

STEEL GIRDER BRIDGES



State Bridge 155, Marshallton Bridge over Red Clay Creek, New Castle County.

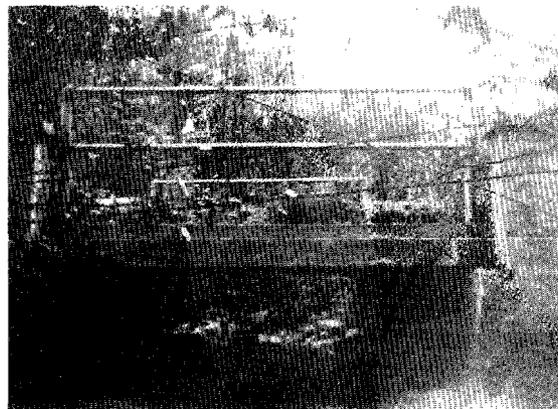
STEEL GIRDER BRIDGES

There are twenty-one steel girder bridges included among the significant historic highway bridges of Delaware. They have been categorized in three broad subgroups based on technological differences: concrete encased girders, standard girders, and plate girders. Viewed in elevation, the concrete encased fascia beams of the first subgroup render them indistinguishable from concrete bridges. The bridges can also be grouped according to variations in embellishment styles. Stylistic treatment of the steel girder bridges is very similar to that of the concrete bridges; one group from New Castle County are masonry embellished, others feature highly embellished concrete surfaces and some are simply embellished with incised rectangles.

There were approximately 40 steel I-beam bridges illustrated in the Delaware Department of Transportation photographic archives for New Castle County bridges for the 1920s-1930s. Slightly less than half were I-beams encased in concrete, while the rest comprised plain I-beams. There were two described as "deck plate girder spans". The I-beam bridges were visually similar. Much more variety was represented among the concrete encased I-beam

bridges. One type consisted of a plain I-beam encased section, which spanned masonry abutments and wing walls, and was capped with a simple pipe rail or more ornamental lattice rail. Another girder type spans masonry abutments and wing walls but includes an attractive masonry parapet, generally with a concrete cap. The last group, with only a few examples, have all-concrete exterior surfaces (abutments, wing walls, parapets). The plain I-beam bridges, and the plate girder bridges invariably span masonry abutments and wing walls, and are topped with a simple pipe or lattice rail. The wearing surfaces were timber planks. These groups are illustrated in the photographs below, from the archives.

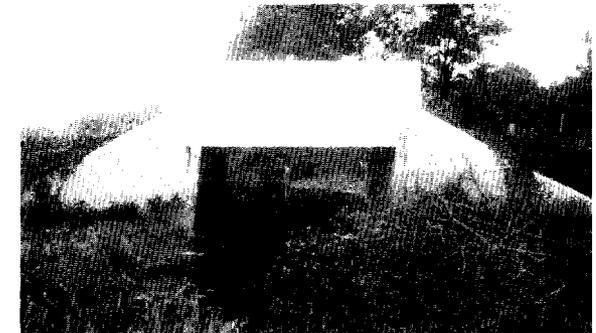
EARLY I-BEAM BRIDGES OF NEW CASTLE COUNTY



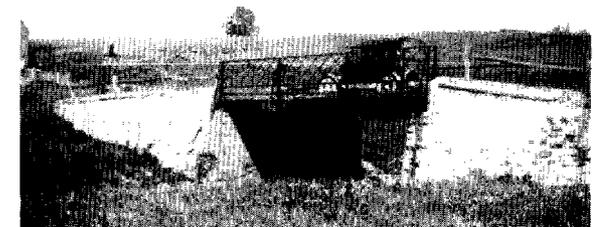
*Encased I-beam span with simple rail.
Silverside Road, New Castle County.
No longer standing.*



*Encased I-Beam span with masonry parapet.
Lancaster Pike, New Castle County.
No longer standing.*



*All-concrete encased I-beam span.
Near Maryland line, New Castle County.
No longer standing.*



*Exposed I-beam span on masonry abutments
with lattice railing. Duncan Road, New Castle County.
No longer standing.*

STEEL GIRDER

Although similar records do not exist in Kent or Sussex Counties, Delaware State Archives contain Kent County General Specifications for Highway Bridges, dating about 1910. Located in the Kent County Road papers, this document contained standard engineering specifications for the excavation and construction of iron bridges. Abutments and wing walls were to be rubble masonry, and the "iron" span should be built according to plans, with no deviation without the consent of the County Engineer. Bridge 505 is an extant example of these early girder bridges.

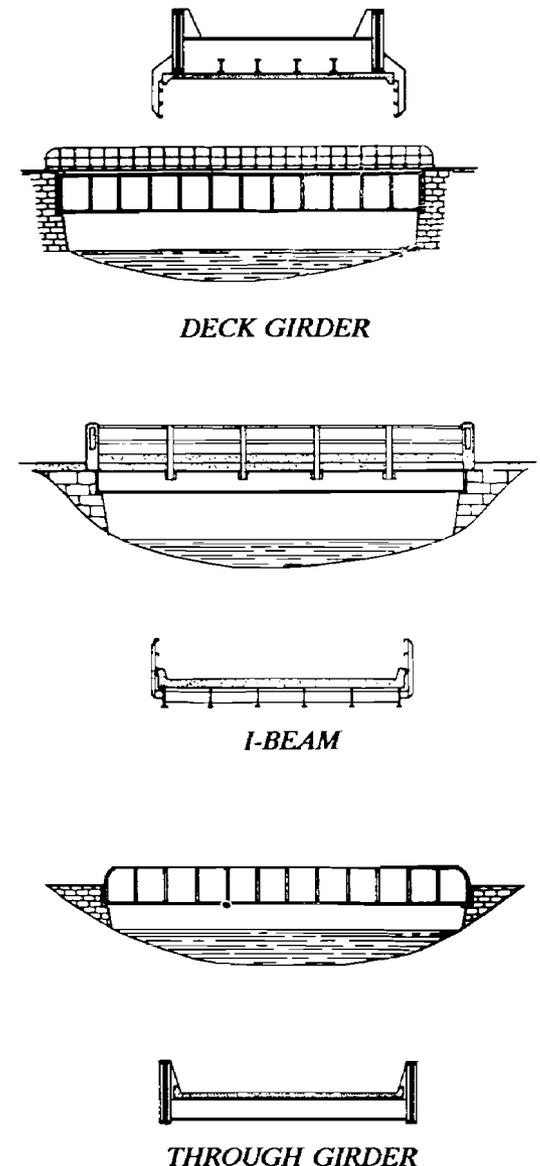
Steel girder bridges were built prolifically across the United States from the late nineteenth century throughout the twentieth century. The simple steel girder span was fully developed technologically during the late nineteenth century. Its evolution followed that of other metal structure types, reflecting the changes from iron to steel manufacture and construction. The transition from wood and masonry construction to iron members began in the 1840s. By 1861, major bridge components were manufactured of rolled iron, and the decade saw the establishment of mass produced iron structural shapes. However, iron members were used as primary components for only a few decades. Steel technology was introduced and it improved so rapidly that by 1895 wrought iron

shapes were no longer available; steel became the structural metal in use for bridge components.

The steel girder bridge is a structure in which a floor system and roadway, concrete or timber, is supported by girders, usually rolled section beams which are plain or encased in concrete. Defined by the relationship of the roadway to the girder, these are deck girder bridges. Plate girders, built-up of riveted sections, can be deck or half-through girder bridges. The adjacent diagrams illustrate these relationships.

The girder bridge began to be built in the years around 1850, when the metal truss form was evolving into its many variations. As early as 1847, plate girder span were built for small railroad bridges. These girders were built-up members, fabricated of riveted shapes. They competed with the metal truss, and had several advantages. Short spans were easily fabricated, completely finished, at the bridge shop and shipped to the site to be erected on the constructed masonry abutments and wing walls. In 1889, American engineer, Theodore Cooper, said of plate girders,

"These are generally used for spans up to 65 feet...These



girders are riveted completely at the shops. Plate girders completed at the shops in this manner give excellent satisfaction."

By the end of the nineteenth century, the girder bridge was established in all its forms, plate girders, I-beams and concrete encased I-beams. All forms continued in use into the twentieth century. In 1900, girder bridges were used for spans less than 100 feet long, but by 1930, spans were built up to 150'.

The century-long tradition of steel girder bridge construction has resulted in thousands of small-span structures of these subtypes across the United States.

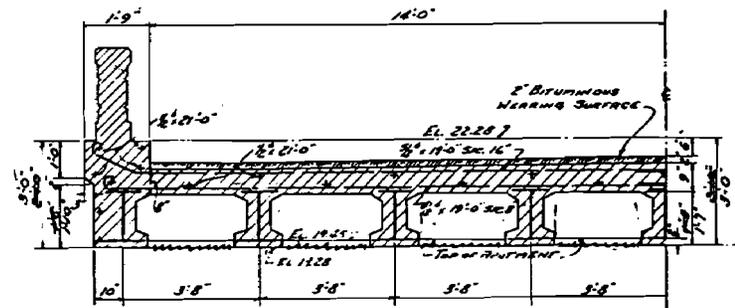
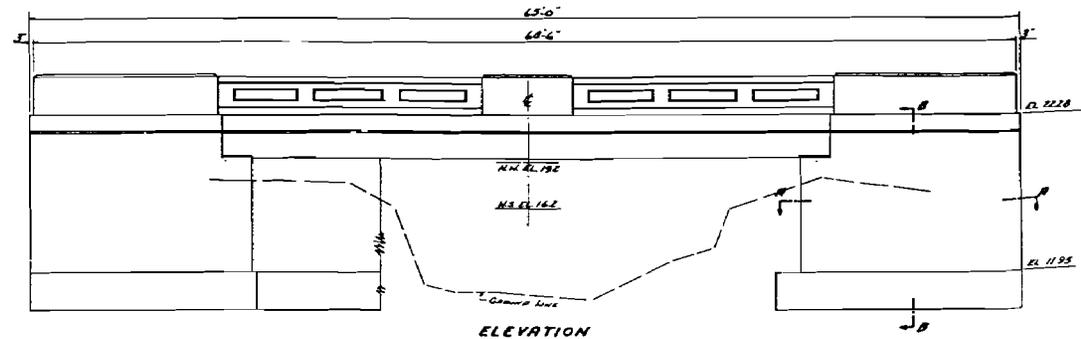
As a class, these engineering structures lack technological distinction; they do not represent a milestone in the development of bridge construction, but rather an economical and expedient engineering solution which found broad application across the nation over an extensive period. Generally they do not possess aesthetic significance; their embellishment, when it is present at all, is limited to simple geometric designs breaking up the visual mass of the typical solid concrete parapet. Their design is handled in a formulaic manner, and presents a standardized impression. The ubiquity of steel girder bridges, and their

non-innovative technological and aesthetic character, prompted engineering historian Carl Condit to observe, "the great number and essential similarity of girder bridges make it difficult to point out examples of special technical significance. There are a few, however which stand out for their structural or visual quality".

Illustrated below are portions of the original 1932 drawings for Bridge 239 which show the standardized version of a concrete encased steel girder bridge.

The results of the historic bridge survey in Delaware confirm that simple, small spans were widely built. This commonly built type exemplifies the continuing expansion and improvement of the road network under the auspices of the Delaware State Highway Department. The bridges which are presented in this report are those which "stand out for their structural or visual quality".

The other steel girder bridges are listed in Appendix 1.



STEEL GIRDER



State Bridge 155: Marshallton Bridge

STATE BRIDGE NUMBER 155

Marshallton Bridge
Old Capitol Trail over Red Clay Creek
Elsmere, New Castle County, Delaware
1931

State Highway Bridge 155, Marshallton Bridge, is a 113'-0" built-up steel plate girder span, carrying two lanes of traffic on a 24'-0" wide deck. Constructed at a 40°

skew, the bridge rests on concrete abutments, with U-shaped wing walls; there is a fixed bearing on the south abutment, and an expansion bearing on the north. Concrete end blocks with concrete lampposts mark the portals. A 6'-10" wide sidewalk of wooden planks is cantilevered on built-up plate supports on each elevation, and features an elaborate metal

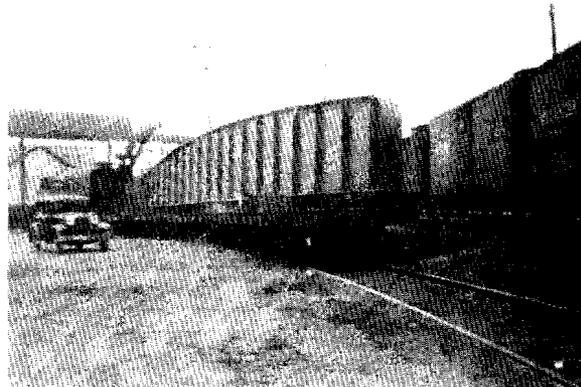
railing with diamond shaped openings inside rectangular panels and posts corresponding to every other girder rib. The ornamentation is carried through in a concrete railing which caps the wingwalls.

Delaware Department of Transportation records state that Bridge 155 was built in 1931. Original drawings for the "Marshallton Bridge" dated September 1930 are on file at the Delaware Department of Transportation. Construction photographs and portions of the original drawings are shown on the following pages. The bridge was constructed as part of a road relocation project called the Marshallton Cutoff. It replaced a previous Warren pony truss constructed in 1919. Opening of the structure awaited completion of the road, and a formal celebration was held on November 21, 1931. The total cost of the bridge was \$32,300. The State Highway Department highlighted this project in its Annual Report for 1931, stating that "through careful attention to details in its design this bridge presents an unusually pleasing appearance and with its approaches eliminates the traffic congestion and hazards which formerly existed on account of the narrow and winding route through the town." A newspaper item called the bridge "one of the finest structures of its kind in the county, the light standards adding much to its beauty". The

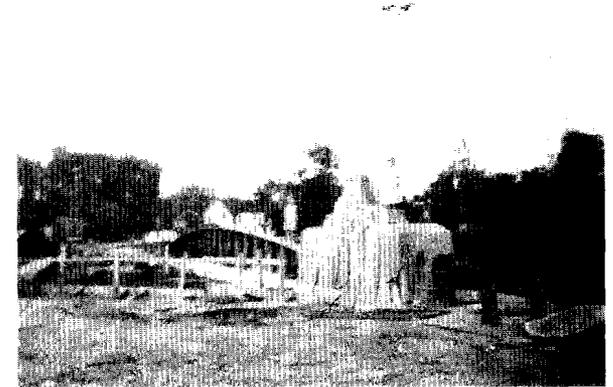
concrete obelisks marking the portals carried "Venetian" pendant lanterns on cast bronze "Commonwealth" brackets.

State Bridge No. 155, constructed in 1931, is an example of a through plate girder bridge, a commonly built type during the time of expansion and improvement of the road network in the 1920s and 1930s. Bridge 155 appears to be in good structural condition and is unaltered, and is a good representative example of this type, with unusual embellishment.

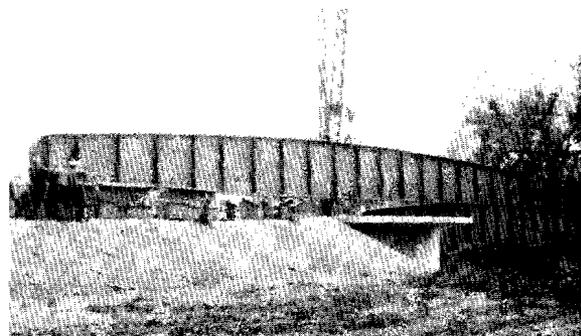
The bridge was constructed as part of a project, assisted by federal funds, to correct dangerous conditions of alignment and relieve traffic congestion in a growing suburb of Wilmington. During the period 1926-1935, the Department focused on the consolidation and improvement of the state's highway system, taking advantage of federal assistance to widen and realign thoroughfares to meet the demands of increasing traffic and higher speeds.



Steel girder arriving by rail.



Finishing touches are applied.



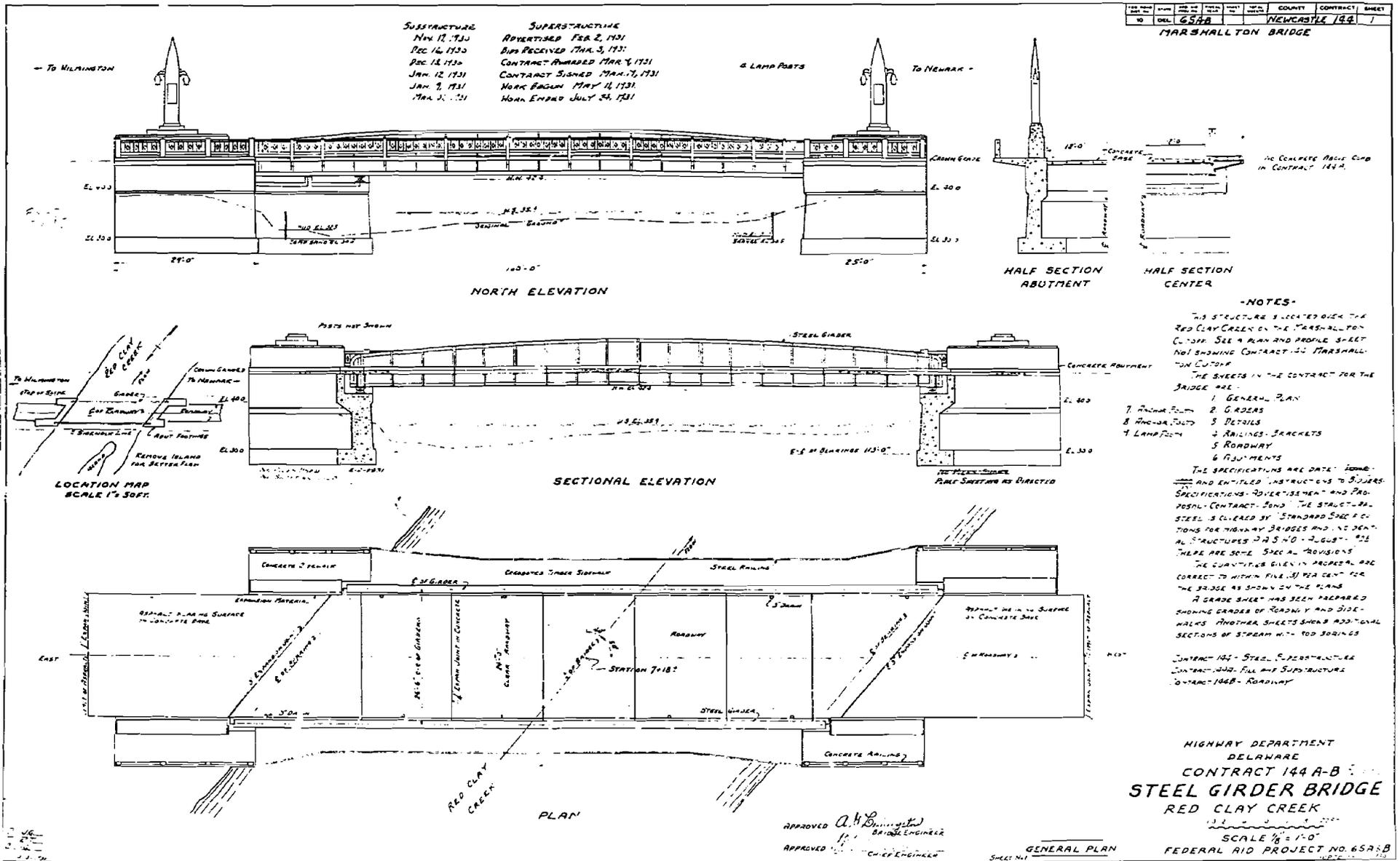
Steel girder being positioned.



The completed bridge.

CONSTRUCTION PHOTOGRAPHS OF BRIDGE 155

STEEL GIRDER



Elevation, section and plan from original 1930 drawings for Bridge 155.



State Bridge 182



State Bridge 182 before replacement in 1922.

STATE BRIDGE NUMBER 182

**Faulkland Road over Hyde Run
Greenbank Mill, New Castle County,
Delaware
1922**

State Highway Bridge 182 is a 25'-0" concrete encased steel girder span, carrying two lanes of traffic on a 24'-8" wide deck. The superstructure rests on concrete

abutments, with U-shaped concrete wing walls. Seven concrete encased I-beams, spaced at 4'-0" intervals, support the deck. The concrete parapet is ramped at the portals, and features depressed rectangular, square, and ramped panels. A corbeled band defines the top of the fascia, whose bottom edge has a molded treatment. The beam seat projects from the abutment face;

the underside of this projection is coved.

Delaware Department of Transportation records state that Bridge 182 was built in 1922 by the New Castle County Levy Court. The bridge replaced a timber covered bridge on the same site. Levy Court specifications called for the replacement of the existing wooden covered

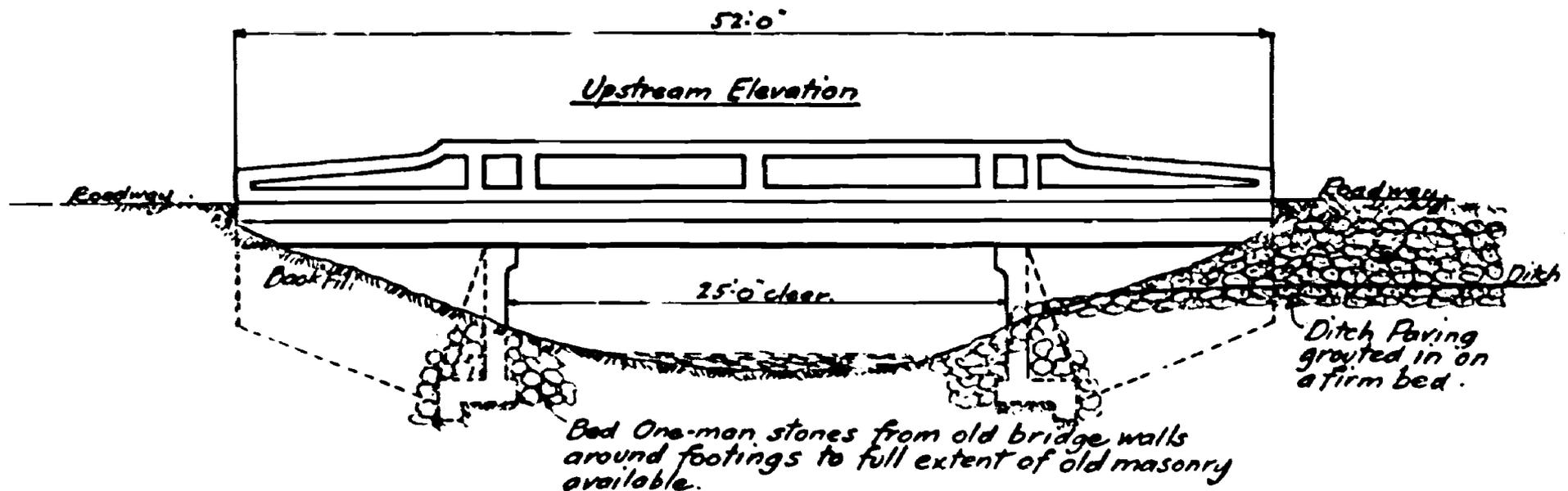
STEEL GIRDER

bridge with a concrete encased steel I-beam bridge with a reinforced concrete floor slab, abutments and wing walls. The remains of the covered bridge were to be stored on nearby county land, but some of the stone from the old masonry abutments could be reused. A photograph of the earlier covered bridge, from the photographic archives for New Castle County appears on the previous page. Shown below is an excerpt from the original drawings for the replacement bridge. The specifications included notes on

construction materials such as steel for the reinforcement and steel beams. No re-rolled or square twisted bars were permissible. The ditch surrounding the bridge was paved with stone and thoroughly grouted with concrete. Original drawings dated May 1922, prepared by the New Castle County Engineer, detail the reinforcement scheme.

State Bridge 182 is an example of a concrete encased steel girder bridge, with an incised, solid concrete parapet which

exhibits some ornamental variation from the standard rectilinear profile. The construction of a new steel girder bridge for the Hyde Run crossing reflects a significant trend which occurred in the 1920s and 1930s in New Castle County, as the Levy Court pursued a systematic program of replacing obsolescent bridges, including covered bridges, with structures which could accommodate growing traffic needs. Bridge 182 was constructed as part of this program.



Elevation from 1922 drawings for Bridge 182.



Bridge 211A: Carter's Bridge

BRIDGE NUMBER 211A

Carters Bridge
Road 211 over Choptank River
Kent County, Delaware

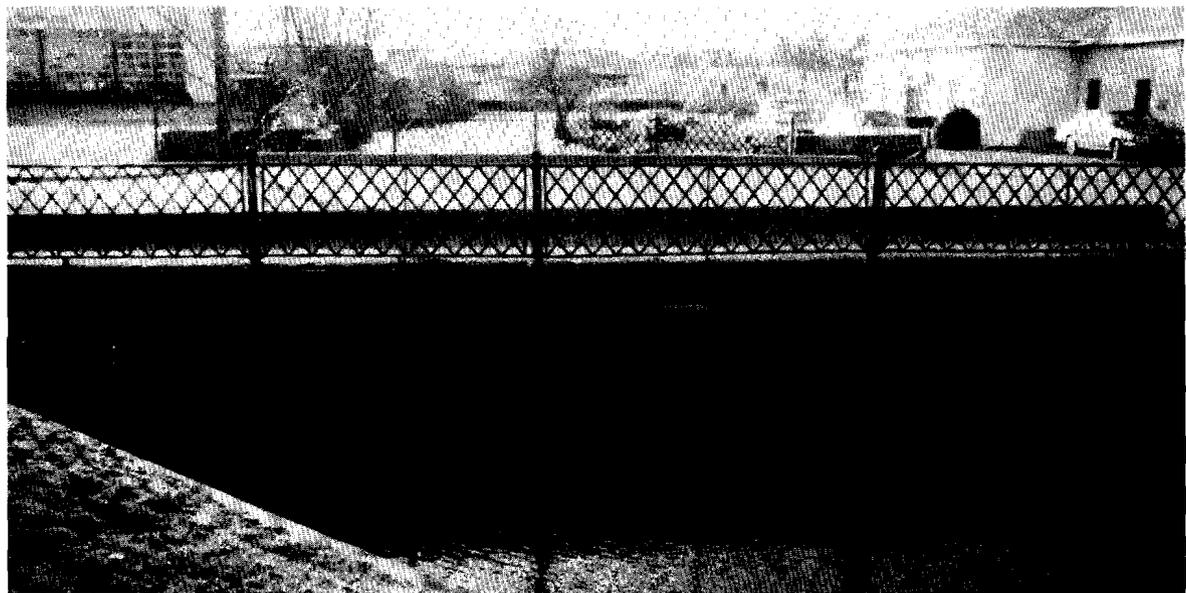
State Highway Bridge 211A, Carter's Bridge, is a four span steel girder bridge 135'-0" in length. The structure comprises ten rolled sections supported on timber

abutments with straight timber wing walls. The superstructure is supported by steel encased concrete piles 2' in diameter. Two steel pipe rails serve as the parapet. The roadway is 13'-4" wide and carries two lanes of traffic.

Delaware Department of Transportation records indicate that Bridge 211A was

repaired in 1936. The original date of construction is unknown. Repairs to the existing steel girder bridge were undertaken in 1936 under State Highway Department contract 494. Drawings for the repairs, dated May 1936, show that work was done on the I-beams, wing walls and abutments, and the bridge was posted for 10 tons. Portions of the original drawings are shown on the following page.

Bridge 211A possesses technological significance within the context of Delaware bridge construction. Its four-span length is unusual, as most I-beam bridges surveyed in Delaware were single spans, and the substructure, comprising steel encased concrete piles, is the only example of this type surveyed for all Delaware highway bridges. The columns, sometimes called lally columns, are examples of a substructure type which was patented; these proprietary types included various systems of metal cylinders filled with concrete. The repairs to Bridge 211A reflect the Delaware State Highway Department's program of improvements to the secondary road system during the period 1935-1942.



State Bridge 505

STATE BRIDGE NUMBER 505

**Church Street over Mispillion River
Milford, Kent County, Delaware
1903**

State Highway Bridge 505 is a 36'-0" concrete encased steel girder bridge with a concrete deck. The superstructure is supported by stone abutments and U-shaped wing walls of semicoursed rubble and a concrete center pier. There is a simple steel lattice railing on the deck. The bridge is 35'-0" wide and carries two lanes of traffic.

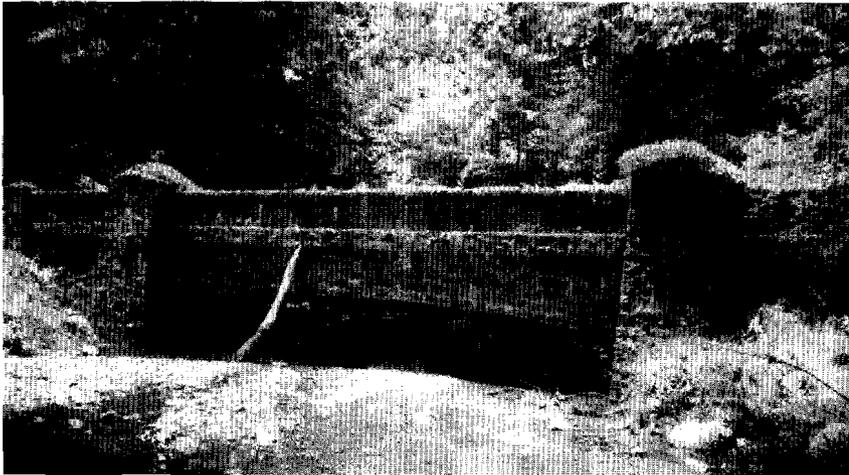
Delaware Department of Transportation records state that Bridge 505 was built in 1903. This is verified on the bridge plate, which also states that the structure was the work of J.A. Hirons, builder, and Joseph Russo, mason. Drawings are no longer available.

The 1903 construction date makes Bridge 505 the earliest steel girder bridge surveyed in Delaware. The bridge remains in good structural condition. Its extant masonry abutments and wing walls are

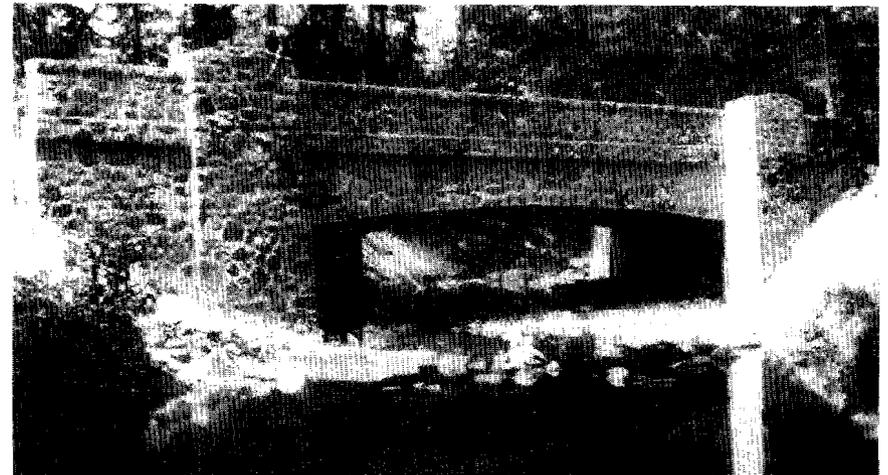
unusual survivors in combination with a 1903 steel girder superstructure. It is an intact example of a type commonly built in the late nineteenth and twentieth century, and stands as an illustration of the bridge type cited in Kent County General Specifications for Highway Bridges, dating from 1900-1910. These bridge specifications described iron bridges, and required abutments and wing walls of rubble masonry, with an "iron" span built exactly to plans; any deviations required the consent of the County Engineer.

The steel girder bridge, like the concrete bridges of the same time, represents a common type constructed from the early growth period through the period of rapid expansion of the state road network. Bridge 505 was built in a town, during the first wave of the public demand for road improvements engendered by the increasing popularity of the automobile. Its date of construction coincides with the passage of the State Aid Law of 1903, which made state funds available to counties on a matching basis for road construction; this was the first effort by the state legislature to subsidize highway improvements.

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State Bridge 543



State Bridge 543 as it appeared in the 1932 Annual Report.

STATE BRIDGE NUMBER 543

**Carr Road over Shellpot Creek
Shellburne, New Castle County, Delaware
1936/46**

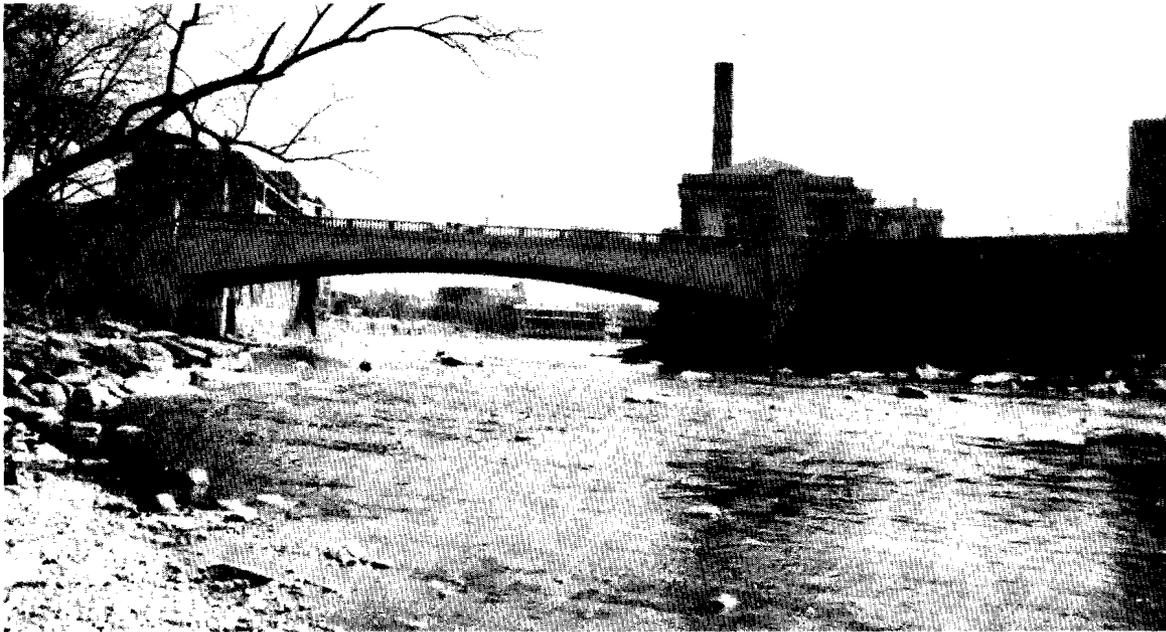
State Bridge Number 543 is a single span steel girder bridge, with a span length of 36'-0". In elevation, the bridge has the appearance of a shallow stone arch bridge. The structure consists of nine rolled steel beams supported on stone abutments and is built at a 40° skew. The stone wing walls are U-shaped. The deck is 37'-0" wide and carries two lanes of vehicular traffic. It is

capped with a handsome solid parapet wall made of stone, with four posts on each side built up higher than the parapet and extending to the base of the wingwalls. The posts at either end of the span are decorated with diamond shapes ("the Diamond State"). The parapet is capped with a band of coursed ashlar. A corbeled stone belt course extends across the fascia.

Delaware Department of Transportation records state that Bridge 543 was built in 1936 and repaired in 1946.

The bridge was one of two structures built as part of a project to construct a new spur road off Washington Street Extension to Carrcroft, a distance of 1.42 miles. Drawings dated December 1933 on file at the Delaware Department of Transportation document the design, materials, and construction of the bridge. Notes refer to the unusual stone veneer, cautioning that "the placing of Rubble Masonry should follow the best practice so the stone veneer will be held securely in position especially in arch." The notes provide insight into the

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State Bridge 575: North Market Street Bridge

STATE BRIDGE NUMBER 575

**North Market Street Bridge over
Brandywine Creek
Wilmington, New Castle County, Delaware
1928**

State Bridge Number 575 is a 213 feet long steel girder bridge with a clear span of 150 feet. The girders are cantilevered from the abutments with counterweight pockets extending 29 feet into the abutments. The

fascia girders are concrete encased. All girders are curved giving the bridge the appearance of an arch in elevation. The substructure is concrete and the railing is a concrete balustrade. End posts at the portals are concrete and highly ornamented.

Delaware Department of Transportation records indicate that Bridge 575 was built in 1928. The bridge was designed by Harrington, Howard, and Ash,

consulting engineers of Kansas City. It was built by authority of the Levy Court of New Castle County, under the direction of County Engineer Charles E. Grubb. The builder was the Frederick Snare Corporation of Philadelphia and New York, for a bid price of \$382,060.

At the time of construction, the bridge location was situated within Wilmington's ninth ward. This area had been experiencing consistent growth during the mid-1920s and the local businessmen looked forward to an improved crossing to encourage additional growth for the ward. In addition, this location was an important point in a heavily traveled route within the city, feeding traffic to Sixteenth Street, King Street and French Street. A traffic study conducted by the New Castle County Engineer revealed that 85% of the traffic across the previous bridge comprised passenger automobiles.

The specifications for the present Bridge 575 describe a "double cantilever steel deck girder structure with a single span of 150 feet supported upon two concrete abutments. It provides a paved roadway 60 feet wide accommodating double street car tracks, and two 10 feet sidewalks. The steel girders will be encased, in part with poured concrete and in part [sic] cement mortar placed with the

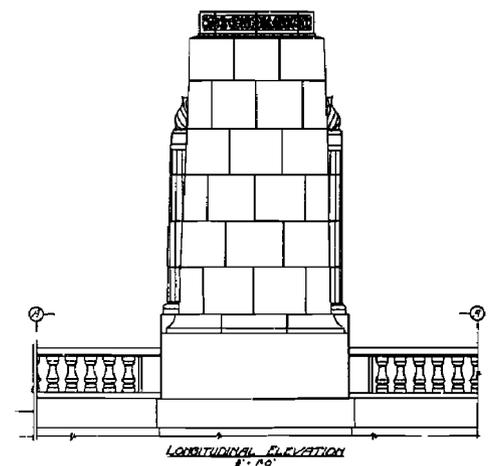
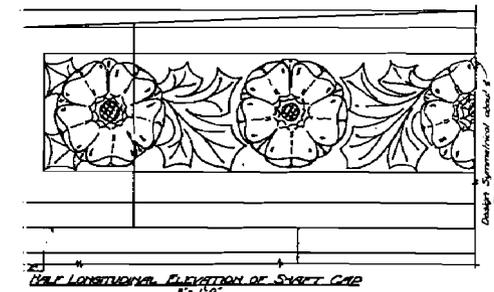
cement gun. . . . Each cantilever arm has nine parallel deck girders which extend back across the supporting abutment and are anchored down at the rear. The pairs of cantilever arms are connected by shear locks in the center of the span." Eight combined trolley and light poles were to be erected along the bridge, and water pipes, gas pipes, electrical conduits and other utilities were incorporated into the structure. This extensive project also involved the construction of a stone retaining wall and a concrete comfort station, alterations to the street grades, and the raising of the railroad track at the north end of the bridge. Due to the high volume of traffic at this location, the specifications required the builder to construct the western half of the new bridge while traffic continued to use the previous bridge. When the western half of the bridge was finished except for the Gunnite encasement on the steel girders, the traffic was shifted to the completed portion and the east half of the new bridge was constructed. At that point, the old bridge was removed. Portions of the original drawings are shown below.

A crossing of the Brandywine Creek has existed at this location since the eighteenth century. In 1762, the Delaware General Assembly authorized the construction of a chain suspension bridge on stone abutments. Prior to that, a ford

or ferry offered the only means of crossing the Brandywine. The first Market Street Bridge over Brandywine Creek, a timber structure, was completed and opened to traffic in 1764, superseding the ferry that operated from a terminus on French Street. The bridge underwent repairs at various times and, in 1806, a company was formed to replace the deteriorated span with a stone arch bridge. That bridge was never built despite vigorous public petitioning for a new crossing. The Levy Court continued to study the various proposals but took no action until 1809, when \$4,000 was appropriated to construct a chain bridge. Completed in 1810, the chain-link suspension bridge was used until 1822, when a freshet washed it away. A timber covered bridge was next constructed at a cost of \$7558.23; however, it too was destroyed by a flood in 1839. A new timber covered bridge was constructed in 1839. A wrought iron Pratt through truss, erected by New Jersey Steel and Iron Company, replaced the second covered bridge in 1887 and was used until 1928, when the present structure was erected.

Bridge 575 is an embellished steel girder bridge with a clear span of 150 feet. Unlike the majority of historic steel girder bridges surveyed in Delaware, which are simple spans, this bridge is a cantilevered structure. It is also located within the

Brandywine Village Historic District. Bridge 575 was designed by the firm of Harrington, Howard and Ash of Kansas City, Missouri, a nationally-prominent firm of bridge engineers during this period known especially for their work on movable bridges. More information on this firm and its principals is available in the Movable Bridge section of this report.



Decorative details from original drawings for Bridge 575.



State Bridge 684

STATE BRIDGE NUMBER 684

**South Heald St. over Conrail
Wilmington, New Castle County, Delaware
1942**

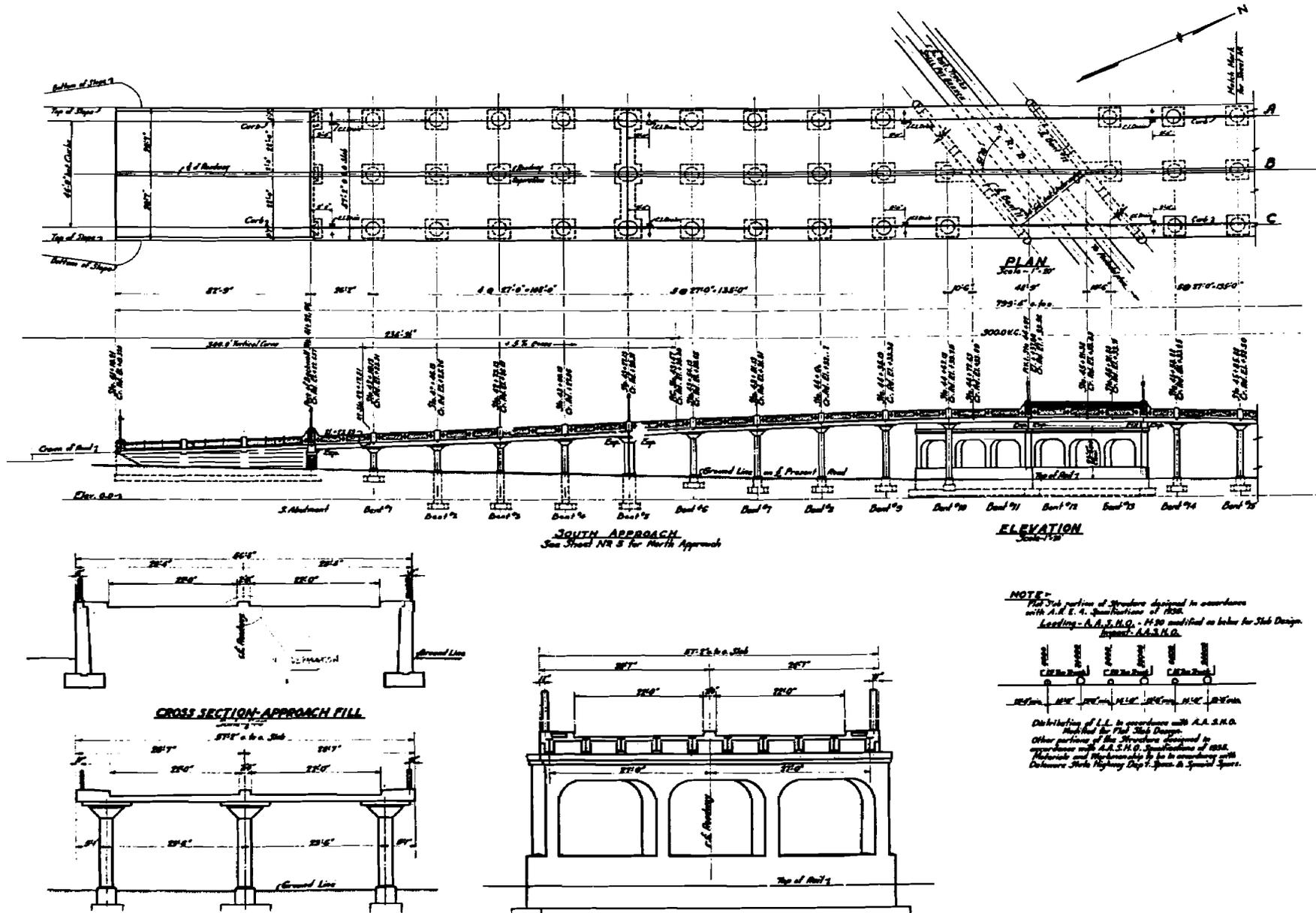
State Bridge Number 684 is a composite girder and slab structure, 21 spans in length, built on a twenty degree skew. The 34'-6" main span comprises 10 concrete encased steel girders. The other spans are concrete slabs. The deck is 57'-

2" wide and carries four lanes of traffic, a 2'-0" median and a 4'-0" sidewalk on each side. The substructure consists of concrete abutments and U-shaped wing walls. The main span, the encased steel girder portion, is supported by concrete piers with arched openings, while the slab spans are supported by individual concrete columns with mushroom capitals grouped in threes at each end.

The bridge features geometrical embellishment reflecting the influence of the Art Moderne movement of the period. The portals are marked by large concrete pylons with vertical striations and a chevron motif on their outer faces; these pylons formerly supported light standards, and serve as end blocks for a metal railing which runs above the wing walls. The wing walls feature a pattern of incised horizontal lines. Each approach span is defined by large concrete blocks at either end, above the piers; a concrete parapet wall unites the blocks, with rectangular panels punctuated with diamond-shaped openings. Where the approaches meet the main span, the parapet steps up in a series of sloping setbacks to join pylons similar to those at the portals. The parapet of the main span is higher than that of the approach spans; its upper section is decorated with incised horizontal lines. On the main span, diamond-shaped insets of glazed tile replace the openings found on the approach parapets. A steel rail continues the parapet above the wing walls. Bridge 684 is very similar to Bridge 686/Conrail 0.55, Delaware River Extension.

Delaware Department of Transportation records state that Bridge 684 was built in 1942. A plaque on the bridge states that it is named in memory of Paul F. Livingston "Born 1895 Died 1963, Delaware

STEEL GIRDER



Plan, elevation and sections from original 1940 drawings for Bridge 684.

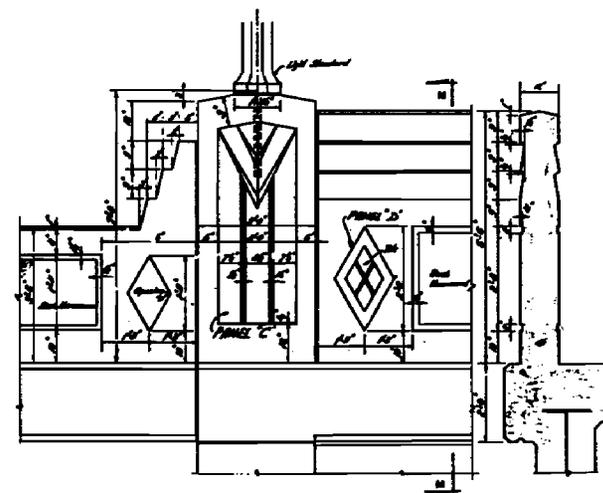
Legislator 1953-1963". Drawings on file at the Delaware Department of Transportation document the details of design, materials, and construction for this structure. Portions of the drawings are shown on the previous page. These drawings, dated August 1940, indicate that the bridge was designed by the Delaware State Highway Department. The structure carried Heald Street over the Shellpot Branch of the Pennsylvania Railroad; the drawings note that plans were approved by the Pennsylvania Railroad Office of Engineering for Bridges and Buildings on December 19, 1940. Contract #700 was awarded to J.A. Bader & Co., Inc. of Wilmington on June 23, 1941 for \$137,774.85. Bethlehem Steel Company of Bethlehem, Pennsylvania supplied the steel. The bridge opened on June 25 of the following year, and work was completed on August 20, 1942. This quick construction time reflects the priority rating this project received from the Public Road in order to avoid wartime delays in material delivery. Repairs to the parapets were required in 1961 due to movement of the concrete deck caused by the skew of the bridge over the railroad. Twenty years use had created slab movement greater than an inch; this in turn, applied pressure to the parapets and caused damage. The parapet, railings, columns, and curb, as well as the expansion rockers, were repaired. Decorative lamp standards, shown in the

drawings, may have been removed during railing repairs.

This multiple span, highly embellished example of a concrete encased steel girder and concrete slab bridge is significant for its multiple spans, its architectural treatment and the structural configuration of its slab spans. Its Art Moderne ornamentation (detail illustrated on this page) is stylistically very similar to New Castle County Bridge 686 and Sussex County Bridge 257E, both grade crossings. Most steel and concrete bridges surveyed in Delaware were single spans with little ornamentation.

In addition to these characteristics, the bridge's slab spans are late applications of an early twentieth century technological innovation more commonly used in building construction, the concrete slab on mushroom columns. The reinforced slab carried on round columns with flared capitals was first developed for building design by C.A.P. Turner in 1905. Application of the mushroom column and concrete slab to bridge construction occurred shortly after that. As the scientific understanding of reinforcement increased in the twentieth century, the form evolved to include a beam which connected cylindrical columns, and to the commonly used pier form more typically seen in mid-twentieth century bridge design.

Bridge 684 was designed to eliminate a grade crossing at the Pennsylvania Railroad tracks. 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. 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.



Art Moderne railing details from original 1940 drawings for Bridge 684.