhaps most important, "Mr. Gilman seemed very well pleased with the progress on the work."

BIOGRAPHICAL: THOMAS CURTIS CLARKE

Thomas Curtis Clarke was born 5 September 1827 in Newton, Massachusetts. He was well-educated (Boston Latin School 1841-44, Harvard 1844-48) and at first planned to study law. Instead, upon his graduation from Harvard (as class poet), Clarke joined the engineering section of the Mobile & Ohio Railway, then headed by Captain John Childe.[1] Childe (1802-1858), "the foremost railroad engineer of the day" was an 1827 graduate of West Point who had served for eleven years with the U. S. Army Corps of Engineers. After 1835, Childe specialized in railroad survey and location work on a consulting basis. In 1848, Childe obtained a post with the Mobile & Ohio Railroad as chief engineer, and Thomas Clarke worked with him that first year.[2]

Poor health forced Clarke back to the Boston area in 1849. As his Memoir noted years later, "at that time there were few schools of engineering, and young engineers had to obtain their technical education as best they could."[3] To that end, Clarke spent perhaps a year in the offices of Edward Clark Cabot (1818-1901), who had opened an architectural practice in Boston in 1847. After working with Cabot, Clarke was associated briefly with the Ogdensburg & Lake Champlain Railroad, and again for a short time with the Mobile & Ohio. In 1851, Clarke went to Chicago, to study with Edward Burling (1819-1892), "the second professional architect to practice" in that city.[4]

For fourteen years, Clarke worked in Canada. His first Canadian job began in October 1852, when he signed on as Resident Engineer of the Great Western Railway's Second Division. This work was followed by three years with the Port Hope & Peterboro Railway. In 1856, Clarke and an engineer with the Grand

Trunk Railway leased the Port Hope line, "and operated it as a private enterprise." This project failing in 1858 (the line's directors broke the lease agreement, with inevitable litigation), Clarke joined the Canadian government's survey of the Ottawa River. Late the following year, Clarke, along with Ralph Jones and Edward Haycock, contracted to erect two major government buildings in Ottawa, a project that occupied him until 1866.[5]

Thomas Clarke's career as a bridge designer seems to have begun in earnest with the Burlington railroad's span over the Mississippi at Quincy, Illinois in 1866-68, and the Keokuk-Hamilton bridge, built 1869-71 but apparently designed in 1868. In the fall of 1868, Clarke and Charles Kellogg formed a New York partnership under the name Phoenix Bridge Company. Two years later, in 1870, Thomas Clarke moved to Philadelphia and established Clarke, Reeves & Co., which became "one of the leading bridge builders of the United States." One of Clarke's associates was Samuel Reeves, of the Pennsylvania family that had taken over the late 18th century Phoenix Iron Works in 1827. Reeves was also designer, in 1862, of the polygonal Phoenix Column that was a hallmark of the firm's work for decades. With organization of Clarke, Reeves & Co., Phoenix achieved a vertical operation that included design, fabrication and erection.[6]

Clarke "severed his connection" with Clarke, Reeves in 1883 (the firm subsequently was reorganized as the Phoenix Bridge Co.) and the following year co-founded the Union Bridge Company in New York. Major works during Clarke's four-year tenure with this firm included the Hawksbury Bridge (Australia) and the Hudson River span at Poughkeepsie (completed 1888). Shortly after his retirement from Union Bridge Co., Clarke established a consulting firm with a former Clarke, Reeves associate, Adolphus Bonzano, which lasted from 1893 to 1898. Clarke died 15 June, 1901.[7]

FOOTNOTES

[1]"Memoir for Thomas Curtis Clarke," American Society of Civil Engineers Transactions 50 (April, 1903): 495.

[2]Who Was Who in America (Chicago: Marquis Who's Who, 1963), Historical Volume, p. 104.

[3]"Memoir," p. 496.

[4]Ibid., p. 496-497; H.F. and E.R. Withey Biographical Dictionary of Architects (Deceased) (Los Angeles: Hennessey and Ingalls, 1970), pp. 96, 102-103.

[5]"Memoir," p. 497.

[6]Ibid.; William T. Hogan Economic History of the Iron and Steel Industries in the United States (Lexington: D.C. Heath & Co., 1971), Vol. I, p. 94.

[7]"Memoir," pp. 498-499.

BIOGRAPHICAL: CHARLES LOUIS STROBEL

Strobel Steel was organized in 1905 by Charles Louis Strobel (1852-1936) toward the end of a distinguished career in civil engineering. Strobel was born in Cincinnati, Ohio, and received his professional training at Stuttgart's Royal Institute of Technology, from which he graduated in 1873. From 1874 to 1878, Strobel worked with the engineering section of the Cincinnati Southern Railway, where "construction ... was in advance of the times."[1] This was due in part perhaps to Strobel's own efforts, which included development of a method for calculating stresses from "definite locomotive-wheel concentration ... [which became] common practice."[2]

In 1878, Strobel began an association with Andrew Carnegie's Keystone Bridge Company that was to last for many years. From 1878 to 1885, Strobel served as Engineer and Assistant to the President. From 1885 to 1893 he was the firm's consulting engineer and agent in Chicago, and also consulting engineer to Carnegie, Phipps & Co.; the architectural firm of Burnham and Root; and other Chicago firms. Strobel's contributions to engineering during this period included development of the Z-bar column and design of standard sections for I-beams and channels, the latter for Carnegie, Phipps' mills. Another major project was development of "A Pocket Companion of Useful Information and Tables Appertaining to the Use of Wrought Iron for Engineers, Architects and Builders," a guide first issued in 1881 by Carnegie, Phipps.[3]

During the later 1890's, Strobel continued his work in design of steel I-beam sections for production in universal mills, and built the first rolling lift bascule bridge (designed by William Scherzer) in Chicago in 1894. Subsequently, Strobel collaborated with Theodore Rall in development of the

"Rall"-type bascule. He rounded out his career as a designer with the asymmetrical cantilever bridge at Marietta, Ohio, completed in 1903. From 1905 until his retirement in 1926, Strobel headed his Strobel Steel Construction firm, established in the former year. He died 9 April 1936, in Chicago.[4]

FOOTNOTES

[1]"Memoir for Charles Louis Strobel," American Society of Engineers Transactions 102(1937): 1492.

[2]Ibid.

[3]Ibid., pp. 1493-1494.

[4]Who Was Who in America (Chicago: Marquis Who's Who, 1943), Vol.I, p. 1198; David Plowden Bridges: The Spans of North America (New York: Viking Press, 1974), pp. 176, 239.

BIOGRAPHICAL: RALPH MODJESKI

Ralph Modjeski (1861-1940) has rightly been considered one of America's foremost bridge engineers, his spans numbering among the major contributions to bridge design and construction of the early 20th century. Modjeski was born in Cracow, Poland, the son of the then internationally-famous tragedienne Mme. Helena Modjeska (a fact which in early years of his engineering practice in the U.S. was often noted in newspaper accounts of his work). He was musically inclined, and in his youth studied piano with the intention of pursuing a concert career. However, after a two-year visit to the United States (1876-78) as an agent for his mother, Ralph Modjeski decided to become an engineer instead.[1]

Modjeski's subsequent training was probably among the best available at the time. He studied at the prestigious Ecole des Ponts et Chausees, Paris, from 1878 to 1885, a period when French engineering was in the forefront of iron construction and design. While in Paris, Modjeski would have had an opportunity to see such notable works as Beltard's Les Halles and church of St. Augustine; Gustav Eiffel's Bon Marche and Pont Garabit; and would no doubt learn of, if not see first hand, Eiffel's landmark bridge over the Douro at Oporto, Portugal of 1876-77.

Upon his return to the United States about 1886, Modjeski obtained a position with George S. Morison, "father of bridge building in America."[2] At the time, Morison was working on a series of seven railroad bridges over the Missouri River. These bridges, the first built in 1880, the last in 1889, employed Whipple-Murphy trusses and a progressive increase in use of steel to the point where the last three (one of which was the recently-demolished span at Sioux City) were constructed almost entirely of this material. Ralph Modjeski, who began his work with Morison as assistant on the Union Pacific Railroad bridge at Omaha of 1885-1887, no doubt participated as well in the design of the later steel Missouri River bridges. Promoted to chief draftsman, Modjeski was put in charge of the design for the landmark cantilever bridge over the Mississippi at Memphis, which was completed in 1892.[3]

In 1893, Modjeski left Morison to begin his own practice, which he established in Chicago as Modjeski & Nickerson. Like many small businesses before and since, Modjeski's firm "struggled with small projects, surveys and reports" for a year, after which this apparent lack of success dissolved the partnership.[4] In 1894 however, probably soon after the failure of this venture, Ralph Modjeski received "his first major assignment", to design and supervise construction on the rebuilding of the railroad bridge between Arsenal Island and Davenport, Iowa.[5]

With the successful completion of this project in 1896, Modjeski's career was fairly launched. Over the next forty years a wide variety of clients, many of them railroad companies and municipal bridge commissions, retained Modjeski to design, and often to supervise construction of, bridges in all regions of the United States. Major works from the early years of his career included the Thebes, Illinois bridge over the Mississippi (with Alfred Noble) and a series of spans for the Northern Pacific and Oregon Trunk railroads, among the latter a 340-foot two-arched span 350 feet above the Crooked River in Oregon. Modjeski also served from 1908 to 1918 on the three-man board of engineers appointed to oversee the redesign and reconstruction of the calamity-plagued Quebec Bridge over the St. Lawrence.[6]

Although Modjeski could and did design concrete arch bridges (including the Cherry St. Bridge, Toledo, Ohio, 1912-1915; and the 15-span Clark's Ferry Bridge near Harrisburg of 1923-1925), most of his major efforts were in the areas of truss and suspension bridge design. Among the latter was the Delaware River Bridge, which, when opened to traffic in 1926 was considered "the longest suspension bridge ever built," with a main span of 1750 feet and an overall length of 9570 feet. This was followed by the Mid-Hudson Bridge at Poughkeepsie (1923-1930), which the American Society of Civil Engineers cited for its "Gothic beauty".[8] A quite different beauty was achieved by Modjeski's Henry Avenue Bridge in Philadelphia's Fairmount Park (1927-1932) in which a concrete-arch span was faced with stone to complement the picturesque wooded landscape that was its setting.[9]

Through much of his career, Modjeski worked in partnership with Frank Masters, who joined him in 1923. Other partners included Clement E. Chase (1926-1933) and Montgomery Case (1933-1938). Modjeski's work, which took him from Alaska to New Orleans and encompassed nearly 60 projects,[10] earned him international recognition, including the French Legion of Honor (1926) and the Grand Prize at the Exposition of Industry and Science in his Polish homeland (1929). Among his American honors was the Washington Award, granted by the Western Society of Engineers in 1931.[11] Modjeski's last major project was the San Francisco-Oakland Bay Bridge, for which he moved to California in 1936 "so that he could be close to the work."[12] Poor health limited his efforts in his last years, and Modjeski died June 25, 1940.

> When I was four years old I got hold of a screwdriver. This gave me an idea. I immediately investigated what this screwdriver was for and practiced on a door lock of the drawing room in the house we lived in and took

it all apart. I could not put it together again. And my father said, "You will be an engineer."[13]

FOOTNOTES

[1]"Memoir for Ralph Modjeski," American Society of Civil Engineers Transactions 106 (1940): 1624.

[2]Ibid., p. 1624.

[3]David Plowden Bridges: The Spans of North America (New York: Viking Press, 1974), pp. 137, 171.

[4]"Memoir," p. 1624.

[5]Ibid.; Railroad Gazette 13 November 1896, pp. 787-788; F.E.Robbins, "History of the Rock Island Bridge," typescript, 14 June 1910.

[6]"Memoir," pp. 1624-25; Plowden, Bridges, pp. 172-176.

[7]"Memoir," p. 1626.

[8]Ibid.

[9]Modjeski & Masters, Consulting Engineers (Mechanicsburg, Pennsylvania, n.d.), p. 15.

[10]Modjeski & Masters, Consulting Engineers contains a list of Modjeski's (and the firm's) major projects, many of which are illustrated.

[11]"The Washington Award Presentation," Journal of the Western Society of Engineers 36(April, 1931): 69-79.

[12]"Memoir," p. 1628.

[13]"The Washington Award...," p. 973.

BIBLIOGRAPHY

Bickel Scrapbooks, Keokuk Public Library, Keokuk, Iowa.

Bridge, James Howard. Inside History of the Carnegie Steel Company. New York: Aldine Book Co., 1903.

Cleveland, Frederick A. and F.W. Powell. Railroad Promotion and Capitalization in the United States. New York: Longmans, Green and Co., 1909.

Dull, J. A. "The City of Keokuk and its Advantages...", pamphlet, 1881, Iowa State Historical Society Library.

Gregg, T. H. History of Hancock County, Illinois. Chicago: Chapman & Co., 1880.

Hancock County Board of Supervisors. History of Hancock County, Illinois. Privately printed, 1968.

Hendrick, Burton J. Life of Andrew Carnegie. Garden City: Doubleday, Doran & Co., 1932.

"Historical Review of the Keokuk Hydroelectric Development," Electrical World 62 (1913):462-464.

History of Lee County, Iowa. Chicago: Western Historical Co., 1879.

Keokuk Constitution-Democrat. "Keokuk History", 29 September 1906.

Keokuk Daily Gate City, 1869-1954.

"Keokuk-Hamilton Bridge," vertical file, Keokuk Public Library.

Keokuk Industrial Association. "A Survey of the City of Keokuk, Iowa," typescript, 1914, Iowa State Historical Society Library.

Mechanicsburg, Pennsylvania. Modjeski & Masters, Consulting Engineers. General Letter Book, 21 May 1913-31 December 1914.

Mechanicsburg, Pennsylvania. Modjeski & Masters, Consulting Engineers. General Letter Files, Keokuk & Hamilton Bridge.

Mechanicsburg, Pennsylvania. Modjeski & Masters, Consulting Engineers. Inspection Reports, Keokuk & Hamilton Bridge.

"Memoir for Charles Louis Strobel," American Society of Civil Engineers, Transactions 102 (1937):1491-1494.

"Memoir for Thomas Curtis Clarke," American Society of Civil Engineers, Transactions 50 (1903):495-499.

"Memoir for Ralph Modjeski," American Society of Civil Engineers, Transactions 106 (1941):1624-1628.

Modjeski, Ralph. Keokuk & Hamilton Bridge Co., Specifications for Rebuilding the Bridge Across the Mississippi River between Keokuk, Iowa and Hamilton, Illinois. Chicago: Ralph Modjeski, 1915.

Modjeski and Masters. Modjeski and Masters: Consulting Engineers. (Promotional Brochure). Mechanicsburg: Modjeski and Masters, n.d.

National Cyclopaedia of American Biography. Ann Arbor: University Microfilms, 1967 (reprint of 1892 edition).

Plowden, David. Bridges: The Spans of North America. New York: Viking Press, 1974.

Railroad Gazette, 13 November 1896, pp. 787-788.

"Reconstruction of the Keokuk Bridge," Railway Age Gazette 61 (1916):97-100.

"Reconstruction of the Mississippi River Bridge at Keokuk," Engineering News 74 (1915):260-262.

"Reconstruction of the Mississippi River Bridge at Keokuk," Engineering News 75 (1916):690-693.

Robbins, F. E. "History of the Rock Island Bridge," typescript, 14 June 1914, Iowa State Historical Society Library.

Roberts, Nelson C. and S.W. Moorhead, eds. Story of Lee County, Iowa. Chicago: S. J. Clarke, 1914.

Scofield, Charles J., ed. Historical Encyclopedia of Illinois and History of Hancock County. Chicago: Munsell Publishing Co., 1921.

Tratman, E. E. R. "Depreciation of an Old Mississippi River Bridge," Chicago, 1915. (Typescript.)

U.S. Congress. House. Bridges at Keokuk, Iowa. Hearings before the Committee on Interstate and Foreign Commerce on Bills HR 26559 and HR 26672. 62nd Congress, 3rd Session, 17 January 1917.

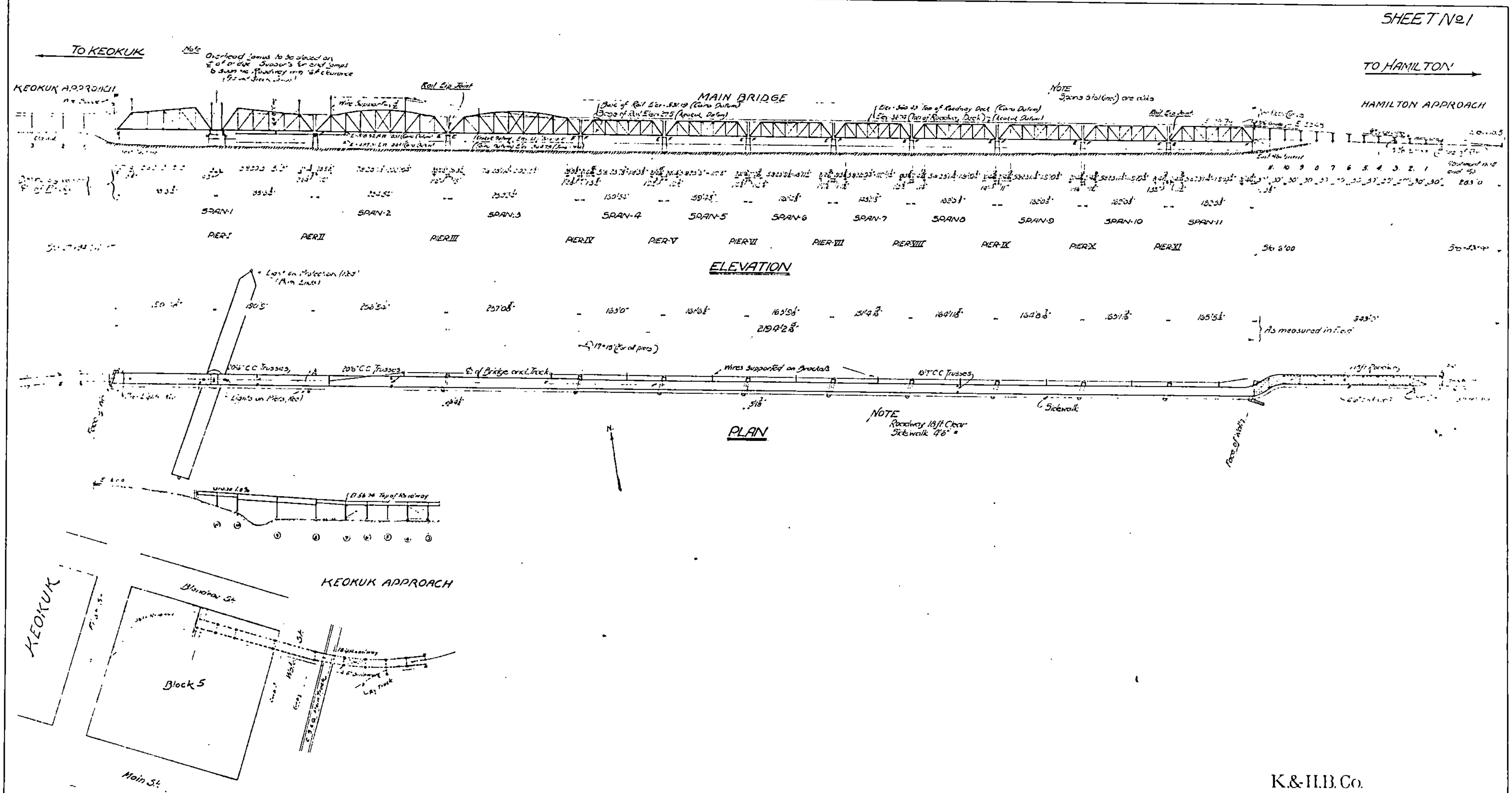
Waddell, J. A. L. Bridge Engineering. New York: John Wiley & Sons, 1916.

"The Washington Award Presentation," Journal of the Western Society of Engineers 36 (April 1931):69-79.

Who Was Who in America. Vol. I, 1897-1942, Chicago: Marquis Who's Who, 1943; Historical Volume (1607-1896), 1963.

Withey, H. F. and E. R. Withey. Biographical Dictinary of American Architects (Deceased). Los Angeles: Hennessey and Ingalls, 1970.

"World's Greatest Water-Power Plant," Electrical World 61 (1913): 1157-1168.



K.&H.B. Co.

KEOKUK BRIDGE.

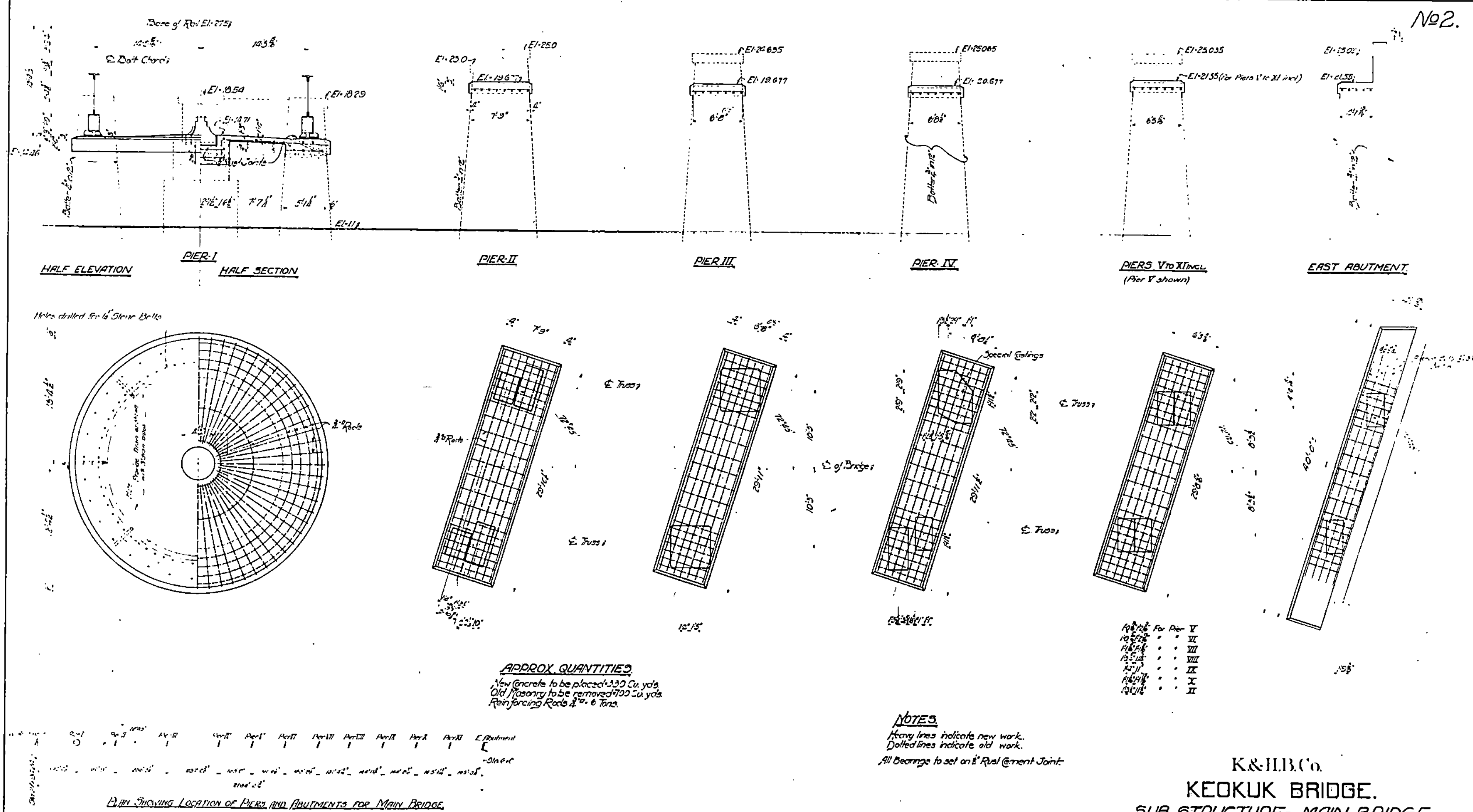
GENERAL ELEVATION AND PLAN.

Scale 1" = 80'0"

Approved _[signature]_

Consulting Engineer in charge

№2.



APPROX. QUANTITIES.

New Concrete to be placed - 330 Cu. yds.
Old Masonry to be removed - 700 Cu. yds.
Reinforcing Rods ⅞" ☐ - 6 Tons.

NOTES.

Heavy lines indicate new work.
Dotted lines indicate old work.

All Bearings to set on ½" Rust Cement Joint.

Approved Ralph Modjeski
Consulting Engineer in charge.

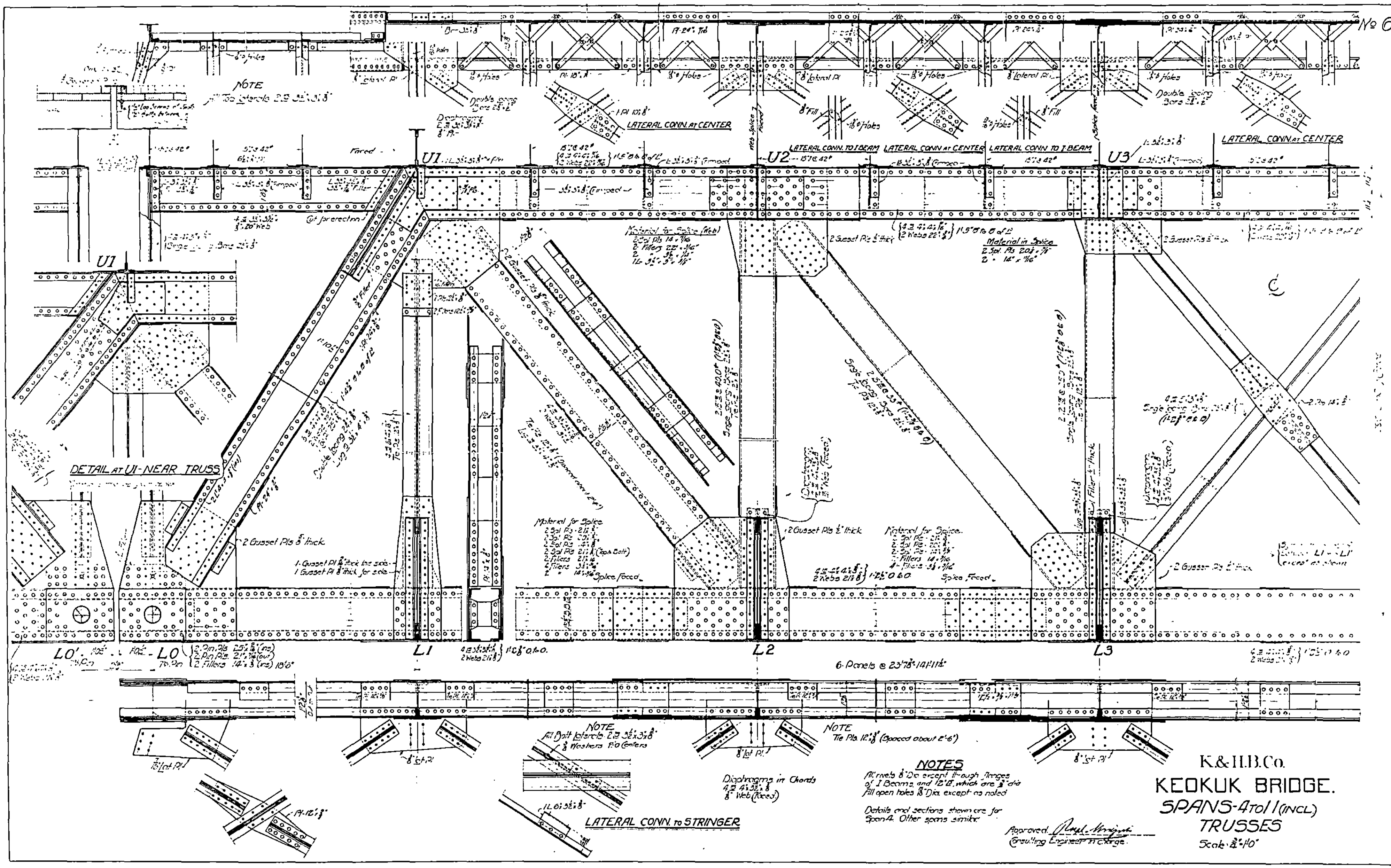
K.&.H.B.Co.

KEOKUK BRIDGE.

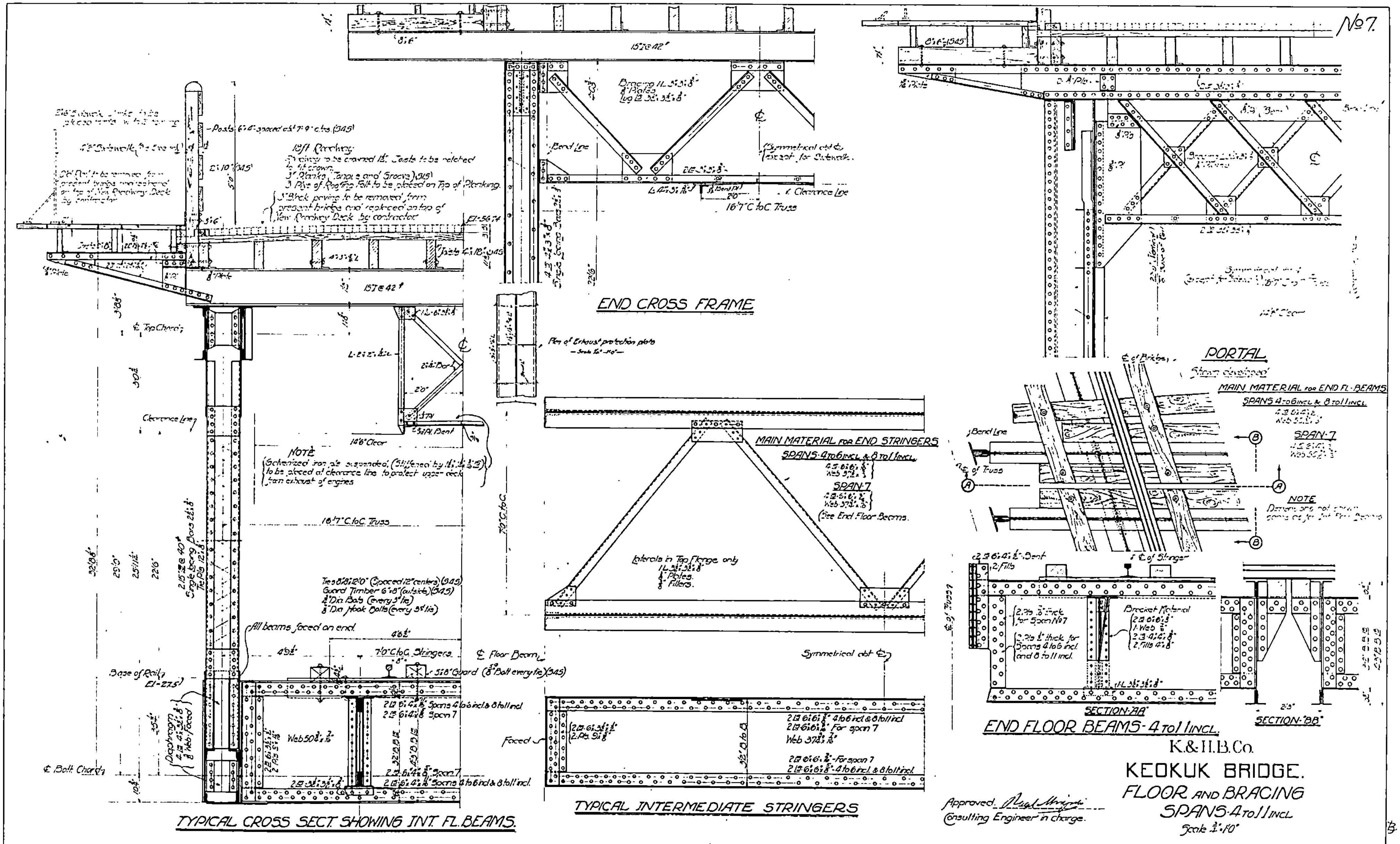
SUB STRUCTURE - MAIN BRIDGE.

PIERS I TO 11 INCL. AND EAST ABUTMENT

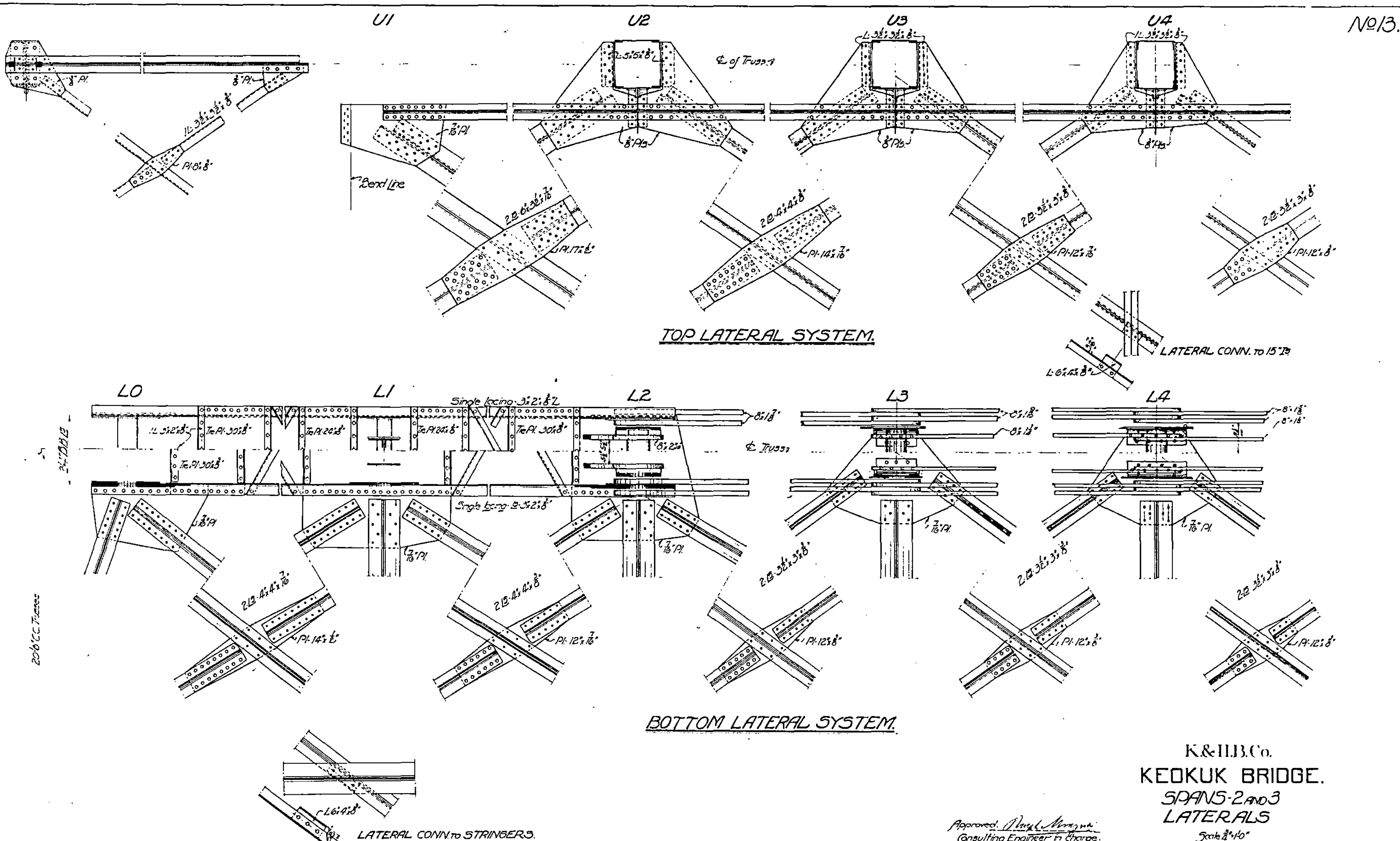
Scale - ⅛" = 1'0"



No 6.
NOTE
LATERAL CONN. AT CENTER
LATERAL CONN. TO I BEAM
U1
U2
U3
L0'
L0
L1
L2
L3
DETAIL AT U1-NEAR TRUSS
Material for Splice
2 Gusset Pls 5/8" thick
Splice Faced
6 Panels @ 23'-7 7/8" = 141'-11¼"
NOTE
Tie Pls. 12 x 3/8 (Spaced about 2'-6")
LATERAL CONN. TO STRINGER
Diaphragms in Chords
NOTES
All rivets 7/8" Dia. except through flanges of I Beams and 12" ⊏, which are 3/4" dia.
All open holes 15/16" Dia. except as noted.
Details and sections shown are for Span 4. Other spans similar.
Approved
Consulting Engineer in Charge.
K.&H.B.Co.
KEOKUK BRIDGE.
SPANS-4 TO 11 (INCL)
TRUSSES
Scale 1/8"=1'0"



No 7.
END CROSS FRAME
Symmetrical abt ℄ except for Sidewalk.
16'7" C to C Truss
Plan of Exhaust protection plate
PORTAL
MAIN MATERIAL FOR END FL. BEAMS
SPANS 4 TO 6 INCL. & 8 TO 11 INCL.
SPAN-7
NOTE
MAIN MATERIAL FOR END STRINGERS
SPANS 4 TO 6 INCL. & 8 TO 11 INCL.
SPAN 7
(See End Floor Beams.
Laterals in Top Flange only
NOTE
Galvanized iron pls suspended (Stiffened by ...) to be placed at clearance line to protect upper deck from exhaust of engines
16'7" C. to C. Truss
All beams faced on end.
7'0" C. to C. Stringers
℄ Floor Beam
Base of Rail El-27.5
℄ Bott. Chord
Faced
Symmetrical abt ℄
SECTION-AA
SECTION-BB
END FLOOR BEAMS - 4 TO 11 INCL.
TYPICAL CROSS SECT. SHOWING INT. FL. BEAMS.
TYPICAL INTERMEDIATE STRINGERS
Approved.
Consulting Engineer in charge.
K.&H.B.Co.
KEOKUK BRIDGE.
FLOOR AND BRACING
SPANS 4 TO 11 INCL.
Scale ¾"=1'0"



K.&H.B.Co.

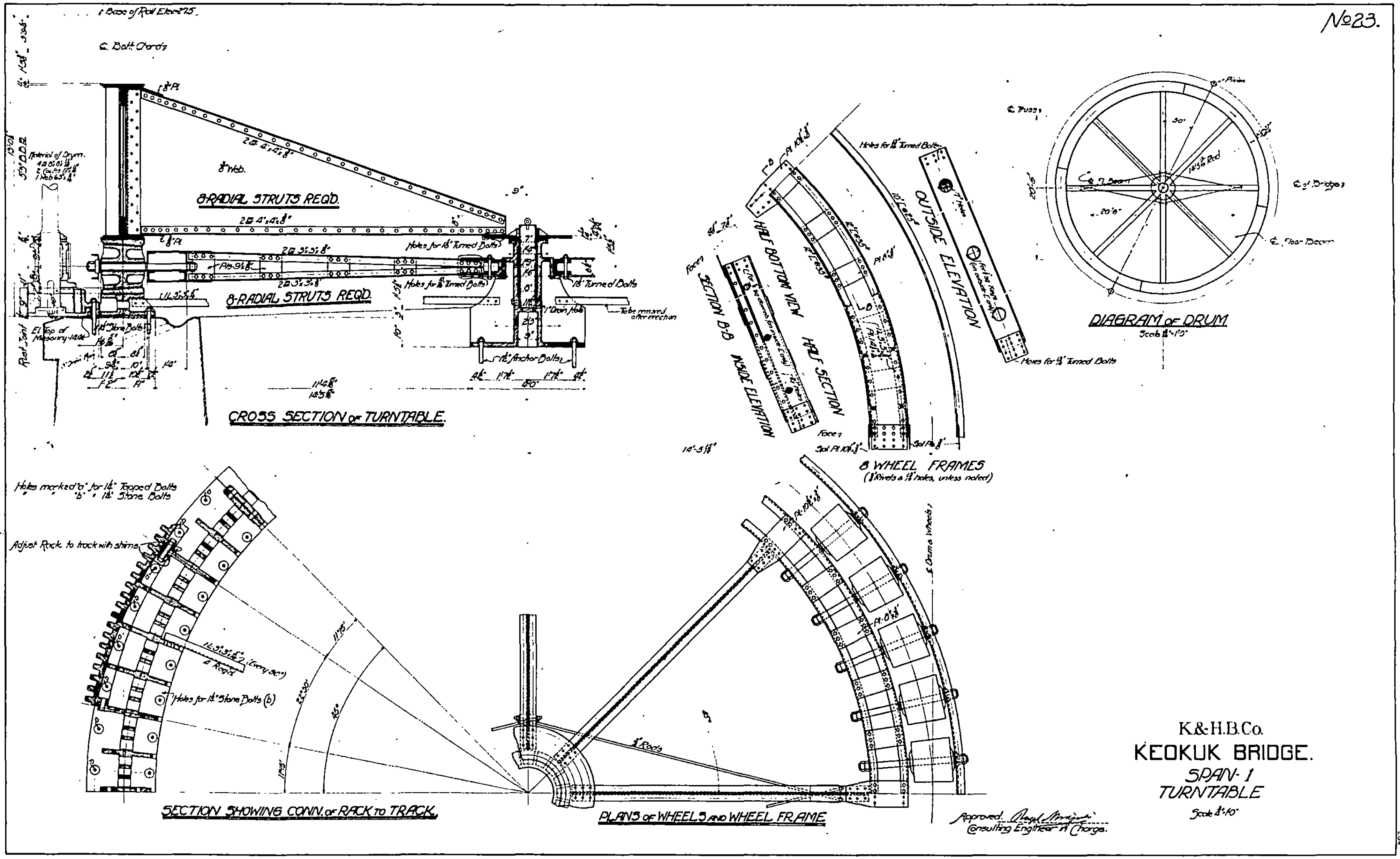
KEOKUK BRIDGE.

SPANS-2 AND 3

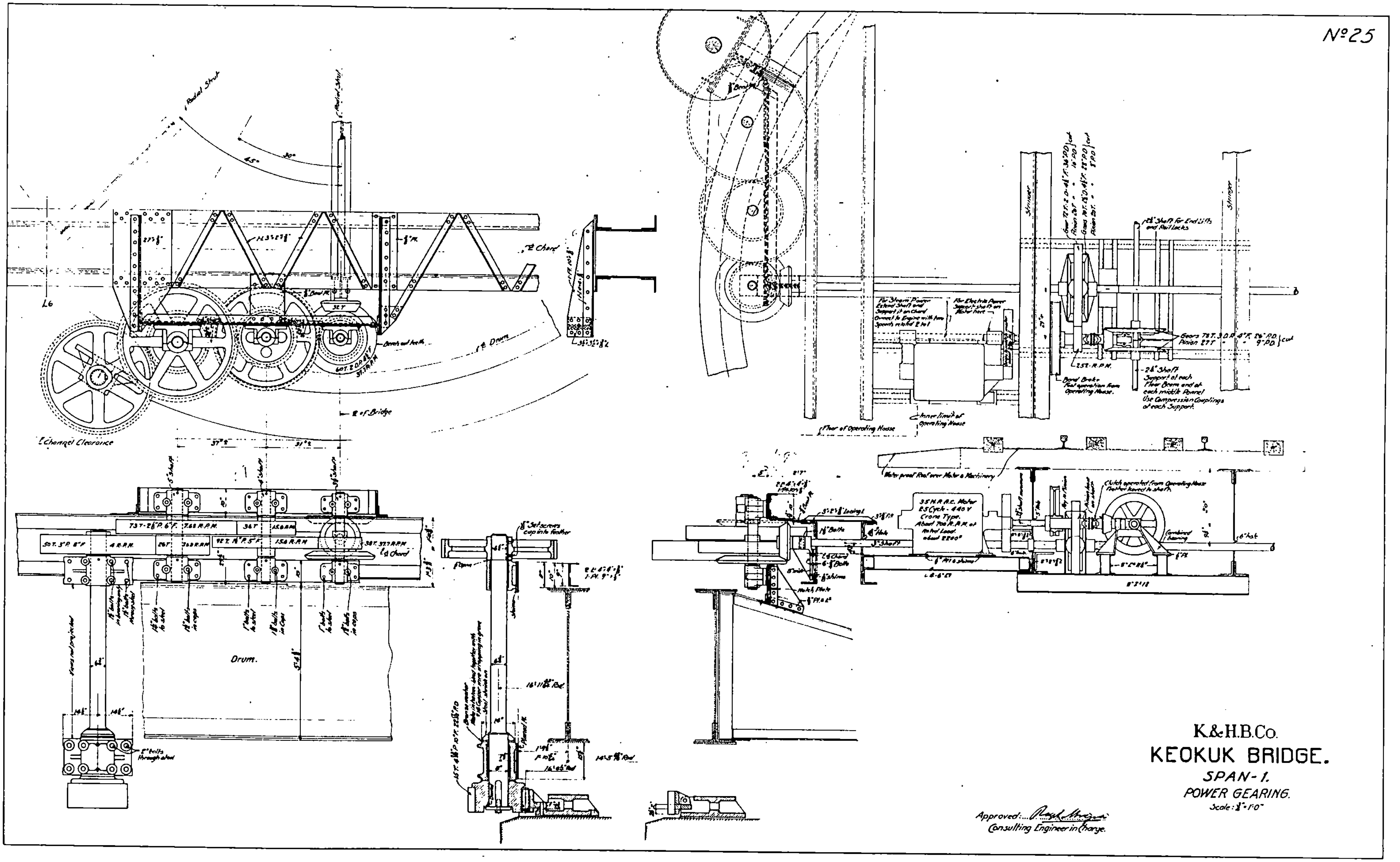
LATERALS

Scale 3/4"=1'0"

Approved: [signature]
Consulting Engineer in Charge.



№23.
8-RADIAL STRUTS REQ'D.
8-RADIAL STRUTS REQ'D.
CROSS SECTION OF TURNTABLE.
HALF BOTTOM VIEW
HALF SECTION
SECTION B-B
INSIDE ELEVATION
OUTSIDE ELEVATION
8 WHEEL FRAMES
DIAGRAM OF DRUM
Holes marked "a" for 1¼" Tapped Bolts
Adjust Rack to track with shims
SECTION SHOWING CONN. OF RACK TO TRACK.
PLANS OF WHEELS AND WHEEL FRAME
Approved.
Consulting Engineer in Charge.
K.&H.B.Co.
KEOKUK BRIDGE.
SPAN-1
TURNTABLE



K&H.B.Co.

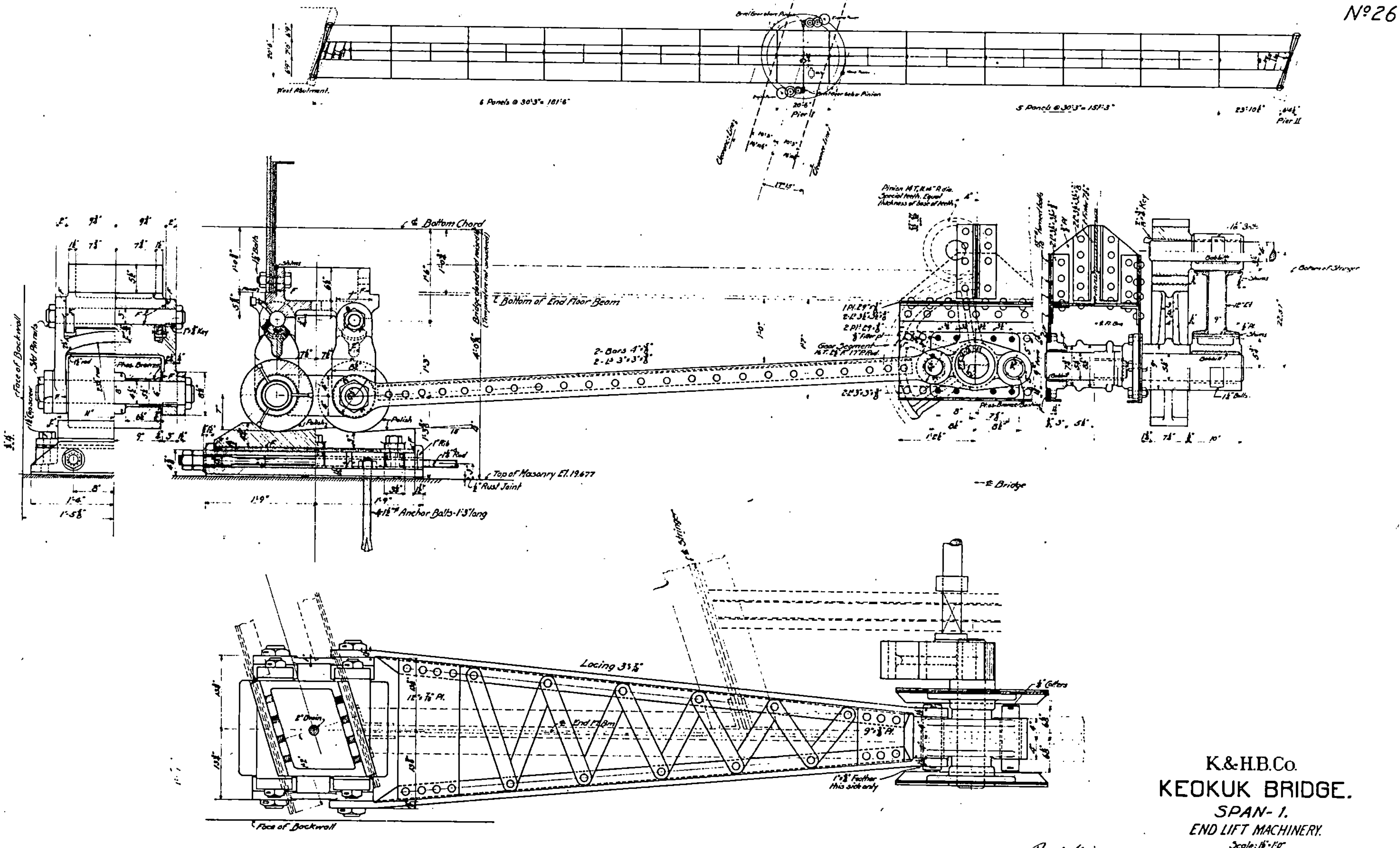
KEOKUK BRIDGE.

SPAN-1.

POWER GEARING.

Scale: $\frac{3}{8}$" = 1'0"

No 26



K.&H.B.Co.

KEOKUK BRIDGE.

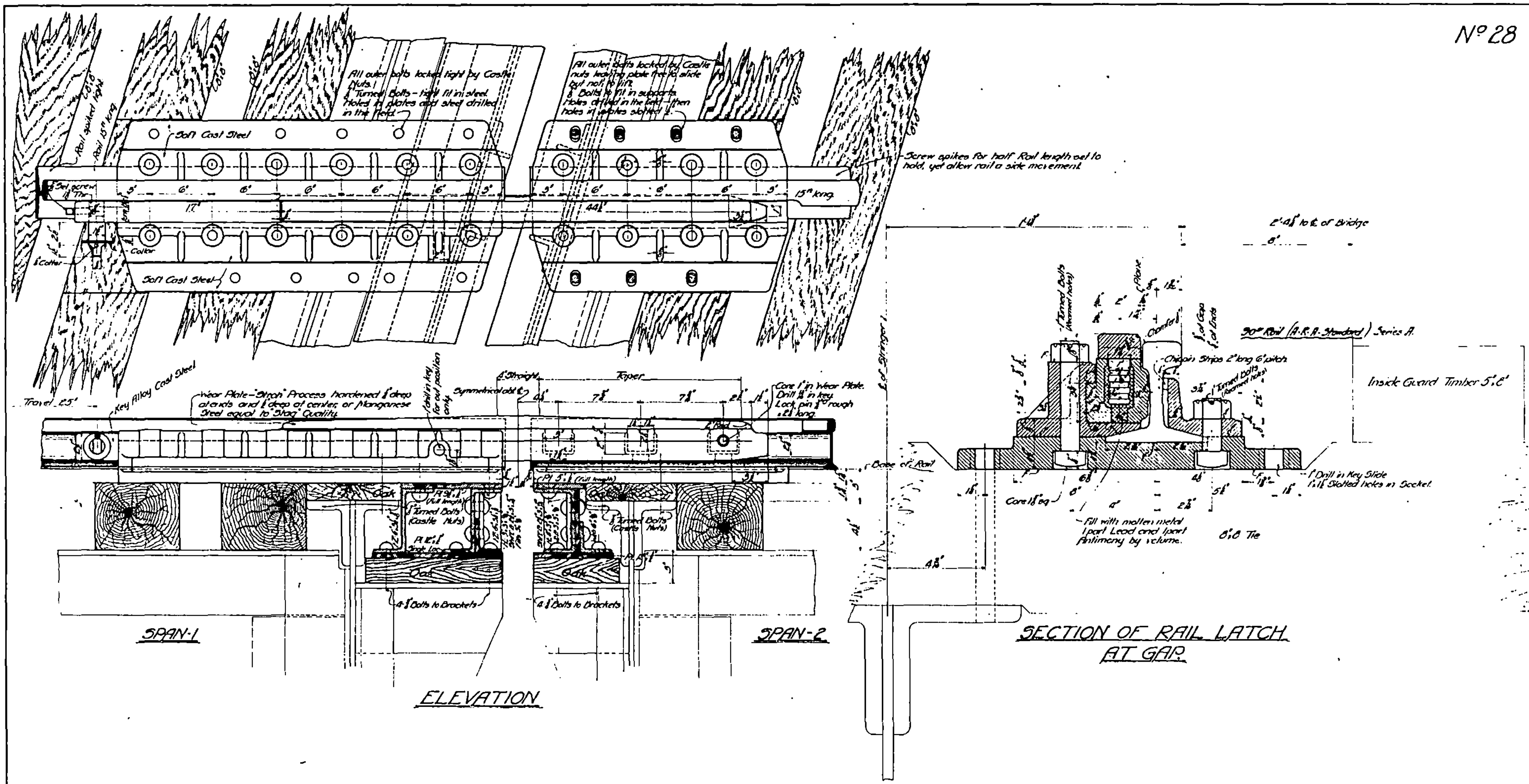
SPAN-1.

END LIFT MACHINERY.

Scale: 1½"=1'0"

Approved: [signature]
Consulting Engineer in Charge.

No 28



K.&H.B.Co.

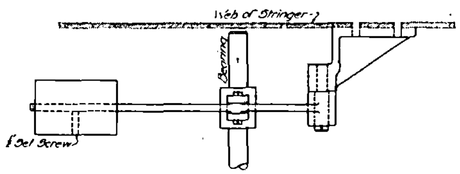
KEOKUK BRIDGE.

RAIL LATCH

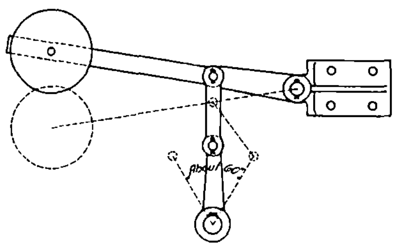
Scale 3" = 1'-0"

Approved ______ Consulting Engineer in charge.

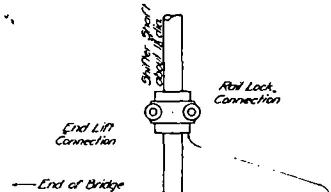
Nº 29



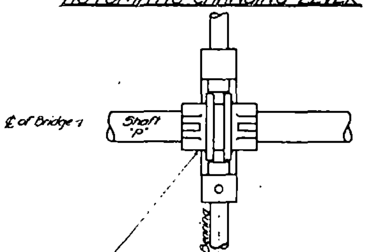
TOP VIEW



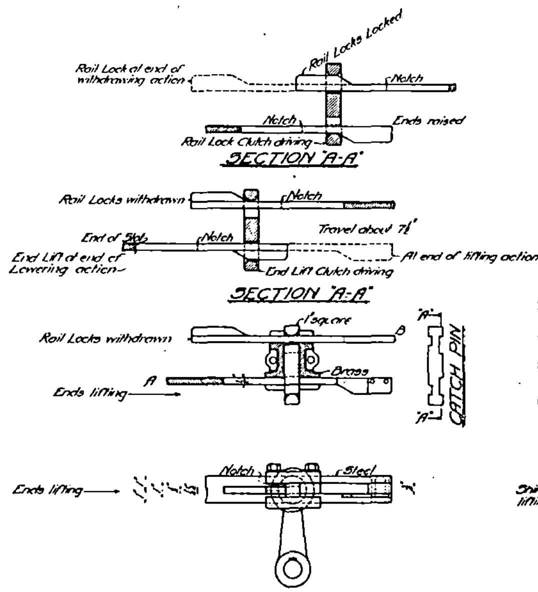
ELEVATION
HOLDING LEVERS



AUTOMATIC CHANGING LEVER



CLUTCH SHIFTER



AUTOMATIC CHANGING DEVICE

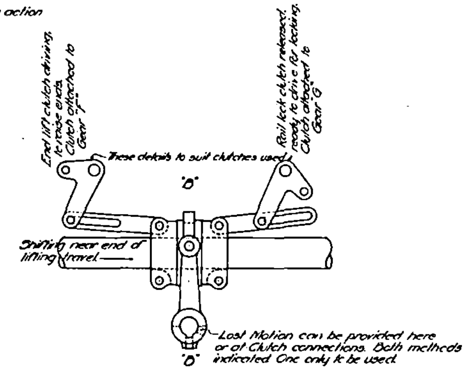
NOTE

Slide "A" is operated by a pin on the side of Gear "A". One revolution of Gear gives full travel of End Lifts. Slide "A" is to be operated in the directions shown, rapidly near each end of the Lift travel.

Slide "B" is operated by cranks on Shaft Q in same manner as above, except that one-half revolution of Shaft Q gives full movement to Rail Locks.

Slide "A" to fit the Yoke and Catch Pin.

Slide "B" to be allowed a small angle variation.

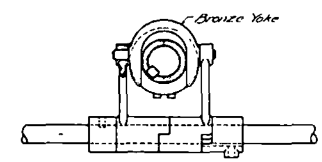


CLUTCH SHIFTER
AND LEVER

NOTE

As all proportions of parts will be affected by the requirements of the clutches, exact sizes are not indicated.

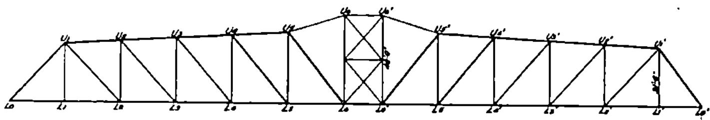
Proportions shown are about right for 3" travel of clutch shifter, or 6" full travel of Shifter Sleeve.



SECTION "B-B"

Approved ______ Consulting Engineer in charge.

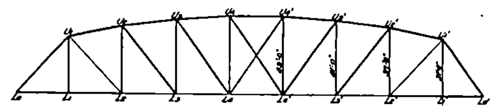
K.&H.B.Co.
KEOKUK BRIDGE.
SPAN -1-
SKETCHES SHOWING OPERATION
OF
AUTOMATIC SHIFTER.
Scale 3"=1'-0"



6 Panels @ 30'3" = 181'6" — 50'6" — 5 Panels @ 30'3" = 151'3" — 23'10"

377'0"

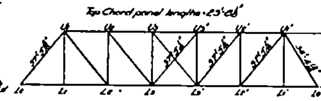
SPAN-1



8 Panels @ 28'11 5/8" = 231'10" — 22'7 1/2"

254'5 1/2"

SPANS-2 & 3

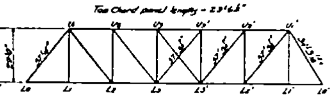


Top Chord panel lengths = 23'6"

6 @ 23'7 3/8" = 141'11 1/4" — 18'6"

160'5 1/4"

SPAN-4

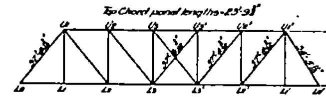


Top Chord panel lengths = 23'6"

6 @ 23'6" = 141'0" — 18'6"

159'6"

SPAN-5

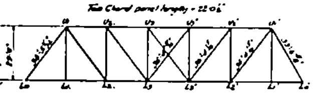


Top Chord panel lengths = 23'9"

6 @ 23'9 1/2" = 142'9" — 18'7 1/2"

161'4"

SPAN-6

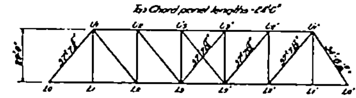


Top Chord panel lengths = 22'0"

6 Panels @ 22'0 1/2" = 132'1 1/2" — 8'0"

140'1"

SPAN-7



Top Chord panel lengths = 25'6"

6 @ 25'11 3/4" = 145'10 1/2" — 18'9 1/2"

164'0"

SPANS 8 to 11 incl.

Member	DL+LL	Area Gr.	Geom. Length	Distortion	Shop Length c to c of Intersections
End Post L_0U_1	+340	56.0	43.6726	+.0088	43'-8 3/16"
Top Chord U_1U_2	+328	44.0	30.3006	+.0070	30'-3 11/16"
" " U_2U_3	+296	47.1	30.3006	+.0058	30'-3 5/8"
" " U_3U_4	+151	60.9	30.3006	+.0023	30'-3 5/8"
" " U_4U_5	−94	60.9	30.3006	−.0014	30'-3 19/32"
" " U_5U_6	−376	65.3	31.7068	−.0063	31'-7 3/8" (Deflection of L_6 taken up in here)
" " U_6U_6'	−369	63.0	20.5000	−.0040	20'-5 15/16"
End Post $U_1'L_b$	+306	56.0	39.5255	+.0068	39'-6 3/8"
Bot. Chord L_0L_1	−236	32.4	30.2500	−.0067	30'-2 31/32"
" " L_1L_2	−235	32.4	30.2500	−.0067	30'-2 31/32"
" " L_2L_3	−328	48.4	30.2500	−.0063	30'-2 15/16"
" " L_3L_4	−295	54.7	30.2500	−.0050	30'-2 15/16"
" " L_4L_5	−151	54.7	30.2500	−.0026	30'-2 31/32"
" " L_5L_6	+94	54.7	30.2500	+.0016	30'-3 1/32"
" " L_6L_6'	+359	65.5	20.5000	+.0034	20'-6 1/32"
" " $L_1'L_0'$	−186	32.4	23.8750	−.0047	23'-10 7/16"
Diagonal U_1L_2	−134	35.0	43.6726	−.0051	43'-8
" U_2L_3	+49	39.3	44.9513	+.0017	44'-11 7/16"
" U_3L_4	+220	49.3	46.2608	+.0064	46'-3 7/32"
" U_4L_5	+385	60.8	47.5986	+.0094	47'-7 9/32"
" U_5L_6	+430	67.4	48.9628	+.0100	48'-11 21/32"
Hanger U_1L_1	−103	19.0	31.5000	−.0050	31'-5 15/16"
Post U_2L_2	−9	28.8	33.2500	−.0003	33'-3"
" U_3L_3	−143	31.0	35.0000	−.0048	34'-11 15/16"
" U_4L_4	−277	40.0	36.7500	−.0076	36'-8 27/32"
" U_5L_5	−409	48.7	38.5000	−.0038	38'-5 7/8"
" U_6L_6	+145	37.0	48.0000	+.0069	48'-0 1/16"

—Notes—

No allowance has been made in Column of Shop Lengths for play in Pin holes.—

In calculation of distortions, details have been added to gross area of built up members, excluding tie pls. and facing.—

Member	DL+LL	Area Gr.	Geom. Length	Distortion	Shop Length c to c of Intersections
End Post L_0U_1	+732	90.8	42.4357	+.0107	42'-5 13/16"
Top Chord U_1U_2	+748	66.1	29.5938	+.0104	29'-7 1/4"
" " U_2U_3	+852	75.5	29.2539	+.0105	29'-3 3/16"
" " U_3U_4	+898	78.6	29.0481	+.0108	29'-0 23/32"
" " U_4U_4'	+896	78.6	28.9792	+.0105	28'-11 7/8"
End Post $U_1'L_0'$	+662	84.5	38.3660	+.0089	38'-4 1/2"
Bot. Chord L_0L_1	−497	51.2	28.9792	−.0087	28'-11 21/32"
" " L_1L_2	−497	51.2	28.9792	−.0087	28'-11 21/32"
" " L_2L_3	−727	60.0	28.9792	−.0121	28'-11 19/32"
" " L_3L_4	−845	70.0	28.9792	−.0121	28'-11 19/32"
" " L_4L_4'	−896	72.0	28.9792	−.0124	28'-11 19/32"
" " $L_1'L_0'$	−388	43.8	22.6042	−.0060	22'-7 3/16"
Diagonal U_1L_2	−342	33.0	42.4357	−.0151	42'-5 1/16"
" U_2L_3	−191	28.8	46.9978	−.0097	46'-11 27/32"
" U_3L_4	−80	27.3	50.2075	−.0050	50'-2 7/16"
" U_4L_4'	0	15.9	51.8396	0	51'-10 1/16"
Hanger U_1L_1	−102	19.0	31.0000	−.0050	30'-11 15/16"
Post U_2L_2	+147	27.3	37.0000	+.0060	37'-0 1/16"
" U_3L_3	+46	28.5	41.0000	+.0025	41'-0 1/32"
" U_4L_4	−33	19.8	43.0000	−.0021	42'-11 31/32"

—Notes—

No allowance has been made in column of Shop Lengths for play in Pin holes.—

In calculations of distortions details have been added to gross area of built up members, excluding tie plates and facing—

—Note—

In calculating live load stresses used in determining distortions of truss members for Spans 1-2 & 3. A uniform load of 5000# per ft. for Ry. track has been used. Spans fully loaded. No Highway load considered.—

K.&H.B.Co.

KEOKUK BRIDGE.

Spans 1 to 11 inclusive.

Geometrical & Distorted Lengths.

Approved [signature]

Consulting Engineer in Charge.