

**BRIDGE DOCUMENTATION**

**SPOEDE BRIDGE (K0601R)**

**LINDBERG BRIDGE (K600R2)**

**AND**

**MCKNIGHT BRIDGE (K0854R)**

St. Louis County  
Route I-64  
MoDOT Job Numbers J6I0978 and J6I1248

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June 2007

## Abstract

The Missouri Department of Transportation (MoDOT) proposes improvements to Interstate 64 (I-64) as part of MoDOT Job Numbers J6I0978 and J6I1248. These improvements will have an adverse effect on bridges eligible for listing in the National Register of Historic Places (NRHP): Spoede Road Bridge (K0601R), Lindberg Boulevard (K0600R2), McKnight Road (K0854R) and McCutcheon Road (K0854R).

A Historic American Engineering Record (HAER) document will be prepared for the McCutcheon Road bridge. A lower level of documentation, Missouri SHPO level, which includes 35-mm black and white photography, a historic context and descriptions of the bridges, is presented in this report for the Spoede, Lindberg and McKnight bridges. Copies of the archival photographs are being sent to the State Historic Preservation Office (SHPO), the City of Richmond Heights, St. Louis County, the St. Louis County Public Library Special Collections Department, as well as a set being retained by the Missouri Department of Transportation. These photographs have been scanned and are being presented in this report.

All three bridges were built in response to increased automotive traffic and the westward expansion of the St. Louis metropolitan area as part of the Daniel Boone Expressway (later U. S. Highway 40, and I-64) between 1937 and 1942.

The Spoede Bridge (K0854R) was constructed in 1937-1938 in response to increased traffic and the westward expansion of the St. Louis metropolitan area. Although the bridge was built using standard departmental designs, it served as a visible reminder of early efforts by the Missouri State Highway Department to improve traffic conditions in the St. Louis metropolitan area.

The Lindberg Bridge (K0600R2) was constructed in 1941-1942 and partially reconstructed in 1971. The bridge was one of seven concrete rigid-frame bridges constructed by the Missouri State Highway Department, and all were built in urban settings. Although a steel rigid-frame component was added to the structure in 1971, the Lindbergh Bridge still serves as an example of an unusual design rarely used by the Missouri State Highway Department.

The McKnight Bridge (K0854R) was constructed in 1940-1942 and was another of the seven Missouri examples of a concrete rigid-frame bridge. Bridge K-854R represented a well-preserved example of an unusual structural design, and it is a visible reminder of early efforts to improve traffic flow in suburban St. Louis.

This report, along with the archival photographs that accompanied the report (copies available at the SHPO and other depositories), fulfills the mitigation responsibilities for the I-64 improvements for these three bridges.

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## **Introduction**

In February 2006 the Missouri Department of Transportation (MoDOT) conducted mitigation of three bridges adversely affected by improvements to Interstate Route 64 (I-64) in St. Louis City and County in compliance with Section 106 of the National Historic Preservation Act and Section 4(f) of the U. S. Department of Transportation Act.

In 2002 and 2003 architectural and bridge surveys were conducted throughout the eleven-mile long project corridor. The architectural surveys identified 28 buildings that were individually eligible and 12 districts that were eligible for listing on the National Register of Historic Places (NRHP). The survey also identified four bridges that were eligible for listing on the NRHP.

Through consultation with the State Historic Preservation Office (SHPO) and the other consulting parties it was determined that the project would have an adverse effect on two architectural resources, the property at 1334 Highland Terrace and the Lavinia Gardens Historic District, and four bridges, at Spoede Road, Lindberg Boulevard, McKnight Road, and McCutcheon Road. Mitigation measures were developed that would mitigate the adverse effects on the properties.

It was determined that one of the bridges, the McCutcheon Bridge, warranted documentation to the Historic American Engineering Record (HAER) standards. The HAER standards require large format (4 X 5-inch) negatives, a narrative description and historical context, and copies of the original construction plans; the Library of Congress maintains the collection. Documentation for the McCutcheon Bridge will be submitted under separate cover.

The remaining three bridges, the Spoede Bridge, the Lindberg Bridge, and the McKnight Bridge were to be documented to "SHPO Level" standards. This standard requires archival photographs, taken with black and white 35-mm film, printed on acid-free paper, and processed to remove all residual chemicals. In addition a contextual history and description of each bridge is provided. This document contains the mitigation for these three bridges.

For each of the adversely affected historic properties archival photographs were taken with a 35-mm camera with TMAX black and white 100-speed film. The film was processed to archival standards, and selected shots were printed on fiber based archival paper and processed to archival standards. Copies of the archival photographs were provided to the SHPO, the City of Richmond Heights, St. Louis County, and the St. Louis County Public Library Special Collections. Each archival photograph was scanned; plates were created and are included in the Appendices of this report.

### **Historic Context for the Construction of I-64 Bridges**

In the early 1930s the demographic profile of Missouri's largest community, St. Louis, was changing. Large numbers of St. Louis residents were leaving congested older neighborhoods for new subdivisions on the western fringe of the metropolitan area. Suburban developments were drawing people away from St. Louis' declining urban core. The population of the City of St. Louis declined during the 1930s, but the population of St. Louis County grew by approximately 12 percent. Due in part to this demographic shift, automobile traffic on St. Louis' east-west

roads increased steadily throughout the decade.<sup>1</sup> The Missouri State Highway Department conducted several traffic studies during the 1930s, and the results showed that highways linking St. Louis' central business district to growing suburban communities on the edge of the metropolitan area were needed to maintain a vibrant regional economy.<sup>2</sup>

To alleviate growing traffic problems in the St. Louis area, the Missouri State Highway Department recommended the construction of two expressways. The first expressway was to be built along Oakland Avenue, a major thoroughfare immediately south of Forest Park that carried extremely heavy traffic. Construction of this highway began in 1935 and was completed in 1938. A second expressway to serve growing suburbs on the western fringes of St. Louis was also planned by the highway department. This road would begin west of St. Louis in Richmond Heights and connect to Wentzville, a small farming community in St. Charles County. The expressway would feature a divided highway and limited access, and it was dubbed the "Daniel Boone Expressway."<sup>3</sup> This road promised to relieve traffic and aid migration away from St. Louis, but the highway department had to carefully finance the project so it did not run afoul of state laws limiting urban highway construction.

In the early twentieth century the Missouri General Assembly was apportioned in such a way as to favor rural interests over urban concerns, and thus the Centennial Road Law was biased toward rural road construction. For example, all highway funds given to county governments had to be distributed equally among Missouri's counties regardless of population or traffic levels. In addition, the Centennial Road Law allowed the Missouri State Highway Department to build roads connecting Missouri's rural towns, but the department could not build roads inside cities with a population greater than 2,500 or areas where houses on either side of the street were less than 200 feet apart.<sup>4</sup> To get around these restrictive state road laws, the Missouri State Highway Department labeled the Daniel Boone Expressway "Traffic Relief Route 40," commonly shortened to Route 40TR. Missouri voters in 1928 had approved the sale of \$75 million of bonds to pay for road construction, and the 1928 bond issue allowed the highway department to build traffic relief routes in urban centers to ease road congestion.<sup>5</sup> The department seized upon this

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<sup>1</sup>Caroline Loughlin and Catherine Anderson, *Forest Park* (Columbia, Missouri: University of Missouri Press, 1986): 175-176; James Neal Primm, *Lion of the Valley: St. Louis, Missouri*, 2d ed. (St. Louis, Missouri: Missouri Historical Society Press, 1990): 472-473; and St. Louis City Plan Commission, "Physical Growth of the City of Saint Louis," 1969, downloaded 6 June 2006 from <http://stlouis.missouri.org/heritage/History69/>.

<sup>2</sup>For detailed discussions of traffic studies conducted by the Missouri State Highway Department during the 1930s, see Missouri State Highway Commission, *Ninth Biennial Report of the State Highway Commission of Missouri for the Period Ending December 1, 1934* (Jefferson City, Missouri: Missouri State Highway Commission, 1934): 427; and *Official Manual of the State of Missouri for Years Nineteen Thirty-Nine and Nineteen Forty* (Missouri Secretary of State: Jefferson City, Missouri, 1940): 685.

<sup>3</sup>Tim O'Neil, "U.S. 40 Battles Recur," *St Louis Post-Dispatch*, 1 November 1992, 1D; and Virgil Tipton, "The Way West: Highway 40 Grew in Fits and Starts Over 60 Years," *St. Louis Post-Dispatch*, 19 September 1994, 1A.

<sup>4</sup>Missouri State Highway Commission, *Roads and their Builders* (Jefferson City, Missouri: Division of Public Information, n.d.), 115-116.

<sup>5</sup>Missouri State Highway Commission, *Seventh Biennial Report of the State Highway Commission of Missouri for the Period Ending December 1, 1930* (Jefferson City, Missouri: Hugh Stephens Press, 1930), 109-111.

new law to justify construction projects in St. Louis and Kansas City, and it provided a loophole allowing for urban projects such as the Daniel Boone Expressway. The laws prohibiting the use of state funds for urban highway projects were eventually repealed when the Missouri State Constitution was rewritten in 1945.<sup>6</sup>

As highway department designers began to create plans for the Daniel Boone Expressway, they quickly realized that numerous overpasses and grade separations would be needed to carry local roads across the new highway. For example, in September 1935, Missouri State Highway Department Bridge Engineer N.R. Sack noted that at least five overpass bridges needed to be built along the westernmost portion of the planned expressway.<sup>7</sup>

### *Spoede Bridge (K0601R)*

According to the recommendations of highway department designers, a bridge was needed to carry Spoede Road across Route 40TR. Spoede Road was located in a rapidly developing suburban region on the western outskirts of the St. Louis metropolitan area. Although Spoede Road was located in an unincorporated area, numerous housing developments had already sprung up in the area during the early 1930s. It was clear that the highway department needed to provide for future growth by building an overpass over Route 40TR to allow local traffic to pass freely over the limited-access expressway below.<sup>8</sup>

Highway department designers initially proposed a four-span bridge resting on open bents for the bridge that would carry Spoede Road across the Daniel Boone Expressway.<sup>9</sup> However, the department ultimately decided instead to construct a standard two-span continuous plate girder bridge at the site. The Baltimore and Susquehanna Railroad Company built the first plate girder bridge in America in 1846 at Bolton Station, Maryland, and the design was widely used for short railroad spans throughout the nation. Riveted built-up steel plate girder bridges were adapted for use by many highway departments in the early twentieth century, and it remains a common bridge design that is still frequently used today.<sup>10</sup>

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<sup>6</sup>For specific revisions made in 1945 related to road construction and the powers of the Missouri State Highway Commission, see Missouri Constitution [1945], art. 4, sec. 29-34.

<sup>7</sup>N.R. Sack to P.H. Daniells, Signed Letter, 25 September 1935, microfiche copy in “General Correspondence File – Construction Project No. FAP 513(I),” Collection 12-0388, Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. Materials in Collection 12-0388 henceforth cited as being in the “Spoede Bridge File.” The five roads that Sack suggested would need overpasses across Route 40TR were Lewis Road, Mason Road, Ballas Road, Spoede Road, and Lindbergh Boulevard.

<sup>8</sup>Benjamin Wood, a St. Louis County landowner, began to subdivide his property in the early 1930s, naming the new neighborhood “Frontenac Estates” after the Chateau Frontenac in Quebec, Canada. The community formally incorporated in 1947 as the Village of Frontenac, and today, the City of Frontenac is a prosperous suburban community with a population of approximately 3,411 residents. See City of Frontenac, Missouri, “Our Community: Origin,” downloaded 5 June 2006 from [http://www.cityoffrontenac.org/content.php?page=ourcom\\_1](http://www.cityoffrontenac.org/content.php?page=ourcom_1); and City of Frontenac, Missouri, “Our Community: The City,” downloaded 5 June 2006 from [http://www.cityoffrontenac.org/content.php?page=ourcom\\_2](http://www.cityoffrontenac.org/content.php?page=ourcom_2).

<sup>9</sup>N.R. Sack to P.H. Daniells, Signed Letter, 30 September 1936, Spoede Bridge File.

<sup>10</sup>National Cooperative Highway Research Program, “A Context for Common Historic Bridge Types,” NCHRP Project 25-25, Task 15, October 2005, 3.110-3.112.

The bridge that would carry Spoede Road was based on standard Missouri State Highway Department designs for steel plate girder bridges, and it was labeled on official documents as Bridge K-601. Plans for the new structure called for the construction of two 59' 8" plate girder spans resting atop a single pier and two concrete abutments. The bridge was to feature a 14' vertical clearance so traffic along Route 40TR could pass freely underneath. Designers also called for a single entrance and exit ramp in the southwest corner of the intersection of the two roads to allow for traffic to move between the expressway and Spoede Road. Finally, the plans for Bridge K-601 called for a decorative art-deco pattern on the outside of the concrete abutments and the central pier that would support the steel superstructure.<sup>11</sup>

To qualify for federal road-building assistance in the 1930s and early 1940s, state transportation agencies had to send design plans for new roads and bridges to the Public Roads Administration (PRA) for review. Thus, the Missouri State Highway Department sent preliminary plans for Bridge K-601 to the Kansas City branch of the PRA in the fall of 1936 in anticipation of a February 1937 letting. The PRA in turn suggested two changes in the design of the bridge. First, they recommended a grade change along Spoede Road to improve sight distances for traffic crossing the planned bridge.<sup>12</sup> The Missouri State Highway Department agreed that such an adjustment would be beneficial, but as Chief Engineer C.W. Brown explained, the change was not practical due to complex right of way issues:

The grade line of Spoede Road was given much consideration at the time of acquiring the necessary right of way for this layout, and any appreciable change in grade line...will result in great damage to the adjacent property at this intersection. This property is well subdivided. Our right of way has been obtained through condemnation proceedings, and any decided change at this time will cause us considerable trouble.<sup>13</sup>

Instead of adjusting Spoede Road, the vertical curve along the ramp between the local road and the Daniel Boone Expressway were altered slightly along with the grade across the bridge itself, providing the improved sight distance sought by the PRA.

In addition to commenting on sight distance issues, the PRA also inquired into the highway department's decision to only build a single connection ramp between Spoede Road and the Daniel Boone Expressway. Instead of a single ramp in the southwest quadrant of the intersection, the PRA recommended either the construction of a second ramp to the northeast of Bridge K-601 or the complete elimination of the access point altogether.<sup>14</sup> The highway

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<sup>11</sup>Missouri State Highway Department, "Bridge Over U.S. Route 40 T.R. (Spoede Road): Project No. FAP 513(I)," microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri.

<sup>12</sup>James Clay to Clifford Shoemaker, Signed Memorandum, 25 November 1936, Spoede Bridge File.

<sup>13</sup>C.W. Brown to Clifford Shoemaker, Singed Letter, 3 December 1936, Spoede Bridge File.

<sup>14</sup>James Clay to Clifford Shoemaker, Signed Memorandum, 25 November 1936, Spoede Bridge File.

department responded that construction of a single ramp would adequately handle local traffic and that, once again, right of way issues foreclosed any changes to the planned exchange:

The matter of connection with Spoede Road was thrashed out during the procedure of condemning right of way, and on account of conditions the one ramp was provided to take care of the small amount of traffic entering or leaving the highway at this point. To eliminate the ramp would disrupt all of our condemnation proceedings pertaining to this right of way. The same situation would result in providing an additional ramp.<sup>15</sup>

The PRA ultimately accepted the arguments of the Missouri State Highway Department, and in January 1937, the project was allowed to move forward onto the letting schedule.<sup>16</sup>

On February 13, 1937, five bids were received from contractors hoping to build Bridge K-601. The lowest bid came from M.E. Gillioz, Inc., a construction company headquartered in Monett, Missouri. The Gillioz Construction Company offered to build Bridge K-601 for \$60,672, a bid that was more than \$10,000 less than the bids offered by other competitors.<sup>17</sup> Unfortunately for the Missouri State Highway Department, federal officials discovered a minor flaw in the plans for Bridge K-601 that threatened to delay the project significantly. Federal inspectors noted that the flange angles that would link the bridge girders to the support web were to be joined using a single line of rivets, whereas engineering norms called for two lines of rivets. This meant that approximately 400 additional rivets would need to be used on the bridge than called for in the original design. Because of this flaw, federal officials ordered the Missouri State Highway Department to hold the official contract for the construction of Bridge K-601 in Jefferson City until they could negotiate a price for the additional riveting of the superstructure.<sup>18</sup> Fortunately for the highway department, Maurice Gillioz, the President of M.E. Gillioz, Inc., was more interested in starting work on the project than demanding additional money for another row of rivets on the underside of Bridge K-601:

For your information wish to advise that there will be no additional charge for the rivets mentioned in your letter. Of course, this will cost us a little something but it would also cause some changes to be made in the structural steel should we make an additional charge for this item. The cost of reaming of the holes and the placing of the rivets on this item will cost us in the neighborhood of \$320.00 but since we are already so low on the job we might as well leave the bid as is. We

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<sup>15</sup> C.W. Brown to Clifford Shoemaker, Signed Letter, 3 December 1936, Spoede Bridge File.

<sup>16</sup> Clifford Shoemaker to C.W. Brown, Signed Letter, 26 January 1937. Clifford Shoemaker was the PRA district engineer responsible for reviewing road-building projects in Missouri, Kansas, Iowa, and Nebraska, and he needed to approve the plans for Bridge K-601 before a contract to build the structure could be let.

<sup>17</sup> Missouri State Highway Commission, "Tabulation of Bids: Project No. FA-513-I," microfiche copy available from Design Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri.

<sup>18</sup> S.W. O'Brien to C.W. Brown, Signed Letter, 20 February 1937, Spoede Bridge File; C.W. Brown to S.W. O'Brien, Signed Letter, 24 February 1937, Spoede Bridge File; and N.R. Sack to M.E. Gillioz, Inc., Signed Letter 24 February 1937, Spoede Bridge File.

hope the above is the information you desire and that we may receive our contracts in due time so we that we may get the work started.<sup>19</sup>

Thanks to Gillioz's flexibility, the highway department released the contract for K-601 on March 1, 1937 and construction work began on the new structure.<sup>20</sup> The project was completed and accepted into the state system in March 1938.<sup>21</sup> Bridge K-601 was one of the first overpass bridges to be completed along the Daniel Boone Expressway, and it allowed the surrounding area to quickly develop into a thriving suburban community.

Although Bridge K-601 opened in 1938, the Daniel Boone Expressway was not completed until the late 1940s. In the 1950s the Missouri State Highway Department linked the Daniel Boone Expressway to the Oakland Express Highway in the City of St. Louis. This extended route, renamed U.S. Highway 40, provided the means for St. Louis-area residents to live in suburbs such as Frontenac, Ladue and Richmond Heights while still working in the city. As one journalist recently observed, "subdivisions and businesses grow along Highway 40 like trees and flowers grow alongside a stream," and some of the most expensive homes and prosperous businesses in the St. Louis metropolitan area are located along suburban segments of the highway.<sup>22</sup>

Bridge K-601 has functioned in place since 1938 with only minor alterations. In 1992 interstate signs were installed on the exterior of the bridge, but no major changes were made to the superstructure.<sup>23</sup> Unfortunately, Highway 40 has become a victim of its own success. The highway helped spur the flight of St. Louis residents away from the urban core, and today the road carries much more traffic than it was originally designed to accommodate. Plans are currently being prepared to rebuild Highway 40 in suburban St. Louis and fully upgrade the facility to interstate highway standards. The rebuilt Highway 40 is now known as Interstate 64, and Bridge K-601R and its adjacent interchange with Spoede Road will be replaced with a modern bridge structure and an offset diamond interchange.<sup>24</sup>

#### *Lindbergh Bridge (K0600R2)*

The department also realized a structure was needed separate Route 40TR from Lindbergh Boulevard and to provide access between the two roads. Lindbergh Boulevard was a local thoroughfare that carried heavy traffic through suburban St. Louis, and it served as a state spur

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<sup>19</sup>M.E. Gillioz to N.R. Sack, Signed Letter, 26 February 1937, Spoede Bridge File.

<sup>20</sup>C.W. Brown to S.W. O'Brien, Signed Letter, 1 March 1937, Spoede Bridge File.

<sup>21</sup>C.W. Brown to Robert Hodson, Signed Letter, 31 March 1938, Spoede Bridge File.

<sup>22</sup>Tipton, "The Way West: Highway 40 Grew in Fits and Starts Over 60 Years, 1A.

<sup>23</sup>Missouri Highway and Transportation Department, "Job No. J6U0897: Sign No. 2, Bridge K-601R," microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. When the installation of the new signs was completed, Bridge K-600 was relabeled Bridge K-601R in the highway department's bridge inventory

<sup>24</sup>Missouri Department of Transportation, "The New I-64 Interactive Study Map: Spoede Road," downloaded 7 June 2006 from [http://www.thenewi64.org/2\\_studyarea.jsp](http://www.thenewi64.org/2_studyarea.jsp).

highway known as Route 66TR.<sup>25</sup> Early in the design process, the Missouri State Highway Department considered the construction of twin bridges to carry the Daniel Boone Expressway's four lanes of traffic across Lindbergh Boulevard. Department designers suggested the construction of two similar bridges featuring two traffic lanes and adjacent sidewalks for pedestrian traffic along Route 40TR, but the twin bridge idea was soon abandoned in favor a single, larger structure with extensive aesthetic enhancements to honor Lindbergh Boulevard's namesake, famed St. Louis aviator Charles Lindbergh.<sup>26</sup>

When the Missouri State Highway Department's Bridge Division drew up preliminary plans for a bridge to carry the Daniel Boone Expressway across Lindbergh Boulevard, they recommended the construction of a single-span structure. The structure was labeled Bridge K-600, and according to preliminary plans, it was to be a rigid-frame bridge.<sup>27</sup> Robert Hayden, an engineer who worked for the State of New York, had introduced rigid-frame bridges to America. Hayden designed several rigid-frame bridges for the Bronx River Parkway, and his design won national notoriety. Federally funded work-relief crews often built rigid-frame bridges during the 1930s as they were considered an aesthetically pleasing alternative to other designs. In addition, rigid-frame bridges cost less to construct than other designs because they could be built using less materials than traditional truss bridges and they required minimal abutments for support. Rigid-frame bridges became a popular choice among the designers of urban expressways, and several were built as part of the famous Merritt Parkway.<sup>28</sup> Clearly the Missouri State Highway Department wanted to make the bridge that would carry the Daniel Boone Expressway over Lindbergh Boulevard an aesthetically pleasing structure, and thus the rigid-frame design was chosen.

Although the Missouri State Highway Department decided in early 1939 that the bridge carrying Route 40TR across Lindbergh Boulevard would be a rigid-frame structure, department officials were unsure whether to build the bridge using concrete or steel. The highway department built four steel rigid-frame bridges in the mid-1930s, including one connecting Chouteau Avenue to the Oakland Express Highway in the City of St. Louis. Steel rigid-frame bridges had fallen out

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<sup>25</sup>Today, Lindbergh Boulevard is part of U.S. Highways 61 and 67 in the St. Louis area.

<sup>26</sup>S.M. Rudder to N.R. Sack, Signed Memorandum, 16 December 1935, microfiche copy in "General Correspondence File – Construction Project F-623 A(2)," Collection 12-0391, Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri; and C.W. Brown to Clifford Shoemaker, Signed Letter, 27 December 1938, microfiche copy in "General Correspondence File – Construction Project F-623 A(2)," Collection 12-0391, Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. Materials in Collection 12-0391 henceforth cited as being in the "Lindbergh Bridge File."

<sup>27</sup>"Preliminary Layout: Bridge No. K-600," 25 March 1939, Lindbergh Bridge File.

<sup>28</sup>Arthur Hayden and Maurice Barron, *The Rigid-Frame Bridge*, 3d ed., (New York: John Wiley and Sons, Inc., 1950), 1-4, 219-229; Clayton Fraser, *Missouri Historic Bridge Inventory: Draft Inventory Report* (Loveland, Colorado: Fraserdesign Inc., 1996), 141; Elmer Napier, "Rigid-Frame Bridges," *Roads and Bridges*, April 1940, 13-14; Eric DeLony, "Merritt Parkway," HAER No. CT-63, Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, 1992, 79-80; and National Cooperative Highway Research Program, "A Context for Common Historic Bridge Types," NCHRP Project 25-25, Task 15, October 2005, 3.95-3.97. For a detailed explanation of the engineering principles behind the rigid-frame design, see DeLony, "Merritt Parkway," 78; and Hayden and Barron, *The Rigid-Frame Bridge*, *passim*.

of national favor by the start of the twentieth century, but the Missouri State Highway Department considered the design a viable option for the Lindbergh Boulevard grade separation.<sup>29</sup>

In the summer of 1939, the highway department told Clifford Shoemaker of the Public Roads Administration that it had drawn up two sets of plans for the bridge across Lindbergh Boulevard. The first design called for the construction of a steel rigid-frame bridge with a concrete roadbed, and the estimated cost to build the structure was \$65,025. In contrast, the second design featuring a concrete rigid-frame bridge and a concrete roadbed would cost the highway department approximately \$43,940.<sup>30</sup> The department asked Shoemaker which design he favored, and Shoemaker suggested that the department adopt the less expensive bridge design:

We note that the preliminary designs cover both steel and concrete construction and that the estimates show a material saving in favor of concrete. A possible rise in steel prices in the near future makes it reasonable to anticipate a still greater difference in cost by the time that bids are received. For the rigid frame type of structure which is proposed, concrete construction should give results as satisfactory as may be obtained with steel. We recommend, therefore, that concrete construction be adopted.<sup>31</sup>

Once Shoemaker's blessing was received, the highway department's Bridge Division began work on a final design for the overpass, and the division completed plans for the structure in January 1940. The structure was labeled Bridge K-600, and construction plans called for a large, one-span concrete rigid-frame bridge that allowed for an 81'-wide roadway to pass underneath and a minimum 14' vertical clearance between Route 40TR and Lindbergh Boulevard below. The roadbed that would carry the Daniel Boone Expressway was designed to accommodate two lanes of traffic in each direction and a large decorative median, making Bridge K-600 larger than any of the other concrete rigid-frame bridges built by the highway department.<sup>32</sup>

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<sup>29</sup>Fraser, *Missouri Historic Bridge Inventory: Draft Inventory Report*, 132. For more information about the highway department's use of the steel rigid-frame design and its application in the St. Louis area, see Thomas Gubbels, "Historic Documentation, Vandeventer Avenue Overpass," October 2004, as held in the Cultural Inventory, Missouri State Historic Preservation Office, Jefferson City, Missouri, *passim*.

<sup>30</sup>C.W. Brown to Clifford Shoemaker, Signed Letter, 29 August 1939, Lindbergh Bridge File. To qualify for the limited federal road-building funding available in the 1930s and 1940s, state transportation agencies had to send plans for new roads and bridges to the Public Roads Administration for review. Clifford Shoemaker was the Public Roads Administration district engineer responsible for reviewing all road-building projects in Missouri, Kansas, Iowa, and Nebraska, and his opinions strongly influenced the bridge designs adopted by the Missouri State Highway Department.

<sup>31</sup>Clifford Shoemaker to C.W. Brown, Signed Letter, 16 September 1939, Lindbergh Bridge File.

<sup>32</sup>Missouri State Highway Department, "Grade Separation Over Lindbergh Boulevard: Project No. FA623-A(2)," microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. Although Bridge K-600 incorporated a design that was used only a handful of times by the Missouri State Highway Department, the interchange between the Daniel Boone Expressway and Lindbergh Boulevard was to feature a standard cloverleaf design. This interchange design may have been an effective choice in the 1930s, but today, it cannot handle the heavy traffic that moves between the two highways.

Although the Missouri State Highway Department completed plans for Bridge K-600 in January 1940, several months of revisions were needed before the department was able to seek bids for construction of the new overpass. The primary reason for this delay was the large number of aesthetic enhancements added to the bridge. The Daniel Boone Expressway was designed as a parkway in suburban St. Louis with numerous aesthetic enhancements, and the highway department wanted to make sure that its new structure would enhance the parkway rather than detract from it. For example, the highway across Bridge K-600 was to feature a decorative median with a two large globe-like statues honoring Charles Lindbergh's first solo flight across the Atlantic Ocean. In addition, the bridge would feature customized concrete handrails along its sidewalks, art deco detailing on its wingwalls, and stone facing on its pylons.<sup>33</sup> All these elements were designed to enhance the aesthetics of the bridge and to provide a positive driving experience for travelers on Lindbergh Boulevard and the Daniel Boone Expressway, and finalizing the details for these enhancements delayed the completion of bridge plans for several months.

Another aesthetic enhancement that caused a delay in the completion of plans for Bridge K-600 was the selection of lighting features. Early in the design process, the Missouri State Highway Department's Bridge Engineer N.R. Sack provided details as to how the department hoped to light the new structure to emphasize its aesthetic features:

On blue print No. 1, we have shown the location of the various lights which we propose to use on the structure. Lights A to F, inclusive, are to be lights set in the top of the recessed panels for the purpose of lighting the panels brightly and providing a diffused light over the adjacent parts of the structure. On print No. 7, we have shown in elevation the proposed location of lights L and K. The purpose of this light is to furnish illumination for the architectural treatment of the structure between the upper lanes. This light should be either a low power spot light or a diffused light smaller to that which is furnished with florescent lighting tubes. We have no set type of light in mind but it will be necessary that we use a type of light which will illuminate the structure between lanes of traffic but will not be projected in such a manner as to blind or confuse traffic approaching the light.<sup>34</sup>

Providing a lighting system for the bridge posed two problems. First, the Missouri State Highway Department needed to negotiate the style of lighting that would be used on the bridge and the price that the department would pay for the lighting system.<sup>35</sup> A second issue that took

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See Missouri Department of Transportation, "The New I-64 Interactive Study Map: Lindbergh Blvd.," downloaded 25 May 2006 from [http://www.thenewi64.org/2\\_studyarea.jsp](http://www.thenewi64.org/2_studyarea.jsp).

<sup>33</sup>Missouri State Highway Department, "Grade Separation Over Lindbergh Boulevard: Project No. FA623-A(2)." To view historic photographs of the Lindbergh Boulevard Bridge detailing several of its aesthetic features, see Missouri Department of Transportation, "The New I-64 Interactive Study Map: Lindbergh Blvd."

<sup>34</sup>N.R. Sack to C.A. Patterson, Signed Letter, 6 February 1940, Lindbergh Bridge File

time to resolve was how to place electric conduits inside a solid concrete structure for the lighting system. The highway department also worked with the Union Electric Company to ensure that power lines along the bridge would not detract from its aesthetics.<sup>36</sup> The details of the lighting system along the bridge were ironed out in the summer and fall of 1940, and the bridge project was added to the November 1940 letting.

Four companies offered bids on November 29, 1940, to build the bridge that would carry Route 40TR across Lindbergh Boulevard. The low bid came from the Atkinson-Windle Company of Chillicothe, Missouri, who offered to build the bridge and its adjacent interchange for \$101,827.95.<sup>37</sup> The contract signed between the Atkinson-Windle Company and the Missouri State Highway Commission called for construction of Bridge K-600 to be finished by September 1941. In addition, the Atkinson-Windle Company had to implement steps to control traffic along Route 40TR during the construction process, including the use of flagmen to direct traffic and the construction of a temporary crossing across Lindbergh Boulevard. A notice to proceed was granted by the highway department on January 6, 1941, and construction work began the same day.<sup>38</sup>

Work proceeded smoothly on the construction of Bridge K-600, but occasional problems arose that delayed the completion of the project for several months. For example, the Atkinson-Windle Company began buying wood to construct forms for pouring cement in December 1940. However, the company discovered that it was virtually impossible to purchase wood with the 1-

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<sup>35</sup>The Missouri State Department hired the Holophane Glass Company of New York to provide lighting fixtures for the Lindbergh Boulevard Bridge, and it took several rounds of negotiations to determine the type and layout of lighting fixtures that would best suit the highway department's needs. See D.H. Tuck to N.R. Sack, Signed Letter, 21 February 1940, Lindbergh Bridge File; N.R. Sack to D.H. Tuck, Signed Letter, 23 February 1940, Lindbergh Bridge File; D.H. Tuck to N.R. Sack, Signed Letter, 28 February 1940, Lindbergh Bridge File; and N.R. Sack to D.H. Tuck, Signed Letter, 18 March 1940, Lindbergh Bridge File. For more information about the history of the Holophane Glass Company, see Holophane Corporation, "History of Holophane," downloaded 25 May 2006 from <http://www.holophane.com/company/history/index.asp>.

<sup>36</sup>N.R. Sack to R.W. Hodson, Signed Letter, 3 April 1940, Lindbergh Bridge File; N.R. Sack to R.W. Hodson, Signed Letter, 16 April 1940, Lindbergh Bridge File; S.F. Janzen to N.R. Sack, Signed Letter, 26 July 1940, Lindbergh Bridge File; and N.R. Sack to R.W. Hodson, Signed Letter, 6 August 1940, Lindbergh Bridge File.

<sup>37</sup>Missouri State Highway Commission, "Tabulation of Bids: Federal Aid Project FA 623-A(2)," microfiche copy available from Design Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri; and Missouri State Highway Commission, "Minutes of the Special Meeting of the State Highway Commission Held in Jefferson City, Missouri, December 20-21, 1940," as held by the Secretary to the Missouri State Highway Commission, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri, 44. Three other companies subcontracted with the Atkinson-Windle Company to work on Bridge K-600. The St. Louis Contracting Company provided the stone facing that was installed on the bridge's abutments, the S.C. Sachs Company installed a lighting system along the bridge, and the Laclede Steel Company provided reinforcing steel for the structure. All three subcontractors were headquartered in St. Louis, and they worked with the highway department to ensure the bridge would be completed in a timely manner. See B.H. Volm to Missouri State Highway Department, Signed Letter, 4 January 1941, Lindbergh Bridge File; E.E. Rippstein to N.R. Sack, Signed Letter, 21 January 1941, Lindbergh Bridge File; and Robert Cradock to Missouri State Highway Department, Signed Letter, 26 July 1941, Lindbergh Bridge File.

<sup>38</sup>Robert Hodson to P.H. Daniells, Signed Letter, 23 September 1940, Lindbergh Bridge File; and Robert Hodson to J.J. Corbett, Signed Letter, 6 August 1941, Lindbergh Bridge File.

1/4" thickness required in construction specifications issued by the Missouri State Highway Department. Thus, representatives from the company approached department officials and asked if the forms could be built using wood that was only 3/4" thick.<sup>39</sup> The Division Engineer for the St. Louis District recommended that this request be approved, explaining that federal defense projects were creating a nationwide shortage of construction materials:

It is our understanding that contractors are having some difficulty securing the 1-1/4" plywood as the government has contracted for a large supply of this material which no doubt accounts for the reason that the various contractors would like to substitute the 3/4" plywood without backing as there seems to be plenty of this material on hand. We believe this request is reasonable and suggest that the substitution be approved provided he uses backing plank at least 1" in thickness on each edge of the plywood that will represent the finished line of the structure.<sup>40</sup>

The highway department ultimately acceded to the contractor's request and allowed the forms for Bridge K-600 to be built using thinner wood forms.<sup>41</sup>

Throughout the summer and fall of 1941 the Atkinson-Windle Company encountered additional construction delays due to supply and manpower shortages caused by the build-up of America's national defense industry. For example, Robert Hodson, an engineer with the Missouri State Highway Department, noted in August 1941 that the Atkinson-Windle Company would not complete the Lindbergh Boulevard Bridge by September 1941 as specified in the construction contract. Hodson explained that the main reason for the delays was a shortage of quality workers:

After special concrete protection was lifted progress increased considerably. The contractor was successful in maintaining approximately the same rate of progress but could not pick up enough speed because of lack of skilled labor to bring the job to the status it should be in order to realize a completed structure on the date specified. Several cases can be sited [sic] where the various carpenters and ironworkers quit to accept higher paying jobs on defense projects and incompetent men were put in their places. It has been necessary to keep a carpenter with the ironworkers in order to lay out the reinforcing steel properly.<sup>42</sup>

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<sup>39</sup>A. Moret to C. C. Tevis, Signed Letter, 16 December 1940, Lindbergh Bridge File.

<sup>40</sup>Robert Hodson to J. J. Corbett, Signed Letter, 16 December 1940, Lindbergh Bridge File.

<sup>41</sup>Robert Hodson to Atkinson-Windle Company, Signed Letter, 18 December 1940, Lindbergh Bridge File. The Atkinson-Windle Company also encountered a similar problem while building another bridge for the Missouri State Highway Department. The company in the fall of 1940 was preparing to start work on the construction of Bridge K-854, a concrete rigid-frame structure that would carry McKnight Road across Route 40TR near Richmond Heights. The highway department allowed modified wood forms to be used while pouring concrete for both structures, and no adverse effects were observed.

<sup>42</sup>Robert Hodson to J.J. Corbett, Signed Letter, 6 August 1941, Lindbergh Bridge File. Robert Hodson was the Division Engineer in charge of the highway department's St. Louis-area district, which was based in Kirkwood, Missouri. Hodson's office oversaw progress on all construction projects in the St. Louis metropolitan area and served as a mediator between construction contractors and the highway department's main offices in Jefferson City.

Hodson also noted that additional delays had been caused by an inability of the Holophane Company to supply lighting fixtures for the bridge and a decision by the Atkinson-Windle Company to start pouring the bridge's flooring before completing all work on the abutments and wingwalls. Because of these delays, Hodson recommended that the deadline for completing the bridge be extended from September 1, 1941, to the "date that the project is actually completed."<sup>43</sup>

C.W. Brown, Chief Engineer of the Missouri State Highway Department, responded to the Atkinson-Windle Company's request for additional time to complete the construction of Bridge K-600 with a sympathetic ear. He acknowledged that construction delays had been caused by the failure of the Holophane Company to provide lighting fixtures for the bridge in a timely manner as well as by changes in the pouring sequence. However, Brown also realized that the primary reason for the delays was a severe shortage of laborers in the St. Louis area:

You are, no doubt, aware that there are several Defense projects in the St. Louis that are using an abnormal amount of labor, both skilled and unskilled, and furthermore, it has been difficult to secure enough material for the normal progress of the work. Our engineers advise that it is their opinion that the class of skilled labor secured has been responsible for the lack of progress of work rather than the number of men employed. An examination of the pay rolls for this project will indicate that the contractor is employing more men to secure a given amount of work and it is taking these men a greater length of time to perform the work than could be expected if labor conditions in this area were normal.<sup>44</sup>

Because of these problems, Brown agreed to a ninety-day extension of the deadline for completion of the overpass. Brown also anticipated that other problems beyond the control of the Atkinson-Windle Company might arise in the final months of 1941, and he promised to provide additional extensions if construction of the bridge could not be completed by the end of the year.<sup>45</sup>

On December 7, 1941, Japanese military forces struck the U.S. Naval Base at Pearl Harbor, Hawaii, drawing America into the Second World War. The federal government immediately began to refocus the national economy toward wartime production, and unnecessary road construction projects were moved to the backburner. As part of the national effort to prepare for war, the PRA announced that it would not allow construction to proceed on any highways that were not part of the National Defense System. The National Defense System consisted of highways considered critical to moving men and materiel across the nation during wartime. Fortunately for the Missouri State Highway Department, Route 40TR was included in the National Defense System, and thus work on Bridge K-600 was allowed to continue

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<sup>43</sup>*Ibid.*

<sup>44</sup>C.W. Brown to Clifford Shoemaker, Signed Letter, 9 August 1941, Lindbergh Bridge File.

<sup>45</sup>*Ibid.*

uninterrupted.<sup>46</sup> Ongoing manpower shortages delayed completion of the new bridge well past the original September 1, 1941, deadline. A final inspection of Bridge K-600 took place on July 2, 1942. The structure was found to be in good condition, and it was accepted into the state's highway system.<sup>47</sup>

Although Bridge K-600 opened in 1942, construction of the Daniel Boone Expressway was not finished until after the end of the Second World War. The expressway was completed in the late 1940s, and in the 1950s the Missouri State Highway Department linked the road to the Oakland Express Highway in the City of St. Louis. This extended route, officially renamed U.S. Highway 40, provided the means for St. Louis-area residents to live in suburbs such as Ladue and Richmond Heights while still working in the city.<sup>48</sup>

As metropolitan St. Louis grew in the 1950s and 1960s, traffic increased dramatically along U.S. Highway 40 and other suburban thoroughfares. Bridge K-600 soon became a bottleneck slowing suburban travelers, and the Missouri State Highway Department realized that the parkway atop the structure was inadequate to handle growing traffic loads. The highway department thus decided to expand Highway 40 from a four-lane road to a six-lane facility to accommodate increased traffic, and in 1971 the department hired a contractor to partially reconstruct Bridge K-600. A rigid steel frame was built underneath the median of the Lindbergh Bridge to allow for the lane expansion. The roadway atop the bridge was rebuilt and widened approximately 22' by removing the decorative median and statues in order to accommodate two new lanes of traffic. Fortunately, several elements of the original substructure survived this reconstruction project, including the original wingwalls, concrete frames, and art-deco abutments. The reconstructed overpass was labeled Bridge K-600R in official records, and the new lanes across the bridge provided temporary relief to traffic problems along the expressway.<sup>49</sup>

Additional work on the bridge carrying U.S. Highway 40 across Lindbergh Boulevard was performed in the 1980s when a new wearing surface was installed atop its roadbed.<sup>50</sup> In the

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<sup>46</sup>Missouri State Highway Commission, *Thirteenth Biennial Report of the State Highway Commission of Missouri for the Period Ending December 31, 1942* (Jefferson City, Missouri: Missouri State Highway Commission, 1943), 22-25. For detailed information about the impact of the Second World War on the daily operations of the Missouri State Highway Department, see Missouri State Highway Commission, *Thirteenth Biennial Report of the State Highway Commission of Missouri for the Period Ending December 31, 1942, passim*; Missouri State Highway Commission, *Fourteenth Biennial Report of the State Highway Commission of Missouri for the Period Ending December 31, 1944, passim*; and Missouri State Highway Commission, *Fifteenth Report of the State Highway Commission of Missouri for the Period January 1, 1945 to June 30, 1946* (Jefferson City, Missouri: Missouri State Highway Commission, 1946), *passim*.

<sup>47</sup>J.J. Corbett to Robert Hodson, Signed Letter, 6 July 1942, Lindbergh Bridge File.

<sup>48</sup>Tipton, "The Way West: Highway 40 Grew in Fits and Starts Over 60 Years, 1A.

<sup>49</sup>Missouri State Highway Department, "Bridge Over Lindbergh Road: Project No. CO96-40(9)U," microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. The modified frame underneath Bridge K-600R was built using steel beams and plates instead of concrete, but a rigid-frame design was once again employed by the highway department.

<sup>50</sup>Missouri Highway and Transportation Commission, "Repairs to Bridge Over Lindbergh Boulevard: Project No. 6-U-40-659," microfiche copy available from Bridge Division, Missouri Department of Transportation

early 1990s Highway 40 was renamed Interstate 64 and signs carrying the interstate designation were installed along the overpass.<sup>51</sup> Today, Bridge K0600R2 and its adjacent interchange are no longer adequate to handle modern, high-speed traffic. The current cloverleaf interchange between the two highways will be rebuilt as a single-point urban interchange during the reconstruction of Interstate 64, and Bridge K0600R2 will be replaced by a new structure.<sup>52</sup> Although Bridge K0600R2 was rebuilt in the early 1970s, it remains an example of a rare bridge type that is rapidly disappearing from Missouri's landscape.

#### *McKnight Bridge (K0854R)*

Another overpass location identified early was to carry Lay Road, later renamed McKnight Road, across the new expressway. Lay Road was a major north-south thoroughfare that served as the border between three growing suburbs, Richmond Heights, Ladue and Brentwood. Preliminary surveys and soundings were conducted in the vicinity of Lay Road in the summer and fall of 1939, and by February 1940, department designers had completed preliminary plans for a new overpass. The plans called for the construction of a two-span plate girder bridge that was to be labeled Bridge K-854. Each span of this new bridge would be 61' long with a 14' vertical clearance, and the substructure was to be slightly skewed (less than seven degrees) so traffic could safely move around the substructure. In addition, preliminary plans called for the construction of a retaining wall on the northwest corner of the interchange where Bridge K-854 was to be built.<sup>53</sup> In a lengthy letter to Bridge Engineer N. R. Sack, Robert Hodson, the highway department's Division Engineer for the St. Louis Area, explained that the retaining wall was critical to protect the project from the avarice of a local landowner who hoped to maximize his profits from selling land for the bridge and its associated interchange:

It is imperative that construction be confined to the property south of the Godwin tract in the northwest quadrant in order to eliminate expensive right-of-way difficulties, and this will necessitate a retaining wall parallel to a portion of the pavement on this ramp...Improvements shown on the Godwin tract were constructed after this route [Route 40 TR] was tentatively located which

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General Headquarters, Jefferson City, Missouri. Following completion of this repaving project, the Lindbergh Boulevard Bridge was relabeled Bridge K-600R1 in official highway department records.

<sup>51</sup>Missouri Highway and Transportation Department, "Job No. J6U0897: Sign No. 11," microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. Once the installation of the new signs was completed, Bridge K-600R1 was relabeled Bridge K-600R2 in the department's bridge inventory.

<sup>52</sup>Missouri Department of Transportation, "The New I-64 Interactive Study Map: Lindbergh Blvd."

<sup>53</sup>Vaughn Enslow to R. W. Hodson, Signed Letter, 18 April 1939, microfiche copy in "General Correspondence File – Construction Project F-623 A(4)," Collection 12-0392, Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri; Vaughn Enslow to R. W. Hodson, Signed Letter, 3 February 1940, microfiche copy in "General Correspondence File – Construction Project F-623 A(4)," Collection 12-0392, Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri; and "Preliminary Layout: Bridge No. K-854," 25 January 1940, microfiche copy in "General Correspondence File – Construction Project F-623 A(4)," Collection 12-0392, Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. Materials in Collection 12-0392 henceforth cited as in the "McKnight Bridge File."

necessitated a change in alignment in order to clear this property. Therefore, we do not wish to open negotiations for any right-of-way from this owner as he will, no doubt, claim excessive damages to this property due to the construction of this route.<sup>54</sup>

When preliminary plans for Bridge K-854 were completed, they were sent to Clifford Shoemaker, District Engineer for the Public Roads Administration (PRA), for review.<sup>55</sup> Shoemaker examined the plans and decided that the proposed bridge could handle local traffic levels and provide for an acceptably aesthetic structure. However, he suggested that the Missouri State Highway Department consider lengthening the vertical curve along Lay Road to improve sight distances for approaching drivers. In response to Shoemaker's request, the highway department went back to the drawing board to see if they could come up with a revised bridge design that would allow for improved sight lines while still avoiding the contentious Godwin tract.<sup>56</sup>

In June 1940, the Missouri State Highway Department sent a revised set of plans for Bridge K-854 to the PRA. The new plans called for a dramatically different design for the overpass carrying Lay Road across the Daniel Boone Expressway. Instead of a plate girder bridge, the department suggested the construction of a two-span concrete rigid-frame bridge. As the department explained, such a structure would not only improve sight lines and avoid the Godwin tract; it would also improve the aesthetics of the overpass:

In discussing the various layouts and type of architectural treatment which should be provided it appeared that a two span continuous concrete frame would fit the conditions of this site better than any architectural treatment which could be applied to the two span continuous deck plate girder design. We wish to call to your attention that this sketch will show the east side of the structure although the west side will be similar except for the fact that the northwest wing is of special design and will curve to a connection with the retaining wall which is included with the grading contract. This is one of our reasons for believing that the type of treatment which we have shown will be more adaptable to this site than any other.<sup>57</sup>

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<sup>54</sup>Robert Hodson to N. R. Sack, Signed Letter, 13 March 1939, McKnight Bridge File.

<sup>55</sup>C.W. Brown to Clifford Shoemaker, Signed Letter, 6 February 1940, McKnight Bridge File. In order to qualify for the limited federal road-building assistance that was available in the 1940s, state transportation agencies had to send in design plans for new roads and bridges to the Public Roads Administration for review. Clifford Shoemaker was the PRA district engineer responsible for reviewing all road-building projects in Missouri, Kansas, Iowa, and Nebraska, and his blessing was needed before work on Bridge K-854 could move forward.

<sup>56</sup>Robert Hodson to P. H. Daniells, Signed Letter, 8 March 1940, McKnight Bridge File; Clifford Shoemaker to C. W. Brown, Signed Letter, 9 March 1940, McKnight Bridge File; and Robert Hodson to P. H. Daniells, Signed Letter, 14 March 1940, McKnight Bridge File.

<sup>57</sup>C. W. Brown to Clifford Shoemaker, Signed Letter, 27 June 1940, McKnight Bridge File.

Within days, Clifford Shoemaker approved the highway department's recommendation to build Bridge K-854 as a concrete rigid-frame structure.<sup>58</sup> Changing the design of the bridge promised to provide for an aesthetically pleasing structure while avoiding a disputed land tract and improving sight lines. Thus, the highway department had multiple reasons for selecting the concrete rigid-frame design for its planned overpass carrying traffic over the Daniel Boone Expressway.

The concrete rigid-frame design selected for Bridge K-854 was first used in upstate New York in the 1920s by Arthur Hayden to design structures for the Bronx River Parkway, and the design rapidly won national notoriety. Federally funded work-relief crews often built rigid-frame bridges during the 1930s as they were considered an aesthetically pleasing alternative to other bridge designs. In addition, concrete rigid-frame bridges cost less to build than other structures. Rigid-frame bridges could be built using less steel and concrete than truss bridges, and they required minimal abutments for support. Concrete rigid-frame bridges quickly became a popular choice among the designers of urban expressways, and several were built as part of the famous Merritt Parkway.<sup>59</sup> In addition, an article extolling concrete rigid-frame bridges appeared in an April 1940 construction journal promoting their use in urban situations, and this article may have influenced the highway department's vision for Bridge K-854:

Rigid-frame bridges are usually more economical to build than other comparative types. Possessing by virtue of their design graceful and pleasing lines, which readily lend themselves to the incorporation of architectural principles in their construction, it is possible to secure a structure infinitely superior, from the aesthetic viewpoint, than previously-accepted types of bridges...they require no expensive ugly superstructure projecting itself above the deck and they are equally satisfactory, as a general rule, when built of reinforced concrete or structural steel.<sup>60</sup>

Despite their national popularity, the Missouri State Highway Department only built seven concrete rigid-frame bridges between 1931 and 1950. The department used concrete rigid-frame bridges exclusively for grade separations and overpasses along urban expressways, and as in the case of Bridge K-854, the design was usually chosen to enhance the aesthetics of a highway construction project.<sup>61</sup>

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<sup>58</sup>Clifford Shoemaker to C. W. Brown, Signed Letter, 2 July 1940, McKnight Bridge File.

<sup>59</sup>Arthur Hayden and Maurice Barron, *The Rigid-Frame Bridge*, 3d ed., (New York: John Wiley and Sons, Inc., 1950), 1-4, 219-229; Clayton Fraser, *Missouri Historic Bridge Inventory: Draft Inventory Report* (Loveland, Colorado: Fraserdesign Inc., 1996), 141; Elmer Napier, "Rigid-Frame Bridges," *Roads and Bridges*, April 1940, 13-14; Eric DeLony, "Merritt Parkway," HAER No. CT-63, Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, 1992, 79-80; and National Cooperative Highway Research Program, "A Context for Common Historic Bridge Types," NCHRP Project 25-25, Task 15, October 2005, 3.95-3.97. For a detailed explanation of the engineering principles behind the rigid-frame design, see DeLony, "Merritt Parkway," 78; and Hayden and Barron, *The Rigid-Frame Bridge*, *passim*.

<sup>60</sup>Napier, "Rigid-Frame Bridges," 13.

<sup>61</sup>Fraser, *Missouri Historic Bridge Inventory*, 141. By the 1950s, the concrete rigid-frame design

Throughout the summer and fall of 1940 designers in the Missouri State Highway Department's Bridge Division finalized the plans for Bridge K-854. The final bridge plans called for a two-span rigid-frame bridge with five individual concrete frames. The bridge design also called for minimal aesthetic enhancements to the new structure. The walls of the structure were to feature an art deco design, but the main arches were to be simple concrete structures.<sup>62</sup> Perhaps this lack of aesthetic design enhancements can be attributed to an emerging labor shortage within the highway department. Many workers were leaving the department to take positions in defense related industries that were beginning to prepare for war. In a letter written in April 1941, Bridge Engineer N. R. Sack explained how the manpower shortage had forced the department to farm out many of its design projects to private contractors:

Last fall I called to your attention the number of men who were leaving this bureau for military service and for other industries connected with the National Defense Program and stated that if this continued it was doubtful if the required bridge designs for our future program could be completed by this bureau. Designs will be required in the near future for six bridges on Route 40TR, St. Louis County, from Lay Road east. With the amount of work which we now have on hand it appears that it will not be possible for us to complete the above designs in order that they may be placed under contract at the desired time. I, therefore, suggest that arrangements be made with Sverdrup and Parcel, Consulting Engineers, of St. Louis, to prepare these designs for us.<sup>63</sup>

This manpower shortage reached a critical level when the United States entered into the Second World War. All bureaus and divisions within the highway department lost workers to private industries and military service, and the department was unable to restore its manpower to prewar levels until the late 1940s.<sup>64</sup>

When final plans for Bridge K-854 were completed, the project was placed on the letting schedule for November 29, 1940. Three companies offered bids for the project, with the lowest coming from the Atkinson-Windle Company from Chillicothe, Missouri. The Atkinson-Windle Company offered to build the bridge for \$55,180, a bid that was more than \$10,000 lower than

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had fallen out of vogue with bridge designers. Instead, the introduction of pre-stressed concrete had made it more efficient to use other designs for urban bridges, especially the ubiquitous concrete t-beam design. See National Cooperative Highway Research Program, "A Context for Common Historic Bridge Types," 3.88, 3.96-3.97.

<sup>62</sup>Missouri State Highway Department, "Bridge on Lay Road Over US 40TR," microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri; and N. R. Sack to J. C. Quigley, Signed Letter, 10 September 1940, McKnight Bridge File.

<sup>63</sup>N. R. Sack to C. W. Brown, Signed Letter, 8 April 1941, McKnight Bridge File.

<sup>64</sup>For a detailed discussion of the impact of the Second World War on the daily operations of the Missouri State Highway Department, see Missouri State Highway Commission, *Fourteenth Biennial Report of the State Highway Commission of Missouri for the Period Ending December 31, 1944* (Jefferson City, Missouri: Missouri State Highway Commission, 1945), *passim*; and Missouri State Highway Commission, *Fifteenth Report of the State Highway Commission of Missouri for the Period January 1, 1945 to June 30, 1946* (Jefferson City, Missouri: Missouri State Highway Commission, 1946), *passim*.

its closest competitor.<sup>65</sup> Work proceeded smoothly on construction of Bridge K-854 in the winter of 1940 and throughout 1941, but occasional problems arose that delayed the completion of the project. For example, the Atkinson-Windle Company began to purchase wood that would be used to build forms for pouring cement in December 1940. However, the company discovered that it was virtually impossible to purchase wood with the 1-1/4" thickness required in the construction specifications for the new bridge. Thus, representatives from the company approached the highway department and asked if the forms needed to pour concrete could be built using wood that was only 3/4" thick.<sup>66</sup> The Division Engineer for the St. Louis District recommended that this request be approved, explaining that federal defense projects were creating significant shortages of construction supplies:

It is our understanding that contractors are having some difficulty securing the 1-1/4" plywood as the government has contracted for a large supply of this material which no doubt accounts for the reason that the various contractors would like to substitute the 3/4" plywood without backing as there seems to be plenty of this material on hand. We believe this request is reasonable and suggest that the substitution be approved.<sup>67</sup>

The highway department eventually acceded to the contractor's request and allowed the forms for Bridge K-854 to be built using thinner wood forms.

In addition to facing a shortage of construction materials, the Atkinson-Windle Company also faced manpower problems during construction of Bridge K-854. One example of this occurred in the fall of 1941 when the construction contractor discovered that the soundings for the south end of the bridge structure were wrong. The Atkinson-Windle Company planned to have the footings for the south wall poured by September 20, 1940, but they had to make a design change in the field to compensate for the inaccurate sounding information. This threatened to delay the entire project, so the contractor asked the highway department for a blanket change order allowing them to revise the bridge footings on site. Such changes usually required approval from Jefferson City, but as the contractor explained, quick decisions were needed because they were about to lose many of their skilled workers to other industries:

We have only a small amount of work remaining that we can do with our carpenter crew and we will have to lay them off in a few days. This is a very serious matter, as these carpenters have been loyal and staid [sic] with us, as against going to defense jobs where they can get longer hours and overtime pay. The minute we have to lay them off they will go to a defense job and we cannot get them back and will then be forced to hire inexperienced carpenters, which can easily double our form cost.<sup>68</sup>

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<sup>65</sup>Missouri State Highway Commission, "Tabulation of Bids: Federal Aid Project FA 623-A(4)," microfiche copy available from Design Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri.

<sup>66</sup>A. Moret to C. C. Tevis, Signed Letter, 16 December 1940, McKnight Bridge File.

<sup>67</sup>Robert Hodson to J. J. Corbett, Signed Letter, 16 December 1940, McKnight Bridge File.

In order to prevent further delays, the highway department gave permission to the Atkinson-Windle Company to make minor design changes in the field. The highway department also told the construction contractor to make arrangements to heat the concrete that would be used to build the bridge so work could continue during the winter months. The detour of Lay Road around the construction zone was hazardous for local drivers, and thus the highway department hoped to continue construction of the overpass throughout the winter months.<sup>69</sup>

On December 7, 1941, Japanese military forces struck the U.S. Naval Base at Pearl Harbor, Hawaii, drawing America into the Second World War. The federal government immediately began to refocus the national economy toward wartime production, and unnecessary road construction projects were moved to the backburner. As part of the national effort to prepare for war, the PRA announced that it would not allow construction to proceed on any highways that were not part of the National Defense System. The National Defense System consisted of highways considered critical to moving men and materiel across the nation during wartime. Fortunately for the Missouri State Highway Department, Route 40TR was included in the National Defense System, and thus work on Bridge K-854 was allowed to continue.<sup>70</sup> After several months of delays due to manpower and material shortages, the bridge was finally completed and accepted into the state highway system in September 1942.<sup>71</sup>

Although Bridge K-854 opened to traffic in 1942, construction of the Daniel Boone Expressway was not completed until after the end of the Second World War. This can be seen in an interesting letter sent to the highway department in 1944 by F. W. Panhorst, a Bridge Engineer with the California Department of Public Works. Panhorst had driven across Missouri in January 1944, and he recalled seeing a “very beautiful and unique” bridge designed by the highway department. The bridge was located on a “dead ended freeway west of the City [St. Louis] where a section of freeway had been built but blocked at both ends” because of wartime restrictions.<sup>72</sup> The bridge that Parhorst admired turned out to be Bridge K-854, and the highway department sent Parhorst a set of plans for the bridge so he could study them and use them as a model for new structures on California’s road system.<sup>73</sup> Bridge K-854 differed from most bridges built by the Missouri State Highway Department, and the Daniel Boone Expressway

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<sup>68</sup>M. M. Windle to Robert Hodson, Signed Letter, 25 September 1941, McKnight Bridge File.

<sup>69</sup>M. M. Windle to Robert Hodson, Signed Letter, 20 October 1941, McKnight Bridge File; and Robert Hodson to J. J. Corbett, Signed Letter, 22 October 1941, McKnight Bridge File.

<sup>70</sup>Missouri State Highway Commission, *Thirteenth Biennial Report of the State Highway Commission of Missouri for the Period Ending December 31, 1942* (Jefferson City, Missouri: Missouri State Highway Commission, 1943), 22-25.

<sup>71</sup>C. W. Brown to Robert Hodson, Signed Letter, 26 September 1942, McKnight Bridge File.

<sup>72</sup>F. W. Panhorst to Vaughn Enslow, Signed Letter, 21 April 1944, McKnight Bridge File. Panhorst was particularly intrigued by the aesthetic designs applied to the abutments of Bridge K-854, and he noted that during his trip through Missouri he saw many “good looking structures” along the state’s highways.

<sup>73</sup>Vaughn Enslow to F. W. Panhorst, Signed Letter, 25 April 1944, McKnight Bridge File.

quickly became one of the most critical transportation corridors in the St. Louis metropolitan area.

Construction of the Daniel Boone Expressway was finally finished in the late 1940s, and in the late 1950s the Expressway was joined to the Oakland Expressway Highway to complete the full route of Highway 40 through the St. Louis area. Highway 40 provided the means for St. Louis residents to live in suburban neighborhoods while working in the city, and the highway encouraged the rapid growth of suburban communities.<sup>74</sup>

Unfortunately, Highway 40 quickly became a victim of its own success. The highway helped spur the flight of St. Louis residents away from the urban core, and today the road carries much more traffic than it was originally designed to accommodate. As early as the mid-1960s the Missouri State Highway Department noticed that traffic congestion was causing significant delays for motorists along Highway 40, and the department warned the public, “unless the operational characteristics of the study section [of Highway 40] are improved, future increases in vehicular density and congestion seem inevitable.”<sup>75</sup> Today, plans are underway to rebuild Highway 40 in suburban St. Louis and upgrade the facility to interstate highway standards. The rebuilt road will be known as Interstate 64, and Bridge K-854 will need to be replaced with a structure designed to modern interstate standards. The bridge has functioned in place since 1942 with only minor alterations. In 1992 portions of the bridge’s concrete were ground and smoothed in order to install new signs, but no major changes were made to the superstructure.<sup>76</sup>

### **The Bridge Builders**

#### *M.E. Gillioz, Inc. (Spoede Bridge)*

Maurice E. Gillioz was born in rural Phelps County in 1877, and as a young man he worked as a laborer for both the Santa Fe Railroad and the St. Louis and San Francisco Railroad. In 1905 he put in a successful bid to build a foundation and floor for St. Mary’s Catholic Church in Pierce City, Missouri, and upon receiving this contract he decided to become a full-time contractor. Gillioz began to win construction contracts for projects throughout Missouri, and in 1914 he moved the headquarters of his company to Monett, Missouri. Gillioz built several structures in the 1920s. Within Monett alone he built Plymouth School, City Park Casino, Monett City Hall, and the local Masonic Temple. During the 1930s Gillioz received contracts to build bridges throughout Missouri, and by 1934 Gillioz was a millionaire.

Although Gillioz came to own a wide range of businesses, including the Gillioz Motor Company, the Gillioz Clothing Store, and the Gillioz Theater, construction remained his primary enterprise. Some of the major projects completed by the Gillioz Construction Company included the Route

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<sup>74</sup>Tipton, “The Way West: Highway 40 Grew in Fits and Starts Over 60 Years, 1A.

<sup>75</sup>Missouri State Highway Department, *Peak Hour Traffic and Congestion on U.S. Route 40, Daniel Boone Expressway, St. Louis, Missouri* (Jefferson City, Missouri: Missouri State Highway Department, 1965), 3

<sup>76</sup>Missouri Highway and Transportation Department, “Job No. J6U0897: Signs 87 and 88, Bridge K-854R,” microfiche copy available from Bridge Division, Missouri Department of Transportation General Headquarters, Jefferson City, Missouri. Once the installation of new signs was completed, Bridge K-854 was relabeled Bridge K-854R in the department’s bridge inventory.

66 Bridge over the Arkansas River in Tulsa, Oklahoma, the Blue Mountain Dam near Boonville, Arkansas, and the Southwest Trafficway in Kansas City, Missouri. By 1957, the Gillioz Construction Company had completed over \$31 million worth of projects for the Missouri State Highway Department. Gillioz was widely hailed as a civic leader in Monett, Missouri, with over 300 guests attending his eightieth birthday party in 1957. At his birthday party Gillioz was hailed by Rex Whitton, a former Chief Engineer of the Missouri State Highway Department, as a pioneer road and bridge builder who had a tremendous impact upon transportation throughout the state. Maurice Gillioz died on April 17, 1962, and the Gillioz Construction Company went out of business in the late 1960s.<sup>77</sup>

#### *Atkinson-Windle Company (Lindberg and McKnight Bridges)*

Archival research yielded minimal information about the contractor responsible for the construction of Bridge K-854, the Atkinson-Windle Company. The company was created in May 1940 as a partnership between two men, Murray N. Windle of Chillicothe, Missouri, and Edward C. Atkinson of St. Joseph, Missouri. These two men each owned forty-five shares of the company's initial subscribed capital of \$10,000. The remaining ten shares of company stock were divided equally between Clarence Cooley of St. Joseph and Winslow Tilford of Chillicothe. In addition to the \$10,000 capital, the company also owned a variety of construction equipment when it incorporated in 1940, including several tractors, earthmovers, and concrete mixers. According to its Articles of Incorporation, the primary business focus of the new company was as a general contracting company that would build streets, roads, and highways, as well as paving existing routes. In addition, the company also planned "to contract for, construct, and build and repair bridges, buildings, and other structures."<sup>78</sup> The Atkinson-Windle Company won the contract to build Bridge K-854 for the Missouri State Highway Department in November 1940, and records indicate that the company built numerous roads and bridges for the highway department, especially projects near the Chillicothe area. The Atkinson-Windle Company continued until 1984 when it was dissolved by the descendents of its original founders.<sup>79</sup>

### **Bridge Descriptions**

#### *Spoede Bridge*

The Spoede bridge (K0601R) is a two-span continuous deck plate girder structure. The bottom of each plate girder span is slightly arched, and each deck plate girder span measures 59'-8" in length. The substructure of the bridge is composed of two abutments and a single central pier. The abutments are identical in design, and both rest on seventeen buried pedestals sitting atop

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<sup>77</sup>David Austin and Steven Mitchell, "VanBuren Bridge," HAER No. MO-90, Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, 1995, 13-14; Thomas Gubbels, "Historic Documentation, Shoal Creek Bridge: Bridge J-349," June 2001, as held in the Cultural Inventory, Missouri State Historic Preservation Office, Jefferson City, Missouri, 3; and Western Historical Manuscripts Collection, "Information Sheet: M.E. Gillioz Papers," downloaded 7 June 2006 from <http://web.umn.edu/~whmcinfo/shelf23/r575/info.html>.

<sup>78</sup>Atkinson-Windle Company, "Articles of Incorporation," 13 May 1940, as held by the Missouri Secretary of State Corporations Office, Jefferson City, Missouri.

<sup>79</sup>Atkinson-Windle Company, "Articles of Dissolution by Voluntary Action," 26 July 1984, as held by the Missouri Secretary of State Corporations Office, Jefferson City, Missouri.

underlying bedrock. The abutments are both approximately 20'-10" in height from the top of the footing to the crown, allowing a 14' vertical clearance beneath the bridge. The abutments feature a decorative art-deco design on their exterior, and the top of each abutment rises slightly above the superstructure and bridge deck. The central pier that supports the superstructure rests upon seven square concrete footings that are 6' x 6' in width and depth and 3' in vertical thickness. Seven separate reinforced concrete columns compose the central pier. The concrete columns measure 2' x 4', and each is linked by a concrete crown measuring 4'-8" in length and 4' in width. The central pier measures approximately 23'-5" in height from the top of its footing to the top of its crown, and the length of the pier from the outer edge of the first column to the outer edge of the seventh column is approximately 53'-8". The outside of the central pier also features an art-deco design in its concrete, adding to the aesthetic beauty of the structure.

The superstructure of Bridge K0601R is composed primarily of seven massive steel plate girders that measure 59'-8" in length. The outermost girders atop the outside edges of the bridge are formed from four steel angles measuring 6"x 6" with a thickness of 1/2" joined together by 1/2" steel web plates. The other five girders are formed from steel angles measuring 6" x 6" with a 3/8" thickness linked together by 1/2" steel web plates. The space between each individual girder is filled by cross bracing composed of steel angles measuring 3-1/2" x 3-1/2" and 3/8" thick steel web plates. The steel superstructure of the bridge is joined to its substructure by rocker bearing plates that give flexibility to the structure. The roadbed of Bridge K-601R is composed of 12" of concrete poured to achieve a 3" crown. The roadbed is 42' wide to accommodate several lanes of traffic, and it features a 2.8% grade across its length. A concrete and steel guardrail was installed across the bridge. A bronze nameplate attached to the bridge lists the date of construction and the bridge contractor, M.E. Gillioz. In the early 1990s, several signs were attached to the outside of the girder web to identify the newly named Interstate 64 passing underneath the structure, but no other major alterations have been made to Bridge K-601R since it opened to traffic in the late 1930s.<sup>80</sup>

### *Lindberg Bridge*

The Lindberg bridge (K0600R2) is a single-span rigid-frame structure. A rigid-frame bridge is defined as a bridge where the piers and deck girder are joined to form a single structure. Unlike ordinary girder bridges where the deck rests on bearings atop a separate substructure, a rigid-frame bridge acts as a single functional unit. When Bridge K-600 was originally built, concrete was poured on several occasions by the Atkinson-Windle Company into wood forms and allowed to set as a single unit. Thus, the original bridge did not have a separate substructure and superstructure. The central frames and roadbed of Bridge K-600 were reconstructed in the early 1970s, and the rebuilt structure reincorporated the rigid-frame design. Rigid-frame bridges gained national popularity in the 1930s. Such bridges were seen as picturesque and practical alternatives to girder or truss bridges, and they were less expensive and easier to build than other bridge types. Bridge K-600 was designed using standards similar to those used by urban road builders throughout America. For example, a similar rigid-frame bridge built in 1934 in Douglas County, Nebraska, the Dodge Street Overpass, was constructed as part of the expansion of Nebraska State Highway 6 from downtown Omaha to the city's western limits. Like Bridge

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<sup>80</sup>The physical description of Bridge K-601R is based on Missouri State Highway Department, "Bridge Over U.S. Route 40 T.R. (Spoede Road): Project No. FAP 513(I)"; and Missouri Highway and Transportation Department, "Job No. J6U0897: Sign No. 2, Bridge K-601R."

K0600R2, this urban structure is considered eligible for listing on the National Register of Historic Places (NRHP).<sup>81</sup>

Bridge K0600R2 was originally built as a concrete rigid-frame structure featuring massive concrete abutments. The bridge deck sat atop eight arched concrete frames supported by buried concrete footings. Each of the eight arched concrete frames varied dramatically in height, width, and thickness, but they were all designed to provide a minimal vertical clearance of 14' and 81' of clear space between the abutments for traffic passing underneath the bridge. The wingwalls featured an art-deco design with horizontal stripes and concrete columns with an incorporated lighting system and stone facing. The bridge deck carrying Route 40TR across the structure was 188'-10" long, and it originally featured four driving lanes each 20' in width. The bridge also featured 2'-9" sidewalks on either side along with a custom concrete handrail. Since Route 40TR was designed as a parkway, the bridge deck originally featured a 22' wide concrete median with two decorative statues honoring Charles Lindbergh as well as an indirect lighting system to highlight the structure's aesthetic features.<sup>82</sup>

In 1971, Bridge K-600 was partially rebuilt. The eight concrete frames of the original structure were supplemented by the addition of a new frame composed of welded steel in the center of the substructure. The new steel frame was a uniform 22' 3" in height, 10' wide, and it featured an increased vertical clearance of 15' 2" compared to the 14' clearance of the original concrete frames. Two new concrete abutments were also built in the center of the bridge to support the additional steel frame. Since the primary motivation behind the reconstruction of Bridge K-600 was to increase traffic capacity on U.S. Highway 40, the median and sidewalks of the original structure were obliterated. The deck of the rebuilt bridge featured three driving lanes for both east and westbound traffic, and instead of being divided by a decorative median; a utilitarian concrete barrier separated the opposing traffic lanes. In addition, the aesthetic features of the original deck such as the lighting system and the decorative handrails were removed, but the overall bridge retained its art deco features on the outside of its original concrete frames.<sup>83</sup> Today, Bridge K-600R2 can best be described as a concrete rigid-frame bridge that features a significant steel-frame component.

### *McKnight Bridge*

The McKnight bridge (K0854R) is a ribbed, two-span reinforced concrete rigid-frame structure. A rigid-frame bridge is defined as a bridge where the piers and deck girder are joined to form a single structure. Unlike ordinary girder bridges where the deck rests on bearings atop a separate

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<sup>81</sup>Hayden and Barron, *The Rigid-Frame Bridge*, 184-191; National Cooperative Highway Research Program, "A Context for Common Historic Bridge Types," 3.96; and Nebraska State Historical Society, "More Nebraska National Register Sites in Douglas County," downloaded 2 June 2006 from <http://www.nebraskahistory.org/histpres/nebraska/douglas2.htm>. For additional examples of rigid-frame bridges built in the 1930s and 1940s, see Hayden and Barron, *The Rigid-Frame Bridge*, 230-240.

<sup>82</sup>The physical description of the original Bridge K-600 is based on Missouri State Highway Department, "Grade Separation Over Lindbergh Boulevard: Project No. FA623-A(2)."

<sup>83</sup>The description of the reconstructed bridge is based on Missouri State Highway Department, "Bridge Over Lindbergh Road: Project No. CO96-40(9)U."

substructure, a rigid-frame bridge acts as a single functional unit. In the case of Bridge K-854R, concrete was poured on several occasions by the Atkinson-Windle Company into wood forms and allowed to set as a single unit. Thus, the bridge does not have a separate substructure and superstructure.

The first concrete rigid-frame bridge in the United States was constructed in Westchester County, New York, in 1922. Rigid-frame bridges rapidly gained popularity in the 1930s. Such bridges were seen as a picturesque and practical alternative to girder or truss bridges, and they were also less expensive and easier to build than other bridge types. Bridge K0854R was designed using standards similar to those used by urban road designers throughout America. For example, a similar concrete rigid-frame bridge built in 1934 in Douglas County, Nebraska, the Dodge Street Overpass, was constructed as part of the expansion of Nebraska Highway 6 from downtown Omaha to the city's western limits. This bridge is also considered eligible to the National Register of Historic Places.<sup>84</sup>

Bridge K0854R rests atop reinforced concrete abutments built atop concrete piles set to underlying bedrock. The deck for Bridge K-854 was poured atop five concrete frames supported by buried concrete footings. The large central columns of each individual frame divide the bridge's two spans. Each frame varies dramatically in height, width, and thickness, but they were all designed to provide a minimal vertical clearance of 14' for traffic passing underneath the bridge. In addition, the outside columns of each frame are 61'-3" from the frames' central column, allowing for several traffic lanes beneath the structure. Each concrete frame is also skewed slightly, featuring a 7-degree turn from the centerline. The bridge deck itself was laid in a sequence of six pours performed after the arched concrete frames and support walls had been poured and allowed to set. The bridge deck carrying McKnight Road is 123' long. The roadway across the bridge is 44' wide to accommodate several lanes of traffic, and the bridge deck is approximately 10-1/2" thick with a 2-1/2" parabolic crown. Generous sidewalks measuring 5' in width were built along both sides of the bridge protected from traffic by a 20" curb and standard 3' concrete guardrails along the outside of the structure. The only aesthetic enhancements added to Bridge K-854R were several stepped indentations along the outside of the bridge frames, giving the structure an art deco appearance. Portions of the bridge's exterior were ground down in 1992 when interstate highway signs were added to Bridge K0854, but no other modifications have been made to the structure since it opened to traffic in 1942.<sup>85</sup>

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<sup>84</sup>Hayden and Barron, *The Rigid-Frame Bridge*, 184-191; National Cooperative Highway Research Program, "A Context for Common Historic Bridge Types," 3.96; and United States Department of Transportation - Federal Highway Administration, "Historic Bridges of Nebraska, Douglas County: Dodge Street Overpass," downloaded 10 April 2006 from <http://www.fhwa.dot.gov/nediv/bridges/Douglas.htm>. For additional examples of rigid-frame bridges built throughout the nation in the 1930s and 1940s, see Hayden and Barron, *The Rigid-Frame Bridge*, 230-240.

<sup>85</sup>The physical description of Bridge K-854R is based on Missouri State Highway Department, "Bridge on Lay Road Over US 40TR"; and Missouri Highway and Transportation Department, "Job No. J6U0897: Signs 87 and 88, Bridge K-854R."

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