Timber-Concrete Composite Bridges in Maryland: 1937-1972

HISTORIC CONTEXT REPORT

Prepared by Rebecca Howell Crew
MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION
BALTIMORE, MARYLAND
2021

Table of Contents

Preface

This Historic Context Report was prepared in fulfillment of stipulation I.B in the Memorandum of Agreement (MOA) Among the Federal Highway Administration, the Maryland Department of Transportation State Highway Administration and the Maryland State Historic Preservation Officer Pursuant to 36 CFR Part 800 Regarding the Replacement of MDOT SHA Bridge No. 2200400 in Wicomico County, Maryland executed November 30, 2017. The MOA required that MDOT SHA shall complete a historic context of timber-concrete composite bridges built by the State Roads Commission in Maryland. The Maryland State Roads Commission (SRC) built Bridge No. 2200400, carrying US 13 Business over the East Branch of the Wicomico River in 1937 as one of the original eight timber-concrete composite bridges built in Maryland. The Maryland Historical Trust and MDOT SHA concurred in 2001 that Bridge No. 2200400 was eligible for listing in the National Register of Historic Places (NRHP). The replacement of Bridge No. 2200400 with a new bridge constitutes the loss of one of the last remaining examples of timber-composite bridges found in Maryland. The following document consolidates previous research and expands upon it to provide a fuller understanding of this uncommon bridge type, complementing the more general existing historic context of bridges in Maryland, *Historic Highway Bridges in Maryland: 1631-1960 Historic Context Report*, prepared by P.A.C. Spero & Company and Louis Berger & Associates for MDOT SHA in 1995.

Definition of the Type

Composite Timber and Concrete Bridges, also known as Timber-Concrete Composite Bridges or Composite Wood and Concrete Bridges, refers to specific methods in which concrete and timber are combined to make bridge decks. Timber-and-concrete composite bridges include a superstructure consisting of a composite timber and concrete slab. The timber and concrete materials work integrally to carry the deck loads. These composite decks are typically supported on timber piers or piles. In Maryland, railings may be of concrete, wood, or metal.

There are two basic construction methods for composite timber-concrete bridge decks: T-beams and slab decks. Composite T-beams feature timber stringers that form the stem, rib, or web of the T-beam. Poured concrete forms a thin slab above the stringers; this can also be considered the flange of the T-beam. Metal fasteners are driven through the concrete and wood to prevent vertical separation between the timber stringers and concrete slab.

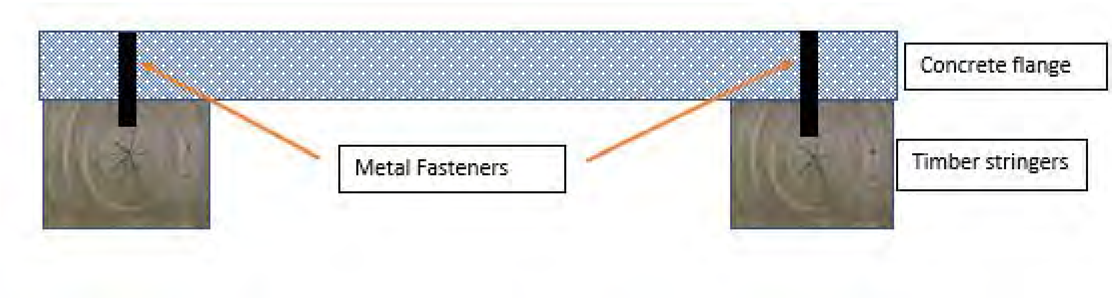


Figure 1. Schematic cross-section of T-beam type of Timber-Concrete Composite Bridge (Rebecca Crew, 2021).

The second type of composite timber and concrete bridge is the slab deck, which has a layered construction. The base consists of pieces of lumber placed on edge and fastened together; alternating pieces of lumber will be raised higher than the others, creating longitudinal troughs, and a layer of concrete is poured over the wooden base.

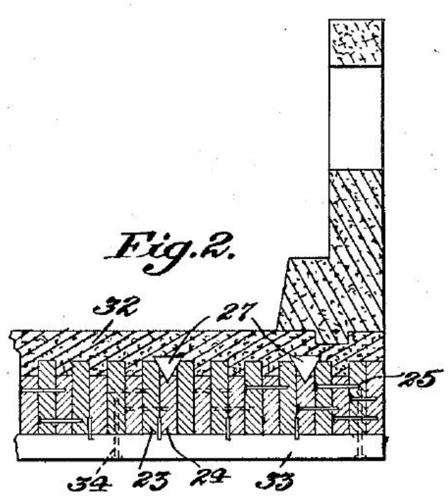


Figure 2. Partial Cross Section of Timber-Concrete composite deck, as designed by James F. Seiler; included in U.S. Patent No. 2,022,693.

Historic Summary of the Development of Bridge Design and Materials Used in Maryland

The design of timber-concrete composite bridges came from developments in bridge engineering that evolved bridge design using different materials. Timber-concrete composite bridges are included in the *Historic Highway Bridges in Maryland: 1631-1960 Historic Context Report* in the Chapter on Timber Bridges (P.A.C. Spero & Company and Louis Berger & Associates 1995, 35-46). To understand the place that timber-concrete composite bridges occupy in the history of Maryland bridge building, the following summary provides key dates in which different types of bridges were introduced and commonly built in the state.

Timber bridge types constructed in Maryland begin with timber beam bridges which consist of timber beams supported by a timber or masonry structure. Spero et. al. assigned a period of significance for timber beam bridges in Maryland from 1724 to ca. 1900. Timber covered bridges (typically built in Maryland between ca. 1800-ca. 1900) consist of a structural timber truss covered by timber roofing and siding which serve to protect the structural components from the weather; subtypes of covered bridges include king-post, queen-post, Town, and Burr trusses. Timber trestle bridges consist of timber beams supported by a system of high timber piers or pile bents. High timber trestles were frequently utilized as railroad bridges and were commonly built in Maryland ca. 1840-1900.

Maryland bridge builders expanded from timber to other materials in the early nineteenth century. Stone arch bridges were built along Maryland's turnpikes (ca. 1790-1830), railroads (ca. 1825-1910), and canal bridges (ca. 1828-1924). Metal truss bridges may have first been built in Maryland in 1846; bridge designers advanced truss designs originally built with timber, transitioned to iron-and-timber structures, and converted to all-metal designs following improvements in steel manufacturing. From ca. 1860-1900, metal truss bridges became popular for railroads and highways, and iron fell out of use; from ca. 1900-1900, metal truss bridges became increasingly standardized and then replaced for general use by metal girder bridges. Metal girder bridges, first introduced in Maryland ca. 1846 for railroad use, became common for roadway use in the period ca. 1870-1920, and came to dominate bridge construction in the 1920-1965 period.

Elsewhere in the United States, engineers introduced concrete arch bridges as early as 1871, reviving a material once used by ancient Romans, and building upon stone arch designs (P.A.C. Spero & Company and Louis Berger & Associates 1995, 148). Worldwide, engineers experimented with combining concrete and metal in new ways, developing new bridge forms such as reinforced concrete slab bridges and concrete beam bridges. In 1898, Arthur Newhall Johnson, first Highway Engineer of the Maryland Geological Survey Commission, recommended that Maryland consider reinforced concrete highway bridges as a durable option (*ibid.*, 184). Baltimore City used concrete to retrofit an iron I-beam bridge in Baltimore City in 1902, while Baltimore County built the first reinforced concrete slab bridge in the state in 1903. Walter Wilson Crosby of the Maryland Geological Survey saw the benefits of concrete bridges and small structures and established a program to replace wooden bridges. Crosby considered wood bridges to be dangerous, due to the damage that automobiles, which were growing in popularity, and weather events could inflict upon them. In addition, wood bridges and required frequent repairs and maintenance, which added on-going expenses. Crosby continued this wooden bridge replacement program when he became the first Chief Engineer of the Maryland State Roads Commission (SRC) when it was established in 1908. The SRC built concrete arch bridges (including both closed spandrel and open spandrel variants); concrete slab bridges; concrete beam, or girder, bridges; concrete rigid frame bridges; and concrete small structures. In a move to standardize the design of the state's highways bridges, the SRC first drafted Standard Plans in 1909 for a variety of reinforced concrete beam, slab, and girder bridges. Through 1933, the SRC periodically updated the Standard Plans for concrete culverts and bridges ranging in span from 6 to 42 feet.

Despite the advancements in metal and concrete bridges and the general opinion that wooden bridges did not meet strength and durability standards for modern roadways, wood was not entirely abandoned as a bridge building material in Maryland in the twentieth century. One of its primary benefits was its relative low cost, which had particular appeal during the Great Depression of the 1930s. Additionally, during World War II, military needs for metal took precedence over its use for bridge and road building; wood saw a renewed desirability as a result. The SRC's professional engineers also had a vocational interest in applying new combinations of materials to find satisfactory solutions to roadway problems. The SRC primarily applied timber-and-concrete composite bridges when highways in low-lying areas of Tidewater Maryland needed reliable crossings for broad expanses of water. Tidewater Maryland is another name for the state's coastal plain region, encompassing the Eastern Shore and counties in Southern Maryland, encompassing a significant portion of the eastern part of the state, as shown by the yellow areas in Figure 3.

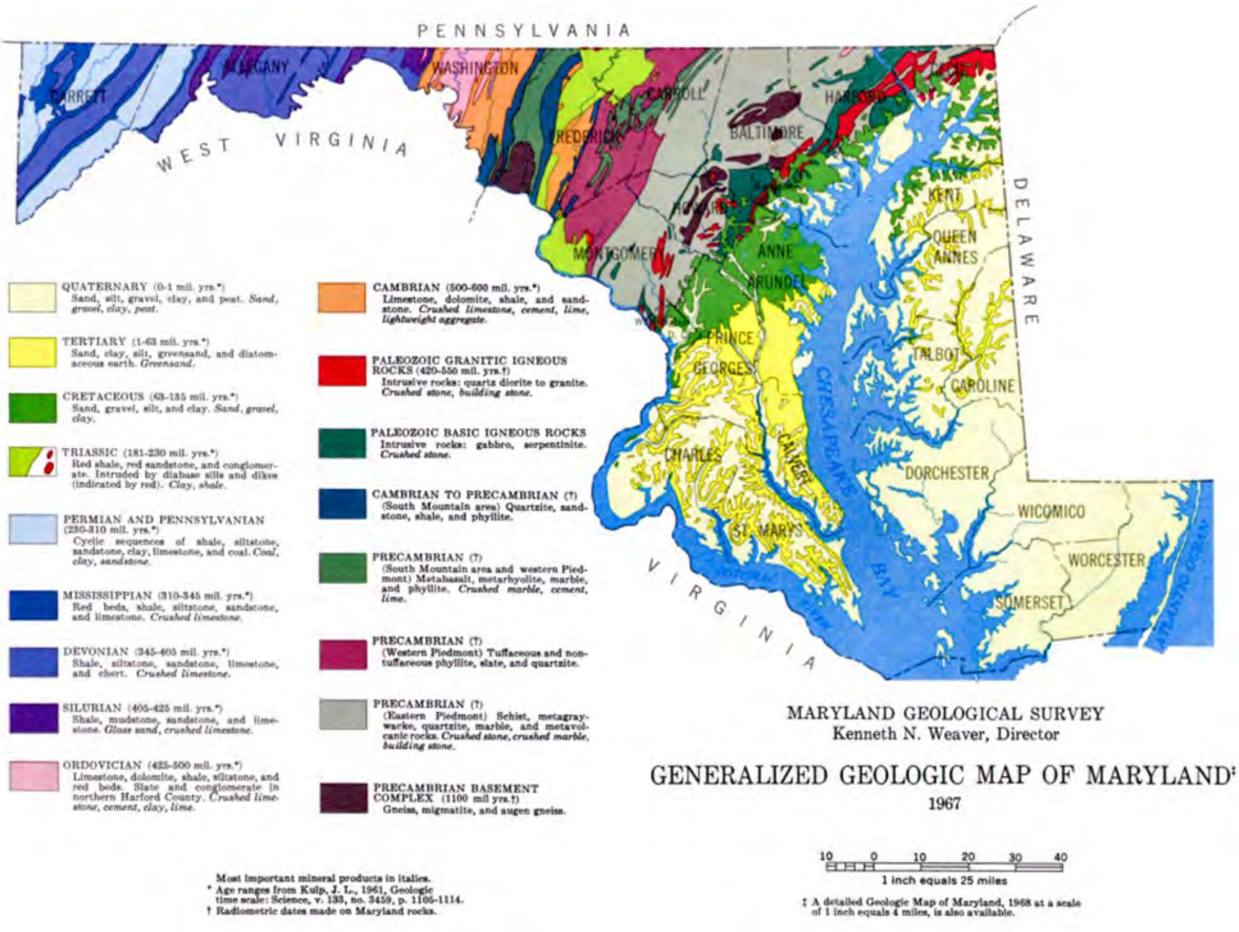


Figure 3. The Maryland Geological Survey's Generalized Geological Map of Maryland describes the Coastal Plain's sediments as containing sand, silt, gravel, and clay.

Development of the Timber-Concrete Composite Bridge Type

Composite Timber and Concrete Bridges are an uncommon bridge type in Maryland, with only a few extant examples. The earliest bridges in Maryland were built of timber, and methods of preserving timber through use of creosote and other chemicals was a development in timber bridge engineering, dating to the late nineteenth century. Concrete bridges were introduced in Maryland in the early twentieth century, and shortly thereafter, bridge engineers began combining the two materials.

Interest in concrete-timber structures began in the 1920s in the northwest part of the United States when increasing automobile traffic called for more durable roadways and bridges that could withstand heavier loads. George D. Burr, a Seattle, Washington engineer, began experiments in 1924 to test different types of connectors that could bond concrete and timber together, leading to the development of the T-beam type of composite bridge. The method was first utilized in 1924 for a temporary bridge to serve during the construction of the Spokane Street Bridge in Seattle, a several-hundred-foot-long bridge that connected Harbor Island to West Seattle over the Duwamish River (Casella 1994, 5). A noted bridge engineer in Oregon, C.B. McCullough elaborated on Burr's T-beam design, and the Oregon State Highway Department constructed two T-beam composite viaducts along in Portland's Barbur Boulevard in 1934 (Eby 1989). The T-beam type of composite bridge required large-diameter timber beams for strong stringers; timber of this dimension was still available in the northwestern United States in the early twentieth century, while other regions of the country had very little remaining old growth. As a result, construction of the T-beam form of composite timber-concrete bridges occurred mostly in the northwest. No examples of the subtype are known to have been built in Maryland.

The engineer most responsible for the development of the composite concrete-timber slab bridge type was James F. Seiler. Seiler was an American, born in in 1885 in India to Presbyterian missionary parents. He was educated at the College of Wooster and the University of Michigan. He became a professor at the Colorado School of Mines and then served eight years as the State Bridge Engineer of Wyoming. In 1931, he joined the American Wood Preservers' Association in Washington, D.C. as senior engineer (*The Washington Post* 1949, B2).

In this role, Seiler developed the design for the slab deck form of the composite timber and concrete bridge in the early 1930s. He joined timbers together with nails, creating a continuous solid deck that could be any width desired and integrated troughs into the deck that improved the connection between the wood and concrete. Seiler experimented with designs that improved the stress levels that the bridge could withstand. Seiler's designs focused on reducing shear stress, one of the four types of stress a bridge must withstand (the others being compression or pushing; tension or pulling; and torsion or twisting). Shear occurs when two opposing forces act on the same point, which eventually can cause a structure to snap into two.

Seiler invented a "shear developer" which transferred the shear stresses to the end grain of the timbers (shown in Figure 4). To assist in holding the concrete in place and prevent sliding and to help distribute the load of the weight on the bridge, transverse shear developers would be placed in the troughs prior to the pouring of concrete. For best effectiveness, the shear developers, which had a triangular shape and were preferably a metal material, needed to engage the piece of wood at the bottom of the trough and the pieces of wood to each side. Seiler applied for a patent for Composite Wood and Concrete Construction on May 10, 1933; the United States Patent Office issued the patent on December 3, 1935 (Patent No. 2,022,693). Seiler continued to revise his designs and applied for a patent for Shear Developers on December 7, 1943, which was issued December 5, 1944 (Patent No. 2,364,481). By then Seiler had determined that the shear developers worked best as a truncated isosceles triangular metal plate with a perforation near the base. The patent included a specialized "shear developer seat grooving tool" for setting the shear developer into place.

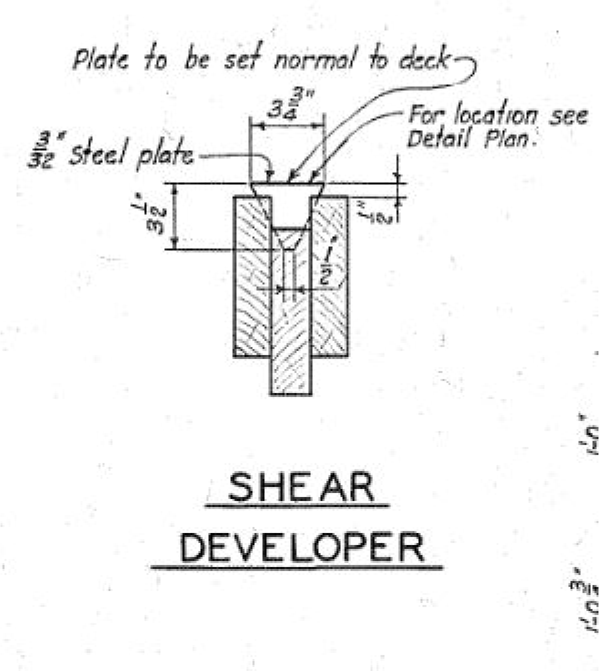


Figure 1 Plan detail of the Shear Developer, invented by Seiler, and utilized by the SRC in its timber-concrete composite bridges. This detail is from the plans for Bridge 2200502, carrying US 13 over Tony Tank Pond (SRC Contract No. WI-99-1-18; on file at MDOT SHA).

Seiler published plans for a composite concrete-timber bridge in 1933, in *Wood Preserving News*, a publication of the American Wood Preservers' Association. The first bridge constructed to Seiler's design was built in Florida in 1934: the 3,500-foot-long Tampa-Clearwater Causeway across Old Tampa Bay. Two years later, in 1936, the Delaware State Highway Department used Seiler's method to build the 100-foot-long Mill Creek Bridge, carrying Delaware State Route 6 over Mill Creek near Smyrna.

Application of the Type in Maryland, Phase I: 1937-1939

The Mill Creek Bridge, located less than ten miles from the Maryland state line, provided a nearby example of composite construction that the SRC could study to determine if its proponents' claims of its merits could be field verified, and its construction details studied, as the SRC's Chief Bridge Engineer, Walter C. Hopkins, explained in a 1939 presentation to the American Wood-Preservers' Association (Hopkins 1939, 270).

Walter Cleary Hopkins was born on September 5, 1892, in Newport News, Virginia; according to Census records, his father worked as a ship joiner and a draftsman at the shipyard, and his mother would later work there as a weaver. Hopkins graduated from the University of North Carolina at Chapel Hill in 1913 with a degree in Civil Engineering. By 1917, he was living in Baltimore, employed as a civil engineer with the Baltimore and Ohio Railroad. During World War I, he served as engineer in the Army from September 29, 1917, to October 29, 1919, rising to Engineer Supervisor Officer at Fort Sill (Maryland Wars Commission 1933, 988). In January 1920, Hopkins briefly worked as a civil engineer in the Newport News shipyard, but he soon returned to Baltimore, becoming the first bridge engineer of the SRC newly formed Bridge Division in 1920; he worked for the SRC until 1961 (*The Sun* 1961, 9).

Hopkins' upbringing in the Tidewater region of Virginia (similar in character to Maryland's Tidewater) and his railroad and maritime engineering experience indicate possible reasons for an affinity for designing with wood. In his 1939 presentation to the Annual Meeting of the American Wood Preservers' Association, Hopkins laid out the specific challenges of bridge building in Tidewater Maryland, with low-lying land and broad rivers and estuaries, in addition to the climatic threats of storms and flooding; the corrosive action of humidity and salt water on metal; and ever-increasing traffic loads. Maryland had previously used creosote-treated piles on many bridges, but composite timber-concrete construction promised broad applicability in the state due to its low cost of construction and maintenance costs, strength, durability, ease and speed of construction in any season of the year, and an applicability of good architectural treatment (Hopkins 1939, 268).

Hopkins noted that the SRC became interested in composite construction methods in the summer of 1937, and after inspecting the nearby Mill Creek Bridge in Smyrna, Delaware, the SRC began work on a composite bridge at Federalsburg on Maryland's Eastern Shore later in 1937 (ibid, 269-70). The SRC completed the Federalsburg bridge by December 1937, as documented by *Wood Preserving News*.

Between 1937 and 1939, the SRC Bridge Division built eight composite timber and concrete bridges, adopting Seiler's American Wood Preservers' Association technique, including with use of specialized tools to place the shear developers. The eight bridges were:

- A timber and concrete composite bridge, of five 18-foot spans, providing a clear roadway of 30 feet, over Faulkner Branch on the road (later MD 313) from Federalsburg to American Corners, Caroline County (now Caroline County Bridge CO-03700).
- A timber and concrete composite bridge, of three 20-foot spans, providing a 24-foot roadway (MD 354), over Adkins Pond at Powellsville, Wicomico County (Bridge 2202000).
- A timber and concrete composite bridge, of two 21-foot spans, providing a clear roadway (US 13, now US 13 Business) of 56 feet and two 3-foot, 1-inch sidewalks, over East Branch of Wicomico River in Salisbury, Wicomico County (Bridge 2200400).
- A timber and concrete composite bridge of twelve 20-foot spans, providing a clear roadway of 26 feet, and a two 3-foot, 1-inch sidewalks, over Tony Tank Pond, on the road from Salisbury to Princess Anne (US 13) near Salisbury, Wicomico County (Bridge 2200502).

- A timber and concrete composite bridge of three 20-foot spans, providing a clear roadway of 26 feet, over Swan Creek, on the road from Sassafras to Massey (MD 299), Kent County (Bridge 1401800).
- A timber and concrete composite bridge of three 18-foot spans, providing a clear roadway of 26 feet, over Unicorn Branch on the road from Sudlersville to Delaware Line (MD 300), Queen Anne’s County (Bridge 1702500).
- A timber and concrete composite bridge of five 18-foot spans, providing a 30-foot clear roadway, over St. Clement’s Creek, on the road from Morganza to Clements (MD 242), St. Mary’s County (Bridge 1802000).
- A timber and concrete composite bridge of five 20-foot spans, providing a 40-foot clear roadway, over Hunting Creek, on the Huntington to Prince Frederick Road (now MD 2), Calvert County (Bridge 0400200).

Each of these bridges is discussed in greater detail in Appendix 1.

To accomplish the design of these bridges, Walter Hopkins’ staff included the Junior Bridge Engineer Benjamin W. Lesueur, seven additional engineers, nine draftsmen, and four other staff, who worked on these moderate-length bridge designs “in-house” while their workload also included other moderate-length reinforced concrete rigid frame bridges and standard plan steel beam bridges for state highways; the SRC Bridge Division also provided plans for repairs to County Bridges in this period.

Maryland’s eight timber-and-concrete composite bridges built in 1937-1939 were all built in Tidewater Maryland, almost all in rural locales. They were geographically distributed such that six were built on the Eastern Shore (three concentrated in Wicomico County, and one each in Queen Anne’s, Kent, and Caroline counties) and two in Southern Maryland (one each in Calvert and St. Mary’s counties). The longest and the shortest bridges were both on US 13 in Wicomico County. The longest bridge was the Tony Tank Pond Bridge at 240 feet long and the shortest bridge was the Salisbury bridge at 42 feet long, which was the most urban setting for any of the eight bridges. The eight timber-concrete bridges ranged in roadway width from 24 feet to 56 feet, with the 56-foot-wide bridge in Salisbury being the only bridge that carried four lanes of traffic. All eight bridges met H-20 Loading standards of the American Association of State Highway Officials (meaning they could support vehicles with axels carrying loads of 32,000 pounds).

Walter C. Hopkins emphasized the importance of designing attractive bridges, and Maryland’s first eight timber-and-concrete composite bridges reflect this attitude. While the SRC bridge engineers studied the Mill Creek Bridge in Delaware as an example of the composite bridge type, the SRC did not make an exact copy of its design which featured a chunky concrete railing and unadorned end posts. All of the eight original Maryland composite bridges featured parapets with Cyma-curve concrete end posts. For six of the eight original Maryland composite bridges, the SRC engineers utilized concrete railing with more graceful proportions, set between Cyma-curve concrete endposts. The two exceptions to this aesthetic treatment were US 13 over the East Branch of the Wicomico River, which had a concrete colonnade of small arches for its parapets, and US 13 over Tony Tank Pond, which had a decorative iron railing set between concrete posts. US 13 was part of the Ocean Highway which was routed as close as possible to the Atlantic Ocean between New Jersey and Florida, and it was promoted as a tourist route; the variety of bridge design at these locations may have been purposeful to provide visual interest for the tourist.

Application of the Type in Maryland, Phase II: 1940-1945

In 1940, the threat of World War II caused overarching changes to the SRC's mission. Wilson T. Ballard, SRC's Chief Engineer, wrote in 1941, "During the year 1940, the problem of national defense occupied the center of the stage in national affairs, as a result of war conditions prevailing in Europe and Asia. One of the primary functions in national preparedness is the provision of adequate highways for the movement of troops, equipment, and materials involved in a general preparedness and training program" (Maryland State Roads Commission 1941, 5).

Walter C. Hopkins wrote in the bridge division's section of the 1941-1942 Annual Report how defense preparations affected the SRC's bridge designs: "It has been necessary, in the design of current projects, to eliminate the use of critical materials insofar as possible. Timber or reinforced concrete construction has been used in many places where structural steel would ordinarily have been the choice" (Maryland State Roads Commission 1943, 42).

During the World War II period, the following six timber-concrete composite bridges are known to have been built in Maryland:

- Bridge 2301700, carrying MD 374 over Pocomoke River in Worcester County (1941-1942)
- (part of) Bridge 1202300, carrying Boothby Hill Road (now MD 715) over Philadelphia Road in Harford County (1942)
- Bridge 0900600, carrying US 50 (WB) over Chicamacomico/Big Mill Pond in Dorchester County (1942)
- Bridge 0402300, carrying MD 506 over Battle Creek in Calvert County (1944)
- Bridge 0900200, carrying MD 16 over Cabin Creek in Dorchester County (1944)
- Bridge 2300502, carrying US 13 (now SB) over Wagram Creek in Worcester County (1945)

Of these, only Bridge 0900200 and 2300502 are extant, but due to modifications, they are not eligible for listing in the NRHP. The others were replaced between 1985 and 2003. Perhaps because these bridges were built under the constraints of war, research identified fewer plans, drawings, and photographs of these bridges. Additionally due to wartime constraints, they may have been built with impermanence in mind, that they could be replaced when the war ceased.

The Boothby Hill Road bridge over Philadelphia Road is an outlier in many ways, but it particularly exemplifies wartime efforts. It is the only example known in Maryland where timber-concrete composite decks were used to cross another roadway, rather than a body of water, and it is located in Harford County, which is neither on the Eastern Shore nor part of Southern Maryland. Boothby Hill Road provided access to Aberdeen Proving Ground (APG) from Philadelphia Road, and the SRC built a partial cloverleaf exit to provide better traffic flow at this intersection; due to the war, APG had significantly more traffic, as well as heavier vehicular loads, due to military movements. The Boothby Hill Road bridge over Philadelphia Road and the Boothby Hill Road over the Pennsylvania Railroad were advertised together for bidding, and the notice specified that the bridge over Philadelphia Road would include six 20-foot and one 15-foot composite timber concrete spans and two 47-foot steel I-beam spans (*The Sun* 1942, 23). This bridge was built in 1942 and replaced in 1985. No plans or photographs of the bridge were located.

Each of the other five composite timber-concrete bridges built during World War II originally had concrete horizontal or timber railings similar to the railings utilized by many of the original eight. It appears however these bridges lacked the Cyma-curve endposts that accented the earlier set of the original eight composite bridges. Thus, the overall aesthetic of the World War II composite bridges was more utilitarian than the original set of bridges.

In 1947, Bridge Division engineers observed, “The development of the composite use of timber and concrete has permitted the design of economical structures with the general appearance from the roadway of a much more costly bridge” (Maryland State Roads Commission 1947, 53).

Post-1945 Timber-Concrete Composite Bridges

Six additional timber-concrete composite bridges are known to have been built in Maryland after 1945; they are all extant.

The first was not built until 1953, when the United States Navy built a Perimeter Road at the Patuxent Naval Air Base in St. Mary’s County (considered Southern Maryland). This 2,460-foot-long wood-concrete composite-deck bridge was featured on the cover of the July 1953 issue of *BuDocks Technical Digest* and was inspected by the American Wood Preservers’ Association (Mann 1953, 25). Aerial photography indicates that bridge appears to still be extant, carrying Cedar Point Road over Harper’s Creek and Pearson Creek, located between the recreational resources of the Pax River Beach House and Paradise Grove Campground.

The next composite bridge built known to be in Maryland, Bridge 1901300, was built in 1966 in Somerset County. The State Roads Commission built a 118-foot-long composite bridge along Hall Highway near Crisfield at the southwest part of the Eastern Shore. Hall Highway (MD 460) provided access to McCready Memorial Hospital, which was built on a piece of land extending into West Cove, at the mouth of Daughtery Creek. Governor Millard Tawes and his wife Lulu owned a house called Miramar, at 117 Hall Highway, on the south side of the bridge, overlooking the Little Annemessex River. Governor Tawes, who was a strong proponent of highway building, completed his second term as governor in 1967, and the couple returned to Miramar where they both were involved with hospital efforts, suggesting they used this new bridge frequently (Reppert 1967, 20-21). However, this association is tangential to the political role of Governor Tawes in Maryland’s history and likely does not warrant eligibility consideration under of NRHP Criterion B for associations with significant persons.

The following year, Wicomico County used State Aid funds to build two composite timber-concrete bridges in the Aydelotte Watershed on Tom Smith and Bethel roads near Willards. The County advertised the project in *The Baltimore Sun* on June 12, 1967, listing the two bridges together under Contracts WI-414-118 and WI-415-118. Wicomico County Bridge WI-1231001 is a four-span bridge with a total length of almost 69 feet, carrying Three Bridges Road (formerly known as Tom Smith Road) over Burnt Mill Branch, while Wicomico County Bridge WI-1661001 is a three-span bridge with a total length of 62 feet, carrying Bethel Road over Burnt Mill Branch. Bridge WI-1231001 is about one mile downstream of Bridge WI-1661001. These two bridges are in rural locations.

In 1971, the State Roads Commission built a new bridge carrying MD 14 (Shady Drive/Main Street) over the South Prong of the Warwick River near Secretary in Dorchester County on the Eastern Shore. Bridge 0901600 is 368 feet long, and it includes 13 composite timber-and-concrete spans that make up 263 feet as well as three prestressed concrete slabs in the middle, totaling 105 feet. This location is a remote location, with Secretary having a small population.

Finally, the last composite timber-concrete bridge known to have been built in Maryland was built near Crumpton in Queen Anne’s County in 1972. Bridge 1703800, carrying MD 544 (McGinnes Road) over Red Lion Branch, is an 82-foot-long bridge with five spans. It has concrete and steel parapets and timber piles and timber bulkhead abutments.

The State Roads Commission was re-organized into the Maryland Department of Transportation State Highway Administration in 1971, making the 1971-1972 fiscal year a logical endpoint to this context. No timber-concrete composite bridges are known to have been built in Maryland after 1972. The six timber-concrete composite bridges known to have been built in Maryland after 1945 do not have a connecting theme under which they should be evaluated for NRHP-eligibility. Built after the prime period of significance for timber-concrete composite bridges, they are not examples of technological advancement, and research did not reveal clear reasoning for why composite bridges were chosen in these examples other than it continued to be a low-cost, yet durable design option, particularly suited for low-lying roads over tidal water or marshy ground. Aesthetically, they do not share the character-defining features of the original set of eight composite bridges in Maryland and they lack any monumental design. Except for the bridge at Patuxent Naval Air Station they are moderate-length bridges. Also, with the exception of the bridge at Patuxent Naval Air Station, which has associations related to its location at a military facility, these bridges are utilitarian and non-monumental and unlikely to be found eligible for listing in the NRHP.

Research Conclusions

Maryland currently has eleven extant timber-concrete composite bridges, according to research conducted for this historic context. Of these, one is owned by the federal government, two (WI-1231001 and WI-1661001) are owned by county governments. Of the eight owned by MDOT SHA, one (Bridge 2200400) is pending replacement and three have been determined not eligible for listing in the NRHP (Bridges 0900200, 1702500, and 2300502). This leaves one eligible bridge (Bridge 1401800) and three unevaluated bridges (Bridges 1901300, 0901600, and 1703800).

In a separate study, James P. Wacker, Alfredo M.P. G. Dias, and Travis K. Hosteng data-mined the National Bridge Inventory (NBI) database and identified 11 timber-concrete composite bridges in Maryland as of 2016. Wacker, Dias, and Hosteng identified 1,644 timber-concrete composite bridges through the NBI, but they note that this may include a certain number of bridges falsely identified as timber-concrete composite bridges. North Carolina has the most of this bridge type, with 391; California has the second most, with 229. Alabama, Louisiana, Arkansas, and Kansas all have over 100 examples of the type (Wacker 2017). In comparison, Maryland’s examples of the timber-concrete composite bridges are few.

At current writing, of the original set, only MD 299 over Jacobs Creek, Bridge 1401800 (MIHP # K-681) and US 13 Business over East Branch of the Wicomico River, Bridge 2200400 (MIHP # WI-224) are eligible for listing in the NRHP. With the planned replacement of Bridge 2200400, special consideration should be given towards the preservation of Bridge 1401800 as the only extant bridge of the original eight timber-concrete composite bridges built in Maryland.

Updated Framework for Evaluating Maryland's Timber-Concrete Composite Bridges

Timber-concrete composite bridges were included in Historic Highway Bridges in Maryland: 1631-1960: Historic Context Report prepared for Maryland Department of Transportation State Highway Administration by P.A.C. Spero & Company and Louis Berger & Associates (July 1995, Revised October 1995) which included the following framework for assessing eligibility under the Criteria of the National Register of Historic Places (Spero 1995, 44-46; C-10 and C-11; C-37 and C-38.)

An updated framework for evaluating Timber-Concrete Composite Bridges is provided for two periods of significance: 1937-1939 and 1940-1945. The Post-1945 Composite Timber-Concrete Bridges built between 1953-1972 do not represent significant aspects in engineering or history and they are unlikely to meet NRHP Criteria.

Period of Significance	*1937-1939*
Potential Applicable National Register Criteria	*Criterion C as early example of the type in Maryland*
Integrity Considerations	*All CDEs must be intact*

Structural Component Importance Rating for Timber-Concrete Composite Bridges, 1937-1939

	Structural Element	***Rating***
Substructure	Timber piles or bents	CDE
Superstructure	Timber-concrete slab deck	CDE
	Original parapets (horizontal concrete rails, decorative metal rails, or colonnade of small concrete arches) with Cyma-curve concrete end posts	CDE

Period of Significance	*1940-1945*
Potential Applicable National Register Criteria	*Criterion A for its association with the effects of World War II in Maryland*
Integrity Considerations	*All CDEs must be intact*

Structural Component Importance Rating for Timber-Concrete Composite Bridges, 1940-1945

	Structural Element	***Rating***
Substructure	Timber piles or bents	CDE
Superstructure	Timber-concrete slab deck	CDE
	Original parapets (horizontal concrete or timber rails)	CDE

Reference List

Casella, Richard. 1994. Mill Creek Bridge (Delaware Bridge No. 9A). Historic American Engineering Record, HAER No. DE-39. Available online at https://www.loc.gov/resource/hhh.de0418.photos?st=gallery.

Duwadi, Sheila Rimal, and Michael A. Ritter. 1997. "Timber Bridges in the United States." *Public Roads*- Winter 1997. Vol. 60 No. 3. Reproduced online at https://highways.dot.gov/public-roads/winter-1997/timber-bridges-united-states.

Eby, Robert. 1989. "Composite T Beam Bridge Deck on Timber Towers." Chapter in Classic Wood Structures. New York, NY: American Society of Civil Engineers. Reproduced online at https://swtrails.org/blog/2016/08/27/history-of-the-barbur-blvd-bridges/.

Hopkins, Walter C. 1939. "Treated Timber in Heavy Duty Composite Bridges." Proceedings of the Annual Meeting of the American Wood-Preservers' Association, Vol 26-35, pg. 268-282.

Hopkins, Walter C. 1942. "Attention Turned to Timber Bridges By Priorities on Structural Steel." *Engineering News Record*, 128 (7), 279-84.

Mann, Carl M., editor. 1953. "Composite Deck for Patuxent Bridge." BuDocks Technical Digest: Construction, Maintenance and Operation of the Navy's Shore Establishments. No. 36, July 1953, pg. 25.

Maryland War Records Commission. 1933. Maryland in the World War, 1917-1919; Military and Naval Service Records. Vol. I-II. Baltimore, MD, USA: Twentieth Century Press, 1933. Accessed online at https://babel.hathitrust.org/cgi/pt?id=mdp.39015030674603&view=1up&seq=7&skin=2021.

Maryland State Roads Commission. 1939. Report of the State Roads Commission of Maryland: Operating Report for the Years 1937-1938 and Financial Report for the Fiscal Years 1937-1938. Baltimore, MD: 1939.

Maryland State Roads Commission. 1941. Report of the State Roads Commission of Maryland: Operating Report and Financial Report, 1939-1940. Baltimore, MD: 1941.

Maryland State Roads Commission. 1945. Report of the State Roads Commission of Maryland: Operating Report and Financial Report, 1943-1944. Baltimore, MD: 1945.

May, T.K. 1954. "Composite Timber-Concrete Construction." American Railway Engineering Association-Bulletin. Vol. 516, June-July 1954, pg. 642-648.

The New York Times. 1926. "Wood Preserving Makes Big Strides: Ancient Practice Becomes Modern." November 4, 1926, pg. 48. ProQuest Historical Newspapers: The New York Times.

Reppert, Ralph. 1967. "The Happy Days of Millard Tawes: Relaxation, Contentment Mark the Life of the Two-Term Governor Back-but Not Idle- In His Home Town, Crisfield." The Sun, October 8, 1967, pg. SM19. ProQuest Historical Newspapers: The Baltimore Sun.

Richart, Frank E., and Clarence B. Williams, Jr. 1943. "Tests of Composite Timber and Concrete Beams." Illinois Bulletin Vol. 40, May 11, 1943, No. 38. Engineering Experiment Station Bulletin Series No. 343. Urbana, IL: Univ. of Illinois at Urbana- Champaign.

Seiler, James F. 1933. Application for Composite Wood and Concrete Construction, May 10, 1933. United States Patent Office, Patented December 3, 1935 (Patent No. 2,022,693).

Seiler, James F. 1943. Application for Shear Developers, December 7, 1943. United States Patent Office, Patented December 5, 1944 (Patent No. 2,364,481).

*The Sun.*1941. Legal notice 1- No Title. November 7, 1941, pg. 30. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1942. Proposals: Department of Public Works State of Maryland State Roads, June 23, 1942, pg. 23. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1944. Legal Notice 2- No Title. August 18, 1944, pg. 19. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1944. “Bids Offered For Road Jobs On Eastern Shore.” August 31, 1944, pg. 9. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1944. Legal Notice 4- No Title. September 15, 1944, pg. 23. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1944. Classified Ad 8- No Title. September 22, 1944, pg. 21. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1967. Classified Ad 10- No Title. June 12, 1967, pg. C19. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1971. Classified Ad 8- No Title. July 29, 1971, pg. D19. ProQuest Historical Newspapers: The Baltimore Sun.

P.A.C. Spero & Company and Louis Berger & Associates. 1995. Historic Highway Bridges in Maryland: 1631-1960 Historic Context Report Prepared for Maryland State Highway Administration, July 1995, Revised October 1995.

P.A.C. Spero & Company with Kidde Consultants. 1988. State Bridge Number 707, Road 50 over Silver Lake, Rehoboth Beach, Sussex County, Delaware, HABS/HAER Inventory Form. Accessed online at: https://deldot.gov/environmental/archaeology/historic_pres/bridges/pdf/br_707.pdf.

The Sun. 1961. “Hopkins Eyes Manila Post: Retiring Roads Aide Will Start New Career.” October 8, 1961, pg. 9. ProQuest Historical Newspapers: The Baltimore Sun.

The Sun. 1974. “Hopkins, SRC aide, dies at 82.” October 17, 1974, pg. A21. ProQuest Historical Newspapers: The Baltimore Sun.

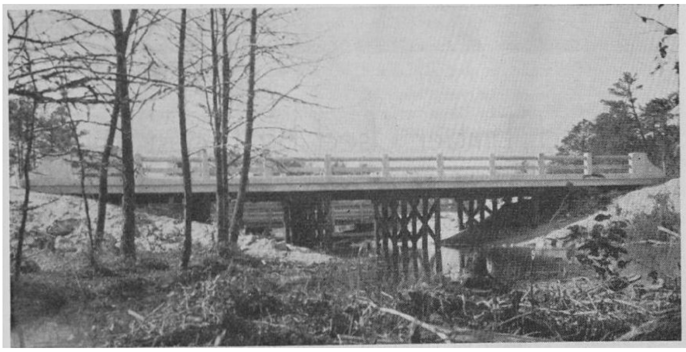
Wacker, James P., Alfredo M.P. G. Dias, and Travis K. Hosteng. 2017. “Investigation of Early Timber–Concrete Composite Bridges in the United States.” Presentation at 3rd International Conference on Timber Bridges 2017- Skellefteå, Sweden.

Wacker, James P., Alfredo M.P. G. Dias, and Travis K. Hosteng. 2020. “100-Year Performance of Timber–Concrete Composite Bridges in the United States.

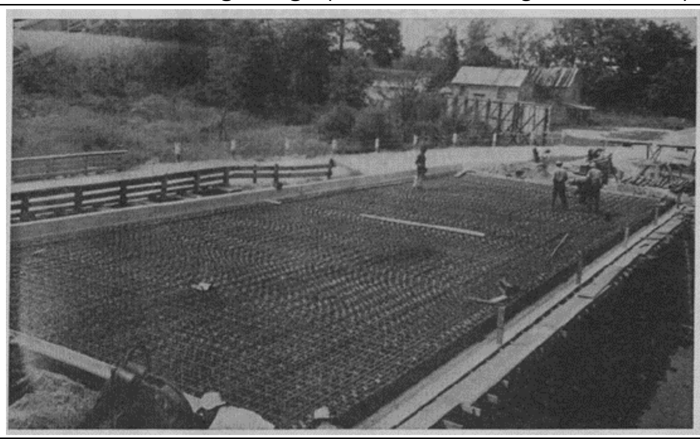
The Washington Post. 1949. “J.F. Seiler, Bridge Design Expert, Dies.” January 17, 1949, B2. ProQuest Historical Newspapers: The Washington Post.

Wood Preserving News. 1937. "Maryland State Roads Commission Constructs Group of Composite Bridges." Vol. XV, No. 12, p. 148-151; 158.

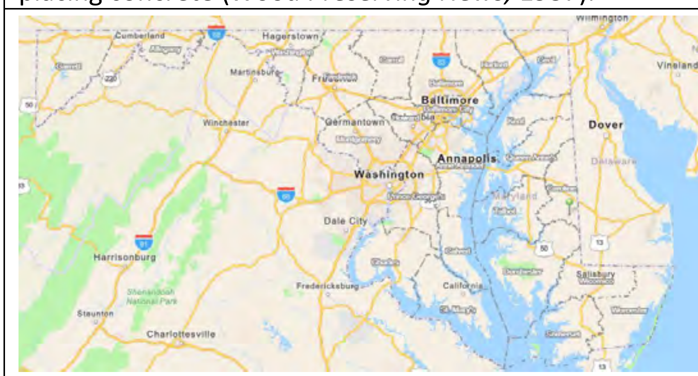
Wood Preserving News. 1945. "Maryland Continues Construction of Composite Timber-concrete Bridges." Vol. XXIII, No. 6. p. 55-57; 61.



The 1937 bridge SRC built over Faulkner Branch was known as the Federalsburg Bridge (*Wood Preserving News*, 1937).



Construction photo showing the bridge deck before placing concrete (*Wood Preserving News,* 1937).



Map showing the location of Caroline County Bridge CO-03700 near Federalsburg.

Denton Road over Faulkner Branch

In 1937, the State Roads Commission (SRC) constructed a timber and concrete composite bridge, of five 18-foot spans for a total length of 90 feet, providing a clear roadway of 30 feet, over Faulkner Branch on the road from Federalsburg to American Corners. It featured cross-braced bents and concrete-rail parapets with Cyma-curve endposts.

The bridge was featured in the December 1937 issue of *Wood Preserving News*.

In 1955, the SRC re-routed Federalsburg Highway (MD 313) on a new alignment, and the old road was transferred to Caroline County and named Denton Road.

Caroline County built a new timber bridge on Denton Road over Faulkner Branch in 1963.

View facing north on Willards-Whiton Road (MD 354) with Bridge 2202000 (built in 1937) in foreground and Bridge 2201900 (built in 1930) in background (MHT, 1999).

Detail showing concrete rail and Cyma-curve endposts (MHT, 1999).

Map showing Bridge 2202000's location in Wicomico County near Powellsville.

MD 354 over Adkins Pond

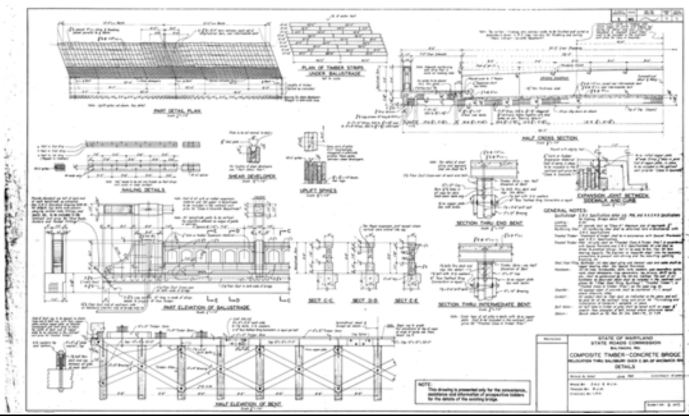
MIHP # WI-342

The SRC built Bridge 2202000 as a three-span, two-lane, composite timber and concrete bridge built in 1937. The structure was 70.5 feet long and 27.9 feet wide. The substructure consisted of two timber abutments, and two 6-pile timber bents with cross-bracing spaced at 20-foot intervals. There were no wing walls. The superstructure consisted of two timber beams supporting a composite timber and concrete deck and reinforced concrete rails. The structure had a reinforced concrete rail with square posts, cyma curve endposts, and two square horizontal rails. The posts and endposts Art Deco detailing.

The bridge underwent minor repairs, including splice repairs to several piles and cap channelization in 1994.

Bridge 2202000 was replaced in 2002, along with Bridge 2201900 (MIHP # WI-221), which was a ca. 1930 concrete slab bridge located about 100 feet north of Bridge 2201900.

View facing east towards Bridge 2200400 (MDOT SHA, 2006).



Plan showing original parapet cross-bracing.

Map showing location of Bridge 2200400 in Salisbury in Wicomico County.

US 13 Business over
East Branch, Wicomico River

MIHP # WI-224

Bridge 2200400 is a 42-foot, two span timber and concrete structure supported on steel pile bents that partially encased in fiberglass jackets.

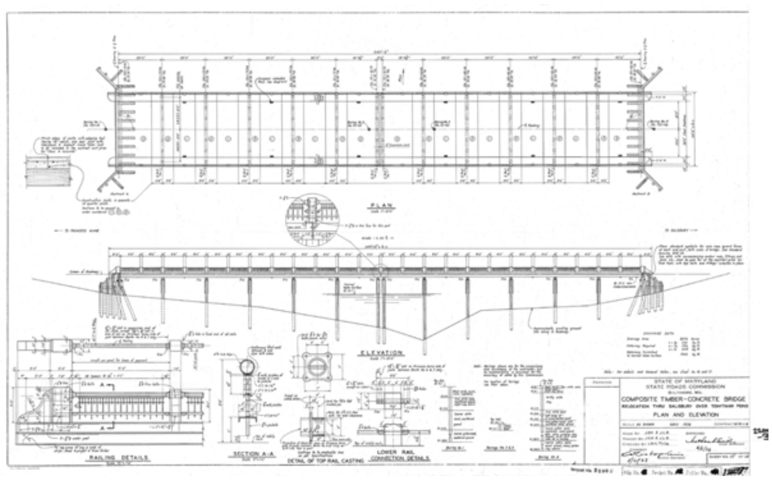
The substructure consists of three steel H-pile bents, each having 8 pilings. The piles are spaced approximately 11 feet across the channel. A steel channel cap separates the top of the piles and the base of the timber and concrete deck slab. The piles are encased.

The structure still retains its original parapets and balustrade.

Major Alterations: The H-pile substructure is not the original. MDOT SHA replaced the timber bent and pile substructure of this bridge in 1977. Originally the bridge had three bents with 14 piles each. The piles were 5-5" apart (center to center), supported by cross bracing, and connected by a timber cap. A copper plate separated the top of the pile from the cap.

In 2017, MDOT SHA planned the replacement of this bridge.

The Report of the State Roads Commission included this image of the Bridge over the Tonytank Pond.



SRC Plans from 1938 showing the plan and elevation of the Tonytank Bridge.

Map showing Bridge 2200502's location in Wicomico County.

US 13 NB over Tonytank Pond

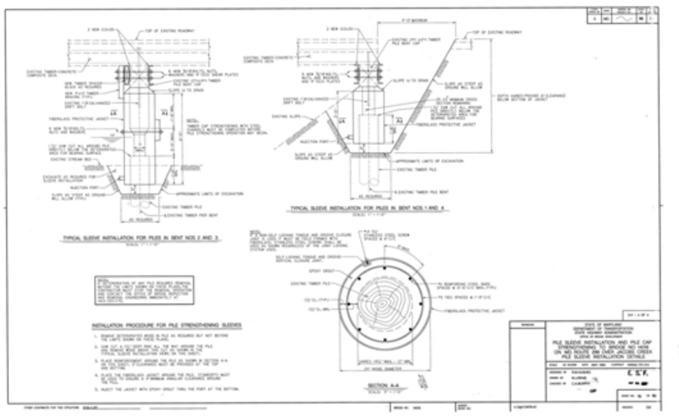
MIHP # WI-553

In the 1930s, as part of the Ocean Highway, the SRC relocated the road between Salisbury and Princess Anne, resulting in a new bridge over Tonytank Pond. It was a timber and concrete composite bridge of twelve 20-foot spans, providing a clear roadway of 26 feet, and a two 3-foot, 1-inch sidewalks. It had cyma-curve endposts, but the metal railing was similar to the one utilized at Chesapeake Beach in Calvert County.

The highway was later dualized, and as part of the dualization a parallel, Southbound, bridge (2200501) was built in 1954.

The Northbound Bridge was replaced in 1995.

View showing concrete rails and pile jackets (MDOT SHA, 2013) .



Plan detail showing jackets added to timber piles (MDOT SHA, 1994).

Map showing Bridge 1401800's location near Massey in Kent County.

MD 299 over Jacobs Creek

MIHP # K-681

Bridge 1401800 is a three-span, two-lane, composite timber and concrete bridge originally built in 1938, when MD 299 was known as the road from Sassafras to Massey and Jacobs Creek was known Swan Creek. The structure is 70 feet long and has a clear roadway width of 26 feet; there are no sidewalks.

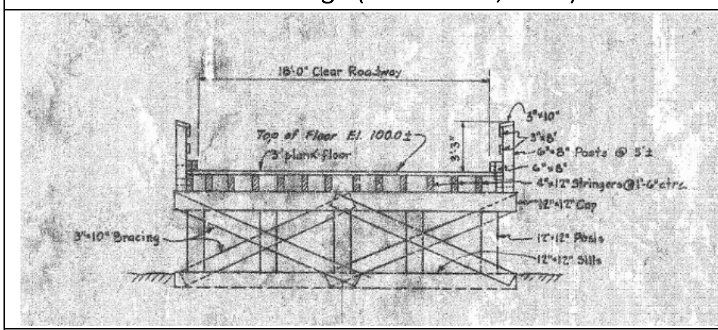
The substructure consists of two timber abutments and two 6-pile intermediate bents at 20-foot intervals. There are no wingwalls.

The superstructure consists of two timber beams which support a composite timber and concrete deck and concrete rails. There is a concrete wearing surface. The bridge has reinforced concrete railings made up of square posts, Cyma curve endposts, and two horizontal square reinforced concrete rails.

Major alterations: MDOT SHA added fiberglass and epoxy pile jackets, steel cap strengtheners, and new timber cross-bracing in 1994.

Bridge 1401800 was determined eligible for listing in the NRHP in 2001 as an example of standard design developed for building of bridges over bodies of water on Tidewater highways of the late 1930s. It is the only example of a composite timber and concrete bridge built in Kent County and retains moderate integrity.

View of south side of bridge (MDOT SHA, 2000).



Section detail showing timber and concrete slab.

Map showing location of Bridge 1702500 in Queen Anne's County.

MD 300 over Unicorn Branch

MIHP # QA-495

SRC built this composite timber and concrete bridge in 1939 along the road from Sudlersvile to the Delaware State Line. The bridge consisted of **three 18-foot spans, providing a clear roadway of 26 feet.**

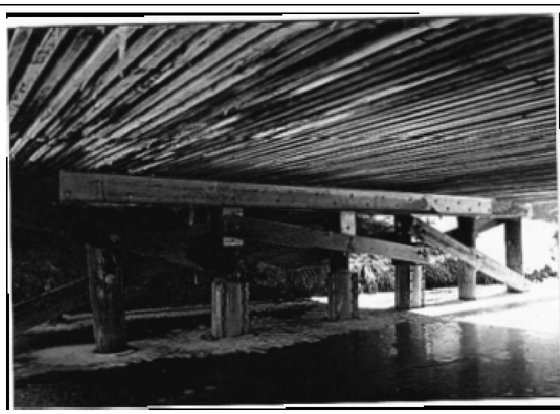
The substructure consists of two timber abutments augmented with a steel "H" beam for additional support, and two steel bents augmenting the two 6-pile timber bents which formerly supported the superstructure. The superstructure consists of two timber beams which support a composite and timber deck and reinforced concrete rails. The structure has reinforced concrete railings, with square posts, and Cyma-curve endposts.

Major Alterations:

Steel bents were constructed in 1994 to replace the timber bents as the structural support for the bridge. The original timber bents remain in place, but are not structural.

Bridge 1702500 was determined not eligible for listing in the National Register of Historic Places in 2001, due to deterioration and alterations.

View of Bridge 1802000 (MHT, 1997).



View showing composite timber and concrete deck and steel beams with pile jackets (MHT, 1998).

Map showing Bridge 1802000’s location north of Dynard in St. Mary’s County.

MD 242 over St. Clements Creek

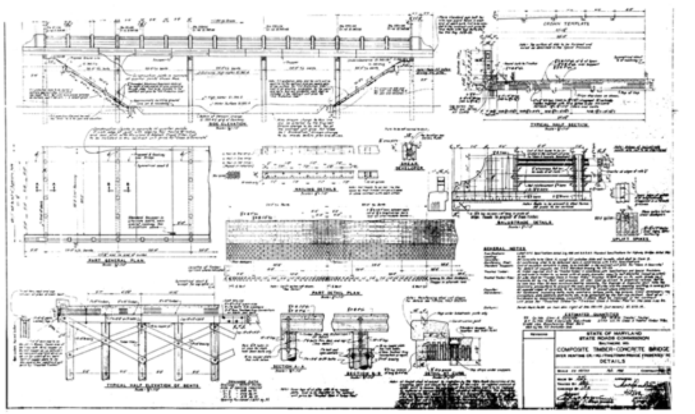
MIHP # SM-507

SHA Bridge 1802000 originally was a 5-span, wood and concrete beam bridge on timber piles built in 1937 on the road from Morganza to Clements. It was 101.5 feet long with a 30-foot roadway, devoid of sidewalks. The substructure consisted of four timber beams supporting a composite timber and concrete deck and concrete rails.
The square concrete posts and cyma curve endposts had Art Deco detailing.

Major alterations: In 1985-86, the original concrete rails were replaced with timber rails and 8 timber piles were spliced and strengthened with steel pile jackets. In 1991, the concrete parapets were replaced with wooden railings. In 1992, steel pile jackets were attached to more piles.

The entire bridge was rebuilt in 2000.

The 1943-1944 Report of the State Roads Commission included this photograph on page 96, described as "A Treated Timber Bridge over Coster's Creek on Route 2 in Calvert County".



February 1938 Plan Details of the Composite Concrete-Timber Bridge over Hunting Creek-Huntington-Prince Frederick Road.

Map showing the location of Bridge 0400200 between Huntington and Prince Frederick in Calvert County.

MD 2 SB over Hunting Creek

The 1937-38 *Report of the State Roads Commission* (published in 1939) described the following bridge as completed or under construction:

- A timber and concrete composite bridge of five 20-foot spans, providing a 40-foot clear roadway, over Hunting Creek, on the Huntington to Prince Frederick Road, Calvert County.

The 1943-44 *Report of the State Roads Commission* included a photograph of a treated timber bridge a treated timber bridge over Coster's Creek on Route 2 in Calvert County. Although Coster's Creek could not be confirmed as an alternative name to Hunting Creek, the bridge appears to match the Hunting Creek plans with five spans, concrete rails, and Cyma-curve endposts.

The current MDOT SHA Bridge 0400200 is a 97-foot-long composite timber and concrete bridge built in 1992 to carry the Southbound lanes of MD 2 over Hunting Creek.

View facing upstream towards Bridge 2301700 (MHT, 1998).

View facing downsteam towards Bridge 2301700 (MHT, 1998).

Map showing Bridge 2301700's location in Worcester County.

MD 374 over Pocomoke River

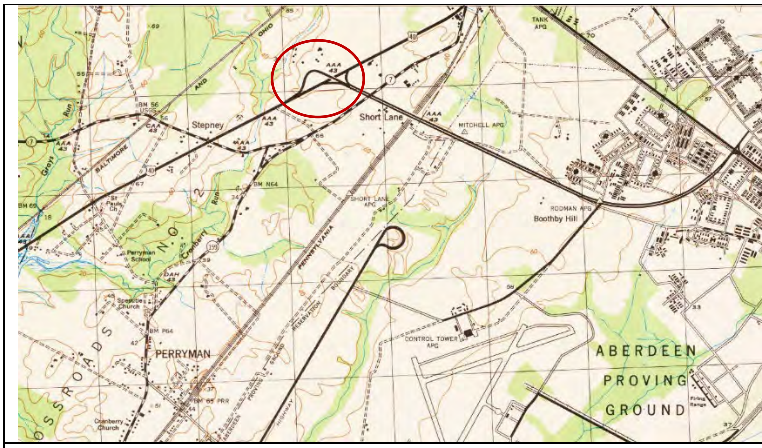
MIHP # WO-488

The SRC designed a a six-span, two-lane composite timber and concrete bridge in 1941-42 to carry the Libertytown-Powellville Road over the Pocomoke River. The SRC advertised the submittal of bids for Contracts WO-178-1-150 and WO-145-1-150 on November 7, 1941 (*The Sun* 1941, 30).

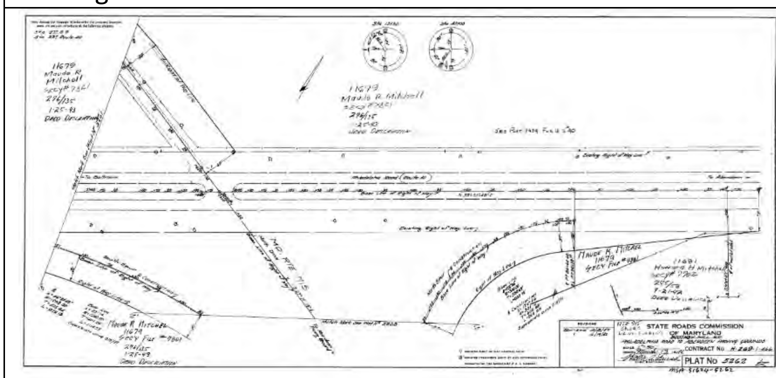
The bridge was 120 feet long supported on timber abutments and bents. Each timber bent was made up of six timber piles connected by cross bracing. Giant dowels attached a timber cap to each pile. The parapet design consisted of concrete posts with concrete rails with angled concrete endposts.

Bent cap supports and pile jacket supports were added in 1998.

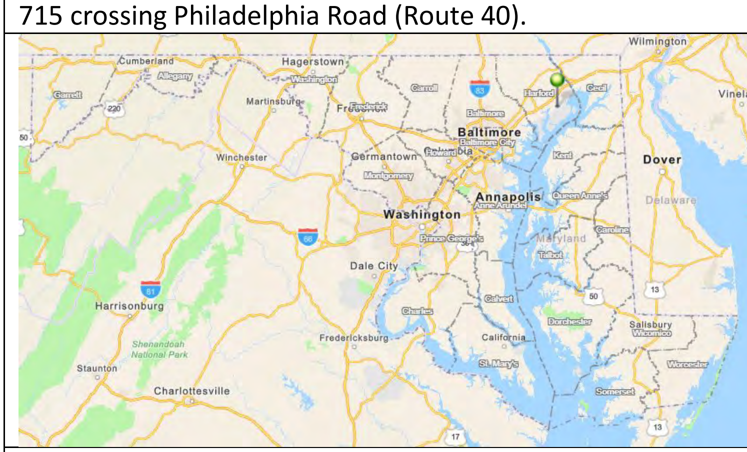
Due to deterioration of the timber pile bents, despite previous replacement and splicing of the cross bracing, the bridge was replaced in 2001.



Detail of 1944 edition of USGS Perryman Quad map, showing location of partial cloverleaf at Short Lane near Aberdeen Proving Ground.



SRC Right-of-way Plat 5262 (Contract H-269-I-466) showing MD 715 crossing Philadelphia Road (Route 40).



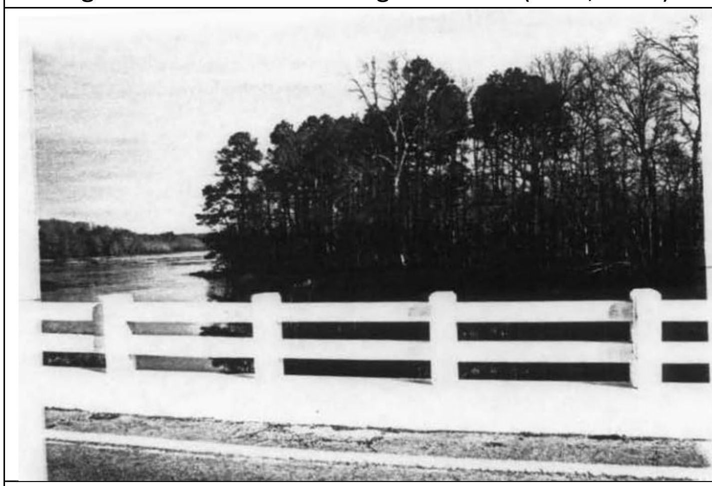
Map showing Bridge 1202300's location near Aberdeen Proving Ground in Harford County.

MD 715 over US 40

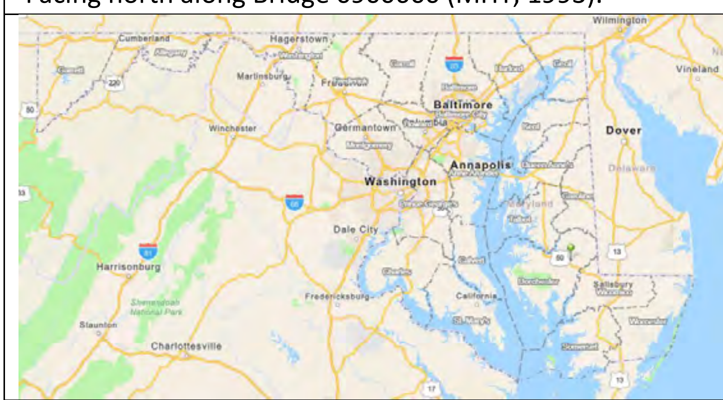
In 1942, as a Military Access Project, the SRC provided improved access to Aberdeen Proving Ground (APG) from Philadelphia Road (US 40) by constructing a partial cloverleaf to provide better traffic flow at the junction of Boothby Hill Road (later known as Short Lane and now known as Maryland Boulevard or MD 715) and Philadelphia Road. In addition, the SRC built a new, grade-separated crossing of Boothby Hill Road over the Pennsylvania Railroad (now known as MDOT SHA Bridges 1205803 and 1205804). The bridges were advertised together, and the notice specified that the bridge over Philadelphia Road would include six 20-foot and one 15-foot composite timber concrete spans and two 47-foot steel I-beam spans for a total length of 250 feet (*The Sun* 1942, 23).

MDOT SHA rebuilt Bridge 1202300 in 1985.

Facing east at east end of Bridge 0900600 (MHT, 1993).



Facing north along Bridge 0900600 (MHT, 1993).



Map showing location of Bridge 0900600 at between Linkwood and Vienna in Dorchester County.

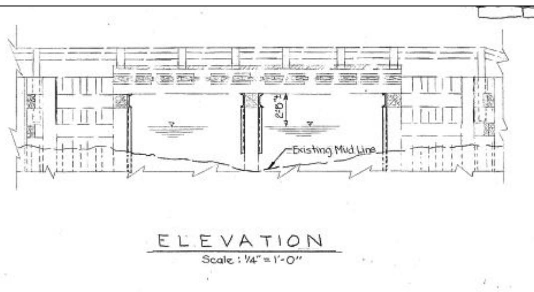
US 50 (WB) over Chicamacomico/ Big Mill Pond

MIHP # D-678

On September 15, 1944, the SRC advertised a notice to contractors in *The Baltimore Sun* to submit proposals for construction of a bridge for Contract D-144-2-146; Federal Aid Project 467-C. The notice specified a composite timber-concrete bridge ontreated timber piles overbig Mill Pond (Chicamacomico River) on the road from Mt. holly to Vienna (U.S. Route 213). The Bridge would include six spans measuring 19'6"; 20'; 20'; 20'; 20'; and 19'6" for a total length of 119 feet. The notice also specified that the superstructure would require use of a patented type of shear developer and the contractor would be required to pay a royalty to the American Wood Preservers' Association at a rate of $7.40 per thousand shear developers used (*The Sun* 1944, 23).

The highway was dualized in 1967, and Bridge 0900600 was replaced in 1996 after MHT and MDOT SHA concurred it was not eligible for listing in the National Register of Historic Places.

North elevation of Bridge 0402300 (MHT, 1997).



Detail of SRC plan showing elevation of the bridge over Battle Creek.

Map showing location of Bridge No. 0402300 in Calvert County (Prince Frederick vicinity).

MD 506 over Battle Creek

MIHP # CT-1294

Bridge 0402300 carries MD 506 (Sixes Road) over Battle Creek. The SRC built a two-span composite timber and concrete bridge here in 1944. In 1985 and 1989, the bridge was substantially altered with steel beam supports and W-beam rails.

Bridge 0402300 was determined eligible for listing in the National Register of Historic Places in 2001 although no justification is recorded in the MIHP.

Bridge 0402300 was replaced in 2003. The current Bridge 0402300 is a 28-foot-long pretensioned concrete slab.

BRIDGE 0900200, DORCHESTER COUNTY

BUILT 1944

View, facing upstream, of Bridge 0900200 (MHT, 1998).

Detail showing timber stringers and galvanized pier cap (MHT, 1998).

Map showing Bridge 0900200's location in Dorchester County.

MD 16 over Cabin Creek

MIHP # D-724

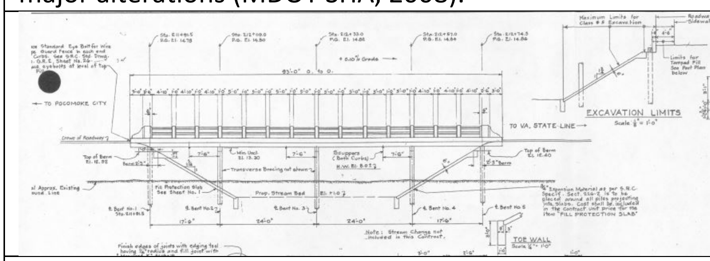
The SRC designed this 3-span, 2-lane, composite timber and concrete bridge in 1944 along the road from Preston to East New Market. In August 1944, the SRC awarded the construction contract, D-115-1-111 , to Waller Paving Company of Salisbury for their bid of $14, 153 (*The Sun,* August 18, 1944, 19 and August 31, 1944, 9).

The structure is 54 feet long and has a clear roadway width of 28 feet. It has no sidewalks. The substructure consists of two timber bent abutments and two timber bent piers. There are no wing walls. The superstructure consists of timber stringers which support a concrete deck and metal guardrails.

Major Alterations:
In 1996, the abutment caps and pier caps were reconstructed, a galvanized H-beam was added to the north abutment, and galvanized channels were added to the first and second piers and to the south abutment. The original two strand timber railings were replaced with metal guardrails at an unknown date.

In 2001, MHT concurred with MDOT SHA's determination that Bridge 0900200 is not eligible for listing in the National Register of Historic Places, due to alterations.

East elevation of US 13SB over Wagram Creek prior to major alterations (MDOT SHA, 2008).



Detail of SRC plans from 1944 showing Elevation of the Composite Timber Concrete Bridge over Wagram Creek on the road from Pocomoke City to the Virginia State Line.

Map showing Bridge 2300502's location in Worcester County.

US 13 SB over Wagram Creek

MIHP # WO-491

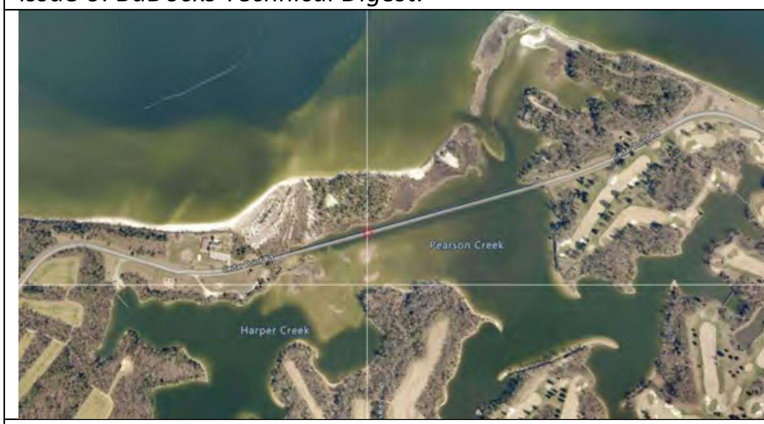
On September 22, 1944, the SRC advertised bids to construct a bridge over Wagram Creek under Contract No. WO-223-4-111 (*The Sun* 1944, 21). 2300502 was constructed in 1945 as a four-span, two-lane composite timber and concrete bridge with concrete railing and decorative end blocks.

The parallel span, 2300501, is a concrete slab built in 1954.

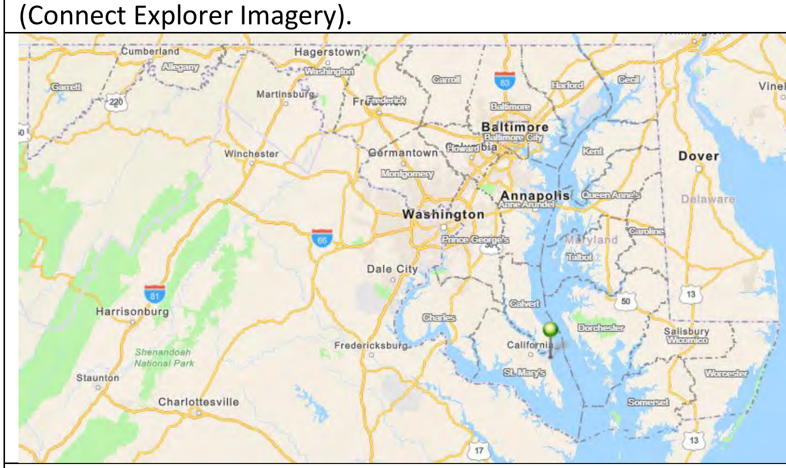
Bridge 2300502 was determined eligible for the NRHP in 2001 as a significant example of a composite timber and concrete construction.

Following emergency work in 2010 and subsequent alterations in 2013, Bridge 2300502 now features steel jackets and bents. It is no longer eligible for listing in the National Register of Historic Places.

Construction photograph of the composite timber concrete bridge at Patuxent NAS published on the cover of the July 1953 issue of *BuDocks Technical Digest.*



Aerial view of Cedar Point Road over Pearson and Harper Creeks (Connect Explorer Imagery).



Map showing Bridge 1802000's location at the Patuxent Naval Air Station in St. Mary's County.

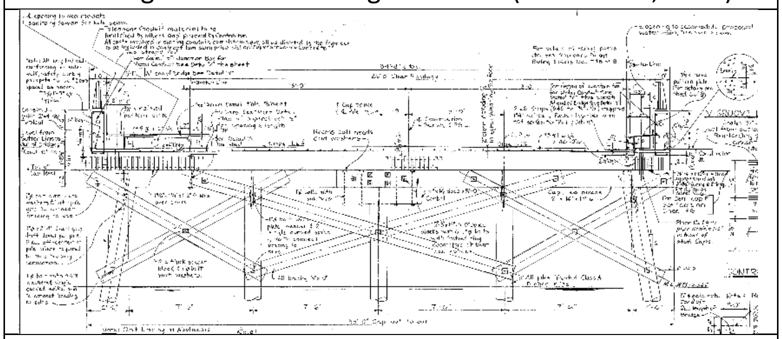
Cedar Point Road over Pearson and Harper Creeks

Located within MIHP # SM-357 (U.S. Naval Air Station Patuxent River)

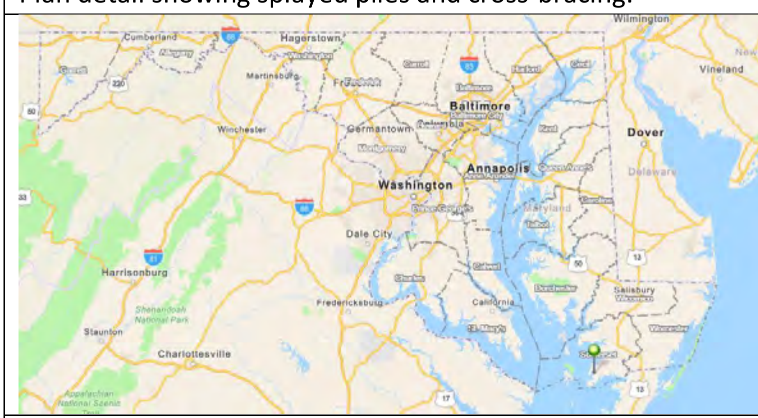
In 1953, the United States Navy built a Perimeter Road at the Patuxent Naval Air Base in St. Mary's County. The Perimeter Road, now known as Cedar Point Road, included a 2,460-foot-long wood-concrete composite-deck bridge over Harper and Pearson's Creek. The bridge was featured in the July 1953 issue of *BuDocks Technical Digest* (a publication of the United States Bureau of Yards and Docks), indicating the bridge consisted of 123 20-foot spans, a 26-foot roadway, bents each consisting of 5 vertical piles capped by 12" x 16" timber, timber wing walls, and a H-20 loading capacity. The bridge was used using the patented method of the American Wood-Preservers' Association, with laminated 2" x 6" and 2" x 8" creosoted timber (laid flush on the underside of the bridge), shear developers, and approximately 6 inches of concrete slab reinforced with mesh.

Aerial photography indicates that the bridge built in 1953 is still extant.

View facing south side of Bridge 1901300 (MDOT SHA, 2000).



Plan detail showing splayed piles and cross-bracing.



Location of Bridge 1901300 near Crisfield in Somerset County.

MD 460 over West Cove

(Hall Highway) over West Cove (or Little Annemessex River)

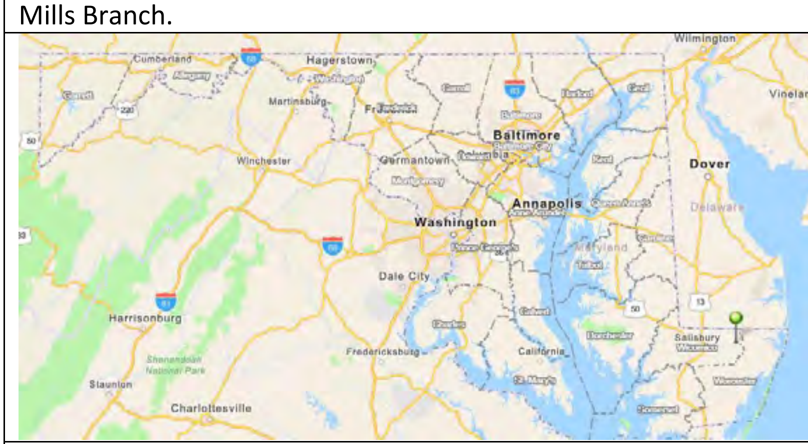
Bridge 1901300 is a seven-span, composite timber and concrete bridge; each span is 17 feet, making a total bridge length of 118 feet connecting Hall Highway to McCready Memorial Hospital.

Bridge 1901300 has concrete parapets with metal railings. The SRC developed the bridge plans in 1965 to replace a 1922 concrete arch bridge .

Bridge 1901300 remains unevaluated for eligibility in the National Register of Historic Places.

Facing northeast on Three Bridges Road towards Wicomico County Bridge WI-1231001 (Google Earth, 2014).

Birds-eye view, facing north, of Three Bridges Road over Burnt Mills Branch.



Map showing the location of Wicomico County Bridge WI-1231001 near Willards.

Three Bridges Road over Burnt Mill Branch

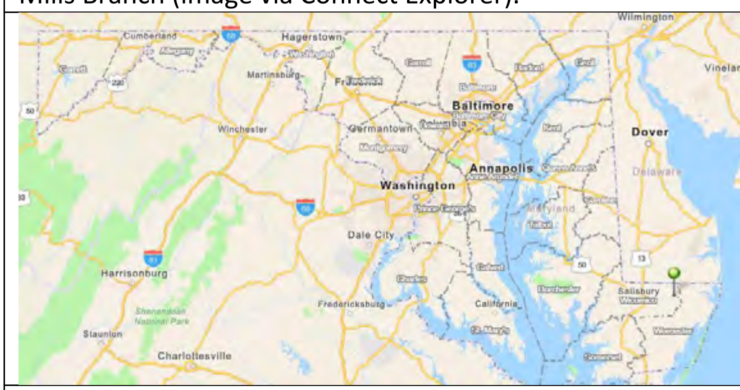
In 1967, Wicomico County used State-Aid to build a four-span timber and concrete composite slab bridge to carry Tom Smith Road over Burnt Mill Branch. Each span is seventeen feet long for a total length of nearly 69 feet. The roadway width is 32 feet. The parapet design is comprised of a solid concrete base with a steel railing.

Wicomico County advertised this bridge and WI-1661001 together as Project 9-RC-67 and Contracts WI-414-118 and WI-415-118, located in the Aydelotte Watershed near Willards (*The Sun* 1967, C19).

Wicomico County Bridge WI-1231001 remains unevaluated for eligibility in the NRHP.

Facing south on Bethel Road towards Wicomico County Bridge WI-1661001 (Google Earth, 2014).

Birds-eye view, facing west, of Bethel Road over Burnt Mills Branch (image via Connect Explorer).



Map showing the location of Wicomico County Bridge WI-1661001.

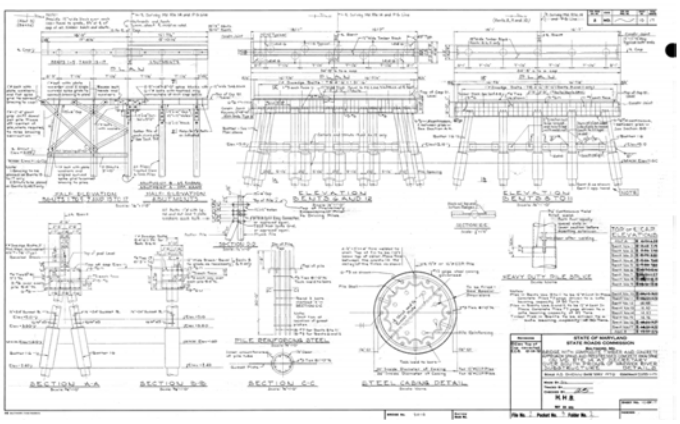
Bethel Road over Burnt Mill Branch

In 1967, Wicomico County built a three-span timber and concrete composite slab bridge to carry Bethel Road over Burnt Mill Branch near Willards. Each span is twenty feet long for a total length of sixty feet. The roadway width is 36 feet. The parapet design is comprised of a solid concrete base with a steel railing.

Wicomico County advertised this bridge and WI-1231001 together as Project 9-RC-67 and Contracts WI-414-118 and WI-415-118, located in the Aydelotte Watershed near Willards (The Sun 1967, C19).

Wicomico County Bridge WI-661001 remains unevaluated for eligibility in the NRHP.

View facing south side of Bridge 0901600 (MDOT SHA, 2003).



Substructure plan details designed in 1970.

Map showing location of Bridge 0901600 at Secretary in Dorchester County.

MD 14 over South Prong of the Warwick River

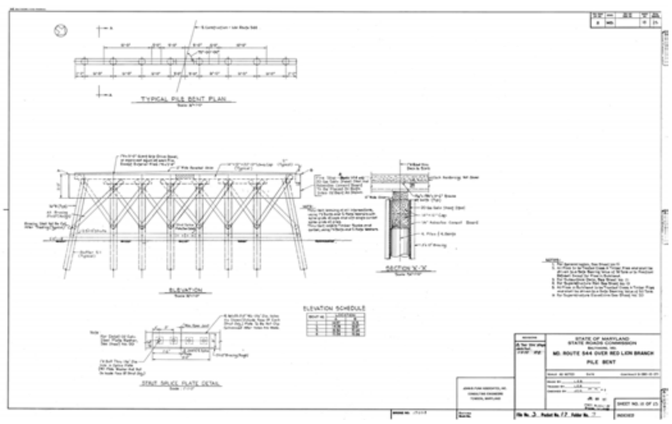
Bridge 0901600, carrying Shady Drive/ Main Street, is a 368-foot-long combination bridge that consists of composite timber and concrete approach spans and pre-stressed concrete main spans. The 13 composite timber and concrete spans each measure 19 or 20 feet; the three pre-stressed concrete slabs measure 35 feet each. The bridge railing has standard, two-strand aluminum or galvanized steel railings.

Bridge 0901600 remains unevaluated for National Register of Historic Places-eligibility.

BRIDGE 1703800, QUEEN ANNE'S COUNTY

BUILT 1972

View of north side of Bridge 1703800 (MDOT SHA, 2008)



Plan detail showing splayed piles and cross-bracing.

Map showing Bridge 1703800's location near Crumpton in Queen Anne's County.

MD 544 over Red Lion Branch

The SRC developed plans for this composite timber and concrete bridge on McGinnes Road in 1971. It was constructed in 1972 and is 82 feet long, with five spans of 16.5 feet each. It has supplemental steel beams to support the timber bents.

MDOT SHA advertised this project as Contract No. Q-280-12-271, which involved grading, draining, and paving MD 544 from U.S. 301 to Maryland 290, including the details that the roadway width was 44 feet between "N.J. parapets" (*The Sun* 1971, D19).

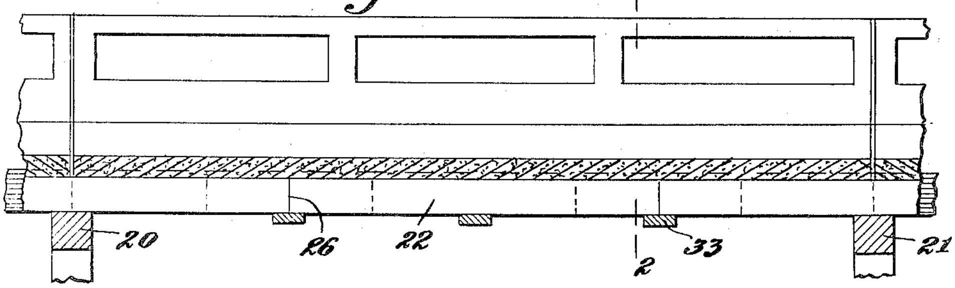
Bridge 1703800 remains unevaluated for National Register of Historic Places-eligibility.

Dec. 3, 1935.   J. F. SEILER   2,022,693

COMPOSITE WOOD AND CONCRETE CONSTRUCTION

Filed May 10, 1933   2 Sheets-Sheet 1

Fig.1.



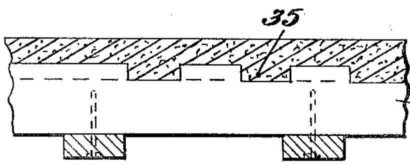


Fig.12.

Fig.2.

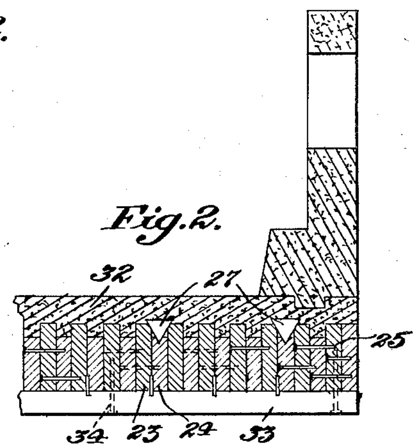


Fig.3.

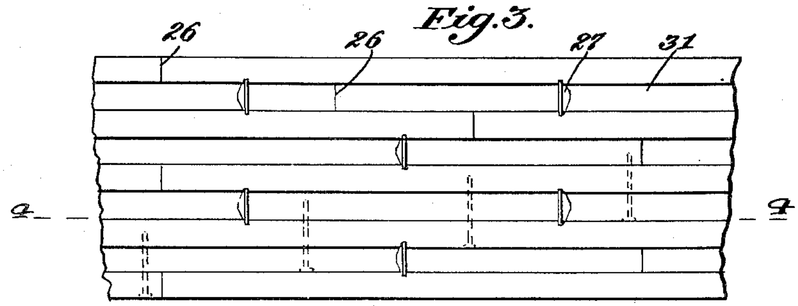


Fig.5.

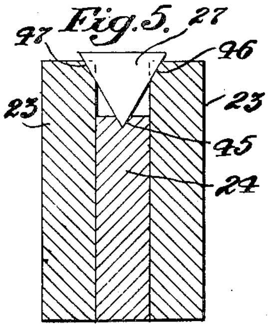
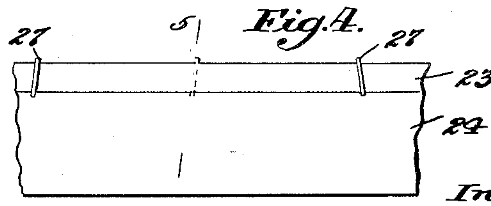


Fig.4.



Inventor:
J. F. Seiler,
by Karl Fenning
his Att'y.

Dec. 3, 1935. J. F. SEILER 2,022,693

COMPOSITE WOOD AND CONCRETE CONSTRUCTION

Filed May 10, 1933 2 Sheets-Sheet 2

Fig. 6.

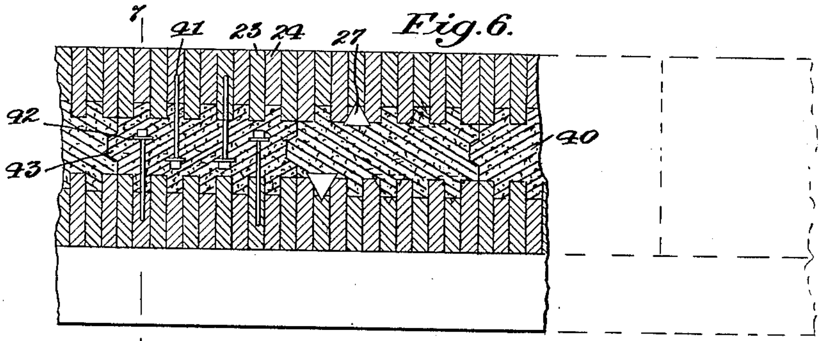


Fig. 7.

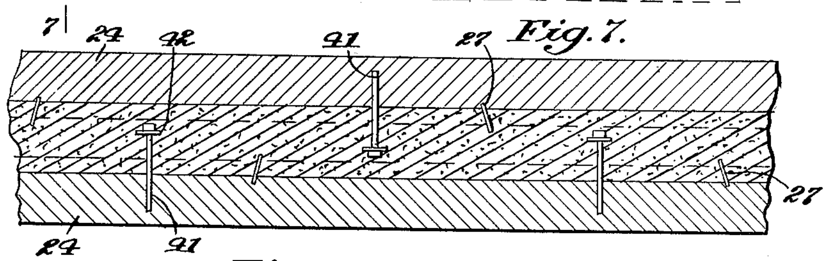


Fig. 8.

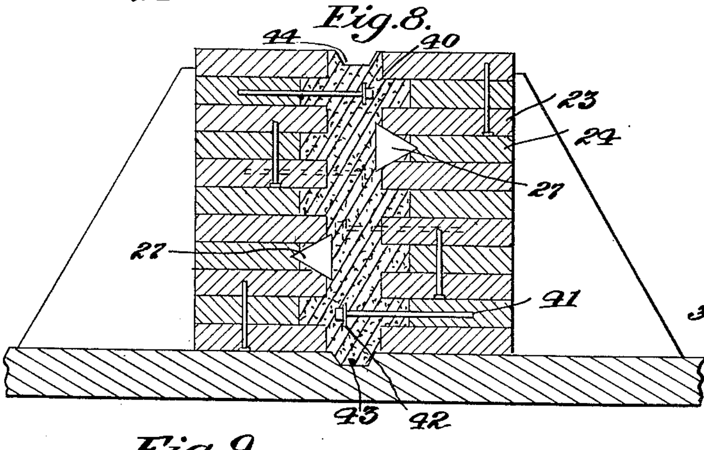


Fig. 10.

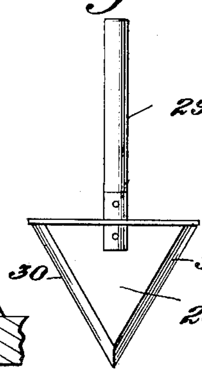


Fig. 11.

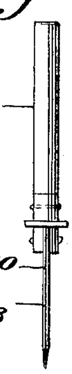
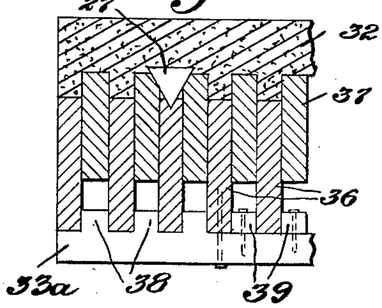


Fig. 9.



Inventor:
J. F. Seiler,
by Carl Fruning
his Att'y.

Patented Dec. 3, 1935

2,022,693

UNITED STATES PATENT OFFICE

2,022,693

COMPOSITE WOOD AND CONCRETE CONSTRUCTION

James F. Seiler, Washington, D. C.

Application May 10, 1933, Serial No. 670,367

23 Claims. (Cl. 72—33)

The invention relates to the economical, efficient use of wood and concrete combined in such a way as to properly employ the advantages of both materials. It may be employed in the manufacture of beams, girders and the like as well as in decks, floors, bridges, wharves, piers and in general in any position in which lasting strong material resistant to stresses and to wear or deterioration is desirable.

While not exclusively confined thereto the advantages of the invention are best brought out when wood properly preserved with creosote or salts is used. Of course wood appropriately treated to make fireproof may also be employed.

By the use of the invention the effect of lumber of large dimensions in cross section or in length or in both may be accomplished by the use of smaller or shorter pieces of wood which are more generally available and more economical to handle and transport as well as lower in cost. This is particularly so with respect to treated lumber since the difficulties and costs incident to treating large pieces of lumber may be very great.

As a specific illustration of the invention a wooden structure may be formed as the base. This may consist of suitable pieces of lumber preferably placed on edge and fastened together by spikes or other suitable means. Random lengths of lumber may be used and each of the edgewise pieces of lumber may be lengthened out by placing at its end a similar piece and so building up a unitary laminated structure of whatever length or width may be desired. In constructing the laminated structure preferably alternate laminations will be raised forming extended troughs therebetween. A layer of concrete of suitable depth may be poured upon the wooden base. The longitudinal troughs may form seats for keys of concrete to prevent the concrete from lateral displacement under stress. The longitudinal and lateral stress may be distributed by the more or less solid uniform concrete layer throughout the entire area or width of the structure, the greatest stress of course occurs at the bottom edge where the laminated wood occurs. In order to make the structure stronger laterally at this point there may be placed across the bottom at suitable points straps crossing the laminations and, if desired, extending from side to side of the structure, provided with suitable means for attachment to the laminations either with or without stress distributing means to be inserted between the laminations. In order to assist in holding the cement top more firmly in place and prevent any sliding thereof with respect to the underlying wood and also to aid in the distribution of the load there may be placed in the longitudinal troughs, and before the cement is poured, transverse shear developers which preferably will engage the laminations at the bottom of the troughs and also may engage the laminations at both sides of the trough and extend thereabove so as to go beyond the natural line of cleavage or least resistance of the cement when poured. An important advantage of the longitudinal grooves is that they provide ready and efficient seats for the shear developers which placed therein are thoroughly and well anchored and efficiently resist bending. The stresses developed and borne by each shear developer so arranged may be calculated and a sufficient number may be specified in advance and installed. Since the chief function of these shear developers has to do with the longitudinal stress it may be convenient to particularly position the shear developers with respect thereto. Thus at each side of the center of stress they may be inclined toward the center in order to act more efficiently and meet the stress more directly. These oppositely inclined shear developers may aid in preventing the cement leaving the wood in a vertical direction also.

If desired a somewhat similar structure may be built up by providing a pair of such wooden foundations with their sides containing the troughs facing each other and placing a layer of cement or concrete between.

A tool especially adapted for providing seats for the shear developers is also contemplated.

Various phases of the invention will appear from the description of the accompanying drawings in which Figure 1 is a side elevation of a longitudinal section of a flooring illustrating the invention. Fig. 2 is a fragmentary transverse vertical section on the line 2—2 of Fig. 1. Fig. 3 is a fragmentary plan view of a portion of the under portion of the structure. Fig. 4 is a longitudinal vertical section on the line 4—4 of Fig. 3. Fig. 5 is a fragmentary transverse vertical section on the line 5—5 of Fig. 4 somewhat enlarged in scale. Fig. 6 is a transverse vertical section of a plurality of structures made up of cement associated with two series of wooden laminations in position for use. Fig. 7 is a vertical section on the line 7—7 of Fig. 6. Fig. 8 is a transverse vertical section somewhat enlarged showing the structure of Fig. 6 in position for pouring the cement. Fig. 9 is a transverse vertical fragmentary section showing an alternative arrangement of the wooden laminations. Figs. 10 and 11 are front and side elevations of a tool which may be conveniently employed for providing seats for the shear developers, and Fig. 12 is a fragmentary view of an optional element.

Resting on suitably spaced supports **20** and **21** in the drawings is a longitudinally laminated structure **22** consisting of a plurality of boards or timbers **23** and **24**. As illustrated the boards **23** are wider than the boards **24** and they are all set upon edge. While not essential they have been illustrated as of the same thickness. The timbers are preferably treated with a suitable preservative in the manner well known to the art before being assembled but untreated wood might be used. The type of character of preservative is not essential but may consist of creosoting or metallic salt impenetration. The timbers are preferably dressed so that they may fit tightly and evenly against each other and the laminated fabric is made up by fastening the various boards together by means of nails or spikes **25** or in any other suitable manner. Each longitudinal timber **23** or **24** may be of any suitable length. Preferably the timbers are made as long as the structure to be manufactured by adding boards or timbers at their ends. In the drawings vertical splices **26** are shown for convenience and economy but splices of any other character may be employed. The boards making up the individual timbers may be of random length as may be most economically procured or they may be of regular length but their arrangement in the laminated structure preferably will be such that the splices **26** will be staggered and overlapped by adjacent boards, the location of the splices preferably being such as to properly develop the strength of the structure. Preferably the ends of the boards should be neatly fitted in the splices **26**. It will be observed that this arrangement may make a sturdy relatively rigid construction extending throughout the entire structure.

The alternate timbers **24** being narrower vertically than the adjacent timbers **23** provide longitudinal grooves in the surface of the laminated structure. Into the laminated grooves at suitable points may be placed shear developers for transmitting and distributing the strains presently to be considered. The shear developers will preferably consist of triangular pieces of metal **27** shown somewhat enlarged in Fig. 5.

In Figs. 10 and 11 is shown a tool **28** having a handle **29**. The tool **28** is substantially the same size and shape as the shear developer **27** and is sharpened at its two edges **30**. Of course each shear developer might be sharpened on its edges and driven into its appropriate seat in the channels **31** above the narrower timbers **24** and between the wider timbers **23**. The expense of preparing and sharpening the shear developers **27**, however, would be relatively large and I therefore prefer to place the tool **28** at appropriate spots in the structure and give the handle **29** a blow so as to cut a seat for the shear developers **27** in the sides of the channel **31** and also in the bottom of the channels **31**. When the tool **28** is removed the shear developers may be placed in their seats and driven further home, insuring a rigid close grasp in the wood members.

In Fig. 5 is shown an enlarged fragmentary view of a shear developer **27** in position. It will be observed that the downwardly projecting tip **45** of the shear developer enters the edge of the narrower timber **24** and the two sides **46** and **47** of the shear developer **27** enter the wider timbers **23** at their upper corners. The area of the shear developer **27** which is in engagement with the three timbers may be calculated and adjusted so as to determine the stress which may be transmitted by the shear developer from the concrete into the wood. This arrangement as controlled by the tool **28** driven in to form the seat for the shear developer makes it possible to calculate in advance the stresses which may be transmitted by them and accordingly the stresses to which the completed structure may be put safely.

When the shear developers have been put in place a suitable surface coating such as concrete or cement **32** may be poured upon the laminated wood fabric. This will enter the channels **31** and engage the shear developers **27** and so be prevented from slipping or sliding in any direction. Because the cement slab is solid and rigid any strains or stresses caused by superincumbent weights will be distributed through the grooves **31** and shear developers **27** more or less uniformly throughout the entire structure. Weight placed midway between the supports **20** and **21** for instance will tend to be distributed in opposite directions toward those supports and for better supporting and distributing strains the shear developers **27** may be inclined toward this center from both sides as illustrated in Figs. 3 and 4.

As is well known, the principal stresses caused by superincumbent weights will be borne by the upper and lower edges of the construction. By properly proportioning integral parts of the structure of this invention, however, including the shear developers, the longitudinal strain, especially tension, will be largely upon the lower edge of the timbers making up the fabricated structure. Because wood is very considerably stronger than cement and because it is very much lighter, the present construction in which the wood and cement are so intimately associated as to form practically a unitary stress member is highly economical to construct, is relatively light and requires a minimum of supporting structure to carry it. It is to be noted that there are no longitudinal stringers necessary with the present construction but the laminated wood and concrete fabric has in itself sufficient strength to carry strains placed upon it.

The spikes **25** used to fasten the laminations together may be sufficient to distribute and carry whatever lateral strains may be placed upon the structure, but it may be convenient to provide at suitable intervals transverse straps **33** placed across the bottom of the structure. These straps may be of wood, preferably treated, and put in place on the bottom after the laminated structure has been built up in position. When the laminated structure is made up and assembled a strap **33** may be temporarily placed in position and suitably marked to indicate occasional separations or joints between the boards making up the laminated structure. A saw or other suitable instrument may be employed for making kerfs in the strap **33** corresponding with the positions of the joints in the laminations. In the kerfs may be seated shear developers **27**. The shear developers **27** preferably will be inserted so that their points extend upwardly and the straps **33** may be then placed in position below the laminated structure so that the points of the various shear developers enter between the laminations and then the entire strap carrying the shear developers **27** driven upward to contact with the lower side of the fabricated structure to the position shown in Fig. 2 where the shear developers have entered between the layers of the fabricated structure so as to equalize and distribute the load transversely. Of course the straps 33 may be additionally held in position by means of bolts or spikes 34. By this construction much of the transverse strain is applied longitudinally to the cross straps 33.

While a satisfactory construction can be made by employing boards 23 of uniform width, when desired, the upper edges of the projecting boards 23 may be apertured as indicated at 35 in Fig. 12. This construction may be somewhat more expensive but may be more effective for some purposes.

In Fig. 9 is shown an arrangement in which the wooden fabricated structure is made up of a series of alternate boards 36 which have between them boards 37 which extend somewhat above the upper edges of the boards 36 but do not come entirely to the bottoms of the boards 36. The alternate boards may be of equal or different widths. This arrangement saves considerable lumber and may be more effective for some uses. If in the arrangement shown in Fig. 2 the boards 23 are 2x10 inches for instance, and the boards 24 are 2x8 inches for instance, the layer of concrete 32 may be 4 inches for instance, giving the effect of a 14 inch beam. In the arrangement in Fig. 9, however, the members 36 may be 2x10 and the members 37 may be 2x8 or 2x6 arranged to project two inches above the tops of the members 36. When on this is put a layer of 4-inch concrete such as 32, there is produced the effect of a 16-inch beam with less or no more wood and cement than in the previously described 14-inch beam effect.

In view of the fact that the longitudinal strength of wood is very considerably more than the strength of the concrete it may be that by the arrangement in Fig. 2 which causes all of the wooden members to come to the bottom of the structure, more strength is produced at the bottom than is needed. By the arrangement in Fig. 9 only one half as much wood is provided at the bottom of the structure as by the arrangements illustrated in Fig. 2. This reduced amount of wood may ordinarily be sufficient to bear the strains imposed at the bottom as limited by the cement surface. In view of the fact that there are channels left below the members 37 in Fig. 9 the cross strap 33a instead of being provided with the shear developers 27 may be cut out on its upper surface leaving projections 38 to engage the channels or may have fastened upon or set into it blocks 39 to enter into and engage the channels.

The shear developers are illustrated in the form of equilateral triangles but this is not essential as various other triangular or other forms may be employed to engage the wood and concrete. The material of which the shear developers is made may be selected to meet various conditions of cost, durability and stress involved. Preferably they will be made of metal including such strong material as steel, wrought iron or steel alloys and of a size and thickness which may be suitable for the particular condition involved.

In view of the fact that timber as delivered may come of somewhat varying thickness, it is possible that in a long structure made up of spliced laminations the grooves 31 may not be straight but may waver somewhat in contour. This may not be fatal to the invention or indeed may be advantageous as forming an irregular grasp on the concrete. Nevertheless the timbers employed in the construction will preferably be dressed to approximately uniform thickness thus giving better, closer fits in the various timbers especially at the splices where this is more important.

The composite structure will ordinarily contain within itself in the laminated structure sufficient wood to support the workmen and machinery involved in the installation and pouring of the cement surface and since the cement is poured directly upon the laminated wood structure no construction supports, posts or frames are needed. It will be observed that there is produced a construction having great strength for its weight and having a rigid, hard-wearing surface for traffic, whether of foot or vehicles.

The invention produces a construction of vertical laminations of wood of the same or different depths forming grooves on the top surface of the wood operating to bind the concrete top to the wood thus forming a composite structure the two materials acting together as a single stress member, especially in view of the metal shear developers which are driven into the tops and sides of the laminations to prevent slippage between the concrete and wood when beam action or bending stress is developed, the laminated pieces of wood being so proportioned and placed as to develop the maximum strength and stiffness of the two materials making up the composite structure. The concrete top also acts as a protection from weather to the underlying laminated wood structure thus tending to afford a permanent construction free from the expense of frequent repairs.

The construction may be of any desired length or of any desired width depending upon the number and size of laminations employed.

When the structure is installed as a flooring in a building the underside of the laminated structure may be exposed unfinished or may be painted or have applied to it or suspended from it any suitable plastering or other desired ceiling material.

It may be desired to fabricate separate units and place them in appropriate positions for use. Such an arrangement is especially indicated in Figs. 6, 7 and 8. A plurality of laminated fabrics of wood similar to that already described may be formed of a suitable length and width. A pair of such laminated structures after being provided with suitable shear developers 27 may be placed on their sides as indicated in Fig. 8 with their channel sides facing each other and a suitable distance apart. Cement or concrete 40 may then be poured between the members fastening them together and finally setting into a unit. Projecting from the fabricated members may be bolts 41 provided with collars or washers 42 at their heads to produce additional anchorage in the concrete and reinforcement for the structure as a whole. Tongues 43 and grooves 44 may be formed in the respective sides of the elements so that when they are placed side by side as illustrated in Fig. 6 they may interlock.

Since the concrete 32 enters into the grooves or channels above the members 24 there is a natural line of weakness or cleavage in the concrete at the upper edge of the members 23. It will be noted, however, that as shown more clearly in Fig. 5 the shear developers 27 are arranged so that they project above the upper edges of the timbers 23 and into the cement 32 beyond this line of weakness thus transferring the stress directly from the body of the cement into the wood and insuring a better and stronger construction of the combined member.

Ordinarily it may be found desirable to use a surface layer of concrete made by the use of Portland cement but other types of concrete may be used when desired or convenient and where the terms concrete or cement are used in the claims they are to be taken in the broader sense as relating to any suitable concrete however produced.

The proportions described and illustrated may make the substance of the invention clear but are not essential to the invention. The forms, shapes, arrangements, proportions and sizes of the various elements may be suitably varied without departing from the invention.

I claim as my invention:

1. A composite construction comprising a laminated wood base made up of contacting vertical laminations of preserved wood each made up of a plurality of boards placed end to end the joints in the various laminations overlapping and alternate laminations having edges at different levels, triangular metallic shear developers inserted between projecting laminations and engaging them and the intermediate lamination each shear developer being inclined in an appropriate direction, a layer of concrete on the face of the wood base and engaging and enveloping the shear developers, a transverse strap across the free edge of the laminations and shear developers between the laminations and engaging the strap.

2. A composite construction comprising a laminated wood base made up of contacting vertical laminations of preserved wood each made up of a plurality of boards placed end to end the joints in the various laminations overlapping and alternate laminations having edges at different levels, triangular metallic shear developers inserted between projecting laminations and engaging them and the intermediate lamination each shear developer being inclined in an appropriate direction, a layer of concrete on the face of the wood base and engaging and enveloping the shear developers and a transverse strap across the free edge of the laminations.

3. A composite construction comprising a laminated wood base made up of contacting vertical laminations of preserved wood each made up of a plurality of boards placed end to end the joints in the various laminations overlapping and alternate laminations having edges at different levels, shear developers in the face of the laminated structure and extending therebeyond each shear developer being inclined in an appropriate direction, a layer of concrete on the face of the wood base and engaging and enveloping the shear developers, a transverse strap across the free edge of the laminations and shear developers between the laminations and engaging the strap.

4. A composite construction comprising a laminated wood base made up of contacting vertical laminations of preserved wood each made up of a plurality of boards placed end to end the joints in the various laminations overlapping and alternate laminations having edges at different levels, shear developers inserted between and engaging projecting laminations each shear developer being inclined in an appropriate direction, a layer of concrete on the face of the wood base and engaging and enveloping the shear developers, a transverse strap across the free edge of the laminations and shear developers between the laminations and engaging the strap.

5. A composite construction comprising a laminated wood base made up of contacting vertical laminations of preserved wood each made up of a plurality of boards placed end to end the joints in the various laminations overlapping and alternate laminations having edges at different levels on both sides, triangular metallic shear developers inserted between projecting laminations and engaging them and the intermediate lamination, each shear developer being inclined in an appropriate direction, a layer of concrete on the face of the wood base and engaging and enveloping the shear developers, a transverse strap across the free edge of the laminations and means thereon for engaging the projecting edges of the laminations.

6. A composite construction comprising two series of longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels in their faces, shear developers in the channels and engaging the adjacent timbers and projecting beyond the timbers and channels, the two series being arranged with their channel sides facing each other, cement between the two series and filling the channels of each and engaging all the shear developers and additional anchoring and reinforcing members projecting from the series into the cement.

7. A composite construction comprising two series of longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels in their faces, shear developers in the channels and engaging the adjacent timbers and projecting beyond the timbers and channels, the two series being arranged with their channel sides facing each other, and cement between the two series and filling the channels of each and engaging all the shear developers.

8. A composite construction comprising two series of longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels in their faces, the two series being arranged with their channel sides facing each other, cement between the two series and filling the channels of each and anchoring and reinforcing members projecting from the series into the cement.

9. A composite construction comprising two series of longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels in their faces, the two series being arranged with their channel sides facing each other, and cement between the two series and filling the channels of each.

10. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height secured thereto and forming longitudinal channels all secured together in continuous succession the timbers being made of a plurality of pieces laid end to end with staggered joints, shear developers in the channels engaging the timbers forming the channels and extending beyond the timbers and channels and cement on the face engaging the channels and the shear developers.

11. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers having edges of less height secured thereto and forming longitudinal channels all

secured together in continuous succession the timbers being made of a plurality of pieces laid end to end with staggered joints, shear developers in the channels engaging the timbers forming the channels and extending beyond the timbers and channels, cement on the face engaging the channels and the shear developers, and a transverse strap across the free edge of the laminations.

12. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height secured thereto and forming longitudinal channels all secured together in continuous succession the timbers being made of a plurality of pieces laid end to end with staggered joints, transverse shear developers in the channels engaging the timbers forming the channels and extending beyond the timbers and the channels and cement on the face engaging the channels and the shear developers.

13. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels, shear developers in the channels and engaging the adjacent timbers and projecting beyond the timbers and out of the channels, and a layer of cement over the surface and filling the channels and engaging the shear developers.

14. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels, transverse shear developers in the channels and engaging the adjacent timbers and extending beyond the timbers and the channels and a layer of cement over the surface and filling the channels and engaging the shear developers.

15. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels, transverse metallic shear developers in the channels and engaging the adjacent timbers and projecting beyond the timbers and out of the channels, and a layer of cement over the surface and filling the channels and engaging the shear developers.

16. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels at both faces, shear developers in the channels at one face and engaging the adjacent timbers and projecting beyond the timbers and out of the channels, a layer of cement over the face filling the channels and engaging the shear developers, a strap across the other face and means thereon for engaging the projecting edges of the timbers.

17. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels at both faces, a layer of cement over the face filling the channels, a strap across the other face and means thereon for engaging the projecting edges of the timbers.

18. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels at both faces each timber made up of a plurality of boards placed end to end the joints of the various laminations overlapping, shear developers in the channels at one face and engaging the adjacent timbers and projecting beyond the timbers and out of the channels, a layer of cement over the face filling the channels and engaging the shear developers, a strap across the other face and means thereon for engaging the projecting edges of the timbers.

19. A composite construction comprising longitudinal timbers laid on edge with intermediate timbers of less height rigidly secured thereto and forming longitudinal channels at both faces, shear developers in the channels at one face and engaging the adjacent timbers and projecting beyond them, a layer of cement over the face filling the channels and engaging the shear developers, a strap across the other face and means integral therewith for engaging the projecting edges of the timbers.

20. A composite construction comprising longitudinal timbers laid on edge with the edges of alternate timbers extending beyond the others and rigidly secured together to form longitudinal channels, shear developers in the channels and engaging the adjacent timbers and extending beyond the timbers and out of the channels, and a layer of cement on the surface engaging the shear developers and filling the channels.

21. A composite construction comprising longitudinal timbers with their exposed surfaces separated from each other and secured together to form longitudinal channels, shear developers in the channels and engaging the timbers and extending beyond the timbers and out of the channels, and a layer of cement over the exposed surface and engaging the shear developers and filling the channels.

22. A composite construction comprising longitudinal timbers laid on edge, transverse shear developers extending from the edges of the timbers and beyond the area enclosed by the timbers, and a layer of cement engaging the edges of the timbers and the shear developers.

23. A composite construction comprising longitudinal timbers laid on edge, transverse diversely inclined shear developers extending from the edges of the timbers, and a layer of cement engaging the edges of the timbers and the shear developers.

JAMES F. SEILER.

Dec. 5, 1944.

J. F. SEILER

2,364,481

SHEAR DEVELOPER

Filed Dec. 7, 1943

2 Sheets-Sheet 1

Fig. 1

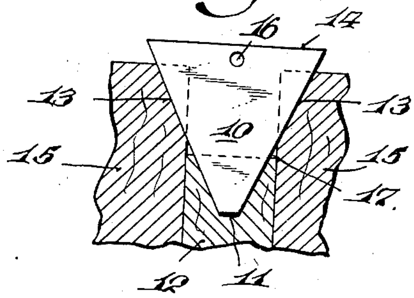


Fig. 3

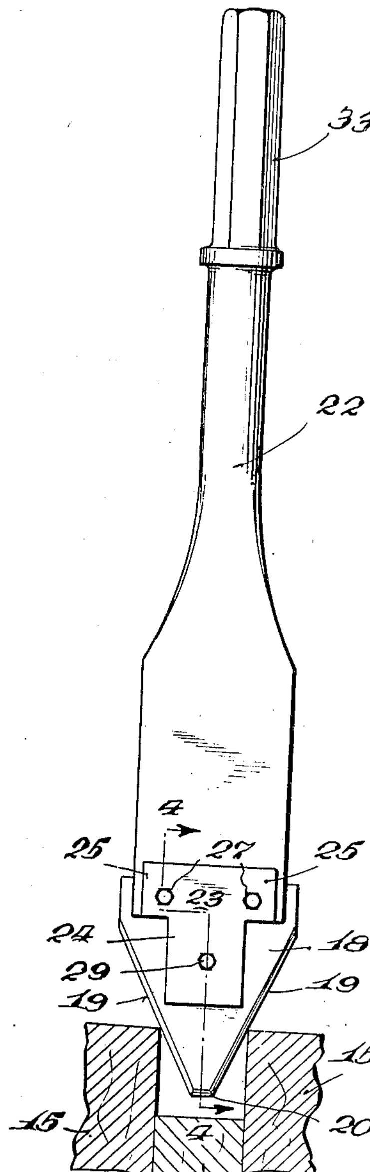


Fig. 2

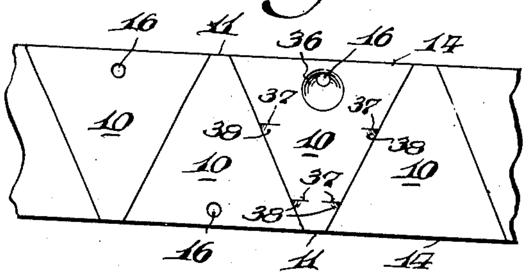
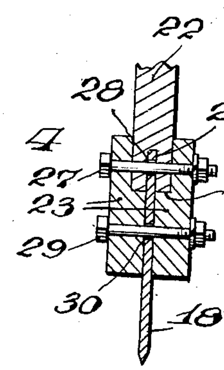


Fig. 4



Inventor

J. F. Seiler,

By Karl Fenning

his Attorney

Dec. 5, 1944. J. F. SEILER 2,364,481

SHEAR DEVELOPER

Filed Dec. 7, 1943 2 Sheets-Sheet 2

Fig. 5

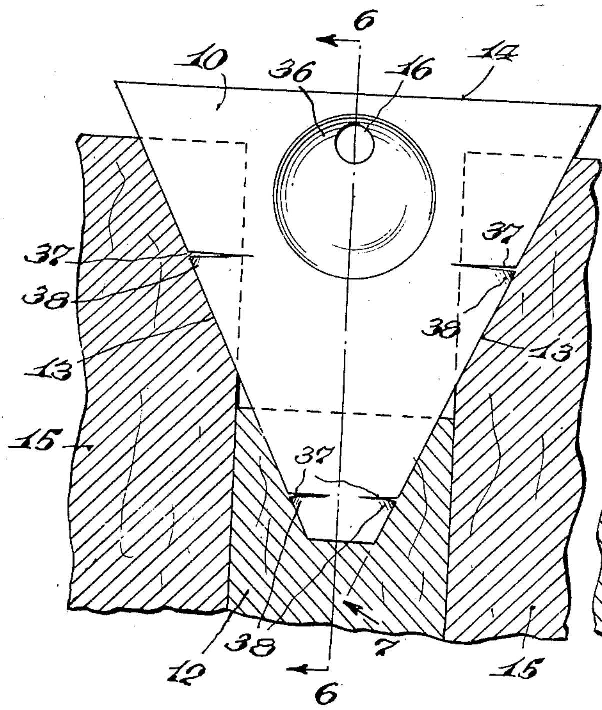


Fig. 6

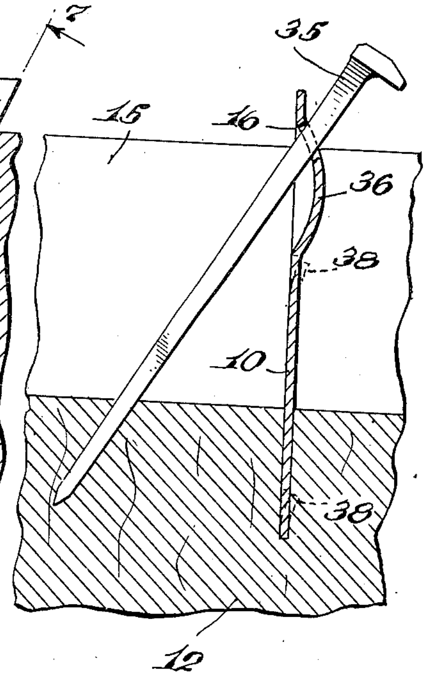
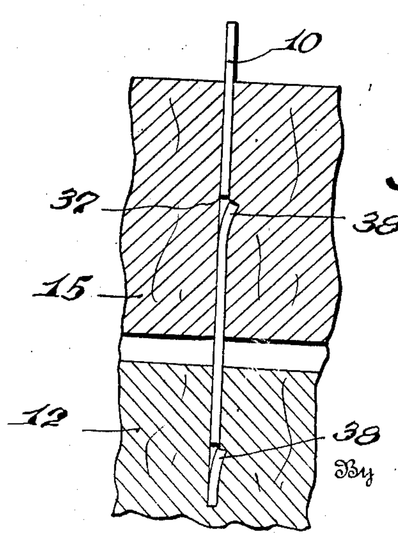


Fig. 7



Inventor

J. F. Seiler,

By Karl Henning

his Attorney

UNITED STATES PATENT OFFICE

2,364,481

SHEAR DEVELOPER

James F. Seiler, Washington, D. C., assignor to American Wood-Preservers' Association, a corporation of Illinois

Application December 7, 1943, Serial No. 513,292

14 Claims. (Cl. 72—33)

The invention relates to an improvement in apparatus adapted for making the construction of my Patent 2,022,693, issued December 3, 1935. In that patent is described a structure made up of wood and concrete in which are employed shear developers adapted to partially receive and distribute the loads carried by the structure. It is a purpose of the present invention to provide an improved form of shear developer. Since these devices are disposed as connecting units between the concrete and wood, it is essential that they engage both and form a satisfactory connection. This requires the developers to be secured into the wood in such a way as to have sure strong seats and extend out sufficiently to be securely embedded in the concrete when it is applied. It has been found that this may be done most effectively by employing a specially shaped shear developer as set out herein.

The shear developers in general are set in or across a trough made by three pieces of wood, the middle one being set below or inwardly of the edges of the adjacent members. In order to effect a strong setting, the shear developer must engage the piece of wood at the bottom of the trough and also at its sides must engage the extending edges of the wood at the side of the trough. It has been found that this may be done efficiently by employing a shear developer especially adapted to this end and also so as to cross and close almost the entire area of the trough and at the same time extend therebeyond and be free to be engaged by the concrete when put in place.

In order to insure better holding in the wood, the shear developers may be provided with irregularities or projections at some or all of the areas which are buried in the wood.

In order to make the shear developer better resist the stresses in the completed structure, it may be dished or bent or deformed especially at the areas engaged by the concrete and more especially about the holes if present.

An additional purpose of the present invention is to provide means for conveniently handling the shear developers during manufacture, transportation and installation. This may conveniently consist of a hole formed at a predetermined part in the shear developer so as to act as an index or guide to the proper placing of it in the wooden base. The hole may also furnish a seat for a bolt or spike passing therethrough and entering the wood and being buried in the concrete to further reinforce the shear developer against movement during pouring of the concrete and construction activities and also in the completed structure which may thus be made more sturdy.

An improved tool for grooving the seats for the shear developers is also included.

This application is a continuation-in-part of my application Serial No. 351,007, filed August 3, 1940.

In the accompanying drawings, Figure 1 is a front elevation of one form of shear developer in place in a trough between pieces of wood which are shown in section. Fig. 2 is a fragmentary plan view of a portion of a blank from which may be made a plurality of shear developers. Fig. 3 is a front elevation of a tool which may be conveniently used to form seats for shear developers in the wood which is shown in section. Fig. 4 is a fragmentary vertical section on the line 4—4 of Fig. 3. Fig. 5 is a view similar to Fig. 1 showing another form of shear developer. Fig. 6 is a vertical section on line 6—6 of Fig. 5 showing a spike in place, and Fig. 7 is a section on the line 7—7 of Fig. 5.

The trough into which the shear developers are set is normally about as wide as it is deep and it is desirable that the developer have a sturdy sure engagement with the bottom and with both sides of the trough. One element which may determine the strength of engagement may be how deep into the wood the developer enters. It has been found that a pointed end must go much further into the wood to obtain a comparable seating than if the end is obtuse or wider. It has also been found that an inclined seat is more easily made in the sides of the trough with such an end. The shear developer **10** is made triangular in shape but with one point omitted forming a straight edge at **11**. Preferably the shape will be that of a trapezoid in the form of a truncated isosceles triangle, the apex being cut off parallel to the base. This truncated end is embedded a suitable depth in the wood **12** at the bottom of the trough giving a wide grasp on the wood. By being embedded to a slight depth it may extend nearly entirely across the bottom of the trough. In this position the sides of the shear developer will be embedded through most of the remainder of their extent in the wooden side walls **15** of the trough as indicated at **13**. This may give a strong engagement with the wood to hold the shear developer more or less certainly in place and so allow it to form a more or less sturdy connection with the concrete to be put in place. The base **14** of the triangle and a small area adjacent thereto extend beyond the edges of the side walls **15** of the trough and are free to be embedded in concrete to be applied. The concrete also enters the trough and makes contact with the entire surface of the shear developers 10 except the portions buried in the walls 15 and the bottom 12 of the trough.

The shear developer near its base is provided with a hole 16 which may act as a key and aid in holding the concrete. It will be noted that the form of shear developer shown leaves, when installed, small triangular areas 17 at the bottom corners of the trough unfilled and concrete settling into these to some extent may act as keys and assist in holding the concrete and to preserve the continuity of concrete on both sides of the shear developer.

Because of their peculiar shape the shear developers 10 may be economically made by cutting or stamping or the like from a strip or sheet of suitable thickness without substantial loss of material by being formed and separated as shown in Fig. 2 where the edge of each shear developer fully adjoins the edge of an adjacent shear developer.

Large numbers of shear developers are used in each structure and the hole 16 is found a convenient means of fastening them together for shipping and handling during manufacture, transportation, storage and installation. Unskilled labor may be used for installation since the hole 16 may be used as a guide or index as it may indicate the edge of the device which extends from the trough and is to be entirely covered with concrete.

As shown in Fig. 6, a spike or nail 35 may be passed through the hole and driven into the bottom wood member 12. This tends to hold the shear developer rigidly in place and at the same time the spike may furnish additional anchorage for the concrete.

The shear developer may be made of suitable material to stand the strains to which it is put, being preferably of structural grade steel. It may be desirable to have the shear developer plated or coated such as by galvanizing or dipping in zinc or other protective coverings. For such procedure the hole 16 forms an easy and convenient means for handling during coating.

To further reinforce or strengthen the shear developer, it may be deformed or dished as shown at 36 in Figs. 5, 6 and 2. When both hole and dished portion are present, it may or may not be desirable to have the hole 16 in the dished part of the shear developer.

The shear developer may be installed by being suitably positioned and driven in place and, to aid in such procedure, the sides and truncated end may be sharpened if desired. It is found better and more convenient in general, however, to employ a tool for cutting or grooving the seats into which the shear developers are to be placed. Such a tool is illustrated in Figs. 3 and 4. There is provided a blade corresponding in size and shape to the shear developer to be installed. This blade may be made of hardened cutting metal and is sharpened at its edges 19 and at its truncated end 20 and is held in a slot 21 in a handle 22, the end 33 of which may be so shaped that it may be driven by a manual sledge hammer or in a standard pneumatic hammer or other power-operated device. The handle also carries guides 23, one on each side of the blade 18. Each guide has a tongue 24 slightly narrower than the width of the trough between the members 15 but somewhat longer than the depth of the trough. At its upper end each tongue 24 is provided with laterally extending projections 25 to provide for proper connection to the handle and to brace the device. When the tongue 24 reaches the bottom member 12 a sufficient groove has been made to receive the shear developer. The bottom of the handle 22 finds a seat 26 in the guides 23. Bolts 27 hold the guides 23 onto the handle 22 and pass through enlarged holes 28 in the blade 18. A bolt 29 is shown holding the guides 23 against the blade 18 and passing through an enlarged hole 30 in the blade. Thus pressure from the handle 22 is put on the blade 18 at its upper edge in the slot 21 and no strain is carried by the bolts 27 and 29 to the blade 18. When desired, the bolts 27 and 29 may be removed and guides and blades of other sizes and shapes may be substituted to correspond with whatever shear developers are being installed in whatever troughs are being used.

To aid in holding the shear developer in place in its seat, cuts 37 may be provided at points in their margins or edges 13 which are adapted to be set in the wood. The portions 38 below the cuts may be pushed or turned out of the plane of the shear developer. As indicated especially in Fig. 7, such cut and turned or pushed out portions may pass through the wood resiliently and finally seat themselves in such a way as to press into the wood and grip it so as to better resist the strains and hold against withdrawal or displacement. While not essential it may be desirable that the cut portions be not pushed out farther than the thickness of the material as shown.

The shear developers may be plain as shown in Fig. 1, or may have holes, dished portions and gripping portions turned out at cuts in their edges as illustrated in Figs. 5 and 7, or any one or more of these extra elements may be omitted.

Since the dished portion 36 extends on the same side of the shear developer as the turned out portions 38, even the shear developer with all the details shown in Fig. 5 may be made by a single operation of the die from the strip of metal, as indicated in Fig. 2.

Forms and dimensions may be varied to meet desires and conditions of use without departing from the invention.

I claim:

1. A shear developer comprising a truncated isosceles triangular metal plate with a perforation near the base and substantially equidistant from the sides.

2. A shear developer for wood and concrete structure comprising a truncated isosceles triangular metal plate adapted to have an area near its base extending into the concrete and its truncated end and most of its sides embedded in the wood.

3. A shear developer for a wood and concrete structure comprising a truncated isosceles triangular metal plate adapted to be seated in a trough in the wood with its truncated end embedded in the bottom of the trough and most of its sides embedded in the sides of the trough and the remainder embedded in the concrete with a portion adjacent the base extending beyond the mouth of the trough and provided with a hole in the extending portion.

4. A shear developer seat grooving tool comprising a blade corresponding in size to the shear developer and sharpened at its edges, a pair of guides one on each side of the blade, a tongue on each guide fitting in the trough into which the shear developer is to be seated and engaging

the material at the bottom of the trough and limiting the entrance of the blade, and a handle carrying the blade and the guides and adapted when hit to cause the blade to groove the seat for the developer.

5. In a device of the class described, a truncated isosceles triangular metal plate adapted to be seated in a trough of wood with its truncated end and part of its sides embedded in the bottom of the trough and most of the rest of its sides embedded in the sides of the trough.

6. A shear developer comprising a truncated isosceles triangular metal plate with a reinforcing depression near the base and between the sides.

7. A shear developer comprising a truncated isosceles triangular metal plate with a perforation near the base and substantially equidistant from the sides, a reinforcing depression, and portions at the margins cut and pushed out.

8. A shear developer for a wood and concrete structure comprising a truncated isosceles triangular metal plate adapted to be seated in a trough in the wood with its truncated end embedded in the bottom of the trough and most of its sides embedded in the sides of the trough and the remainder embedded in the concrete with a portion adjacent the base extending beyond the mouth of the trough and portions at wood-embedded points cut and pushed out to engage the wood, and a reinforcing depression in the concrete embedded portion.

9. A shear developer for a wood and concrete structure comprising a truncated isosceles triangular metal plate adapted to be seated in a trough in the wood with its truncated end embedded in the bottom of the trough and most of its sides embedded in the sides of the trough and the remainder embedded in the concrete with a portion adjacent the base extending beyond the mouth of the trough and portions at wood-embedded points cut and pushed out to engage the wood.

10. A shear developer for wood and concrete structures comprising a truncated isosceles triangular metal plate adapted to have an area near its base extending into the concrete and its truncated end and most of its sides embedded in the wood, portions at embedded points cut and pushed out to engage the wood.

11. A shear developer for wood and concrete structures comprising a truncated isosceles triangular metal plate adapted to have an area near its base extending into the concrete and provided with a reinforcing depression and its truncated end and most of its sides embedded in the wood and portions at embedded points pushed out to engage the wood.

12. A shear developer for wood and concrete structures comprising a truncated isosceles triangular metal plate adapted to have an area near its base provided with a hole and extending into the concrete and its truncated end and most of its sides embedded in the wood, a spike through the hole and engaging the wood.

13. A shear developer for a wood and concrete structure comprising a truncated isosceles triangular metal plate adapted to be seated in a trough in the wood with its truncated end embedded in the bottom of the trough and most of its sides embedded in the sides of the trough and the remainder embedded in the concrete with a portion adjacent the base extending beyond the mouth of the trough and provided with a hole in the extending portion, and a spike through the hole and seated in the bottom of the trough.

14. A shear developer for a wood and concrete structure comprising a truncated isosceles triangular metal plate adapted to be seated in a trough in the wood with its truncated end embedded in the bottom of the trough and most of its sides embedded in the sides of the trough and the remainder embedded in the concrete with a portion adjacent the base extending beyond the mouth of the trough and provided with a hole in the extending portion and portions at points embedded in the wood cut and pushed out to engage the wood, and a spike through the hole and seated in the bottom of the trough.

JAMES F. SEILER.