

Historic Context for Louisiana Bridges

Louisiana Statewide Historic Bridge Inventory

Prepared for

**Louisiana Department of
Transportation and Development**

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Table of Contents

	Page
Executive Summary	1
1. Project Background	3
A. Research design and methods	3
B. Purpose	6
2. Bridge-related Legislation, Policies, and Practice	9
Timeline of events	9
A. Before the roads: Early water and railroad-based transportation	10
B. Influence of the Good Roads Movement	11
C. Early government involvement in roads and bridges	12
(1) State Highway Department and early efforts	12
(2) Transcontinental highways	14
(3) Early federal aid to roads	14
(4) Emergence of the Louisiana Highway Commission	17
(a) Design role of Bridge Department	19
(b) Local bridge construction	20
D. Huey Long's era and the Great Depression	21
(1) Commission reorganization	21
(a) The Long administration's methods	23
(2) New Deal and Federal Relief Programs	24
(a) State-Federal government relationship	25
(b) Bridge projects	26
E. Wartime planning	27
(1) Federal influence	27
(2) State reorganization and war efforts	29
F. Postwar acceleration of road and bridge building	29
(1) The Interstate Highway System	30
(2) The Department of Highway's postwar transformation	31
(3) Department of Highways bridge design	34
(4) Consultant bridge design	35
(5) Improvement of parish roads	35
(6) Private bridge construction	36
G. Conclusion	37

3.	Geography, Bridge Materials, and Design	39
A.	Influence of geography on bridge location, design, and construction	39
(1)	Geography and navigable waterways	40
(2)	Soil conditions and bridge construction	41
B.	Bridge-building materials	43
(1)	Wood/timber	44
(2)	Metal (iron and steel)	45
(a)	Steel connection methods	46
(3)	Concrete	48
(a)	Reinforced concrete	49
(b)	Prestressed concrete	51
(c)	Lightweight concrete	53
C.	Bridge design	54
(1)	Substructure design and construction	54
(a)	Spread footings and mud sills	55
(b)	Pile foundations	55
(c)	Caissons	58
(2)	Superstructure design	60
(a)	Influence of national design standards	60
(b)	Continuous and cantilever design	62
(c)	Composite deck	63
D.	Bridge types	64
(1)	Arch	65
(a)	Concrete arch	65
(2)	Truss	66
(a)	Pratt	68
(b)	Parker	68
(c)	Camelback	69
(d)	Warren	69
(e)	K-truss	70
(3)	Movable bridges	72
(a)	Swing-span bridges	73
(b)	Vertical lift bridges	75
(c)	Bascule bridges	78
(d)	Pontoon bridges	81
(e)	Removable-span bridges	82
(4)	Culverts	83
(a)	Metal	83
(b)	Concrete	84
(5)	Beam/girder	85
(a)	Concrete slab	86

Table of Contents

(b)	Concrete girder	87
(c)	Concrete deck girder (tee beam)	88
(d)	Concrete rigid frame	89
(e)	Concrete box girder	91
(f)	Concrete channel beam.....	91
(g)	Steel I-beam.....	92
(h)	Steel plate girder.....	92
(i)	Timber trestles	93
(j)	Timber mud sill	94
E.	Engineers, designers, and builders	97
(1)	Louisiana Highway Commission and Department of Highways.....	97
(a)	Norman E. Lant.....	97
(b)	Harry B. Henderlite	99
(c)	George F. Stevenson.....	100
(d)	Louis Duclos	101
(e)	Sidney L. Poleynard.....	101
(f)	Albert J. Dunn	101
(2)	Consulting engineers and firms.....	102
(a)	Modjeski and Masters	102
(b)	Harrington & Cortelyou	103
(c)	Daniel Moran and Moran and Proctor Co.	103
(d)	William Horace Williams Company.....	104
(e)	Ford, Bacon & Davis.....	104
(f)	Howard, Needles, Tammen & Bergendoff.....	104
(g)	J.B. Carter and the Nashville Bridge Company .	104
(h)	Siems-Helmets, Inc.	105
(3)	Bridge builders, construction companies, and fabricators.....	105
F.	Aesthetics in bridge design.....	107
G.	Conclusion	111
4.	Conclusion.....	113
	Bibliography.....	115

Tables

1 Historic transportation routes 3

2 Postwar spending trends for the state highway system..... 32

3 Pre-1971 bridges over the Mississippi River in Louisiana
with caisson construction 58

4 Pre-1971 bridges in Louisiana by type..... 65

5 Pre-1971 movable bridges in Louisiana..... 73

6 Pre-1971 culverts in Louisiana 20 feet or longer 83

7 Pre-1971 beam/girder bridges in Louisiana 85

8 Preliminary analysis of bridge types in Louisiana 95

Figures

1	Map of Louisiana Federal Aid Highway System, 1924	18
2	Louisiana bridges built prior to 1971, by material	44
3	Illustration of Pratt truss	68
4	Illustration of Parker truss	69
5	Illustration of Camelback truss	69
6	Illustrations of Warren truss	70
7	Illustrations of Warren truss with verticals	70
8	1931 Louisiana Highway Commission standard plan for a K-truss ...	71
9	Sketch of swing-span bridge in closed position, showing piers and location of operating components	74
10	Sketch of vertical lift bridge showing fully opened and fully closed positions, as well as operation components	76
11	Sketch showing the operating components of one leaf of a double-leaf, simple-trunnion, bascule bridge	79
12	Sketch of a hydraulically operated rolling-lift bascule bridge	80
13	Sketch showing a heel-trunnion bascule design	81

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Executive Summary

The *Historic Context for Louisiana Historic Bridge Inventory* is the first major component in the Louisiana Department of Transportation and Development (LADOTD)'s effort to evaluate its statewide inventory of historic bridges constructed through 1970. The complete project is known as the Historic Bridge Inventory. This context report is intended to provide a solid foundation for understanding trends and developments in Louisiana bridge design engineering through 1970. The contexts and themes will provide the basis for developing criteria for evaluating the state's bridges based on the standards of the National Register of Historic Places (National Register). The inventory project involves determining the historic significance of approximately 5,400 structures across the state of Louisiana through 1970.

The historic context is addressed in four sections described as follows:

- *Section 1: Project Background* explains the LADOTD's purpose in undertaking this project and describes the project's research methods. The section outlines the steps of the project, the importance of the development of a historic context, and how this project complies with federal preservation regulations.
- *Section 2: Bridge-related Legislation, Policies, and Practices* begins with an overview of the general lack of a distinctive road and bridge network in the nineteenth century due to the state's reliance on water and rail transportation. The story continues with a description of major trends and initiatives in road and bridge building in the twentieth century, including the Good Roads Movement, early federal funding, the Depression, World War II, and the development of modern highways, including the Interstate, in the post-World War II years. Initiatives in Louisiana are described within the context of these significant national developments, and the history of local and state bridge building is discussed, highlighting the establishment of a state agency to manage bridge construction.
- *Section 3: Geography, Bridge Materials, and Design* begins with a discussion of the unique geography of Louisiana and how development of the state's transportation network, focusing on bridges, had to address particular challenges as a result. The state's vast water network and poor soil conditions led to challenges in bridge design and construction. The section continues with a focus on established bridge-building materials and types used during the subject period, as well as new materials, types, and technological advances that were introduced. Advances in bridge engineering in the early-to-mid twentieth century were largely focused on developing economical bridge types. This section also addresses bridge aesthetics and an overview of the bridge engineers, designers, and fabricators that worked in Louisiana during the subject period.
- Finally, *Section 4: Next Steps* describes how the findings of the context will be used to identify relationships between Louisiana bridges and significant historical themes as the project progresses.

Important themes described in the historic context report support the identification of historically significant bridges in a subsequent phase of the project. Specifically, major components of the state's Historic Bridge Inventory project will build upon the foundation the historic context report provides. These subsequent steps included recommendations as to which bridges are and are not eligible for listing in the National Register, and identification of historic bridges that are and are not suitable candidates for preservation.

1. Project Background

The Historic Bridge Inventory is being completed by the LADOTD to manage and preserve Louisiana’s historic bridges as part of the environmental review process, in particular Section 106 of the National Historic Preservation Act (Section 106) in cooperation with the Federal Highway Administration (FHWA) and the State Historic Preservation Office (SHPO) within the Louisiana Office of Cultural Development, Division of Historic Preservation. The current project will evaluate the historical significance of approximately 5,400 structures across the state of Louisiana, built through 1970, referred to in the report as the bridge pool.¹ This comprehensive identification of significant bridges will allow the LADOTD to make informed and timely reviews of proposed projects to identify historic properties and determine effects.

A. Research design and methods

This first step of the inventory project, now completed and presented in this report, involved conducting research and developing historic contexts relevant to Louisiana bridge design and construction. This historic context is intended to provide a solid foundation for understanding significant themes relevant to Louisiana bridges constructed through 1970. Since the Louisiana SHPO recently contracted for the development of a statewide transportation context through 1965, trends and themes related to road development in this period are not fully addressed in this context. See *Transportation in Louisiana: Historic Context* (R. Christopher Goodwin & Associates, Inc., May 2012) for limited information about the state’s early roads.

For the purpose of this context report, 13 routes established through local and state efforts were identified as reflecting the evolution of the state’s road system over the early decades of the twentieth century. The first important vehicular routes included the River Road, developed along the Mississippi River, and early named highways that were a direct result of the Good Roads Movement, such as the Jefferson Highway, Old Spanish Trail, and Dixie Overland Highway. From the late 1910s through the 1930s the LHC assumed responsibility for, designated, and established state routes, and a portion of these were designated U.S. Highways as part of the national highway system. These routes are summarized in Table 1.

Table 1. Historic transportation routes

Historic Route	Current Route Name
River Road	River Road
Jefferson Highway	Portions of State Route (LA) 1 and U.S. Highway (US) 71
Old Spanish Trail	Portions of LA 182 and US 90
Dixie Overland Highway	Portions of LA 4 and US 80
LA 10	Portions of various state highways
US 11	US 11
US 51	US 51

¹ The project ending date of 1970 was chosen to include bridges that were 50 years or older and also so the study continues to have longevity as bridges newly become 50 years old.

Table 1. Historic transportation routes

Historic Route	Current Route Name
Airline Highway	Portions of US 61
Chef Menteur Highway	Portions of LA 2, LA 3052, and US 90
Lone Star Route	Portions of US 165
Pershing Highway	Portions of LA 26 and US 167
US 190	US 190
Beauregard Highway	Portions of US 171

Additional pertinent information regarding the state’s transportation history related to bridges is included in Section 2 of this context, especially covering the period from 1966 to 1970 that was not addressed in the SHPO’s statewide transportation context.

The context report provides a framework to understand the broad patterns and themes of transportation development and bridge design and construction in Louisiana. Several factors led to the decision to focus research at the state level. The foremost reason was the strong influence of the state. The LADOTD and its predecessors, the Louisiana State Highway Department, the Louisiana Highway Commission, and the Louisiana Department of Highways, exerted major influence over bridge design and construction beginning in 1911 and continuing throughout the subject period. In addition, the use of standardized plans, prepared by the agency, was commonplace. Additionally, the large number of bridges included in the inventory made it practical to focus research efforts at the state level.

Research included investigating primary and secondary sources at major repositories in Louisiana, and conducting interviews and consultation with experts on Louisiana bridge construction and design prior to 1971. Research materials were gathered from the following repositories and collections:

- LADOTD collections including standard plans and the bridge engineering library
- Louisiana SHPO
- State Library of Louisiana
- Louisiana State Archives
- Louisiana State University Library and Archives
- University of Wisconsin, Wendt Engineering Library (for national journals)

This research was supplemented with applicable online sources and historic contexts completed by other state departments of transportation. The scope of the inventory project did not include gathering research at Louisiana parishes or cities or investigating specific bridges. Outreach to local governments, preservation organizations, and members of the public with knowledge of bridges in their communities also served to uncover bridges with ties to local communities.

Key sources for the context report included the following:

- Annual reports of the LADOTD and its predecessors
- State and national engineering journals from the period
- Oral history interviews conducted with professional engineers having extensive experience with Louisiana bridge design and construction. The following engineers were interviewed:
 - Albert (Al) J. Dunn, PE, PLS
 - Chief Engineering Design and Contract Management, LADOTD (Retired)
 - LADOTD Highway Hall of Honor, inducted 2011
 - Gill M. Gautreau, PE
 - Bridge Maintenance Engineer, LADOTD (Retired)
 - Hossein Ghara, PE, MBA
 - Bridge Design Engineer Administrator, LADOTD
 - David Huval, Sr., PE
 - President, Huval & Associates, Inc., a consulting engineering firm
 - Former Bridge Design Engineer, LADOTD
 - James C. Porter, PE
 - Planning Support Engineer, LADOTD
 - Donald F. Sorgenfrei, PE
 - Senior Vice President, Modjeski & Masters Engineers, New Orleans Office
- National Register nominations, determinations of eligibility, and Historic American Engineering Report (HAER) documentation for individual bridges
- The LADOTD's Master Structure File (MSF) and the FHWA's National Bridge Inventory (NBI) bridge databases that contain decades of inspection findings for individual bridges

These and other sources consulted are provided in the Bibliography of this report.

The inventory project includes bridges constructed through 1970 as identified in two related databases: LADOTD's MSF and FHWA's NBI. Culverts (structures less than 20 feet) are not in these databases and are therefore not included in the project; however, structures of the culvert structural type 20 feet or longer are included. The statistics for bridge population and prevalence of use within the historic context are for the state's entire pre-1971 bridge population. Railroad bridges, privately owned bridges, and

bridges located on Interstate highways will not be included in the inventory project.² As such, the context report does not address non-roadway and private structures.

The Analysis of Bridge Types (see Table 8 in Section 3.D.) was derived from the LADOTD's MSF and the FHWA's NBI. Mead & Hunt combined this data and analyzed the data to identify general characteristics of bridges built through 1971. Through this analysis, Mead & Hunt identified that there may be certain errors in assignment of bridge types and dates of construction that are expected to be resolved as the project progresses. During the course of the inventory project, the total number of bridges and their classification by type may increase or decrease based on newly identified information. In this historic context report, examples of specific bridges are given to illuminate relevant themes; the status of these bridges (i.e., extant or demolished) will be confirmed during future project tasks. This report should be considered a work-in-progress that informs the overall project but does not provide definitive conclusions.

B. Purpose

The driving force behind the statewide bridge inventory is the LADOTD and FHWA's need to comply with major federal preservation laws and regulations that affect the management of historic bridges. As a result, the focus of the context is on vehicular bridges that are included in the LADOTD and FHWA's bridge inventories. These laws and regulations include the National Historic Preservation Act (NHPA) of 1966 and the U.S. Department of Transportation Act of 1966. Results of the statewide historic bridge inventory will facilitate LADOTD and FHWA compliance with federal requirements under Section 106 and Section 4(f) of the U.S. Department of Transportation Act of 1966 (Section 4(f)).

The NHPA of 1966 established a national policy for the protection of historic properties and archaeological sites, and outlined responsibilities for federal and state governments to preserve our nation's heritage. The NHPA created the National Register of Historic Places (National Register), which is an official list of sites, districts, buildings, structures, and objects of national, regional, or local significance. To qualify for the National Register, a property generally must be 50 years old, be associated with a significant theme, and retain the characteristics that make it a good representative of properties associated with the past. The National Park Service within the Department of the Interior is charged with maintaining the National Register. Historic bridges are among the structures listed in, or eligible for listing in, the National Register.

Historic bridges may be afforded protection under the Section 106 regulations that were developed to implement the NHPA. Section 106 requires federal agencies and owners seeking federal assistance to review actions that may affect a property listed in, or eligible for, the National Register. The process includes identifying historic properties, assessing the effect of proposed actions on historic properties, and developing agreements that specify measures to deal with any adverse effects. To comply with

² See final minutes of August 9, 2012, Historic Bridge Inventory committee meeting regarding exclusion of such bridges (final revised minutes dated September 11, 2012). Bridges carrying the interstate were previously evaluated pursuant to Section 6007 of the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU). As defined in Section 6007 of the bill, this includes "facilities in the right-of-way to those highways carrying the official Interstate System shield, including but not limited to the road bed, engineering features, bridges, tunnels, rest stops, interchanges, off ramps and on-ramps."

Section 1 Project Background

Section 106, appropriate consultation among the federal agency, the SHPO, Native American tribes, the public, and other interested parties is required. The Advisory Council on Historic Preservation (ACHP), an independent federal agency in the executive branch, oversees the Section 106 review process.

Section 4(f) provides additional protection to historic bridges, and applies to undertakings that require the “use” of a historic property, including a bridge.³ A historic property is defined as any property listed in, or eligible for listing in, the National Register, or a historic property that is locally designated or recognized. In relation to bridges, a “use” is defined as the replacement or the rehabilitation of a bridge that impairs the historic integrity of the structure. The federal agency must ensure that the provisions of Section 4(f) are met before approving a federally funded project. Projects, including appropriate rehabilitation, that do not impair the historic integrity of a bridge are not subject to Section 4(f).

To support the broader purpose of regulatory compliance for historic bridges, the agencies need to have clear information on which bridges are historic and which are not. This report supports that purpose by defining the relevant historic contexts that will be used to identify significant bridges. Specifically, the historic context report identifies the themes expected to relate to the significance of bridges constructed in Louisiana through 1970. These themes served as a starting point for the development of National Register evaluation criteria specific to Louisiana’s bridges, which was the next stage of the inventory project. Based on the scope of research conducted to complete the context report, National Register criteria are expected to focus on the state level, but will also accommodate significant local trends and developments identified through bridge-specific research. These criteria are used to evaluate and document how bridges may qualify as eligible for listing in the National Register.

³ Section 4(f) of the U.S. Department of Transportation Act of 1966 was set forth in Title 49 United States Code (U.S.C.) Section 1653(f). A similar provision was added to Title 23 U.S.C. Section 138, which applies only to the Federal-Aid Highway Program.

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2. Bridge-related Legislation, Policies, and Practice

The following section provides a chronological history of bridge construction in Louisiana, focusing on the role of funding from the federal government, the establishment and accomplishments of a state-level agency to direct road and bridge construction, and how bridges became a critical link in the state's transportation system during the twentieth century. Significant events and individuals that influenced bridge building are described, including the Good Roads Movement, Governor Huey Long, the Depression, and post-World War II road and bridge building. This section focuses on the National Register theme of Transportation to assist in future evaluations of the subject bridges.

Inclusion of a bridge in this section is as a reference to inform subsequent project steps, but does not necessarily indicate significance under National Register Criteria. Instead, the bridge is provided as an example to aid in understanding historical themes and associations within Louisiana's bridge-building history.

Timeline of events

- *1803: Louisiana Purchase*
- *1812: Louisiana statehood*
- *1860-65: US Civil War*
- *1850s-90s: Railroad era*
- *1896: Rural Free Delivery Service established*
- *By 1900 Good Roads Movement had begun*
- *1909: National Good Roads Association meeting in New Orleans*
- *1910: State Highway Department and Board of State Engineers created*
- *1910s: early transcontinental highways established*
- *1916: Federal-Aid Highway Act of 1916*
- *1917-18: American involvement in World War I*
- *1921: Federal-Aid Highway Act of 1921*
- *1921: New State Constitution*
- *1921: Louisiana Highway Commission created*
- *1927: Great Mississippi Flood*
- *1928: Huey Long elected Governor*
- *1928: Reorganization of the LHC*
- *1928: State Constitution amended to allow the issue of construction bonds*
- *1929: Stock market crash and beginning of the Great Depression*
- *1930: \$75 million bond authorized for the construction of roads and bridges*
- *1933: Roosevelt Administration and the New Deal implemented*
- *1935: Assassination of Huey Long*
- *1935: Mississippi River Bridge at New Orleans completed*
- *1940: Mississippi River Bridge at Baton Rouge completed*
- *1940: Department of Highways reorganized*
- *1941-45: American involvement in World War II*

- 1944: *Federal Aid Highway Act of 1944*
- 1952: *Mississippi River Bridge Authority established to oversee financing, construction, and maintenance of the Crescent City Connection (Greater New Orleans Bridge)*
- 1956: *Federal Aid Highway Act of 1956*
- 1956: *Lake Pontchartrain Causeway completed*
- 1958: *Crescent City Connection (Greater New Orleans Bridge) completed*
- 1976: *Louisiana Department of Transportation and Development established*

A. Before the roads: Early water and railroad-based transportation

Bridge construction in Louisiana was limited until the twentieth century. With the exception of a few small railway bridges, water crossing was accomplished by boat or ferry. The state's earliest roads evolved from animal paths and settlement or Native American Indian trails, which generally followed rivers and connected to water routes. Instead of overland routes, much of the state's early transportation history was centered on water-based transportation. Since all of the large plantations and most of the farms were located on or very near navigable water, there was little need to develop a system of roads to aid in the transfer of goods. The main urban center in New Orleans was a major port, with its population concentrated in a small defined area. The arduous nature of land-based transportation of goods and people, and the lack of technology capable of reducing these difficulties, made water-based transportation the method of choice during the region's early years. However, as the timber industry grew and immigration to the state increased, railroads were increasingly turned to as an alternative transportation method.⁴

Like most states, Louisiana had few rail lines until the 1850s, when three major corporations began large-scale construction of rail lines running from New Orleans to Canton, Mississippi; New Orleans to Morgan City; and from the river landing opposite Vicksburg, Mississippi, to Monroe, Shreveport, and the Texas border.⁵ The Civil War saw the budding railroad system in the state almost completely destroyed, and little progress was made to replace the lines until the 1880s. By the late nineteenth century, railroads crisscrossed and connected the state. The railroads built structures for this new system of tracks, including a few notable, large railroad bridges. However, building a railroad bridge across the Mississippi River or the state's other large rivers was not technically feasible until well into the twentieth century due to the challenge of poor, sandy soil conditions and the length and strength of the span that would be required. The railroad bridges constructed comprise some of the state's earliest bridges, and their construction served as the predecessor of vehicular bridges.

The development of the railroads in the nineteenth century and their need for bridges encouraged the growth of the civil engineering profession in the country and the state. Earlier, in 1852 the American Society of Civil Engineers (ASCE) was founded and the scientific approach of engineers became increasingly

⁴ R. Christopher Goodwin & Associates, *Transportation in Louisiana: Final Report*, prepared for the Office of Cultural Development Department of Culture, Recreation, & Tourism (2012), 26, 46.

⁵ R. Christopher Goodwin & Associates, *Transportation in Louisiana: Final Report*, 50.

valued during the late nineteenth century.⁶ The complexity and scale of projects and the demands and experience of wartime railroad and infrastructure building during the Civil War allowed bridge engineering to distinguish itself as a profession. Nationally, engineers designed enormous steel truss and suspension bridges for long spans in the late nineteenth century for both railway and vehicular traffic. From this legacy, engineers would become instrumental in setting up the federal and state organizations for the design, building, and maintenance of infrastructure, roads, and bridges in the early twentieth century.

B. Influence of the Good Roads Movement

With the dominance of water and rail transportation, the few improved roads throughout Louisiana in the nineteenth century aided settlement and agricultural production or served industrial purposes. Farmers who drove animals and hauled crops by wagon along the road were the most frequent users of farm-to-market roads on a parish scale. However, no statewide road system existed, and these market roads often led only from a town out into the surrounding countryside. In the absence of an adequate number of improved public roads, private ventures were chartered to construct toll roads and ferries.

Although the construction of modern roads and highways is often associated with the development of automobile travel, the earliest promoters of good roads were bicyclists in the 1880s and 1890s. The bicycling craze struck many of the nation's citizens, but they soon realized that a severe lack of passable thoroughfares limited their ability to take full advantage of this new sport. These citizens' push for improved roads was also moved along by the federal government's establishment of Rural Free Delivery mail service in 1896. Since a mail route had to be passable in all weather, the designation of a road as a mail route became a reason for funding improved surfaces.⁷

Gathering strength with automobile interests by 1900, the Good Roads Movement led to the formation of new organizations, including the American Automobile Association in 1902 and the American Association for Highway Improvement in 1910.⁸ The introduction of the automobile and the rapid expansion of its use both ended the bicycle era and inaugurated a long-term effort to enlarge and improve the country's highway system. By the early twentieth century, road improvement was recognized as more than just a local problem.

The Good Roads Movement had supporters in Louisiana; in 1909 the Louisiana Good Roads Convention featured an address by Governor Jared Sanders. Sanders highlighted the construction of the Baton Rouge-New Orleans Road (later the Airline Highway) to be completed in 1910, mentioning that through taxes parishes would build and maintain the road. Sanders also stated it was beginning the age of Good Roads in Louisiana.⁹

⁶ American Society of Civil Engineers, "About ASCE," <http://www.asce.org/About-ASCE/> (accessed 17 September 2012).

⁷ Bruce Seely, *Building the American Highway System: Engineers as Policy Makers* (Philadelphia: Temple University Press, 1987), 15.

⁸ Laurence I. Hewes and Clarkson H. Oglesby, *Highway Engineering* (New York: John Wiley & Sons, Inc., 1954), 3.

⁹ Coastal Environments, Inc., "Determination of Eligibility for the Bayou Boeuf Bridge Route LA 1177," prepared for the Louisiana Department of Transportation and Development (August 2011), n.p.

National and state interest groups worked to designate, promote, and improve a network of highways. On a national scale, farmers, bicyclists, automobile owners, local commercial clubs, business associations, automobile clubs, and merchants often contributed labor and funds to bring major roads through their towns and improve local roads. The limited federal effort focused on rural farm-to-market roads that met the needs of farmers, under the belief that interstate transportation needs would continue to be served by the railroads. The alternative vision of an automobile-dominated transportation system involving major, paved, continental highways was not fully shared by federal administrators, despite their own engineers' understanding of the need for improved roads for automobiles.¹⁰

C. Early government involvement in roads and bridges

The influence of the Good Roads Movement and a progressive push towards modernization in the U.S. can be seen in the development of transcontinental highways and increased government role in road and bridge construction that followed.¹¹ Road and bridge improvement efforts continued in the 1910s and 1920s as the state began to benefit from increased federal funding and support for transportation. The state's highway mileage reached 4,158 miles by 1928, accommodating that state's population growth from nearly 1.4 million in 1900 to 2.1 million by 1930.¹²

(1) State Highway Department and early efforts

As early as 1909 the state began a road construction initiative under Governor Sanders. This initiative included the extension of state aid to parishes for "systematic" road construction and led to the creation of the State Highway Department (predecessor to the Louisiana Highway Commission and Louisiana Department of Highways) and Board of State Engineers.¹³ Both were created by Act 49, which was approved in 1910. Enabling legislation under Act 14 provided revenue for their organization and operation. Among its duties, the State Highway Department was authorized to:

- Assume control of State Highways
- Elect a State Highway Engineer
- Authorize construction and maintenance of highways by contract or internally
- Define a State Highway
- Provide revenue for carrying out the objectives and purposes of the act

¹⁰ James Cooper, *Artistry and Ingenuity in Artificial Stone: Indiana's Concrete Bridges, 1900-1942* (N.p.: James L. Cooper, 1997), 110-111.

¹¹ Seely, 7.

¹² U.S. Census Bureau, "Resident Population," <http://www.census.gov/dmd/www/resapport/states/louisiana.pdf> (accessed 17 September 2012); Louisiana Highway Commission, Fourth Biennial Report, 1926-1928, 13.

¹³ Louisiana State Highway Department, Report of the State Highway Engineer, 1916-1918, 7. Note: The full names and publication information of annual and biennial reports of the Louisiana State Highway Department, Louisiana Highway Commission, and Louisiana Department of Highways have been shortened in the footnotes, with the appropriate agency and year(s) provided for each report. Full citation information for these sources can be found in the bibliography.

Section 2
Bridge-related Legislation,
Policies, and Practice

- Require parishes, cities, towns and villages to contribute a certain proportion of the cost of construction and maintenance of highways¹⁴

The interest in the creation of the State Highway Department was attributed to the Good Roads Movement by the State Highway Engineer, W.E. Atkinson.¹⁵ An early Louisiana State Highway Department's biennial report covering 1916 through 1918 described that the main duty of the State Highway Department was to "furnish plans, estimates and specifications for the construction of roads, bridges and culverts."¹⁶ Charged with improving the state's roads and bridges, the new department also focused on adopting a system of state highways that would tie the haphazard and disconnected parish roads and plans together. The State Highway Department's biennial report cites that the new system "was favorably received by Parishes contemplating the construction of State Aid Highways." It goes on to state that the State Highway Department endeavored to have State Aid highways maintained by the parish police juries in which the highways were constructed, but was not generally successful as the local authorities could not be depended upon to maintain the State's highways after construction.¹⁷ Police juries were provided an opportunity to participate in the apportionment of state aid funds for improvements, although early funding was limited.¹⁸ Other early efforts of the State Highway Department included the promotion of concrete bridges and culverts to replace wood structures due to their "permanence and economy" as compared to timber bridges that require a large maintenance expense for upkeep.¹⁹

By 1913 the State Highway Department outlined Louisiana's first state route system, which encompassed approximately 5,000 miles of main line roads that connected several parish seats and major trade centers. Funding for the state's early highway development programs was limited and financed through property taxes and surpluses from state commissions that licensed harvesting and/or hunting. In 1914 the state imposed a motor vehicle tax that directed funds to the parishes for use in making road improvements.

Throughout the first decade of the State Highway Department, from 1911 to 1921, the parish police juries primarily initiated road construction through petition to the state. The highway department and highway commission's role was to give aid and advice to parishes, approve proposed location of work, and recommend standards and specifications to use. The State Highway Department could also refuse financial aid if the project location was undesirable. The process of parish police jury-initiated road development came to a close with the passage of the Federal Aid Act of 1921, which required all state

¹⁴ Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914, 80-81.

¹⁵ Louisiana State Highway Department, Report of Board of State Engineers, 1914-1916, 81.

¹⁶ Louisiana State Highway Department, Report of the State Highway Engineer, 1916-1918, 8.

¹⁷ Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914, 84-85.

¹⁸ Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914, 96.

¹⁹ Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914, 83.

highway departments be responsible for maintenance and growth of the state's highway system.²⁰ With the passage of this act, the motor vehicle tax was allocated to the state's highway fund for road construction and maintenance.²¹

(2) Transcontinental highways

The initiation of the named transcontinental highways prior to World War I represented the “most successful private roads campaign” of the Good Roads Movement.²² From the earliest years of automobile travel, it had become increasingly clear that dirt, gravel, and stone-surfaced roads were inappropriate. Nationally known road promoter Carl Fisher encouraged new hard-surfaced transcontinental highways, such as the Lincoln and Dixie Highways, as ideal ways to demonstrate the effectiveness of new paving, engineering, and signage. Although roads existed across the U.S. before this time, there were no formally designated or direct transportation routes, and the majority of the roads were not paved.²³

Early transcontinental highways that crossed through Louisiana included the auto trail Dixie Overland Highway, which transects the state from east to west along its northern edge, connecting Savannah, Georgia, with San Diego, California; and the Old Spanish Trail, which crosses the state in a similar route along the southern coast, connecting St. Augustine, Florida, with San Diego, California. Another early road being promoted was the Jefferson Highway, which enters the state in the north and roughly follows the Mississippi River to New Orleans, connecting New Orleans to Winnipeg, Canada. These highway corridors, established from 1914 to 1919, served as the inspiration for future routes in the state and were later integrated into the U.S. Highway System when it was first designated by the federal government in 1925.²⁴ In the wake of the Good Roads Movement, states including Louisiana moved away from local, disparate road-building towards increased centralization and professionalization of road and bridge commissioning and construction.

(3) Early federal aid to roads

Nationally, public demands for action were answered in the Federal-Aid Road Act of 1916. By this time the number of automobile registrations in the country had reached 2.3 million and the auto industry and motorists were heavily lobbying for programs and funds to improve roads.²⁵ This was true in Louisiana, where motor vehicle registration was nearing 70,000 (up from 8,000 in 1910), creating a demand for

²⁰ “A Review of the History of Highways in Louisiana,” n.p., in *Vol. 1: Everything You Ever Wanted to Know about Roads and Bridges in Louisiana* (possession of Huval and Associates).

²¹ “A Review of the History of Highways in Louisiana,” n.p.

²² National Park Service, *Lincoln Highway: Special Resource Study, Environmental Assessment* ([Washington, D.C.]: National Park Service, 2004), 32.

²³ Drake Hokanson, *The Lincoln Highway: Main Street Across America* (Iowa City, Iowa: University of Iowa Press, 1988), 5.

²⁴ Louisiana Highway Commission, Third Biennial Report, 1924-1926, 159.

²⁵ Louisiana State Highway Department, Report of the Board of State Engineers, 1916-1918, 19.

better roads in the state.²⁶ The Act marked the first time the federal government was directly involved in road building efforts, with the intention of improving and modernizing transportation across the country by setting aside \$75 million for the construction and improvement of highways and rural roads through the Department of Agriculture. Approximately \$5 million was appropriated the first year, with the funding escalating in annual steps to \$25 million by 1921. Under the provisions, Louisiana was to receive just over \$1 million in federal funds for fiscal years 1917-1921.²⁷ In order to obtain federal funds and participate in the program, a state had to:

- Maintain a state highway department to administer the Act
- Assume responsibility of all roads on which federal funds were spent
- Classify mileage in eligible systems based on traffic needs and services rendered
- Agree to uniform standards of construction and design
- Match federal funds under mutually acceptable standards

At the federal level, the Office of Public Roads of the U.S. Department of Agriculture (USDA), soon to be renamed the Bureau of Public Roads (BPR), was charged with assisting with the disbursement of funds and supporting states in their planning and design efforts (see the sidebar titled National Organizations and Their Missions below for more information on this agency's mission). Following the passage of the Federal-Aid Act of 1916, the State Highway Department, in cooperation with the Office of Public Roads, developed new specifications for construction that followed the requirements of the federal government for federal-aid road construction.²⁸

Following World War I, federal funding for highway construction was continued by Congress with the passage of the Federal Highway Act of 1921. This Act called for each state to designate seven percent of its roads to be part of the federal-aid system, creating a genuine national highway system. It also required that each state, not its component counties (or parishes), be responsible for maintenance of these roads, a move intended to further strengthen the state highway departments.²⁹ Federal funding for roads designated as part of the federal-aid system was to be matched by the state on a 50/50 basis.³⁰ Provisions of the Federal Highway Act of 1921 kept the BPR in control of setting highway and bridge design standards.³¹

²⁶ "A Review of the History of Highways in Louisiana," n.p.

²⁷ Louisiana State Highway Department, Report of the Board of State Engineers, 1916-1918, 19.

²⁸ Louisiana State Highway Department, Report of the Board of State Engineers, 1916-1918, 27.

²⁹ Seely, 62

³⁰ Louisiana Highway Commission, Biennial Report, 1922-24, 51.

³¹ Cooper, 113.

National organizations and their missions

Two national organizations, the BPR and the American Association of State Highway Officials (AASHO), influenced state highway and bridge development by serving as a model of professional planning and a scientific approach to bridge design. The BPR and AASHO were instrumental in setting federal transportation policy and disseminating information regarding new materials and technology, standard bridge designs, and best practices to state departments of transportation.

The BPR (and its predecessors, housed originally within the USDA), put research at the forefront, which was viewed as fundamental to good highway and bridge design. To disseminate research, the BPR began the monthly publication *Public Roads—A Journal of Highway Research* in 1918, which continues to be published today by the FHWA.³² During the 1920s to 1940s BPR officials focused on cooperative research by associating their efforts with the National Research Council and its Advisory Board for Highway Research (later Highway Research Board - HRB), and AASHO. Moreover, state highway department testing facilities and laboratories (which the BPR was responsible for) and engineering colleges became research partners with the HRB.³³

Chronology of national highway agencies

At the federal level, road and transportation agencies underwent several name changes and reorganizations during the twentieth century.³⁴

1905-1915	Office of Public Roads ³⁵
1915-1918	Office of Public Roads and Rural Engineering
1918-1939	Bureau of Public Roads
1939-1949	Public Roads Administration
1949-1967	Bureau of Public Roads
1967-present	Federal Highway Administration

AASHO, the predecessor to the American Association of State Highway and Transportation Officials (AASHTO), also promoted professional planning and national standards intended to be adopted by state highway departments. As the professional organization of state highway officials, AASHO (and later AASHTO) has a long history of defining and disseminating standard practices for road and bridge engineering. State highway officials from Maryland, Virginia, and North Carolina established this national professional organization in 1914 to facilitate discussion of issues related to road construction, including legislation, economics, and design. Discouraged with the rural road focus of other federal efforts of the period, AASHO leaders identified the federal road network and a federal roads bill as their first priority. During the inaugural AASHO convention in 1915, members ratified a revised federal roads bill, which was then introduced to Congress by Senator J.H. Bankhead and passed as the Federal-Aid Highway Act of 1916.³⁶

³² Cooper, 114.

³³ Seely, 109-114.

³⁴ Federal Highway Administration, "Names of the Nation's Highway Agency-1893 to the Present," *FHWA By Day*, www.fhwa.dot.gov/byday/acronyms.htm (accessed 17 September 2012).

³⁵ Pre-1905 predecessors are not addressed since they are not relevant to the Louisiana context.

³⁶ Seely, 41-43.

As early as 1921, AASHO formed a subcommittee on bridges and structures with the mission of establishing uniform methods in support of standardized construction, in cooperation with states.³⁷ The policies, research results, and specifications developed and promoted by AASHO and the BPR influenced state bridge programs, including Louisiana's, throughout the twentieth century. The influential role of these organizations in developing and disseminating standard plans is addressed within an associated sidebar in Section 3.D, Bridge Types.

(4) Emergence of the Louisiana Highway Commission

The new State Constitution, ratified in 1921, required the State Legislature to provide for the building of bridges over navigable streams using current revenues. That same year, Act 95 created the Louisiana Highway Commission (LHC), replacing the earlier State Highway Department. The report of the State Highway Engineer, contained in the 1922-1924 biennial report, outlines the new organization and its efficiencies in the separation of responsibilities into the following units:

- Construction Department responsible for highways, bridges (surveying with the Bridge Department as a component), and construction
- Maintenance Department responsible for enforcement and upkeep
- Auditing Department responsible for estimates and finances
- Traffic Department responsible for the transportation of materials
- Equipment Department responsible for the distribution and inventories³⁸

The LHC recruited engineers from around the country to join the young agency. One prominent example was Norman E. Lant, an Indiana engineer who came to work for the commission as a bridge designer in 1922 and went on to serve the LHC (and its successor, the Louisiana Department of Highways) for three decades, overseeing the construction of many notable bridge designs in the state. His role is distinct in that he served through multiple periods of bridge design in Louisiana, but his example of a professional engineer drawn to the state is not uncommon (see discussion of engineers, builders and designers in Section 4.E).³⁹

The 1921 Act that had created the LHC also outlined 98 automobile highway routes in the state totaling 7,000 miles (see Figure 1), and charged the LHC to “locate, construct and maintain” which would inevitably involve the construction of bridges.⁴⁰ The state also, through this Act, authorized a tax from automobile

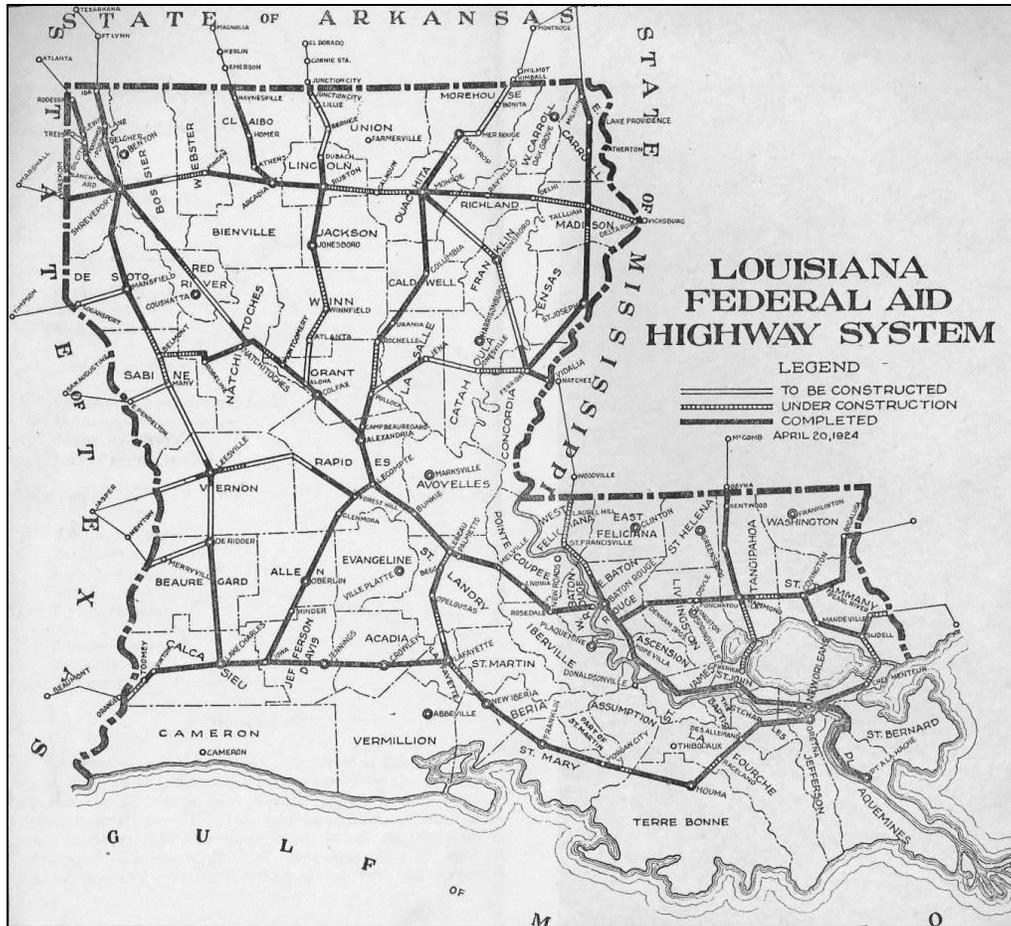
³⁷ A.E. Johnson, ed., *Published on the Occasion of the Golden Anniversary American Association of State Highway Officials: A Story of the Beginning, Purposes, Growth, Activities and Achievements of AASHO* (Washington, D.C.: American Association of State Highway Officials, 1965), 105.

³⁸ Louisiana Highway Commission, *Biennial Report, 1922-1924*, 17.

³⁹ Dawson Corley, “Remembering a Bridge Builder,” *Baton Rouge Sunday Advocate*, 11 May 1980; “Highway Hall of Honor Induction Set,” *Ruston Daily Leader* (Louisiana), 23 September 1974.

⁴⁰ Louisiana Highway Commission, *Biennial Report, 1922-1924*, 5.

licensing and gasoline sales to help provide additional revenue to the Commission. The gasoline tax was to be used for maintenance of roads, and the licensing tax for the purposes of construction.⁴¹



*Figure 1. Map of Louisiana Federal Aid Highway System, 1924
 (source: Louisiana Highway Commission, 1922-1924 Biennial Report).*

At this time, the state also took over maintenance responsibility of the state highways from the parishes.⁴² Formerly, the department's role was to give aid and advise on locally sponsored construction efforts. Under the new system these efforts were delegated to the LHC, though due consideration for all parish petitions of road improvements was required.⁴³ The first extensive biennial report of the LHC from 1922-1924 refers to the excellent results and success of the administration of federal aid in Louisiana, noting, "it is believed that Louisiana ranks first in the South in this respect."⁴⁴ Louisiana was successful in raising state revenue

⁴¹ Louisiana Highway Commission, Biennial Report, 1922-1924, 59, 62.

⁴² Louisiana Highway Commission, Biennial Report, 1922-1924, 7.

⁴³ "A Review of the History of Highways in Louisiana," n.p.

⁴⁴ Louisiana Highway Commission, Biennial Report, 1922-1924, 15.

to match the federal aid funding, receiving \$6.2 million from 1916 to 1924.⁴⁵ By 1924, 2,681 miles of the 2,800 miles in the state's Federal Aid System (a portion of the total state highway miles) have been approved by the federal government.⁴⁶

(a) Design role of Bridge Department

The LHC's Bridge Department originally operated within the agency's construction division. After the initial hiring of Lant in 1922, the department's staffing grew through the 1920s. The 1924-1926 biennial report noted that both office and field personnel had increased to be able to "handle all features of the engineering work involved, i.e. surveys, designs, details, specifications and field supervision."⁴⁷ Projects with only bridges were handled by the Bridge Department and those with both roads and bridges were completed by the office engineer with assistance from the bridge engineer.⁴⁸

As the BPR proceeded to create design standards at the national level (see sidebar in Section 3.D), the LHC did the same with Louisiana standard plans developed to assist in bridge design. During the early 1920s the Bridge Department prepared a large number of standard plans for timber, steel, and concrete structures, but also designed special plans for specific projects.⁴⁹

The Bridge Department designed and built a number of notable bridges in this decade, among the largest of which were the Mermentau River Bridge, East and West Pearl River Bridges, and the Pass Manchac Bridge.⁵⁰ Despite these major efforts, the Bridge Department also stressed that much more difficult work lay ahead to construct significant bridge crossings considering the nature of Louisiana's environment and landscape.

The Mermentau River Bridge is especially important in the role the LHC played in its development and construction. Aiding in the final completion of the main trunk routes of the Jefferson Highway, Old Spanish Trail, and Dixie Overland Highway in 1924, the Mermentau River Bridge between Acadia and Jefferson Davis Parish was one of the largest undertakings in the state during the period and the first large bridge project by the Bridge Department. The project was not originally an in-house Bridge Department design, as a consulting engineer was contracted to complete the design. When the resulting consultant designs of swing-span and vertical lift combination were rejected, the Bridge Department took on the design process itself. The result was a successful fixed-span bridge completed under budget.⁵¹

⁴⁵ Louisiana Highway Commission, Biennial Report, 1922-1924, 103; John W. Scott, "Highway Building in Louisiana before Huey Long: an Overdue Re-Appraisal," *Louisiana History* 44, no. 1 (Winter, 2003), 7-8.

⁴⁶ Louisiana Highway Commission, Biennial Report, 1922-1924, 51.

⁴⁷ Louisiana Highway Commission, Third Biennial Report, 1924-1926, 142.

⁴⁸ Louisiana Highway Commission, Biennial Report, 1922-1924, 93.

⁴⁹ Louisiana Highway Commission, Biennial Report, 1922-1924, 93 and 95.

⁵⁰ The Mermentau River Bridge and Pass Manchac Bridge are both nonextant, while the East and West Pearl River Bridges are both extant.

⁵¹ Louisiana Highway Commission, Biennial Report, 1922-1924, 48.

This experience gave the LHC, and specifically the Bridge Department, confidence in its abilities and in the value of a centralized office able to conduct complex projects with its own forces.

Challenges faced by the Bridge Department in this era included keeping up maintenance and/or replacement of existing bridges, which became an economic concern as the LHC realized that the growing use of roads under increased automobile travel would result in a need for significant future investment. The issue of constant repairs was routinely featured in *Louisiana Highway Magazine*. The 1920s articles of this magazine highlight the need to replace existing timber bridges with more permanent structures, as well as the number of major bridges that required reconstruction in the period, from the Grand Ecore Bridge over the Red River to the Bayou Vermillion Bridge at Abbeville.⁵² In addition, the Bridge Department was working to comply with a mandate tied to federal aid to eliminate grade crossings for railways across the state.⁵³

In addition to routine maintenance and bridge replacement, the Bridge Department faced reconstruction of roads and bridges following major flooding in 1927, known as the “Great Mississippi Flood of 1927.” A number of state and parish bridges were destroyed or damaged to an extent they were unsafe for traffic. The Bridge Department used ferries and temporary bridges until a new permanent structure could be built. In some cases standardized concrete bridges were quickly erected, or the original bridge, which had washed away, would simply be returned to its original position and repaired.⁵⁴

(b) Local bridge construction

During the 1920s the LHC was responsible for much of the state’s bridges, including preparing plans and specifications and construction supervision as the state centralized control. According to the 1921 State Constitution, the state legislature was required to provide for the building of bridges over navigable streams from the General Highway Fund. However, the LHC notes in its 1924-1926 biennial report that it planned to propose an amendment to the constitution permitting parishes, road districts, or municipalities to participate in funding bridges over navigable streams in their jurisdiction at the next general election.⁵⁵ The successful amendment was passed by the state legislature in 1926, allowing parishes, municipalities, and road districts to contribute to the cost of bridges over navigable rivers and streams.⁵⁶

Parishes maintained some autonomy and control over local bridges and roads, with responsibility for their construction and maintenance. It is generally known that the state was allowing parishes to build roads and bridges with the understanding that the parishes would receive state aid after the fact.⁵⁷ A number of

⁵² *Louisiana Highway Magazine*, February 1925 to August 1928. Both bridges are nonextant.

⁵³ Louisiana Highway Commission, Biennial Report, 1922-1924, 56.

⁵⁴ Louisiana Highway Commission, Fourth Biennial Report, 1926-1928, 34-35.

⁵⁵ Louisiana Highway Commission, Third Biennial Report, 1924-1926, 26-27.

⁵⁶ “1926 Election Proclamation on Proposed Amendments to the Constitution,” *State Times Advocate*, 20 November 1926, 8.

⁵⁷ Miscellaneous *Proceedings of the Caddo Parish Police Jury* from 1928-1931, books on file, Archives and Special Collections, Noel Memorial Library, Louisiana State University Shreveport.

parish bridges on lateral roads connecting to state highways were damaged in the Flood of 1927, and in some cases state crews assisted with the repair and replacement of these structures.⁵⁸

D. Huey Long's era and the Great Depression

The governorship of Huey Pierce Long was transformational for Louisiana infrastructure. When Long began serving his term as the 40th governor of Louisiana on May 21, 1928, the Great Depression was in the future and the Flood of 1927 had the public's attention. Long had campaigned as a populist in a state regarded as undeveloped in infrastructure and other areas of public investment. "Every man a king" was Long's famous campaign slogan, emphasizing his goal of improving the lives of ordinary people. A major component of that goal was to improve roads for the state's citizens. Even today Louisianans recall that Long "got us out of the mud," paraphrasing a period appraisal of the governor's tremendous influence.

After Long assumed office, the LHC summarized the sorry state of Louisiana's roads, bridges, and finances in its 1928-1930 biennial report and attributed the deficiencies to the previous administration, concluding that "When this Commission was first established and assumed its duties it found the affairs inherited from the previous administration in a state of utter chaos." At the same time, the LHC touted all of the promise of the Long administration's plans. Under Long's administration, the LHC would be completely reorganized, enlarged, and strengthened to tackle "the severe task of beginning the largest highway construction program in the history of the State."⁵⁹

(1) Commission reorganization

The reorganization of the LHC, initiated immediately after Long took office in 1928, was considered fundamental to recovering from the mismanagement of previous administrations.⁶⁰ A \$30 million sale of state bonds was also quickly passed by the State Legislature as one of its first actions. This bond issue, which would fund new road and bridge projects while covering previous LHC obligations, was submitted to voters as a constitutional amendment. A standing provision, which had been put in place in the 1921 Constitution, required that road and bridge expenditures be financed only from current revenue. This restriction dramatically limited state transportation funding and forced reliance on Federal aid. This ceased to be the case after 1928.⁶¹ State bond issues constituted Long's strategy for funding his ambitious road and bridge infrastructure program. The bonds were backed by revenue collected by the state from gasoline taxes, which was also doubled to two cents per gallon at this time. A state advisory board was created with the explicit purpose of arranging bond issues, quickly adding millions of new dollars to the state's coffers for roads and bridges.⁶²

⁵⁸ Louisiana Highway Commission, Fourth Biennial Report, 1926-1928, 35.

⁵⁹ Louisiana Highway Commission, Fifth Biennial Report, 1928- 1930, 9-19.

⁶⁰ Louisiana Highway Commission, Fifth Biennial Report, 1928- 1930, 9.

⁶¹ Hair, William Ivy, *The Kingfish and His Realm: The Life and Times of Huey P. Long* (Baton Rouge, La.: Louisiana State University Press, 1991), 162.

⁶² Louisiana Highway Commission, Seventh Biennial Report, 1932-1934, 5-6. See Act 219, 1928, approved as a constitutional amendment, which authorized bonding of anticipated revenues from one cent of the state's two-cent gasoline tax; Act 6 of the 1928 E.S., approved as a constitutional amendment, then increased the state gasoline tax to four cents per gallon. From "Legislation: A Partial List of Statutes Pertinent to the Development of Louisiana

Thanks to the added funds, the LHC entered a period of rapid growth and building across Louisiana. Bridge construction during this period would not be matched until the late 1950s. A program to fill in the gaps of the fledgling state highway system was adopted along with long-term goals of crossing major rivers. The programs became increasingly popular with the public because they created many jobs and visible progress as the Depression began in 1929.⁶³

By the mid-1930s, 15 major bridge projects were underway across Louisiana, including the Mississippi River Bridge at New Orleans; the Atchafalaya River bridges at Morgan City (also called the Long-Allen Bridge) and Krotz Springs; the Red River bridges at Shreveport, Coushatta, Moncla, and Alexandria; the Ouachita River bridges at Monroe, Harrisonburg, and Sterlington; and the Caminada Bay Bridge.⁶⁴ The LHC also undertook an effort to eliminate all ferry crossings and upgrade US 90 (Old Spanish Trail). The highway was an integral part of the Rigolets-Pearlington shortcut between Louisiana and the Mississippi Gulf Coast. The 1933 US 90 Bridge over the East Pearl River provided the final link in this 22-mile shortcut.⁶⁵ While some in the state took issue with Long's methods and near-dictatorial powers, most conceded that the infrastructure results were impressive. One of Long's severest critics and rivals, newspaper reporter and author Harnett Kane, conceded in retrospect that Long "...took Louisiana out of the mud,"⁶⁶ thus coining the famous phrase.

Initiatives implemented by the LHC included those driven by Long's desire to ease the burden on the public, including the replacement of toll bridges where possible. Where bridges could not be built, toll-free ferries were.⁶⁷ Under the Long administration, the LHC expanded staff through the recruitment of young and talented engineers from around the country to meet its goals. Harry Henderlite, who would go on to serve as chief engineer and the State Highway Engineer from 1929 to 1947, was approached directly by Long to work for the LHC (see Section 3.E for more on Henderlite).⁶⁸

During the period, bridge designs and construction projects were completed by the LHC's Bridge Department. The only exceptions noted in the 1930-1932 biennial report were two bridges with movable spans that "could be more quickly handled by specialists in the field."⁶⁹ The Bridge Department worked to improve its standards and specifications at this time, observing that "higher type construction of highways

Highways, in *Compilation of Highway Acts 1921-1955 Passed by the Legislature of the State of Louisiana* (N.p., n.d.), n.p.

⁶³ Hair, 192.

⁶⁴ Louisiana Highway Commission, Sixth Biennial Report, 1930-1932, 16. Of these bridges only the Ouachita River Bridges at Monroe and Harrisonburg, the Atchafalaya River Bridge at Morgan City, and the Mississippi River Bridge at New Orleans are extant. The status of the Coushatta Bridge is unknown.

⁶⁵ Recall No. 058750 (extant).

⁶⁶ Hair, 227.

⁶⁷ Louisiana Highway Commission, Fifth Biennial Report, 1928-1930, 39, 245.

⁶⁸ "Highway Hall of Honor Induction Set," 3.

⁶⁹ Louisiana Highway Commission, Sixth Biennial Report, 1930-1932, 363.

has obviously made it necessary to raise correspondingly the specifications for their corollaries, highway bridges.” Pre-1929 bridge standards were replaced with new standards incorporating “heavier design and wider roadways.”⁷⁰

(a) The Long administration’s methods

The emphasis on infrastructure and road building by Long, with support from LHC Chairman O.K. Allen, had a political dimension. *Louisiana Highway Magazine* was used by the LHC to promote and encourage support for the great benefits and necessities of bridge and road building, while portraying opponents of the Long administration in a negative light. Many LHC project decisions were intended to strengthen political popularity, including extensive rural paving programs and toll-free ferries and bridges.⁷¹ There was also a certain amount of credit taken for projects planned and started by earlier administrations.⁷² Several examples of the expedient practices of the Long administration can be found in a case of eight bridges (including the large Ouachita River Bridge at Sterlington⁷³) designed and built by the Nashville Bridge Company. Originally intended to go through the regular process in the LHC, the specific bond issue for the bridges failed to pass, so Long personally went to a private contractor and paid a lump sum of \$6 million, raised through an earlier bond issue, to build the eight bridges.⁷⁴

In 1930 Long backed an amendment to the State Constitution to allow for \$75 million in bonds for road and bridge construction. It passed, along with a doubling of the state gasoline tax to four cents per gallon to support the bond issue.⁷⁵ This solidified his political strength and popularity in the state and led to many more bridge and infrastructure projects. In 1930 Long was elected to the U.S. Senate for a term that was intended to begin in March 1931. Deciding that he was more effective continuing as Louisiana’s governor, he chose to stay until January 25, 1932, when he resigned to begin his Senate term.⁷⁶ At the federal level he continued to advocate for funds for infrastructure projects in the state. After his assassination by the relative of a political opponent in 1935, Long’s legacy was continued in its two major forms: politics and infrastructure. Political factions highlighted during Long’s tenure continued to battle, with the two sides (the pro-Longs and anti-Longs representing those for and against his ideas) seesawing back and forth depending on which was in power for the next several decades.⁷⁷ Meanwhile the system

⁷⁰ Louisiana Highway Commission, Sixth Biennial Report, 1930-1932, 364.

⁷¹ Louisiana Highway Commission, Sixth Biennial Report, 1930-1932, 373.

⁷² Scott, 5-38.

⁷³ Nonextant.

⁷⁴ Originally discussed in T. Harry Williams, *Huey Long* (New York: Knopf, 1969), 441-444, and cited in Earth Search, Inc., “Intensive Cultural Resources Survey: Ouachita River Bridge, Sterlington, Ouachita and Union Parishes, Louisiana,” Final Report, February 1997, Prepared for Louisiana Department of Transportation and Development (LADOTD Project No. 700-37-0002), 8-1.

⁷⁵ Hair, 207.

⁷⁶ “Huey Pierce Long (1893-1935),” Biographical Directory of the United States Congress, 1774-Present, <http://bioguide.congress.gov/scripts/biodisplay.pl?index=L000418> (accessed 24 September 2012).

⁷⁷ “Huey Long’s Legacy – A New Louisiana,” *Huey Long: The Man, His Mission, and Legacy*, <http://www.hueylong.com/legacy/new-louisiana.php> (accessed 15 September 2012).

of highways and bridges that Long pushed through became the backbone of the Louisiana's modern highway system.⁷⁸

(2) New Deal and Federal Relief Programs

Although the Depression had not yet begun when Long became governor, his populist-inspired program to build roads and bridges proved to be a state-level solution to the coming economic crisis. Long promoted infrastructure spending to build roads and bridges, but it also created many jobs that were needed after the economic crisis precipitated by the stock market crash on October 29, 1929. A similar effort came later in the form of New Deal federal relief programs initiated by President Franklin Roosevelt.

Highways became a focus, and a direct financial beneficiary, of federal efforts to combat unemployment and provide emergency relief during the New Deal. FDR's New Deal has been synonymous with the infusion of federal power and money into the national economy. While some spending was made directly by federal agencies, other highway dollars were passed through the states, which had to provide matching funds. The depressed economy made this match difficult for states like Louisiana. Cities and parishes had a particularly difficult time throughout the 1930s, and their funding levels by the end of the decade remained below that of 1929. Nevertheless, federal highway funding overall was so powerful that almost no other area of the economy recovered so quickly. Between 1930 and 1940, surfaced highways in America doubled from 694,000 miles to 1,367,000 miles.⁷⁹ Important New Deal agencies that funded road and bridge construction included:

- Civilian Conservation Corps (CCC) – Created in March 1933 at the outset of the Roosevelt administration, the CCC was designed to provide jobs for men between the ages of 17 and 24 whose families were already on relief. It soon added veterans of the Spanish American War and World War I, without age restrictions. The CCC was organized into work camps for construction projects, including roads and bridges, usually administered by another agency.⁸⁰
- Civil Works Administration (CWA) – A short-lived program that lasted only from November 1933 to March 1934, the CWA nevertheless was a successful program that worked entirely on the federal level, employing workers directly rather than providing relief money. CWA workers constructed 250,000 miles of roads.⁸¹
- Federal Emergency Relief Administration (FERA) – Created by Congress in May 1933, FERA empowered Roosevelt to spend \$500 million in cash grants to state and city work-relief projects, providing one federal dollar for three local dollars.⁸²

⁷⁸ Davis, Edwin Adams. *Louisiana: A Narrative History, 3rd Edition* (Baton Rouge, La.: Claitor's Publishing, 1971), 352.

⁷⁹ James S. Olson, ed., *Historical Dictionary of the New Deal* (Westport, Conn.: Greenwood Press, 1985), 369.

⁸⁰ Olson, 85.

⁸¹ Olson, 83.

⁸² Olson, 177.

Section 2
Bridge-related Legislation,
Policies, and Practice

- National Industrial Recovery Act (NIRA) implemented by the National Recovery Administration (NRA) – Created in June 1933, the act served to regulate industries and establish a national public works program. The act was nullified by the U.S. Supreme Court in 1935.⁸³
- Public Works Administration (PWA) – Created soon after Roosevelt took office, the PWA distributed nearly \$6 billion for construction projects in the 1930s. In 1933 alone it accounted for one-third of all construction in the U.S., and was distributed on a local basis.⁸⁴
- Works Progress Administration, renamed the Works Projects Administration (WPA) in 1939 – Roosevelt created the WPA through Executive Order in May 1935. The WPA, along with the Social Security program, was intended to replace FERA (which ended in 1935) with a permanent program. The WPA built 572,000 miles of highways, 67,000 miles of city streets, and 78,000 bridges.⁸⁵

Nationwide, federal relief programs kept the highway building boom of the 1920s alive through the 1930s, with 35 to 45 percent of all workers on federal relief building bridges and roads. At first, the funds benefited all areas except cities, but after 1935 federal dollars provided substantial road work in cities as well. Because of changes in federal appropriations in 1933, the BPR was required to devote some funds to roads outside the existing federal-aid system. Receiving aid now were farm-to-market roads in rural areas and railroad grade crossings and feeder roads to the federal-aid networks in cities. Because of Depression-related budget cuts on the local level, officials became dependent on the new assistance.⁸⁶

(a) State-Federal government relationship

Expecting future money from bond sales, the Long administration had awarded contracts for \$25 million more than it had cash on hand by 1932. As the Depression deepened, bond issues that sold easily in 1930 and 1931 could no longer be sold at all by 1932. At this point very few new projects were introduced and cost cutting was implemented through the cessation of payment to municipalities like New Orleans and curtailing rural gravel road and small bridge construction.⁸⁷ Fortunately, much of the work that had to be trimmed was quickly picked up by new federal relief programs of the New Deal beginning with the NIRA in 1933. A total of \$5.9 million immediately went to Louisiana for 67 projects, with priorities given to U.S. Highway routes.⁸⁸

A rivalry developed between Long and President Roosevelt, slowing the WPA and other New Deal programs in Louisiana, with the Long administration attempting to introduce its own form of the New Deal.

⁸³ James S. Olson, ed., *Historical Dictionary of the New Deal*. Westport, Conn.: Greenwood Press, 1985, 96.

⁸⁴ Olson, 183.

⁸⁵ Olson, 548.

⁸⁶ Seely. 88-89.

⁸⁷ Louisiana Highway Commission, Seventh Biennial Report, 1932-1934, 5-7.

⁸⁸ Louisiana Highway Commission, Seventh Biennial Report, 1932-1934, 22.

After Long's death in 1935 the tension was largely released and the New Deal programs ended up employing a far greater number of workers than Long's building programs of the early 1930s. Long's program at its peak employed 22,000 workers, while the CWA employed 80,372 people and the WPA had approximately 40,000 workers per month from 1936 to 1940.⁸⁹ The WPA in particular was able to address small-scale projects in the underserved rural areas that Long relied on for political support. Direct federal involvement enabled the 1930s to be a period of rapid growth in the state, including bridge building.

(b) Bridge projects

As the Depression took hold, the New Deal federal relief programs and the LHC focused their large project efforts on major crossings, especially the difficult cases of the Mississippi and Atchafalaya Rivers. The Mississippi River Bridges at New Orleans and Baton Rouge (both later to be named for Long), though begun in the 1920s, were finished with federal support in 1935 and 1939, respectively.⁹⁰ The LHC completed the Atchafalaya River bridges at Morgan City (1933) and Krotz Springs (1934), necessary to cut across the bayous of south-central Louisiana.⁹¹ Smaller bridge projects in the state were part of the initial focus of the Long administration and a part of his political appeal to rural voters. By the mid-1930s many of the small, local projects in Louisiana were being completed through a federal relief program.

Attention was also given to creating grade separations between railway lines and roads, which had begun in the early 1920s.⁹² Extant examples of early grade-separation structures include those in Caddo Parish (1927) and LaSalle Parish (1932).⁹³ Construction of grade-separation structures continued during the Depression and was an important focus of New Deal programs. Increased attention was given to creating grade separations between railway lines and roads, and specific legislation was passed to provide funds for highway-rail grade separations through the National Industrial Recovery Act (NIRA) (1933), Hayden Cartwright Act (1934), and Emergency Relief Appropriation Act (1935). Examples, such as the Perkins Road Overpass in Baton Rouge, were built in several parishes from 1935 to 1939 with funding provided by the U.S. Works Program Grade Crossing program.⁹⁴

Emergency federal aid was used to support the completion of many of the large projects in the state initiated by the LHC. The Rigolets-Pearlington shortcut and the accompanying pair of Pearl River

⁸⁹ Robert Leighninger Jr., *Building Louisiana: The Legacy of the Public Works Administration* (Jackson, Miss.: University Press of Mississippi, 2007), 29.

⁹⁰ Louisiana Highway Commission, Eighth Biennial Report, 1934-1936, 93; Louisiana Highway Commission, Tenth Biennial Report, 1938-1939, 119. The Mississippi River Bridge at New Orleans is Recall No. 000060 (extant) and the Mississippi River Bridge at Baton Rouge is Recall No. 051880 (extant).

⁹¹ Louisiana Highway Commission, Seventh Biennial Report, 1932-1934, 182. The Atchafalaya River Bridge at Morgan City is Recall No. 009000) while the bridge at Krotz Springs is nonextant.

⁹² Louisiana Highway Commission, Ninth Biennial Report, 1936-1937, 128.

⁹³ Recall Nos. 013480 and 049130, respectively.

⁹⁴ Seven examples in the subject population were directly tied to this program. They are Recall Nos. 023620, 059090, 055130, 015500, 19040, 059730, and 610023 (Perkins Road Overpass in Baton Rouge) and are all extant.

bridges, for instance, were finished exclusively through Emergency Federal Aid.⁹⁵ Various WPA projects were often small in scale and located in a wide variety of urban and rural areas, filling in the long-overdue gaps in the development of state infrastructure that local parish and municipal governments were unable to address. Bridge construction was also part of federal-relief efforts by the WPA, PWA, CWA, and Federal Emergency Relief Administration (FERA) in New Orleans's City Park. These efforts included the reconfiguration of the park layout; landscaping; and sidewalk, road, bridge, and building construction. Between 1936 and 1939 the WPA constructed eight reinforced concrete arch bridges and one rigid frame bridge in City Park featuring Classical Revival and Art Deco stylized influences typical of the period.⁹⁶ Even these federal projects dwindled after 1938 as New Deal programs wound down.⁹⁷ This hiatus would last through the following war years.

E. Wartime planning

The infrastructure construction boom of the Long era that had continued through the various work relief programs of the Depression came to an end as the U.S. became involved in World War II. With a shift to the war effort, labor and materials became scarce and overall funding for infrastructure was reduced at the federal and state levels. However, several federal acts provided funding for transportation networks specifically related to national defense.

At the beginning of this period, the LHC was reorganized as the Louisiana Department of Highways (LDH). The agency made due with available manpower and resources, and largely focused on road improvements related to defense along with planning for future projects when the war was over.

(1) Federal influence

During the war years, federal funding and support of road and bridge construction continued in a more restrictive fashion. The 1941 Defense Highway Act called for the adoption of highways or routes as the Strategic Highway Network and construction of these roads were funded with 75% federal funds and 25% state funds. In addition, the Defense Highway Act provided funds for projects essential to the war effort and provided funds to be matched on a 50/50 basis for "advance engineering surveys on projects of unusual importance to be constructed after the end of the existing emergency."⁹⁸ Planning activities could be traffic studies, surveys, foundation and soil studies, and preparation of plans and specifications.⁹⁹

One road and bridge construction project that LDH and the U.S. War Department completed during the war years included the Morganza Floodway Bridge (1945).¹⁰⁰ In the 1940s the U.S. War Department began diverting water from the Mississippi River into the Atchafalaya River to prevent flooding of the

⁹⁵ Louisiana Highway Commission, Seventh Biennial Report, 1932-1934, 149.

⁹⁶ Recall Nos. for New Orleans City Park bridges are 102114, 102115, 102235, 102236, 102337, 102113, 102233, 102226, and 102234 (all extant).

⁹⁷ Louisiana Highway Commission, Tenth Biennial Report, 1938-1939, 13-18.

⁹⁸ Louisiana Department of Highways, Twelfth Biennial Report, 1942-1943, 14-15.

⁹⁹ Louisiana Department of Highways, Twelfth Biennial Report, 1942-1943, 14-15 and 120

¹⁰⁰ Recall No. 054830 (extant).

lower reaches of the Mississippi River. The diversion channels and floodplains extended across existing state highways and prevented vehicular use during periods of flooding. At the request of the federal government, the LDH initiated improvements to the affected highways with the construction of high-level bridges that spanned the floodplain on a long series of piers. Completed in 1945, the bridge provided uninterrupted access over the Morganza floodplain.¹⁰¹

In consideration of the needs after the war, President Roosevelt appointed the National Interregional Highway Committee in 1941 to analyze the need for a national expressway system. In 1944 the committee supported a nationwide system of 33,900 miles, plus 5,000 additional miles of auxiliary urban routes.¹⁰² The committee's recommendation was adopted with the 1944 Federal-Aid Highway Act, which called for the designation of a National System of Interstate Highways of up to 40,000 miles.¹⁰³ The system of highways was to connect principal metropolitan areas, cities, and industrial centers by direct routes and to connect with routes of continental importance in Canada and Mexico.¹⁰⁴

The Federal-Aid Highway Act of 1944 also amended previous highway acts and authorized appropriations for the post-World War II construction of highways and bridges. The Act provided new funding for construction of secondary roads (also known as feeder roads, which included farm-to-market roads, rural free delivery routes, and public school bus routes) and urban highways in areas with a population over 5,000.¹⁰⁵ Previous federal aid focused largely on primary roads and restricted the miles of secondary roads that could be improved with federal funds.

The 1944 Act provided \$500 million in nationwide funding over a three-year period, with \$225 million allocated to primary roads, \$150 million to secondary roads, and \$125 million to urban roads. Funding for urban highways was distributed by population, and for rural highways it was distributed to the states in proportion to rural population, geographic area, and post-road mileage (roads along postal routes). States were required to match federal allotments on a 50/50 basis. States were allowed to use 10 percent of their funds to eliminate highway-railway crossing hazards on the federal-aid system. Where vehicular and railroad traffic intersected on the same grade level, the intersection was termed an at-grade crossing. Under this program, hazardous at-grade crossings were replaced by new grade-separation structures, designed to elevate one, either roadway or railroad, over the other.¹⁰⁶

¹⁰¹ George Stevenson, "Final Report Morganza Floodway Bridge at Lottie, Louisiana with Test Pile Data on other Crossings of the Morganza Floodway," prepared by the Louisiana Department of Highways (c.1945), 7-9.

¹⁰² Federal Highway Administration, "Dwight D. Eisenhower National System of Interstate and Defense Highways," <http://www.fhwa.dot.gov/programadmin/interstate.cfm> (accessed 17 September 2012).

¹⁰³ Seely, 190.

¹⁰⁴ Federal Highway Administration, "Dwight D. Eisenhower National System of Interstate and Defense Highways."

¹⁰⁵ Louisiana Department of Highways, Thirteenth Biennial Report, 1944-1945, 10-11.

¹⁰⁶ Louisiana Department of Highways, Thirteenth Biennial Report, 1944-1945, 10-12.

(2) State reorganization and war efforts

During a reorganization of state government in 1940, the LHC was reorganized into the LDH, with seven maintenance districts.¹⁰⁷ The reorganization was instigated by the new governor, Sam Houston Jones, a member of the anti-Long faction who sought to limit the influence within the government of pro-Long employees.

Many of the construction workers and engineers had enlisted or been drafted for the war, and only a “skeleton crew” remained for highway maintenance in the war years.¹⁰⁸ Since the LDH could not maintain the highway system with its own forces, a limited allotment of \$10,000 per year was sent to parishes to maintain local roads and bridges. Additionally, the war economy made many bridge construction materials like steel difficult to acquire in large quantities. In particular, the LDH cited the need to maintain and repair the state’s many movable spans, and these repairs often required the use of critical materials.¹⁰⁹ The scarcity of materials also forced the LDH to adjust its standards of construction to meet the restriction on materials.¹¹⁰ Given the shortages of personnel and key materials, the new department could undertake few construction projects.¹¹¹ Only projects that were considered essential to the war effort and public health and safety were funded.¹¹² State activities under the Defense Highway Act of 1941 included specific projects related to the roads designated as part of the Strategic Highway Network and general planning studies. In particular, the 1942-1943 biennial report identified five Strategic Highway Network projects, of which four involved bridges. Total funds spent for the Strategic Network Highways in the state totaled \$369,903 through 1945.¹¹³

The LDH’s revenues declined during the World War II period due to reduction in revenues collected from the gasoline tax. In April 1942 the funding from the tax fell below \$1,000,000 for the first time since April 1939, in part due to the scarcity of rubber for tires and the reduction in travel that resulted.¹¹⁴ Despite lower revenue, state aid to parishes continued in the period to assist police juries with reconditioning school bus and mail routes and farm-to-market roads that were not in the state highway system.¹¹⁵

F. Postwar acceleration of road and bridge building

While the World War II era saw little occur in the way of road and bridge building, Louisiana entered an era of booming industry following the war, with new businesses attracted by the state’s rich natural

¹⁰⁷ Louisiana Department of Highways, Eleventh Biennial Report, 1940-1941, 4.

¹⁰⁸ Louisiana Department of Highways, Eleventh Biennial Report, 1940-1941, 7.

¹⁰⁹ Louisiana Department of Highways, Twelfth Biennial Report, 1942-1943, 11.

¹¹⁰ Louisiana Department of Highways, Twelfth Biennial Report, 1942-1943, 8.

¹¹¹ Louisiana Department of Highways, Twelfth Biennial Report of the Department of Highways of the State of Louisiana, January 1st, 1942 to December 31st, 1943. 8.

¹¹² Louisiana Department of Highways, Twelfth Biennial Report, 1942-1943, 8.

¹¹³ Louisiana Department of Highways, Thirteenth Biennial Report, 1944-1945, 97.

¹¹⁴ Louisiana Department of Highways, Eleventh Biennial Report, 1940-1941, 12.

¹¹⁵ Louisiana Department of Highways, Twelfth Biennial Report, 1942-1943, 11.

resources.¹¹⁶ Vehicle registrations tripled from 476,000 in 1947 to 1.5 million in 1965, putting pressure on the overall transportation network and creating greater maintenance costs for roads and bridges.¹¹⁷

The Korean War (1950-1953) briefly reduced federal highway spending as federal dollars shifted to the war effort. It also helped generate a steel shortage as materials once again were devoted to war efforts. At the same time, however, that war provided the opportunity for Interstate highway supporters to again argue, as in 1944, for a highway system based on the needs of national defense. This, in turn, supported the argument for increased federal highway funding that would soon come to fruition.¹¹⁸

In Louisiana, the LDH biennial reports from the 1950s and 1960s tell a clear story of rapid growth and exponential expansion after the pause of the war years. Economic growth and government funding combined to not only increase investment on a grand scale, but to also improve and expand the roadways and bridges statewide. The postwar Federal-Aid Highway Acts dwarfed previous road and bridge investment and construction in the state.¹¹⁹ With the increased traffic and need mounting, the Louisiana Legislative Council conducted the state's first complete study of highway needs survey.¹²⁰

(1) The Interstate Highway System

Though the Federal-Aid Highway Acts of 1950, 1952, and 1954 affirmed the commitment originally made in the 1944 Act, it was the 1956 Act that truly got the Interstate Highway System underway and provided adequate funding for its construction. Though the 1952 Federal-Aid Highway Act included the first authorized federal funds specifically for Interstate highway construction, it was a nominal \$25 million nationally for two years.¹²¹ The Federal-Aid Highway Act of 1954 provided some additional funding for the Interstate system with \$175 million for fiscal years 1956 and 1957, with the federal government providing 60 percent of the funds for the construction.¹²² The acts of the early 1950s moved the focus of federal spending for construction more toward the cities.

President Dwight D. Eisenhower, recognizing the importance of a national highway system for defense, appointed a committee to study American highway needs in 1954 at the height of the Cold War. The committee advised Eisenhower that an Interstate system was needed. New York's "master builder,"

¹¹⁶ Louisiana Department of Highways, Annual Report, 1960-1961, 4.

¹¹⁷ Louisiana Department of Highways, Public Relations and Education Section, *Louisiana Highway Needs, 1967-1985*, 2-3, 5.

¹¹⁸ Seely, 199-203.

¹¹⁹ Louisiana Department of Highways, *Louisiana Highways – Two Years of Progress, 1954-1955* (Biennial Report), 7; Louisiana Department of Highways, Annual Report, 1960-1961, 6.

¹²⁰ Louisiana Department of Highways, *Louisiana Highways – Two Years of Progress, 1954-1955* (Biennial Report), 9.

¹²¹ Seely, 204; A.E. Johnson, ed., *Published on the Occasion of the Golden Anniversary American Association of State Highway Officials: A Story of the Beginning, Purposes, Growth, Activities and Achievements of AASHO* (Washington, D.C.: American Association of State Highway Officials, 1965),

¹²² Seely, 213.

Robert Moses, also involved in the development of the system, had pushed for the large scope of the project through consultations with Eisenhower assistant Sherman Adams and with General Lucius D. Clay, chairman of a key presidential committee studying highways.¹²³

In 1956 both the Federal-Aid Highway Act, which got the Interstate program underway, and the Highway Revenue Act, which provided the funding for the program, were passed. The acts expanded the Interstate system to 41,000 miles and provided allocations for 90 percent of construction costs, with states responsible only for the remaining 10 percent, a major departure from earlier matches. The entire Interstate system was anticipated to cost more than \$27 billion nationwide. In order to finance construction, the legislation created the Highway Trust Fund, which was supported by an increased federal tax on gas and diesel fuel. The 1956 legislation also authorized an initial 13-year construction period for Interstate highways, which would eventually be extended as states faced routing and funding difficulties.¹²⁴ Interstate highway innovations included such design elements as wide, four-lane, divided highways, with limited access, minimum grades, and wide curves.

The Federal Aid Act of 1956 also brought uniformity to nationwide road-building efforts and included a provision requiring the BPR to work with the AASHTO to develop design standards to accommodate traffic forecasts through the 1970s. Standards were meant to ensure national uniformity of design, provide for full control of road access, and eliminate at-grade crossings in Louisiana.¹²⁵ Such standards were also necessary for engineers to keep pace with the high demands for bridge construction in the 1950s and 1960s.

(2) The Department of Highway's postwar transformation

Increased federal funding also enabled states (including Louisiana) to construct new bridges on new and improved primary and secondary roads, urban expressways, and farm-to-market roads. Much of the LDH's work on highways and bridges had been focused on keeping the existing infrastructure operating and up-to-date to meet increasing demand.¹²⁶ In 1944-1945 new construction was \$12 million for a two-year period.¹²⁷ In 1948-1949 new construction reached \$42.8 million for a two-year period, but the LDH identified that, "Much remains to be done to bring Louisiana's Highway System up to modern standards."¹²⁸ Noting that bridge construction raises the cost of Louisiana's highways, the LDH outlined location of roads to minimize "expensive bridging" as a key consideration.¹²⁹ As an indication of the level of construction activity during this period, the LDH built 140 bridges between 1948 and 1949 alone. An example is the Warren through truss bridge over the Calcasieu River in Calcasieu Parish, underway in

¹²³ Robert A. Caro, *The Power Broker* (New York: Alfred A. Knopf, 1974), 921.

¹²⁴ Richard Weingroff, "Federal-Aid Highway Act of 1956: Creating the Interstate System," *Public Roads* 60, no. 1 (Summer 1996), <http://www.fhwa.dot.gov/publications/publicroads/96summer/p96su10.cfm> (accessed 18 September 2012).

¹²⁵ Weingroff.

¹²⁶ Louisiana Department of Highways, *Two Years of Highway Progress, 1952 & 1953* (Biennial Report), n.p.

¹²⁷ Louisiana Department of Highways, Thirteenth Biennial Report, 1944-1945, 90-91.

¹²⁸ Louisiana Department of Highways, *Two Years of Highway Progress, 1948 & 1949* (Biennial Report), 4.

¹²⁹ Louisiana Department of Highways, *Two Years of Highway Progress, 1948 & 1949* (Biennial Report), 20.

1948-1949 and completed in 1951.¹³⁰ The dramatic increase in new construction contracts for the State Highway System issued over the postwar period is shown in Table 2.

Table 2. Postwar spending trends for the state highway system¹³¹

Fiscal year (ending June 30)	New construction contracts issued (in millions)	Miles of highway maintained
1953	\$25	15,170
1955	\$46	15,181
1960	\$112	15,225
1965	\$109	15,475
1970	\$114	16,900

The LDH began issuing a “non-technical” version of its biennial report in 1949, offering a popular overview of its activities in a format that was accessible to constituencies including the state legislature, to which it would soon turn for additional support. The popular version of the report covered topics such as aid to Interstates, the primary and secondary system, urban connections and municipal aid, farm-to-market roads, parish aid, construction, personnel, maintenance and signage. Financial and statistical topics continued to be provided in a statistical addendum, which was prepared annually.

In 1952 the Legislative Council commissioned a study to outline specific needs for highway construction in the state.¹³² The results were published in the LDH’s 1954-1955 report. The study addressed the Louisiana’s existing 47,000 miles of road from the state level to parishes and municipalities. The Legislative Council, working in cooperation of the LDH and the BPR, had engaged independent groups to both identify highway needs and recommend various financing strategies to cover the next 30 years. The resulting long-range program was approved by the state legislature in 1955 and by voters as a constitutional amendment in 1956.¹³³ After approval of the plan, the LDH announced a goal to provide paved roads to every part of the state. At the time, the state-maintained highway system, which was comprised of about 15,000 miles (about 35% of the state’s roads), was approximately 60% hard-surfaced. Parish roads accounted for 65% of the system (presumably little of this was paved; however, the report does not specify). The state legislature allocated additional funds to accomplish the long-range plan and approved of a new method of earmarking projects based solely on sound engineering. The result was a less political LDH that could speed up design and construction due to their increased autonomy and expertise.¹³⁴

¹³⁰ Recall No. 032780 (extant).

¹³¹ Summary drawn from Louisiana Department of Highways, *Financial and Statistical Reports* for years listed, data appears in Director’s cover letter to each report (data not available every year).

¹³² Louisiana Department of Highways, *Two Years of Highway Progress, 1952 & 1953* (Biennial Report), n.p.

¹³³ Louisiana Department of Highways, *Two Years of Highway Progress, 1954 & 1955* (Biennial Report), 2-3, 9, 15.

¹³⁴ Louisiana Department of Highways, *Two Years of Highway Progress, 1954 & 1955* (Biennial Report), 2-3, 14, 17.

Bridge construction during this period also included the first vehicular crossing of the Red River approximately 23 miles north of Shreveport in 1952, eliminating a ferry crossing and providing for uninterrupted east-west travel on Louisiana Highway (LA) 2 through the northern portion of Louisiana.¹³⁵ Other projects included additional flood control improvements, such as the Old River Control Structure with its canal and two spillways built in the late 1950s as part of a conservation effort to manage flooding on the Mississippi River.¹³⁶ The associated Old River Navigation Canal provided passage of waterway traffic between the Mississippi River and the Atchafalaya River. The LHD constructed a vertical lift bridge in 1964 to carry LA 15 over the canal.¹³⁷ The vertical lift structure provided necessary navigational clearance for boats in the canal lock.¹³⁸ Another state bridge project constructed in the post-war era related to flood management included the series of six high-level bridges, built in three pairs in the 1960s over the West Atchafalaya Floodway to carry vehicles over the floodplain.¹³⁹

In the 1960s the LDH put significant effort into its new Interstate highways, most of which were constructed by the late 1970s. In Louisiana the state's Interstate Highway System would cover 686 miles, including Interstate 10 (I-10), I-12, I-20, and I-55. By 1960-1961 more than 100 miles were under construction, focusing around the metropolitan areas, and 56 miles were completed by 1962. Louisiana was third among all states in obligating federal Interstate funds.¹⁴⁰ By 1967, 42% of the state's planned interstate system, or 281 miles, were open to traffic.¹⁴¹

During this same time of frantic Interstate construction, the LDH was responsible for the state's other road and bridge projects. For example, the agency was responsible for more than 500 highway and bridge projects in 1960. Projects completed or underway for the 1960 fiscal year totaled \$329 million, of which \$207 million represented construction completed. The state had 932 miles of improvements underway for major highways, and 247 miles of blacktopping farm-to-market roads.¹⁴² By 1962 the state had 48,352 miles of state and local highways, with 87% of these categorized as rural.¹⁴³ The two-year period from 1965 to 1967 was the largest two-year timeframe to date for construction projects in Louisiana, with \$231

¹³⁵ Recall No. 012548 (extant).

¹³⁶ The spillways include bridges with Recall Nos. F15771 and F15321 (extant).

¹³⁷ Recall No. 054900 (extant).

¹³⁸ U.S. Army Corps of Engineers, "Filling and Emptying System Old River Navigational Lock, Louisiana," Technical Report No. 2-459, prepared by the U.S. Army Engineer Waterways Experiment Station (June 1960), 1.

¹³⁹ Louisiana Department of Highways, "West Atchafalaya Floodway Crossing Bridges" plans prepared by the Department of Highways 1958. Available from the LADOTD, Baton Rouge, La. One original pair of bridges is extant (Recall Nos. 007300 and 007310); the other two pairs were replaced in 2004-2005.

¹⁴⁰ Louisiana Department of Highways, Annual Report, 1960-61, 9; Louisiana Department of Highways, Annual Report, 1961-62, 8-9.

¹⁴¹ Louisiana Department of Highways, Bi-annual Report, 1963-65, 9; Louisiana Department of Highways, Biennial Report, 1965-67, 7.

¹⁴² Louisiana Department of Highways, Annual Report, 1960-61, 6-8.

¹⁴³ Louisiana Department of Highways, Public Relations and Education Section, *Louisiana Highway Needs, 1967-1985*, 3, 6.

million spent across the state on all projects to support a growing infrastructure and economy that was increasingly based on transportation and movement of people and materials.¹⁴⁴ The industrial and economic boom that began after World War II and continued through the 1960s aided this process of modernization of the state's roads and bridges.

Professionalism was firmly established in the LDH, with engineers, inspectors, and other professional staff possessing special knowledge and skills. Plans and specifications for each project were approved by the LDH and the federal agency, the BPR (later the FHWA).¹⁴⁵ The LDH's Central Testing Laboratory conducted scientific research directed toward improving the design of highways and bridges, and worked to determine that construction materials and methods met specifications.¹⁴⁶ New federal and state statutes put an increased focus on safety, requiring transportation facilities to be constructed to modern design standards.¹⁴⁷

(3) Department of Highways bridge design

The LDH Bridge Section had a strong tradition of designing most of the state's major crossings in addition to the design of smaller structures.¹⁴⁸ Large river crossing bridges under construction or completed in the postwar period included:

- Bridge at Lake Charles over the Calcasieu River, underway in 1948-1949 and completed in 1952.¹⁴⁹
- Bridge at Moncla over the Red River, underway in 1948-1949 and completed in 1950.¹⁵⁰
- Twin bridges across Lake Pontchartrain from New Orleans to Slidell (carries I-10, locally known as the "Twin Spans"), the single largest project under contract in the state in 1961. The bridges opened in 1965.¹⁵¹

¹⁴⁴ Louisiana Department of Highways, Biennial Report, 1965-67, 6.

¹⁴⁵ Louisiana Department of Highways, Biennial Report, 1965-67, 23.

¹⁴⁶ Louisiana Department of Highways, Annual Report, 1960-61, 28.

¹⁴⁷ Louisiana Department of Highways, Public Relations and Education Section, *Louisiana Highway Needs, 1967-1985*, 4.

¹⁴⁸ R.B. Richardson, "Highway Planning," *Louisiana Police Jury Review* (April 1950), 19.

¹⁴⁹ Recall No. 032780 (extant). Louisiana Department of Highways, *Two Years of Highway Progress 1948 & 1949* (Biennial Report), 4, 15; Wilbur, Smith, and Associates, *Uptown Bridge Preliminary Impact Planning Study*, prepared for the Mississippi River Bridge Authority (1970), 1.

¹⁵⁰ Nonextant. Louisiana Department of Highways, *Two Years of Highway Progress, 1948 & 1949* (Biennial Report), 4; Richardson, 17.

¹⁵¹ Nonextant. Louisiana Department of Highways, Annual Report, 1960-61, 6; Louisiana Department of Highways, Annual Report, 1963-1965, 7.

(4) Consultant bridge design

During this period, the LDH used consultants for certain major projects. The following firms were influential in the development of Louisiana's bridges in the postwar period (see Section 3.E for more information):

- Modjeski and Masters – This engineering firm, based in New York City, opened a Baton Rouge office in 1947 due to its continued work in the state, which dated back to the 1930s. Modjeski and Masters completed the design and construction of the new Mississippi River Bridge in Greater New Orleans in 1958, later known as the Crescent City Connection. Originally designed as a toll bridge, carrying U.S. Highway 90 (U.S. 90), the bridge was intended to connect downtown New Orleans with the growing west bank area while relieving the existing Huey Long Bridge, which was at peak capacity by 1970.¹⁵²
- Howard, Needles, Tammen & Bergendoff – Today known as HNTB Corporation, this Missouri-based firm also has a strong presence in Louisiana's bridge-building history. The firm primarily worked on projects occurring in the last half of the study period, including the design and construction of early Interstate routes.¹⁵³

(5) Improvement of parish roads

State spending on parish roads also increased in the postwar period, but more moderately than did spending on the state highway system. In 1948-1949 the LDH spent \$10,000 in each of the state's 64 parishes on local roads and farm-to-market routes, and gave parish authorities another \$30,000 to spend for local road development. This amounted to a total of \$2.5 million in expenditures for the two-year period.¹⁵⁴ According to the 1954-1955 biennial report, large-scale construction was evident in all parishes of the state. The long-range study and new financing approved by the state legislature in 1955 had also provided a boost to parishes. Under a special legislative act adopted that same year, a formula was adopted for distribution of additional state aid to parishes based on need. This provided new funds of \$2.3 million annually above what was provided under "regular road-building revenues," which were identified at \$3 million in the 1954-1955 biennium. The long-range plan provided ongoing appropriations to parishes, and specified that the funds must be used for new construction or improvement projects rather than routine maintenance. The 1955 act also required the LDH to maintain standards and specifications for parish projects.¹⁵⁵

In 1960-1961 the LDH provided about \$1.3 million in regular parish aid to improve and maintain the parish road system, which included feeder routes to the state's system and farm-to-market roads. Continuing the additional allocation that was provided under the 1955 special legislative act, an additional \$2.4 million was allocated to individual parishes under the need-based formula to support their improvement of

¹⁵² Wilbur, Smith, and Associates, 1. Recall No. 200790 (extant).

¹⁵³ Louisiana Highway Hall of Honor, photograph of John Cotton's biography provided by LADOTD.

¹⁵⁴ Louisiana Department of Highways, *Two Years of Highway Progress, 1948 & 1949* (Biennial Report), 31.

¹⁵⁵ Louisiana Department of Highways, *Louisiana Highways – Two Years of Progress, 1954-1955* (Biennial Report), 2, 5, 24.

roads and bridges.¹⁵⁶ By 1965-1967 the LDH reported spending \$2.3 million in regular parish aid, \$2.2 million in extra parish aid to municipalities, and \$26 million in extra parish aid, for a total of more than \$30 million.¹⁵⁷ Over a nearly 20-year period, the state's investment in local roads and bridges had increased more than ten-fold.

(6) Private bridge construction

In addition to LDH initiated bridge-building efforts, in the 1950s parish police juries in a few cases formed commissions responsible for the construction and maintenance of new bridges. The Louisiana State Legislature provided parishes authority to form private bridge authorities (or commissions) under Act No.7, or the Bridges and Ferries Authority Act of 1952. According to the act, bridge authorities were granted authority to acquire land and construct, improve, repair, and operate toll bridges and ferries in the state to "improve and extend the highway system of the State of Louisiana."¹⁵⁸ Concurrent legislation under Act No. 8 afforded that the LDH could contract with the bridge authority to construct, maintain, and operate any bridges constructed by the authority. Though bridge plans were not required to be reviewed and approved by the LDH, all bridges were to be constructed to prescribe highway safety standards.¹⁵⁹

Two notable commissions were established under the Bridges and Ferries Act of 1952 to oversee design, construction, and maintenance of privately owned, toll bridges in New Orleans. The first was the Mississippi River Bridge Authority (now known as the Crescent City Connection Division). The Louisiana State Legislature provided authority for the organization of the Mississippi River Bridge Authority in 1952, which was made up of board members from city, parish, state, and consulting agencies. The group coordinated between the state, Jefferson Parish, the City of New Orleans, the LDH, and bridge engineers Modjeski and Masters to finance, design, and construct the Mississippi River Bridge in Greater New Orleans (now known as the Crescent City Connection).¹⁶⁰ The toll bridge, completed in 1958, provided an additional route over the Mississippi River as the existing Mississippi River Bridge at New Orleans (Huey P. Long Bridge) had reached vehicular capacity.¹⁶¹ When the second, parallel span was added to the structure in 1988, the Mississippi River Bridge Authority was incorporated as a division of the LDH.

The second bridge authority established in the 1950s was the Greater New Orleans Expressway Commission. The parishes of Jefferson and St. Tammany established the commission in 1954 to construct a toll bridge across Lake Pontchartrain to connect the greater New Orleans area. Financing for

¹⁵⁶ Louisiana Department of Highways, Annual Report, 1960-61, 15.

¹⁵⁷ Louisiana Department of Highways, Biennial Report, 1965-67, n.p.

¹⁵⁸ Louisiana State Legislature, *Bridges and Ferries Authorities Act of 1952*, in "The Mississippi River Bridge Authority, Compilation of Legislative Acts 7, 8, and 90 of 1952 and Act 684 of 1954 of the Legislature of the State of Louisiana."

¹⁵⁹ Louisiana State Legislature, *Act No. 8, 1952*, in "The Mississippi River Bridge Authority, Compilation of Legislative Acts 7, 8, and 90 of 1952 and Act 684 of 1954 of the Legislature of the State of Louisiana." Available from the Louisiana State Library, Baton Rouge, La.

¹⁶⁰ Bridge Recall No. 200790 (extant).

¹⁶¹ Mississippi River Bridge Authority, *First Report of the Mississippi River Bridge Authority, 1952-1955* (New Orleans: Mississippi River Bridge Authority, 1955), 6, 21. Recall No. 000060 (extant).

the bridges came through the use of bonds and the state highway fund. Designed by the Louisiana Bridge Company, the Lake Pontchartrain Causeway opened to traffic in 1956. The second parallel span was added in 1969, designed by David Volkert & Associates.¹⁶² The bridge maintenance, repair, and oversight remains in private hands with the Greater New Orleans Expressway Commission (also known as the Causeway Commission) today.¹⁶³

G. Conclusion

By the end of the subject period, Louisiana's population stood at 3.6 million and had swung from less than one-third urban (two-thirds rural) to predominantly urban, with a nearly 80/20 split. The need for cooperative planning and financing of the transportation network among federal, state, and local officials to serve this shift of population to urban centers was acute. State highway mileage was still largely rural, though major investments in urban highways including the Interstate were beginning to yield results.¹⁶⁴ The physical manifestation of this shift in both population and expenditures was evident in complex interchanges, major bridges, and miles of urban Interstate that were built in Louisiana by 1970.¹⁶⁵ The LDH, and its Bridge Section in particular, was an organization of professionals focused on providing a modern highway network with bridges as an important component due to the state's many waterways.

¹⁶² Recall Nos. 203830 and 203832 (extant).

¹⁶³ David Volkert & Associates, *Consulting Engineers Annual Report* prepared for the Greater New Orleans Expressway Commission (1980), 1-4; "Lake Pontchartrain/Causeway History," *Lake Pontchartrain Causeway Bridge*, available at <http://www.thecauseway.us/causeway/history.php> (accessed 1 August 2013).

¹⁶⁴ U.S. Census Bureau, "Resident Population"; Louisiana Department of Highways, Public Relations and Education Section, *Louisiana Highway Needs, 1967-1985*, 6-9.

¹⁶⁵ Louisiana Department of Highways, Public Relations and Education Section, *Louisiana Highway Needs, 1967-1985*, 16-17.

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3. Geography, Bridge Materials, and Design

The following section explores the different bridge materials, design methods, and types used throughout Louisiana's bridge-building history. This section begins with a discussion of the influence of the state's geography on bridge building, then describes materials, advances in design, and bridge types. It continues with an introduction to the bridge engineers, designers, and fabricators that worked in Louisiana during the subject period, and concludes with an overview of aesthetics related to bridge design. This section focuses on the National Register theme of Engineering to assist in future evaluations of the subject bridges.

Where chronologically appropriate, this section will reference either the LHC or LDH, as it was known after 1940. However, when bridge types, materials, or construction techniques span the length of the state's bridge history, the more general term "Department" will be used.

Inclusion of a bridge in this section is as a reference to inform subsequent project steps, but does not necessarily indicate significance under any National Register criterion. Instead, the bridge is provided as an example to understand historical themes and associations within Louisiana's bridge-building history.

A. Influence of geography on bridge location, design, and construction

The state of Louisiana is located within what geographers term the Gulf Coastal Plain, and includes four sub-areas: the Pine Hills, the Prairies, the Coastal Marshes, and the Alluvial Plains. Parts of north-central, western, and southeastern Louisiana are in the Pine Hills, which has undulating hills with extensive pine and hardwood forests. Parts of southern and southwestern Louisiana are in the Prairies, with land surface elevations from 20 to 30 feet above sea level. Much of coastal Louisiana is in the Coastal Marshes, characterized by areas that are flat and subject to tidal flooding from the Gulf of Mexico. The flood plains adjacent to the Mississippi, Ouachita, and Red Rivers are in the Alluvial Plains, where the topography is flat with interconnecting streams that allow flow between the river basins.¹⁶⁶

The environment of Louisiana has often posed great challenges to bridge construction in the state but has also served as the driving force behind developments in bridge design and construction. Geography affects bridge location, design, and construction in two major areas. The most common, which affects bridges in all states, is the number, location, and navigability of waterways. This is significant in Louisiana due to the sheer number of navigable waterways in the state that required crossings. The other is the nature of soils and their suitability for bridge construction. This second area is particularly significant for Louisiana, setting it apart from most other states because soil conditions have created substantial difficulties in constructing bridge substructures, which includes foundations. Both situations are discussed below, including their particular impacts on bridges in the state.

¹⁶⁶ This introductory section is adapted from Charles R. Garrison, *Statistical Summary of Surface-Water Quality in Louisiana—Lake Pontchartrain-Lake Maurepas Basin, 1943-95*, Louisiana Department of Transportation and Development, Water Resources Technical Report No. 55G, 1999, 10-11.

(1) Geography and navigable waterways

Louisiana has a natural system of navigable waterways aggregating over 4,000 miles in length, or, as the Louisiana Highway Commission put it in 1932, “The State has the misfortune, from the point of view of highway continuity, to be traversed by five major navigable rivers; the Mississippi, the Red, the Ouachita, the Atchafalaya and the Black.”¹⁶⁷

The principal rivers draining the state are the Mississippi, Atchafalaya, Red, Ouachita, Sabine, and Pearl Rivers. The Mississippi River is the largest river in Louisiana, but few streams within the state are tributary to it. The Atchafalaya River is a controlled “distributary” of the Mississippi River and carries flow from the Red, Mississippi, and Ouachita Rivers to the Gulf of Mexico. The Sabine River forms part of the western boundary between Louisiana and Texas and drains only a small part of the state. Similarly, the Pearl River forms part of the eastern boundary between Louisiana and Mississippi, and also drains only a small part of the state.

All other streams in the state are tributary to these rivers with the exception of two groups. The first group consists of streams east of the Mississippi River and west of the Pearl River. This group includes the Tchefuncte, Tangipahoa, Natalbany, and Amite Rivers. These rivers eventually flow into the Gulf of Mexico by way of Lake Pontchartrain and Lake Maurepas. The second group includes rivers west of the Mississippi River and east of the Sabine River. Major streams in this group are Bayou Teche and the Vermilion, Mermentau, and Calcasieu Rivers. These rivers flow into the Gulf of Mexico.

Because of its location, Louisiana has the most wetlands of any state in the U.S., including 11,000 square miles of floodplains and 7,800 square miles of coastal swamps, marshes, and estuarine waters.¹⁶⁸ At mid-century, Louisiana had an area of 50,820 square miles, of which 7,409 were water.¹⁶⁹ The area of water would now be larger (and land smaller) because Louisiana, with 40 percent of all wetlands in the U.S., has the highest rate of coastal land loss at approximately 25 square miles per year.¹⁷⁰

In addition to the natural waterways that are navigable, a number of canals and other artificial waterways are also present. These include the Gulf Intracoastal Waterway, which was constructed through southern Louisiana from the 1920s through the late 1940s and intersected 16 state highways, each of which required a movable bridge. Canal bridges typically were needed quickly, once the canal was completed, so the LHC embarked on construction of a series of movable bridges, including bascule, swing, and pontoon types.¹⁷¹ Other artificial waterways include the Mississippi River-Gulf Outlet (MRGO), begun in 1958 and closed in 2009; the Inner Harbor Navigation Canal (aka the Industrial Canal), constructed 1918-1923 and connecting Lake Pontchartrain and the Mississippi River; and a number of smaller canals

¹⁶⁷ Louisiana Highway Commission, Sixth Biennial Report, 1930-1932, 15.

¹⁶⁸ “Louisiana: Geographical Features,” Louisiana Diary, <http://www.louisianadiary.us/Geography/index.aspx> (accessed 15 August 2012).

¹⁶⁹ *Louisiana: A Guide to the State* (Baton Rouge: Louisiana Library Commission at Baton Rouge, 1941): 7.

¹⁷⁰ David C. Johnson and Elaine G. Yodis, *Geography of Louisiana* (New York: The McGraw-Hill Companies, 1998), 34.

¹⁷¹ Louisiana Highway Commission, Seventh Biennial Report, 1932-1934, 151-157.

through Louisiana marshland for flood control, transportation, and other uses, including facilitating the petroleum industry in the mid-twentieth century.¹⁷² In addition to canals, Louisiana also has spillways and floodways, including the Atchafalaya Floodway, the Morganza Spillway, and associated canals and outlets. Some of these projects were a reaction, in part, to the Great Mississippi Flood of 1927, which prompted the state to pass the Flood Control Act of 1928.¹⁷³

Finally, a number of lakes are present in Louisiana. The most prominent is Lake Pontchartrain, although it is not a true lake but an estuary connected to the Gulf of Mexico via the Rigolets strait and Chef Menteur Pass into Lake Borgne, which has been changed by a century of coastal erosion from a lake into an arm of the Gulf of Mexico.¹⁷⁴

In the mid-1920s, when the state began to seriously plan an extensive (and expensive) network of highways, the extent of navigable waterways was estimated to be 5,000 miles, plus “numerous non-navigable streams, lakes, bayous and smaller waterways.” According to the LHC, all of these “must be crossed many times by the 7000 miles included in the State highway system.”¹⁷⁵ While many of the bridges constructed to carry the state’s highway system are fairly simple examples, others are enormous and complex structures.

Further complicating bridge construction was the need to maintain navigation on many waterways. It was one thing to build a low and narrow bridge over a river or bayou, but if the waterway being crossed carried water-based traffic, the bridge had to be designed in such a way to allow the boats and barges to pass unhindered. It was not until the railroads expanded in Louisiana during the late nineteenth century that any number of large bridges were professionally designed and built that would offer a model for roadway structures.¹⁷⁶ The United States Army Corp of Engineers (USACE) and the United States Coast Guard (USCG) developed rules in the 1910s regulating navigable waterways that set clearance requirements and movable spans as the standard for Louisiana.¹⁷⁷

(2) Soil conditions and bridge construction

From the earliest years, the Louisiana state agencies responsible for the design and construction of roads and bridges commented in their annual and biennial reports on the complex nature of the state’s soil conditions and their impact on bridge building. As early as the 1916-1918 biennial report, the State Highway Engineer noted: “While it is comparatively an easy and inexpensive matter to provide proper and

¹⁷² R. Christopher Goodwin & Associates, *Transportation in Louisiana: Final Report*, prepared for the Louisiana Office of Cultural Development, Department of Culture, Recreation & Tourism, May 2012, 19-21.

¹⁷³ Johnson and Yodis, 25; Louisiana Highway Commission, Fourth Biennial Report, 1926-1928, 36; see also Norman E. Lant, “Highway Crossing, Morganza Floodway, Louisiana,” *Roads and Streets* 85 (August 1942), 29.

¹⁷⁴ Johnson and Yodis, 29.

¹⁷⁵ Louisiana Highway Commission, Third Biennial Report, 1924-1926, 27.

¹⁷⁶ URS Greiner Woodward Clyde, 24.

¹⁷⁷ URS Greiner Woodward Clyde, Final Report: Revised Identification and Evaluation Survey of Historic High Steel Swing-Span Bridges in Louisiana, Prepared for Louisiana Department of Transportation and Development (1999), 48.

necessary drainage for a highway constructed through localities having sufficient natural or artificial drainage, difficulties and extra expense are encountered and brought about when a highway is located through poorly drained sections of the State.” This is a reference, in part, to the difference in elevation, soil saturation, and soil consolidation between the northern and southern areas of Louisiana or, more specifically, between the less-saturated soils of the Pine Hills and Prairies regions in the north and the more-saturated, highly compressible soils of the Coastal Marshes and Alluvial Plains in the south. The unconsolidated soils in the south are susceptible to compression, subsidence, and foundation settlement. He went on to say that “the development and prosperity of the State are dependent upon River Protection, Good Roads and Drainage.”¹⁷⁸

When long-serving State Bridge Engineer Normal E. Lant arrived in Louisiana in 1919 to begin his new job, he found the state virtually road-less. His wife later recalled that the only way to New Orleans was by railroad or boat. Lant qualified for the position, in part, because of his particular college coursework in geology “that dealt with the intricacies of construction in heavily saturated lands.” He had come to the right place to put his training to good use.¹⁷⁹

By the early 1920s, with the advent of the recently formed LHC, the problems of soil conditions and their effects on road and bridge construction received increased attention. In 1924 State Highway Engineer (and Lant’s supervisor) J.M. Fourmy stated, “I am sure no state in the entire United States offers greater construction difficulties than are encountered on some of our swamp and marsh road projects; and the problem is not alone one of physically constructing the road but often the difficult one of financing the project.” The problems were caused particularly by the large area of swamp and marsh land, poor foundation conditions, and drainage canals being dug or existing ones enlarged across the state’s highways. In response, the LHC initiated a new program of soil surveys “in connection with planning and constructing highways through swamp and marsh areas where soil conditions are very poor.” A chemist was employed for analysis of surface and subsurface samples to determine the anticipated shrinkage and subsidence to be expected in the soil at a project location. The most extensive use of the new soil survey program was in planning the Hammond-New Orleans Highway and involved areas along the shores of Lake Pontchartrain. In conducting the soil surveys for a proposed road from Vinton to the Sabine River in Calcasieu Parish, the “Wash boring process” was used to analyze subsoil strata and determine “the probable length of piling for timber trestle work.” Without this process and analysis, according to the engineers, it would have amounted to “more or less guess work, [and] the construction of [the project] would have been an experiment.”¹⁸⁰

As the LHC embarked on a series of ambitious bridge projects at major river crossings in the early 1930s, new and more difficult design and construction situations were encountered, and complex engineering solutions were required for foundations. These were identified as “bond bridges” in a constitutional amendment of 1930 and involved 10 highway crossings of major state waterways requiring unusually large amounts of funding. The 1930-1932 biennial report stated:

¹⁷⁸ Louisiana State Highway Department, Report of the State Highway Engineer, 1916-1918, 25-26.

¹⁷⁹ Corley, 2.

¹⁸⁰ Louisiana Highway Commission, Third Biennial Report, 1924-1926, 78.

The bridging of the Red, Ouachita, Black and Atchafalaya Rivers presents many difficult foundation problems. All of these streams are large rivers having relatively large variations between low water and high water, and in general the river beds consist of materials unsuitable for heavy bridge foundations, thereby necessitating the employment of various types of subaqueous pier design and various methods of construction.¹⁸¹

The bridge foundation and substructure challenges were significant and prompted major innovative designs and technologies. The issue of deep and unstable soils was first resolved through a series of new approaches to piles, incorporating materials and designs that allowed piles to reach new depths exceeding 200 feet in some cases. In even more difficult and even hazardous situations, the solutions involved pneumatic caissons and new specialized caisson technology, notably with the National Historic Civil Engineering Landmark Mississippi River Bridge at New Orleans (also known as the Huey P. Long Bridge).¹⁸² Sometimes, instead of foundation depth, bridge length across extremely wide expanses of open water posed significant challenges. This was the case with the record-breaking length of the Lake Pontchartrain Causeway. The foundation problems and solutions for these bridges are discussed in Section 3.C.(1).

B. Bridge-building materials

Like other states, Louisiana's bridges are constructed using materials that were available, economical, and suitable for the technology of the time. Of the four basic bridge-building materials used nationally—stone, wood (or timber), metal (iron and steel), and concrete (reinforced and prestressed)—Louisiana bridges employed all but stone masonry. This is due to the lack of stone as a natural material in the state. Before the national introduction of steel and concrete in the 1890s, Louisiana used only wood (or timber) and iron for bridge building.

The percentage of the number of bridges by material is shown in Figure 2 below.¹⁸³ Concrete bridges make up the largest percentage of the total bridge population with 63 percent (reinforced and prestressed concrete combined), followed by wood/timber with 22 percent, and metal/steel with 15 percent. Rather than organizing the following discussion by prevalence in the state, bridge materials are presented by their first use both nationally and within the state.

¹⁸¹ Louisiana Highway Commission, Sixth Biennial Report, 1930-1932, 367.

¹⁸² The Mississippi River Bridge at New Orleans/Huey P. Long Bridge was dedicated as a National Historic Civil Engineering Landmark in September 2012. Recall No. 000060 (extant).

¹⁸³ Note: Three bridges with unknown construction materials were found in the LADOTD's MSF and FHWA's NBI for Louisiana. They represent a statistically insignificant amount to the total bridge population and were not included in the count. All other percentages were rounded to the nearest percentage to equal 100. The MSF database was provided by LADOTD on June 20, 2012, and the NBI was provided by the FHWA on June 13, 2012.

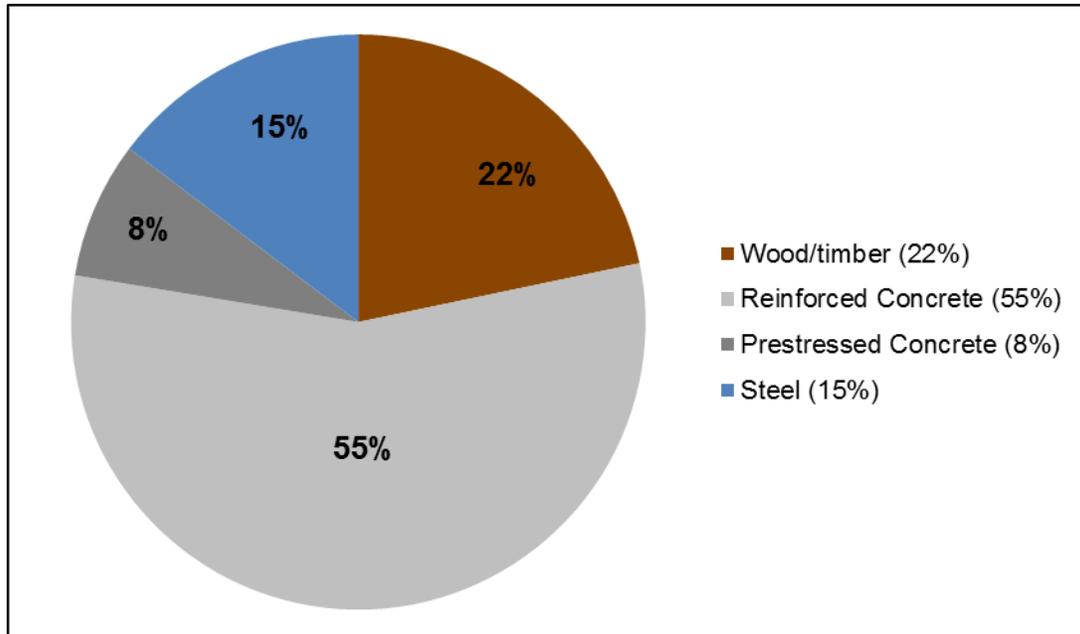


Figure 2. Louisiana bridges built prior to 1971, by material.

(1) Wood/timber

Louisiana's earliest bridges (built prior to the twentieth century) were constructed of timber, a readily available material. Nationally, timber was used for the earliest American bridges due to its abundance, simplicity, and low cost to erect, as well as its ability to be worked with few tools. Timber's disadvantages include its natural susceptibility to deterioration, high maintenance requirements compared to other bridge materials, lack of resistance to fire, and loading limits. Untreated timber bridges have a relatively short life-span. An exposed wood bridge may be expected to last up to 10 years if it is not damaged by fire or a flood.¹⁸⁴ The impermanence of wood was an accepted fact in Louisiana as timber bridges were prone to rapid decay in the humid climate. As a result, timber bridges required continuous maintenance and frequent replacement.¹⁸⁵ Because early bridges needed to be constructed quickly, low erection cost was more important than longer-term maintenance costs.

Although iron supplanted wood as the preferred material nationally for railroad bridges in the mid-nineteenth century, Louisiana railroads continued to use wood, largely because foundation technology had not yet developed to support the heavier metal structures in the state's unstable soils. Moreover, timber continued to be more abundant and economical than iron. A similar situation prevailed with the rise of automobile transportation and vehicular bridge construction in the twentieth century; wood bridge construction declined nationally, but remained viable in Louisiana.¹⁸⁶ Timber bridges in Louisiana usually

¹⁸⁴ F.J. Angier, "The Seasoning and Preservative Treatment of Wood Ties," *Railway Age Gazette* 48 (1910), 409.

¹⁸⁵ URS Greiner Woodward Clyde, 2-3.

¹⁸⁶ National Research Council, *A Context for Common Historic Bridge Types*, prepared for the National Cooperative Highway Research Program, Transportation Research Council, National Research Council, by Parsons Brinckerhoff and Engineering and Industrial Heritage, 2005, 2-6, 2-25, 3-80. Hereafter identified as *Common Historic Bridge Types*.

had short spans of between 10 and 30 feet and typically featured treated timber stringers or beams as the primary superstructure supported by an open, braced timber trestle framework. There are two subtypes of timber bridges: timber trestle and mud sill. Timber trestle bridges are constructed of treated timber in an elevated beam or girder structure supported by an open, braced trestle on timber bents. Bridge beams are constructed from logs, sawn lumber, or glued-laminated timber. The timber mud sill is similar to a timber trestle but rather than the pilings typical of a trestle, the timber mud sill bridge is supported on spread timber footings, known as “mud sills,” that distribute the bridge load.

The timber trestle was one of the earliest known standard bridge plans in Louisiana, developed by state engineers in 1917. By 1924 the newly formed LHC had developed a number of timber bridge standard plans. Mud sill standard plans were developed for LHC use in the 1930s and 1940s. Standard plans for wood/timber bridges included designs for trestle bridges, multiple box culverts, trusses, and movable spans.¹⁸⁷

To extend the life of a timber bridge and prevent wood rot and deterioration, creosote, a distillate of coal tar, was commonly applied to wood members prior to construction, creating what is termed “treated timber.” Most LHC designed bridges specified use of creosote timber. A light treatment of creosote could approximately double the life of an untreated timber bridge by preventing decay and termite destruction.¹⁸⁸ According to the LADOTD MSF and FHWA NBI, all extant timber bridges in the state were treated with creosote.¹⁸⁹ Despite the use of treated timber, maintenance of these structures still requires frequent replacement of deteriorated members.

(2) Metal (iron and steel)

Use of metal as a building material in the U.S. progressed from cast and wrought iron in the mid-nineteenth century to steel after 1890. Steel provided increased strength and versatility, resisting failure that had plagued its iron predecessors. It is unknown if any cast or wrought iron bridges were ever constructed in the state. Rolled steel beams were introduced nationally in 1885, facilitating the material's use for short bridge spans. By 1895 steel overtook iron as the metal of choice. Improvements to steel through the mid-twentieth century increased the material's strength and durability and provided many options to bridge designers. As a result, span lengths were increased and new designs were developed. All extant metal vehicular bridges in Louisiana are constructed of steel.

Louisiana's earliest steel bridges were constructed for railroads. The oldest documented steel bridge in the state is the Levert-St. John Bridge in St. Martinville, a movable Warren truss constructed in 1899 for

¹⁸⁷ Information based on a review of archived and digitized standard plans dating from 1915 throughout the study period provided by LADOTD, Baton Rouge, La.

¹⁸⁸ "Report of the Research and Extension Activities of the Engineering Schools and Departments for the Sessions of 1935-1936," *Engineering Bulletin Purdue University, Research Series Number 55, Engineering Experiment Station 20*, no. 5 (September 1936), 13-15.

¹⁸⁹ The bridge types described are those that are known to be extant in Louisiana based on an analysis of the LADOTD MSF and FHWA NBI data. There may be additional extant unidentified bridges that are not represented in the data.

railroad use, but later converted to vehicular use.¹⁹⁰ In the early twentieth century, steel truss bridges were used by the LHC to span wide rivers; in fact, the first highway bridge constructed over the Mississippi River at New Orleans (Huey P. Long Bridge, built in 1935) was done with a steel truss bridge.¹⁹¹ While its use as a bridge material is less common than concrete or timber in Louisiana, steel bridges have been constructed throughout the study period in the following forms: plate girder, I-beam, and truss.

(a) Steel connection methods

The connection of steel structural members in bridges historically has been achieved by a variety of methods, including pins, rivets, welding, and bolts. In many cases a metal bridge will employ multiple types of connection methods, depending on the bridge design. In Louisiana, all four connection methods were used in bridge construction.

The use of pin connections, introduced in truss bridges in the 1840s, allowed for easier erection of bridges, some of which could be completed off-site. Pin connections feature removable iron or steel cylinders inserted into holes aligned in adjoining structural members. This connection type was specifically recommended by bridge engineer James Waddell in his 1916 *Bridge Engineering* to be appropriate for long span trusses. Pin connections were gradually replaced by riveted connections in the early twentieth century.¹⁹²

Riveting became widespread after pneumatic or mechanical riveting replaced manual riveting in the late-nineteenth century. Rivets were the common steel truss-bridge connection method nationally and in Louisiana until replaced by high-strength bolts in the 1960s. Standard LHC specifications from the 1920s provided guidance for riveting, including the use of pneumatic hammers and the amount of field rivets to furnish at each construction site.¹⁹³ The Department's preference for riveted connections is reflected in the number of standard plans developed utilizing this connection type. Between 1920 and 1937, the Department developed 46 riveted truss standard plans for highway use.¹⁹⁴

In the mid-twentieth century, riveted connections were replaced with high-strength bolts. The transition away from riveted connections posed a problem for one state-designed bridge. When the plate girder bridges carrying I-10 across the City Park Lake in Baton Rouge were designed in the 1950s, riveting was still the preferred connection type.¹⁹⁵ During the time that a multi-year delay in construction occurred,

¹⁹⁰ This bridge is extant, but was bypassed in 2002 with a new bridge and is not in vehicular service.

¹⁹¹ Recall No. 000060 (extant).

¹⁹² *Common Historic Bridge Types*, 2-16; James Waddell, *Bridge Engineering* (New York: John Wiley and Sons, 1916), 747.

¹⁹³ Louisiana Highway Commission, "Pamphlet 'M'" *Standard Specifications February, 1929* (Baton Rouge, La.: Louisiana Highway Commission, 1929), 10.

¹⁹⁴ Archived and digitized standard plans are available from the LADOTD in Baton Rouge, La.

¹⁹⁵ Recall Nos. 052680 and 052690 (both extant).

riveting went out of practice and experienced crews quickly vanished from the contract work force. When construction of the bridge began in 1964, the Department had to train workers to rivet the structure.¹⁹⁶

By the mid-twentieth century, the LHC considered bolts and welds an acceptable and even desirable substitute for rivets in certain situations.¹⁹⁷ Although bolts had been used for structural connections on highway bridges for many decades, these connections, which were called “unfinished bolts,” could not be tightened sufficiently to eliminate the possibility of slippage under shear loads.¹⁹⁸ Use of high-strength bolts, manufactured from carbon steel and heat-treated for strength, was fairly new for structural steel connections in the 1950s. High-strength bolts were first used on railroad bridges and were seen as a favorable option because they were cheaper to install in the field than rivets, thanks largely to reduced labor costs.¹⁹⁹ The transition from rivets to high-strength bolts on highway bridges was slow nationwide and may have been prompted by the formation of the Research Council on Riveted & Bolted Structural Joints in 1947. The council was established “to advance the state of the art of civil engineering structural connections using threaded fasteners and rivets.”²⁰⁰ Researchers found that high-strength bolts had many advantages over riveting, including being stronger than rivets in both shear and tension, less expensive to produce, easier to install in the field, requiring a smaller installation crew, and needing fewer inspections because the mass-manufactured bolts were more uniform than rivets.²⁰¹

In 1955 the LDH embraced the use of high-strength bolts, which prior to this time were not permitted without specific approval of the State Highway Engineer.²⁰² In 1958 high-strength bolts were used exclusively as the steel connection method on the Bayou Boeuf Bridge near Morgan City.²⁰³ Reflecting the advantages of high-strength bolts, an article written about the bolting process on the bridge stated that bolting “speeds Louisiana bridge erection.” Bolts were chosen over riveted connections for the bridge because “they required less work and were cheaper to install.” Workers could set an average of

¹⁹⁶ James Porter, interview by Robert Frame of Mead & Hunt, Inc., en route to Leesville, La., 19 July 2010.

¹⁹⁷ Louisiana Highway Commission, *Standard Specifications for Roads and Bridges* (Baton Rouge, La.: Louisiana Highway Commission, 1955), 263.

¹⁹⁸ Wayne Henneberger, “High Tensile Bolting of Highway Structures,” *The Texas Engineer* 27, no. 7 (August 1957), 9; W. H. Munse, “High-Strength Bolting,” *AISC Engineering Journal* (January 1967), 36.

¹⁹⁹ T.R. Higgins and Mace H. Bell, “High-Strength Bolts - A New Structural Fastener,” in Proceedings of the Texas Structural Engineering Conference, 21-22 March 1952 (Austin, Tex.: The University of Texas, Department of Civil Engineering and Bureau of Engineering Research, [1952]), 43.

²⁰⁰ “Research Council on Structural Connections, Background and Scope,” Research Council on Structural Connections, <http://www.boltcouncil.org/files/RCSCApplicationonlineform.pdf> (accessed 17 September 2012); “Minutes of [First] Meeting, Research Council on Riveted & Bolted Structural Joints, New York City, 15 January 1947,” Research Council on Structural Connections, <http://www.boltcouncil.org/files/OriginalMinutes.pdf> (accessed 17 September 2012).

²⁰¹ Munse, 36.

²⁰² Louisiana Highway Commission, *Standard Specifications 1929-1940*.

²⁰³ Recall No. 051390 (extant).

800 bolts a day with practically 100 percent consistency in specified torque. In total, 36,025 bolts were used in the construction of the bridge.²⁰⁴

Welding was also an accepted LDH steel connection method beginning in the 1950s. Arc-welding is a process by which steel parts are joined in their molten state, thus creating a metallurgical bond. Intense heat is provided to the joint by an electric arc. Before being applied to dynamically loaded structures, such as bridges, arc-welding was reserved for buildings and other statically loaded structures, including pipe work and shipping vessels during and after World War I.²⁰⁵ Nationally, arc-welding was first applied to the connection of metal bridges in the 1920s, and the process was readily accepted by the 1940s.

After World War II, state highway departments across the nation embraced arc-welding over riveting for fabricating built-up steel girders. Welding meant a reduction in the size and weight of structural members, allowing a lighter superstructure, reduced fabrication time and expense, and smoother surfaces with lower maintenance costs and less corrosion. Compared with riveting, welding typically resulted in a 15 to 20 percent savings in steel weight by making possible edge-to-edge joints without flange angles, splice plates, and rivets.²⁰⁶

Increased use of welding over riveting for connections after World War II allowed the design of more economical and lighter superstructures. The LDH embraced welding in the 1950s, providing guidance and standards in the state's 1955 *Standard Specifications for Roads and Bridges* that all shop and field welding, when authorized, should conform to the "latest specifications for Welded Highway and Railway Bridges of the American Welding Society."²⁰⁷ An example of an all-welded structure is the plate girder bridge in Lake Charles, which carries I-210 over the ship canal to the Calcausieu River.²⁰⁸ Opened in 1964, it had the longest all-welded steel girder span in the U.S. at that time with a main span of 225 feet.²⁰⁹ The practice of all-welding structures was discontinued in the late 1970s as it was found that the welds were susceptible to fatigue crack failure. As a result, welding was replaced by bolted connections and splices.²¹⁰

(3) Concrete

Concrete is the most common bridge construction material in Louisiana, representing 55 percent of the total extant bridge pool. Extant concrete bridge types include: arch, slab (precast, cast-in-place, and voided), rigid frame, deck girder, pipe and box culverts, and channel units.

²⁰⁴ "Bolting Blitz," *Roads and Streets* (December 1958), 45.

²⁰⁵ Nathan W. Morgan, *Welded Bridge Construction* (Washington, D.C.: U.S. Department of Commerce, Bureau of Public Roads, [1957]), 1; H.M. Priest, "Strength of Structural Welds," *Engineering News-Record* 107 (17 September 1931): 436.

²⁰⁶ A.L. Elliott, "How To Use High-Strength Steel Effectively," *Engineering News-Record* 164 (18 February 1960): 52-56.

²⁰⁷ State of Louisiana Department of Highways, *Standard Specifications for Roads and Bridges* (Baton Rouge, La.: Department of Highways, 1955), 263.

²⁰⁸ Recall No. 033210 (extant).

²⁰⁹ La Motte Grover, "Welding for Bridges," *Civil Engineering* 33 (December 1963): 60.

²¹⁰ Common Historic Bridge Types, 3-110.

Concrete is made up of a binder (cement) and an aggregate that hardens and strengthens over time due to a chemical reaction when mixed with water. In use, concrete is strong in compression forces, but weak in resistance to tensile stresses. Early concrete bridges took on an arched form because the arch is a compressive form, which worked well with the compressive strength of concrete. In the modern period, concrete was first used in American bridges as early as the 1870s.²¹¹

Concrete became more common for bridge building after methods of reinforcement with metal were introduced, improving concrete's tensile strength and resistance to longitudinal stress. The technological advancement of reinforcing in concrete allowed engineers to expand beyond the arched form and experiment with reinforcing beams/girders and slab spans. By the 1930s a new technological advancement in concrete was developed called prestressing that allowed concrete beams to be extended. Prestressed concrete emerged nationally for bridge construction in the 1950s. Reinforced and prestressed concrete construction are discussed below.

Another advancement in concrete bridge design that occurred in the post-World War II period was the ability to precast concrete members and ship them to the construction sites. Prior to this time, most concrete bridges were cast in place. Precast concrete was used not only by the LDH for standard short-span bridges, but was also popular amongst police juries for parish structures. Precasting was well-liked by police juries for a number of reasons, chiefly the economy provided by off-site mass production, elimination of on-site production problems common to cast-in-place bridge construction, and cost savings resulting from needing only a small construction crew to erect the precast structure. Also, precast units allowed for quick repair or replacement of existing structures with minimal disruption to traffic. A *Louisiana Police Jury Review* article from 1965 further describes the additional advantages precast structures had over other construction techniques:

[precast construction] is particularly advantageous in isolated places where labor and materials are not readily available. It facilitates the bridging of swamps where erection of centering is difficult and the crossing of railroads and highways where construction interferes with traffic. It is also well suited for structures crossing bodies of water since it eliminates many of the inherent dangers of construction over open water.²¹²

(a) Reinforced concrete

Advances in steel in the late nineteenth century allowed for expanded use in combination with concrete as steel was embedded within concrete to provide tensile strength. The resulting concrete and steel combination was referred to as reinforced concrete. In 1889 Ernest Ransom designed and constructed the Alvord Lake Bridge in San Francisco's Golden Gate Park, the first reinforced concrete bridge in the United States.²¹³

²¹¹ *Common Historic Bridge Types*, 2-17; Robert M. Frame, *Reinforced Concrete Highway Bridges in Minnesota* (Washington, D.C.: National Register of Historic Places Multiple Property Documentation Form, 1989), E-1 to E-2.

²¹² "Bridges Use of Precast Units Being Universally Adopted," *Louisiana Police Jury Review* (April 1965): 93.

²¹³ *Common Historic Bridge Types*, 2-17; David Plowden, *Bridges: The Spans of North America* (New York: Viking Press, 1974), 298.

The use and popularity of reinforced concrete grew steadily in the early twentieth century. Reinforced concrete was promoted as the ideal bridge material due to its durability and minimal maintenance compared to timber or steel bridges, as well as freeing engineers and contractors from large steel companies.²¹⁴ According to Fritz von Emperger, a pioneer in concrete reinforcing systems, in 1904, “ten years ago the number of concrete-steel bridges was so small that there would have been no difficulty in giving a complete list, whereas now it would be quite impossible to give such a list.”²¹⁵ Concrete became the building material of choice in Louisiana in 1914 for its economy, durability, and minimal maintenance. The 1912-1914 State Board of Engineers biennial report sums up the Highway Department’s (precursor to the LHC) views on using reinforced concrete over other materials:

The department is of the opinion that reinforced concrete bridges and culverts are more economical and safer in the end than some cheaper form of construction having a large annual maintenance expense and upkeep, and therefore the Department has for the past year and a half, advocated and urged the construction of reinforced concrete bridges and culverts, where possible, on all State Aid Highways, and it is gratifying to note how rapidly many of the Road Districts and Parishes are concurring with the Highway Department in replacing the old wooden form of construction with that of a more permanent and economical concrete structures.²¹⁶

The biennial report further extolls the State Highway Department’s use of the material, having already constructed nearly 3,000 linear feet of reinforced concrete bridges and more than 5,500 linear feet of reinforced concrete culverts on newly constructed State Aid Highways in Grant, Sabine, Caddo, DeSoto, Madison, Caldwell, Lafayette, East Baton Rouge, Plaquemines, Iberia, and East Carroll Parishes between 1912 and 1914.²¹⁷ All of Louisiana’s concrete bridges are believed to be reinforced not only due to their date of construction but also because the earliest standard concrete bridge plans, dated 1915, employ reinforcing. Unreinforced concrete bridges, sometimes termed “plain concrete,” are rare nationally.

Gradually reinforced concrete bridges replaced the steel truss as the standard American bridge as engineers designed innovative new bridges in concrete, aided by the tensile strength of reinforcement. The arch form, while still popular, was no longer the only bridge type that engineers could construct with concrete; standard plans were developed in the early twentieth century for non-arched bridge types, including slab and girder bridges.²¹⁸ The 1914-1916 biennial report includes reinforced concrete bridge plans for 40- and 60-foot spans of arch, slab-and-beam, and slab-and-girder designs, and by the 1930s the LHC developed standard reinforced concrete bridge plans for arches, box culverts, and pile trestles

²¹⁴ Common Historic Bridge Types, 2-26.

²¹⁵ Common Historic Bridge Types, 2-25 to 2-26.

²¹⁶ Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914, 83.

²¹⁷ Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914, 83, 88-91.

²¹⁸ Common Historic Bridge Types, 2-26.

and girders with spans up to 40 feet.²¹⁹ During World War II, shortages of materials, specifically metal, led to the limited use of un-reinforced concrete; however, it is not known if any plain concrete structures were constructed in Louisiana.²²⁰ It should be noted that bridge construction during this period was slowed as the nation focused on the war.

(b) Prestressed concrete

Prestressed concrete was the next innovation in concrete bridge design and represents 8 percent of the bridge pool. Prestressed concrete bridges were constructed in the state beginning in the 1950s through the study period.

Prestressed concrete is superficially similar to reinforced concrete in that both employ longitudinal steel elements within a beam of concrete. As prestressed-concrete pioneer engineer T.Y. Lin explains, “the steel is pre-elongated so as to avoid excessive lengthening under service load, while the concrete is precompressed so as to prevent cracks under tensile stress. Thus an ideal combination of the two materials is achieved.”²²¹ The major difference between reinforced concrete and prestressed concrete, according to Lin, is the latter’s use of higher-strength materials, including high-tensile steel and high-strength concrete. There are two types of prestressed concrete: post-tensioned and pretensioned. To form pretensioned concrete, steel reinforcing rods are stretched and placed into forms and held under stress until the concrete is poured. Once the concrete is hardened, it holds the steel to its stressed length. Post-tensioned concrete is formed when the steel rod or wire is inserted through open recesses or along the outside of the concrete member and is stretched and attached with a permanent anchor to maintain stress.

Experiments with prestressing concrete took place as early as the late nineteenth century, and in the 1920s the idea of linear stressing became more practical through the work of French engineer Eugene Freyssinet. In 1939 Freyssinet patented the process that allowed the depth of large spans to be reduced by about half for the same concrete section.²²² Since prestressing offered economic advantages, during the Depression state engineers began to study and experiment with the material. State departments of transportation in Florida, Tennessee, California, and Pennsylvania were involved in the early development and use of prestressing.²²³

²¹⁹Archived and digitized standard plans are available from the LADOTD in Baton Rouge, La. Discussion of standard plans in this document refers to those standard plans that were available from LADOTD, and may not represent all of the plans developed by the Department over its history; Louisiana State Highway Department, Report of the Board of State Engineers, 1912-1914. Bridge plans are unpaginated and are opposite the following pages: 142, 164, 182, 198, 232, 264, 270, and 272.

²²⁰ Common Historic Bridge Types, 2-26 and 2-24.

²²¹ Tung Y. Lin, *Design of Prestressed Concrete Structures* (New York: John Wiley & Sons, Inc., 1955), 9.

²²² Kenneth Frampton, *Modern Architecture: A Critical History* (New York: Oxford University Press, 1980), 40.

²²³ Carl W. Condit, *American Building: Materials and Techniques from the First Colonial Settlements to the Present*, 2d ed. (Chicago: University of Chicago Press, 1982), 248; *Common Historic Bridge Types*, 3-104.

It was not until the 1950s that prestressing became widely used across the country, following the completion of the Walnut Lane Bridge in 1949, considered the first prestressed concrete bridge in the U.S. In response, the BPR published engineering specifications for prestressed concrete bridges in its early 1950s publication, *Criteria for Prestressed Concrete Bridges*. Prestressed concrete was not included in the AASHTO specifications until 1961 due to continuing research and innovations throughout the 1950s.²²⁴ Louisiana's *Standard Specifications for Roads & Bridges* guided prestressed construction by the 1960s. In the state specifications a number of aspects relating to prestressed concrete were discussed, including stressing equipment requirements, the method of pretensioning or post-tensioning, standards for the beams, testing, transportation, and inspection. The Department also published specific standard specifications for precast, prestressed concrete piles and precast, prestressed concrete girders.²²⁵ According to former LDH engineer James Porter, the first prestressed girders used by the LDH in 1961 were designed based on the national AASHTO prestressed girder standard plans.²²⁶

Prestressed concrete has significant advantages over reinforced concrete. Prestressed concrete requires a smaller quantity of steel and concrete to carry the same loads as reinforced concrete and results in more efficient use of materials.²²⁷ Like the reinforced concrete beam, a prestressed concrete beam is made deeper to provide greater span length. Because of the prestressing technology, however, a prestressed beam can be proportioned to achieve a longer length with less beam depth. The prestressed beam can provide greater vertical clearance, especially for Interstate highway use, where prestressed beams have been widely employed. Additionally, prestressed beams are more durable and resistant to corrosion than reinforced-concrete beams.²²⁸

A disadvantage to prestressed beams is the specialized tensioning or casting bed required for their manufacture, meaning they cannot readily or easily be produced on-site unless the project is large enough to justify a major investment. The design and construction of the casting beds were technological achievements in their own right in the early years of prestressed development, thus limiting the process of prestressing to those precasters who made the investment in beds and could provide transportation of the increasingly longer and heavier beams to the project site. On the other hand, precasting of prestressed concrete units allowed cost savings, as large quantities of beams could be mass produced at yards and then delivered to construction sites, allowing reuse of forms.²²⁹ Louisiana had limited precasting yards in the state during the 1950s and early 1960s. According to LADOTD engineer James Porter, prestressed

²²⁴ American Association of State Highway Officials, *Standard Specifications for Highway Bridges (1957)*, (Washington, D.C.: American Association of State Highway Officials, 1957), xxiii.

²²⁵ State of Louisiana Department of Highways, *Standard Specifications for Roads and Bridges* (Baton Rouge, La.: Department of Highways, 1966), 261, 277, 330, 334-336.

²²⁶ James Porter, interview by Robert Frame of Mead & Hunt, Inc. en route to Leesville, La., 19 July 2010.

²²⁷ Tung Y. Lin, *Design of Prestressed Concrete Structures*, 2d ed. (New York: John Wiley & Sons, 1963), 30-33.

²²⁸ Lin, *Design of Prestressed Concrete Structures*, 2nd ed., 31-32.

²²⁹ Lin, *Design of Prestressed Concrete Structures*, 31; Tung Y. Lin and Felix Kulka, "Fifty-Year Advancement in Concrete Bridge Construction," *Journal of the Construction Division, Proceedings of the American Society of Civil Engineers* 101, no. CO3 (September 1975): 494-495.

girders were often either ordered from a plant near Biloxi, Mississippi, or constructed at a prestressing yard at the construction site, complete with prestressed girder casting beds.²³⁰

(c) Lightweight concrete

Lightweight concrete was a material innovation researched and utilized by numerous states to construct lighter structures in the 1960s. Lightweight concrete, used for decks, was an integral part of the design of composite steel beam bridges that grew out of the 1961 American Institute of Steel Construction (AISC) Specifications. Lightweight concrete had advantages of fire resistance and reduced dead load compared to traditional concrete, making it attractive in bridge design. However, early research indicated that lightweight concrete had disadvantages of greater shrinkage and reduced elasticity.²³¹

The LDH used lightweight concrete for a short time in the 1960s. The use of the material was in part an effort to support regional industries where clay was mined and used the primary aggregate in the concrete mixture. In the early 1960s lightweight concrete was used for 98 composite deck superstructures on Louisiana highway bridges. While the cost of lightweight concrete was higher than regular concrete, it was determined that the added cost was offset by the reduction of dead weight on the bridge. As a result, two steel girders were used instead of five for two-lane structures. Even though the bridges were found to be economical to build in comparison to other structure types, many did not perform as was expected, experiencing concrete cracking, scaling, pitting, chipping, and flaking within a short time after construction. Many of these decks have since been replaced.²³²

Investigation into the use of lightweight concrete was undertaken by researchers Humphreys Turner and Rodolfo Aguilar of the Louisiana State University Division of Engineering Research in 1965 to determine the reasons for the concrete cracking. Field investigators found that lightweight concrete superstructures were more “flexible” than normal weight structures causing more displacement within the bridge. It was ultimately determined that a number of factors resulted in the cracking, including shrinking and deflection. The largest contributor to cracking was the shrinkage and expansion of the concrete in relation to the steel girder caused by improper curing and hydration of the concrete. The cracks caused by shrinking were then made worse by the flexibility and oscillation of the superstructure under moving loads.²³³ The Department also found that the lightweight concrete decks were susceptible to failure and would crumble. According to Porter, the lightweight concrete was a “very poor choice of material for a bridge deck that serves as the roof of the bridge and as the member of the bridge that has the greatest impact [and] direct contact with the wheels of the traffic.” In fact, Porter indicated that plywood forms were erected under the concrete deck to ensure that the concrete would not fall out before the decks were

²³⁰ James Porter, interview by Robert Frame of Mead & Hunt, Inc. en route to Leesville, La., 19 July 2010.

²³¹ Irwin Benjamin, “Composite Beams of Steel and Lightweight Concrete,” *American Institute of Steel Construction Engineering Journal* Q4 (October 1965), 125.

²³² Humphreys Turner and Rodolfo Aguilar, *Performance of Composite Lightweight Concrete Decks on Steel Stringers*, prepared for the Louisiana Department of Highways (1965), 1-3; Don Sorgenfrei, interview by Robert Frame of Mead & Hunt, Inc., New Orleans, 18 July 2012.

²³³ Turner and Anguilar, 86-88; James Porter, interview by Robert Frame of Mead & Hunt, Inc. en route to Leesville, La., 19 July 2010.

replaced.²³⁴ Though the earliest form of lightweight concrete was unsuccessful in Louisiana, technology has evolved from its earliest application and is used in bridge construction today.²³⁵

C. Bridge design

Bridges are generally comprised of a substructure and superstructure. The substructure, which includes the foundation, supports the bridge's superstructure and the superstructure supports the bridge's use (e.g., vehicles, railroad, etc.). Traditionally, historic bridge inventories focus on the superstructure and bridges are categorized based on the various types of superstructures found in the state. For certain bridges in Louisiana, however, the substructure can be equally or more important than the superstructure. Substructure and superstructure design is explained in the following section. A description of the substructure technology needed to construct bridges in Louisiana is discussed first, followed by a general description of superstructure design.

(1) Substructure design and construction

Because great expanses of Louisiana's geography, particularly the southern area of the state, are comprised of rivers, floodplain, marshes, and large areas impacted generally by water, the soils and river beds have presented severe challenges to highway and bridge design and construction. In particular, these soil conditions have posed major problems for the construction of bridge substructures, which include the foundation. Beginning with railroad bridge construction at the end of the nineteenth century and continuing with vehicular bridges in the twentieth century, engineers were forced to develop innovative methods for constructing substructures to support increasingly larger and longer bridge superstructures.

In Louisiana, bridges became larger to carry increasingly greater loads over major waterways, particularly the Mississippi River, and longer to cross the state's expanses of marshland and lakes, particularly Lake Pontchartrain. Each of these developments in size and length required more complex engineering. Some of the innovations developed in Louisiana substructure design have pioneered engineering strategies of national significance.

A bridge substructure, which carries the superstructure, typically is comprised of two parts: the foundation or lower part and the remaining upper part that is supported by the foundation.²³⁶ In the development and evolution of bridge substructures in Louisiana, substructures have sometimes consisted of separate foundations and sometimes incorporated the foundation into the substructure with no particular differentiation. The categories of foundations used in Louisiana may not be different from those used nationally, but some Louisiana applications may be more complex, advanced, or experimental because of the special soil conditions encountered in the state. Most of the buildings in New Orleans, for example, were built on pile foundations beginning in 1897, and the highly compressible soils of the city are typical

²³⁴ James Porter, interview by Robert Frame of Mead & Hunt, Inc. en route to Leesville, La., 19 July 2010.

²³⁵ Don Sorgenfrei, interview by Robert Frame of Mead & Hunt, Inc., New Orleans, 18 July 2012.

²³⁶ Henry S. Jacoby and Roland P. Davis, *Foundations of Bridges and Buildings* (New York: McGraw-Hill Book Company, Inc., 1914), 1. General background information on substructures and foundations are adapted from this volume, unless otherwise noted.

of the soil deposits at bridge locations in the Mississippi River basin. Coping with foundations for both buildings and bridges inspired innovative technological solutions.²³⁷ Generally, the categories of foundations include: spread footings or mud sills, pile foundations, and caissons, all of which are discussed below.

(a) Spread footings and mud sills

A spread footing is one of the simplest forms of a foundation and is a variation on the practice of merely widening the base of a wall or pier to distribute the bridge load over a sufficient area to provide necessary support. As opposed to a widened base, a spread footing is concrete that is reinforced. Spread footings are rarely used as foundations in bridge construction because they provide very limited support for such large structures, and depend to a great degree on the stability of the soil beneath the footing.

Louisiana's earliest bridge standard plans, prepared in 1915 by the Highway Department of the Louisiana Board of State Engineers (precursor to the LHC), indicate spread footings as the only option for bridge foundations. On the plans they are termed "mud sills." The sizes vary among the plans, but are typically rectangular blocks of reinforced concrete, ranging from 3 to 6 feet in length, 2 to 3 feet in width, and not more than 3 feet in depth.²³⁸

In standard plans for concrete bridges issued two years later, in 1917, spread footings were still indicated, but had become much longer and wider relative to their depth. More importantly, however, the 1917 plans provided an alternative foundation of wood pilings. The "Plan of a Concrete Girder Bridge" included the following note, along with a sketch: "1/4" scale detail of alternate design of footing, using wooden piles. Piles should be used where the safe bearing power of the soil is less than 1500 lbs per sq ft."²³⁹ These plans from 1917 appear to represent the last recommendations for spread footings for bridges in Louisiana and mark the transition to pile-supported foundations, a technology that has been used ever since, in one form or another.

(b) Pile foundations

A pile is described as "an element of construction placed in the ground, either vertically or nearly so, to increase its power to sustain the weight of a structure, or to resist a lateral force." They distribute load to the earth through a considerable depth, either by friction alone or by friction in combination with bearing on the pile end. Piles are categorized by their material, cross-section, inclination, and use, and by attachments they may have. The basic material types include timber, steel, concrete, and prestressed concrete. Cross-sections may include round or octagonal. Inclination includes batter piles, driven at an angle to provide lateral support. Use or function may include guide piles or sheet piles. Attachments

²³⁷ Lloyd A. Held Jr., "History of Driven Piles in New Orleans," *Louisiana Civil Engineer* 12 (February 2004): 5.

²³⁸ Louisiana State Highway Department, Report of Board of State Engineers, 1914-1916. Bridge plans are unpaginated; see plan sheets with spread footings and/or mud sills opposite pp. 142, 164, 182, 198, 232, 264, and 270.

²³⁹ Louisiana State Highway Department, Report of Board of State Engineers, 1914-1916. See concrete bridge plan sheets opposite pp. 50 and 98.

include screw piles or disk piles. The details of piles, including pile types and the technology of driving piles, is not discussed in this context.²⁴⁰

Piles were in active use in Louisiana in the 1870s for railroad bridge construction. The pile foundations of major Louisiana railroad bridges were discussed in detail in the national engineering literature in the early twentieth century.²⁴¹ The history of pile foundations for buildings in New Orleans has been documented, with the earliest example being the Central Power Station in 1897.²⁴²

A review of LHC standard plan titles and descriptions indicates many bridges using pile bents, both wood and concrete, beginning as early as 1925. Later, these became all concrete, with only an occasional use of a timber pile. In the design and construction of very long bridges or causeways, with minimal clearance above high water, the bridge pilings are an integral part of the substructure for beam and girder spans. In other words, the piles extending into the soil below water continue vertically to a pier cap that supports beams, girders, or slabs. The foundation and pier are all the same pile, with no separate pile foundation below.

In the 1950s the standard plans for concrete pile bents began to name additional elements and lengths. For example, a 1953 standard plan called for “precast concrete piles 15’ to 100’ long.” Another called for “Metal Pile details 167” and 18” fluted and smooth shell cast-in-place concrete piles.” Precast concrete pile bents for composite welded spans appeared in 1960 and precast concrete piles, both reinforced and prestressed, appeared in 1961. By the mid-1960s the standard plans showed only prestressed concrete piles.²⁴³

There are key turning points in Louisiana in the evolution from traditional timber piles to precast concrete piles, both reinforced and prestressed. The New Orleans Charity Hospital, constructed in 1938, precipitated an investigation because of serious and unexplained settlement issues related to the pile foundations. Two internationally respected engineers were brought in to study the problem: Hardy Cross, who earlier had published a major study of rigid frame bridges, and Karl Terzaghi, who was known as the “father of soil mechanics.” The Charity Hospital settlement and foundation investigation signaled a highly visible search for higher capacity piles, leading to the development of substitutes for the traditional timber pile. The higher capacities were achieved with steel-pipe piles, step-taper piles, steel H-section piles, and

²⁴⁰ Jacoby and Davis, 2-5.

²⁴¹ Jacoby and Davis, 65, which references an article on Louisiana bridge piling in *Engineering News* 61 (March 11, 1909): 277.

²⁴² Held Jr., 5.

²⁴³ Archived and digitized standard plans are available from the LADOTD in Baton Rouge, La.

precast prestressed concrete piles with a patented connector.²⁴⁴ The advantage of these new pile types was the capability of reaching greater depths where more desirable soil strata existed.

A significant development in the use of precast prestressed concrete piles for bridge construction occurred at Lake Pontchartrain. In "Reflections on the Beginnings of Prestressed Concrete in America," Charles Zollman, a pioneering engineer in prestressed concrete, states that "Few are aware that it was in Louisiana that revolutionary pile foundation concepts were developed, tested and used."²⁴⁵ The prestressed concrete pile developments in the late 1930s involved several engineers with Louisiana connections, Tulane University, and the Raymond Concrete Pile Company (Raymond Pile). The engineer Maxwell Mayhew Upson was connected with the Raymond Company; Henry F. LeMieux was the New Orleans District Manager for Raymond Pile; and Walter E. Blessey was Professor of Civil Engineering at Tulane. The three were friends from their university days at Tulane, and formed a team to study and test precast prestressed concrete in the laboratory of Tulane's Civil Engineering Department. The work at Tulane, developed and marketed by Raymond Pile, led to the development of prestressed cylindrical piles that were driven experimentally in New York in 1948, used in the Gulf of Mexico offshore oil industry, and used to construct the Lake Pontchartrain Causeway.²⁴⁶

The prestressed concrete hollow cylinder piles used in the Causeway were centrifugally cast in a pile-spinning and assembly section of the casting yard engineered by Raymond Pile. The bridge required 4,886 individual piles, each of which was 54 inches in outside diameter with a 4-inch shell, in lengths of 80, 88, and 96 feet. The piles were post-tensioned. Six 16-foot reinforced-concrete sections were laid end-to-end and joined with tensioning wires to create one 96-foot post-tensioned pile weighing 33 tons. In the bridge itself, the giant piles constitute the foundation and the substructure, being driven into the lake bottom and rising out of the water to directly support the monolithic, precast, prestressed span panels.²⁴⁷

Not every challenge and solution created by southern Louisiana soil deposits was as large as those noted above. Some were persistent problems that occurred regularly with smaller bridges that required innovative solutions. A notable example was the differential settlement rate between a bridge pier with its stabilizing deep pilings and the concrete roadway pavement unit founded on soils near the surface. The area between the two points was typically connected with a 20-foot approach span, which would have

²⁴⁴ Held Jr., 5-7, 17-21. Held outlines the evolution of pile design and usage in the New Orleans area from the beginnings to recent years. See also Hardy Cross and New Dolbey Morgan, *Continuous Frames of Reinforced Concrete* (New York: John Wiley & Sons, Inc., 1932), and the entry for Karl von Terzaghi in the World Wide Web of Geotechnical Engineers, Hall of Fame, which notes his title as the "father of soil mechanics" and his multiple awards of the Norman Medal of ASCE, <http://www.ejge.com/People/Terzaghi/Terzaghi.htm> (accessed 29 August 2012).

²⁴⁵ Charles C. Zollman, "The End of the 'Beginnings,'" Part 9 of "Reflections on the Beginnings of Prestressed Concrete in America," continuing series in *PCI Journal* (January-February 1980): 124-145. Zollman notes that the Raymond Company was a partner in a joint-venture bid on the alternate design for the Walnut Lane Bridge, the first prestressed concrete bridge; a different bid was accepted and Zollman himself was involved with the final project.

²⁴⁶ Zollman, 128-133; Robert N. Bruce Jr., "Tulane University: Pioneer in Prestressed Concrete," *Louisiana Civil Engineer* (August 2002): 5-7, 22-24. Recall Nos. 203830 and 203832.

²⁴⁷ "A 24-Mi. Bridge Across Louisiana's Lake Pontchartrain," *Engineering News-Record* (30 August 1956): 30-33. Bridges completed in 1956; Recall Nos. 203830 and 203832, extant.

settlement differential between its ends that could amount to one or two feet. That is, the end of the slab on the bridge pier would remain stable while the end of the slab at the roadway may settle drastically, along with the road pavement. The result would be a dangerously steep, ramp-like bump up for a vehicle traveling from the roadway onto the bridge proper. In 1964-1965 LADOTD engineer Albert Dunn collaborated with LADOTD engineer Conway Lusk to develop the innovative “pile-supported approach span,” which used a series of decreasing-length piles with an extremely long approach span (150 feet instead of the traditional 20 feet) to absorb the settlement. Dunn’s role in the creation of the design was cited as a significant achievement supporting his induction into the Louisiana Highway Hall of Honor in 2011, which noted that his design “is used so extensively in South Louisiana’s unconsolidated soils.”²⁴⁸

(c) Caissons

A caisson, by simple definition, is a large and watertight box or casing, in which work is conducted below water level to construct a foundation for a bridge pier. Caissons became very significant for bridge construction in Louisiana because of the challenging soil and site conditions, particularly in crossings of the Mississippi River and the Atchafalaya River basin. The Mississippi River, in particular, is crossed with 12 bridges all of which have caisson foundations. Of those bridges, seven were constructed prior to 1971, and all are extant.²⁴⁹ Table 3 provides a listing of the bridges, their construction date, main span length, designer, contractor, and recall number.

Table 3. Pre-1971 bridges over the Mississippi River in Louisiana with caisson construction²⁵⁰

Name	Date Built	Main Span Length	Designer	Contractor	Recall No.
Crescent City Connection (no. 1)	1958	1575'	Modjeski and Masters	Dravo Corporation	200790
Mississippi River Bridge at New Orleans (Huey P. Long Bridge)	1935	790'	Modjeski and Masters	Seims-Helmers, Inc.	000060
Sunshine Bridge/Mississippi River Bridge at Donaldsonville	1964	825'	Palmer and Baker	Morrison Knudsen	203760
Horace Wilkinson Bridge/New Mississippi River Bridge	1967	1235'	Modjeski and Masters	Massman	052640
Mississippi River Bridge at Baton Rouge (Huey P. Long Bridge at Baton Rouge)	1940	850'	Louisiana Highway Commission	Kansas City Bridge Co.	051880
Natchez-Vidalia Bridge	1940	875'	HNTB	Dravo Corporation	048070
Mississippi River Bridge at Vicksburg-Delta (Old Vicksburg Bridge)	1930	825'	HNTB	U.G.I. Contracting	No recall number as the bridge is closed

²⁴⁸ See citation statement for Albert J. Dunn, LADOTD, Louisiana Highway Hall of Honor, 2011, DOTD building, Baton Rouge, La. A detailed description of the pile-supported approach span is provided in James Porter, LADOTD, email to Robert M. Frame, Mead & Hunt, Inc., 17 September 2012.

²⁴⁹ Donald Sorgenfrei, “Caissons of the Mississippi River Bridges,” *The Louisiana Civil Engineer* (August 1997): 4.

²⁵⁰ Table adapted from Sorgenfrei, “Caissons of the Mississippi River Bridges,” 4.

In terms of form, most caissons are rectangular in plan; however the caissons for the Mississippi River Bridge at Baton Rouge (also known as the Huey P. Long Bridge), applied a circular form to provide greater stability against bank movement caused by erosion.²⁵¹ If the box-like caisson is open at the top and closed at the bottom, it is a box caisson. If open at both top and bottom, it is an open caisson. If open at the bottom and filled with compressed air to drive out the water, it is a pneumatic caisson. In all cases it is simply a shell that must be filled with concrete or other material to form the foundation. The caisson shell may be constructed of timber, masonry, reinforced-concrete, or steel.²⁵² Of the seven bridges constructed over the Mississippi River prior to 1971, six have open caisson construction. The former US 80 Bridge at Vicksburg, constructed in 1930 is the only bridge that used pneumatic caisson construction.²⁵³

Caissons have a long history in bridge construction, with their most well-known and documented uses in the construction of the Eads Bridge (1874) in St. Louis and the Brooklyn Bridge (1879) in New York. In these projects, caisson work resulted in injuries, disease, and deaths to workers on a substantial scale, prompting serious study of caisson use.²⁵⁴ Caisson technology has undergone continuous study since the late nineteenth century, and has been employed on numerous other large bridges projects in the U.S. Caissons are generally employed in large structures that require deep piers, particularly where soil conditions are unstable and difficult to work with. In constructing such bridges, the caissons will probably involve unusual or custom design, involving innovations unique to that site and application.

The importance of caissons to bridge construction in Louisiana may be illustrated by their use in the construction of the massive Mississippi River bridges in New Orleans and Baton Rouge (both also known as Huey P. Long Bridge), and the Atchafalaya River Bridges at Morgan City and Krotz Springs.²⁵⁵ The piers for the Atchafalaya River Bridge (also known as the Long-Allen Bridge), when constructed in 1933, had the deepest caissons in the world at 178 feet.²⁵⁶ In the construction of the Mississippi River Bridge at New Orleans (Huey P. Long Bridge), which opened in 1935, a new patented “sand island” method of caisson design and employment was used. The sand island method was developed and patented by Siems-Helmets, Inc., of St. Paul, Minnesota, which had experimented with the process on one previous bridge in San Francisco. It was described in the Modjeski and Masters final report on the 1935 Mississippi River Bridge at New Orleans (also known as the Huey P. Long Bridge):

²⁵¹ Sorgenfrei, “Caissons of the Mississippi River Bridges,” 5. Recall No. 051880 (extant).

²⁵² Jacoby and Davis, 239-240.

²⁵³ Sorgenfrei, 5. The bridge is extant but closed to vehicular traffic.

²⁵⁴ W.P. Butler, “Caisson disease during the construction of the Eads and Brooklyn Bridges: A review,” *Undersea and Hyperbaric Medical Society* 31 (2004): 445-459.

²⁵⁵ The Mississippi River Bridge in New Orleans is Recall No. 000060 (extant), the Mississippi River Bridge in Baton Rouge is Recall No. 051880), and then Atchafalaya River Bridge at Morgan City is Recall No. 009000 (extant). The Atchafalaya River Bridge at Krotz Springs is nonextant.

²⁵⁶ “Highway Hall of Honor Induction Set.” The bridge is nonextant.

The plan of the lowest bidder, Siems-Helmers, Inc., was based on the "sand island" method of sinking and controlling the caisson, which this Company had developed and used once before in constructing the piers of the Suisun Bay Bridge near San Francisco, California, for the Southern Pacific Railway. The procedure with this method consists of the construction of a large island of sand enclosed in a steel shell at the site of each pier, on which the caisson is built. Construction of the caisson takes place entirely above water level, and as each new section is completed, the caisson is sunk by open dredging through the island and into the river bed until the cutting edge reaches the desired final depth. This "sand island" method has several advantages over the conventional method of sinking a floating caisson.²⁵⁷

The sand island method was used again in the Mississippi River Bridge at Baton Rouge (also known as the Huey P. Long Bridge) completed in 1940.²⁵⁸ According to an engineering discussion of the sand island procedure, Baton Rouge and New Orleans constituted two "of three great bridges built during the thirties in which the sand-island method of caisson sinking by dredging has been brought to its highest development." The third example was the San Francisco railroad bridge referenced above.²⁵⁹

(2) Superstructure design

Bridge superstructures are constructed in simple, continuous, or cantilevered arrangements of spans. The choice of bridge arrangement is determined by site conditions, crossing lengths, and locations of foundation piers. The simplest bridge arrangement is the simple span, where the spanning superstructure extends from one vertical support, abutment, or pier to another without crossing over an intermediate support. The other two bridge span arrangements are continuous and cantilever, which are discussed in more detail below. Superstructures with composite decks are also addressed.

(a) Influence of national design standards

Two national organizations, AASHTO and the BPR, played a prominent role in setting and disseminating design standards for bridge construction, and often worked in partnership. The origins and missions of these agencies is described in an associated sidebar in Section 2 titled "National Organizations and Their Missions." Together, AASHTO and the BPR established and implemented consensus design standards while seeking to standardize the road- and bridge-building practice itself. Bridge design standards developed by federal engineers and BPR officials were frequently disseminated under AASHTO's name.²⁶⁰ The design standards, plans, and specifications developed by these two organizations were frequently adopted by state departments of transportation and assisted states, including Louisiana, in efficiently and economically implementing bridge planning and construction.

AASHTO, a professional organization of state highway officials and predecessor to AASHTO, began its role in 1914 and developed a subcommittee on bridges and structures in 1921 to assist in establishing standard methods of construction and maintenance. In working toward its mission, AASHTO published its

²⁵⁷ Frank Masters, *Mississippi River Bridge at New Orleans, Louisiana: Final Report* ([Harrisburg, Pa.: Modjeski and Masters], 1941), 22. Although this substructure detail is not noted in the HAER report on the bridge, it remains a significant element in the history of foundations and substructures of bridge design and construction in Louisiana, as indicated by the detailed discussion in 1941 report by Modjeski and Masters.

²⁵⁸ Recall No. 051880 (extant).

²⁵⁹ E.S. Blaine, "Practical Lessons in Caisson Sinking from the Baton Rouge Bridge," *Engineering News-Record*, (February 1947): 85-87.

²⁶⁰ Seely, *Building the American Highway System: Engineers as Policy Makers*, 121-126.

first set of bridge specifications in 1931, although informal versions were available as early as 1926.²⁶¹ AASHO's bridge specifications were intended to be a model for state highway departments, providing minimum requirements for bridge construction that could be tailored to meet local needs. Changes in standard specifications were reviewed annually by AASHO and revised periodically. Updated versions were published in 1949, 1953, 1957, 1961, and 1965.²⁶² Regular updates reflected changes and developments in new materials and technologies.

State highway specifications disseminated by AASHO committees, such as the committee on bridges and structures, often reflected BPR design philosophies and policies. During the 1920s-1940s, AASHO committees were generally headed by BPR officials, and bridge and road specifications released were frequently prepared by federal engineers. Examples of AASHO-BPR standard specifications include those for grade-separation structures, released between 1938 and 1943 and revised thereafter.²⁶³

In 1945 AASHO's recommended bridge design standards included construction of steel, reinforced concrete or masonry, and preferably using deck construction, where supporting members of the bridge are all beneath the roadway.²⁶⁴

The collaborative effect of these nationally disseminated design standards helped to position the BPR as a cooperative partner to states. The BPR published its first edition of standard bridge plans in 1953 and periodically updated these plans to reflect new technologies and materials. The 1956 edition includes plans for a variety of highway superstructures of varying span lengths and roadway widths. Bridge types included in the BPR standard plan set reflected established bridge types and designs commonly constructed. Bridge plans were developed for I-beams, deck plate girders, concrete slabs, T-beams, box girders, timber spans, and prestressed concrete I-beams. Most, if not all, of these types appear to have been used in Louisiana during the period. The plan sets were updated every few years to include new and improved designs. In 1962 the BPR expanded its standard plans to a five-volume series, including concrete superstructures, structural steel superstructures, timber bridges, continuous bridges, and pedestrian bridges.

Several innovations were introduced in AASHO specifications after World War II. In 1949 a design method for plate girders was introduced that permitted thinner webs (the portion of a beam located between and connected to the flanges, or the horizontal part of a girder extending transversely across the

²⁶¹ A.E. Johnson, ed., 105.

²⁶² American Association of State Highway Officials, *Standard Specifications for Highway Bridges (1949)*, 5th ed. (Washington, D.C.: American Association of State Highway Officials, 1949); American Association of State Highway Officials. *Standard Specifications for Highway Bridges (1953)*, 6th ed. (Washington, D.C.: American Association of State Highway Officials, 1953); AASHO, *Standard Specifications for Highway Bridges (1957)*, (Washington, D.C.: American Association of State Highway Officials, 1957); AASHO, *Standard Specifications for Highway Bridges (1961)*, (Washington, D.C.: American Association of State Highway Officials, 1961); AASHO, *Standard Specifications for Highway Bridges (1965)*, 9th ed. (Washington, D.C.: American Association of State Highway Officials, 1965).

²⁶³ Seely, 121-126.

²⁶⁴ American Association of State Highway Officials, *Policies on Geometric Highway Design* (Washington, D.C.: American Association of State Highway Officials, 1945), 4.

top and bottom of the web) for long girders (the flexural members or beams that are the main or primary support for the structure).²⁶⁵ In 1956 AASHO adopted *A Policy on Design Standards, Interstate System*, which included standards to address the new Interstate Highway System, including bridges to serve as overpasses and underpasses. Deck construction was recommended for bridges and overpasses to fit the overall alignment and profile of the highway. For all structures, the bridge clear height was recommended to be 16 feet to allow large vehicles to pass underneath. For all structures of 150 feet or less, including grade separations, bridge width was recommended to be the full approach roadway, including pavement and shoulders.²⁶⁶ The 1957 specifications included new discussions on use of high-tensile bolts (bolts and nuts made of high-strength steel) and concrete box girders. Specifications were also added for structural steel welding that were “developed largely to meet the demand for weldable steel for highway bridges.”²⁶⁷

Prestressed concrete was first included in AASHO standard specifications in 1961, largely based on the joint ASCE and American Concrete Institute Committee on Prestressed Concrete report of 1958.²⁶⁸ Other significant revisions in the 1961 edition based on the latest research and developments addressed the following topics: neoprene (elastomeric) bearing plates (a support element transferring loads from superstructure to substructure while permitting limited movement capability), plate girders, and high-strength bolts.²⁶⁹ Updated recommendations were provided by AASHO in its 1965 publication *A Policy on Geometric Design of Rural Highways*. In this version, AASHO continued to advocate the use of deck-type structures and recommended prestressed deck designs for longer spans.²⁷⁰

(b) Continuous and cantilever design

In a continuous span design, the superstructure spans uninterrupted over one or more intermediate supports. This type of design was advantageous because such spans required less steel and concrete, produced less deflection, and avoided problematic joints over piers. The use of continuous beam structures was first introduced in the U.S. in the late 1870s, but was not used nationally in highway bridge construction until the early 1940s.²⁷¹ In the mid-twentieth century, incorporation of technological innovations such as high-tensile bolts and all-welded construction made designing with continuous spans more efficient and cost-effective, increasing its popularity. Approximately two percent of pre-1971 bridges in Louisiana are continuous spans.

²⁶⁵ A.E. Johnson, ed., xxiii; Ted Johnson, "Precast-Concrete Control Structures: Economical for an Irrigation District," *Civil Engineering* 32, no. 7 (July 1962), 105.

²⁶⁶ American Association of State Highway Officials, *A Policy on Design Standards: Interstate System* (Washington, D.C.: American Association of State Highway Officials, 1959), 5-6.

²⁶⁷ American Association of State Highway Officials, *Standard Specifications for Highway Bridges* (1957), xxiii.

²⁶⁸ American Association of State Highway Officials, *Standard Specifications for Highway Bridges* (1961), xxiii.

²⁶⁹ American Association of State Highway Officials, *Standard Specifications for Highway Bridges* (1961), n.p.

²⁷⁰ American Association of State Highway Officials, *Standard Specifications for Highway Bridges*, 9th ed. (Washington, D.C.: American Association of State Highway Officials, 1965), 502.

²⁷¹ *Common Historic Bridge Types*, 3-107.

Often, continuous span design is used in conjunction with cantilevering. Cantilever design refers to a span that projects beyond a supporting column or wall and is counterbalanced and/or supported at only one end. Cantilever designs were first introduced in the U.S. in the late nineteenth century and applied to truss construction. However, cantilever and continuous support methods were later applied to other bridge types, including steel I-beams. Cantilevered designs are particularly advantageous because of their adaptability to intermediate and long spans and because they can be erected without falsework, which would obstruct the navigable channel. Continuous spans were connected with the cantilevered design, allowing for greater lengths to be reached. In the twentieth century, a suspended span was added between two cantilevers, which was helpful in increasing the distance between piers for navigable waterways.²⁷²

In order to connect the suspended span to the adjacent cantilever spans, a pin and hanger connection is used. In design, the suspended span is connected to the cantilevered beam using a connecting plate or eyebar (hangers) that is bolted together. The connection is to allow for expansion and rotation between the suspended and cantilevered spans. Pin and hanger systems are typically found in multi-span bridges designed prior to 1970. The pin and hanger system was found to be susceptible to failure due to bending, stress, and corrosion, which does not allow the pin to move freely.²⁷³

Cantilever bridges are used often in response to complex site conditions.²⁷⁴ Continuous and cantilever bridge designs have been used since at least 1936 in Louisiana to cross navigable rivers. Approximately 2.6 percent of the pre-1971 bridges in the state are continuous and/or cantilever bridges. They are found in the following types: deck girder (tee beam), I-beam, composite I-beam, plate girder, and through truss. In fact, Louisiana boasts one of the longest cantilever highway bridges in the world. Designed by Modjeski & Masters and constructed in 1957, the Crescent City Connection (formerly known as the Greater New Orleans Bridge) carries business U.S. 90 over the Mississippi River in New Orleans. The main cantilevered through truss span stretches 1,575 feet and was designed to withstand hurricane winds up to 140 miles per hour.²⁷⁵

(c) Composite deck

Continuous multi-beam bridges may involve composite construction, which involves pouring a concrete deck on top of steel girders so the deck supplements the capacity of the top flange of the beam. The concrete slab is anchored to steel girders with shear connectors and, thus, concrete is used with steel for a fully composite design.²⁷⁶

²⁷² Common Historic Bridge Types, 3-107, 3-124, 3-142.

²⁷³ National Highway Institute, *Bridge Inspector's Reference Manual* vol. 2 (Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 2002) 8.4.1 – 8.4.11; G-32.

²⁷⁴ *Common Historic Bridge Types*, 3-142 to 3-144.

²⁷⁵ Bethlehem Steel Company, *The Greater New Orleans Bridge: Bethlehem's Role in Building the Nation's Longest Cantilever Bridge* (booklet published by the author c.1957), 21. Recall No. 200790 (extant).

²⁷⁶ Fisher et. al., "Steel Bridges in the United States: Past, Present, and Future," *Transportation Research Circular*, 38; Kerensky, "Critical Survey of Bridge Design," *Engineering*, 180; Ben C. Gerwick, "Precast Segmental Construction for Long-Span Bridges," *Civil Engineering* 34, (January 1964): 44.

AASHO permitted composite bridge construction as early as 1944, including a section on composite beams in the 1944 and 1949 standard specifications.²⁷⁷ However, composite design was not widely used until the 1950s and 1960s, when research on beam and shear connectors was conducted. As a result of research performed in the 1950s, the 1957 AASHO specifications section on composite beams was entirely rewritten.²⁷⁸ In 1961 the AISC published specifications on composite design, and afterward the usage of composite structures increased considerably.²⁷⁹ This is true in Louisiana, where the majority of composite bridges in the subject period were constructed between 1963 and 1966. The LDH's *1966 Standard Specifications for Road and Bridge Design* provided additional guidance on the use of shear connections and composite decks, which continued beyond the study period.

D. Bridge types

The term bridge type traditionally refers to the bridge's superstructure. Different bridge types are composed of different materials as previously discussed. Engineers choose the bridge type based on the site needs, cost, and engineering challenges. A multiple-span bridge can be comprised of different span types. For the purposes of this study, bridges are categorized by their main span type.

The bridge types found in Louisiana and discussed in this section are arranged by the form of the bridge (e.g., arch, beam, truss, etc.) and then by material (e.g., concrete, timber, steel), as applicable. An exception to this organization is made for movable bridges and culverts. Movable bridges are constructed of various bridge types but are discussed in one section because their mobility is the dominant feature. Culverts are also an exception because their type designation refers to both the function of the structure as well as its form.

The dominant pre-1971 bridge types in Louisiana include beam/girder bridges and culverts. There are few extant trusses, which may be explained by the gradual replacement of earlier truss bridges with newer bridges. Table 4 presents the types of pre-1971 bridges in Louisiana by type. Table 8 at the end of this section presents a summary of information for each bridge type noted below, with details including years of construction, standard span lengths and overall structure lengths. This information informs the evaluation of National Register significance of bridges, conducted in a subsequent phase of the project.

²⁷⁷ American Association of State Highway Officials, *Standard Specifications for Highway Bridges* (1944) (Washington D.C.: American Association of State Highway Officials, 1944), xviii.

²⁷⁸ *American Association of State Highway Officials, Standard Specifications for Highway Bridges* (1957) (Washington D.C.: American Association of State Highway Officials, 1957b), xxiii.

²⁷⁹ Irwin A. Benjamin, "Composite Beams of Steel and Lightweight Concrete," *AISC Engineering Journal* (October 1965): 125.

Table 4. Pre-1971 bridges in Louisiana, by type

Bridge type	% of pre-1971 bridges
Arch	<1%
Truss	<1%
Movable	2%
Culvert	20%
Beam/Girder	77%
Total	100%

(1) Arch

The arch is one of the least common of the bridge types seen in Louisiana. In design, an arch is a semi-circular form that can be comprised of stone, brick, steel, or concrete. Arch bridges occur in both deck and through variants. In the deck arch bridge the roadway passes above the arch. The through arch bridge carries the roadway at the bottom of the arch, while the less-common half-through arch supports the deck at the mid-point of the arch.

The rarity of the arch bridge type in Louisiana may be explained by a few factors. First, the state's scarcity of stone or brick, common materials for early arch bridge construction in the U.S., may explain why this type was not favored. Also, arch spans typically require stable foundations to support the weight of the span. The rarity of the arch as a type might be directly tied to the difficulty of constructing an arch on the unstable soils of the state. On the other hand, the earliest biennial report to include bridge plans, 1914-1916, published plans for two reinforced-concrete arch bridges, both of which are tied arches. The tied-arch design may have been intended to cope with the soils by providing internal stability to the structure with less reliance on settling foundations. One of the designs indicates the use of mud-sill foundations.²⁸⁰ The presence of concrete arches coincides with the beginning of bridge construction in the state. Metal arch bridges are uncommon nationally, and no metal arch bridges were identified in the review of the LADOTD MSF and FHWA NBI data or through contextual research.

(a) Concrete arch

Concrete arch bridges came into widespread use in the U.S. in the late 1890s following the introduction of reinforcing systems, which became the popular concrete technique used extensively in highway and pedestrian bridge construction.²⁸¹ Concrete arch bridges can either have an open or closed spandrel. The spandrel is the area between the arch ring and deck. Closed spandrel arches are primarily used for short span lengths and often appear to replicate a masonry arch when the spandrel area is faced with brick or stone. The spandrel wall retains fill material such as earth or rubble, which bears the live loads. Nationally, reinforced concrete closed spandrel arches generally date from the 1890s through the 1940s; Louisiana examples were constructed through the 1930s. Closed spandrel arch bridges typically predate open spandrel arches.²⁸²

²⁸⁰ Louisiana State Highway Department, Report of Board of State Engineers, 1914-1916; bridge plans opposite p. 142 and p. 264.

²⁸¹ Common Historic Bridge Types, 2-17.

²⁸² Common Historic Bridge Types, 3-65.

First constructed in the U.S. in 1906, the open spandrel concrete arch became a popular form in the 1920s and 1930s, particularly for long spans and settings where significant vertical clearance was required. The open spandrel arch had the advantage over closed spandrel arches because significant weight and material was eliminated from the bridge when the spandrel wall was opened. Additionally, the open spandrel arch form was visually pleasing and often used for scenic locations.²⁸³ None of the concrete arch bridges in Louisiana have an open-spandrel configuration.

The concrete arch form was used commonly throughout the 1940s nationally; later examples are often related to federal relief programs during the Great Depression, where concrete arch spans were used in park development and often featured stone veneer.²⁸⁴ Despite its popularity, the concrete arch was less common nationally compared to other reinforced-concrete bridge types, including the concrete slab and girder bridges. This is especially true in Louisiana, with only nine examples dating from 1924 to 1939. Louisiana's concrete arches all have a closed-spandrel configuration and are located in New Orleans's City Park.²⁸⁵ The rarity of the arch bridge type in Louisiana may be related to challenges of placing stable foundations, which were needed to support the weight of the arch.

(2) Truss

Truss bridges became common in the U.S. in the mid-nineteenth century and were used beginning in Louisiana in the late nineteenth century for movable bridge designs, and in the twentieth century as fixed-span bridges. Movable bridge types that incorporate a truss superstructure are addressed in Section 3.D(3); this section focuses on fixed spans. The truss was a common bridge form throughout the state as variations on truss types were easily adapted to specific site conditions. Their popularity can be expressed by the number of standard plans that were developed by the LHC in the early twentieth century. The earliest known standard plan for a truss bridge is a 1917 design for a 48-foot timber truss span. Over the course of the 1920s, the LHC produced a number of standard plans for both pony and through trusses that included different variations in type, length, and deck width. The last known standard truss plan is a 1946 design for a 320-foot-long Camelback span (no examples are extant). Thereafter, the state continued to revise existing truss plan sets until the 1960s. Louisiana has few trusses remaining and only a handful can be associated with any particular standard plan.

In design, a truss bridge has a superstructure that features parallel trusses that use diagonal and vertical members to support deck loads. The truss can be constructed of either wood or metal, with the former material predating the latter. The bridge members are joined with plates and fasteners: pins, rivets or bolts in early examples and welding in later examples. There are three basic arrangements of trusses—low (or pony), high (or through or overhead), and deck—and a wide variety of types. The arrangement is called a low truss when the span is short enough to permit shallow truss design. The high truss required a full-depth truss with lateral bracing between parallel top chords of the two trusses. The deck truss

²⁸³ *Common Historic Bridge Types*, 3-67.

²⁸⁴ *Common Historic Bridge Types*, 2-26, 3-67; *Frame*, E-15.

²⁸⁵ Recall Nos. for New Orleans City Park bridges are 102114, 102115, 102235, 102236, 102337, 102113, 102233, 102226, and 102234 (all extant).

carries the roadway on its top chord and is used when maximum vertical clearance below the truss is not required. The deck truss is the least common of the three arrangements.

The choice of truss arrangement (low, deck, or high) depended on the span length and/or vertical clearance needed below or above the bridge. For example, a through truss allows more vertical clearance under the superstructure than a deck truss; however, if vertical clearance is needed above the bridge, a deck truss is often employed. High truss bridges were used to cross major tributaries, including the Mississippi River at Baton Rouge and New Orleans.

At the turn of the twentieth century, continuous and cantilevered designs were employed to achieve longer spans. The use of cantilever and continuous designs allowed for the construction of bridges with significant lengths and a wider clear channel. The continuous design is characterized by the use of a single truss span carried across multiple piers. The cantilever design uses two self-supporting spans that meet in the center, sometimes incorporating a suspended central span. A distinctive variation within this design is the cantilever truss with a tied-arch suspended span, in which two arched cantilever arms are joined at their apex and a horizontal deck is suspended below.

Prior to the development of the LHC, parishes, cities, or toll bridge companies erected truss bridges over waterways. Beginning in the 1920s the LHC constructed new steel high and low trusses based on their standard plans and repaired or reconstructed existing truss bridges.²⁸⁶ High and low truss examples are distributed throughout the state, though extant numbers are relatively small, comprising less than one percent of all pre-1971 bridge types in the state. Generally, extant low truss bridges are concentrated in the southern third of the state.

Early examples in the state are considered to be those constructed before 1920, the time at which the state's first-known standardized plans for metal pony truss bridges were prepared. The state continued to refine these plans and introduce standard plans for new variations through the 1940s. Extant high truss bridges are widespread throughout the state along major tributaries and in larger cities such as Baton Rouge and New Orleans. Early through truss examples in Louisiana are considered to be those with pinned primary connections constructed before 1921, the time at which the state compiled its first known standardized plans for metal through truss bridges with riveted connections. The state continued to refine these plans and introduce standard plans for new variations through the 1950s.

Standard truss plans developed by the LHC included Warren, Pratt, Parker, and Camelback configurations. The plans were typically for bridges 100 to 400 feet in span length and the K-truss configuration could be used for longer spans. The following discusses truss types identified historically in Louisiana. A brief description of the truss types is provided, as well as its common span ranges seen nationally. There is also one known additional unusual truss configuration used in Louisiana: the Waddell A-truss seen in one extant example.²⁸⁷

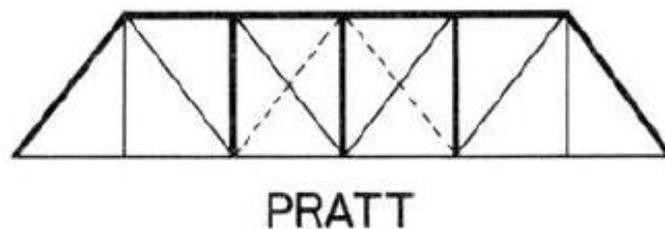
²⁸⁶ N.E. Lant, "Repairs and Reconstruction of Existing Bridges," *The Louisiana Highway Magazine*, no. 2 (March 1926): 23-26.

²⁸⁷ This bridge in Caddo Parish is not currently on LADOTD's system; it carries an abandoned Kansas Southern Railroad over Cross Bayou (assigned number XXXX06).

(a) Pratt

Pratt trusses were first introduced in 1844 by Thomas and Caleb Pratt. The design of the truss reversed the load-bearing system of the earlier Howe truss, using its verticals in compression and diagonals in tension. The middle truss panel often incorporated a crossbar system to reduce buckling that could be caused by compressive loads. The Pratt truss was typically used for a wide range of spans, from approximately 25 to 250 feet.²⁸⁸

The LHC developed standard plans for Pratt trusses in the 1920s and 1930s, with the first plan drawn in October 1921. In total, 11 standard plans are known to have been completed, with span length ranging from 100 to 200 feet.



*Figure 3. Illustration of Pratt truss.*²⁸⁹

(b) Parker

The Parker truss was developed by namesake Charles H. Parker in 1870 as an adaptation of the Pratt truss. In design, the Parker truss is simply a Pratt truss with a polygonal top chord. The polygonal top chord on the Pratt truss form allowed additional economy of materials as the vertical and diagonal members were progressively shortened from the center to the ends of the truss. In the early twentieth century, the Parker truss supplanted the basic Pratt truss as the ideal long-span truss because less materials were needed for construction.²⁹⁰

Parker trusses were used in both short- and long-span bridge design, with spans from 40 to 300 feet. The form was used by many highway departments, including Louisiana's, in through- and deck-truss variations. In the 1930s, the LDH developed at least 13 standard plans using the Parker truss, ranging from 120 feet to 250 feet. One example of a steel Parker high-truss in Louisiana is the Boeuf River Bridge in rural Richland Parish.²⁹¹ Constructed in 1938-39, the bridge carries LA 15 over the Boeuf River. Parker trusses were constructed as fixed and movable bridge spans.

²⁸⁸ Common Historic Bridge Types, 3-25 to 3-26.

²⁸⁹ Figures 3 through 7 are from National Park Service, Historic American Engineering Record, *Trusses*, poster, available at <http://www.nps.gov/history/hdp/samples/HAER/truss%20poster.pdf> (accessed 5 September 2012).

²⁹⁰ Common Historic Bridge Types, 3-34.

²⁹¹ Recall No. 026240 (extant).

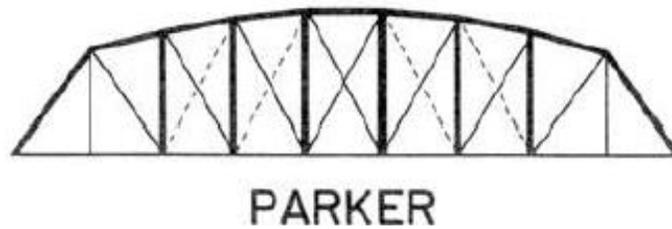


Figure 4. Illustration of Parker truss.

(c) Camelback

The Camelback truss is a variation of the Parker truss with a polygonal top chord of exactly five slopes. The truss type was used exclusively for through trusses from 100 to 300 feet.²⁹² The LHC developed at least five standard Camelback bridge plans from 1923 to 1946 with span ranges of 140 to 320 feet. These plans were revised in the 1950s, indicating the Department was likely still using them for bridge design.

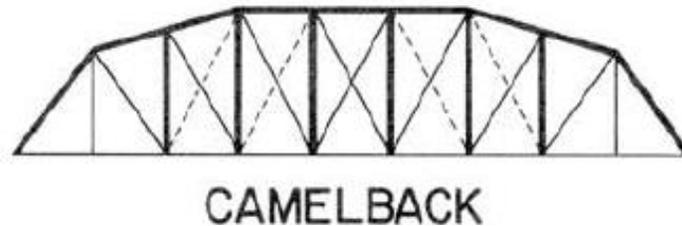


Figure 5. Illustration of Camelback truss.

(d) Warren

One of the most popular truss designs nationally and in Louisiana was the Warren truss. First developed in 1848, the Warren truss design eliminated the vertical members found in most other truss forms by using diagonal members to withstand both tensile and compressive forces. When vertical members were included, primarily as bracing units rather than load-bearing system, the configuration is referred to as a “Warren with verticals.” The span of the Warren and Warren-with-vertical configuration generally ranged from 50 to 400 feet.

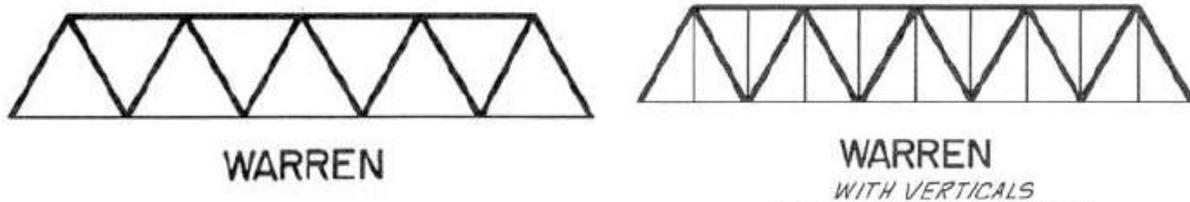
The Warren truss became the most common truss form beginning in the 1920s, when it supplanted the Pratt truss as the standard American truss. The Warren had the advantage of being more economical in materials and was considered “more refined” than the Pratt truss. The bridge was popular among state highway departments in the 1920s and railroads in the 1930s.²⁹³ This was also true in Louisiana, where the Department developed at least 16 standard Warren truss plans between 1920 and 1937. The majority of the plans were for pony trusses, but one deck truss using the Warren configuration was provided in 1931. The standard plans ranged in span length from 50 to 100 feet, with variations in details such as deck type, sidewalks, and roadway width. The state used standard plans for Warren low truss

²⁹² Common Historic Bridge Types, 3-35.

²⁹³ Common Historic Bridge Types, 2-27; 3-39.

construction through 1949. An example of a Warren low truss can be found in Caddo Parish, carrying LA 1 over the Caddo Lake.²⁹⁴

Warren trusses can be found in several variations. Multiple-intersection Warren trusses, also known as lattices, feature double- or triple-intersection webs with inclined end posts and can span from 75 to 400 feet. Other variations include Warren trusses with polygonal top chords or vertical end posts.²⁹⁵ Warren trusses were constructed as fixed and movable bridge spans.



Figures 6 and 7. Illustrations of Warren truss and Warren with verticals.

(e) K-truss

The K-truss was another truss design utilized by the LDH throughout the early to mid-twentieth century for long spans. The K-truss is one of the easiest truss configurations to recognize, as the individual vertical and horizontal members form characteristic K shapes in each panel that are arranged symmetrically around each truss's centerpoint. A polygonal top chord is typical (see Figure 8). The K-truss is unique in that it transfers an equal amount of loading to each of its individual members. While the Warren and Pratt variations were developed in the nineteenth century and were common in the U.S., the K-truss was developed in the early twentieth century. It is reportedly one of only two truss types introduced in the twentieth century (the other is the Vierendeel truss) and its design is attributed to Ralph Modjeski of Modjeski and Masters. Modjeski first proposed the K-truss design for the St. Lawrence River in Quebec. The bridge had a cantilevered center span and was constructed in 1917.²⁹⁶

²⁹⁴ Recall No. 013970 (extant).

²⁹⁵ National Park Service, Historic American Engineering Record, *Trusses*, Poster, available at <http://www.nps.gov/history/hdp/samples/HAER/truss%20poster.pdf> (accessed 5 September 2012).

²⁹⁶ The K-truss's obscure nineteenth-century origins are discussed in Carl Condit, *American Building Art: The Twentieth Century* (New York: Oxford University Press, 1961), 89-90.

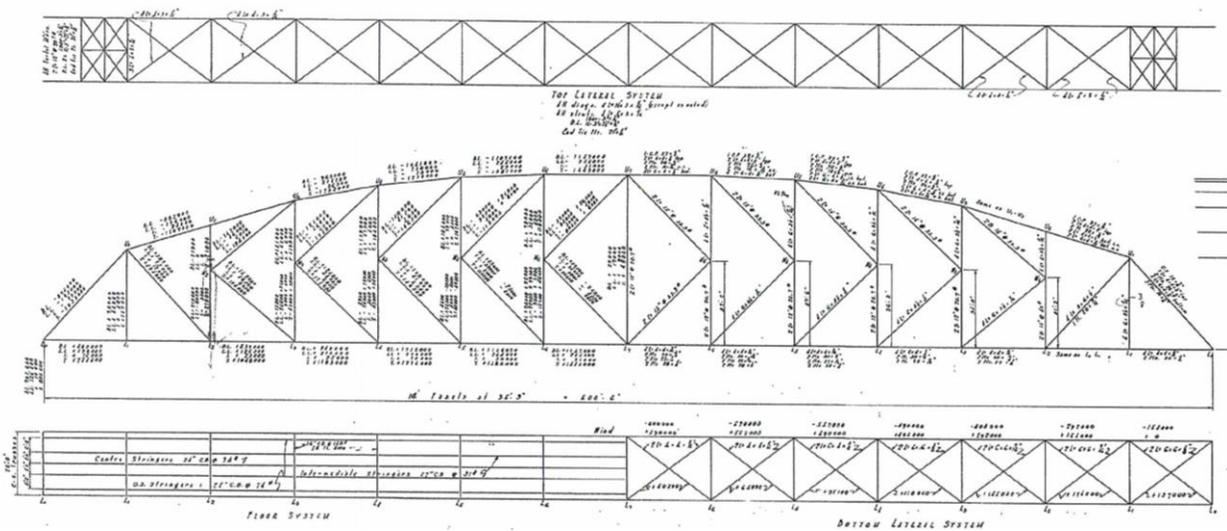


Figure 8. 1931 Louisiana Highway Commission standard plan for a K-truss (source: Louisiana Highway Commission standard plan, May 1931).

The K-truss is considered to be the lightest truss for its length,²⁹⁷ providing long spans from 200 to 800 feet, nationally.²⁹⁸ The 1933 Morgan City Bridge (also known as the Long-Allen Bridge) across the Atchafalaya River is a good example of the span lengths the K-truss could reach, with three 600-foot-long spans carrying LA 182 (old U.S. 90) over the river between Berwick and Morgan City.²⁹⁹

In addition to its engineering advantage, the repetition of the “K” created by the vertical and diagonal members was considered aesthetically pleasing and “probably the most picturesque of all the bridges in Louisiana.”³⁰⁰ According to the HAER documentation for the Fort Buhlow K-truss bridge, “the repetition of the “K” motif along each span, arranged symmetrically to each side of the truss’s center point, combined with a fine sense of proportion exhibited by the Fort Buhlow Bridge, gives the bridge an unusually arresting physical appearance when viewed in its entirety.”³⁰¹ The sentiment that a K-truss is a pleasing truss form was further highlighted by the Wax Lake Outlet Bridge, a K-truss bridge designed by Louisiana Bridge Engineer Norman Lant in 1940, which won honorable mention in the AISC bridge competition for 1941. The competition was created to promote appreciation for the most beautiful steel bridges constructed in a single year, as judged by a panel of architects, consulting engineers, engineering educators, and art museum curators.³⁰²

²⁹⁷ David Huval, interview by Robert Frame of Mead & Hunt, Inc., Lafayette, La., 18 July 2012.

²⁹⁸ National Park Service, Historic American Engineering Record, *Trusses*, Poster, available at <http://www.nps.gov/history/hdp/samples/HAER/truss%20poster.pdf> (accessed 5 September 2012).

²⁹⁹ Recall No. 009000 (extant).

³⁰⁰ David Huval, interview by Robert Frame of Mead & Hunt, Inc., Lafayette, La., 18 July 2012.

³⁰¹ Nonextant. URS Corporation, Historic American Engineering Record (HAER) Level II Documentation for the Fort Buhlow Bridge, Alexandria, Rapides Parish, Louisiana, prepared for the Louisiana Department of Transportation and Development (2001), 6.

³⁰² Nonextant. American Institute of Steel Construction, Inc., *Prize Bridges 1928-1956* (New York, published by the author, 1958), see 1941 section.

The disadvantage of the K-truss, however, was in the amount of materials needed to construct the bridge, making it uneconomical compared to other long-span trusses. Additionally, a K-truss bridge was complex to construct, likely requiring additional construction time. As a result, the K-truss was never a popular bridge type nationally.³⁰³

A number of K-truss bridges were constructed using the standard plans developed by the LHC in 1931.³⁰⁴ The standard plans included both high and deck truss configurations, with spans of 100 feet for the deck truss, and 500 feet and 608 feet for the high truss. The 608-foot K-truss is the longest standard plan developed by the state for a simple through-truss; one example of this plan is known to have been built and remains extant (located in Morgan City over the Atchafalaya River).³⁰⁵

(3) Movable bridges

Louisiana has one of the largest collections of movable bridges of any state, thanks to its proliferation of navigable waterways, particularly in the southern section of the state near the Gulf of Mexico. In addition to the large number, Louisiana also has a wide variety of types and sizes of movable bridges.

The factors governing the initial selection of a movable span instead of a fixed span, and governing the ongoing service life of a movable bridge, are different from those for conventional fixed-span bridges. The choice is based on site-specific conditions that can change over time and over the life of the movable bridge itself. Movable-span bridges are constructed to provide clearance for navigable waterways when the construction of a fixed span that is high enough to provide vertical clearance is too expensive or not feasible for technical reasons. A movable bridge has a lower initial cost compared to a fixed bridge that would provide navigation clearance. The ongoing cost of maintaining a movable bridge, however, is much greater than that of a fixed bridge.

Over time, local conditions may change and a fixed span may become a more economical and efficient choice than a movable span. With population growth and development, as well as increased marine traffic, the movable bridge may need to be opened more frequently than originally required, interrupting both vehicular and marine traffic. In addition, a movable bridge requires maintenance for the lifting or swinging mechanism as well as electrical power and personnel, adding up to substantial annual costs. A significant problem for movable bridges is the ever-present danger of being hit by a vessel, typically a barge, thus incurring additional maintenance and repair costs.³⁰⁶

The basic principle of a movable bridge is ancient: one span, multiple spans, or part of a span is moved to provide navigation clearance. Depending on the span type, the movement may be in a horizontal plane

³⁰³ URS Corporation, Historic American Engineering Record (HAER) Level II Documentation for the Fort Buhlow Bridge (a.k.a. the O.K. Allen/Long Bridge) Alexandria, Rapides Parish, Louisiana, 6.

³⁰⁴ Paul Hawke, *Krotz Springs Bridge*, Historic American Engineering Record, prepared for the Louisiana Department of Transportation (undated), 1.

³⁰⁵ Recall No. 009000 (extant).

³⁰⁶ Gil Gautreau, Interview by Robert Frame of Mead & Hunt, Inc., Baton Rouge, La., 20 July 2012.

or a vertical plane to take the span out of the way of a vessel on the water. Modern movable bridges resulted from the development of engines and motors to mechanically manipulate the span and control systems to govern the action. Some of these innovations were originally developed in the design and construction of railroad bridges in the nineteenth century. Innovation has continued with the use of movable bridges for roads and highways, particularly in the development of modern control systems.

Movable bridges are comprised of three major types found in Louisiana and throughout the U.S.: swing-span, bascule, and vertical lift. Less common types include pontoon bridges in Louisiana and transporter and retractable bridges, which are not found in Louisiana.³⁰⁷ An additional bridge type used in Louisiana for navigable waterways with extremely infrequent marine traffic is the removable-span bridge, which is designed so that one span may be physically removed by lifting it out of place temporarily. Several distinctive subtypes and variations related to the operation of mechanical systems are also found in Louisiana (see Table 5).

Table 5. Pre-1971 movable bridges in Louisiana

Movable type	% of movable bridges pre-1971
Swing-span bridges	44%
Vertical lift bridges	24%
Bascule bridges	9%
Pontoon bridges	9%
Removable-span bridges	14%
Total	100%

(a) Swing-span bridges

Swing-span bridges open by rotating (swinging) the movable span 90 degrees in a horizontal plane about a vertical axis (the central pivot pier), so the span is parallel with the navigation channel. This creates open navigation channels on either side of the central pier that supports the movable span. When in the closed position (closed to marine traffic), the span is supported at three points: the two span ends and the pivot pier. The pivot pier, generally at the mid-span point, supports the weight of the swing span itself. The piers at each span end are “rest piers,” which stabilize the span end along with the pivot pier, and also support the live load (the weight of vehicular traffic) as it passes over the bridge.³⁰⁸

Swing-span bridges were widely used nationally from the 1890s to the 1920s, after which they were gradually supplanted by bascule and vertical lift bridges for many applications. The restrictive element for a swing-span bridge is the unavoidable center pier, which remains an obstruction to navigation in the

³⁰⁷ *Common Historic Bridge Types*, 3-115. The standard reference work for movable bridges is Otis E. Hovey’s *Movable Bridges* in two volumes, Vol. 1. *Superstructure* and Vol. II. *Machinery* (New York: John Wiley & Sons, 1926 [vol. 1] and 1927 [vol. 2]). Hovey’s volumes discuss movable bridges in great detail and from a national and international perspective.

³⁰⁸ Louisiana Department of Transportation and Development, *Movable Bridge Inspectors Program Workbook*, typescript (Baton Rouge: LADOTD, n.d.): II-11.

waterway when the span is open. Additionally, the swinging span requires a large circle of clear space in which to operate, limiting its applicability in congested urban waterway locations. For that reason, cities such as Milwaukee and Chicago became innovative in developing alternative types of movable spans to replace their early swing-span bridges for river navigation.

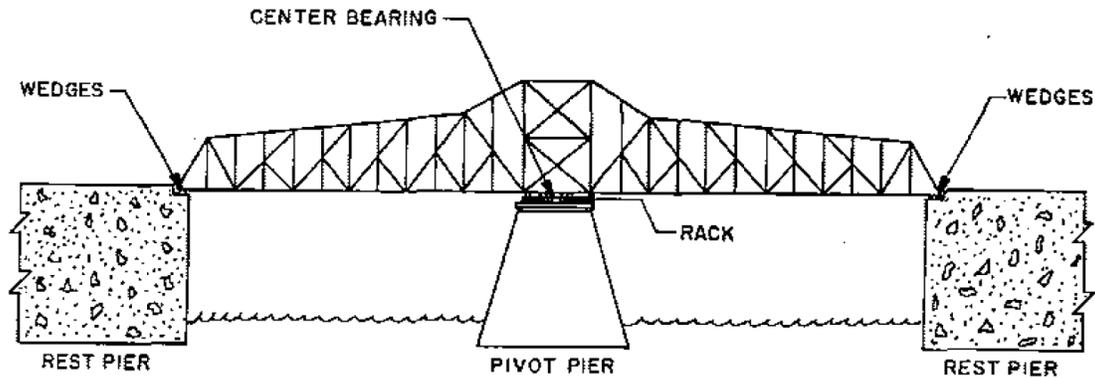


Figure 9. Sketch of swing-span bridge in closed position, showing piers and location of operating components (source: LADOTD Movable Bridge Inspectors Program, Workbook).

Two key design features that help differentiate among the various swing-span bridge types include: (1) the turning mechanism on the pivot pier, and (2) the span itself. Although swing-span bridges involve a number of additional elements and features, this general description will be limited to these two key features to differentiate types of swing-span bridges.

Turning mechanisms generally are either center-bearing or rim-bearing, depending on the way the mechanism supports the weight of the span as it moves. When the movable span is opened, the entire weight of the span is carried to the pivot pier by either a center-bearing or a series of rim-bearing rollers. The use of one type or the other largely reflects the design and construction era of the bridge, with rim-bearing examples typically being earlier than center-bearing examples. The center-bearing type swing span receives its name from a large bronze spherical thrust bearing at the center of the span. The center of gravity of the movable span is located over the center of this bearing. The bearing supports the entire weight of the movable span and also keeps the span in proper location. Balance wheels are provided on the center bearing swing span to prevent the span from tipping out of plane during operation.

Rim-bearing swing spans have a large number of tapered rollers located on a circular track around the center of the pivot pier. Each roller is mounted on a radial shaft, which restrains it from moving away from the center of the span. A second track attached to the bottom of the swing span itself rests on top of the rollers. The entire weight of the span is carried by the rollers. A small radial bearing is provided at the center to keep the span in proper location.

The earliest swing-span bridges were operated manually, and some small spans retain manual operation. Early mechanization was accomplished with gasoline engines, which have been replaced by electric motors. Some recent swing spans are operated hydraulically; all hydraulic mechanisms are center-bearing.

Nationally, most swing-span bridges resemble typical steel through-truss or girder bridges in the closed position. In addition to these types of span construction, Louisiana also has examples pony-truss spans and the rare cable-stayed swing span. Cable-stayed swing bridges feature a steel beam or truss swing span and a tower structure above the pivot pier that connects to floor beams via cables, which support the bridge arms when in open position. Examples of cable-stayed swing bridges are restricted to small bayous in Terrebonne Parish near the Gulf of Mexico and are considered highly uncommon nationally with no other known examples outside of Louisiana.³⁰⁹

An additional adaptation involves the length of one half of the swing span itself. Most spans are symmetrical about the span center; that is, the span is of equal lengths on both sides of the pivot pier. In some locations, however, the location of the navigation channel in the waterway, or some other locational feature, dictates that the pivot pier must be located near the shoreline, or some other location that will limit the swing arc of the span or the length of the span. In such cases, the span is designed to be non-symmetrical, with one side of the span considerably shorter than the other, to accommodate the restriction in the setting. The short end has a counterweight to compensate for the missing weight of the span to balance the other span half. This design is termed a “bob-tailed swing span” and, in Louisiana, is used on bayous where the horizontal clearance is restricted.

Extant examples of swing-span bridges in Louisiana feature four types of span construction: cable-stayed (I-beam and pony truss variations), through-truss, pony truss, and plate girder (most common).³¹⁰ Standard plans for most swing bridge types were developed by the LHC and LDH from 1924 to 1961; little information exists about the cable-stayed swing span bridges but they do not appear to have followed a standard design. Consulting engineer J.B. Carter prepared the standard plan that was applied to the Ouachita River bridges near Sterlington in 1931, and the plan was then used to fabricate and build eight other swing-span structures on the river as part of a \$6 million deal with Governor Huey P. Long.³¹¹ There is a significant linear distribution of swing-span bridges along Bayou Teche, with smaller groups along Bayou Black, Bayou du Large, and Petit Caillou Bayou.

(b) Vertical lift bridges

While the swing-span bridge rotates the movable span horizontally to clear the navigation channel, the vertical lift configuration elevates the movable span vertically to clear the channel. Unlike the swing span with its pivot pier, the vertical lift span has no obstacle remaining in the waterway. The vertical lift span’s clearance, however, is limited by the clear height between the waterway and bottom of the raised span.

³⁰⁹ The vernacular cable-stayed type of swing bridge is likely unusual in the state as it is not mentioned in the DOTD *Movable Bridge Inspectors Program Workbook*. However, an extant (2012) cable-stayed swing bridge near Houma is described in Donald Sorgenfrei, interview by Robert Frame of Mead & Hunt, Inc., New Orleans, 18 July 2012, transcript pp. 12-13.

³¹⁰ Swing spans are generally coded in the LADOTD MSF with the following codes: HISWNG (steel high truss swing span); LOSWNG (steel low truss swing span); IBSWNG (steel I-beam swing span); PGSWNG (steel plate girder swing span).

³¹¹ Coco & Company, Historic American Engineering Record (HAER) for the Ouachita River Bridge at Sterlington, prepared for the Louisiana Department of Transportation and Development (2010), 3.

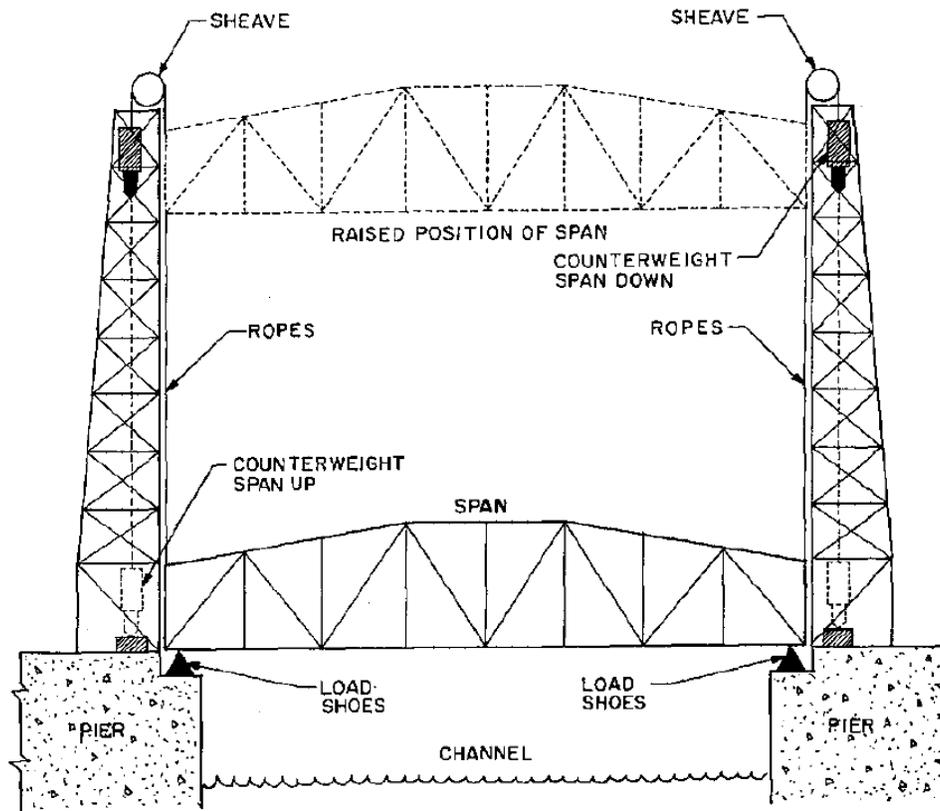


Figure 10. Sketch of vertical lift bridge showing fully opened and fully closed positions, as well as operation components (source: LADOTD Movable Bridge Inspectors Program, Workbook).

Vertical lift bridges consist of a rigid, horizontal, movable span supported between two towers. The movable span remains horizontal at all times, whether fully opened, fully closed, or anywhere in between. The movable span is balanced by large counterweights, which are connected to the span on each end by heavy steel counterweight ropes that are carried over the tops of the two towers on large sheaves, which are grooved steel wheels. Depending on the size of the bridge, sheaves on Louisiana bridges can range from 6 to 15 feet in diameter. The combined weight of the two counterweights (one at each tower or span end) equals the weight of the lift span, providing balance in order to reduce the force needed to move it vertically up and down. To move the counterweighted span, the drive machinery needs to provide only enough force to overcome friction and wind resistance.

The three variations within the vertical lift bridge are based on the configuration of the drive mechanism: the span drive, tower drive, and tower drive with connected towers. The names come from the location of the machinery used to raise and lower the span. Tower drives have the machinery at the top of each tower, while span drives have the machinery on the movable span. Tower drive with connected tower vertical lift spans have machinery located on a fixed span between the two towers.

In the span drive configuration, the driving mechanism is separate from the counterweight ropes, which are carried on free-turning sheaves that are not powered. Instead of powered sheaves, separate sets of wire ropes are installed to provide force to move the span in an upward or downward direction. These

are termed “uphaul” and “downhaul” ropes. Since the span is balanced by the two counterweights, the uphaul and downhaul ropes provide only enough force to overcome inertia, friction, and wind resistance. They are powered by the lift machinery located on the movable span itself and guided from the motor and gears to the span by a series of small wheels and pulleys. Controls are located in a bridge operator’s house, usually mounted on the movable span. Typical locations are atop the span or on the outside of the span, usually at the span’s center. The electric motor and associated machinery for the uphaul and downhaul ropes may be located below the deck and below the operator’s house. An example of an extant span drive configuration is the 1933 U.S. Highway 90 Bridge over the West Pearl River in St. Tammany Parish.³¹²

In the tower drive configuration, the span is raised and lowered by moving the counterweight ropes back and forth on the sheaves, which are driven by motors. A separate motor and drive machinery for each pair of sheaves is located in an enclosed compartment at the top of each tower. Neither motor is connected or synchronized in terms of mechanical operations; the bridge operator controls the speed and positioning of the span and an automatic control system monitors the relative speed of each drive motor. The tower drive system is typically used on the larger vertical lift bridges. The bridge operator’s house and controls are usually mounted within the tower structure above the roadway. Standard plans for this variation existed as early as 1953 in Louisiana. An example of an extant tower drive vertical lift bridge is the 1959 Lockport Company Canal Bridge in Lafourche Parish.³¹³

In the tower drive with connected towers configuration, the span and counterweights are raised and lowered by motorized sheaves that move the counterweight ropes. A single motor, with drive machinery extending to each pair of sheaves, is located on a fixed span that extends between the tops of the two towers. Although the structure connecting the two towers generally results in higher costs, this configuration improves the level of synchronization among the four corners of the movable span in comparison to tower drive examples. It also eliminates the need for the operating ropes and associated maintenance costs found in the span drive configuration. The operator’s house and controls are typically located on a platform alongside one of the approach spans or adjacent to one of the towers. The tower drive with connected towers configuration is typically used on vertical lift bridges over small navigation channels with spans under 200 feet. Standard plans for tower drive with connected towers vertical lift bridges were available by at least 1955. Tower drive with connected tower vertical lift bridges are spread throughout the southernmost parishes in Louisiana with Terrebonne and Lafourche Parishes having the largest numbers. In addition, linear concentrations exist along Bayou Lafourche, Bayou Teche, and the Vermilion River. An example of an extant tower drive with connected tower vertical lift bridge is the 1938 Vermilion River Bridge at Abbeville in Vermilion Parish.³¹⁴ The geography and occurrence of relatively small navigable waterways in this region of the state may explain why this variation is relatively widely used in Louisiana, but quite uncommon nationally, with known examples restricted to Louisiana and New Jersey.

³¹² Recall No. 058710.

³¹³ Recall No. 000930.

³¹⁴ Recall No. 009430.

As with swing-span bridges, vertical lift bridges have numerous additional mechanical elements necessary to their effective operation. These generally include: counterweights and counterweight ropes, balance chains, devices to ensure proper alignment and vertical travel of the span at the towers, locking and leveling devices to seat the span correctly in the closed position, and various types of bridge controls and designs of operators' houses. Operators' houses can be of frame, metal, or concrete construction. Concrete examples typically reflect one of two standard designs, including: one with multi-light windows, a central door, and pilasters; and the other with horizontally divided windows, horizontal scribed lines, and an emblem with Louisiana's state bird, the brown pelican, embedded in the concrete. Standard plans were provided from 1925 to 1959. Vertical lift bridges continued to be built in Louisiana after 1970.

(c) *Bascule bridges*

The operation of the bascule bridge is sometimes described as similar to a historic draw bridge. That description is not completely appropriate, however, because the draw bridge is hinged at one end and lifted free at the other end, the entire span being pivoted up from the hinged end. A more accurate analogy of a bascule bridge is to a seesaw, where the span pivots vertically around a point near the center. As one end is raised, the other end descends, providing (as in a seesaw) balance to the span. This operation, in fact, is represented in the term "bascule," which is derived from the French word "bacule" or seesaw.

When viewed in a bridge design, this analogy describes the most common and most simple of the bascule types, the trunnion bascule. In this design, the raised end of the span is termed the bascule "leaf," the descending end is the counterweight, and the trunnion is a shaft on which the span or leaf pivots. This would be a single-leaf bascule, with the leaf span over the waterway resting on an abutment opposite the pivot point or trunnion end when in the closed position. In the raised or open position, the leaf pivots up, providing a navigation channel with unlimited vertical clearance. If a wider navigation channel is required, two movable leaves may be placed opposite each other for a double-leaf bascule. In this case, the open ends meet and are aligned with each other over the channel with no supporting pier at the center and stability provided only by the locked position of the counterweight end of each leaf. The double-leaf configuration is appropriate for highway traffic but is not stable enough for railroad traffic. Each leaf of a bascule bridge is usually constructed of beams or plate girders, and occasionally of trusses. In a common configuration, the leaf is built of two paired girders (sometimes termed the "bascule girders"), each of which pivots on one of a pair of trunnions.

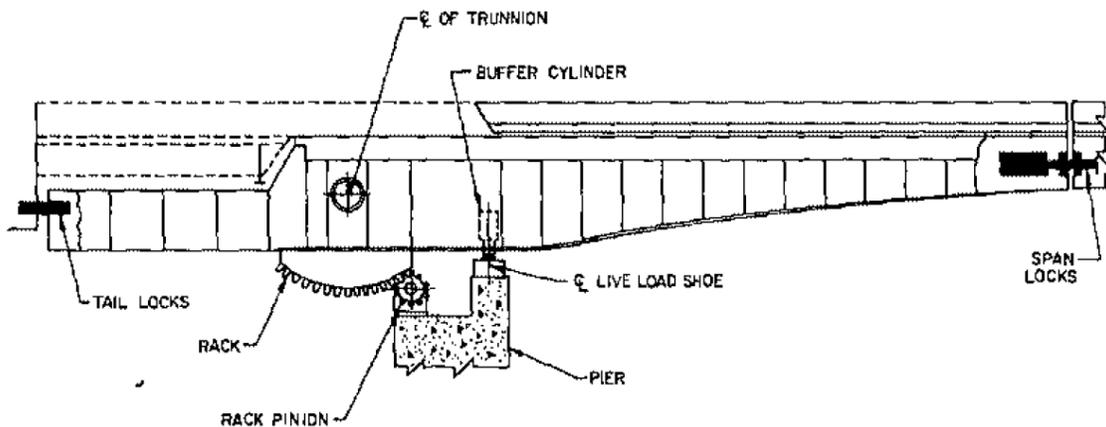


Figure 11. Sketch showing the operating components of one leaf of a double-leaf, simple-trunnion, bascule bridge (source: LADOTD Movable Bridge Inspectors Program, Workbook).

The modern “simple trunnion” design was developed and refined in urban environments in Milwaukee and Chicago at the end of the nineteenth century and beginning of the twentieth century, where it replaced swing spans that required too much space. These examples became known as the Milwaukee-type and Chicago-type bascules, differentiated by details of the gear mechanisms that transmitted power and movement to the spans. Because the machinery of the simple trunnion bascule bridges is contained within the bridge pier and abutment areas and, along with the counterweights, are out of sight, these designs reveal less of their technology on their exteriors. They provide more opportunities for architectural styling and ornamentation than other movable types. The operators’ houses typically are in small towers at each end of the bridge, or at one end in a single-leaf design. The houses offer additional opportunities for architectural treatment and different materials, including concrete and stone.

In addition to the trunnion type are two other bascule designs: the rolling-lift bascule and the heel trunnion. The rolling-lift bridge is also known as the Scherzer rolling-lift bascule for the holders of the original 1893 patent, brothers William and Albert Scherzer. Albert also founded the Scherzer Rolling Lift Bridge Company. Unlike the trunnion design, in which the span pivots on the trunnion, the rolling lift design allows the entire span to rock back on curved sections of the bridge girders themselves, which ride on tracks mounted atop the abutment. In this configuration, as the leaf rises vertically, it also rolls horizontally back in a rocking motion, and the attached counterweight drops down in a pit in the bridge base. Rolling-lift bridges can be single- or double-leaf. Nationally, Scherzer rolling-lift bridges were built into the 1940s, but were used more for railroads than for highways.³¹⁵

³¹⁵ LADOTD *Movable Bridge Inspectors Program Workbook*, II-36-39 refers to this type as the Rolling Lift Bascule and does not mention the Scherzer company. *Common Historic Bridge Types*, 3-129, refers to this type as Rolling Lift (Scherzer) Bascule.

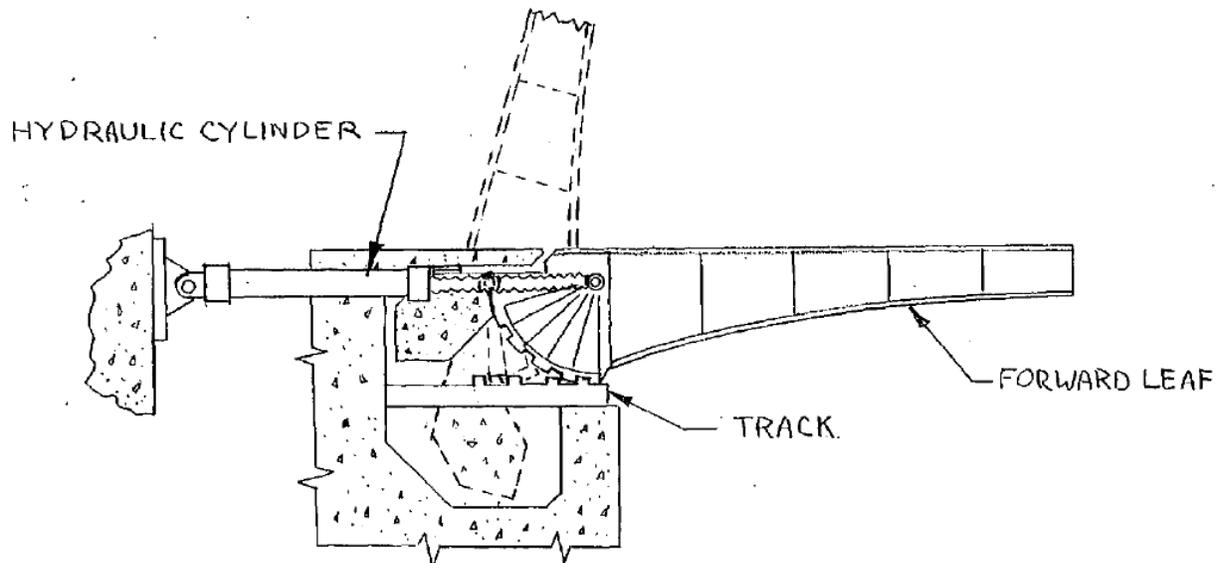


Figure 12. Sketch of a hydraulically operated rolling-lift bascule bridge (source: LADOTD Movable Bridge Inspectors Program, Workbook).

The heel-trunnion bascule design is different than the trunnion and rolling-lift in that the counterweight is separate from the girder span and mounted on a separate, but interconnected, assembly. This type is also known as multiple-trunnion bascule or the Strauss trunnion bascule after its developer, Joseph B. Strauss, who founded the Strauss Bascule Bridge Company in 1902 and received his patents in 1905 and 1906. Strauss was successful at patenting and marketing numerous movable bridge designs during the early twentieth century, including heel trunnion examples.³¹⁶ Strauss produced a modification of his basic concept “in which the main fixed pivot point is located at the end pin of the bottom chord of the truss and the counterweight trunnion is a fixed pivot point at the top of a stationary tower that is supported by the main pier and an auxiliary pier, is known as the ‘heel trunnion’ bascule.” The overhead configuration of the heel trunnion eliminates the need for a pit below grade because the counterweight is mounted overhead. This design allows the trunnion to be placed closer to the waterway, enabling an overall shorter leaf. In addition, the heel trunnion provided design flexibility since the leaf over the waterway may be a truss design instead of a beam or girder design. By eliminating the counterweight chamber, heel trunnions offered a more flexible design solution in terms of structure size and length. Heel trunnion bascules became popular for railroad bridges and are considered less common for vehicular bridges. The Strauss heel trunnion is rare for highway bridges both nationally and in Louisiana.³¹⁷

³¹⁶ Strauss established the Strauss Bascule Bridge Company in 1902 and was a forerunner in developing cost-saving and engineering solutions for movable bridges, including the use of concrete counterweights rather than metal. He is also known as the chief engineer for the construction of the Golden Gate Bridge.

³¹⁷ The DOTD *Movable Bridge Inspectors Program Workbook*, II-39-41, uses the name “Heel Trunnion Bascule” and does not discuss the Strauss origins or name. *Common Historic Bridge Types*, 3-126, refers to this bridge type as Multiple Trunnion (Strauss) Bascule, with no reference to the term “heel.”

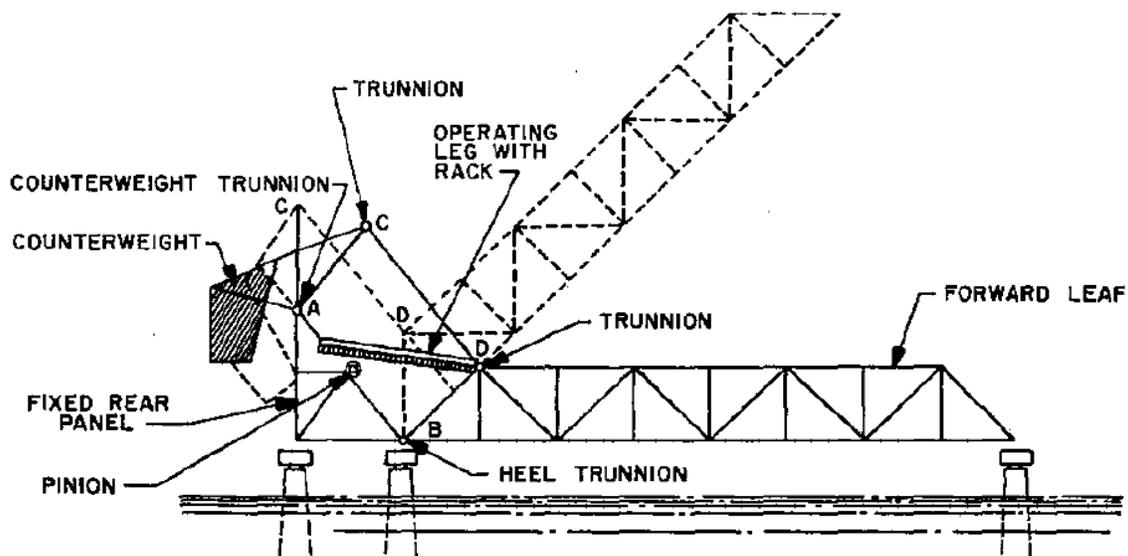


Figure 13. Sketch showing a heel-trunnion bascule design. A heel-trunnion bridge has two fixed trunnions, A and B. The leaf rotates about B, and the counterweight rotates around A. Trunnions C and D move as the leaf is raised (source: LADOTD Movable Bridge Inspectors Program, Workbook).

Bascule bridges, regardless of type, include additional features and components such as operating machinery and transmission devices, live load shoes, buffer cylinders, span locks, and centering devices. The bascule type is found throughout the U.S. and the earliest examples are generally considered to be those constructed prior to 1930. Standard plans for bascule bridges in Louisiana were issued from 1929 to 1949. Within Louisiana, the bascule type is considered uncommon, especially in comparison to populations of other movable bridge types. A limited number of bascule bridges were constructed after 1970.³¹⁸

(d) Pontoon bridges

As developed in Louisiana, the pontoon bridge is another type of movable bridge. Unlike some other states or regions that use so-called “floating bridges” comprised of pontoons, the pontoon bridge in Louisiana consists of a floating section, or pontoon, that can swing or float out of position to open a navigation channel.³¹⁹ It might be conceptualized as an inexpensive, low-tech version of a swing-span bridge, although the design and construction are very different from the swing-span type described above.

Louisiana pontoon swing bridges feature a pontoon or “barge span” that is positioned between the approach spans when in the closed position. A pivot arm connects to a pivot point on the shoreline, and a hand- or motor-operated system of cables, pulleys, sheaves, and winches enables and controls the movement of the pontoon. Therefore, while the pontoon is being moved the cables are above water level and must be dropped to the channel bed to permit passage of marine traffic. Operators’ houses can be of

³¹⁸ Bascule bridges are coded as the following in the LADOTD MSF: PGBASC (steel plate girder bascule span) and TRBASC (steel truss bascule span).

³¹⁹ A “pontoon bridge” type is described in Hovey, *Movable Bridges – Vol. 1, Superstructure* (p. 19) but it does not seem to be the Louisiana type with a movable barge span, but more like the bridge of multiple pontoons that are tied or lashed together.

frame or metal construction and located on the floating pontoon or on the shoreline.³²⁰ Approach aprons enable vehicular access to the pontoon by bringing the approach roadway into alignment with the pontoon driving surface, both vertically and horizontally. These aprons are typically operated via a motorized hoist system housed in towers at the edge of the approach spans; approach aprons can also be attached to the pontoon and operated using hydraulic cylinders. When the bridge is to be opened to marine traffic, the aprons are raised and the pontoon is floated to the shoreline to open the navigable channel to traffic.

Extant examples of pontoon bridges date from 1953 to 1967. Known standard plans for metal pontoon swing bridges date to 1963. The pontoon swing bridge is very uncommon nationally, with most examples restricted to Louisiana and Texas. A limited number of pontoon swing bridges were constructed into the 2000s.³²¹

(e) Removable-span bridges

A removable-span bridge is a type of bridge used in Louisiana for navigable waterways with extremely infrequent marine traffic designed so one span may be temporarily removed to allow watercraft to pass.³²² Removable span bridges are typically between 30 and 50 feet long, with an approximately 20-foot removable span. The infrequency of the opening of the structure for navigation allows for saving in investment and resources by avoiding construction of a more complex and expensive movable-span bridge. The span as such is not actually moved, but is removed from the bridge entirely, then replaced, with the use of a crane or other device. Most removable-span bridges have floor beam extensions on the removable span with openings for a crane to latch on and lift the span. The removable span has a grated deck surface to reduce weight for removal. The removable bridge otherwise has typical I-beam design features, including I-beams connected by floorbeams. Other than the external crane or barge brought to the site for the purpose of lifting out the span unit, this type of bridge is not powered.

Removable span bridges have long been used in Louisiana in particular situations where navigation is infrequent and continue to be utilized due to the vast network of navigable waterways. Standard plans were developed by the state for removable span bridges from 1924 to 1961. The earliest extant examples in the state are from the 1930s. Removable span bridges represent less than one percent of bridges in the subject population.

Extant bridges with removable spans were built from 1936 to 1968. They are concentrated along Bayou Teche, Bayou Grosse Tete, Bayou Black, and Bayou Lafourche.

³²⁰ The design and operation of a pontoon bridge is described in Donald Sorgenfrei, interview by Robert Frame of Mead & Hunt, Inc., New Orleans, 18 July 2012, transcript pp. 10-12.

³²¹ Pontoon bridges are coded as PONTON in the LADOT MSF.

³²² The “removable-span” type of movable bridge is not discussed in LADOTD *Movable Bridge Inspectors Program Workbook*.

(4) Culverts

Culverts are widespread throughout the state and were used extensively throughout the study period. According to the FHWA, a culvert is traditionally defined as a drainage opening beneath a roadway with an overall span of 20 feet or less.³²³ The type designation of “culvert” also refers to a certain structural form, in addition to its drainage function. Culverts that exceed 20 feet are included in this Historic Bridge Inventory. Typically, culverts are unadorned, simple structures without railings, sidewalks, or decks, and in almost all cases with 2 feet or more of fill between the top of the structure and the roadway.

The structural unit or hydraulic opening through which water flows is called a cell (also referred to as a barrel); two or more adjacent cells are combined to create larger structures. Historically, culverts were constructed of a variety of materials, including stone, timber, cast iron, stainless steel, terra cotta, asbestos, cement, and plastic. More common culverts in the study period were constructed of concrete or steel. In Louisiana, extant pre-1971 culverts are constructed of either metal or concrete. A distinctive culvert type is the multi-plate arch, which is formed of curved, corrugated metal segments. These segments are braced on concrete headwalls and piers, and the curved segments are bolted together to form an arch. Most culverts lack engineering distinction or ornamental details.

Nationally, culverts come in a variety of forms, including arched, elliptical, and the more common box and pipe configurations. Types of pre-1971 culverts in Louisiana are summarized in Table 6. The vast majority of examples are the concrete box type.

Table 6. Pre-1971 culverts in Louisiana 20 feet or longer

Culvert type	% of pre-1971 culverts
Metal – pipe	7%
Concrete – pipe	5%
Concrete – box	88%
Total	100%

(a) Metal

Metal culverts in Louisiana are of the pipe form.³²⁴ Pipes have long been used as culverts with and without head walls (walls located at the end of a culvert to divert flow, protect fill, and serve as a retaining wall). The pipe culvert is often used where headroom is limited because it has a lower profile than other types. Pipe culverts are usually prefabricated by manufacturers and shipped to construction sites.

In Louisiana, metal pipe culverts were first believed to have been used during the Depression era, with the majority of the extant structures dating to the 1960s, corresponding to the state’s bridge-building efforts. No state standard plans for pipe culverts were identified, likely because they were prefabricated.

³²³ Raymond Hartle, et. al, *Bridge Inspectors Training Manual/90* (Washington D.C.: U.S. Department of Transportation, 1991), 19-1.

³²⁴ Metal pipe culverts are coded as METRCH in the LADOTD MSF.

(b) Concrete

Concrete culverts were by far the most widely constructed in the state, with 88 percent of the culvert types constructed in the twentieth century, although nationally they were constructed beginning in the late nineteenth century. Concrete culverts can come in a variety of shapes, but most often are found in the box or pipe configuration. A concrete box culvert has four sides, some or all of which may be reinforced, and a square or rectangular opening. Span lengths for reinforced box culverts ranged between 10 and 50 feet; shorter spans were typically unreinforced. The box culvert is traditionally chosen for moderate spans that carry live loads, such as vehicular traffic.³²⁵

Prior to World War II, most concrete culverts were cast-in-place. All cast-in-place concrete culverts are monolithic structures, poured into a pre-made form so the base, top, and walls of the culvert are formed as a single unit and do not have construction joints. One economic benefit of the monolithic construction is that the bottom slab (the culvert's floor) serves as the structure's footing or foundation and no pilings are required as in a bridge to stabilize the structure in the subsoil. Another, and perhaps more important, benefit is that the top of culvert may serve as the driving surface, without the need for a separate deck structure. In this way, the box culvert has a low profile that enables the road to be constructed without significantly raising its grade, as would have been required with a conventional bridge. In other words, the concrete box culvert was a simple, strong structure that was shallow enough to fit in the space between the existing grade of the highway and the creek bed, and used the simplest of foundations, essentially a spread footing. After World War II, cast-in-place concrete culverts were largely superseded by pre-cast concrete units, manufactured off-site.³²⁶ To address extreme water flow changes, sometimes a "double decker" box culvert was used, where two box culverts are stacked. An extant example is the 1930 "double decker" box culvert carrying U.S. 80 over Clark Bayou in Bossier Parish.³²⁷

Concrete box culverts, like many small and simple structures, were built repeatedly throughout the state and used standard plans for efficiency.³²⁸ According to the 1914-1916 *State Highway Engineer's Report*, concrete box culvert plans were prepared by the Department as early as 1914. The standard plan shows the 24-foot barrel (roadway) reinforced with a 6-foot-wide cell opening.³²⁹ Additional plans were developed throughout the early twentieth century for a variety of span lengths and for single or multiple openings. By 1950 the Department had prepared standard plans with quantity sheets for concrete and steel box culvert spans between 6 and 48 feet.

Concrete pipe culverts were also used by the Department, although at a much smaller scale than box culverts.³³⁰ Pipe culverts are manufactured in five standard strength classifications and sizes as large as

³²⁵ Charles H. Hoyt and William H. Burr, *Highway Bridges and Culverts*, U.S. Department of Agriculture, Office of Public Roads - Bulletin No. 39 (Washington, D.C.: Government Printing Office, 1911), 15.

³²⁶ Hartle, et. al., 19-1 to 19-8; Hoyt and Burr, 15.

³²⁷ Recall No. 012200.

³²⁸ Concrete box culverts are coded as CONBOX in the LADOTD MSF.

³²⁹ Louisiana State Highway Department, Report of Board of State Engineers, 1914-1916, 272.

³³⁰ Concrete pipe culverts are coded as CONPIP in the LADOTD MSF.

12 feet in diameter. Elongated pipe culverts, in shapes such as an ellipse or pipe-arch, are used where vertical headroom is limited.³³¹

(5) Beam/girder

Beam and girder bridges comprise the largest number of extant bridges in Louisiana. Many different bridge types using different construction materials fall within this category, including slabs, rigid frame, box girder, channel beam, deck girder (tee beam), I-beams, plate girders, and trestles. Beam bridges can be constructed of concrete, steel, timber, and prestressed concrete, and in simple, continuous, and cantilevered configurations. In practice, engineers would determine the best beam or girder type and configuration based on the site conditions. Beam/girder bridges can be simple, where the girder extends from one vertical support to another, or continuous, where the beam spans uninterrupted over one or more intermediate supports, when built over an intermediate pier. Cantilevered configurations are also utilized, especially for longer spans.

The earliest beam bridges consisted of wooden planks set on timber or stone abutments. As technology advanced, steel and concrete became the preferred materials for these bridges. This is true in Louisiana, where all beam/girder bridges were constructed of either concrete (reinforced or prestressed), steel, or timber. The majority of beam/girder bridges were constructed in concrete or timber, with a small number in steel. Table 7 shows the pre-1971 beam/girder bridge percentages by subtype in Louisiana, and further description of each type is included after the table.

Table 7. Pre-1971 beam/girder bridges in Louisiana

Beam/girder type	% of pre-1971 beam/girder bridges
<i>Concrete</i>	
Concrete slab (including continuous)	40%
Concrete girder (including continuous, reinforced, and prestressed)	14%
Concrete deck girder (tee beam)	<1%
Concrete rigid frame	<1%
Concrete box girder	<1%
Concrete channel beam	4%
<i>Steel</i>	
I-beam (includes continuous)	12%
Steel plate girder (includes continuous)	<1%
<i>Timber</i>	
Timber trestle	28%
Timber mud sill	<1%
Total	100%

³³¹ Hartle, et. al., 19-3 to 19-4.

Beam/girder bridges were heavily utilized in the U.S. in the twentieth century. Standard plans for beam bridges were developed by state highway departments to meet the needs of the growing road system in the 1920s.³³² Even prior to the formal establishment of the LHC, state engineers developed a number of standard plans for concrete or steel beam bridges beginning in 1917. This effort continued throughout the mid-twentieth century. Prestressed concrete beam bridge plans were introduced by the state in the 1960s.

(a) Concrete slab

The concrete slab is widespread and the most common beam/girder bridge type in the state, representing 40 percentage of the population.³³³ Almost always reinforced, the concrete slab is the simplest bridge type. While Louisiana's known examples post-date 1910, concrete slabs can date to as early as 1905 in the U.S. The advent of reinforcing aided in the bridge type's popularity for short spans largely because they were economical and simple to erect. Additionally, the concrete slab was promoted as having "advantages of economy, stiffness, resistance to temperature cycles, resistance to shrinkage, and ease of construction."³³⁴ In concrete slab bridge design, the cast-in-place slab span serves as both the deck and a structural member carrying stresses to abutments and/or piers. Reinforced concrete slab spans are economical only for short spans of 30 feet or less, as longer spans require more concrete and reinforcing than other beam bridges.³³⁵

From the 1920s to 1940s state highway departments developed and extensively used concrete slab standard plans to erect small highway bridges.³³⁶ In the 1930s the continuous slab was introduced with a single slab extending across several spans, providing additional economy and span length.³³⁷ Beginning in the 1930s and continuing into the mid-twentieth century, the LHC developed a number of standard plans for reinforced concrete slab spans. Plans called for spans of between 20 and 30 feet with variations to roadway width and inclusion of sidewalks. The span range used by the LHC was in keeping with the national average, as reinforced concrete slabs were not considered economical for spans over 30 feet.

Several technological advancements were introduced for concrete slab span design. The first was the introduction of the precast slab in the early twentieth century. In this variation of the concrete slab, precast units are placed adjacent to one another and connected together so they act like a single unit.³³⁸ Another variation in Louisiana includes pier caps that are integrated into the concrete slab to form a

³³² Common Historic Bridge Types, 3-80.

³³³ Concrete slabs are coded as CCOVSL (concrete voided slab); COPCSS (concrete precast slab units) and COSLAB (concrete slab) in the LADOTD MSF.

³³⁴ Common Historic Bridge Types, 3-84.

³³⁵ Frame, E-7.

³³⁶ Common Historic Bridge Types, 3-83 to 3-84.

³³⁷ PAC Spero & Company and Louis Berger & Associates, *Historic Highway Bridges in Maryland: 1631-1960: Historic Context Report*, Rev. ed. (1995), 145. Available at Maryland State Highway Administration Website, <http://www.marylandroads.com/open/Acknowl.pdf>.

³³⁸ Common Historic Bridge Types, 3-99.

monolithic design.³³⁹ A more recent variation of the concrete slab span is the “voided concrete slab.” The bridge is fabricated of individual precast slabs with circular voids in the center of the slab. These voids allow for reduced deadload and provide economy of materials. Voided slabs are considered the “modern replacement of the cast-in-place slab,” introduced in the mid-twentieth century but used most extensively after the study period. They are typically used for spans up to 89 feet.³⁴⁰

(b) Concrete girder

The second most widely used beam bridge type in Louisiana is the concrete girder, constructed using reinforced or prestressed concrete. In total, concrete girders represent 14 percent of the beam/girder bridge type in Louisiana and are found throughout the state.³⁴¹ The basic form of the concrete girder was developed by the first decade of the twentieth century, resembling a steel-beam structure encased in concrete. It became the most common type of bridge in the U.S. from 1910 to the 1930s. One variation on this type was the concrete through girder, a structure in which the deck is carried between two girders that rise above the deck and appears as a parapet wall. Concrete girder bridges replaced many of the earlier timber bridges as indicated in the March 1926 edition of *The Louisiana Highway Magazine*, which discusses highway work in the southwest portion of the state with an image of a newly constructed concrete girder bridge. The photograph caption reads, “Type of Concrete Bridges Rapidly Replacing Wooden Structures in Louisiana,” reflecting the growing use of concrete bridges by the Department in the early twentieth century.³⁴²

As early as 1917, the LHC created standard plans for concrete girders with spans from 15 feet to 30 feet. Like the slab span, concrete girders were best suited for short spans, typically from 15 to 40 feet. As the need for wider roadways grew due to increasing automobile use and vehicle size, concrete girder bridges were supplanted by steel I-beam bridges and precast concrete spans due to the cost of formwork and scaffolding in the 1940s.³⁴³

In the mid-twentieth century, concrete girders made a resurgence in the form of prestressed beams. According to engineering historian George Nasser, after the first prestressed bridge was constructed in Philadelphia in 1950, the Lake Pontchartrain Causeway Bridge was influential in the development of prestressing as a national industry and accepted bridge type for state highway bridge design. He states, “The possibilities for prefabrication were vividly demonstrated with the construction of the 24-mile long (39 kilometer) Lake Pontchartrain Causeway (1955-1956) near New Orleans, which at the time was the longest precast, prestressed concrete bridge crossing in the world.”³⁴⁴ The Lake Pontchartrain Causeway was developed privately by the Louisiana Bridge Company (a corporation formed by Brown & Root of Houston, Texas, and the T.L. James Company of Ruston, Louisiana) under the direction of the Louisiana

³³⁹ Recall No. 014900 (extant) is an example of this variation.

³⁴⁰ Hartle, et. al., 9-21.

³⁴¹ Concrete girders are coded as COPSGR (concrete prestressed girders); CPGCCD (concrete prestressed girders w/continuous cast-in-place deck; and PCPSSP (concrete prestressed girders w/precast monolithic deck).

³⁴² “State Highway Work in Southwest Louisiana,” *The Louisiana Highway Magazine* 2 (March 1926): 11, 15.

³⁴³ Common Historic Bridge Types, 3-93.

³⁴⁴ George Nasser, “The Legacy of the Walnut Lane Memorial Bridge,” *Structure Magazine* (October 2008): 30.

Legislature-appointed Causeway Commission (now the Greater New Orleans Expressway Commission) to connect St. Tammany Parish and the greater New Orleans metropolitan area.³⁴⁵ It is the first non-LDH-designed prestressed concrete bridge in the state. The second bridge, constructed parallel to the first, is also a prestressed concrete bridge designed by David Volkert and Associates in 1967 to 1969.³⁴⁶ Since its construction, the second bridge of the Lake Pontchartrain Causeway has been considered to be the world's longest continuous bridge over water, according to the Guinness World Records.³⁴⁷ The bridge was designated a National Historic Civil Engineering Landmark in 2013 for being the first bridge ever constructed using 54-inch-diameter hollow, cylindrical prestressed concrete piles to support a span.³⁴⁸

Prestressed concrete girders were found to be economical and practical for bridges in the medium-span range from 40 to 100 feet, but were generally not cost competitive for spans below 30 feet.³⁴⁹ While prestressed bridges were being constructed in the state in the 1950s, it was not until the 1960s, using AASHTO and Prestressed Concrete Institute (PCI) recommendations, that the LDH designed bridges using prestressed concrete girders. The first LDH-designed prestressed concrete girder bridge constructed was the 1961 Atchafalaya Floodway Bridge (six bridges in three pairs).³⁵⁰ The Atchafalaya bridges were widened with additional prestressed girders in the 1970s and the original lightweight bridge decks replaced.³⁵¹ The Department developed standard plans for prestressed girders in 1967 for a 65-foot precast, prestressed, concrete girder span. This was soon followed with standard plans for 70- and 75-foot prestressed girders. Prestressed concrete girders represent one percent of the beam/girder bridges, and continued to be used after the study period.

(c) Concrete deck girder (tee beam)

The concrete deck girder, also called a tee beam, was used in Louisiana in the first half of the twentieth century. The type represents less than one percent of the beam/girder population in the state.³⁵² Examples are spread throughout the state. Concrete deck girders were introduced in the 1910s and were commonly used nationally from the 1920s to the 1940s. In design, a deck girder features rectangular concrete "T-shaped" beams supporting an integral deck slab or a cast-in-place concrete deck that is used

³⁴⁵ Recall Nos. 203830 and 203832 (extant).

³⁴⁶ Flora K. Scheib, *History of the Southern Yacht Club* (Gretna, La.: Pelican Publishing Co., 1986), 277; "A 24-mile Bridge Across Louisiana's Lake Pontchartrain" *Engineering News-Record* (30 August 1956): 30-33.

³⁴⁷ Guinness Book of World Records "Lake Pontchartrain Causeway," www.guinnessworldrecords.com (accessed 14 September 2012).

³⁴⁸ "Lake Pontchartrain Causeway Named National Historic Civil Engineering Landmark," *The Times-Picayune*, 8 November 2013, http://www.nola.com/traffic/index.ssf/2013/11/lake_pontchartrain_causeway_na.html (accessed 16 November 2013).

³⁴⁹ Norman L. Scott, "Suggestions for Reducing Costs in Prestressed Concrete Bridges," in *Highway Research Record Number 34: Bridge Design, Analysis, and Costs* (Washington, D.C.: Highway Research Board, 1963), 117.

³⁵⁰ One, Recall No. 007300, is extant.

³⁵¹ Louisiana Database; James Porter, LADOTD, email to Robert M. Frame, Mead & Hunt, Inc., 11 September 2012.

³⁵² Concrete deck girders are coded as CODEKG and continuous deck girders as CNTCDG in the LADOTD MSF.

for the roadway surface. The integration of the beam and deck increases bridge strength and allows greater span lengths. A simple span design was most common, with typical spans from 30 to 50 feet.³⁵³ A variation is the continuous span, wherein the beam spans uninterrupted over one or more intermediate supports. Concrete deck girders typically exhibit little aesthetic treatment but decorative parapets, end posts, brackets, pier forms, or light standards can be present.

Concrete deck girder bridges were one of the first concrete bridges constructed in the state. The earliest concrete deck girder was constructed in 1915 in Caddo Parish.³⁵⁴ The LHC prepared standard plans for concrete deck girder spans as early as 1922 and continued to revise and produce additional plans through 1958 with spans between 16 and 40 feet and varying roadway widths.

In the late 1950s to early 1960s, concrete deck girders were replaced by prestressed concrete girders. The concrete deck girder at its longest span length equaled the shorter span lengths of prestressed girders, making prestressed girders a more logical and economical choice. The last reinforced concrete deck girder constructed by the Department in 1961, the Caminada Bay Bridge, carried LA 1 over Caminada Bay to Grand Isle.³⁵⁵

(d) Concrete rigid frame

The rigid frame bridge is considered the last major type of reinforced-concrete bridge to be developed. As a formal type, the rigid frame originated in Europe and was introduced to the U.S. in the 1920s. It was used primarily for grade separations and parkways, where it was readily adaptable for architectural and ornamental treatment. In the rigid frame design and construction, the bridge's superstructure and substructure components are integrated into a single cast-in-place unit. Within this type, some designs have fascias that rise above the deck and also serve as the parapet.³⁵⁶ Bridge historians generally include rigid frame structures among the beam/girder types as the beams and slab walls are simply poured together as a monolithic unit.

Compared to their widespread use nationally, concrete rigid-frame bridges in Louisiana are rare and the reasons are not entirely clear. One extant example, located west of Melville in Pointe Coupee Parish, is known as a slant leg rigid frame bridge.³⁵⁷ Built in 1923, the bridge is an early example of the type, as the

³⁵³ *Safety Inspection of In-Service Bridges: Participant Notebook*, vol. 1-2 ([McLean, Va.]: U.S. Dept. of Transportation, Federal Highway Administration, National Highway Institute, 1992), 8.3.3.

³⁵⁴ Nonextant. James Porter, interview by Robert Frame of Mead & Hunt, Inc., en route to Leesville, La., 19 July 2010.

³⁵⁵ James Porter, interview by Robert Frame of Mead & Hunt, Inc., en route to Leesville, La., 19 July 2010. The bridge was replaced in 2012.

³⁵⁶ This discussion of concrete rigid-frame bridge history and development is adapted from "Common Historic Bridge Types," 3-96.

³⁵⁷ Recall No. 054920. Carries LA 10 over Bayou Morris.

type was generally introduced to the nation at this time. Whether intentionally or by coincidence, it is almost the same design as in the “Plan of Concrete Bridge” dated 1915.³⁵⁸

The “Plan of Concrete Bridge” is one of seven bridge plans in the 1914-1916 *Report of the State Highway Engineer*. All for concrete bridges and appear to be standard plans, although they are not specifically identified as such. The plans represent the earliest bridge plans known to be published by the state. Of the seven plans, two are arch designs and five initially appear to be slab-and-beam or slab-and-girder designs, each dated 1915. The distinctive element common to each of these designs, however, is the rigid-frame or monolithic design and construction. Each design exhibits unmistakable rigid-frame details, including the monolithic concrete construction involving the use of reinforcing bars to create integral connections of all vertical and horizontal components: girders, deck slab, abutment, and pier. The plan similar to the extant example has the longest span at 60 feet. Related to the span length is an unusual and visually distinctive feature: 25-foot-long concrete diagonal braces that extend from the bottoms of the girders to the nearest abutment or pier. Similar braces are prominent on the extant example, making this bridge visually distinctive and unlike any other slab or girder concrete bridge.

The State Highway Department (precursor to the LHC) included bridge plans for concrete rigid frames in only two published reports, 1914-1916 and 1916-1918. The 1915 plans in the 1914-1916 report represent the only known state plans for a concrete rigid-frame design. While the plans in the 1916-1918 report were also for concrete bridges, the concrete design concept had changed and none of the plans included the rigid-frame details.³⁵⁹ By the time of the second report, the Department had begun coordinating bridge specifications with the federal Office of Public Roads, which may account for the elimination of plans including monolithic, rigid-frame-related concrete design details.

³⁵⁸ Louisiana State Highway Department, Report of Board of State Engineers, 1914-1916. Bridge plans are unpaginated and are opposite the following pages: 142, 164, 182, 198, 232, 264, 270, and 272. The particular plan discussed in this section is identified in the title block as “Plan of Concrete Bridge | 16 Ft Roadway – 60 Ft. Span. | Highway Department. | Board of State engineers. | New Orleans, La | Apr. 1915.” The single extant example consistent with this plan is Recall No. 054920.

³⁵⁹ In fact, there is no LADOTD structure type name designation for a concrete rigid-frame bridge and the example remains identified as a concrete slab (COSLAB), but under the FHWA-NBI structure type code of 107 for “concrete frame.”

(e) Concrete box girder

The concrete box girder is one of two variations of the concrete girder, distinguished by its hollow box design, and are uncommon in Louisiana. This type was used rarely in Louisiana during the study period and likely only beginning in the late 1950s.³⁶⁰ The first reinforced concrete box girders were built in the western U.S. in the late 1930s.³⁶¹ In the 1950s prestressed concrete box girder bridges improved upon reinforced concrete box beam types of the late 1930s. These types were used nationally to a limited extent prior to 1960, and standard shapes or forms were developed by AASHTO and the PCI in 1962.³⁶² No standard plans by the state for reinforced or prestressed concrete box girders have been identified.

In design, box girder bridges either have circular or rectangular voids, which serve a dual purpose of reducing beam weight and saving materials. Each beam is cast at 36 or 48 inches wide and has 3- to 6-inch-thick walls. Beams are configured in two ways, either adjacent to one another without any space between or connected using a tie rod, or spread out 2 to 6 feet. Box beams were able to reach practical span lengths between 20 and 130 feet, with the most economical spans ranging from 40 to 90 feet. Due to their similarities, it is often visually difficult for anyone to distinguish between the box beam and a voided concrete slab.³⁶³

(f) Concrete channel beam

The second variation of the concrete girder bridge is the concrete channel beam bridge. A channel beam structure features two rectangular concrete beams supporting an integral deck slab between them used for the roadway surface. This configuration results in an inverted U-shaped beam, which resembles a steel channel section and thus the name “channel beam.” The channel beam was prefabricated in individual units and shipped to the bridge site where they were aligned side-by-side on abutments to create the bridge superstructure. Channel beams were used for short to moderate spans up to 50 feet.³⁶⁴ Though the bridge type has been used by state highway departments since 1910, Louisiana’s extant examples all date to the mid-twentieth century. No standard plans for concrete channel beams developed by the state have been identified.

Concrete channel beams were constructed of either reinforced or prestressed concrete. The type represents three percent of the beam/girder bridges in the state, which are spread throughout the state. Prestressed channel beams were introduced in the 1960s.³⁶⁵

³⁶⁰ Concrete box girders are coded as COBXGR in the LADOTD MSF.

³⁶¹ California Division of Highways, *Manual of Bridge Design Practice*, 2nd ed. ([Sacramento, Calif.]: State of California Highway Transportation Agency, Department of Public Works, Division of Highway, Bridge Department, 1963), 48.

³⁶² *Safety Inspection of In-Service Bridges: Participant Notebook*, vol. 1-2 ([McLean, Va.]: U.S. Dept. of Transportation, Federal Highway Administration, National Highway Institute, 1992), 8.10.3.

³⁶³ Hartle, et. al., 9-24 and 9-21.

³⁶⁴ Common Historic Bridge Types, 3-91.

³⁶⁵ Concrete channel beams are coded as COPSCH (welded concrete prestressed channel units) and CORECH (bolted concrete precast reinforced channel units) in the LADOTD MSF.

(g) Steel I-beam

While the vast majority of beam/girder bridges in Louisiana are constructed of concrete, steel I-beams were also used. The steel I-beam is the third most common beam/girder bridge type in the state, representing 12 percent of the beam/girder population, after concrete slabs and concrete girders (reinforced and prestressed).³⁶⁶ Examples of the type are widespread throughout the state. An I-beam is a joist or girder fabricated of rolled steel that has short flanges (or protruding edges) joined by a web, creating a cross section that forms the letter “I.” A steel I-beam bridge may also be referred to as a steel stringer bridge, particularly if it uses multiple smaller beams. Steel I-beam bridges typically exhibit little aesthetic treatment but may include an open balustrade-type parapet, steel picketed railing, decorative or flared end posts, decorative pier cap design, curved or tapered brackets, and light standards.

In the late nineteenth century, steel was first used in truss bridge design, but the material was quickly applied to new bridge types as steel mills were able to roll I-beams and channels to many lengths and depths.³⁶⁷ Use of steel I-beams by state highway departments became popular in the 1920s and 1930s. At this time steel I-beams were capable of spanning distances up to 60 feet in length by the 1920s. In the 1920s the LHC was busily developing standard plans for I-beam bridges for spans from 15 to 40 feet. These lengths were increased to 80 feet by the mid-twentieth century, aided through the use of cantilever and continuous configurations. The state continued to create and refine standard plans for the bridge type through the 1950s. Steel I-beams were gradually replaced as the bridge type of choice by prestressed concrete beams in the post-World War II era.³⁶⁸

(h) Steel plate girder

The steel plate girder is another steel beam bridge type in Louisiana, making up one percent of the beam/girder bridge pool. It is also one of the most common bridge types nationally for highway construction.³⁶⁹ However, relatively few plate girders were constructed in Louisiana for highway use and most examples date to the post-1945 period. A plate girder, or fabricated steel girder, consists of built-up riveted or welded plates with a deep web fabricated to form a section that looks like the letter “I.” The web lies between the top and bottom flanges, which are fabricated by plate steel placed horizontally over the webs of the girder. With their deep web, plate girders were able to span beyond the length of a standard rolled steel I-beam.³⁷⁰ The plate-girder bridge can be constructed as either a through girder or a deck girder. A through girder is a structure in which the deck is carried between two girders that rise above the deck and appears as a parapet wall. In deck-girder configuration, the deck is carried on top of the girders.

³⁶⁶ Steel I-beams are coded as the following in the LADOTD MSF: CIBTCF (timber trestle w/I-beam stringers and concrete deck); CIBTTF (timber trestle w/I-beam stringers with timber deck); CNTIBM (rolled steel I-beam continuous); CNTWEL (concrete deck w/composite welded I-beams continuous); COMWEL (concrete deck w/composite welded I-beams); CONIBM (concrete deck & bents w/steel I-beam rolled); SUSIBM (suspended steel I-beam).

³⁶⁷ Common Historic Bridge Types, 3-107.

³⁶⁸ Common Historic Bridge Types, 3-107.

³⁶⁹ Common Historic Bridge Types, 3-110.

³⁷⁰ Common Historic Bridge Types, 3-110.

The first plate-girder bridge in the U.S. was introduced in 1846 for railroad use. In the late nineteenth and early twentieth centuries, the bridge type was adopted for highway use. Plate girders competed in use with the steel I-beam and concrete girder, which were more economical to construct. The through plate girder was often chosen when vertical clearance was a concern, such as over railroad corridors or waterways. While adequate for railroads, whose bridge widths rarely changed, through-girder bridges proved difficult to widen as vehicular roads widened in the 1930s. The exterior girders also proved to be hazards for vehicle collisions, and deck girders became the norm.

Plate-girder bridges were used when the required span length exceeded that available in rolled I-beam length. The evolution of the bridge type can be seen in Louisiana's standard plans. The earliest plate girder standard plan identified was prepared in 1923 with a span length of 50 feet. By 1931 the LHC had standard plans prepared for plate girders with 100-foot spans, exceeding the rolled I-beam standard plan of the same date by 60 feet. No standard plans for plate-girder bridges were identified after 1931.

Like other states, Louisiana designed plate-girder bridges as simple, continuous, and cantilevered suspended spans, and sometimes with curved girders. Curved plate girders were introduced to LDH-designed-bridges in 1965. Typically, girders can be curved horizontally or vertically. Horizontally curved girders are used when a particular alignment between roads is needed; vertical curved girders often provide additional vertical clearance. A limited number of steel curved plate girders were identified with construction dates during the study period; they are concentrated in the southeast portion of the state.³⁷¹

(i) Timber trestles

The only timber highway bridges in Louisiana are timber trestles. Trestles, or “a succession of towers of steel, timber, or reinforced concrete, supporting short spans,” were historically used for approach spans for highway and railroad bridges, but were also be used for main spans. Timber trestles represent a large percentage of the beam/girder bridge pool at 28 percent and are widespread through the state. There are a number of advantages to the timber trestle bridge, including that the bridge type could maintain ease grades when crossing deep ravines, it is easy to erect, and materials are abundant.³⁷² Timber trestles were one of the first types of bridges constructed in Louisiana, by railroads, long before a state highway department was organized. Due to their temporary nature, early examples were soon replaced.

The timber trestle was actually one of the earliest known bridge standard plans developed by state engineers. Completed in 1917, timber trestle standard plans were prepared for span lengths between 10 and 30 feet, with variables in deck and clear roadway width. General plan notes from the 1920s specified that timber trestle bridges were to be treated with creosote to resist rot and extend longevity. By 1926 creosoted timber bridges were being constructed across the state, as indicated in the April 1926 edition of *The Louisiana Highway Magazine*, where an image of a treated timber trestle is captioned, “Typical

³⁷¹ Steel plate girders are coded as STPLGR, suspended steel plate girders as SUSPLG, and curved plate girders as STCUGR in the database.

³⁷² *Common Historic Bridge Types*, 3-137 to 3-138.

creosoted timber bridge in use on Louisiana's State Highway System. Such structures have exceptionally long life."³⁷³ The Department constructed timber trestle bridges throughout the twentieth century.³⁷⁴

(j) Timber mud sill

The timber mud sill bridge is similar to a timber trestle bridge, being typically constructed of creosoted timber. Fewer mud sill bridges are extant in the state, and represent less than one percent of the beam/girder type.³⁷⁵ Extant examples of this bridge type dating from the subject period are located in the eastern half of the state. Unlike a trestle bridge, which is supported on pilings, the mud sill distributes the bridge load across the surface the earth beneath the structure on spread timber footings termed "mud sills." The mud sill replaces the abutment or pier in the trestle. Standard plans for mud sills were developed for LHC use in Louisiana in the 1930s. Additional standard plans were prepared by the state into the 1940s. Standard plans specify that mud sills were to be constructed of durable wood species, such as cedar, cypress, or redwood, to resist moisture and insects from its connection to the ground.³⁷⁶

³⁷³ Guillermo M. Sherwell, "The Economic and Social Effects of Highways," *The Louisiana Highway Magazine*, no. 3 (April 1926), 10.

³⁷⁴ Timber trestles are coded as TTCOF (treated timber trestle w/concrete deck) and TTRES (treated timber trestle).

³⁷⁵ Timber mud sills are coded as TTMUDS in the LADOTD MSF.

³⁷⁶ State of Louisiana Department of Highways, *Standard Specifications for Roads and Bridges* (Baton Rouge, L.A.: Department of Highways, 1960), 812.15.

Table 8. Analysis of bridge types in Louisiana

Sources: This table provides a summary of the state's pre-1971 bridge population. Data presented is based on the entire bridge population built through 1971 as received from the LADOTD's MSF provided on June 20, 2012, and the FHWA's NBI provided on June 13, 2012. Subsequent refinements to the data are not reflected in this analysis.

Bridge types (Louisiana Master Structure File (MSF) Code)	Percentage of population	Number of extant bridges built prior to 1971	Span of years constructed during subject period	Main span		Number of spans		Overall structure length	
				Most common main span range	Complete main span range	Most frequent number of overall spans for type	Range of number of overall spans	Range of overall length	Most common overall span length
Arch									
Concrete arch (CONRCH)	Less than 1%	13	1910 - 1965	35 – 50 feet	31 – 55 feet	1 span	1 – 10 spans	31 – 360 feet	55-60 feet
Truss									
Through (STCANT, STHITR, 310)	Less than 1%	23	1908 - 1968	200 – 900 feet	89 – 1,576 feet	15 – 50 spans	1 – 189 spans	120 – 9,163 feet	400-6,000
Pony (STLOTR)	Less than 1%	12	1921 - 1960	60 – 82 feet	60 – 90 feet	5-20 spans	1 – 27 spans	62 – 967 feet	100-600
Deck (STDKTR)	Less than 1%	1	1957	257 feet	257 feet	151 spans	151 spans	5,038 feet	5,038
Movable									
Swing spans (HISWNG, IBSWNG, LOSWNG, PGSWNG)	1%	46	1930 - 1969	70 – 250 feet	52 – 320 feet	3 – 33 spans	1 – 69 spans	122 – 2,005 feet	200-600
Vertical lift (STVERT)	Less than 1%	25	1933 - 1970	50 – 150 feet	50 – 362 feet	10 – 25 spans	5 – 105 spans	112 – 2,558 feet	150-1000
Bascule (PGBASC, TRBASC)	Less than 1%	9	1919 - 1964	68 – 160 feet	22 – 180 feet	5 – 50 spans	1 – 3,744 spans	89 – 126,055 feet	100-2,000
Pontoon (PONTON)	Less than 1%	9	1953 - 1969	52 – 84 feet	52 – 150 feet	10 – 30 spans	9 – 35 spans	136 – 421 feet	200-300
Removable span bridges (CIBTTM, CORIBM)	Less than 1%	15	1936 - 1968	40 – 60 feet	36 – 75 feet	5 – 21 spans	5 – 21 spans	65 – 542 feet	100-300
Culverts									
Metal pipe (METRCH, 319)	1%	75	1936 - 1970	4 – 20 feet	4 – 34 feet	1 – 10 spans	1 – 10 spans	20 – 65 feet	20-50
Concrete box (CONBOX, 119)	18%	963	1920 - 1970	3 – 30 feet	3 – 30 feet	1 – 12 spans	1 – 14 spans	19 – 263 feet	20-200
Concrete pipe (CONPIP)	1%	52	1939 - 1970	4 – 12 feet	4 -31 feet	2-5 spans	1 -7 spans	20 – 40 feet	20-40
Beam and Girder									
Concrete slab (COSLAB, COPCSS, 101)	30%	1657	1915 - 1970	10 – 50 feet	8 – 80 feet	1 – 40 spans	1 – 54 spans	19 – 1,352 feet	20-700
Concrete slab – continuous (CCOVSL)	Less than 1%	3	1965 - 1966	66 feet	66 feet	3 spans	3 spans	163 – 167 feet	163-167
Concrete girder (reinforced and prestressed) (CODEKG, COPSGR, PCPSSP, 102)	10%	523	1919 - 1970	15 – 100 feet	13 – 157 feet	1 – 70 spans	1 – 5,622 spans	13 – 18,778 feet	20-5,000
Concrete girder - continuous (reinforced and prestressed) (CNTCDG, CPGCCD)	1%	40	1921 - 1970	20 – 54 feet	14 – 84 feet	1 -10 spans	1 – 36 spans	27 – 1,250 feet	50-800
Concrete deck girder (tee beam) (104)	Less than 1%	3	1951 - 1955	29 – 38 feet	29 – 38 feet	2 – 4 spans	2 – 125 spans	79 – 4,156 feet	Less than 125
Concrete box girder (COBXGR)	Less than 1%	4	1958 - 1965	90 feet	88 – 90 feet	6 – 19 spans	Less than 20	386 – 565 feet	386-565
Concrete channel beam (reinforced and prestressed) (CORECH, COPSCH, 122, 522)	3%	182	1955 - 1970	15 – 32 feet	15 – 32 feet	1 – 6 spans	1 – 8 spans	21 – 273 feet	20-150
Steel I-beam (CIBTCF, CIBTTF, COMWEL, CONIBM, SUSIBM, 302)	9%	477	1910 - 1970	17 – 150 feet	17 – 633 feet	1 – 75 spans	1 – 470 spans	17 – 19,772 feet	20-5,000
Steel I-beam – continuous (CNTIBM, CNTWEL)	Less than 1%	30	1936 - 1970	71 – 131 feet	50 – 200 feet	3 – 25 spans	3 – 135 spans	60 – 6,715 feet	100-1,500

Table 8. Analysis of bridge types in Louisiana

Bridge types (Louisiana Master Structure File (MSF) Code)	Percentage of population	Number of extant bridges built prior to 1971	Span of years constructed during subject period	Main span		Number of spans		Overall structure length	
				Most common main span range	Complete main span range	Most frequent number of overall spans for type	Range of number of overall spans	Range of overall length	Most common overall span length
Steel plate girder (STPLGR, STCUGR, SUSPLG)	1%	47	1936 - 1970	90 – 300 feet	54 – 450 feet	3 – 100 spans	1 – 298 spans	86 – 9,155 feet	100-2,000
Steel plate girder – continuous (STCPLG)	Less than 1%	15	1935 - 1970	80 – 150 feet	51 – 375 feet	10 – 80 spans	3 – 358 spans	78 – 13,196 feet	200-2,500
Timber trestle (TTTCOF, TTTRES, 702)	21%	1151	1926 - 1970	10 – 29 feet	1 – 29 feet	1 – 20 spans	1 – 24 spans	10 – 457 feet	15-400
Timber mud sill (TTMUDS)	Less than 1%	31	1937 - 1970	11 – 24 feet	11 – 24 feet	1 – 3 spans	1 – 3 spans	16 – 54 feet	16-50
Other (OTHERS, RRTKCR)	Less than 1%	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL		5,408							

E. Engineers, designers, and builders

This section of the context report identifies engineers, designers, fabricators, consulting firms, and builders who are known to have been involved in significant bridge projects within Louisiana through 1970. Influential individuals to Louisiana bridge history were identified during research and review of documents, including National Register documents, determinations of eligibility, standard plans, bridge reports, and HAER documentation.

Inclusion of an engineer, designer, fabricator, consulting firm, and/or builder in this section is as a reference to inform subsequent project steps, but does not necessarily indicate National Register significance under *Criterion C* as a work of a master or *Criterion B* significant person. Instead, the list below is provided as an aid to understand an individual or firm in the context of Louisiana's bridges.

(1) Louisiana Highway Commission and Department of Highways

The largest contributor to the design of bridges, either directly or indirectly, since its inception in the 1920s was the LHC, which later became the LDH. The agency's Bridge Department was responsible for the design and construction of many of Louisiana's bridges beginning in 1922 and continuing through 1970, including some of the state's largest and most significant bridges. The Department designed and often served as supervisor of the project, eliminating the need for a general contractor during construction of state-owned bridges, throughout this period.

Bridge engineering practices of the Bridge Department in the 1950s and 1960s became an increasingly scientific discipline that stressed a calculated approach to the rapidly increasing demand for plentiful, affordable, and efficient bridge designs and construction methods. Standardization and cost analysis accompanied the use of early computer programs and automated work to aid engineers. The Louisiana State University (LSU) engineering department developed a close relationship with the Bridge Department and regional engineers, and collaborated on a number of occasions with each.³⁷⁷ In 1965 the research and development section moved its operations to campus. The Department also adopted the use of computer programs to help in the design of prestressed concrete bridge girders. Developed by the Nebraska Department of Roads, these programs aided in the process of standardization and efficiency that paralleled the professionalization of the Department and bridge engineering.³⁷⁸ A discussion of significant bridge engineers of the state's Bridge Department is presented below.

(a) Norman E. Lant

Perhaps the single most important engineer and bridge designer in the Bridge Department in the first half of the twentieth century was Norman Edward Lant. As head of all bridge engineering work in the agency almost from his first day on the job in 1922 to his retirement in 1955, he oversaw the design and construction of the state's major river crossings, including a number of innovative and complex bridges. Lant's influence on the state's development of roads and bridges is undeniable, contributing to the construction of 11 large-scale bridges crossing major rivers and the state's road system. His presence in the Bridge Department during some of its most productive years of bridge construction is significant.

³⁷⁷ James Porter, interview by Robert Frame of Mead & Hunt, Inc., en route to Leesville, La., 19 July 2010.

³⁷⁸ Louisiana Department of Highways, Biennial Report, 1965-67, 31.

Lant was born in Evansville, Indiana, in 1889 and educated at Purdue University, graduating c.1913 with a civil engineering degree.³⁷⁹ Lant worked as a bridge engineer for the Pan-American Bridge Company in New Castle, Indiana, between 1913 and 1917. After completing military service in World War I, he received his postgraduate degree from Trinity College. His primary studies focused on geology and construction on saturated soils.³⁸⁰ This training would prove to be important for Lant's later bridge work in Louisiana. After returning from service and studies abroad in 1919, he joined the bridge engineering division of the Indiana Highway Commission. There, he worked with important engineers in the early formative years of the Indiana highway and bridge program. Lant left Indiana in 1921 for a position with the U.S. Bureau of Public Roads in Fort Worth, Texas, and later Little Rock, Arkansas.³⁸¹

In 1922 the newly formed LHC recruited Lant from the BPR's Little Rock office, where he was senior bridge engineer. Lant accepted the position of Bridge Engineer, overseeing bridge design and construction, and moved to the Bridge Department's headquarters in Baton Rouge, where he organized the bridge design section. Between 1922 and 1955 Lant held three top engineering positions with the department: bridge engineer (1922-1946), chief engineer (1947-1952), and urban engineer (1952-1955). Lant played a key role in the development of the state's highway network, which was virtually nonexistent when he arrived in the 1920s.

Lant's interest and training in construction of bridges on unstable soils was key to the construction of Louisiana's highway bridges. As Bridge Engineer, he oversaw the design and construction, whether in-house or through consultants, of every major bridge in the state for 33 years. According to the LADOTD, these bridges were significant structures and considered "outstanding engineering feats during the time of their construction."³⁸² Of particular note, Lant designed and supervised the construction of the Atchafalaya River Bridge at Morgan City (Long-Allen Bridge) in 1933. The bridge features the first piers to penetrate to a depth of 178 feet below sea level, the deepest in the world at that time.³⁸³ Lant designed other important Louisiana bridges, including the Atchafalaya River bridges at Krotz Springs; the Red River bridges at Moncla, Alexandria, Coushatta, and Shreveport; the Ouachita River bridges at Harrisonburg, Monroe, and Sterlington; the Bonnet Carre and Morganza Spillways; the Mermentau, Chef Menteur and

³⁷⁹ *Encyclopedia of American Biography* (West Palm Beach, F.L.: American Historical Company, Inc., 1969), 44; "Norman Lant Previously Designed and Supervised Building of Highway Bridges," *Evansville Press* (Indiana), 1946, available at the Evansville Public Library online newspaper archive <http://local.evpl.org/views/viewimage.asp?ID=904045> (accessed 17 August 2012).

³⁸⁰ *Encyclopedia of American Biography*, 45.

³⁸¹ Corley, 29.

³⁸² "Highway Hall of Honor Induction Set."

³⁸³ *Encyclopedia of American Biography*, 45.

Rigolets bridges; Pearl, Sabine, and Calcasieu spans; and the Mississippi River Bridges at Baton Rouge and New Orleans.³⁸⁴

Possibly the most important bridge Lant designed was the Mississippi River Bridge at Baton Rouge (Huey P. Long Bridge at Baton Rouge; constructed 1940).³⁸⁵ The bridge brought Lant international respect as a bridge engineer and the bridge was “called ‘his’ bridge” and a “triumph” back in his Indiana hometown, where his career was followed throughout his life. In the Baton Rouge project, Lant initiated a new bridge construction process where the LHC served as the supervisor and contractor for the project rather than hiring an outside general contractor. The process allowed the LHC to save a large amount on the construction of the bridge, and demonstrated Lant’s administrative skills.³⁸⁶

Lant was not only instrumental in large-scale bridge building, but also with perfecting the state’s existing bridge plans, including the multiple box culvert. Additionally, Lant was influential in the establishment of a road program that included the widening of the state’s highway system from 13 to 24 feet and the construction of the Airline Highway from Baton Rouge to New Orleans.³⁸⁷

Lant was a member of a number of national engineering societies and served as president of the Louisiana Chapter of the ASCE in 1940. He retired from the LDH in 1955, having served 33 years. He died in Baton Rouge in 1967. Posthumously, Lant was inducted into the Louisiana Highway Hall of Honor in 1974, the program’s inaugural year of awards. The Hall of Honor continues today and recognizes individuals “who have made extraordinary contributions to Louisiana’s highways and streets program.” Lant was honored as a “nationally recognized bridge Engineer with the Louisiana Highway Commission and Department of Highways.” Included with Lant in the same inaugural group of inductees were Governor Huey P. Long, State Highway Engineer Harry Henderlite (see below), and Louisiana construction magnate T.L. James, Sr. (see below), indicating the level of his significance to bridge engineering in the state.³⁸⁸

(b) Harry B. Henderlite

Harry B. Henderlite is important to the early development of Louisiana’s roads and bridges and is credited with bringing success to the LHC. Henderlite has been described as “the most dominant force in the planning and construction of highways” during his tenure with the organization and influential in advocating long-range planning principles for highways and road corridor development.³⁸⁹

³⁸⁴ Corley, 29; “Highway Hall of Honor Induction Set.” Of these bridges, the Mississippi River Bridges at Baton Rouge and New Orleans, the Ouachita River Bridges at Monroe and Harrisonburg, the Bonne Carre and Morganza Spillways, the Chef Menteur Bridge, and the Calcasieu River Bridge are extant. The status of the Coughatta Bridge is unknown.

³⁸⁵ Recall No. 051880 (extant).

³⁸⁶ “Norman Lant Previously Designed and Supervised Building of Highway Bridges”; “Builds Big Bridge,” *Evansville Press* (Indiana), 8 August 1940; Corley; “Highway Hall of Honor Induction Set.”

³⁸⁷ Encyclopedia of American Biography, 45.

³⁸⁸ “Highway Hall of Honor Induction Set.”

³⁸⁹ Highway Hall of Honor Induction Set.”

Henderlite was born in Raleigh, North Carolina, in 1893. In the 1920s Henderlite worked as a civil engineer in North Carolina's highway department and also served as a State Highway Commissioner.³⁹⁰ In 1929 Henderlite was one of five engineers in North Carolina recruited to Louisiana by Huey Long.³⁹¹ Henderlite served as State Highway Engineer for six years, from 1929 to 1930 and 1934 to 1939.³⁹² One of the largest projects Henderlite oversaw in his capacity as State Highway Engineer was the construction of a "short cut" highway between New Orleans and the Mississippi Gulf Coast in the 1930s. The new highway (U.S. 90) ran along portions of the Old Spanish Trail to the Mississippi state line, where it was continued by the Mississippi Highway Commission to the gulf.³⁹³ Improvements to the road included paving and the elimination of all ferry crossings with replacement bridges.³⁹⁴

Henderlite served as chief engineer in the early 1940s until 1946, when he retired from the Department. After his retirement he worked as a consulting engineer in the state, helping plan new river crossings. He died in Louisiana in 1970. Harry Henderlite was posthumously inducted in the Louisiana Highway Hall of Honor in 1974.

(c) George F. Stevenson

Another significant individual within the Department during the study period was George Stevenson. Stevenson joined the Bridge Department in 1931 as a bridge designer. In his early years with the LHC he helped design and supervise the construction of the Atchafalaya River Bridge at Krotz Springs, under the direction of Lant. He was also involved in the design and construction of the approaches to the 1958 Crescent City Connection (formerly the Greater New Orleans Mississippi River Bridge).

Stevenson was important for his design and construction work during one of the busiest periods of bridge design and construction in the state. His work included bridges such as the Claiborne and Carrollton Avenue Interchanges in New Orleans, the underpass and elevated circle where the Airline Highway meets the Causeway Boulevard in Jefferson Parish, and bridges at Raceland, Thibodaux, and Houma. Over his 39-year tenure with the Bridge Department, Stevenson served as both chief engineer and urban engineer. As urban engineer, from 1964-1970, he was instrumental in the expansion of the Department's international relationships, and taught visiting engineers from South and Central America the design, construction, financing, and operation of a highway system. Stevenson was inducted into the Louisiana Highway Hall of Honor for his leading role in the LDH bridge engineering department.³⁹⁵

³⁹⁰ 1920 United States Federal Census record for Harry Henderlite; *Biennial Report of the Attorney-General of the State of North Carolina, 1922-1924* (Raleigh, N.C.: Edwards and Beoughton Printing Co., 1924), 217. Biennial report digitized by the University of North Carolina at Chapel Hill.

³⁹¹ "Louisiana Highway Engineers Resign," *Biloxi Daily Herald* (Mississippi), 18 April 1933.

³⁹² Research did not reveal the circumstances behind Henderlite's leaving his position as State Bridge Engineer in 1929-1930.

³⁹³ "Louisiana Ready," *Biloxi Daily Herald* (Mississippi), 19 September 1932.

³⁹⁴ Louisiana Highway Commission, *Sixth Biennial Report, 1930-1932*, 36-37.

³⁹⁵ Louisiana Highway Hall of Honor, photograph of Stevenson's biography provided by the LADOTD.

(d) Louis Duclos

Civil Engineer Louis Duclos was an influential LDH engineer in the mid-twentieth century that pioneered the Department's use of new technologies. Duclos, a graduate of Tulane University with licenses in electrical, mechanical, and civil engineering, was particularly interested in the technology of movable bridges. Of note, Duclos pioneered the design for hydraulic operation of movable bridges. He also was an early user of high-strength fasteners and promoted the use of high-strength steel in bridge design. According to his Louisiana Highway Hall of Honors induction biography, Duclos was "an engineer's engineer" and was pivotal in improving the science of soil mechanics, thereby reducing costs of bridge foundations for the LDH. Duclos worked at the LDH from 1947 to 1964 before assuming a position with Barnard & Burk Engineers, Inc. He died in 1992.³⁹⁶

(e) Sidney L. Poleyarnad

Sidney Poleyarnad was an influential bridge designer with the LDH from his introduction to the Bridge Department in 1947 to his retirement in 1978. Poleyarnad, an LSU graduate, designed "the major portion" of the bridges on the Louisiana's Interstate system, including the major river crossings of the Mississippi, Atchafalaya, and Red Rivers. He was instrumental in developing new concepts in bridge design, the use of prestressed concrete, and cable-stayed bridges. Additionally, he was known as one of the foremost authorities in the field of pile-driving. During his tenure at the LDH, Poleyarnad advanced through a number of positions, including serving as highway assistant director from 1972 to his retirement in 1978. He was a Louisiana Highway Hall of Honors inductee. Poleyarnad died in 2006.³⁹⁷

(f) Albert J. Dunn

Albert Dunn, PE, PLS, was an LDH engineer from 1954 to 1995. His career in construction involved a significant collaboration in 1964-65 with LDH bridge engineer Conway Lusk, PE, to develop the "pile-supported approach slab" (discussed in Section 3.C.(1) above). This method of construction was used throughout southern Louisiana where unconsolidated, organic soils posed large settlement issues for the approach slab between the shallow-founded roadway pavement and the deep founded pile-supported bridge. The innovative new design was cited as a significant reason for Dunn's induction into the Louisiana Highway Hall of Honor in 2011.³⁹⁸

In 1965 Dunn continued his career in the LDH bridge maintenance area near the time when the federal National Bridge Inspection (NBI) Standards were developed and sent to state highway agencies for implementation. He proceeded to recruit others in the Department with the expertise required to implement the processes required to support the new NBI Standards. Dunn provided the leadership to focus and eventually implement the needed processes such as bridge inspection, data development, and data assimilation. Also under Dunn's leadership, the Department's in-house bridge maintenance

³⁹⁶ Louisiana Highway Hall of Honor, photograph of Duclos's biography provided by the LADOTD.

³⁹⁷ Louisiana Highway Hall of Honor, photograph of Poleyarnad's biography provided by the LADOTD; "In Memoriam: Sidney L. Poleyarnad," Louisiana Section ASCE, <http://www.lasce.org/news/newsitem.aspx?id=25> (accessed 19 September 2012).

³⁹⁸ Louisiana Highway Hall of Honor, photograph of Dunn's biography provided by the LADOTD.

capabilities were substantially enhanced notably, including replacing timber bridges with precast concrete slab spans and steel bridge painting.³⁹⁹

(2) Consulting engineers and firms

Louisiana's bridge history also includes a number of significant bridge consulting engineers, construction companies, and fabricators. The following firms were identified during research for their influential roles in the development and construction of Louisiana's roads and bridges during the subject period.

(a) Modjeski and Masters

The engineering firm of Modjeski and Masters (formerly Modjeski, Masters and Chase) was instrumental to the development of many large-scale bridges erected in the 1930s over the Mississippi River. In 1947, due to their continued work in the state, the firm opened a Baton Rouge office. While the firm's complex and rich history extends beyond the scope of this project, its specific involvement and influential role in Louisiana's bridge history is discussed below.

The principals of Modjeski, Masters and Chase, as well as the firm itself, were nationally known for their extensive knowledge and experience in bridge design, including major Mississippi River bridges. This experience was important in securing the design and construction contract with the LHC for the combination railroad and highway bridge over the Mississippi River at New Orleans in 1925. After a number of years of delays, the bridge was completed in 1935. It was considered a major engineering accomplishment and recognized at the time as the longest steel trestle railroad bridge in the world.⁴⁰⁰ The firm also worked as consulting engineers for the railroad/highway bridge crossing on U.S. 190 at Baton Rouge for the Missouri Pacific Railroad and Louisiana State Highway Railway. This bridge was designed and completed between 1931 and 1933, two years before the Mississippi River Bridge at New Orleans (Huey P. Long Bridge) was finished.⁴⁰¹

The success of the Mississippi River Bridge at New Orleans (Huey P. Long Bridge) led to further contracts with the LHC, including the design of the double bascule bridge on U.S. 11 over Lake Pontchartrain in New Orleans.⁴⁰² The bridge, designed in cooperation with the firm of Ford, Bacon and Davis, opened in 1938. Additionally, the firm provided consulting services to railroad companies and the USACE through the 1960s.⁴⁰³ Modjeski and Masters continues to have a local bridge design and building presence, including rehabilitation and renovation of existing bridges constructed by the firm in earlier years.

³⁹⁹ James Porter, LADOTD Planning Support Engineer, email to Mead & Hunt, 28 September 2012.

⁴⁰⁰ Coco & Company, HAER for the Huey P. Long Bridge, 1.

⁴⁰¹ Coco & Company, HAER for the Huey P. Long Bridge, 9.

⁴⁰² Recall No. 001552 (extant).

⁴⁰³ Coco & Company, HAER for the Huey P. Long Bridge, 11; Don Sorgenfrei, interview by Robert Frame of Mead & Hunt, Inc., New Orleans, 18 July 2012.

(b) Harrington & Cortelyou

Harrington & Cortelyou (now absorbed into the consulting firm of Burns & McDonnell) was a national engineering firm that designed and supervised construction of the O.K. Allen Bridge, one of the few extant K-truss bridges in the state.⁴⁰⁴ Constructed in 1936, the 500-foot main span of the bridge spans the Red River near Alexandria. John Lyle Harrington and Frank Corelyou established the partnership in 1928. The firm was headquartered in Kansas City, Missouri.⁴⁰⁵

(c) Daniel Moran and Moran and Proctor Co.

The firm of Moran and Proctor, and its founder Daniel Moran, were influential to Louisiana bridge history because they designed the foundations for the Mississippi River Bridge at New Orleans (Huey P. Long Bridge).⁴⁰⁶ Their work on this bridge was instrumental in the subsequent construction of Mississippi bridges.

Moran was an influential pioneer in the field of foundation engineering, which focused on understanding soils as they applied to construction. After graduation from the Columbia University School of Mines in 1884, Moran spent his early career solving foundation engineering challenges in the mining industry and then for foundations in New York, where unstable soils made construction of deep foundations difficult. His successes earned him the title of “the man who made the skyline of New York” from engineering historians.⁴⁰⁷ Over the course of his career as an expert on foundation design, he received 33 patents relating to caisson and foundation construction, including the Moran Caisson. His businesses reflected his dedication to the advancement of the field by focusing solely on foundation engineering, consulting on some of the most complex and challenging bridge sites in the nation.⁴⁰⁸

In 1920 Moran formed Moran and Proctor, which focused on foundation design. The firm was nationally and internationally recognized and sought out for its work on challenging foundation designs, including nationally recognized buildings, dams, and bridges such as the San Francisco-Oakland Bay Bridge (1933-1936).⁴⁰⁹ The firm’s knowledge and expertise in foundation design, especially on unstable soils, led to its selection for the Mississippi River Bridge at New Orleans (Huey P. Long Bridge). During the design of the bridge, innovative techniques such as soil testing, research, and experimentation were undertaken by Moran to determine the best course of action. Additionally, a new type of caisson was developed, along with Siemes-Helmer’s “sand island” pier foundations, to successfully construct the

⁴⁰⁴ The O.K. Allen Bridge is currently scheduled for demolition in 2014.

⁴⁰⁵ “About H&C,” *Burns & McDonnell*, 2012, <http://www.burnsmcd.com/Services/Details/About-HC> (accessed 21 August 2012).

⁴⁰⁶ Recall No. 000060 (extant).

⁴⁰⁷ Mueser Rutledge Consulting Engineers, *75 Years of Foundation Engineering* (New York: The Benjamin Company, Inc., 1985), 18. The company’s history book references Ralph Peck, Walter Hanson, and Thomas Thornburn’s *Foundation Engineering* (New York: Wiley, 1953), n.p.

⁴⁰⁸ Mueser Rutledge Consulting Engineers, 12, 18, 21.

⁴⁰⁹ Mueser Rutledge Consulting Engineers, 21; American Society of Civil Engineers, “Landmarks in American Civil Engineering History – 1936 San Francisco-Oakland Bay Bridge,” *Civil Engineering* 72 (November/December 2002), 131. This issue is located in a compilation of past articles in *Civil Engineering*.

bridge's foundations. The innovative engineering techniques used in the construction of the bridge were recognized in 2012 when it was designated as a National Historic Civil Engineering Landmark, citing it as "an example of how engineers push the limits of their knowledge of materials, design theories, and methods to advance the state of the art of engineering."⁴¹⁰

Moran and Proctor Co., now called Mueser Rutledge Consulting Engineers, continues to provide foundation and geotechnical engineering services nationally and internationally.⁴¹¹

(d) William Horace Williams Company

The William Horace Williams Company served as both consulting engineer and builder on a number of Louisiana bridges in the Depression and New Deal eras. The company designed and/or constructed the Chef Menteur Bridge (1929), Rigolets Bridge (1930), West Pearl River Bridge (1933), West Middle Pearl River Bridge (1933), Middle Middle Pearl River Bridge (1933), East Middle Pearl River Bridge (1933), and Burr's Ferry Bridge (1937).

(e) Ford, Bacon & Davis

In cooperation with Modjeski, Masters and Chase, the Ford, Bacon & Davis consulting firm designed the double bascule bridge carrying U.S. 11 over Lake Pontchartrain in New Orleans in 1938.⁴¹²

(f) Howard, Needles, Tammen & Bergendoff

The firm of Howard, Needles, Tammen & Bergendoff (today known as HNTB Corporation) has a strong presence in Louisiana's bridge history. The firm primarily worked on projects occurring in the last half of the study period, including the design and construction of early Interstate routes. In cooperation with Barnard and Burk of Baton Rouge, the firm designed I-10 across the Atchafalaya Basin, I-10 from Baton Rouge to LaPlace, and I-10 from Baton Rouge to Slidell.⁴¹³

(g) J.B. Carter and the Nashville Bridge Company

J.B. Carter was a consulting engineer for the nationally known Nashville Bridge Company, based in both Nashville, Tennessee, and Bessemer, Alabama. Carter prepared the standard plan that was applied to the Ouachita River bridges near Sterlington in 1931.⁴¹⁴ The standard plan was used to fabricate and build eight other swing span structures on the river as part of a \$6 million deal with Governor Huey D. Long.⁴¹⁵

⁴¹⁰ Louisiana Times Managers, "Huey P. Long Bridge Dedicated as a National Historic Civil Engineering Landmark," press release dated 28 September 2012.

⁴¹¹ Mueser Rutledge Consulting Engineers, 63-64.

⁴¹² Recall No. 001552 (extant).

⁴¹³ Louisiana Highway Hall of Honor, photograph of John Cotton's biography provided by the LADOTD.

⁴¹⁴ Nonextant.

⁴¹⁵ Coco & Company, Historic American Engineering Record (HAER) for the Ouachita River Bridge at Sterlington, prepared for the Louisiana Department of Transportation and Development (2010), 3.

(h) Siems-Helmers, Inc.

The Siems-Helmers engineering firm, located in St. Paul, Minnesota, developed and pioneered the use of the “sand island” method of caisson construction. The technique made it possible to safely, successfully, and economically provide foundations for bridges constructed on the deep, unstable soils of Louisiana’s rivers, particularly the Mississippi River. The firm filed the original patent for the sand island method in 1931 and received the patent in 1934. At its completion in 1935, the Mississippi River Bridge at New Orleans (Huey P. Long Bridge) was likely the first bridge to utilize the patented version of the design.⁴¹⁶

(3) Bridge builders, construction companies, and fabricators

The following bridge builders and fabricators were identified during research and are known to have participated in construction of one or more bridges in Louisiana. The list is arranged in alphabetical order; in the case of a bridge builder, they are organized by their last name.

- Austin Bridge Company (Dallas, Texas)
- Bethlehem Steel Company (Bethlehem, Pennsylvania)
- Boh Bros. Construction Company (New Orleans, Louisiana)
- Consolidated Western Steel Corporation (Orange, Texas)
- Daniel Jeffrey and Sons, Inc. (Louisiana)
- W.R. Fairchild (Hattiesburg, Mississippi)
- Foundation Company of New York (New York)
- Alvin Fromherz, Fromherz Engineers, Inc. (New Orleans, Louisiana)
Alvin Fromherz, founder of Fromherz Engineering, is important to Louisiana’s bridge history as one of the first companies to use soil borings in New Orleans, which led to work on the Houma Tunnel under the Intercoastal Waterway. Fromherz was recognized for his significance to the transportation history of the state as an inductee to the Louisiana Highway Hall of Honor.⁴¹⁷
- Gauger Construction Company (Memphis, Tennessee)
- Gordon Walker Contracting of Baton Rouge (Louisiana)
- Groton Bridge and Manufacturing Co (Groton, New York)

⁴¹⁶ Melville Clements and Nick Helmerts, 1934, Method of Constructing Foundations, U.S. Patent 1,963,351, filed August 3, 1931, and issued June 19, 1934. Recall No. 000060 (extant).

⁴¹⁷ Louisiana Highway Hall of Honor, photograph of Fromherz’s biography provided by the LADOTD.

- T.L. James & Co. (Louisiana)
T.L. James & Co. was a pioneer in the development of modern construction techniques for highways. The Louisiana-based company, founded in 1926 after Thomas Lewis James, worked on the Lake Pontchartrain Causeway bridges, the New Orleans Expressway, and portions of Louisiana's Interstate system.⁴¹⁸
- Jones & Laughlin Steel Corporation (Louisiana)
- Keiliiher Construction Company (Dallas, Texas)
- List and Weatherly Construction Company (Louisiana)
- Meyer Greenwald Construction Company
- Midland Bridge Company (Kansas City, Missouri)
- Mid-state Prestressed Concrete, Inc. at Alexandria (Louisiana)
Mid-state Prestressed Concrete, Inc. was responsible for production of numerous prestressed beams used for Louisiana bridges beginning in the 1960s. The first may have been those used on the 1961 U.S. 190 bridges over the Atchafalaya River. As noted in the discussion of prestressed as a bridge-building material, once precasters made the investment in beds, large quantities of beams could be mass-produced and delivered to construction sites.
- Miller-Hutchinson Company (Baton Rouge, Louisiana)
- Mount Vernon Bridge Company (Mount Vernon, Ohio)
- Netherton Company, Inc. (Louisiana)
- Stevens Brothers Contractors (Saint Paul, Minnesota)
- Raymond Pile Company – see discussion in Section 3.C.(1)(b)
- The DeLaney Company
- Vincennes Bridge Company (Vincennes, Indiana)
- Virginia Bridge and Iron Company (Roanoke, Virginia)
- James E. Walters and Prestressed Concrete Products Company, Inc. (Mandeville, Louisiana)

⁴¹⁸ Highway Hall of Honor Induction Set.”

Walters, a Louisiana Highway Hall of Honor inductee, was “responsible for the planning, design, and construction” of the prestressed concrete plant near Mandeville, in St. Tammany Parish. The plant produced the precast, prestressed components that constructed the Lake Pontchartrain Causeway and the “Swamp Expressway,” which crosses the Atchafalaya Floodway between Baton Rouge and Lafayette.⁴¹⁹

- Wisconsin Bridge & Iron Company (Milwaukee, Wisconsin)

F. Aesthetics in bridge design

Like buildings, bridges from a particular period may either intentionally or unintentionally reflect the aesthetic of the time. However, aesthetics was not a major focus in bridge design and construction largely due to the limitations of construction materials, bridge types, economics, availability of artisans, and/or community expectations. For example, stone and concrete bridges lend themselves more readily to aesthetic treatment and are found to be more frequently adorned than steel and wood bridges. Aesthetic principles are rarely seen applied to beam and girder bridges, except on railings where aesthetics can easily be expressed, although in limited form. As such, most bridges do not have an overt aesthetic; rather, aesthetics are subtle or not applied at all. Following the national trend, Louisiana has few examples of intentionally applied architectural style to bridges. When aesthetics are applied, it is generally restrained and typically incorporated into railings. The following discussion includes national aesthetic bridge design trends with known Louisiana examples discussed.

Nationally, the desire for application of architectural style to bridges first occurred in the late nineteenth century as part of the City Beautiful Movement, an ideal presented at the 1893 World’s Columbian Exposition. Proponents of the movement argued for monumental structures that exhibited durability, strength, fitness, grace, and beauty. The use of Neoclassical design elements became popular following the Exposition, and the concrete arch was frequently chosen as the bridge form that best conformed with City Beautiful dictums.⁴²⁰ Bridges that evoke the design ideals of the City Beautiful Movement are found in Louisiana’s urban parks. In particular, City Park in New Orleans features a number of graceful arched vehicular and pedestrian bridges that, although constructed in the 1920s and 1930s, still reflect the earlier movement’s aesthetic ideals and express Neoclassical style through the arched form, symmetrical balustrade, and recessed paneling.

Louisiana’s reinforced concrete arch bridges in New Orleans’s City Park display high artistic value through Classical Revival or Art Deco aesthetic treatments. Classical Revival design details includes curved railings with arched posts; recessed or arched panels in the railing or end posts; carved flowers, urns, and/or inscribed cartouches; and integrated lamp posts. The majority of reinforced concrete arch bridges in New Orleans’s City Park express Art Deco influences, including geometric patterns, inscribed vertical lines, crowned and beveled parapets, and recessed arch rings. A more modest example constructed late in the period reflects the transition from Art Deco to a more restrained Streamline

⁴¹⁹ Louisiana Highway Hall of Honor, photograph of Walter’s biography provided by the LADOTD. Recall Nos. 203830 and 203832, extant.

⁴²⁰ Cooper, 7-33.

Moderne style as reflected by its use of limited ornamentation to emphasize overall horizontal massing. Eight of the nine reinforced concrete arches were designed under the direction of architect Richard Koch and contractor/engineer George Rice during the redesign of City Park by WPA efforts between 1936 and 1939. Several of these bridges also display bas-relief sculptures on the parapet walls or exterior pier columns. Designed by sculptor Enrique Alferez, the bas-relief carvings feature reclined figures, WPA workers, and tools, which further enhance the design aesthetic of the bridges. Alferez also completed a number of sculptures throughout the park.

In the early twentieth century, bridge aesthetics shifted to clarity of purpose, symmetry, harmony with the environment, proportion, and harmony of material and form with the purpose of ornamentation as a clear proclamation of functional and pragmatic bridge design.⁴²¹ During this period, technological advancement in concrete and steel allowed bridges to become more slender in appearance. In addition, the development of state highway departments and the establishment and use of standardized bridge plans led to minimized ornamentation for both ease of construction and cost reduction. Bridge designers in the 1910s also preferred what they said were honest, efficient bridges without “ginger-bread ornamentation.”⁴²² In keeping with the move away from intentional aesthetic treatment, LHC-designed concrete bridges limited any decorative treatment to the railings and pier pilasters, as seen in standard plans and structures featured in biennial reports. The aesthetic principle persisted into the early 1930s as highlighted in the *Eighth Biennial Report, 1934-1936* with a photograph of two recently constructed reinforced-concrete arch bridges with symmetrical spans, graceful lines, simple concrete rail, and column light standards.⁴²³

Nationally in the 1920s through 1940s, architectural styles such as Art Deco, Moderne, Period Revival, and the Rustic style were applied to bridge design in limited examples. The Art Deco style, which enjoyed its peak of popularity between 1920 and 1930, was characterized by the use of ornate geometric motifs to express contemporary trends of industrialization and modernization. The Moderne style, or Streamlined Moderne, was a more restrained version of the Art Deco style and was popular from 1930 until World War II. Moderne designs featured smooth surfaces and curved corners. Designs based upon the continuation of the traditions of classical architecture are recognized by the general stylistic term Period Revival. The Rustic style was also employed for bridge design, which promoted natural and native materials with the intention of having the manmade object blend into natural surroundings. Typically stone or stone-veneer concrete arches were built in the Great Depression as part of federal work relief programs.

The application of early-twentieth-century architectural styles to bridges is rare in Louisiana. The People’s Avenue Underpass, carrying Gentilly Boulevard (U.S. 90) over People’s Avenue in New Orleans, shows Moderne style details. The bridge, constructed in 1948, features vertical lines on the piers and railing, exhibiting Moderne design. Decorative details were also applied to a few of Louisiana’s

⁴²¹ William Titus, “The Artistic Design of Concrete Bridges,” in George Hool and Frank Thiessen, *Reinforced Concrete Construction: Volume III, Bridges and Culverts* (New York: McGraw-Hill, 1916), 496-507.

⁴²² Titus, 493.

⁴²³ Louisiana Highway Commission, *Eighth Biennial Report, 1934-1936*, 112 and 120.

bridges to enhance visual appeal in the 1920s through 1940s. Symbolic imagery of Louisiana's heritage, including crossed pistols, pinecones, and fleur-de-lis, were cast in iron and attached to select bridge railings. For example, the 1936 Mississippi River Bridge, carrying U.S. 190 over the Mississippi River between Port Allen and Baton Rouge, originally had cast iron fleur-de-lis attached to the railings. The applied fleur-de-lis were removed when the railing was replaced in the mid-1960s.⁴²⁴ LHC-designed bridges also included a relief of a pelican, the state bird, pressed into concrete railing endposts. Many of these decorative details have been removed or covered.

Although the LHC's use of aesthetic treatment of bridges was rare and, when applied, was minimal, in the 1930s the agency enthusiastically adopted the New Deal era's interest in highway "beautification." The LHC was intensely focused on the beautification of the state's road system, as discussed in its *Biennial Report* of 1932-1934. Beautification included planting trees, vines, and ornamental shrubbery, sodding, and elimination of any construction scars on the landscape.⁴²⁵ Although the LHC and its successor, the LDH, focused on highway beautification and rarely mentioned bridge aesthetics in agency reports, there is at least one example of interest on the part of the state bridge engineer, Norman E. Lant. In 1941 Lant's design for the Wax Lake Outlet Bridge in St. Mary Parish received an honorable mention for aesthetics in the National Steel Bridge Alliance (AISC) prize bridge competition. The award competition, which started in 1928, emphasized the aesthetic of bridges and encouraged the widespread appreciation of the beauty in steel bridge design. Lant's design for a three-span K-truss bridge, including a main span of 510 feet and two approach spans of 350 feet, was recognized for the beauty of its design.⁴²⁶

Following World War II, new architectural styles were embraced as a way to convey the spirit of the era. Modernism increasingly influenced architectural design throughout the U.S. At the foundation of modernist principles was rejection of traditional styles and ornamentation. Beauty and aesthetics in bridge design were realized through simple and clean lines, with little or no applied ornamentation. Aesthetics in bridge design during this period were often unintentional, a product of economy of design and through the technological refinement of structural members. For example, Stanley Grossman, a consulting engineer in Oklahoma, argued in 1965 that in addition to reducing material costs, wide beam spacing in highway bridges presented "a clean, light, and uncluttered appearance for short span bridges by reducing the number of stringers and eliminating the need for cap beams on the piers."⁴²⁷

During the development of the Interstate Highway System, a general "aesthetic" emerged, whether intentional or not, which included the seamless incorporation of bridges into the endless roadway, so that

⁴²⁴ "Mississippi River Bridge," *U.S. Highway 190 Louisiana*, 9 July 2006, http://www.southeastroads.com/us-190_la.html (accessed 17 August 2012); Don Sorgenfrei, interview with Robert Frame of Mead & Hunt, Inc., Baton Rouge, La., 18 July 2012.

⁴²⁵ Louisiana Highway Commission, *Seventh Biennial Report 1932-1934*, 17.

⁴²⁶ American Institute of Steel Construction, *Prize Bridges 1928-1956* (New York: AISC, [1958]), unpaginated, see section for 1941 award recipients; see also the incorrectly hand-dated newspaper article "Former Local Man is Head Road Engineer in Louisiana," *Evansville [Indiana] Press*, 30 December 1946. This bridge was replaced in 1975.

⁴²⁷ Stanley Grossman, "Short Span Highway Bridges with Wide Stringer Spacing and a Two-way Reinforced Concrete Deck," *AISC Engineering Journal* (April 1965), 55.

road structures would be invisible to the motorist and not a visual distraction. In this sense, the aesthetic of seamlessness was the opposite of what had prevailed during most of the twentieth century. In earlier designs, any aesthetic treatment was designed to call attention to the bridge, in order to make it stand out from its surroundings through the artistic or ornamental treatment of structural elements.⁴²⁸ Bridges were often used as symbolic entry points or gateways into cities or as memorials to important individuals and events. Two steel bridges in the early 1960s were highlighted in AISC's Prize Bridges 1963-1964: the Fulton Street Bridge, a vertical lift bridge opened in Alexandria in 1963; and the Calcasieu River High Bridge (Isreal LaFleur Bridge; extant) carrying I-210 in Lake Charles, opened in 1964.⁴²⁹

The Interstate aesthetic in Louisiana is highlighted in the April 1964 edition of the *Louisiana Police Jury Review*, which shows the construction of twin Interstate steel beam bridges over City Park in New Orleans. According to the photograph caption, "Care is taken with expressway construction through Louisiana's major cities not to distract from the natural beauty of the city or its parks." Minimalist design to the bridge superstructure and substructure helped ensure that the new bridge would not compete with its surroundings.⁴³⁰ Louisiana bridge designs of the post-World War II era generally kept with this aesthetic, and were praised for doing so. In 1969 the twin bascule spans over the north channel of the Lake Pontchartrain won the AISC prize bridge design competition for their unadorned simplicity. Keeping with the ideal of "less is more," one juror wrote fondly, "Here is a simple and handsomely detailed bridge. Its subdued treatment of the superstructure presents a clean, unobtrusive effect that avoids the clutter often found in movable span bridges."⁴³¹

During the post-World War II period in Louisiana, as well as the nation, bridge design publications and standards were generally silent on the subject of aesthetics. The LDH's primary focus during the period, like many highway departments, was on the construction of economical and functional structures, while a lesser priority was placed on the incorporation of aesthetics. According to former Louisiana engineer Gill Gautreau, the LDH focused most on economics with "no consideration of long-term cost or aesthetics." Gautreau noted that the more aesthetically pleasing bridge designs were usually dismissed and replaced with less expensive, but more unappealing, designs.⁴³² High labor costs, the need to build many bridges quickly, and improved methods of mass production contributed to the lack of intentional application of ornament. Additionally, during this period, the appearance of ornament on a publicly funded structure could raise questions about the appropriate use of taxpayer dollars. Earlier generations saw positive

⁴²⁸ Lichtenstein Consulting Engineers, *The Third Ohio Historic Bridge Inventory, Evaluation, and Management Plan for Bridges Built 1951-1960 and the Development of Ohio's Interstate Highway System* (Ohio Department of Transportation, 2004), 26-27; Phil Patton, *Open Road: A Celebration of the American Highway* (New York, 1986), 133-135.

⁴²⁹ "Prize Bridges 1963-1964," n.p., in "Well Not Everything, Actually I have Lots More "Stuff" for Volume II," compiled by Joseph Smith (2005), possession of Huval and Associates. The Fulton Street Bridge is nonextant, while the Calcasieu River High Bridge (Recall No. 033210) is extant.

⁴³⁰ Olen LeBlanc, "Louisiana's Department of Highways Completes Its Largest Year in History in 1963," *Louisiana Police Jury Review* (April 1964), 141.

⁴³¹ Award and quotes can be found online for the American Institute of Steel Construction, "Prize Bridge 1969 Moveable Span" at <http://www.aisc.org/WorkArea/showcontent.aspx?id=26972> (accessed 28 August 2012).

⁴³² Gill Gautreau, interview by Robert Frame of Mead & Hunt, Inc., Baton Rouge, La., 20 July 2012.

value in ornamental treatment and willingly paid for it as an expression of civic pride as noted above. By the 1950s and 1960s public attitude had changed and ornament was equated with excess spending. In its own way, however, the popular response to intentional ornament was very compatible with the “less is more” philosophy of professional architects in this era and the elegance of stripped-down functionality preferred by engineers.

Overall, aesthetics in bridge design was limited nationally and similarly in Louisiana. The most common expression of aesthetics in the state is applied ornament, and later in the post-World War II period, the simple use of materials.

G. Conclusion

Technological advancements highlighted in the historic period continue to define and influence bridge design in Louisiana to the present day. For example, Louisiana’s numerous wide and navigable waterways resulted in innovative approaches to substructure and foundation design still used today. In the 1910s and 1920s, LHC began using standard plans to facilitate cost-effective bridge building; their use continued throughout the study period and to the present. Even bridge building materials have had a significant impact on bridge design and construction in the twenty-first century. Notably, the use of prestressed concrete beginning in the mid-twentieth century in Louisiana allowed for longer bridges to be erected. This bridge type continues to be a popular choice for new bridge construction in the state as it affords strength and economy of materials. Finally, use of limited aesthetics in bridge design of the mid-twentieth century persists in Louisiana’s current bridge design practices. As a result of changing public sentiment, use of federal funds for bridge design, and the rapid pace of bridge construction in the mid-twentieth century to the 1970s, simple bridge designs were preferred by LDH. This trend continues today, as applied architectural style and ornament are rarely seen on newly constructed bridges.

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4. Conclusion

This historic context report represented the first step in Louisiana's statewide historic bridge inventory. The report provides an introduction to bridges of the subject period and describes the contextual framework for their design and construction. The topics covered in this report helped to establish relationships of Louisiana bridges to significant historical themes in subsequent steps of the project, including:

- Development of National Register Evaluation Criteria for use in evaluating the historic significance of the structures.
- Completion of field survey and focused research on targeted bridges to determine their relationship to historical themes.
- Evaluation of the historic significance of individual structures.
- Preparation of a final report that presents the results of the National Register evaluations.

Evaluation of National Register eligibility of bridges based on the context resulted in recommendations as to which bridges qualify for listing in the National Register. Final determinations of historic significance were made by the FHWA, in consultation with the SHPO. The Historic Bridge Inventory project provides a comprehensive identification and broad understanding of the state's historic bridges built through 1970.

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