

CONCRETE BRIDGES



Bridge 698: Van Buren Street Bridge over Branywine Creek, Wilmington

CONCRETE BRIDGES

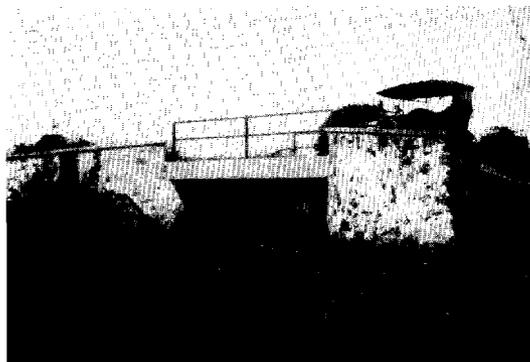
Twenty-nine of the eighty bridges determined historically significant in this survey of Delaware's highway bridges were constructed of reinforced concrete. Within this group, twelve are concrete arches, ten are of slab construction (two of these are combination bridge and waterflow control structures), four are of frame construction and one is a concrete deck girder bridge. Of the bridge building materials used to construct the state's historic highway bridges, concrete is the most common type remaining.

Delaware Department of Transportation photographic archives from a 1920s New Castle County bridge inventory document the existence of 485 of the bridges and culverts which carried vehicular traffic at that time. Approximately 153 of those were concrete structures; only 56 had spans of 10'-0" or longer, and could be classified as bridges. Of those fifty-six concrete bridges, eight were arches, forty-six were concrete slab structures and two were concrete girder structures. An additional fifteen bridges in the New Castle County Photo Archives were described as concrete encased I-beams. While these will be included in this report's discussion of steel girder bridges, it is often difficult to

distinguish the structural configuration of some early twentieth century concrete and steel girder bridges without plans. Some may be considered steel girder bridges protected by concrete encasement, while others may be concrete bridges with the steel beam reinforcement typical of early concrete construction. The difficulty in differentiating between these types is illustrated below in photos from the New Castle County photo archives. Only four of the concrete bridges illustrated in the New Castle County photo archives remain standing today; they are included in this survey.

Although used for building by ancient civilizations, the modern development of concrete as a popular building material was a late nineteenth and early twentieth century phenomenon, approximately simultaneous with that of steel. Concrete technology was

first applied in bridge construction with plain or non-reinforced concrete structures. An early example in the United States was the 1871 Prospect Park Bridge in Brooklyn, New York. Within two decades, the understanding of material behavior quickly had progressed to the composite use of concrete and steel. The addition of iron reinforcement to masonry structures had been used in isolated cases for centuries, since the nature of masonry as a compressive material with inherent weaknesses in tension was appreciated by ancient engineers. The interaction of the two materials remained to be studied by late nineteenth or early twentieth century engineers. The incipient theoretical understanding of metal reinforcement embedded in the new plastic masonry, i.e., concrete, seems to have been realized simultaneously in Europe and the United



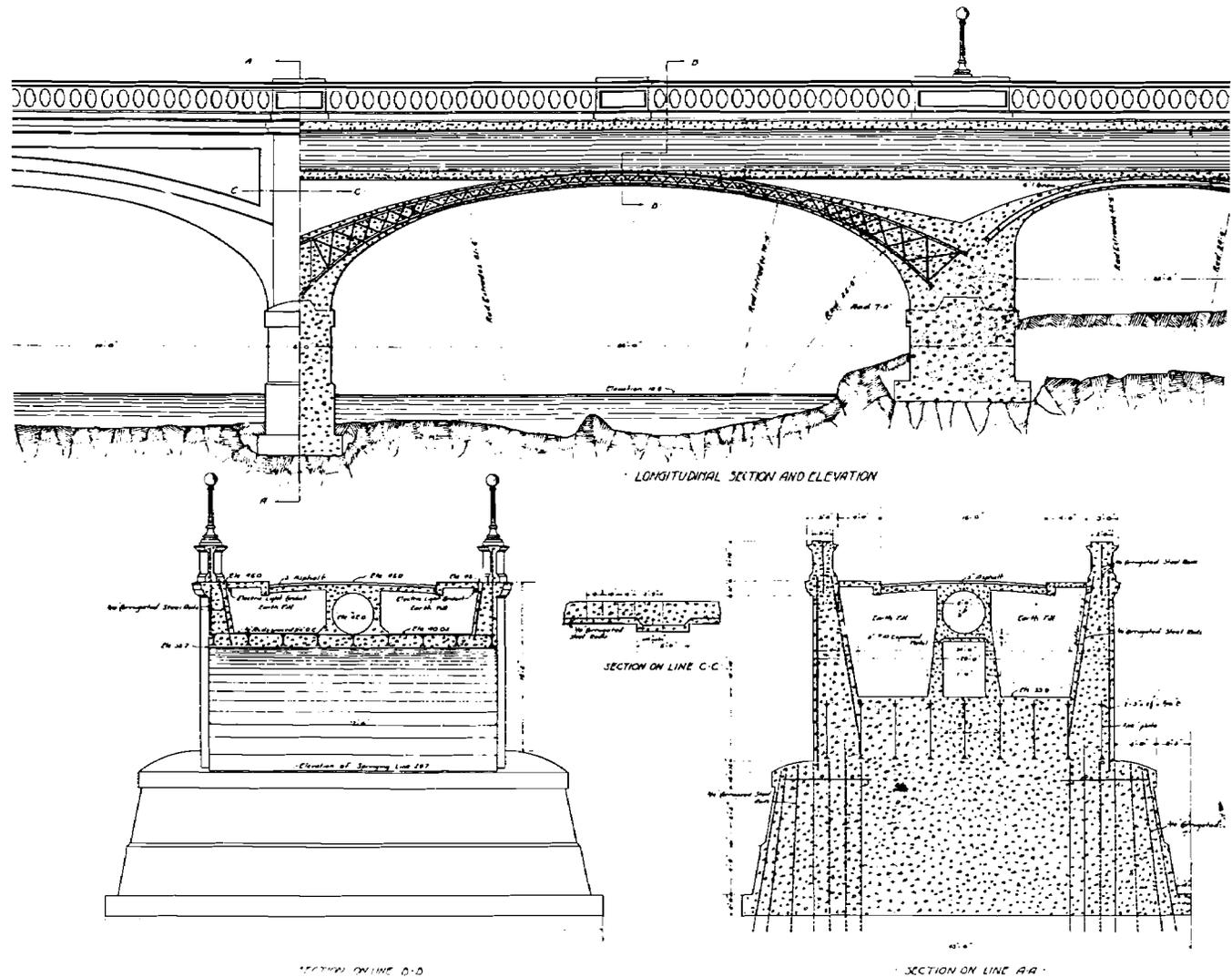
*Early concrete slab bridge.
Mt. Pleasant to Maryland line,
New Castle County. No longer standing.*



*Early encased I-beam bridge.
Bringhurst Bridge, New Castle County
No longer standing.*

CONCRETE

States. However, French and German engineers first studied and tested the principles of steel reinforcement for tensile stresses in concrete arches in the 1880s. A serious obstacle to the use of concrete arches was the unknown character of their behavior under live loads. From 1890-95 the Austrian Society of Engineers and Architects conducted extensive experiments on full-size concrete arches and the results were published in engineering journals throughout Europe and America. In 1899, prior to the publication of the Austrian reinforced concrete arch tests, the first reinforced concrete arch in the United States was built in Golden Gate Park, San Francisco. Designed by Ernest L. Ransome, it was reinforced with rods or bars, possibly of the twisted type patented by Ransome in 1884. Early concrete bridge development included experimentation with different forms of steel reinforcing. Bar reinforcement became the predominant type in the early twentieth century, and is the reinforcement type encountered today; however, the predominant type through the end of the nineteenth century employed beams rather than bars. The I-beam type was introduced by Austrian engineer Joseph Melan, who patented a scheme for arched I-beam reinforcement in the United States in 1894. Two different beam reinforcement schemes are illustrated on this page in drawings from Bridge 698.



Details from original 1906 drawings for Bridge 698 showing two different forms of historic steel beam reinforcement.

Melan's design was modified and patented by another Austrian engineer, Fritz von Emperger, who built a number of beam-reinforced arch bridges in the United States beginning in 1897.

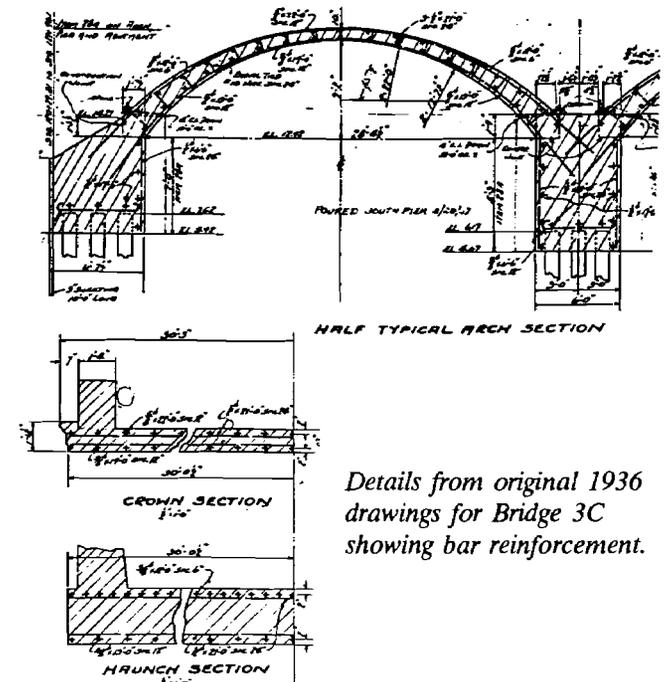
Beam reinforcement was soon recognized as requiring an inordinate amount of steel, and bar reinforcement began to be explored as a more efficient use of material. Bars could be bent and placed in regions of high tensile stresses, thus saving enormous quantities of materials while producing stronger bridges with lower dead loads. Many variations in shapes, patterns of surface deformation (provided to maintain the adhesion between the bars and the concrete), and bending schemes were developed and patented.

Among the American engineers who contributed to the development of reinforced concrete bridge technology during this formative period was Edwin Thacher (1840-1920). An 1863 civil engineering graduate of Rensselaer Polytechnic Institute, Thacher became interested in steel-reinforced concrete construction in the late 1880s, and by 1895 had made this a specialty. He designed and constructed viaducts and bridges for leading southern railroads during the period 1889-1904. Also during that period, he became the western representative of Fritz

von Emperger's company, and was instrumental in disseminating the Austrian engineer's technological innovations in the United States. In partnership with W. H. Keepers, he designed the first major reinforced concrete bridge in the United States, a three-span Melan-type concrete arch with imbedded steel truss bars over the Kansas River at Topeka. Erected between 1894-99, this structure was the largest of its kind at the time.

Thacher developed an improved reinforcing bar. Throughout the development of reinforced concrete technology, engineers sought methods of improving the adhesion between the reinforcing steel and the concrete surrounding it. Their efforts generally involved various deformations to the surface of the bar, such as the "projections" called for in Thacher's 1899 patented design. Ernest L. Ransome patented the first deformed reinforcing bar in 1884, which aimed to increase the mechanical connection between the steel and the concrete by twisting the bar. The "Thacher Bar" (U. S. Patent No. 714,971) was designed as an elongated bar with longitudinally oriented cross-shaped deformations integrally formed on the upper and lower surfaces. This configuration enabled the reinforcing steel to remain uniform in net section throughout the bar,

ensuring that the strength of the bar would be the same at every point and that no unnecessary metal would be used in its manufacture. In addition, sharp corners were minimized during manufacture, so that the bond between the bar and the concrete would be further improved. William Mueser, Thacher's associate in the Concrete-Steel Engineering Company, credited the bar as the first product of its type to achieve its final shape by a direct rolling process. The Thacher bar, like those used in current concrete design as shown below, was available in a range of sizes, starting at 1/4 inch and increasing in 1/8-inch increments to 2 inches.



Details from original 1936 drawings for Bridge 3C showing bar reinforcement.

With growing confidence, the use of reinforced concrete escalated. In an 1899 Engineering News article, "Concrete Steel Bridge Construction", Thacher, who had iron as well as concrete bridge patents, exemplified early enthusiasm for concrete. He wrote of concrete-steel bridges:

...they are more beautiful and graceful in design, architectural ornamentation can be applied as sparingly or as lavishly as desired; they have vastly greater durability, and generally greater ultimate economy; they are comparatively free from vibration and noise; they are proof against tornadoes, high water or fire; the cost of maintenance is confined to the pavements, and is no greater than for any other part of the street; home labor is employed in building it, and the greater part of the money that it costs is left among the people who pay for it, and its cost as a rule does not much, if any, exceed that of a steel bridge carrying a pavement....Public confidence in concrete and concrete-steel construction, is gaining rapidly in this country and in Europe, where there is plenty of precedent, and where the people have been more thoroughly educated up to it, there has been no lack of confidence in it for some

years....We hear nothing now from intelligent men about mud bridges....

Although scientifically understood in some degree of sophistication in the 1890s, concrete began to be used more widely and in a more structurally efficient manner in the United States after the first decade of the twentieth century. In 1903-04 the American Society of Civil Engineers formed its Joint Committee on Concrete and Reinforced Concrete in an attempt to standardize concrete design. Their first report was published in 1909. In 1916, the Committee on Reinforced Concrete Highway Bridges and Culverts of the American Concrete Institute (ACI) issued its first report which classified highway bridges and recommended appropriate design loads. According to bridge engineer-historian Tyrell, between 1894 and 1904 about 100 concrete bridges had been built in the United States in spans up to 125 feet; and in 1917, Waddell claimed that "for city bridges of short span its use is becoming almost universal," with other wide applications noted.

Thacher, one of the most prolific designers of reinforced concrete bridges in the United States, became associated with William Mueser in the Concrete-Steel Engineering Company of New York City in 1901; he remained with that firm until failing

eyesight compelled his retirement in 1912. Between 1895 and 1912, he had designed some 200 reinforced concrete bridges and had supervised the construction of many of them. His preeminent stature in the design and construction of reinforced concrete bridges was recognized by the American Society of Civil Engineers. In a memoir following his death in 1920, the Society observed that "the greater number of the larger concrete steel bridges that have been built in the United States, up to the present time, have been designed by the concerns in which he was a prominent member".

Thacher was with the Concrete-Steel Engineering Company at the time of construction of Delaware's Bridge Number 698 (the 1906 VanBuren Street Bridge in Wilmington), a concrete arch bridge exemplifying the diversity of early reinforcement schemes. Bridge 698 is described in this section.

Another well known patentee for a number of concrete bridge technologies, particularly concrete arches, was Daniel B. Luten whose bridges and culverts were built widely in Delaware. Information concerning Luten is presented in the following section which focuses on concrete arches.

CONCRETE ARCH BRIDGES

Among the eighty historically significant highway bridges in the state of Delaware, twelve are concrete arches. They form a distinguished and diverse group. Bridge Number 698, an early and quite graceful multi-span concrete arch, was designed by the nationally significant Concrete-Steel Engineering Company of New York. Bridge Number 576, another monumental bridge, is composed of multi-span open spandrel arches. Two brick embellished bridges (#3C and 23A) were designed to harmonize in prominent Dover locations, with locally distinguished architect, William Martin, responsible for detailing the ornamentation. Bridge Number 246 is a relatively uncommon surviving "rainbow arch" or "through arch". Four (120, 237, 337, 383) are proprietary types, designed by the nationally significant National Bridge Company, established by Daniel B. Luten. Three (160, 202, 336) are examples of in-house designs influenced by the Luten style.

Concrete arch bridges are classified into four groups based on the way the dead load of the structure is carried. These groups are 1) filled spandrel 2) closed

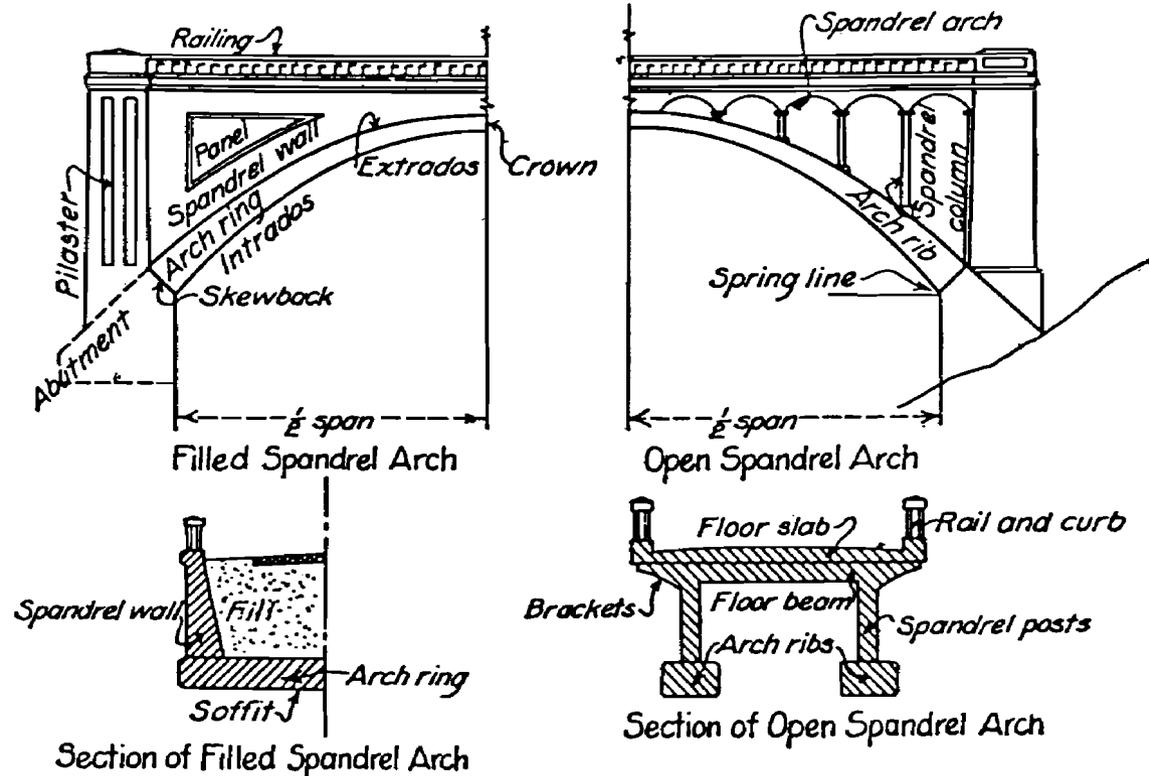


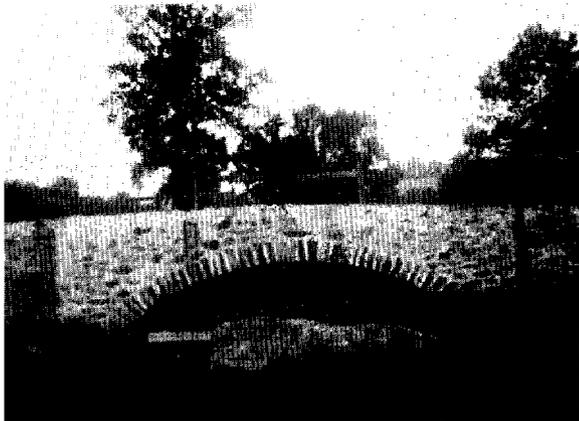
Diagram from 1924 textbook illustrating parts and types of concrete arches.

spandrel 3) open spandrel and 4) through arches. The filled spandrel arch consists of a barrel arch which carries filling material and terminates in closed longitudinal walls that act as retaining walls for the fill. Both closed and open spandrel arch types carry the roadway loads to the arch ribs and contain no fill. The former type carry the deck loads by spandrel walls resting on the arch ribs, while the latter type carry the

roadway loads to the arch ribs by spandrel columns. Through arches consist of ribs which extend above the roadway and carry the deck loads by vertical hangers. The diagram above, from a 1924 textbook Reinforced Concrete and Masonry Structures (McGraw-Hill Book Company, Inc., New York, 1924), illustrates the arch terminology.

CONCRETE

Early concrete arch bridges were governed by building traditions of their predecessor, the stone arch. They were shaped as traditional masonry barrels with solid, filled arches. Shown below are photographs of a stone arch and an early concrete arch from the photo archives for New Castle County. Surface treatment of important bridges incorporated stylistic "stones" such as incised voussoirs or keystones. The first reinforced concrete arch in the United States was designed by Ernest L. Ransome and built in 1889 in Golden Gate Park, San Francisco. It was reinforced with rods or bars, probably of the twisted type patented by Ransome in 1884, and scored to imitate stone.



*Stone arch bridge.
Way Road, New Castle County
No longer standing.*

As the structural advantages of reinforced concrete became apparent, the heavy, filled barrel was lightened into ribs. Spandrel walls were opened giving a lighter appearance and decreasing dead load. This enabled the concrete arch to become flatter and multi-centered with longer spans possible. Designers were no longer limited to the semi-circular or segmental arch form of the stone arch bridge.

The variety of arch types made possible through reinforced concrete design is exemplified by the designs of Daniel B.



*Early concrete arch bridge.
Beaver Valley, New Castle County
No longer standing.*

Luten, whose patented bridges were built in Delaware, and throughout the eastern and midwestern United States.

Luten was an 1894 civil engineering graduate of the University of Michigan. Upon graduation he was retained at Michigan as an instructor and assistant to Professor Charles E. Greene, whose arch analyses were noted in the *A. S. C. E. Transactions*. From 1895 to 1900, Luten was Instructor of Civil Engineering at Purdue University and in 1900 he resigned to design bridges. One year later he was designing and patenting his designs.

In 1899, Luten applied for a patent for an arch bridge of concrete, stone, brick, iron or steel in which ties were placed below the water, from abutment to abutment to resist the arch thrust, and it was granted on May 15, 1900. His ties, "which may be made of any material--as wood, iron, or steel--but in this case are shown as being made of wood or timber, as this is the best material now known to me for the purpose, it being practically everlasting when used under water." This concept developed into his patent for a tied concrete arch in which steel tie rods were embedded in a concrete pavement across the streambed. A 1906 text, on reinforced concrete by Albert Buel, described Luten's steel-tied, paved arch bridge.

Luten's 1907 patent #857,920 shows a barrel arch with recessed panel parapet walls and a similar "flat arch or girder" type design with the same parapet detail. A similar patent of 1907 lightened the bridge dead load with open spandrels, but maintained a barrel arch.

In 1907, Luten patented another arch type which reinforced the arch barrel transversely, as well as longitudinally. In effect, this design was a stiffened spandrel which allowed for thinner arch sections. Included in this patent were several variations, one of which made parapet walls act with the superstructure to carry the loads. In patent #853,203, this variation was described as follows:

A concrete bridge having a roadway bordered by a concrete wall, a longitudinal reinforcing member embedded in the walls, and transverse reinforcing members embedded in the wall and extending into the bridge under the roadway.

Other Luten patents, totaling over 30, included many variations, among them a hinged arch and viaducts; systems of reinforcement; ingenious centering forms and methods; methods of bridge construction; and reinforced concrete beams.

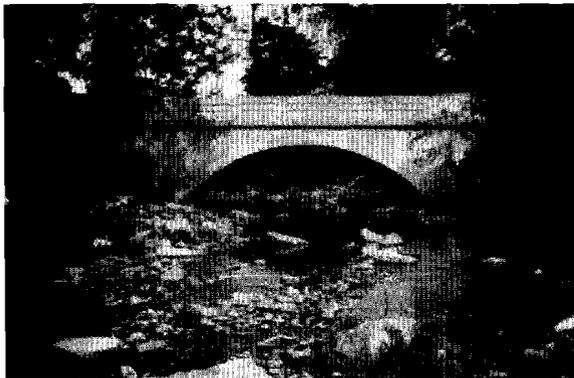
Daniel Luten was also an enthusiastic salesman of his bridge designs,

emphasizing their advantages both in company catalogs and at professional presentations. In the American Concrete Institute Proceedings of 1912, he praised concrete arches:

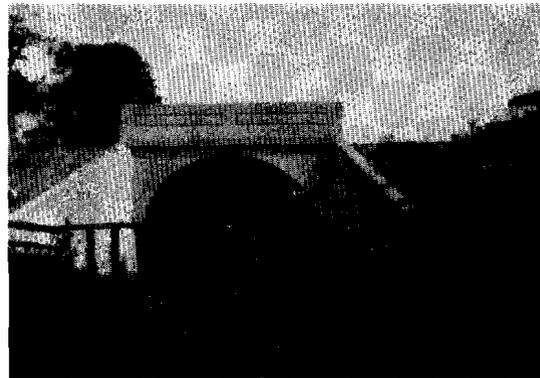
Concrete as a structural material is full of surprising possibilities and one of these is that the most beautiful and appropriate applications of concrete to bridges, that is in the arch form, is also the most satisfactory from almost every engineering standpoint.

Luten's first bridge company was the National Bridge Company, established in

EXAMPLES OF LUTEN BRIDGES FROM NEW CASTLE COUNTY PHOTOGRAPHIC ARCHIVES



*Luten Concrete Arch
Lincoln Highway, Section 4. Mill Creek,
New Castle County. No longer standing.*



*Luten Concrete Arch
Lincoln Highway, Section 4, Calf Run,
New Castle County. No longer standing.*

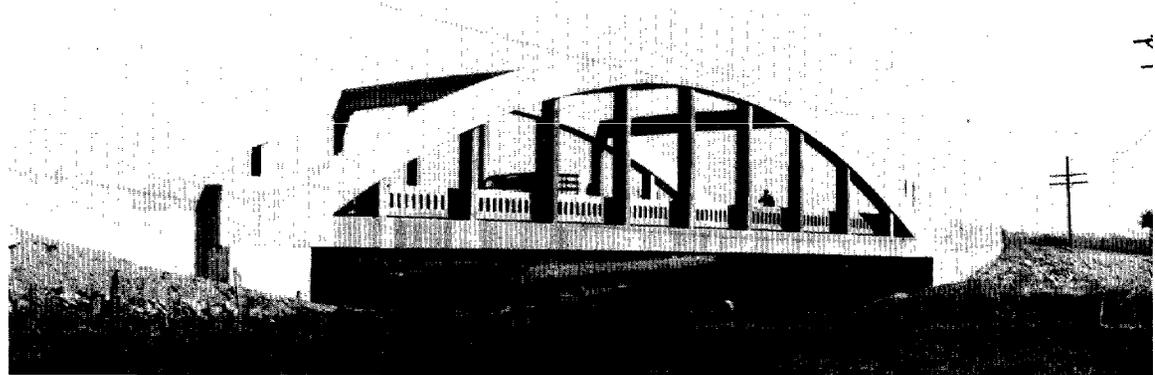


*Luten 1912 Culvert
Near Hares Corner,
New Castle County. No longer standing.*

1902. A 1914 Luten publication stated that until 1905 the National Bridge Company did the contracting and constructing of its bridges, but after that it was involved only in engineering design and supervision. In 1907, a company catalog advertised a variety of earth filled arches reinforced with steel rods. It claimed the company had designed more than 700 bridges of this type. An interesting arch type included in this 1907 catalog was the "arch-girder" bridge, described as a flat arched floor supported on five girders.

By 1911, Luten had won national attention, and was singled out by bridge historian Henry Grattan Tyrell as a "designer and builder of many fine concrete bridges throughout America."

A 1917 publication entitled "Reinforced Concrete Bridges" by Daniel B. Luten, "designing and consulting engineer," illustrated a broader range of arch types, although still based on the same theme as his earlier designs. In this catalog, bridge illustrations ranged from long-span, high-level open spandrel arches to small highway bridges. Luten contrasted a "Highway Bridge of Plain Design" with a "Park Bridge of Attractive Design" in the same publication. The parapet wall of the highway bridge was a solid recessed panel and that of the park bridge, a balustrade type.



Bridge 246: Concrete Through Arch

By 1919, Luten claimed to have designed some 17,000 arches, and stated that examples of his designs could be found in all but three states of the Union. Indiana alone had some 2,000 Luten arches.

Delaware's extant Luten bridges are characterized by curved, inscribed solid parapets, a typical feature of Luten's simple, small highway bridges. This bridge type was described in Luten's company catalogs as "Highway Bridge of Plain Design". Three examples (no longer extant) from the photo archives for New Castle County are shown on the adjacent page. This type of concrete arch was built widely as a proprietary type in the first quarter of the twentieth century. Variations in the Luten style arch and parapet detail soon developed and resulted in numerous, similar

non-proprietary designs prepared by highway department staffs. There are three bridges identified in the survey which are Luten-style highway department designs, Bridges 160, 202 and 336.

Simultaneous with the development of Luten's patented types, another form of reinforced arch rib emerged, the through arch. The two arch ribs of this type rise from piers and carry the deck on vertical members suspended from their crowns. They are sometimes referred to as "Rainbow Arches" and sometimes as "Marsh Arches" after German born engineer, Marsh, who patented his through arch and built it between 1912 and 1930. Bridge Number 246 is the only through arch bridge known to be built in Delaware. Above, a 1942 photograph from Delaware Department of Transportation archives shows Bridge 246.

The procedure for constructing concrete arch bridges was roughly similar to that used for stone arches. In the first phase the foundations, abutments and piers were constructed. Next centering, also used as forms for the concrete, was erected followed by placement of reinforcement. The concrete was then placed in the forms symmetrically from each end moving in toward the crown. Longer spans, more than eighty feet had to be poured in sections but shorter spans could be completed in one pour. The spandrel walls, posts or arches were formed after the arch ring was completed. The centering was gradually released after the concrete had set sufficiently, usually the standard twenty-eight days depending on conditions. After the formwork was removed the concrete surface was finished according to various methods. Sometimes a facing was applied as in brick (Bridges 3C, 23A) or stone. Often monumental bridges had surface treatments imitating stone (Bridge 576). If the surface was to be left exposed then it was rubbed to produce either a smooth surface or worked with tools to produce a texture. Construction photographs of Bridge 23A from Delaware Department of Transportation archives illustrate portions of this process and are presented on this page.

While the historically significant concrete arch bridges surveyed in Delaware do not illustrate all the possible variations in form, they do represent a good sample of diversity. They are presented in groups according to similarities in design.



Bridge 23A: Centering in place with barrel of arch formed.



Bridge 23A: Spandrel wall forms in place.



Bridge 23A: Centering is visible beneath the arch.



Bridge 23A: Brick embellishment is being applied to concrete spandrel walls.



Bridge 23A: The concrete arch ring is visible beyond the spandrel walls.

CONSTRUCTION PHOTOGRAPHS OF BRIDGE 23A

CONCRETE



Bridge 698: Van Buren Street Bridge

STATE BRIDGE NUMBER 698

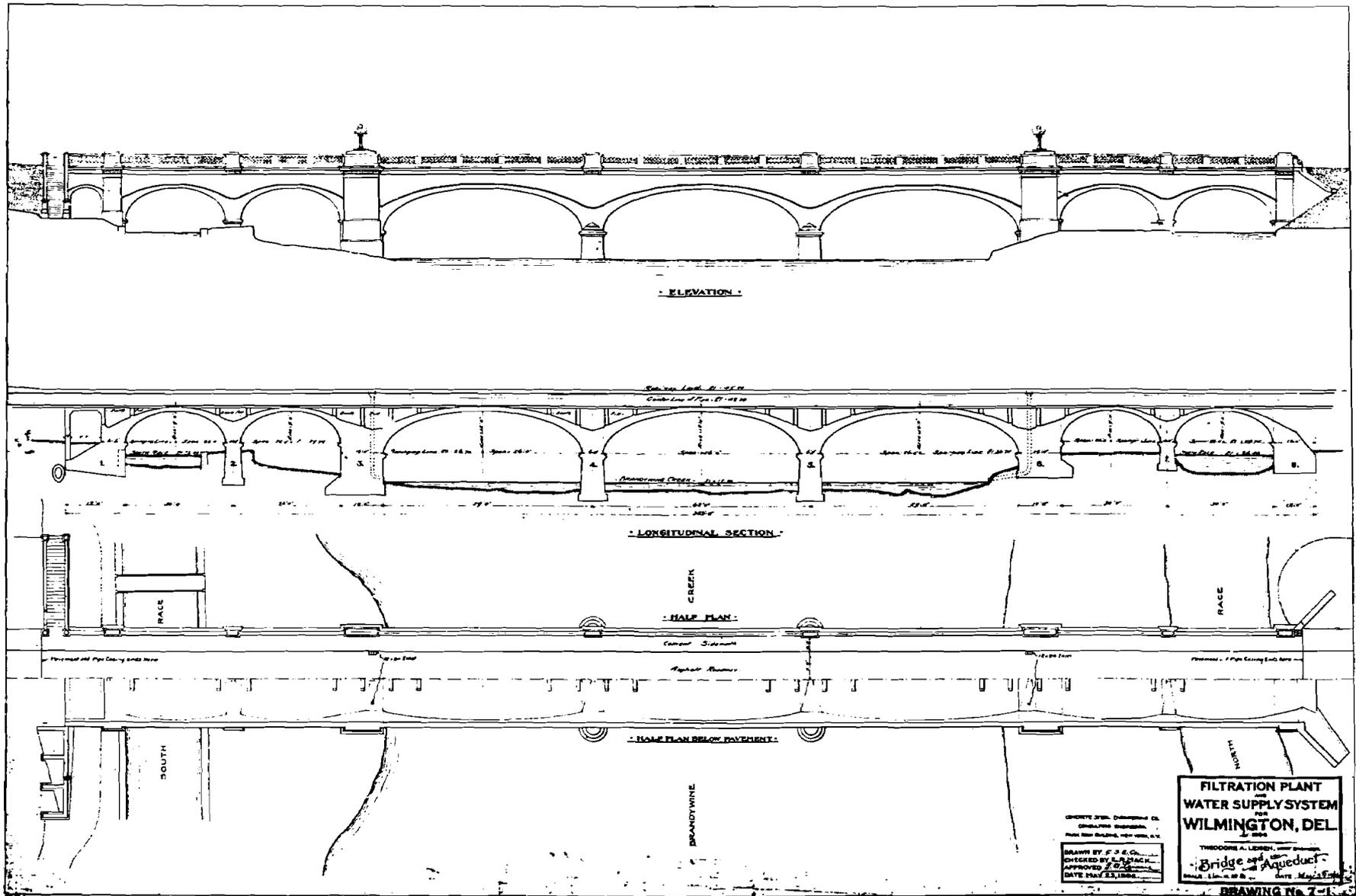
**Van Buren Street over Brandywine Creek & Flume
Wilmington, New Castle County, Delaware
1906**

State Highway Bridge 698 (Van Buren Street Bridge) is a 353 feet long, eight span filled, solid spandrel concrete arch bridge and aqueduct. The spans vary in length, measuring 9'-0", 28'-0", 28'-0", 56'-0", 56'-0",

56'-0", 33'-0" and 33'-0". Arch reinforcement consists of I-beams in the short spans and latticed, riveted girders in the long spans; Thacher bars reinforce the stairs and retaining walls. The bridge carries two lanes of traffic with a total horizontal clearance of 24'-0"; the concrete deck is supported on compacted fill over the arch ribs. The Van Buren Street Bridge is highly embellished, from the concrete substructure

to the ornate balustrade. The bridge is topped with an ornate, urn-shaped concrete balustrade divided into sections which mirror the spans by dentiled short square columns and end posts. All piers are corbeled at the top and rounded below, while four are extended up through the parapet and topped with decorative light posts. The west wing walls serve as the base for a straight staircase that leads to the bridge deck from the park. At the stairs the parapet is extended to act as a railing and is decorated with incised geometric shapes. Square columns serve as the newels at the bottom of the stairs. When viewed in elevation, the detailed ornamentation is augmented by decorative arch rings which emphasize the arch structure, and the corbeled fascia. A marble bridge plate, located between spans 1 and 2 on the south elevation, documents the 1906 date of construction and lists the members of the Board of Water Commissioners and the Chief Engineer, Theodore A. Leisen.

Delaware Department of Transportation records state that Bridge 698 was built in 1906; original drawings are filed at the Department. Portions of these drawings are reproduced on the following two pages. The drawings indicate that the nationally prominent Concrete-Steel Engineering Company of New York served



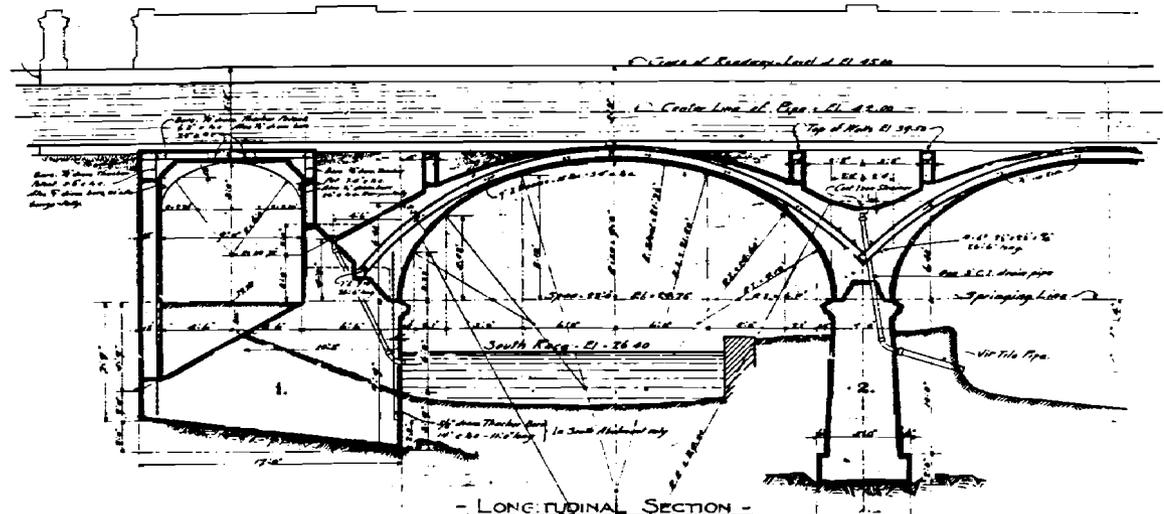
Elevation, section and plan from original 1906 drawings for Bridge 698.

as consulting engineers; from 1901 to 1912, preeminent American engineer, Edwin Thacher, a reinforced concrete pioneer, was associated with the firm. Constructed as a joint project by the Water Commission and the Park Commission, the Van Buren Street Bridge was an integral part of a major project undertaken to improve the city's water supply. The concrete arches encased a pipe, 48 inches in diameter, carrying water across the Brandywine from Porter Reservoir on Concord Pike to the filter station at 16th and Market Streets. The first concept developed by the Water Commission involved submerging the water main across the Brandywine River. Planners decided to incorporate the large main within the bridge, affording the pipe better protection and linking two sections of Brandywine Park to make the Zoo more readily accessible to visitors. The cost of this combination highway bridge and aqueduct was \$40,000. In 1958, an inspection of the structure undertaken by the State Highway Department indicated that the bridge required repairs and improvements totaling \$200,000. The Department's inspection found the substructure in unexpectedly good condition, but recommended removing the deteriorating deck, sidewalks, and balustrades, and replacing the roadway with a modern, wider thoroughfare. In 1970, the roadway was widened 3'-0" by removing the

curb and sidewalk on one side; the existing balustrade was carefully preserved.

State Bridge 698 is the only example of a multiple span solid spandrel, filled concrete arch bridge. This highly embellished structure is also the earliest concrete bridge surveyed in the state. Among the first structures in Wilmington to utilize the relatively new technology of reinforced concrete, or "concrete-steel", construction, the Van Buren Street Bridge represents an early application of this technology to a multiple span bridge set in a city park. It demonstrates the aesthetic potential of the new material, as well as the versatility of design possibilities in the unobtrusive incorporation of a 48-inch water main within this monolithic structure. The Van Buren Street Bridge also has considerable technological significance, reflecting the variety of early twentieth

century concrete reinforcement types in its reinforcing scheme: beam reinforcement (both latticed and Melan-type rolled I-beam) and bar reinforcement (Thacher bars). Consulting engineers were the Concrete-Steel Engineering Company of New York City, which had achieved national prominence in the field of reinforced concrete bridge construction. In the decade ending in 1904, this company and its predecessors had constructed 300 reinforced concrete spans across the country. Among the American engineers who contributed to the development of reinforced concrete bridge technology during its formative period was Edwin Thacher (1840-1920), described in further detail in the introduction to this section. The bridge drawings specify that Thacher bars were used as reinforcement in the stairs and buttresses of the Van Buren Street Bridge.



Details from original 1906 drawings for Bridge 698 showing placement of Thacher bars.



State Bridge 576: Washington Street Bridge

STATE BRIDGE NUMBER 576

**Washington Street Bridge
Washington St. over Brandywine Creek
Wilmington, New Castle County, Delaware
1922**

The Washington Street Bridge (State Highway Bridge No. 576) is a multiple span monumental concrete arch bridge. The main span, an open spandrel arch, is 250 feet long. There are two arch spans flanking the center arch; both are solid spandrel arches. The approach spans are 70' long and 85' long. The roadway is 40'-0" from

curb-to-curb and 14'-0" sidewalks run down either side. The substructure is concrete. The bridge is highly embellished, with a rusticated surface treatment simulating stone, cast stone urn-shaped balustrades and cast iron light standards. Monumental pylons carry bronze tablets and ornamental bronze lanterns, and are topped with carved eagles. The main span arch has incised "voussoirs" and a "keystone". There are eight ornamental pylons located in line with the railings; the four larger shafts, 40' tall, are located over the piers of the main

span, and the smaller 23.5 foot shafts mark the portals. The eagles mounted on the larger pylons are carved from Onondaga Litholite. The pylons at the main span carry bronze tablets commemorating the Revolutionary War; the War of 1812; the Mexican, Civil, and Spanish-American Wars; and two tablets commemorating the World War, one with names of the battles in which Delaware troops fought, and the other inscribed with the names of men from the State of Delaware killed in the World War. The bridge is further elaborated with quotations from Washington, Lincoln, Theodore Roosevelt, Lowell, Tennyson and Ruskin. A stairway at the southwest corner of the bridge leads to the river below.

Delaware Department of Transportation records state that Bridge 576 was built in 1921. It was dedicated on Memorial Day of the following year, to the "sons of Delaware who joined forces of their country in the Great World War." The Washington Street Bridge Commission was created by an act of the General Assembly in March, 1919 to select a design for a new bridge across the Brandywine. The Commission was granted full authority to acquire land for New Castle County, purchase materials, and enter into contracts. Preliminary surveys and data were prepared by Charles E. Grubb, New Castle County Engineer. Upon release of a

preliminary design study, the local newspaper termed the project "the first successful effort to combine an artistic treatment of a municipal bridge with structural solidity and dignity." The preliminary design was developed by John E. Greiner of Baltimore; a competition was held to secure the final design, and such prominent engineers as Greiner, Daniel Luten, and the firm of Harrington, Howard and Ash of Kansas City all submitted entries. The selected design was the product of the collaboration between consulting engineer Benjamin H. Davis and architect Vance W. Torbert. More information concerning the careers of these men is presented with the bridge in the appendix. Work commenced on August 21, 1920. The bridge was opened to traffic on November 24, 1921; streetcar operation began on December 7, and the structure was fully operational by December 23, 1921. Cosmetic work continued into the new year, and the formal opening was deferred until Memorial Day, 1922. At that time, a major event was planned to mark the dedication of the structure. Speakers included General James Harrison Wilson, Judge George Gray, and Colonel Frank S. Cocheu. Bridge Commissioner John S. Rossell also spoke. The Right Reverend Philip Cook, Episcopal Bishop, delivered the invocation, and The Right Reverend John J. Monaghan, Bishop of the Roman Catholic

Church, gave the closing prayer and benediction. After the dedication, an extravagant spectacle depicting the history of the Brandywine in allegory was presented. At the close of the proceedings, the bridge was formally handed over to New Castle County by the Commission, and the memorial tablets were unveiled, followed by a parade of 1200 young girls across the bridge, strewing flowers on the water. The Washington Street Bridge replaced a wrought iron and steel deck truss constructed in 1893, fabricated by the Edge Moor Bridge Works of Wilmington.

The Washington Street Bridge is significant technologically, as the only open-spandrel concrete arch bridge surveyed in Delaware, and architecturally, for the high artistic value of its monumental design. It derives additional significance from its association with the movement to memorialize the soldiers killed in the first World War. During the immediate postwar period, memorial sentiment ran high, spawning a proliferation of mass-produced "doughboy" statues on town greens and courthouse squares across the nation. The Washington Street Bridge combined the functions of an appropriate memorial and a practical transportation improvement; the economic benefits of this combination were noted in a 1924 article in Scientific American: ". . . the cost of making a purely



State Bridge 576: View from below.

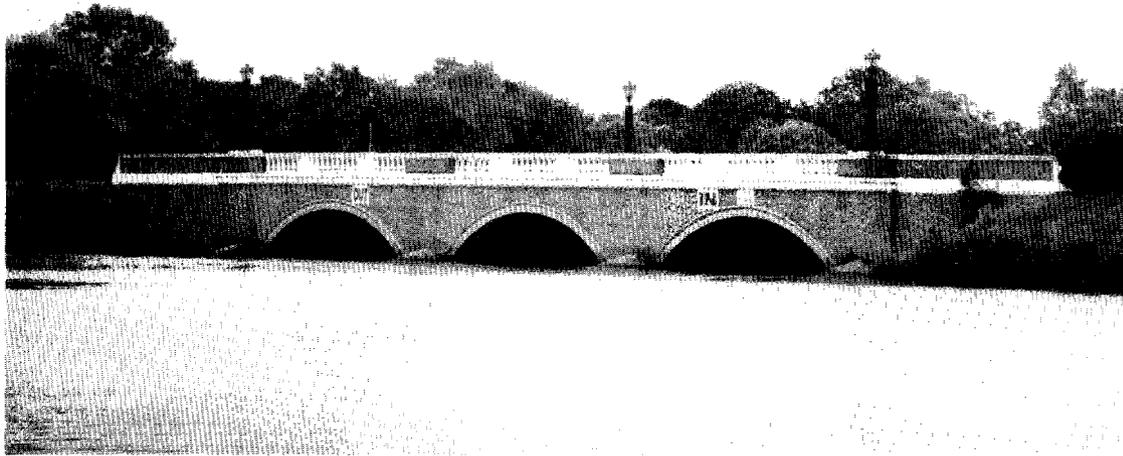
utilitarian bridge further serve as a war memorial was, in this case, approximately \$56,550, this being less than 8 per cent of the entire cost of the structure. A memorial bridge daily serving the needs of a community yet at the same time commemorating the unselfish services of these citizens who rallied to the aid of their country in her hour of need, offers to cities and towns a fitting and economical solution of their war memorial problems." The same article pointed to the technological significance of the bridge, identifying the main span as "probably the longest, low-rise, skew arch span in the United States, if not in the world." The Washington Street Bridge was followed by numerous counterpart memorial bridges in other states, including the Market Street Bridge in Wilkes-Barre, Pennsylvania (1926-29), also designed by Benjamin H. Davis, and the Soldiers and Sailors Memorial Bridge in Harrisburg, Pennsylvania (1926-30).



State Bridge 576 : View of memorial pylon.



State Bridge 576: View of main arch ribs from below.



State Bridge 3C: Silver Lake Bridge

STATE BRIDGE NUMBER 3C

**Silver Lake Bridge
North State Street over Silver Lake
Dover, Kent County, Delaware
1937**

State Highway Bridge 3C is a monumental three span reinforced concrete arch bridge embellished with brick veneer, a brick and white marble balustrade, and

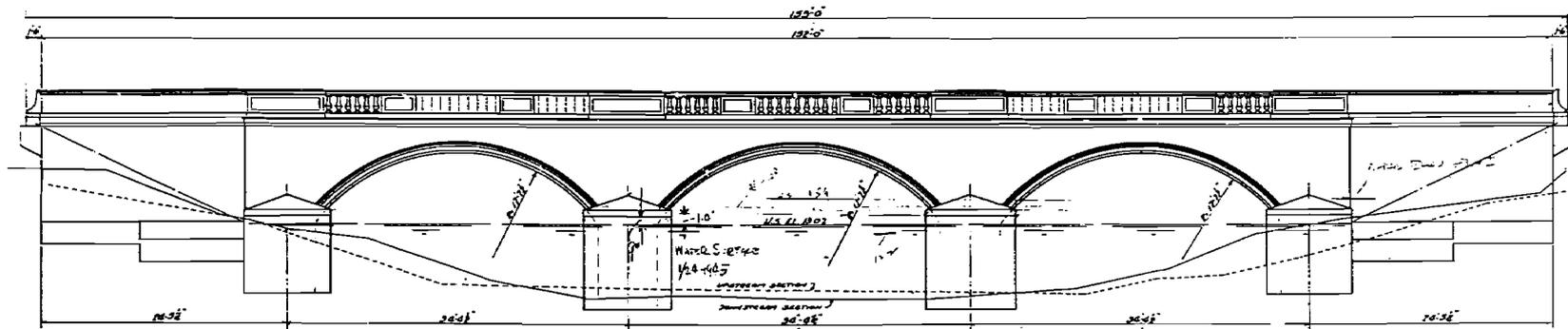
ornamental wrought iron light posts. The bridge is 155'-0" long, with each arch spanning 28'-4 1/2". The arches are segmentally shaped and symmetrical. The substructure consists of reinforced concrete piers, abutments and wing walls which are supported on timber piling. The pier noses are semicircular. All visible portions of the bridge are faced with brick veneer except for a corbelled marble arch ring. The

parapet wall is divided into three sections, mirroring the spans: above the triple arches it consists of a marble balustrade with brick panels, above the wing walls the parapet consists of solid brick panels with corbelled marble rails. A bronze plaque commemorates the veterans of World War I, 1917-1918, by the American Legion Walter L. Fox Post No.2.

Delaware Department of Transportation records state that Bridge 3C was built in 1937. Original drawings, dated November 1936, comprehensively illustrate the configuration of the bridge and its details. Portions of these drawings are reproduced in the following two pages. Added notations on these drawings document the construction process and quantities of materials used. The cost of the bridge amounted to \$48,350. Bridge 3C replaced a three-span stone arch bridge constructed in 1907. Removal of the old stone bridge could not be accomplished until two sections of the new bridge had been built on both sides. This arrangement allowed the previous stone bridge to continue serving traffic until the new spans could accommodate it.

The State Highway Department engaged E. William Martin as consulting architect for the Silver Lake Bridge. Martin, who had designed the State Legislative

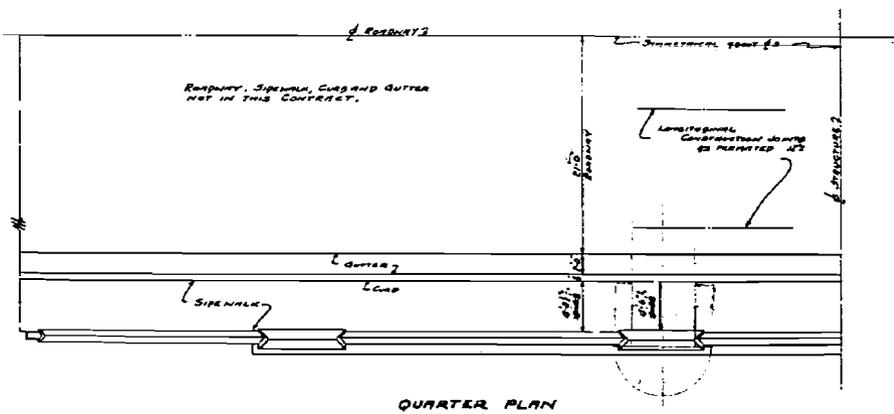
CONCRETE



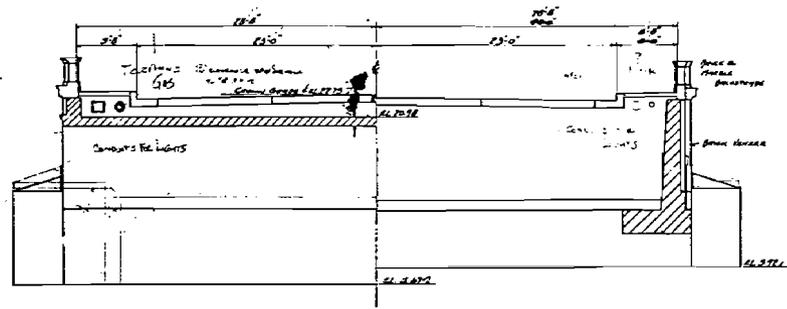
MIN. RISE 1'-0"
FOR SPAN BY 12' SECTION
TOP OF SPAN BY CITY ELEVATION 1448
14 1/2' ± 14.00'

Sheet 133
133 - 155-133
THE SILVER LAKE BRIDGE IS LOCATED NORTH OF DOVER, ON STATE STREET CONTINUED, ON ROUTE U.S. 133. ALL CONSTRUCTION DIMENSIONS AND GRADES TO BE SHOWN ON THE PLANS REFERRED TO THE STATE HIGHWAY DEPARTMENT. SEE TITLE SHEET.
THE PLANS SHOW:
1. GENERAL PLAN
2. SPANMENTS - PIER-ARCHES & PIERS
3. OTHER PLANS CONSISTING OF HALF CROWN SECTION, HALF APPROACH SECTION, QUARTER PLAN, AND ELEVATION. THIS SHEET IS PART OF THE CONTRACT AND IT SHOWS DETAILS FOR THE BRIDGE DECK, TRAILS AND FINAL APPEARANCE OF THE BRIDGE.
LIDS AND SPANDRALS ARE NOT IN THIS CONTRACT. THERE IS NO REINFORCEMENT OR STEELING IN THIS CONTRACT. PLACE REINFORCEMENT FOR ALL LIGHTING.
THE CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE PROVISIONS.

Sheet 134-133



QUARTER PLAN



HALF CROWN SECTION

HALF APPROACH SECTION

1420-1405 WATER REMOVED THE NEW CITY DAM TO DAY
2'-3" OF WATER OVER DAM
1. CLEAR OF WATER ABOUT 15.0' UP ON SIDE OF PIER
COST OF DAM OVER HALF IN PROGRESS = 76,000
TRAIL DAM 1150 - COST ABOUT 30,000

OLD BRIDGE REMOVED 3/15/37
SETTING PAVEMENT 7/10 - 7/10/37
BACK WORK 6/22 - 6-23/37
BACK FILL COMPLETED 6-23/37
TRAFFIC ON BRIDGE 7-1-37
CONTRACT COMPLETED 7/31/37

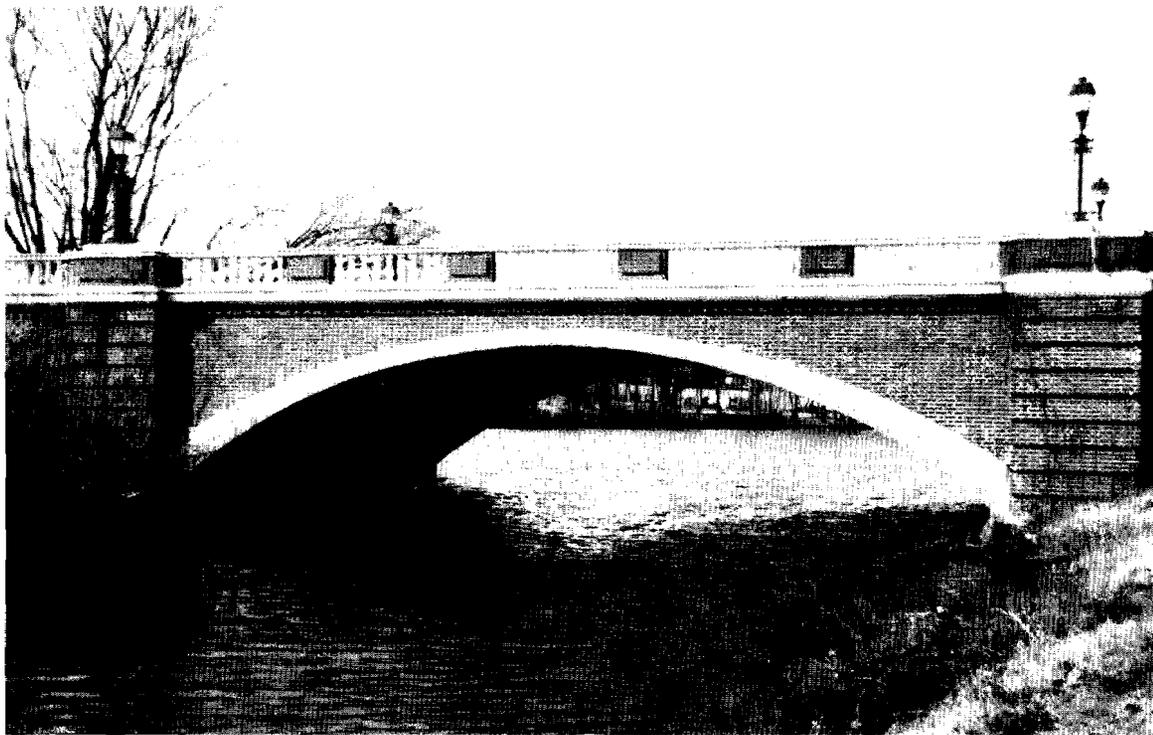
APPROVED *A. N. Huntington*
CIVIL ENGINEER
APPROVED *W. A. Campbell*
CHIEF ENGINEER

CONTRACT 155
HIGHWAY DEPARTMENT
DELAWARE
SILVER LAKE BRIDGE
DOVER

GENERAL PLAN
3 SPANS - 155 FT. LONG

SCALE 1/4" = 1'-0"
FEDERAL AID PROJECT NO. 89 G
SHEET 203 JULY-1936

Plan and elevation from original 1936 drawings for Bridge 3C.



STATE BRIDGE NUMBER 23A

State Bridge 23A: Dover Bridge

**East Lookerman St. over
Saint Jones River
Dover, Kent County, Delaware
1934**

State Highway Bridge 23A (Dover Bridge) is a monumental single span reinforced concrete arch bridge embellished with brick veneer, a brick and white marble balustrade, and ornamental light posts. The

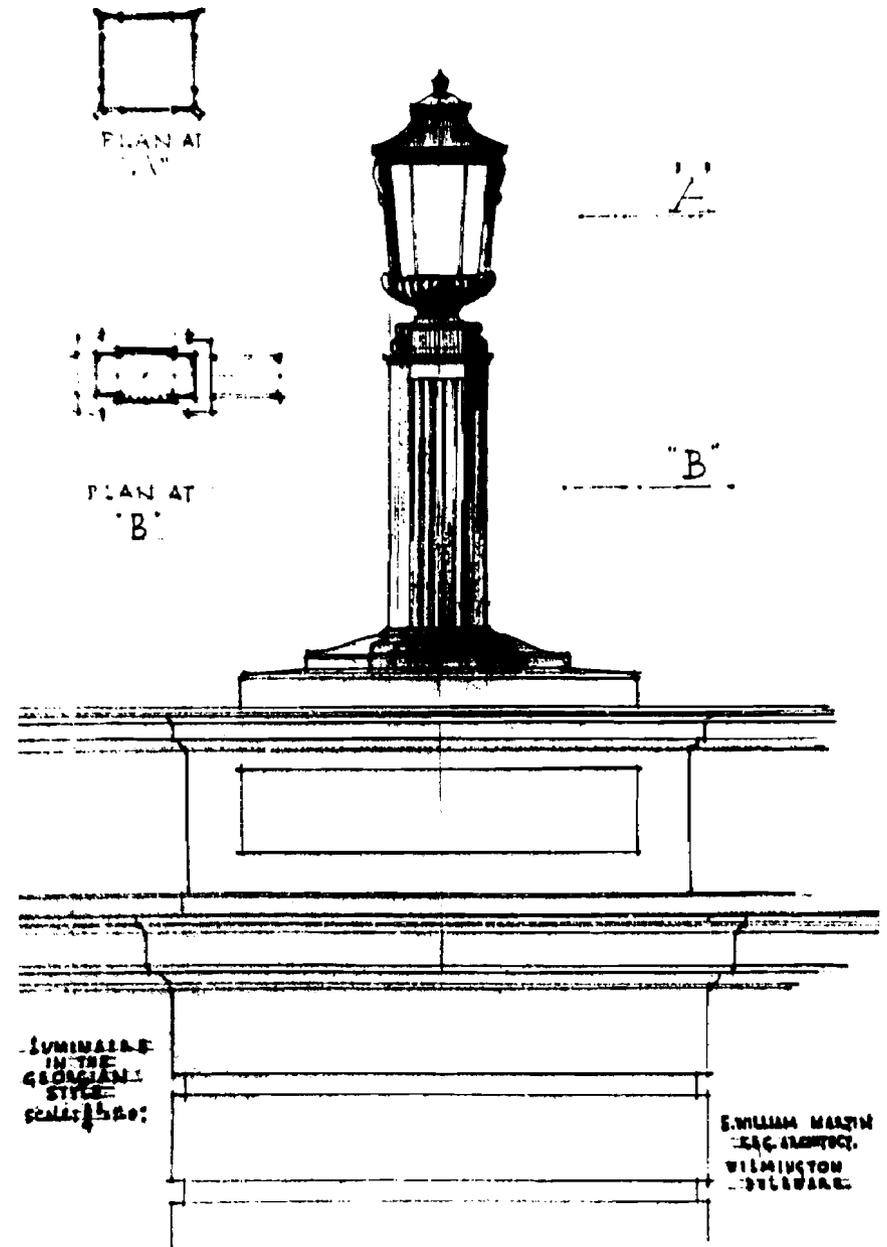
bridge is 114'-3" long, with an arch clear span of 52'-0". The roadway is 30'-0" with a 5'-0" sidewalk on each side. The substructure consists of reinforced concrete abutments and wing walls which are supported on timber piling. The wing walls are U-shaped and highly ornamental, with rusticated brick pilasters accentuating the abutments and portals, and an arched niche breaking up the expanse between

pilasters. All visible portions of the bridge are faced with brick veneer except for a white marble arch ring which emphasizes the arch and corresponds to the balustrade. The parapet wall is divided into three sections which correspond to the arch and the wing walls; it consists of a marble balustrade with corbelled marble rails, solid brick panels, and scrolled endposts.

Delaware Department of Transportation records state that Bridge 23A was built in 1934. Original drawings, dated August 1933, illustrate the configuration of the bridge and its construction and ornamental details. Portions of these drawings are reproduced in the following pages. Added notes on the drawings document the construction process. In 1932, the State Highway Department began planning for a new concrete bridge over the St. Jones River at East Lookerman Street in Dover, the state capital. The Department noted that this structure required "special attention . . . to secure a design which will be in harmony with its surroundings and setting", specifically the new Georgian Colonial State Legislative Hall nearby. To achieve this, the Department developed five alternate elevations, and considered a sixth of polychrome concrete. The decision was made for a traditional Colonial Revival appearance. E. William Martin was engaged to detail the ornamentation.

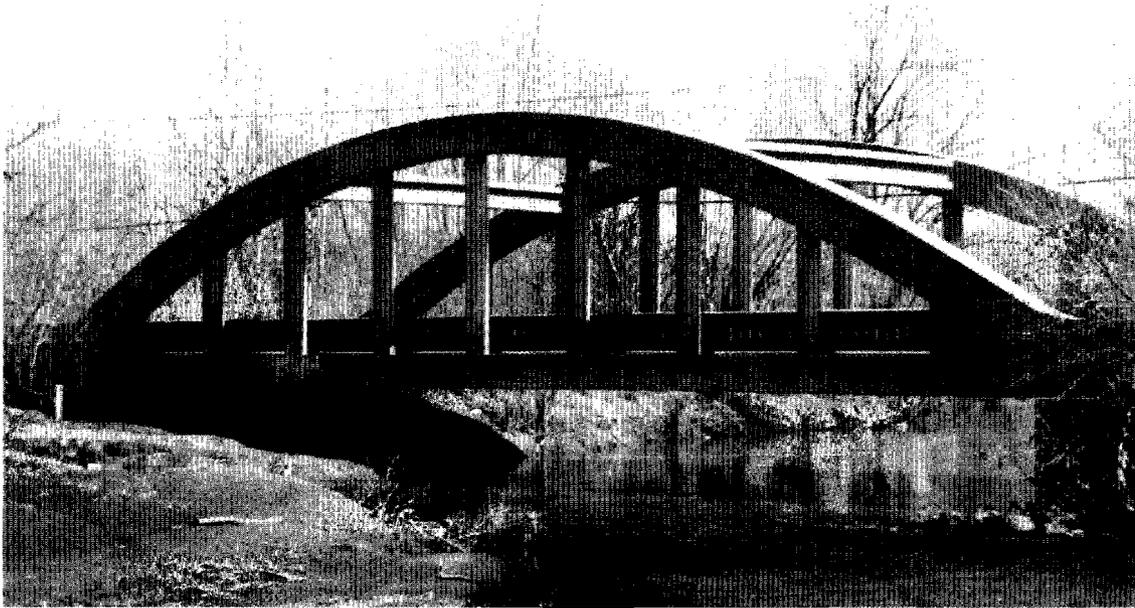
For the East Lookerman Street Bridge, Martin detailed the structure's red brick fascia and white marble trim; the result proved satisfactory to the State Highway Department, which in its 1933 Annual Report called it "one of the beautiful small bridges of America. It is a 52-foot concrete arch finished with colonial brick and white marble, the motif being suggested by that of the nearby new State Legislative Hall. The completion of this bridge . . . will transform this formerly ugly locality into one of undeniable attraction". The marble consoles on the parapet were modeled by Edward Ardolino, Inc., architectural sculptors of Philadelphia, whose work is represented in such monumental buildings as the Cathedral of St. John the Divine in New York City and the Nebraska State Capital. The decorative stonework was executed by the Vermont Marble Company of Proctor, Vermont. Construction began in November, 1933.

Detailing the East Lookerman Street Bridge ornamentation was E. William Martin's first commission for the State Highway Department. Martin subsequently was commissioned for the Colonial Revival detailing of the ornamentation for the North State Street Bridge over Silver Lake in Dover (1937), a similarly prominent crossing in a picturesque location.



"Luminaire in the Georgian Style" designed by E. William Martin, A.I.A. for Bridge 23A.

CONCRETE



State Bridge 246: Stanton Bridge

STATE BRIDGE 246

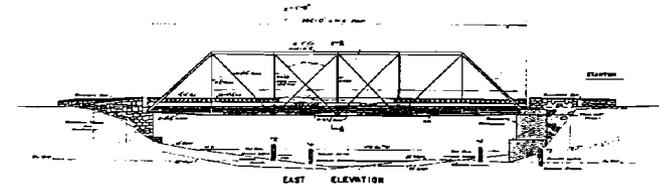
Stanton Bridge
Pedestrian over White Clay Creek and
Mill Creek
Stanton, New Castle County, Delaware
1942

State Highway Bridge 246 (Stanton Bridge) is a concrete through, or rainbow, arch. The bridge has a clear span of 119'-6". The arch consists of two parallel ribs

which are tied by a lower chord; vertical suspenders support the deck and roadway. Below each suspender, a concrete floor beam supports the road; the upper portion of the arch ribs are braced laterally by concrete ties. The substructure consists of concrete piers with plain U-shaped wingwalls. The parapet comprises a simple, abstract concrete balustrade with arcade-style openings. The bridge deck measures

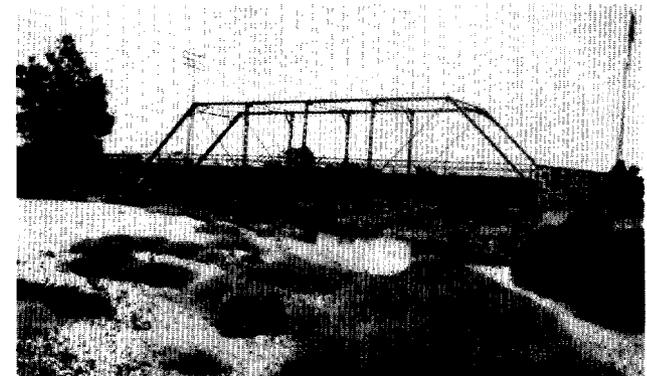
26'-0" wide curb-to-curb with 2'-6" sidewalks on each side.

Delaware Department of Transportation records state that Bridge 246 was built in 1942. Portions of the original drawings are presented in the following pages. The drawings are dated November 1940 and note that the rainbow arch replaced a 102' long steel truss, which had been built in 1904. Drawings and a photograph below illustrate the configuration of this bridge.

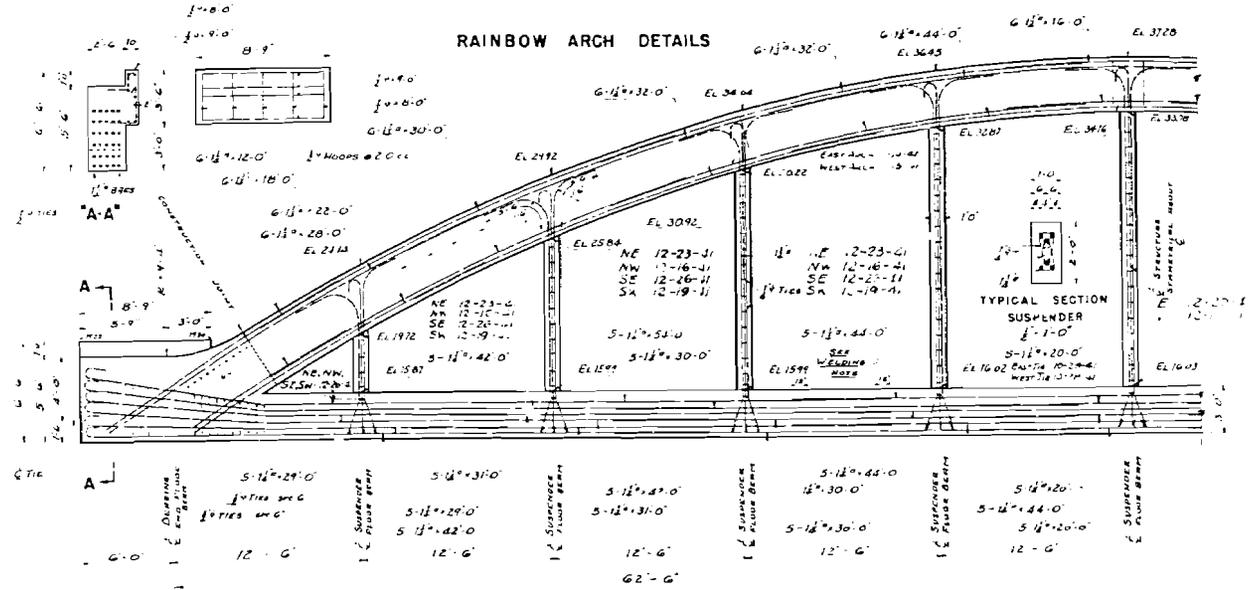


Previous Bridge 246 from preliminary drawings for current Bridge 246....

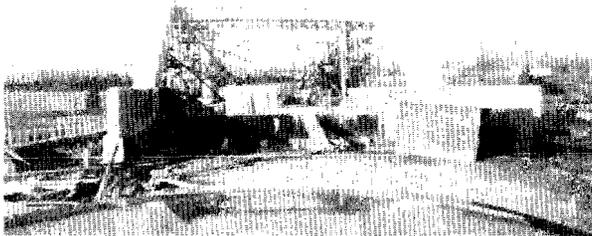
...and as seen in photo archives for New Castle County.



The current bridge was constructed as a vehicular bridge and carried old Route 7 over the creeks. The drawings illustrate reinforcement schemes for the ribs, ties and beams, the parapet details, and foundation configuration. Construction began on July 7, 1941, and was completed except for the final rubbing of the concrete and placement of the bituminous wearing surface on January 16, of the following year; further work was suspended at that time due to cold weather, and was resumed April 15, 1942. The bridge was finished a few weeks later. The contract price was \$42,944.00. A series of construction photographs from Delaware Department of Transportation archives is presented below.



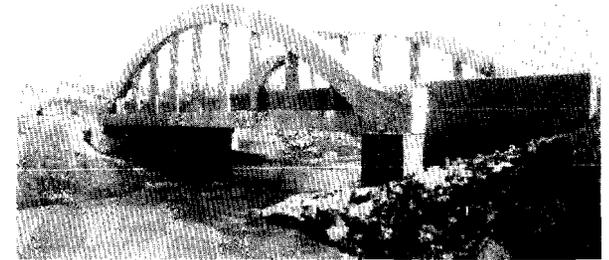
Reinforcement details from original 1940 drawings for Bridge 246.



Construction of Bridge 246: Some of the concrete work is completed.



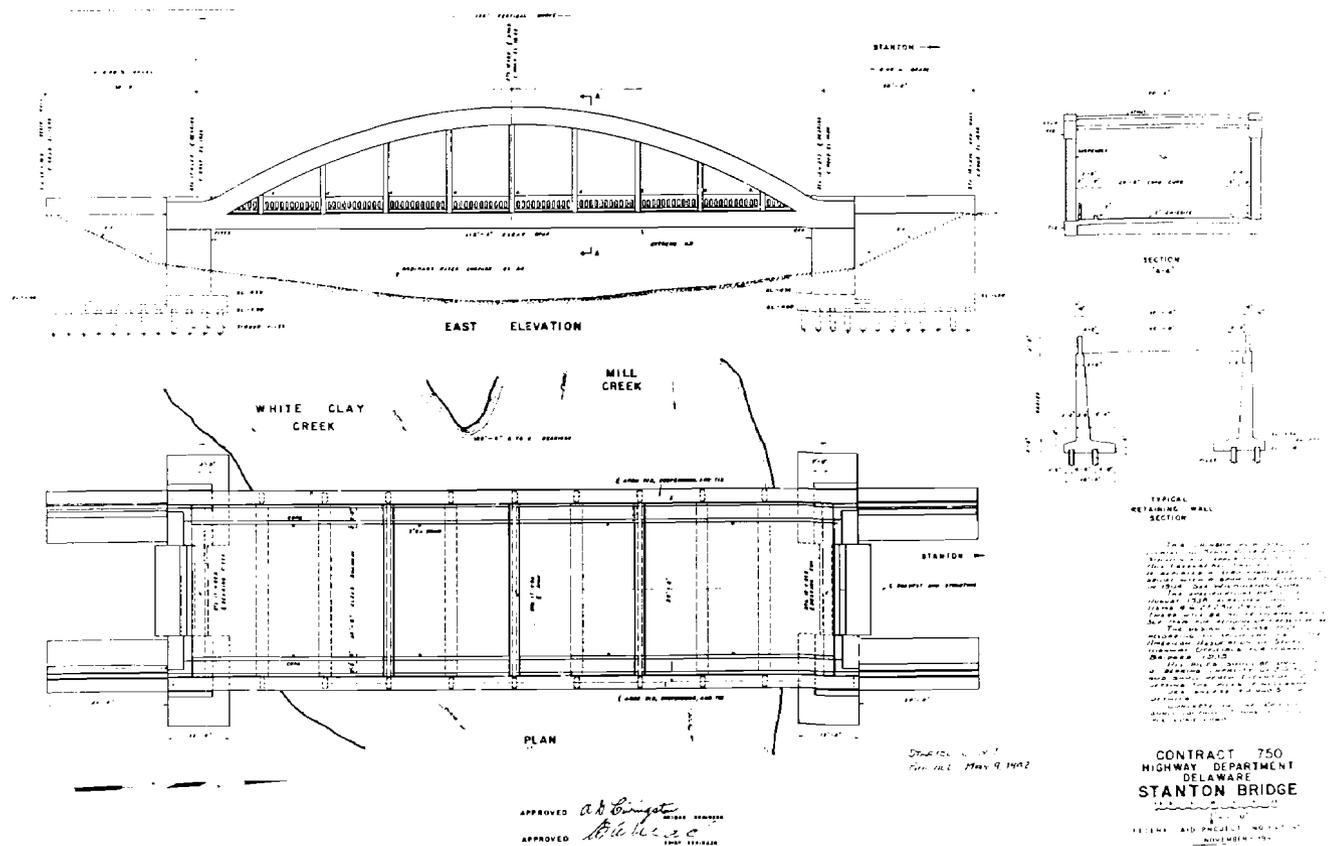
Construction of Bridge 246



Bridge 246 in its final form.

CONCRETE

The 1941-42 Annual Report of the State Highway Department reported that Bridge 246 "was the first bridge of this type to be constructed in Delaware". It is the only example of a concrete through, or rainbow arch surveyed in the state. The concrete through arch was developed as a proprietary bridge type in the early twentieth century. One variation, the Marsh arch, named for the German-born engineer who operated the Marsh Engineering Company of Des Moines, Iowa, was built widely from 1912 to 1930. The through arch, with its two ribs extending above the roadway, can take two forms. The arched ribs may be rigidly fixed at the piers or abutments, or each arch rib may be connected with a tie and rest on the supports. The latter, a bow-string form, was used when conditions were not favorable for the arch thrust to be absorbed by the supports. The tie resisted all the thrust and looked much like the bottom chord of a truss. Bridge 246 is an example of the latter type, a tied rainbow arch. This can be seen in the drawing detail shown on page 108. Variations of the through arch continued to be built after its use as a proprietary type declined, often as in-house designs by State Highway Departments. State Bridge 246 is a good example of the latter. Highway Department drawings are illustrated on this page.



Elevation and plan from original 1940 drawings for Bridge 246.



State Bridge 120

STATE BRIDGE NUMBER 120

**Mt. Cuba Road over Red Clay Creek
Ashland, New Castle, Delaware
1922**

State Highway Bridge 120 is a 81'-0" long solid spandrel, filled concrete arch bridge with a clear span of 81'-0" and an arch rise of 9'-0". It is built on approximately a 45 degree skew. The

bridge carries two lanes of traffic. The total horizontal clearance is 24'-6". The substructure consists of concrete abutments with three flared wing walls. The northeast wing wall is straight. The arch is capped with a concrete parapet, corbelled at the top and bottom, that extends onto the wing walls. The parapet is ornamented with incised rectangles.

Delaware Department of Transportation records state that Bridge 120 was built in 1922, replacing a timber covered bridge of Town lattice construction, nearly identical to the Ashland covered bridge. A plaque on the bridge confirms the construction date and further states that Red Clay Creek Bridge Number 120 was built for the Levy Court, New Castle County, Delaware by the Luten Bridge Company of York, Pennsylvania. The curved, inscribed solid concrete parapets are a typical feature of Luten bridges.

Bridge 120 is an example of a proprietary type by the Luten Bridge Company, the firm established by Daniel B. Luten, whose career is described in the introduction to this section. Characterized by the graceful arch and curved, inscribed solid parapets, this bridge type was described in Luten's company catalogs as a "Highway Bridge of Plain Design". Although it is somewhat deteriorated, this structure represents a proprietary type designed by a nationally significant company. Other Luten bridges identified in Delaware include Bridge 383, constructed in 1910, and Bridge 337 (1912), both in New Castle County, and Bridge 237, constructed in 1922 and located in Sussex County. All are Luten "plain" designs, similar to his patent number 852,970.



State Bridge 237

STATE BRIDGE NUMBER 237

**Road 46 over Gravelly Branch
Middleford, Sussex County, Delaware
1919**

State Highway Bridge 237 is a reinforced concrete arch bridge with a total structure length of 62 feet. This filled, solid spandrel arch carries two lanes of traffic on a 20'-4" wide deck. The substructure consists of concrete abutments with straight wing walls; flared timber wing walls have been added in an apparent effort to arrest

erosion of the embankments. A corbelled band defines the top of the wing walls and fascia; the simple concrete parapet has massive end blocks and incised rectangular panels.

Delaware Department of Transportation records state that Bridge 237 was built in 1919. An inscription in the parapet attributes the construction of Bridge No. 237 to the Luten Bridge Company of York, Pennsylvania under the supervision of

W.E. Hawkins, County Engineer. Construction drawings do not survive.

Bridge 237 is an example of a proprietary type designed by the Luten Bridge Company. Bridge 237 is one of four examples of Luten highway bridges in the present survey, and the only example in Sussex County. Although it is somewhat deteriorated, this structure represents a proprietary type designed by a nationally significant company.



State Bridge 337

STATE BRIDGE NUMBER 337

**Road 408 over tributary to Christiana
Creek
New Castle County, Delaware
1912**

State Highway Bridge 337 is a single span, filled, solid spandrel concrete arch addition of a concrete slab, 7'-6" wide, to its west elevation. The bridge is built on an approximate 20 degree skew. The arch has

a clear span of 8'-6" and an arch rise of 5'-0". It carries two lanes of traffic and has a total horizontal clearance of 28'-10". The substructure consists of concrete abutments with U-shaped concrete wing walls. Both elevations have corbelling on the fascia and are capped with a concrete parapet ornamented with incised horizontal rectangles.

Delaware Department of Transportation records for Bridge 337 do not include original drawings. The bridge has a plaque which gives the date of construction as 1912 and the builders as the Luten Bridge Company of York, Pennsylvania. Bridge 337 is located adjacent to Cooch's Bridge. Drawings are on file at Delaware Department of Transportation for a 1932 alteration, the addition of a concrete slab extension on the west elevation.

While, as mentioned, the bridge was widened in 1932, this widening occurred during the historic period and consists of a concrete slab span which is typical of the period and is in good condition. This composite bridge comprises a good representative example of a typical bridge type from the early growth and expansion periods of the highway network.

STATE BRIDGE NUMBER 383

Road 413 over Scott Run
Jamisons Corner, New Castle County,
Delaware
1910

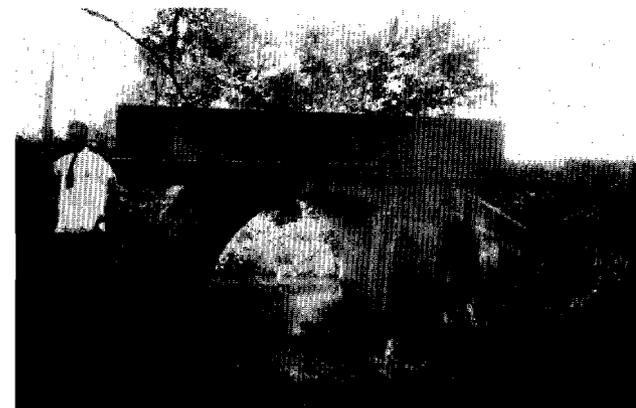
State Highway Bridge 383 is a single span, filled, solid spandrel concrete arch bridge with a clear span of 12'-0" and an arch rise of 4'-6". It carries one lane of traffic. The total horizontal clearance is 15'-11". The substructure consists of concrete abutments with flared concrete wing walls. The arch is capped by a concrete parapet ornamented with incised rectangles.

Delaware Department of Transportation records state that Bridge 383 was built in 1910. This is confirmed by a plaque on the bridge which states "Built for St. Georges Hundred. New Castle Co., James Wilson, Engineer, by Lutten Bridge Co., York, PA. 1910". Original drawings are no longer available.

Bridge 383 is one of four examples of Lutten highway bridges in the present survey, and the earliest known example of its type in Delaware.



State Bridge 383



*State Bridge 383 as it appeared in 1921.
From photo archives for New Castle County.*



State Bridge 202

STATE BRIDGE NUMBER 202

**Route 13 over Clear Brook
Seaford, Sussex County, Delaware
1919**

State Highway Bridge Number 202 (Hearns Mill Bridge) is a 26'-8" long reinforced concrete arch bridge, consisting of a filled concrete segmental arch with a clear span of 24'-0" and a rise of 6'-9". It carries two lanes of traffic on a 32'-0" wide deck. The substructure consists of concrete abutments and flared wing walls on timber piles. A corbelled band follows the intrados of the arch; the sloping wing walls have corbelled caps, and a wide band defines the top of the fascia. The parapet

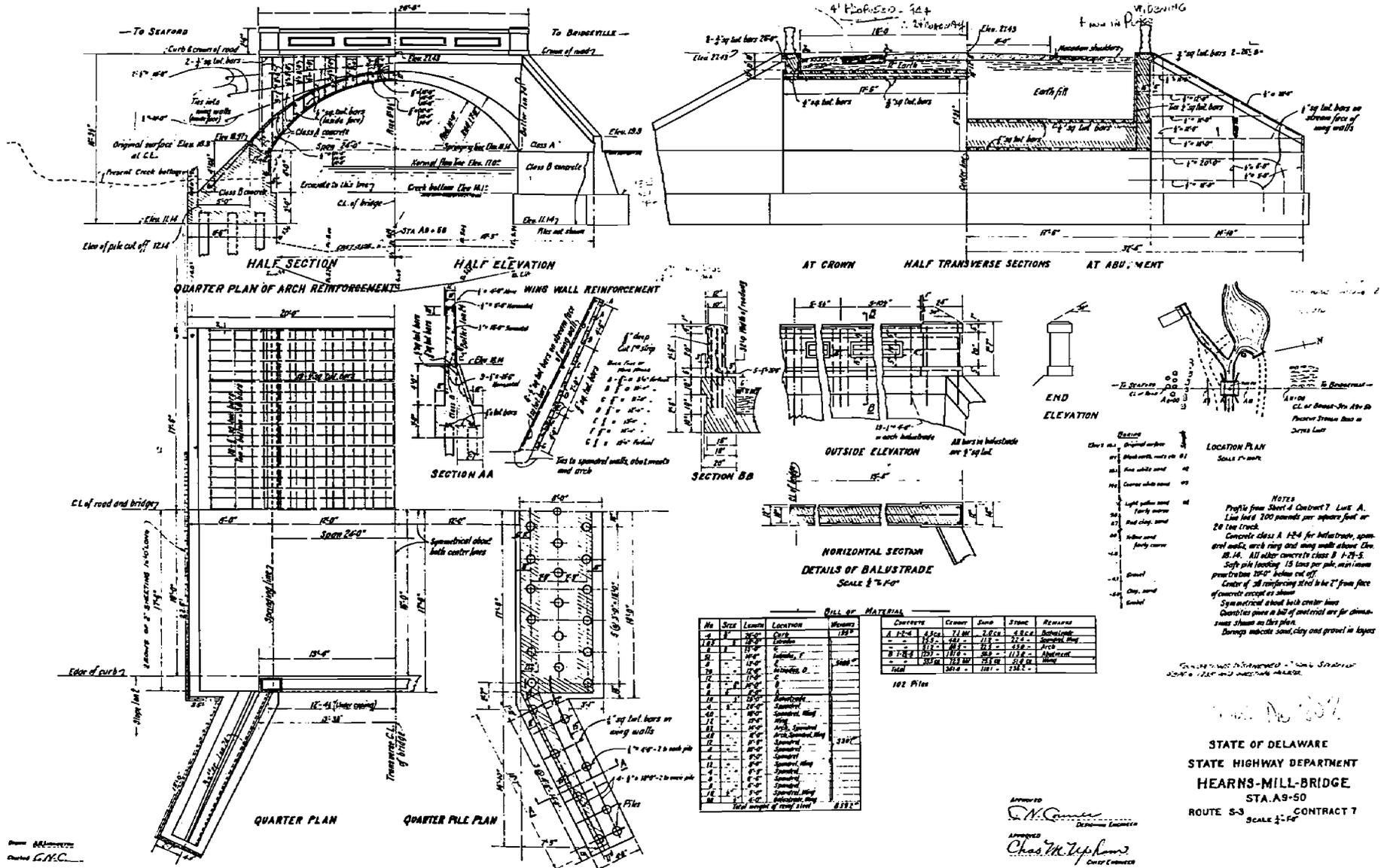
is solid concrete with incised rectangular panels, a corbelled base and cap and square end blocks in a style similar to other bridges built during the same period.

Bridge 202 was built under Delaware Highway Department Contract Number 7. The project encompassed the construction of a 6.6 mile concrete road from Seaford to Bridgeville, and included all bridges and culverts necessary. The estimated cost of the entire project totaled \$537,827.40 with \$20,415.10 requested from the Federal Aid program. The progress of the work was delayed by shortages of material and labor

during World War I. Chief Engineer Upham complained to H. K. Bishop, District Engineer for the Office of Public Roads and Rural Engineering of the U. S. Department of Agriculture, that the project was "on the verge of being held up by the government," and received assurance that Bishop considered "the maintenance of our transportation system, including the highways, is an indirect necessity" to the war effort. Original drawings, dated April 1918, show design details for the bridge; a sheet from these drawings is reproduced on the following page.

State Bridge Number 202 is a typical example of a concrete arch bridge designed by in-house highway department staff in a style similar to the "plain design" Luten arch bridges, patented by Daniel B. Luten. It was constructed during the period of rapid expansion of Delaware's transportation network, following the Federal Aid Highway Act of 1916 and the establishment of the Delaware State Highway Department in 1917. The availability of federal financial assistance enabled the State Highway Department to accelerate its program of improvements to the state's primary road system. Bridge 202, the product of one of the first Federal Aid projects undertaken in Delaware, is associated with this period of expansion, and retains a high level of integrity.

CONCRETE



Original 1918 drawings for Bridge 202.



State Bridge 336: Cooch's Bridge



Previous Cooch's Bridge as seen in photographic archives for New Castle County.

STATE BRIDGE NUMBER 336

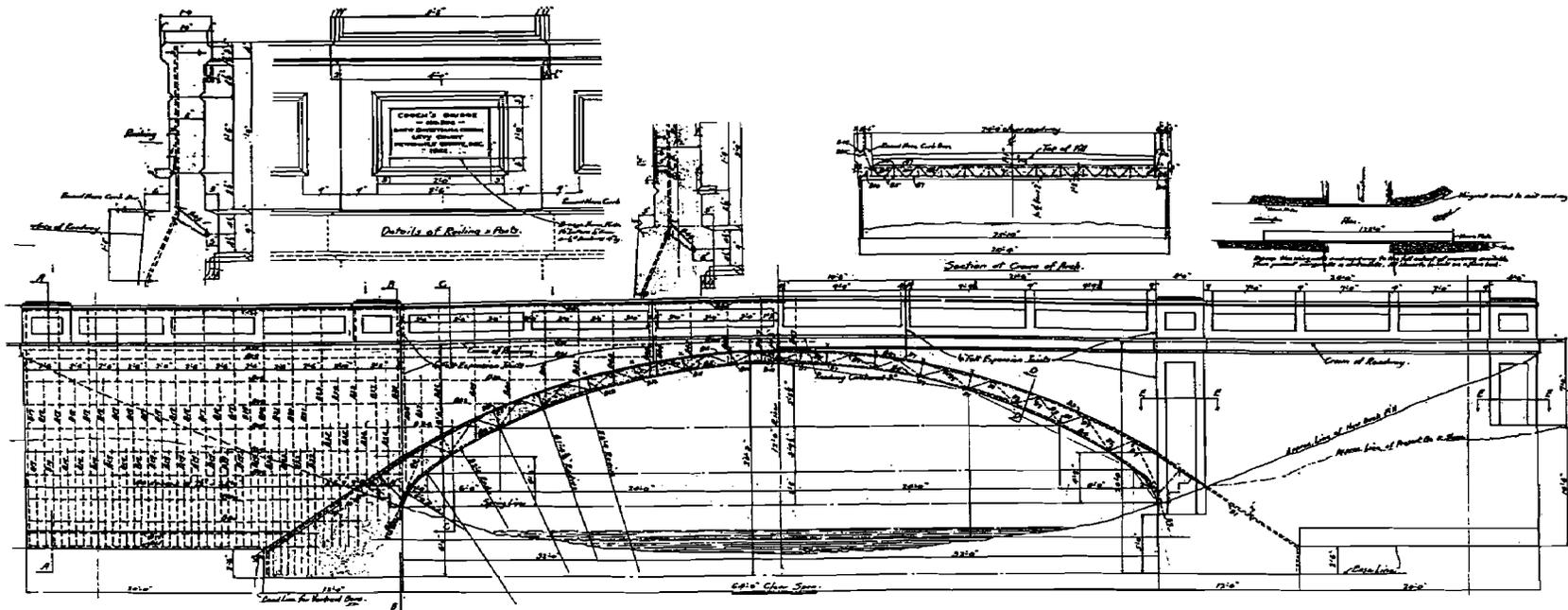
Cooch's Bridge
Old Baltimore Road over Christiana Creek
New Castle County, Delaware
1922

State Highway Bridge 336, Cooch's Bridge, is a single span filled, solid spandrel concrete arch bridge with a clear span of 64'-0" and an arch rise of 12'-0". It carries two lanes of traffic with a total horizontal clearance of 24'-0". The substructure consists of concrete abutments with U-

shaped concrete wing walls. The arch is capped with a concrete parapet ornamented with incised horizontal rectangles and a top rail. The parapet is divided into three sections, mirroring the span and wing walls, by raised square blocks ornamented with stepped, raised caps and two incised rectangles.

Delaware Department of Transportation records state that Bridge 336 was built in 1922. This is confirmed by the

bridge plate which also indicates that the structure was built under the jurisdiction of the Levy Court of New Castle, Delaware. The 1922 bridge replaced a pony truss which had served the site since 1881; a photograph, shown above, from the Delaware Department of Transportation's photo archives for New Castle County shows the earlier bridge. Specifications for the current bridge, dated June 6, 1922, call for a reinforced concrete arch, with at 12'-0" rise and a 64'-0" clear span, with a 24'-



Excerpts from original 1922 drawings for Bridge 336.

0" clear roadway and 32'-0" wing walls at each end. One wing wall "toward Glasgow" was required to be "curved to suit the present roadway." Specifications further direct that the existing truss bridge was to be dismantled at its joints in such a manner as not to injure any member of the structure, so that the bridge could be reassembled and used elsewhere. All truss members were to be match-marked before disassembly and the record of the marking turned over to the County Engineer. The contract was awarded on June 28, 1922, to Charles P. Witsil of Wilmington, Delaware,

for a bid price of \$11,515.50. Drawings dated May, 1922, prepared by the New Castle County Engineer, document the configuration and construction details of the present Coch's Bridge. A portion of these drawings is presented above. A note indicates that the masonry substructure of the previous bridge was to be used to "riprap the wing walls and roadway to the full extent of masonry available from present wing walls and abutments."

State Bridge Number 336 is an example of a solid spandrel, filled concrete

arch bridge, designed by in-house highway department staff in a style similar to the "plain design" Luten arch bridges, patented by Daniel B. Luten. It is distinguished by its relatively long span, its high degree of integrity, and by its aesthetic value. Bridge 336 appears to be in good structural condition and is unaltered; it is considered a good example of the concrete arch bridge type, and it is located within the Coch's Bridge Historic District.



State Bridge 160

STATE BRIDGE NUMBER 160

**Maryland Avenue over Little Mill Creek
Wilmington, New Castle County, Delaware
1931**

State Bridge Number 160 is a filled, solid spandrel concrete arch bridge with a span length of 50'-0" and an arch rise of 7'-0". It carries four lanes of traffic and a 6'-0" sidewalk on each side for a total horizontal clearance of 48'-0". The substructure consists of concrete abutments

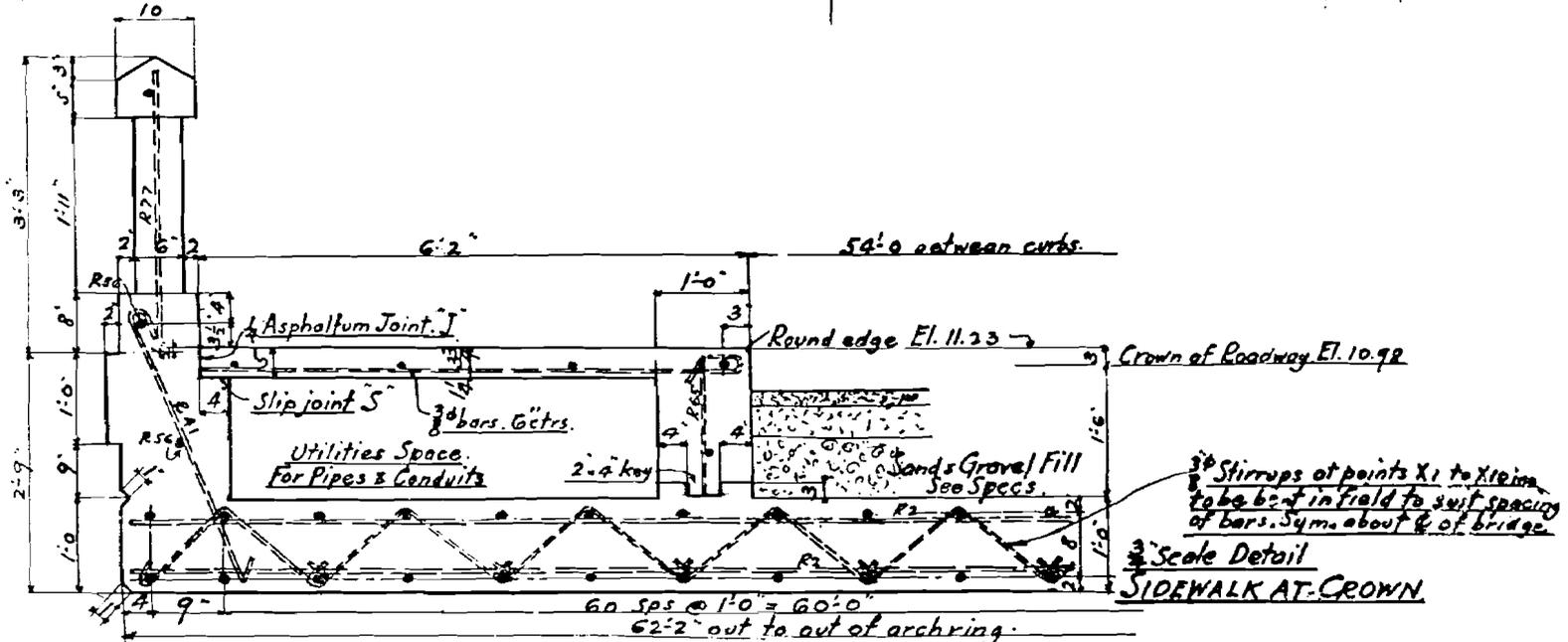
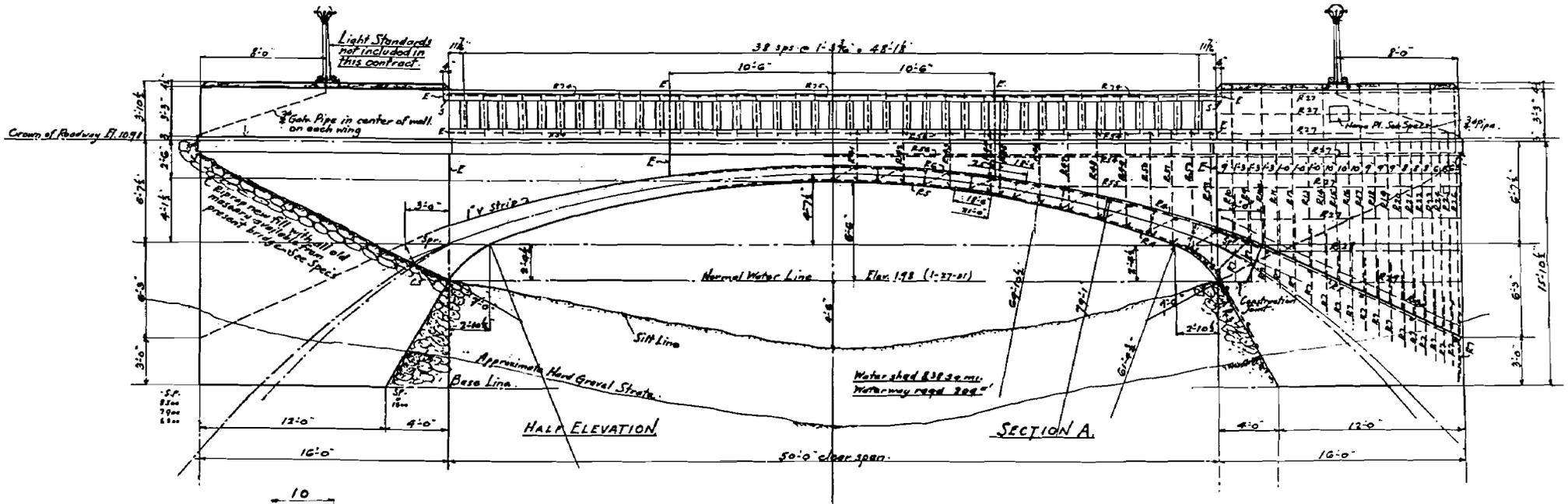
with concrete U-shaped wing walls. The parapet consists of a concrete railing and open rectilinear concrete balustrade above the arch. Solid concrete blocks top the wing walls. An incised line along the arch ring provides emphasis.

Delaware Department of Transportation records state that Bridge 160 was built in 1931 by the Levy Court of New Castle County. Original drawings are on

file at the Department. These drawings show the bridge's configuration and construction details, including ornamental light standards no longer on the bridge. Excerpts from the drawings are reproduced on the following page. The drawings indicate the existence of an earlier stone bridge at this site, stating "rip rap new fill with masonry available from present bridge". Also noted was that a millstone on a pedestal to the south of the bridge was from Richardson Mill, located approximately 100 yards away; dating to about 1684, it was one of the first mills in Delaware. The roadway width was designed to accommodate the future addition of a trolley line as well as vehicular traffic. The construction of the bridge coincided with another Levy Court project, the development of Richardson Park adjacent to the bridge. The opening of the bridge and park was commemorated with a celebration involving speakers and a parade on November 21, 1931.

State Bridge Number 160 is an example of a solid spandrel, filled concrete arch bridge, ornamented in a simplified 1930s version of "park style" bridges, similar to Luten's "Park Bridge of Attractive Design." This embellished arch contributes to the park setting and is considered a good example of the type.

CONCRETE



Excerpts from original 1931 drawings for Bridge 160.



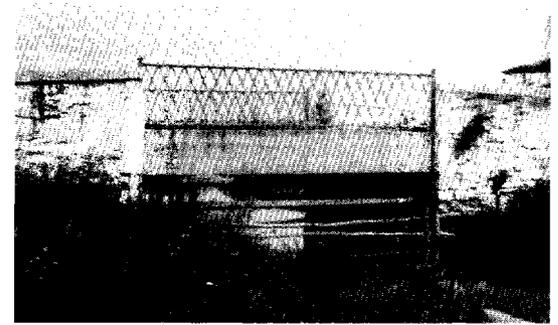
CONCRETE SLAB, FRAME AND GIRDER BRIDGES

The remaining concrete bridges which were determined significant can be categorized structurally as reinforced slab (10), rigid frame (4), and concrete girder (1) bridges. Constructed from 1911 to 1941, they represent types which were commonly built during that time, consisting of standardized engineering designs which were often differentiated only by embellishment. As these standardized types increased in usage, even their embellishment became standardized. In some cases, survey results revealed a regional variation in ornamental treatment (New Castle County masonry articulated concrete bridges), and use (dual-purpose structures, bridge and water flow control, predominantly in Kent and Sussex Counties). The slab, frame and girder bridges have been grouped to illustrate both the embellishment types, and regional variations in ornamentation and use.

Photographs from the Delaware Department of Transportation's photo archives for New Castle County bridges inventoried in the 1920s reveal that concrete slab construction was a popular

county bridge type in the first quarter of the twentieth century. Of the 485 bridges illustrated, approximately 133 were concrete slabs. While only forty-six of these were 10'-0" or longer, the eighty-seven culverts show the same stylistic treatment and variation. In addition, as discussed in the introduction to the concrete section, some of the bridges listed as "concrete encased steel I-beams" may indeed be "concrete girders reinforced with I-beams". By contrast, there were only two bridges designated as concrete girders and no bridges described as concrete frame in the photo archives.

The bridges in the New Castle County photo archives are undated with respect to construction, so it is difficult to trace their development. Several stylistic groups can be identified, however; these correspond to stylistic groups also illustrated in the steel girder category. Generally, the concrete bridges extant in New Castle County in the 1920s illustrate two broad categories: masonry-detailed concrete bridges and solid concrete bridges. In the first category there are two sub-groups. In one sub-group, the slab spans masonry abutments and masonry wingwalls and often incorporates the previous bridge substructure. These are generally topped with either a metal lattice or simple pipe railing. (See adjacent photo) Although undated, these structures compare



*Concrete slab bridge with lattice rail.
Near Green Springs, New Castle County
No longer standing.*



*Concrete slab bridge with masonry parapet
Brick Church Road, New Castle County
No longer standing.*

EARLY CONCRETE SLAB BRIDGES OF NEW CASTLE COUNTY

stylistically to early twentieth century steel girder bridges (see 1903 Bridge #505 photo). Another sub-group of these bridges was further embellished with the slab spanning masonry abutments and attractive masonry wing walls, and featuring stone parapets topped with a concrete capstone (See photograph on previous page.) State Bridge 76 is an existing example. The tradition of masonry embellishment remained strong in New Castle County until late in the survey period. The masonry embellished concrete bridges (and steel girder bridges) built in the 1930s were more elaborate and sometimes replaced the earlier types, or incorporated portions of the previous masonry substructure.

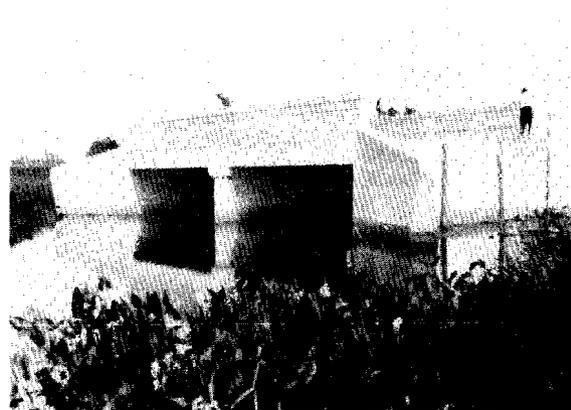
The second broad group of 1920s



*Unembellished all concrete bridge.
Near Mt. Cuba, New Castle County
No longer standing.*

New Castle County bridges consisted of bridges that were all concrete: slab, wing walls and parapets. The photographs below illustrate this group. Some of these were quite plain indeed, with form lines exposed and no attempt at embellishment, while others were more carefully finished with smooth surfaces and incised lines as in the "Luten style". There were, in fact, several Luten concrete slab culverts represented.

Concrete slab bridges, like their steel counterparts, were built widely throughout the United States, as were girder, frame and box culvert spans. The development of concrete as a primary construction material in the United States, discussed in the



*New (ca 1924) all concrete bridge
with simple embellishment.
Dike Bridge, New Castle County. No longer standing.*

introduction to the concrete section, was roughly simultaneous with that of steel. By 1900, zealous proponents of both materials were developing patents and selling their bridge types throughout the states. Concrete became the predominant type for highway bridges and short railroad spans in the early twentieth century; but the competition between it and steel was strong and continues even today, in the late twentieth century. The widespread use of these materials for bridge building corresponded with the consolidation of local road networks and the establishment of state highway departments; the need to rapidly expand the transportation network resulted in standardized, "cookbook" designs.



*Luten all concrete culvert
Between Summit Bridge and Middletown,
New Castle County. No longer standing.*

Nevertheless, the thirteen concrete slab, four concrete frame and one concrete girder bridges chosen as significant in the present survey of Delaware's historic highway bridges are representative of the concrete bridges of the time and show some of the diversity that did exist. They are grouped in the following sections according to similarities of design, and selected examples are presented. Further information concerning these bridges and other surveyed bridges not presented here, can be found in Appendix 2.

State Bridge 76 represents concrete slab bridges embellished with masonry to look like stone bridges. Bridge 69 is a similarly embellished concrete girder bridge. Survey results revealed a number of small concrete bridges and steel girder spans in New Castle County faced with rubble masonry. In an apparent effort to relate to their rustic surroundings as well as to reflect the area's historic association with early turnpike construction, these small stone-faced bridges present an appearance reminiscent of nineteenth century turnpike structures. Survey results indicate that this masonry articulation of the girder bridge type was built only in New Castle County. Several similarly embellished bridges were built by the Levy Court of New Castle County in the early 1930s. Upon taking over responsibility for all road and bridge

construction throughout the state in 1935, the State Highway Department continued designing in this style. As discussed above, this combination of concrete and masonry is also seen in a number of bridges in the photo archives of New Castle County's bridges of the 1920s. Only one of the bridges found in those photo archives, Bridge Number 76, survives and is included in the present survey.

Bridge 258 is a different style concrete slab bridge, and the longest spanning bridge in this group. A grade crossing elimination structure built in 1941, it is the only concrete slab bridge with Art Moderne-influenced detailing. This stylistic treatment

appears on several steel girder grade crossing bridges from the same time period. (257 E, 684, 686). The illustration below, showing the balustrade of Bridge 258 is reproduced from a Delaware Department of Transportation "style sheet" for "Metal Type" balustrades used in the state.

Five of the concrete slab bridges (42A, 329, 504, 709, 808) and one concrete frame bridge (200) are actually dual use structures, combining bridge functions with water flow control functions. Four of these are in Sussex County, one is in New Castle County and one is in Kent County. While this dual function type was built throughout Delaware, with a number of examples in the

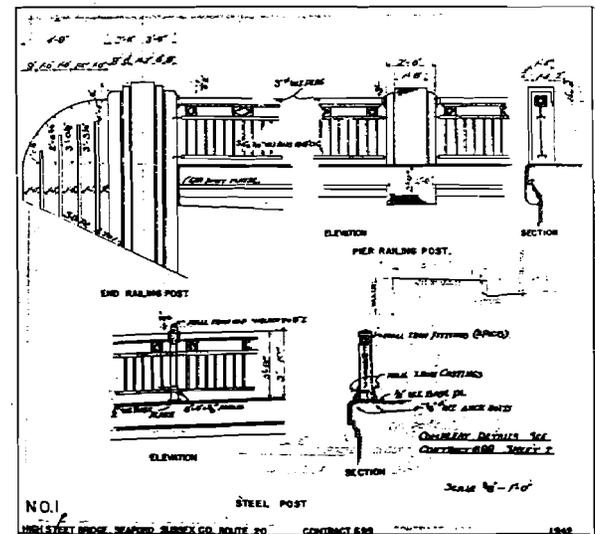
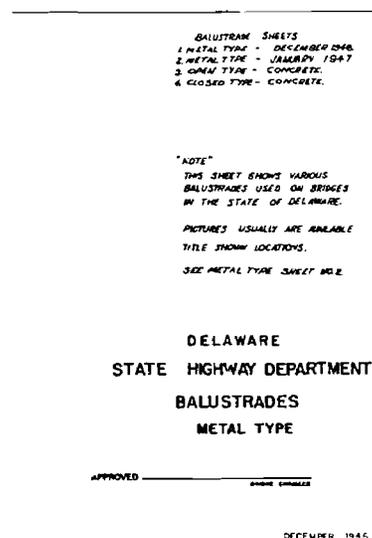
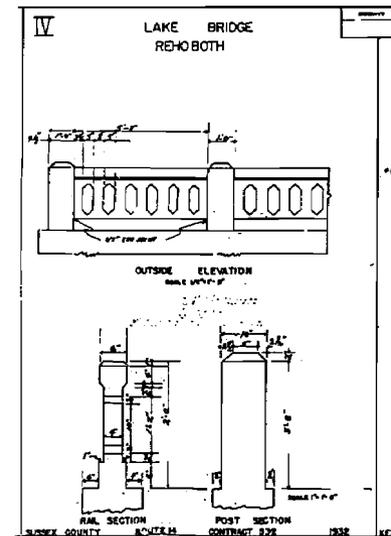
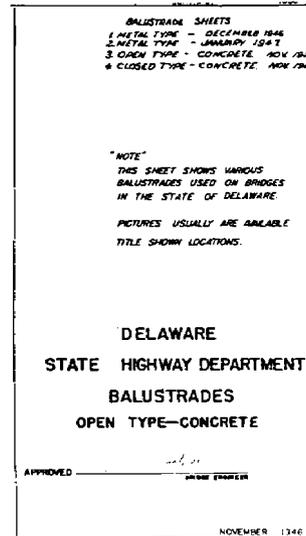


Illustration from 1946 Delaware State Highway Department "Style sheet" depicting metal type balustrades used on bridges in the state of Delaware.

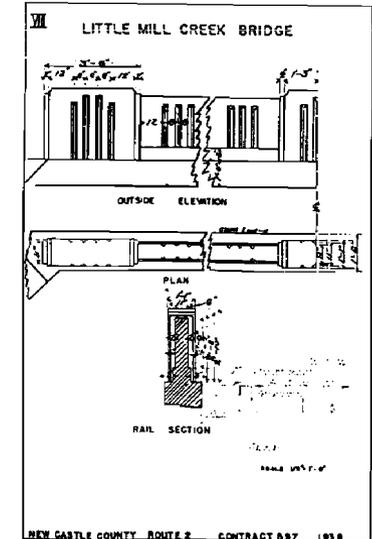
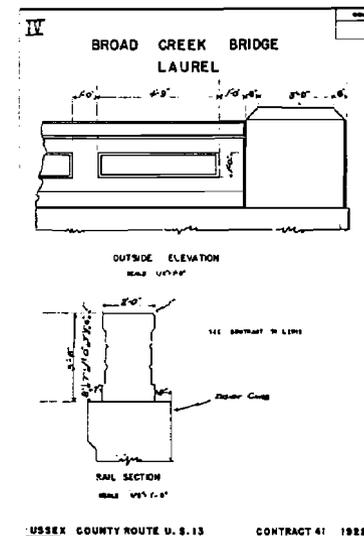
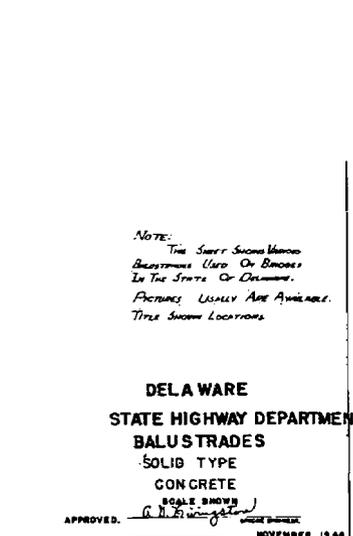
CONCRETE

photo archives of New Castle County bridges from the 1920s-1930s, few remain. These few survivors are not unusual in their design configuration, representing standardized designs in their construction and embellishment. Bridge 709 will serve as a representative example of these structures. Bridge 808 is also presented because of its unusual parapet design. More information about the others is available in Appendix 1.

Bridges 430, 504S, 508S and 673 are representatives of the most common "generic" concrete slab and concrete frame highway bridges. Bridges 504S and 508S were constructed in the early phases of the Dupont Highway; 430 and 673 during the 1925-1935 period of rapid expansion. Bridge 504S will represent this group in the following section. Bridge 300 illustrates an open concrete rail variation which is shared only by Bridge 476. Bridges 153, a slab, and 488N, a frame, illustrate other variations in their embellishment. The adjacent illustrations are taken from Delaware Department of Transportation style sheets depicting various open and closed concrete balustrade styles in use in the state. They demonstrate the standardized method of design used for expediency in times of rapid expansion.



Example of an Open Type Concrete Balustrade....



....and a Closed Type Concrete Balustrade.



STATE BRIDGE NUMBER 69

State Bridge 69

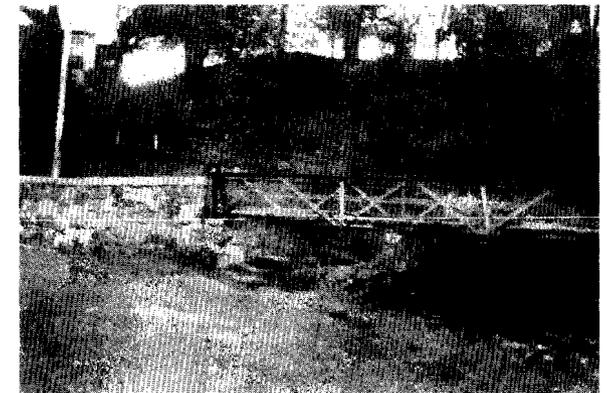
**Adams Dam Road over Waterway
Tavistock, New Castle County, Delaware
1934**

State Highway Bridge 69 is a concrete girder bridge with a single span of 35'-6"(maximum). It is built on approximately a 30 degree skew. It is 40'-0" wide (at widest point) and carries two lanes of traffic. The

structure consists of 16" x 24" rectangular concrete beams supported by random rubble abutments with U-shaped random rubble wing walls. The parapet is also constructed with random rubble. It consists of a center balustrade with pointed arch openings, topped with peaked coping and framed by raised end posts with pyramidal caps. The wing walls extend to parapet

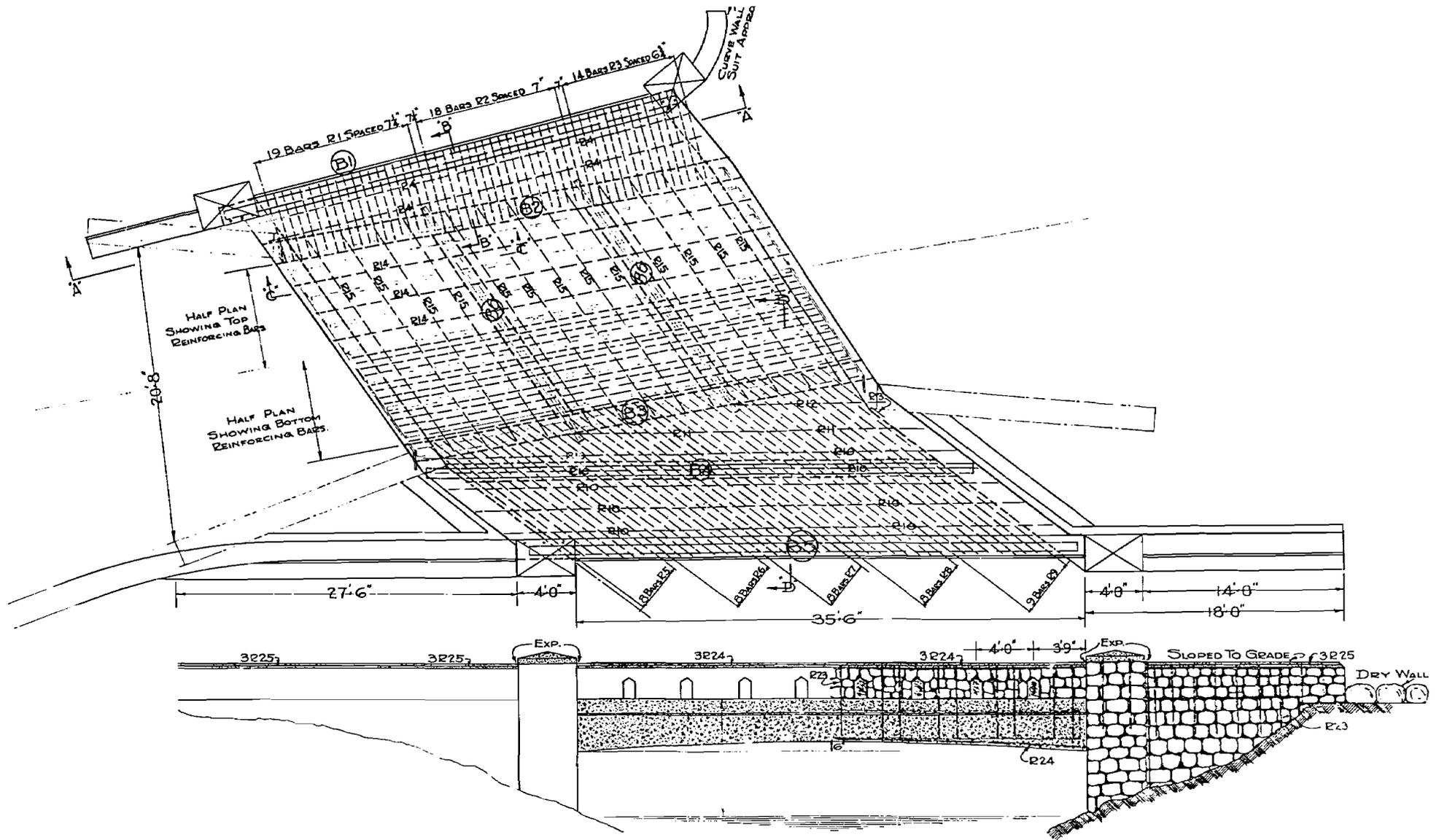
height. The concrete fascia has a single scored horizontal line and is shaped as a shallow segmental arch.

Delaware Department of Transportation records include drawings dated December 8, 1933 documenting the configuration and construction details of this structure. These drawings, prepared for the Levy Court by the Office of the County Engineer, indicate the scheme for placement of reinforcing steel within the concrete core of the masonry-faced bridge. A portion of these drawings are reproduced on the following page. Photo archive records at Delaware Department of Transportation confirm that the bridge was constructed in 1934, replacing an earlier steel pony truss bridge on rubble masonry abutments. The photograph below, from the photo archives for New Castle County, shows the earlier bridge.



*Previous Bridge 69 from
photo archives for New Castle County.*

CONCRETE



Elevation and plan showing reinforcement from original 1933 drawings for Bridge 69.



STATE BRIDGE NUMBER 76

State Bridge 76

**Montchanin Road over Waterway
Granogue, New Castle County, Delaware
1932**

State Highway Bridge 76 is a single span concrete slab bridge spanning 9'-0" feet. The bridge is built on a 13 degree skew. It carries two lanes of traffic on a 24'-0" wide deck. The substructure consists of uncoursed ashlar abutments with U-shaped wing walls. The parapet is also uncoursed ashlar and has a corbelled cap. A stone corbel course divides the parapet from the fascia of the slab.

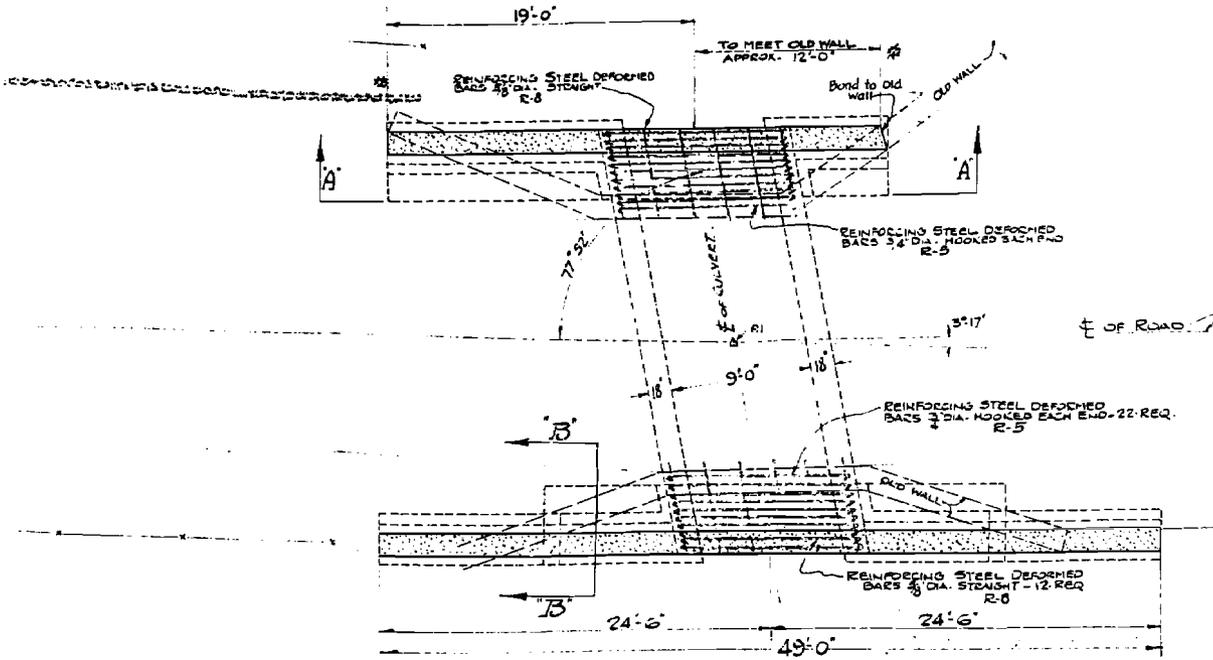
Delaware Department of Transportation drawing files contain one drawing from the "widening and rebuilding" of Bridge 76. Designed by the Levy Court Engineer's Office, the bridge achieved its present appearance in 1932, when a previous structure which incorporated masonry elements was rebuilt and widened from 16 feet to 24 feet. The previous bridge, a concrete slab bridge, 16 feet wide was widened 4 feet on both sides. The rebuilding included the complete demolition of the headwalls and portions of the roadway slab and abutment walls.



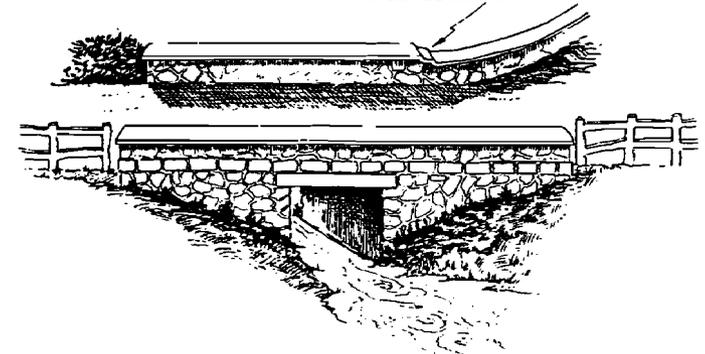
*State Bridge 76 as it appeared in 1921.
From photo archives for New Castle County.*

Specifications provided that all new masonry was to match the existing approach wall. Reuse of existing stones was permitted, provided that the stone was free of any old mortar. This widening and rebuilding contract was awarded to a Philadelphia firm, Hefflin and Kelly, for \$885.77. Portions from the 1931 alteration drawings are shown on the following page.

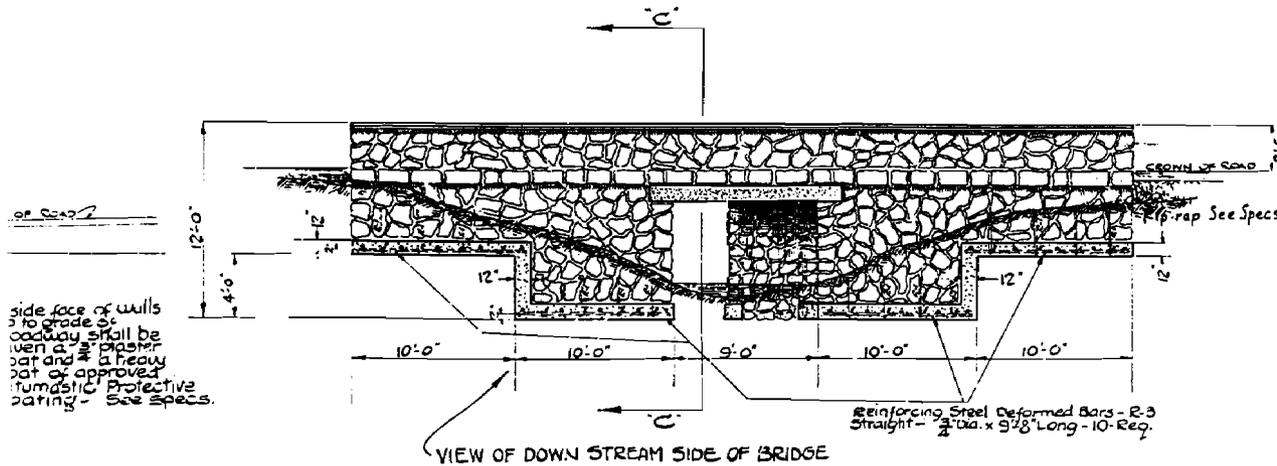
CONCRETE



old wall to be bonded to meet new wall as shown



- BRIDGE No 76 -



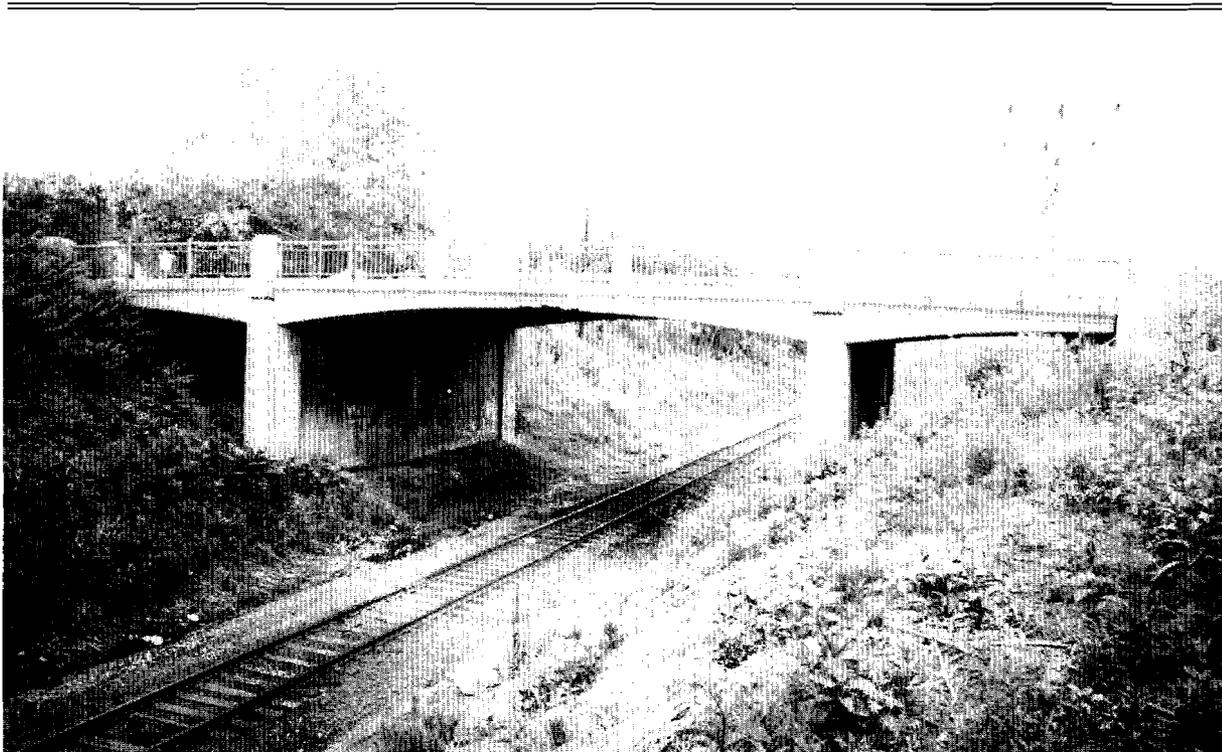
- WIDENING AND REBUILDING -
- BRIDGE No 76 -
FROM 16- TO 24- FEET WIDE

LEVY COURT
NEW CASTLE COUNTY
OFFICE OF COUNTY ENGINEER
WILMINGTON, DELAWARE

DATE DEC - 31 1931
SCALE 1" = 3'-0" HORIZ. - 1" = 4'-0" VERT.

APPROVED BY
C. L. K...
COUNTY ENGINEER

Excerpts from 1931 alteration drawings for Bridge 76.



State Bridge 258 as it appeared in the 1942 Annual Report.

STATE BRIDGE NUMBER 258

**Route 536 over Conrail
Seaford, Sussex County, Delaware
1941**

State Highway Bridge 258, "High Street Bridge", is a three-span continuous concrete slab bridge with an overall length of 100'-0". The center span over the Conrail tracks measures 52 feet; it is flanked by 24'-0" long spans. The

roadway measures 42'-0" curb-to-curb, has 5'-0" sidewalks on each side, and has an asphalt wearing surface. The bridge is built at a slight skew. It exhibits a high level of architectural elaboration. The underside of the spans follow gentle low-rise arches, and the outside edge of the deck is corbelled with a coved bed mold. The piers and wing walls feature stepped forms and vertical bands reflecting Art Moderne

influence. The parapet comprises panels which consist of paired concrete posts with an iron balustrade between them. The balustrade incorporates square-section balusters and a row of diamond forms below the handrail, evoking Delaware's motto, the "Diamond State". The ends of the parapets are rounded and have vertical striations. The concrete posts house street-level lighting. Stairs with an iron pipe railing are located at the southeast corner of the bridge leading, to a train platform below.

Delaware Department of Transportation records indicate that Bridge 258 was constructed in 1941-42, to replace a functionally obsolete timber bridge, which provided a grade separation at the same location on High Street over the Pennsylvania Railroad tracks. The replacement bridge, designed to carry an H-20 live load, was approved by the Pennsylvania Railroad and the State of Delaware, as indicated on the original drawings dated April 1941. Drawing notes chronicle the construction process in detail. A temporary timber pedestrian bridge was provided during construction. These drawings also show the design for the substructure, consisting of concrete footings, battered cast-in-place concrete piles, and the elaborate "Art Moderne" parapet and wing wall ornamentation.

CONCRETE

Drawings of the metal balustrade, which were fabricated by Charles G. Kemp of Philadelphia, are also included on a sheet labeled "Delaware State Highway Department, Balustrades/Metal Type" dated December 1946. The portion of this sheet showing Bridge 258 is reproduced in the introduction to this section and segments from the original drawings for the bridge are shown in the following pages. Contract correspondence indicates that a raised dividing strip was initially contemplated to separate the two opposing traffic lanes, but this detail was not incorporated in the final design. The aesthetic effect of the structure impressed the inspecting engineer for the Public Roads Administration, who declared "the lines on the bridge curb and posts are the best on any major structure built in Delaware this past season".

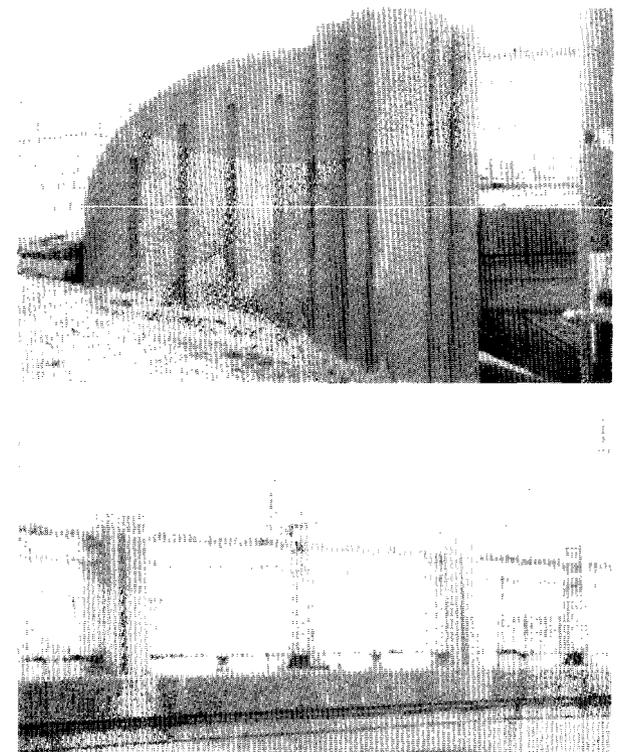
Grade crossings posed a dangerous junction between railroad and highway traffic, accounting for thousands of fatalities in the United States in the first quarter of the twentieth century; in 1926, the Delaware State Highway Department began a systematic program of eliminating these hazardous crossings. The railroad companies acted in cooperation with the Highway Department to replace grade intersections with separated crossings. In some cases, grade crossings could be eliminated by relocating the road or the

railroad tracks, or both, but this program generally involved the construction of overpasses or underpasses. About 1940, the federal government began to offer assistance for this type of construction through the Federal Aid Highway Program of the Public Roads Administration. In the federally-assisted grade separation projects of the period, the cost of construction was borne by the federal government, with the State and the railroad company sharing responsibility for right-of-way acquisition expenses. The contract price for Bridge 258 was \$79,719.00.

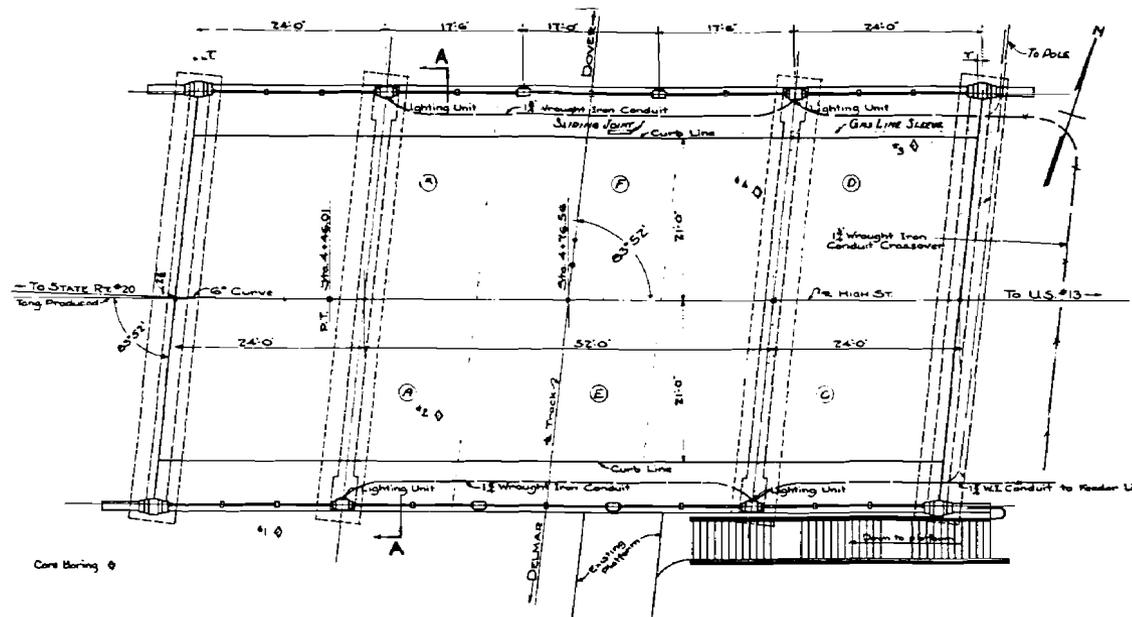
The contractor, J. A. Bader & Company of Wilmington, started work on October 13, 1941; construction was delayed from the outset by difficulties in obtaining critical materials related to the war effort. Important projects, such as federally-assisted grade crossing elimination structures, were awarded priority ratings by the Public Roads Administration to prevent problems in receipt of materials, but these ratings often proved difficult to obtain, and the application process itself introduced delays. It took two months before Bridge 258 received Preference Rating A-7 from the Office of Production Management; the Public Roads Administration acknowledged the effect of this lag in recommending that the contractor not be held liable for damages, despite completing the structure

far behind schedule. All work was reported complete on May 20, 1942, and the bridge was opened to traffic the following July.

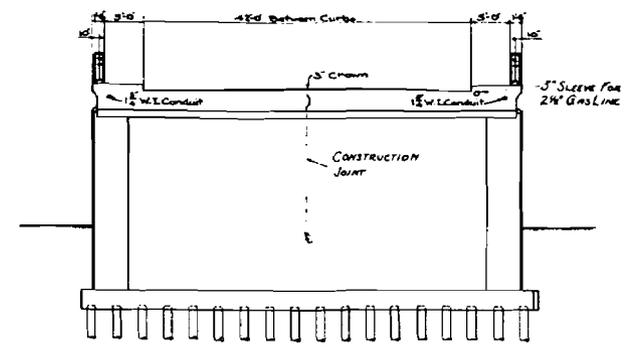
State Bridge No. 258 is an unusually embellished concrete slab bridge. Significant for its Art Moderne-influenced architectural detailing which is uncommon among Sussex County bridges of the period, it derives additional significance from its association with the grade separation program.



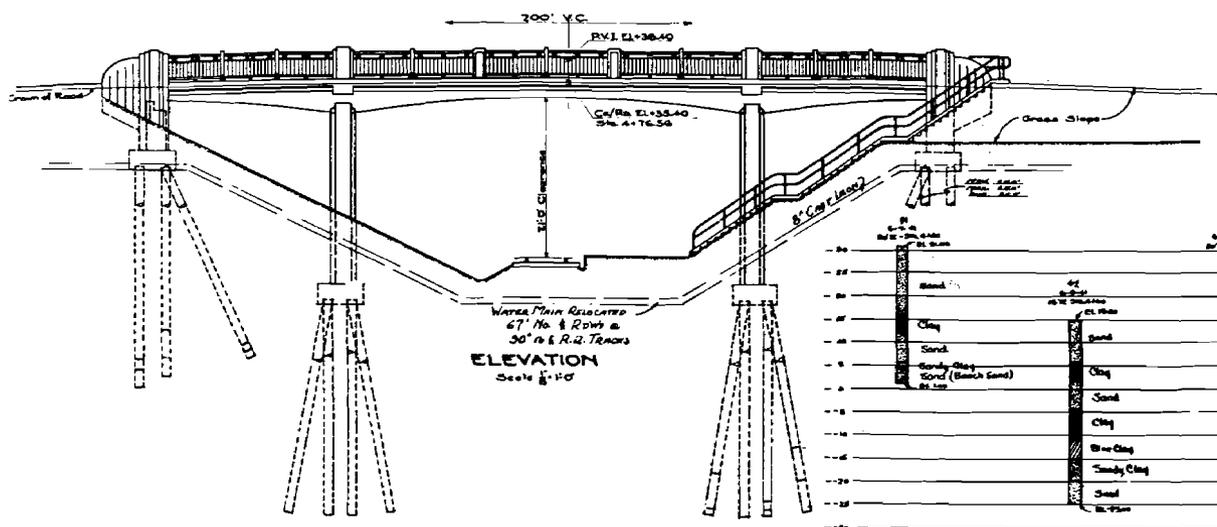
Bridge 258: Art Moderne influenced detailing.



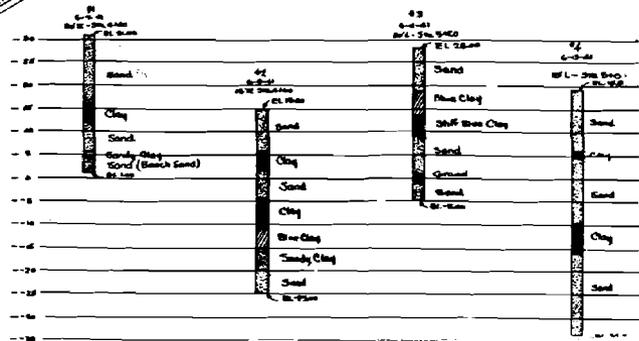
PLAN
Scale 1/4" = 1'-0"



SECTION A-A
Scale 1/4" = 1'-0"

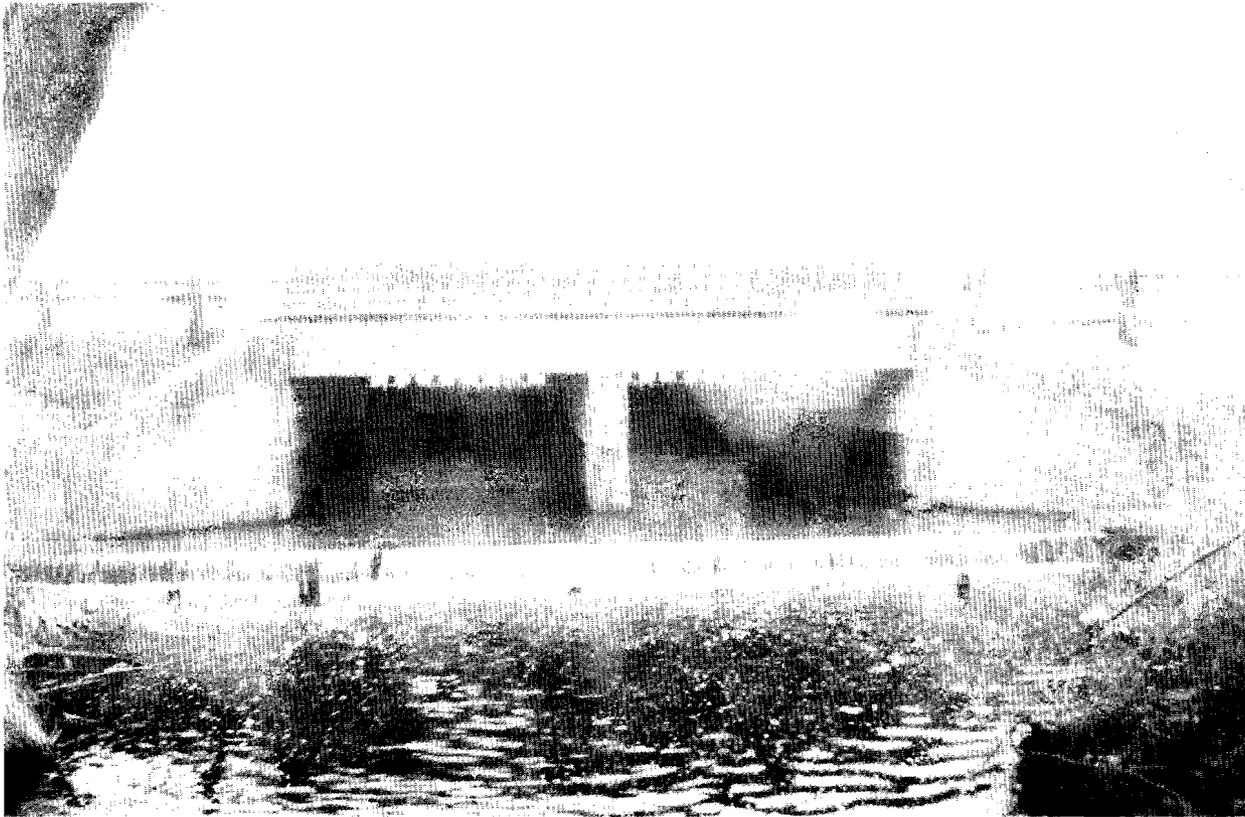


ELEVATION
Scale 1/4" = 1'-0"



REVISIONS	SHEET No. 5 of	PIERS & DECK	20068
	THE PENNSYLVANIA RAILROAD		ML DEL RR
	RECONSTRUCTION O.H. BRIDGE HIGH STREET SEAFORD, DEL.		
	Office of Engineer, Bridges & Highways Philadelphia, Pa. June 18, 1941 Approved: <i>A. C. Miller</i> Engineer Bridges & Highways		Scale - As Shown Approved: <i>[Signature]</i> Chief Engineer - Lehigh Region

Plan, elevation and section from original 1941 drawings for Bridge 258.



STATE BRIDGE NUMBER 709

State Bridge 709

**Route 24 over Herring Creek
Winding Creek Village, Sussex County,
Delaware
1938**

Delaware State Highway Bridge 709 is a 28'-0" two span continuous concrete box culvert with concrete abutments, parapet, and flared wing walls. Incorporated in the

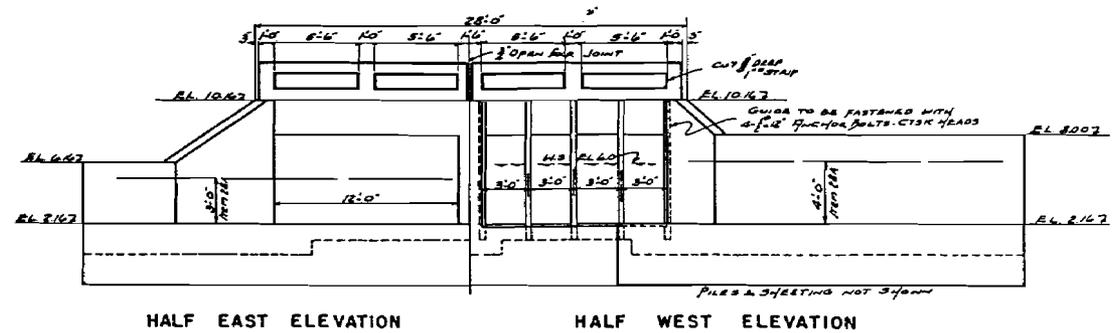
structure is a spillway for Burton Mill Pond. Each span of the bridge measures 12'-0"; the solid concrete parapet consists of two panels on each side of the road. Each panel is simply ornamented with two incised rectangles. The bridge measures 36'-0" wide and carries two lanes of traffic with right and left shoulders. On the west elevation, under the deck, 6" x 10" wood

posts form sheeting which controls the creek flow.

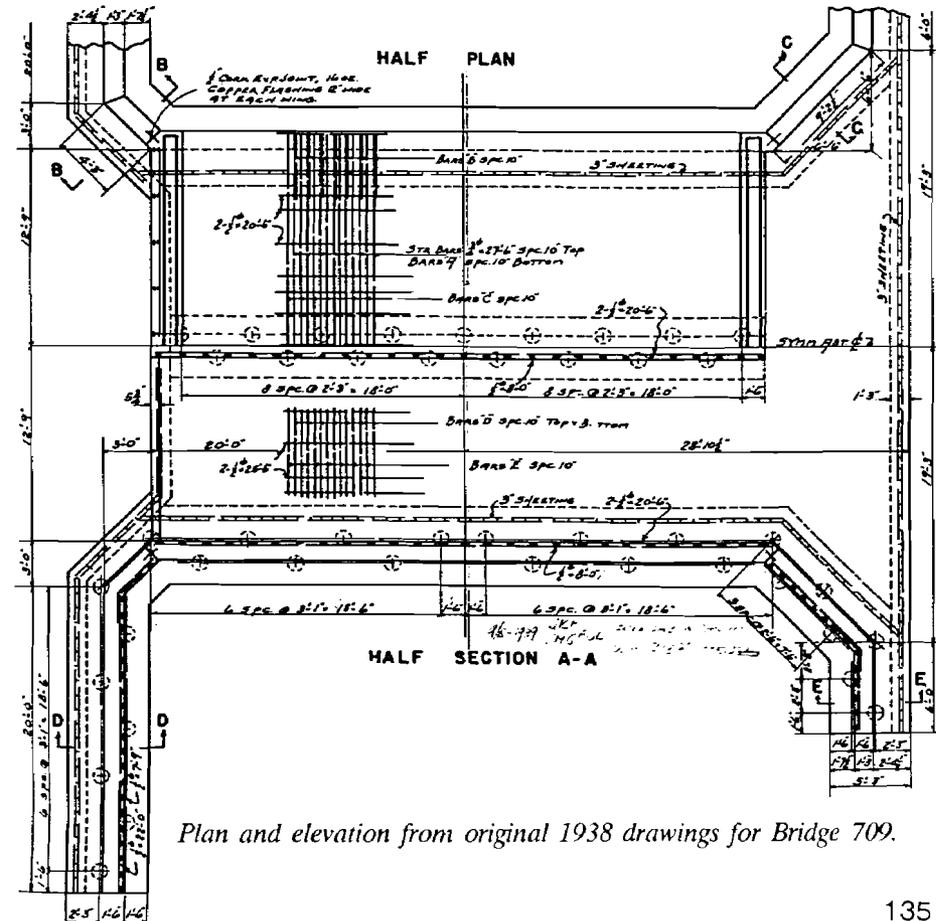
Delaware Department of Transportation records indicate that Bridge 709 was built in 1938. It was constructed as part of a larger road improvement project, involving the widening, with concrete pavement, of 9.022 miles of road between Harmon School and Midway. The preliminary route report prepared by the Bureau of Public Roads, U. S. Department of Agriculture, indicated the rationale for this undertaking: "in addition to carrying a rather heavy volume of summer traffic to beach points, this project serves a substantial area of average farm land. [It] extends through the town of Millsboro [which] provides a railroad shipping point for local farm produce." The contract for this work was awarded to Walter Roach and Sons of Georgetown, Delaware, for the bid price of \$64,210.20. The project was begun June 28, 1939, and completed on July 1, 1940. Construction progress encountered delays due to heavy beach traffic. Original drawings, dated 1938, provide for removal of a previous structure which included a timber spillway. Portions of these drawings are reproduced on the following page. The first structure was built in 1927, under contract CS57; it had been extended in 1932.

CONCRETE

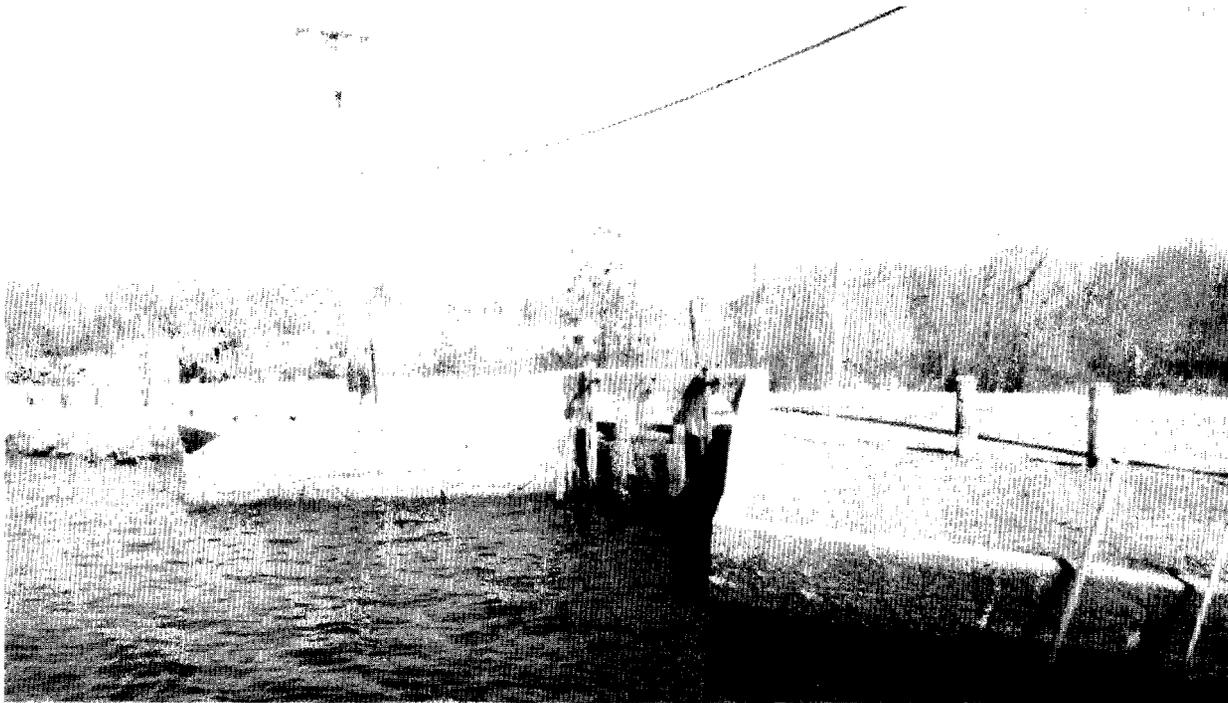
Bridge 709 is an example of a concrete, combined-use structure, serving as a bridge and water flow control structure. This dual-purpose type of structure was found predominantly in Kent and Sussex Counties; these bridges serve as examples of creative design solutions to unusual site conditions, reflecting a specialized engineering response to the water management necessities of lower Delaware. Many of these bridges were built throughout Delaware, but there were only a few extant representatives among the surveyed Delaware DOT bridges. The project, of which this bridge was a part, was undertaken in response to two developments which characterized the economy of lower Delaware during the period: the increasing importance of beach resorts and the continuing predominance of agriculture.



HALF EAST ELEVATION HALF WEST ELEVATION



Plan and elevation from original 1938 drawings for Bridge 709.



State Bridge 808

STATE BRIDGE NUMBER 808

Route 197 over Broadkill Creek Milton, Sussex County, Delaware

State Highway Bridge 808 is a reinforced concrete slab with a structure length of 23'-0", two spans 10'-0" in length and a deck width of 24'-0". The structure serves as both a bridge and a water flow control for Wagamon's Pond. Adjustable wood plank gates retain the water in the pond and are raised or lowered along the concrete tracks by hand to control the

volume of flow through the spillway. The parapet design consists of a series of open arches.

Delaware Department of Transportation records state that Bridge 808 was built in 1900. This early date is undocumented, and generally designates bridges which were built prior to being taken over by the Department, prior to 1935. Construction drawings or records do not survive.

The unusual parapet design of Bridge 808 consists of arched openings, a design not found on any other bridges surveyed in the region. Constructed by the county prior to the 1935 assimilation of county bridges by the Department, this bridge was associated with the early twentieth century development of the secondary road network in rural Sussex County.

CONCRETE



State Bridge 504S

STATE BRIDGE NUMBER 504S

**Route 113S over Wharton Branch
Millsboro, Sussex County, Delaware
1911/1946**

State Highway Bridge 504S consists of a continuous two span concrete slab bridge with an overall length of 29'-0". The deck measures 42'-0" wide, carrying two lanes of traffic on an asphalt wearing

surface. The 12'-9" long slab spans are supported on concrete abutments with flared wing walls; there is one battered intermediate pier which rests on a concrete footing whose outer sides are sheathed in vertical 3"X6" timbers. A simple concrete parapet is embellished with three incised rectangles on its inner and outer surfaces. The upper edge of the slab is corbelled,

and the lower edge is finished with a chamfer, as are the vertical corners of the pier.

Delaware Department of Transportation records indicate that Bridge 504S was constructed in 1911. The bridge was built for the first section of the DuPont Highway, completed in 1917 from Selbyville to Millsboro. The DuPont Highway was conceived and financed by Coleman T. du Pont, who offered in 1908 to organize a corporation to construct a visionary superhighway which would connect the industrial north to agricultural southern Delaware. Du Pont, an active proponent for good roads in the early years of highway development, proposed a futuristic superhighway from Wilmington to the Maryland border. DuPont would bear all costs of construction, and turn the road over to the state upon completion. With roads which were practically impassible in bad weather, construction began in 1911 on the southernmost section in Sussex County. The DuPont Highway was completed from Milford to the Maryland Line in 1917. By the time of its dedication in 1924, du Pont had contributed a total of \$3,917,004 toward the construction of this visionary highway project. More information concerning the DuPont Highway is presented in the section entitled "Modern Highways: The Early Years: Bicycles,

CONCRETE



STATE BRIDGE NUMBER 300

State Bridge 300

**Porter Station Road over Red Lion Creek
Porter, New Castle County, Delaware
1934**

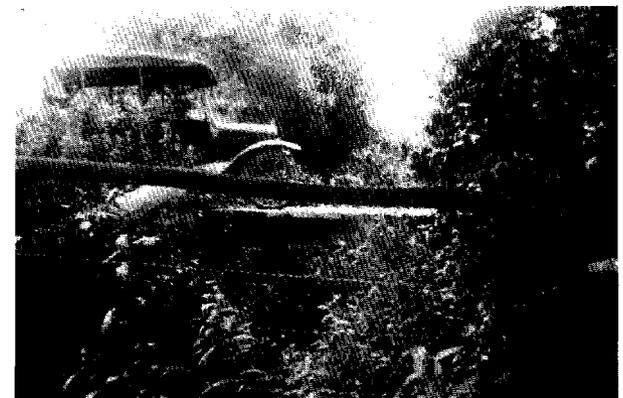
State Highway Bridge 300 is a 10'-10" concrete rigid frame bridge with concrete abutments and U-shaped concrete wing walls. It carries two lanes of traffic on a deck 24'-0" wide. A corbelled band defines the top of the fascia and wing walls. The fascia is shaped as a segmental arch. The concrete parapet consists of two large end

blocks, each 10'-0" long. The wall between the end blocks is lower and is comprised of concrete posts as an oversized balustrade and beveled rail.

Delaware Department of Transportation records state that Bridge 300 was built in 1934 as part of a project to improve 1.37 miles of road between Red Lion and Porter. Original drawings dated September 1934, document the configuration and construction details of

this structure, with particular attention to the scheme for placement of steel reinforcing bars within the concrete, and the provision of a sleeve in each abutment to accommodate future utilities. The concrete frame bridge replaced a wooden beam bridge with masonry abutments. A photograph of the earlier bridge is shown below.

State Bridge 300 is an example of a concrete frame bridge, like the commonly built concrete slab and girder bridges, of standardized design and simply embellished. These common types were constructed during the early growth period and the period of rapid expansion of the state road network. It appears to be in good structural condition and is unaltered, and is considered a good representative example of this type.



*State Bridge 300 before replacement in 1934.
From photo archives for New Castle County.*



STATE BRIDGE NUMBER 153

State Bridge 153

**Kirkwood Highway over Little Mill Creek
Elsmere, New Castle County, Delaware
1938**

State Bridge 153 is a 36'-8" double span, reinforced concrete slab bridge; each span measures 16'-0". The bridge carries four lanes of traffic, a center median strip and a sidewalk on each side for a total width of 106'-0". The substructure consists of concrete abutments with flared wing walls. The slab and the wing walls are topped with a corbelled

band. The parapet is concrete and consists of two solid walls between square, battered end blocks and a center pier. It is ornamented in a simple Art Moderne style, with incised vertical striations.

Delaware Department of Transportation records for Bridge 153 include original drawings for the present bridge. They are dated April 1938, and include plans, sections, elevations, and details of the parapet; drawing notes state "remove present bridges." The bridge

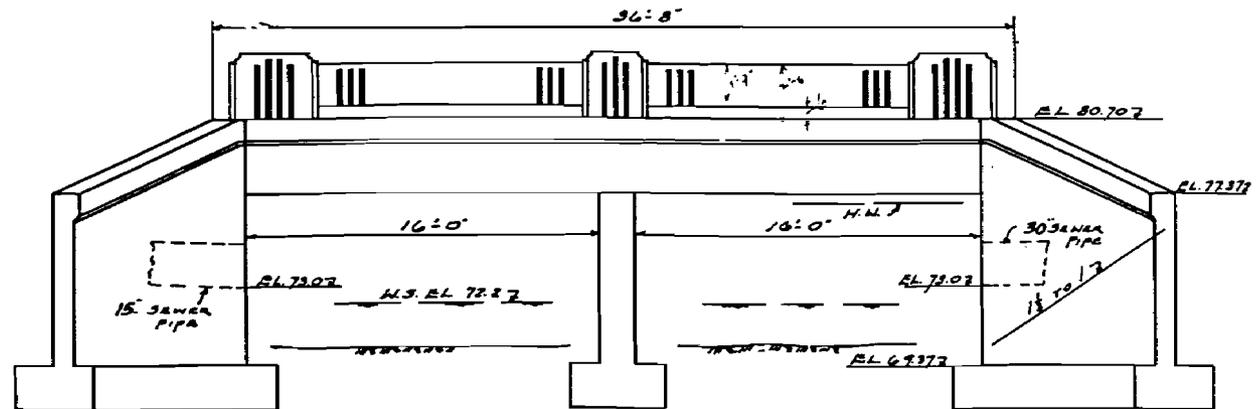
retains its original configuration and detailing. Portions of the original drawings are reproduced on the following page.

State Bridge 153 was part of a 1.26 mile-long project for the "dual highway" from Elsmere to Price's Corner; this highway construction was part of a broader program of improvements intended to reconstruct 12.5 miles of the "Capital Trail" between Newark and Wilmington. The Capital Trail Improvement Project, with an estimated cost of \$500,000, included reconstruction of the existing highway and "relocation where necessary to straighten alignment and bypass congested sections." Six old roadway bridges were to be removed. The contract for the Elsmere to Price's Corner section was awarded on July 13, 1938, to the Alessandro Petrillo Company of Wilmington, for their bid of \$156,106.50; bridge construction was subcontracted to J. A. Bader & Company. The estimated cost of Bridge 153 was \$12,535; it replaced a previous bridge which incorporated masonry abutments and piers. Construction was started on July 21, 1938, and the structure was completed on August 3 of the following year. The south half of the bridge was built first, to maintain traffic flow on this primary artery during construction.

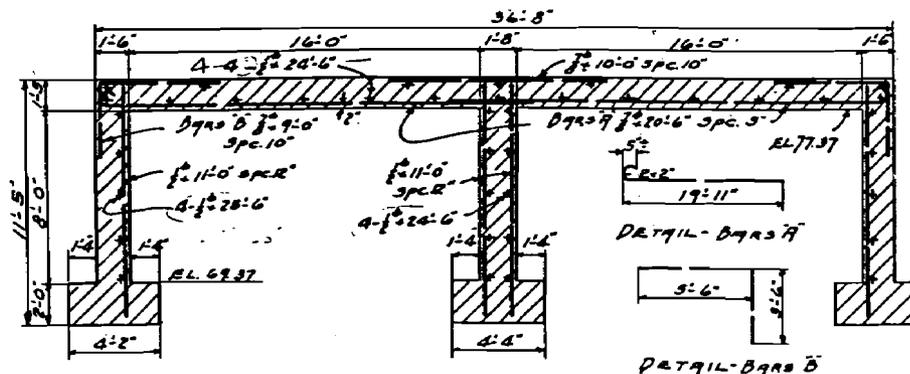
Bridge 153 is a two span concrete

CONCRETE

slab bridge, a commonly built type, of standardized design, reflecting the continuing expansion and improvement of the road network under the auspices of the Delaware State Highway Department. The improvement of the Capital Trail, of which Bridge 153 was a part, exemplified the Department's efforts to bring primary roads up to modern standards; another such project during this period was the Dual Highway between Wilmington and Dover, touted at the time of its construction as the longest such road in the world. In addition to upgrading primary routes, the Department had assumed responsibility for construction and maintenance of all local roads in 1935; between 1935 and 1942, efforts focused on the improvement of rural roads and increasing road construction in towns and cities. Over 250 bridges were built during this period statewide. Bridge 153 is considered a good representative multiple span example of the commonly built concrete slab type. The bridge's parapet type was illustrated by the State Highway Department as a typical number "VIII solid-type, concrete balustrade" during this period of standardized design.



END ELEVATION



TYPICAL SECTION

Excerpts from original 1938 drawings for Bridge 153.



STATE BRIDGE NUMBER 488N

State Bridge 488N

**U.S. 13 Northbound over Blackbird Creek
H & H Corner, New Castle County,
Delaware
1931**

State Highway Bridge 488N is a single span rigid frame concrete bridge, carrying northbound traffic on U.S. 13 over Blackbird Creek at H & H Corner. It has a span length of 40'-0" and a total horizontal clearance of 39'-0". The substructure

consists of a concrete abutment and U-shaped concrete wing walls. The bridge is topped by a concrete parapet wall. Directly above the span the parapet is ornamented with incised rectangles, above the wing walls, it is plain. Ornamental piers separate the span and wing wall portions of the parapet. The piers are topped with a triangular capstone and each decorated with a diamond pattern. The fascia is shaped as a segmental arch.

Delaware Department of Transportation records state that Bridge 488N was built in 1931. Original drawings, dated November 1931, illustrate the configuration and construction details of the structure. Bridge 488N, along with 488S (built over a decade earlier) were part of the final phase of a major highway building project first begun by Coleman T. du Pont in 1911. The completion of that project involved the dualization of Route 13 at this location through the construction of a 4.76 mile road between Reynold's Corner and Fieldsboro. On December 15, 1931, the State Highway Department awarded the contract for this project to Vincent Schiavi, a Buffalo, New York contractor, temporarily located in Alexandria, Virginia, for the bid price of \$189,155.00. Schiavi subcontracted the bridge construction to William F. Anderson. Contract correspondence indicates that the selection of rigid frame construction for Bridge 488N represented "a departure in the design of a semi-arch structure;" by incorporating fixed ends, the design would allow for a saving of approximately 40 yards of concrete over a conventional structure. The cost of materials for this bridge was estimated at \$12,060.

State Bridge 488N is an example of a concrete frame bridge, like the commonly

built concrete slab and girder bridges, a common type constructed during the early growth period and the period of rapid expansion of the state road network. While earlier examples of this type exist, built under the auspices of county road departments, Bridge 488N is the first concrete frame structure to be built by the State Highway Department. In a letter of November 28, 1931 to A. F. Gordon, Bridge Engineer for the Bureau of Public Roads, State Highway Department Bridge Engineer A. G. Livingston noted that "this is a new type of construction to be built in Delaware"; he requested Gordon's comments on the plans for Bridge 488N, as the Bureau could be expected to have broader experience with the type. The bridge features an embellished parapet, and the fascia is constructed in the shape of a segmental arch. The bridge appears to be in good structural condition, is unaltered, and is considered a representative example of this common type. It derives additional significance from its status as the first structure of its type to be built by the State Highway Department.



State Bridge 488N as it appeared in the Annual Report for 1932.

