Conclusion

The following summary statements regarding structural characteristics for concrete bridges, key periods of significance for concrete bridges in Maryland, and the earliest known documented examples of concrete bridges in the state are based solely on documentary research.

Concrete bridges (see Figures 18 through 21) comprise a number of structural variants, including arches, girders, slabs, and rigid frames. Most extant concrete bridges are built of reinforced concrete, or concrete reinforced with metal components such as metal shapes, girders, beams, or reinforcing bars. Concrete bridges may be categorized by the configuration and arrangement of their major components. Substructure and superstructure are usually constructed of concrete, including parapet walls or railings.

Concrete arch bridges (see Plates 13 and 14) include closed spandrel and open spandrel variants, spanning between concrete abutments (the spandrel is the area of the arch between the ring and the roadway). The closed spandrel concrete arch bridge consists of an arch barrel, on the outermost edges of which are built spandrel walls which serve as retaining walls to contain the fill material (rubble, stones, or dry soil) deposited over the arch. The spandrel walls of a closed spandrel concrete arch may extend above the roadway deck level to form the parapet walls of the bridge. When viewed in elevation, the open spandrel arch is pierced above the arch ring. The arch ring of an open spandrel concrete arch bridge may be a barrel or it may be further divided into parallel arch ribs. The open spandrel variant of concrete arch does not contain fill material between the spandrel walls; deck loads are carried by cross walls or spandrel columns supported by the concrete arch ring. A special variant of concrete arch bridge is the through arch, or "Rainbow" arch, characterized by a concrete arch extending above the level of the roadway deck and supporting the deck by means of concrete posts, or suspenders.

Concrete slab bridges (see Figure 18) consist of a concrete slab spanning between concrete abutments and wingwalls, and flanked by concrete parapets. The slab bridge is typically constructed entirely of reinforced concrete, with minimally ornamented parapet walls.

Concrete beam, or girder, bridges (see Figure 19 and Plate 15) consist of a concrete deck, supported on concrete beams (I-beams or T-beams, in cross section), spanning between concrete abutments and wingwalls, and flanked by concrete parapets. In certain concrete beam bridges, the concrete parapet is a structural, reinforced concrete component acting with the beams to support the deck loads; sometimes the parapet walls are treated with linear ornamentation.

Concrete rigid frame bridges (see Figure 20) are structures in which the reinforced concrete continues monolithically from the abutments into the superstructure, thus eliminating the bearings characteristic of slab and beam bridges. The monolithic concrete construction of the rigid frame bridge makes it a bridge with four rigid joints. In multiple-span rigid frame concrete bridges or viaducts, the girders forming the superstructure may also be rigidly connected with intermediate vertical supports or concrete piers.

As indicated by documentary research, key periods of significance for concrete bridges in Maryland include *1890-1910*, the era in which reinforced concrete bridge construction was introduced and popularized within the state, by Baltimore City and Baltimore County officials as well as state highway engineers in the Maryland Geological Survey and State Roads Commission; *1910-1940*, when reinforced concrete bridge building in the state was characterized by the increasing standardization of small slab, beam, frame and culvert spans, and the introduction of special subtypes of reinforced concrete bridges such as the Luten arch (in various patented designs), the open spandrel ribbed arch, the rigid frame bridge and concrete girder bridges built as grade crossing elimination structures; and *1940-present*, when reinforced concrete prestressing, to increase the load-bearing capacity of bridges, was introduced in the state for highway bridge use.

The earliest reinforced concrete bridges built in Maryland were the Lancaster Street Bridge built in 1902 by Baltimore City (featuring a reinforced concrete deck), and the Sherwood Station Bridge built in 1903 by Baltimore County (including reinforced concrete beams). Early concrete arch bridges in Maryland included the bridge carrying Lexington Street over Gywnn's Run (1904) and a group of reinforced concrete arch spans built between 1906 and 1909 in Washington County by the Nelson Construction Company. An early, multiple-span reinforced concrete deck girder bridge was built by state highway engineers in 1906 to cross the Choptank River. The earliest known reinforced concrete arch bridges built by Daniel Luten's National Bridge Company in Maryland were two double-span arch bridges built between 1908 and 1909 to span Rock Creek in Montgomery County. Field survey and further research will be necessary to determine the earliest open spandrel ribbed arch and the first reinforced concrete rigid frame bridges built in Maryland. As few concrete or reinforced concrete bridges have been previously surveyed or studied in Maryland, field survey and additional research will also be required to identify significant extant concrete bridges located in the state.