Society for Industrial Archeology · New England Chapters

VOLUME 22 NUMBER 2 2002

CONTENTS

CONTRIBUTORS
Tom Evans, Jonathan Kranz, Allison Rachleff, David Starbuck, Robert Stewart, and Sara Wermiel.

EDITOR
David Starbuck
PO Box 492
Chestertown, NY 12817-0492
starbuck@netheaven.com

Help is Sought for Endangered Water-Powered Mills

A number of us have become concerned about the probable imminent demise of two important small mills in Northern New England and have been trying to come up with a way to save them. They are both important because they still contain all their original equipment, but they are both in precarious condition and their owners are unable or unwilling to do anything to save them or to turn them over to others who stand ready and able to do something.

The first is the grist mill at Wells, Vermont. It was built in 1806 and operated until the early 1950's, when it was abandoned and has stood unmaintained ever since, saved due to its slate roof. It is important because of the extreme scarcity of complete grist mills in Northern New England (although it has been compromised somewhat by the removal of all but one set of stones and the installation of feed mill equipment late in its carrier) and especially due to the presence in the basement of the original waterwheel (unused after turbines were installed later in the working life of the mill) which is an unremarkable 8' in diameter but an amazing 22' wide. Parts of the walls have begun to fail, and the owner has decided to take it down next year if a way to repair it cannot be found. He does not have the financial resources to fund the work himself. A group of us met with him this spring and were hopeful that a non-profit "Friends" group could be formed and an agreement could be reached which would allow non-profit grant money to be solicited. However since then, the owners havedecided that they don't want to relinquish any control of their property to a non-profit, fearing they might eventually lose their property. This is somewhat understandable considering that the mill is only 13 feet from their house in their backyard.

The other mill is a soapstone mill in Francestown NH. It is a small building on a small plot of land, important because not only are soapstone mills in any condition rare, but because it still contains two complete up-and-down saw rigs identical to the type used in early sawmills but with short carriages adapted to sawing soapstone, other machinery, a stock of cut and uncut soapstone, and even some unsold soapstone stoves. Ice jams in the river have knocked out much of the underpinnings of the building, which is otherwise in fairly good condition considering that it, too, has seen no maintenance since the early 1950's, and it is close to collapsing into the river. The Francestown Historical Society would like to acquire the property for preservation, but the owner, who lives out of state, has resisted all efforts on their part and has failed to do anything about the mill herself despite the fact that she will be liable should it fall into the river.

Besides myself, others who have been working on one or the other of these situations include James Garvin (SIA & NHDHR), Don Woods (SIA & SPOOM), Floyd Harwood (SPOOM), the Vermont Division for Historic Preservation, the Preservation Trust of Vermont, and the Francestown Historical Society. We are all quite frustrated and would welcome any suggestions or appropriate (within the precepts of private property rights) intervention which anyone might be able to offer.

Tom Evans
P.O. Box 178
Campton, NH 03223

Presidents' Comments

Northern New England Chapter

The Northern New England Chapter held its fall 2002 meeting at the Daloz Mill in Hancock, New Hampshire, on November 2. Many of our older chapter members will recall touring the mill years ago with the late Al Daloz -- who was one of our founding members -- and now his son Charles Daloz owns the mill, and he was our most helpful guide. Many thanks to Dennis Howe and Jim Garvin for setting up this meeting. We traveled to Historic Harrisville in the afternoon to view a recently-discovered turbine underneath the "Stone Mill."

Many of our chapter members will also remember Richard Borges, who was a member for many years before becoming Director of the Upper Midwest Conservation Association at the Minneapolis Institute of Arts. Dick has now become Director at the Bennington Museum in Vermont, and we anticipate his becoming active in our chapter once again (and perhaps he will help to set up some chapter meetings in the Bennington area!).

David Starbuck
Plymouth State College

Southern New England Chapter

The Southern New England Chapter toured two contrasting Massachusetts sites earlier this year. On May 24 a score of our members, clad in hard hats and safety gear, visited the LeBaron Foundry in Brockton. The LeBaron Foundry designs and manufactures iron castings used in public works. They've been doing foundry work and making a complete line of the municipal castings for sewers, pipelines, electrical conduits and catch basins since 1855. Our second tour, at Ray Larsen's shop in Hanover, gave chapter members an opportunity to see obsolescent hand tools being made using hand forging techniques. Larsen's Genuine Forgery hosted the chapter on June 1. The forgery turns out extremely high quality tools that are no longer available from commercial tool makers. Ray makes these tools for boatbuilders, traditional wood workers and specialty furniture manufacturers.

Ten SIA-SNEC chapter members attended the recent SIA Study Tour of Sweden. The details of the tour will be covered in a future edition of the SIA Newsletter. Of particular interest to SNEC members who are involved in studying early iron making were the numerous well-preserved sites of proto-industrial iron production. We visited the site of a plant for iron production that dated from the middle of the 12th century. Excavation of the Lapphyttan site started in the 1970s and took six years to complete. The work revealed a blast furnace and complete medieval iron works. Besides houses and stables, there were eight forges, a roasting pit and water powered mechanisms for operating blast furnace bellows. What is even more interesting is that two local communities provided most of the funding to rebuild a replica of the complex at a nearby location. Nya Lapphyttan's equipment has been rebuilt to operate and produce iron. To date they have operated the blast furnace four times and have had success during the last attempt, producing 50 kg of iron. Refining the pig iron takes place in several forges. Only the blast furnace bellows is water powered. Refining forges featured manually operated bellows. The site is an outstanding example of traditional and experimental archaeology. Nya Lapphyttan is a leader in redeveloping the technology of early iron production.

I will be offering a proposal to the national SIA board concerning organizing an annual meeting and conference in the Blackstone Valley in May-June 2004. Our past and present chapter vice-presidents have been successful in arranging plant tours over the years. Our area certainly offers an extensive collection of factories, sites and museums of interest to SIA members. Several of our members expressed confidence that we can organize tours and a successful annual conference. We will be looking for volunteer tour guides, writers, registrars and general volunteers if the national board authorizes us to proceed.

Bob Stewart
West Suffield, Connecticut

Genuine Forgery: The Real Thing

On June 1, SNEC visited Ray Larsen's blacksmithing operation, Genuine Forgery in Hanover, Massachusetts. After giving us an introductory talk on his personal transformation from steel industry journalist to hammer-swinging blacksmith, Ray led us to his workshop for a comprehensive demonstration of his skills, knowledge and business practices. From common 2.5" square stock, Ray made four tools before our eyes, then allowed us an opportunity to heat and hammer some metal ourselves.

Contrary to what one might expect, Ray doesn't concentrate on custom or decorative work, but has found a sustainable business niche manufacturing specialty tools for chair makers, boat builders and advanced woodworkers. For greater efficiency, Ray operates two 25-ton mechanical power hammers; a third air hammer, rescued from the US military, awaits restoration.

After the demo, Ray led us to a creek behind his shop where colonial-era iron processing was suspected to have taken place. Indeed, members found slag in the mud, and Jim Johnston identified a crusty, slag and iron rich nugget as "skull" or "mosser," the remains of iron making in a bloomery furnace. Some participants believed the site may contain bog ore, and there was discussion about a potential future SNEC exploration of the creek.

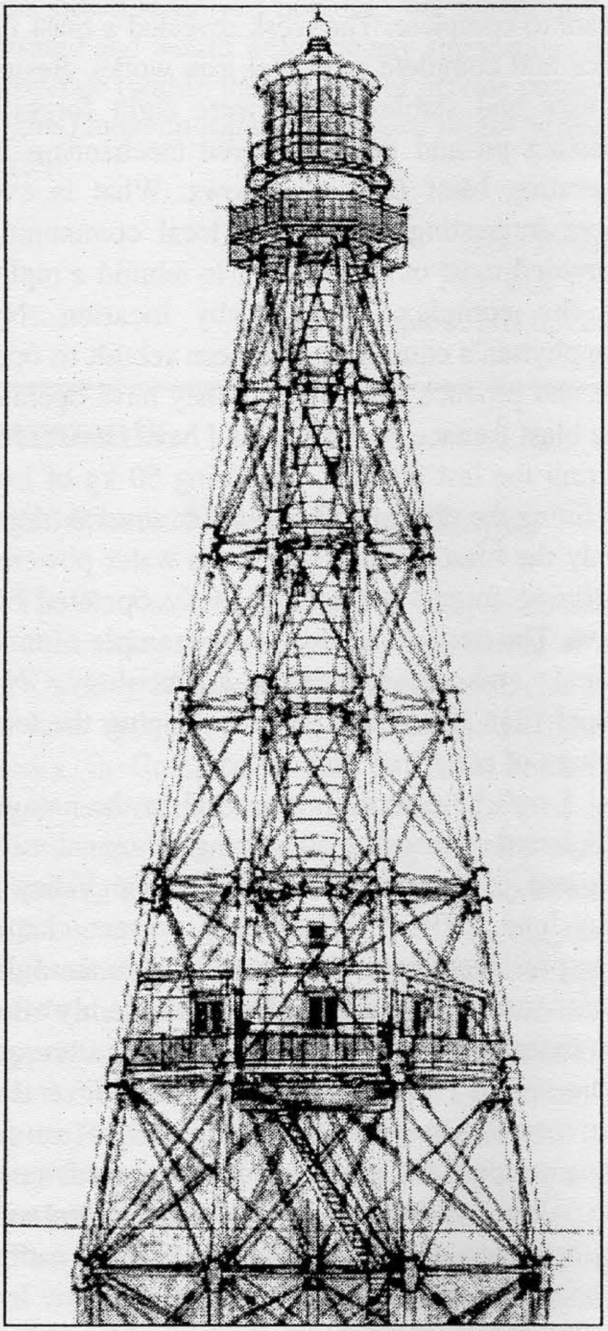
By Jonathan Kranz
with help from Jim Johnston

LeBaron Foundry
Green Sand Casting Streamlined

Members of the Southern New England Chapter toured the LeBaron Foundry in Brockton on May 24. Suitably attired in long-sleeved shirts, hard hats and goggles, we watched workers making "green sand" molds, pouring molten iron, cleanup of finished castings and other foundry techniques. LeBaron, New England's largest manufacturer of municipal castings, has a rich history dating from the mid-19th century. While not familiar to the consumer trade, the LeBaron name is well known among municipal engineers, contractors and public works authorities. They manufacture the manhole frames and covers installed in hundreds of communities. The company began in 1855 in Middleboro, Massachusetts, as a manufacturer of cast iron stoves, sash weights, ornamental iron vases, urns and hitching posts. LeBaron also ran a steamboat excursion service and operated a chain of ice houses. In 1911 LeBaron relocated to Brockton and started making boilers and municipal castings. A group of longtime employees bought the company from the LeBaron family in 1985.

LeBaron operations combine 19th century green sand molding techniques with modern material handling methods and mechanized foundry practice. Mixing of green sand, a blend of damp sand, Bentonite clay and pulverized carbon, is automated. Extensive mechanization and ample use of conveyor belts, roller tables and jib cranes minimized heavy labor. Manpower requirements for handling the heavy flasks, copes, drags and castings were significantly reduced with modern materials handling equipment. The plant melts about 100 tons of scrap iron per day in a cupola. Its scrap storage pile contained old plumbing fixtures, engine blocks, recovered old municipal castings and defective castings. Iron samples are periodically drawn from the cupola and the melt is adjusted to meet an American Society for Testing Materials (ASTM) specification. LeBaron also evaluates test bars for conformance to highway transportation specifications. After cleaning mold sand remains and removing sprues and risers, castings are sandblasted. Some castings undergo machining of mating surfaces. Other castings receive an asphalt coating to resist rust. LeBaron produces every kind of casting seen in the street. The storage yard is filled with finished catch basins, sewerage fittings and pipe fittings. Other finished castings included grids, standard frames, covers, electrical, water and gas box access plates. The tour gave SNEC members an opportunity to see a modern casting operation "close up and personal." The chapter appreciates LeBaron's hospitality and the opportunity to tour their plant.

Bob Stewart
West Suffield, Connecticut



Alligator Reef Lighthouse, Florida, 1873

New Book about Army Engineers and Iron Structures in the Nineteenth Century

By Sara Wermiel

Since the late nineteenth century, the work of the U.S. Army Corps of Engineers has centered on waterways – rivers and harbors. But earlier in the nineteenth century, being some of the few professional engineers in the nation, Army engineers were called on to help with a variety of civil (in contrast to military) engineering projects. Their work on early railroads has received attention by historians. But one facet of their activities – that they were among the first Americans to build with iron – had not been studied as such. Charles Peterson, founder of the HABS program, noted this gap in his 1980 article "Inventing the I-beam: Richard Turner, Cooper & Hewitt and Others." In it, he wrote about the federal government's role in encouraging American rolling mills to introduce I-beams in the 1850s and the involvement of Army engineers in this process, and then concluded, "The whole story of the Corps of Engineers' contribution to the evolution of iron construction in this period is long overdue for a definitive study."

My new book, *Army Engineers' Contributions to the Development of Iron Construction in the Nineteenth Century*, attempts to fill this gap. The method I used to research the topic involved tracking down examples of officers of the U.S. Army Corps of Engineers and Corps of Topographical Engineers' work on iron structures for civil purposes, principally in the years when iron construction was new in the U.S. and designers were feeling their way with this novel structural material. I found that the kinds of iron structures Army officers worked on mainly were iron skeleton lighthouses and iron-framed fireproof buildings. Army engineers continued to have responsibility for constructing the nation's lighthouses until 1910, but stopped working on public buildings during the Civil War and, with the exception of buildings in Washington, D.C., never returned to this line of work.

The first part of the book treats the early history of the iron lighthouses. In New England today, only one skeleton lighthouse survives from the period when Army engineers handled lighthouse construction: an 1896 steel skeleton on land in Marblehead, Massachusetts. But Massachusetts was the site of the nation's first skeleton lighthouse, the original Minot's Ledge lighthouse, near Cohasset, Massachusetts and built by Massachusetts-native, Capt. William Swift. The story of this ill-fated lighthouse has been told before, but in my book, the lighthouse is placed in context of the numerous similar lighthouses that were being built at the same time. Remarkably, several of its contemporaries, completed in the 1850s, are still standing on their original water-covered sites (off the south coast of Florida).

The second part of the book deals with the early iron-framed fireproof buildings built by the federal government in the 1850s under the overall direction of an Army engineer, Capt. Alexander Bowman. These 1850s building were designed by the New Hampshire-born architect, Ammi B. Young. Several New England examples survive, including the post office in Windsor, Vermont, and a former customhouse in Portsmouth, New Hampshire. In this section of the book, the history of the development of rolled I-beams is detailed.

The book will be of interest to anyone who wants to learn more about the history of lighthouses and the use of iron structurally, and the role of Army engineers in this history. Published by the Public Works Historical Society, it can be ordered from the American Public Works Association's online bookstore, http://www.apwa.net/bookstore/detail.asp?ProductID=359 or from the Public Works Historical Society, 2345 Grand Boulevard, Suite 500, Kansas City, MO 64108-2641; (816) 472-6100. Questions or comments? Contact the author, Sara Wermiel, 70A South Street, Jamaica Plain, MA 02130, fireproof2@att.net.

The New York, New Haven & Hartford Railroad's Grand Avenue Bridge over the New Haven Cut (1907),
New Haven, Connecticut

Introduction

The Grand Avenue Bridge (Connecticut Department of Transportation [ConnDOT] Bridge No. 03874) in the City of New Haven, Connecticut, is a reinforced concrete-arch bridge over a railroad cut known as the New Haven Cut. Both the bridge and cut were constructed by the New York, New Haven and Hartford Railroad (hereafter referred to as the New Haven Railroad) between 1906-07 (Figure 1).

In 1990, Matthew Roth and Bruce Clouette of Historic Resource Consultants, Inc. surveyed the Grand Avenue Bridge as part of the ConnDOT statewide historic bridge inventory (Roth & Clouette, 1990). Following the bridge survey, the Connecticut Historical Commission (CHC) and ConnDOT concurred that the Grand Avenue Bridge is National Register-eligible for its historic and engineering importance. The Grand Avenue Bridge possesses historic significance because it survives as one of the earliest reinforced concrete bridges in New Haven, and is the last surviving of six similar bridges originally constructed by the New Haven Railroad over the New Haven Cut in the 1900s. The bridge was built by innovators who were at the forefront of reinforced concrete construction technology at the turn of the 20th century. The Grand Avenue Bridge is also structurally significant because its designers opted to reinforce the crossing with both discarded rail and standard reinforcing rods, resulting in a distinctive structural design along the New Haven Railroad line.

Recently, ConnDOT announced plans to remove and replace the Grand Avenue Bridge, with the exception of the east abutment that will be incorporated into the new structure. In compliance with Section 106 of the National Historic Preservation Act, CHC and ConnDOT concur that this action will result in an Adverse Effect on the historically significant bridge and have agreed upon multiple measures to mitigate the demolition project. These measures include updating the 1990 Historic Bridge Inventory Form, 35 mm black and white photo-documentation of the bridge before and during demolition, and preparation of an article on the history of the bridge for this publication. The updated bridge form and photos are on file at CHC offices in Hartford, Connecticut.

Physical Appearance

The Grand Avenue Bridge is a four-lane, three-span, trapezoidal-shaped, reinforced concrete-arch bridge that measures approximately 115 feet long and approximately 150 feet wide at its broadest point. The crossing is 20 feet high with 18 feet clearance and the skew is 20 degrees. The bridge carries Grand Avenue, a 42-foot wide roadway, east/west over the New Haven Cut. In addition, the bridge carries the northwest portion of Artizan Street, a north/south road that flanks the eastern edge of the railroad cut between Court

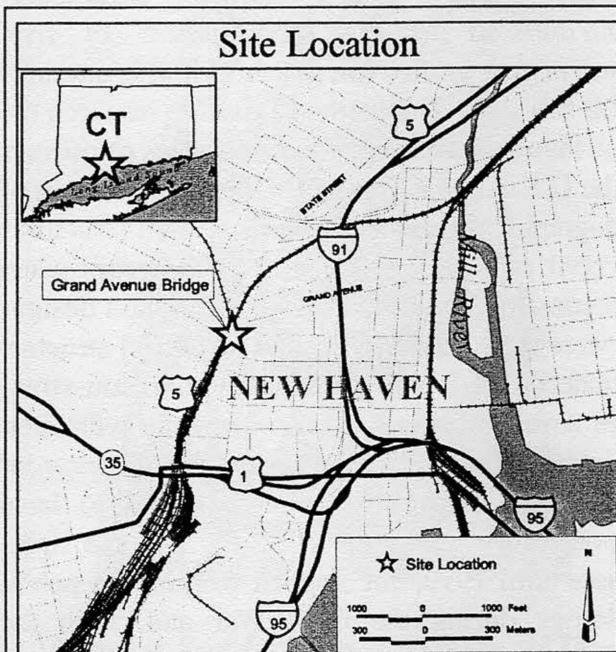


Figure 1

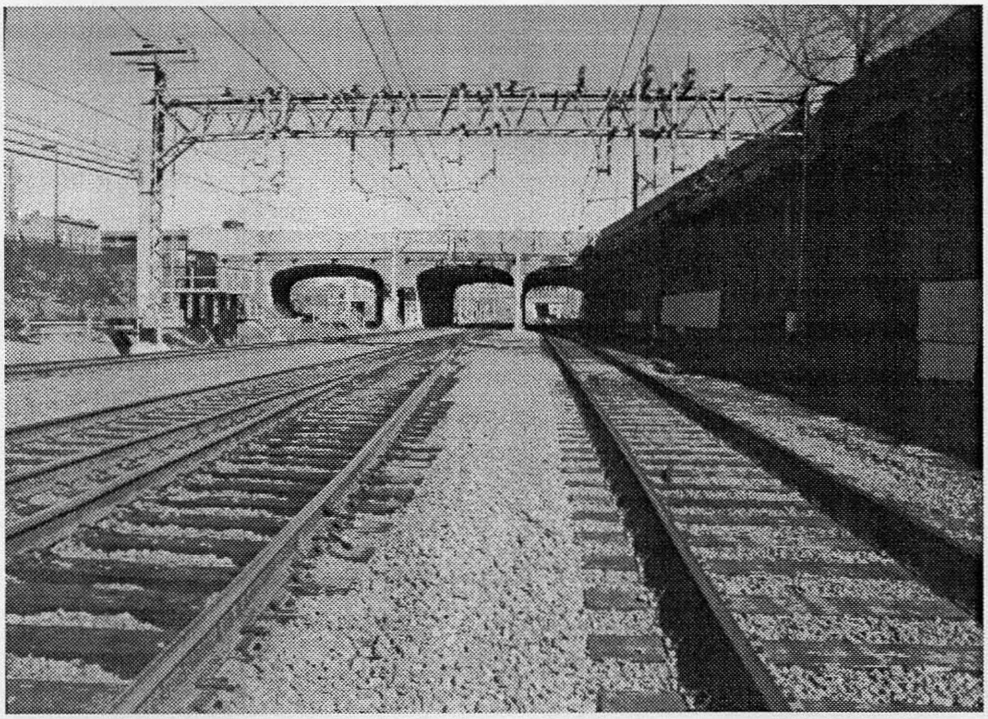


Photo 1. *South Elevation of Grand Avenue Bridge over New Haven Cut. Note active tracks beneath eastern and central arches.*

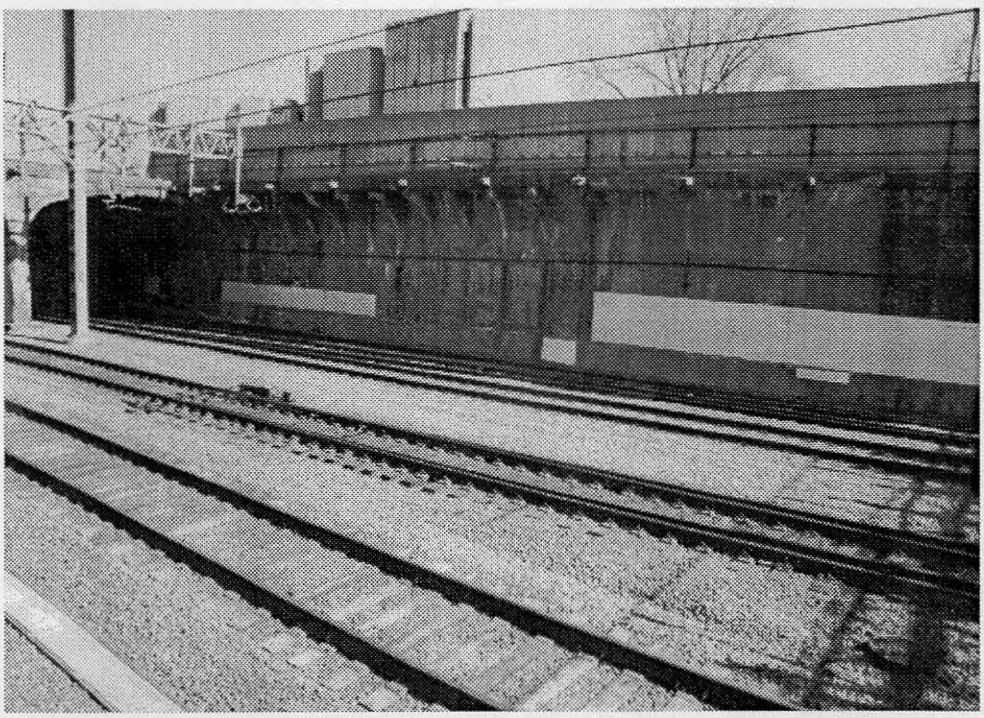


Photo 2. *Reinforced concrete retaining wall along east side of New Haven Cut. Brackets along upper portion of cut carry Artizan Street over railroad right-of-way.*

Street and Grand Avenue, north/south over the eastern edge of the cut.

Currently, the New Haven Cut is owned by the State of Connecticut. Metro-North Railroad maintains the cut and operates trains along the Metro-North New Haven Line. Amtrak also retains trackage rights. The cut includes four active railroad tracks and an abandoned railroad right-of-way.

Two railroad tracks pass below the central arch and two tracks pass below the eastern arch. Tracks have been removed from beneath the western arch (Photo 1).

Substructure

The substructure of the bridge consists of the east and west abutments and two piers. The east abutment is built into a sheer concrete wall that constitutes the eastern edge of the railroad cut. The spalling abutment foundation is stepped outward toward the track with exposed reinforcing bar. At the southeast corner of the bridge, the concrete wingwall blends into a reinforced concrete retaining wall that is strengthened by 12 concrete-encased metal brackets extending southward from the bridge. These brackets support Artizan Street where it meets Grand Avenue above the railroad cut (Photo 2). At the northeast corner of the bridge, a triangular, concrete wingwall extends northward from the abutment and tapers above the surface of the railroad cut. The west abutment is constructed of concrete and is banked into an earthen mound that forms the west side of the railroad cut. Brick and concrete foundation remnants are located at the northwest corner of the bridge and appear to function as the northwest wingwall.

The bridge is also supported by two piers located approximately 30 feet from the east abutment and 35 feet from the west abutment, respectively. The east pier is approximately 2 feet wide and is constructed of concrete reinforced with metal rods and discarded rails. The pier is approximately 150 feet deep, and the upper portion of the pier rises to meet the concrete arches above the two sets of active railroad tracks.

The west pier varies in width between 25 feet on the north elevation and 8 feet on the south elevation. The triangular-shaped, hollow pier is about 120 feet deep and constructed of reinforced concrete. It formerly provided a storage space for track maintenance materials and equipment. The pier ceiling is supported by 22 concrete-encased beams that support Grand Avenue as it passes above the pier. On the north elevation, the pier is accessed by a rectangular door opening, flanked by two window openings. The door and window openings are set within an arched, recessed panel. On the south elevation, the pier is accessed by a rectangular door opening, set within an arched, recessed panel. On the both elevations, the openings may have originally been equipped with doors and window glazing (Photo 3).

Like the piers, the three bridge arches are reinforced with discarded rails, assembled with bolts scavenged from track operations. The arches are largely self-supporting but augmented with reinforcing rods to strengthen the structure.

Superstructure

The bridge superstructure consists of the north and south bridge spandrels, the side railing system and the bridge deck. The reinforced concrete spandrels have a consistent, smooth finish with no embellishment. A narrow coping is located atop the north and south spandrels. A utility conduit is located atop the south coping and is embedded into the bridge at the southwest corner.

The north and south bridge barriers differ. On the north side, an over 7 foot standard high board fence is secured in place by the metal stanchions that are affixed to concrete lobes located along the coping. Facing Grand Avenue, the wood fence is protected by a concrete Jersey barrier, topped by a chain link fence. On the south side, a sheer concrete wall has replaced the high board fence.

The trapezoidal-shaped bridge deck, originally sheathed in bitulithic paving, is now sheathed in asphalt and carries four lanes of traffic (two eastbound; two westbound) and a fifth turning lane at the northwest quadrant. Each lane is approximately 11 feet wide. Sidewalks flank the bridge to the north and south. At the southeast quadrant, the railroad cut widens and accounts for the trapezoidal shape of the crossing. This portion of the bridge supports the Artizan Street/Grand Avenue intersection and a triangular-shaped, asphalt-clad plaza bounded by Grand Avenue to the north, the bridge to the south and Artizan Street to the east.

Historical Significance

The Grand Avenue Bridge was designed by bridge engineers of the New Haven Railroad in 1906. The railroad was formed in 1872 when the

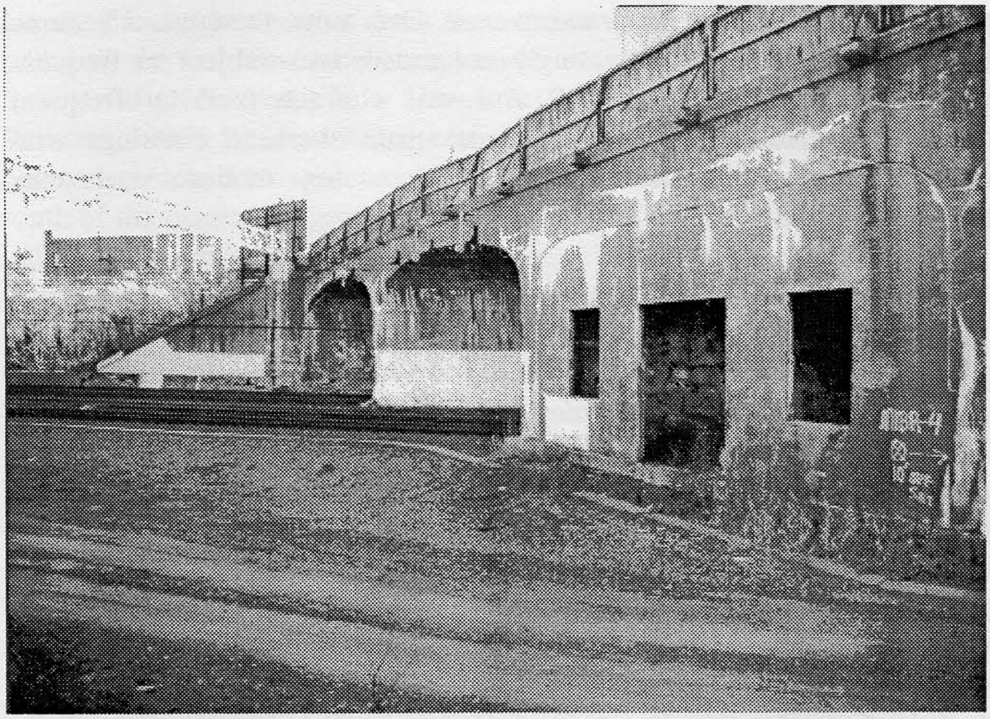


Photo 3. *Window and door openings on north elevation of west pier. East abutment and wingwall in background. Note standard high board fence along upper portion of bridge deck supported by metal stanchions.*

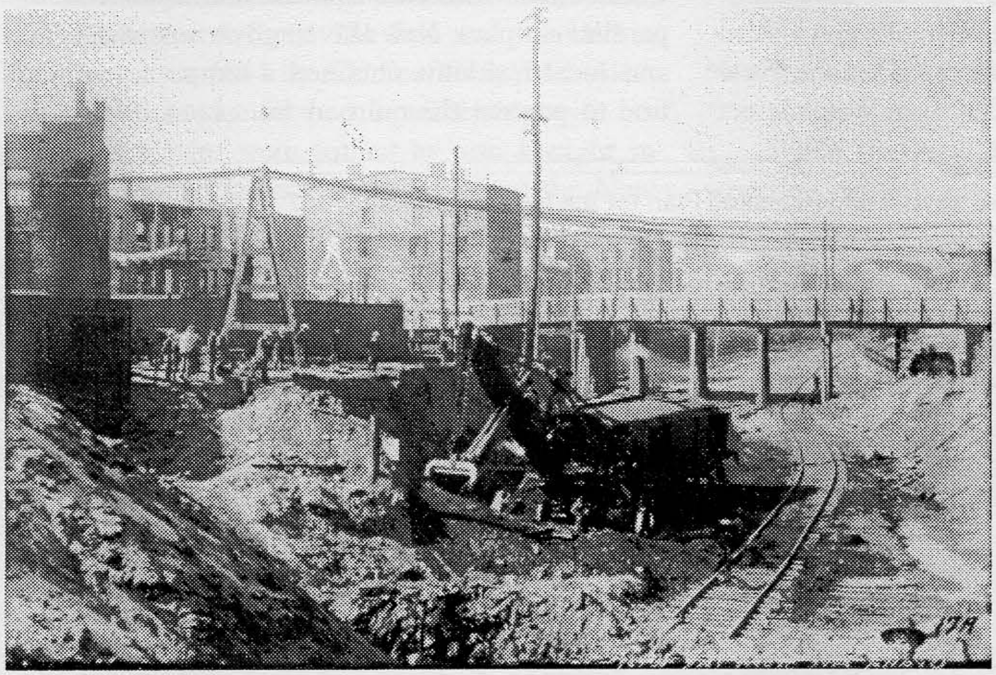


Photo 4. *Looking north toward original Grand Avenue Bridge during widening of New Haven Cut, 1906. Source: Courtesy of Charles R. Harte, New Haven Colony Historical Society, New Haven, CT.*

New York & New Haven and Hartford & New Haven railroads merged to form the new company. The New Haven Railroad operated freight and passenger trains in New York, Connecticut, Massachusetts and Rhode Island, including its well-used main line between New York City and Boston. During its early years, the railroad's management focused on expansion and initiated multiple mergers and acquisitions. By the turn of the century, the railroad acquired over 2,000 miles of trackage and over 25 railroad companies. In the 1900s, the financier, J. Pierpont Morgan, acquired the New Haven Railroad and set out to amass a transportation monopoly in New England, built around the New Haven line. During this period, the New Haven purchased railroads, steamship lines and trolley companies throughout the northeast, and eventually became the subject of a criminal investigation for violating federal and state anti-trust laws. However, during the period when the Grand Avenue Bridge was constructed, the New Haven Railroad was at the forefront of technological innovation when the main line between New York City and New Haven was electrified via overhead catenary wires by 1914 (www.nhrhta.org/ htdocs/history/htm).

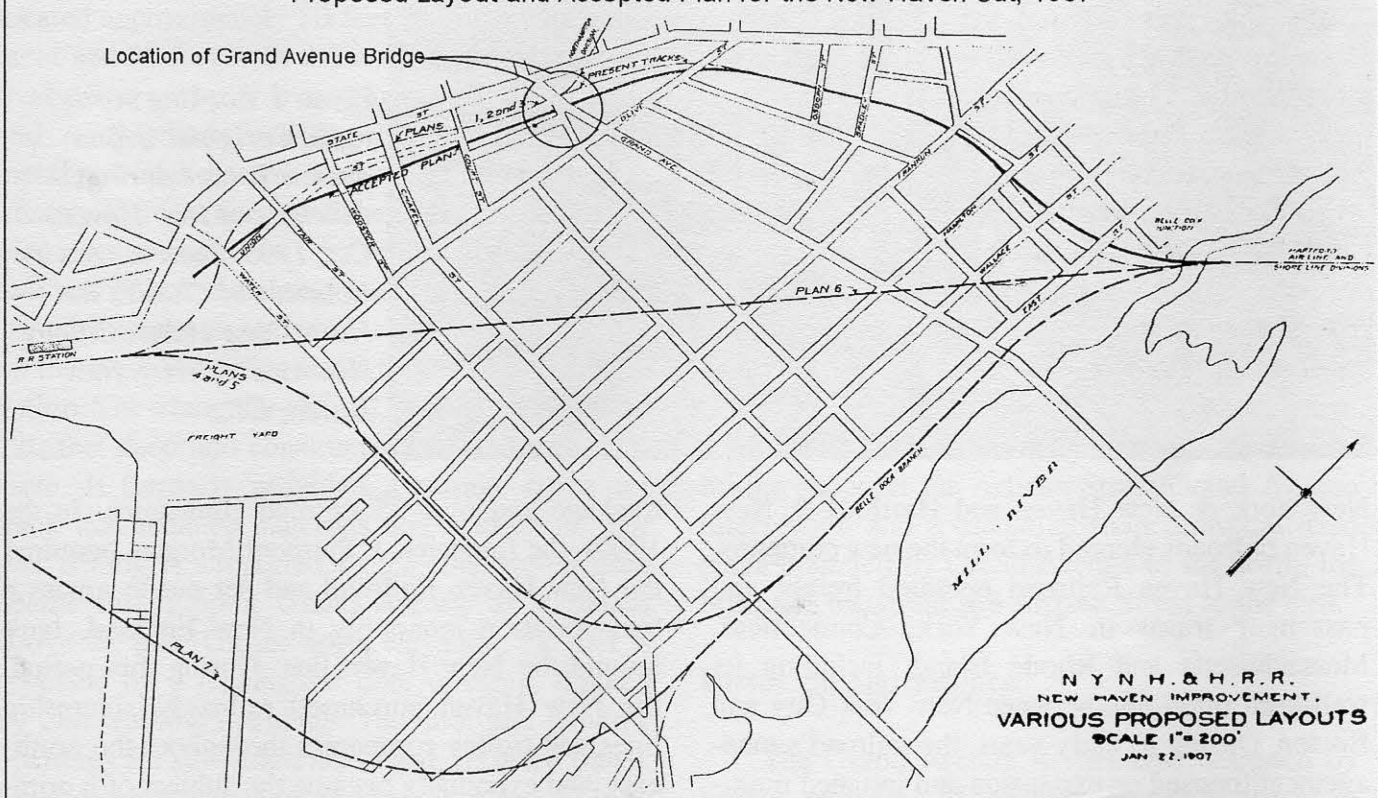
New Haven Cut

The Grand Avenue Bridge was constructed as part of a large improvement program undertaken by the New Haven Railroad during the early 1900s. The program focused on upgrading the New Haven Cut, an 6,700 foot long railroad cut that carried rail traffic northeasterly from the rail yard near the New Haven station at Water Street, through the eastern quadrant of New Haven toward Belle Dock Junction and the Mill River (Figure 2). By the early 1900s, the cut accommodated two New Haven main line tracks and a third track for the Northampton Division of the New Haven Railroad which extended from Water Street to Grand Avenue. Over time, the cut had become increasingly congested, was subject to frequent flooding, and was characterized by frequent curves and inadequate overhead crossings with minimum headroom for modern rail cars (Trumbull, 1907).

Planning and Design

From 1904 to 1905, the New Haven Railroad initiated plans to improve the New Haven Cut to provide room for two sets of double tracks plus two Northampton Division tracks, increase clearance for rail cars and equipment, and eliminate flooding from the cut through deeper excavation. The railroad company proposed several cut improvement plans, including paralleling the original cut with additional tracks. Although the Connecticut Railroad Commission approved the parallel cut plan, New Haven government officials and local residents obtained a temporary injunction to prevent the railroad from constructing the

Proposed Layout and Accepted Plan for the New Haven Cut, 1907



Source: Trumbull, John F. "The New Haven Cut" in Connecticut Society of Engineers Papers and Transactions for 1906 and Proceedings of the Twenty-Third Annual Meeting at Hartford, February 12 and 13, 1907. New Haven, CT: Tuttle, Morehouse & Co.

Figure 2

cut as planned because of fears that streets surrounding the cut would be buried under several feet of fill (New York, New Haven & Hartford Railroad, 1905). By late 1905, the city and railroad company reached an agreement to widen the cut south of the original alignment and thereby create lighter approach grades from State Street, a busy commercial and industrial strip flanked by buildings and structures that would have been damaged under proposed plans (Trumbull, 1907) (see Figure 2). Building of the cut required construction of 13 overgrade bridges and relocation of surface trolley tracks on State Street to a concrete viaduct crossing streets at grade.

Construction Commences

Cut construction commenced in 1906, under the supervision of New Haven-based contractors, C.W. Blakeslee & Sons. The firm was founded in New Haven in 1844 by Charles Wells Blakeslee. In 1872, Blakeslee formed a partnership with his son Dennis who were joined by son Dwight in 1890, and son Clarence in 1895. When the New Haven Cut was constructed, Major Dennis Blakeslee was head of the firm that bore his father's name. For this project, Major Blakeslee oversaw the relocation of sewers and other utilities, installation of a drainage system, approach paving and construction of bridges, retaining walls and trolley viaducts. The project bolstered the reputation of the Blakeslee firm who went on to play a major role in concrete construction projects in Connecticut, including establishment of the New Haven region's first pre-mixed concrete plant; construction of the Stevenson Dam for the Connecticut Light and Power Company; building of a 1,200 foot, reinforced concrete-arch bridge spanning the Housatonic River, the New Haven Railroad and a highway in Cornwall, Connecticut; and many other projects (C.W. Blakeslee & Sons, 1944).

Beginning in February 1906, cut construction was documented on a weekly basis in The New Haven Cut, a newspaper dedicated to covering project progress. According to an interview with Major Blakeslee, construction of the cut necessitated demolition of approximately 130 buildings overseen by the A. Levenson Wrecking Company of New York. Blakeslee also explained that the cut was excavated to a depth of 25 to 30 feet below street level and excavated material was either shipped to New York or used as fill for trestles constructed along the Hartford Air Line and Shore Line divisions of the New Haven Railroad (New Haven Cut, February 10, 1906; Roth & Clouette, 1991) (Photo 4).

To improve drainage within the cut, cast iron water pipes were laid between tracks to allow draining by gravity into the Mill River. Concrete manholes and receiving basins were also installed along the cut for drainage. In addition, a concrete pumping chamber with two automatic pumps was constructed at the western end of the cut near Water Street to force the flow of water toward the New Haven harbor (Trumbull, 1907).

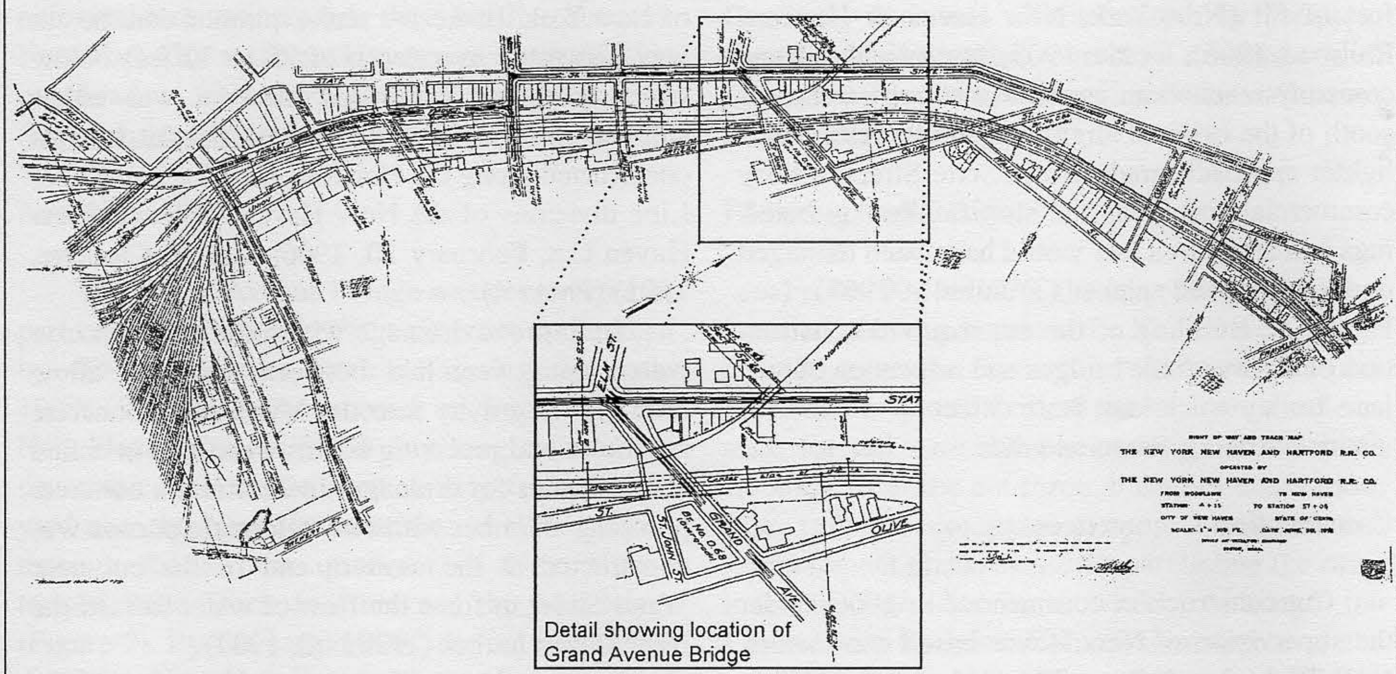
New Haven Cut Bridges

While the New Haven Cut was under construction, 13 bridges were replaced to carry city streets over the relocated depression. These included:

- Six plate girder bridges over Osborn, Bradley, Franklin, Hamilton, Wallace and East Streets;
- Six reinforced concrete-arch bridges over Fair, Union, Crown, Chapel and Court streets, and Grand Avenue; and
- Riveted-truss bridge over Olive Street.

Designed by the New Haven Railroad, the 13 bridges were equipped with longer approaches and higher clearances, including 18 feet of clear headroom, improving upon the original 14 foot clearances. Topography dictated the type of bridge erected over the cut. While plate girder bridges were used for short spans of 63 to 75 feet long, reinforced concrete-arch bridges were used for longer spans and the truss bridge where piers were not possible to install because of space constraints (Slocum, 1907) (Figure 3).

New Haven Cut, 1915



Source: New York, New Haven and Hartford Railroad Archives, Thomas J. Dodd Research Center, University of Connecticut, Storrs, CT.

Figure 3

Grand Avenue Bridge

The Grand Avenue Bridge and the five other similar reinforced concrete-arch bridges spanning the cut were among the first reinforced concrete bridges constructed in Connecticut, and continued the tradition of technological innovation characteristic of the New Haven Railroad (Roth & Clouette, 1991). Reinforced concrete was first used in bridge construction in the U.S. during the late 1800s, and by the turn of the century, was gaining in popularity among bridge designers who recognized the advantages of bar reinforcement that could be placed in regions of high tensile stresses, thus saving enormous quantities of materials while producing stronger bridges with lower dead loads (PAC Spero & Company, 1989).

The New Haven Railroad selected this bridge form for Grand Avenue and other bridges because it was a practical solution to crossing a wide cut, resulting in a graceful bridge design, and, most importantly, facilitated the egress of gasses from trains passing beneath its smooth-faced, concrete surface (Slocum, 1907).

Temporary Crossing

During construction of the concrete-arch bridges, multiple temporary crossings were constructed to keep traffic flowing through the area. The Grand Avenue and Chapel Street crossings remained open to traffic, and therefore, required the largest portions of temporary highway construction associated with the project. The New Haven Cut indicated that the temporary Grand Avenue crossing was constructed during April and May of 1906, and resulted in the removal of the predecessor bridge that crossed the original New Haven Cut on an alignment to the north of the widened cut (The New Haven Cut, April 1906; May 1906) (see Photo 4). The temporary wood, multi-span, pony truss bridge measured 30 feet wide and was equipped with a 7-foot wide pedestrian walkway. The bridge also accommodated trolley tracks that carried trolley traffic to State Street, a main thoroughfare flanked by commercial and industrial development (Trumbull, 1907; New York, New Haven & Hartford Railroad, 1915).

Permanent Crossing

Between 1906-1907, the permanent Grand Avenue Bridge, classified by the New Haven Railroad as Bridge No. 0.68, was constructed. Once the concrete foundation was in place, falsework was created for the concrete elements. The falsework consisted of bolted plank trusses placed 4 feet apart and curved truss forms supported on timber bents. The bents were braced with diagonal wood strips and carried on curved forms that rested on sills. Wedges were inserted between the sills, enabling the falsework to be adjusted as needed. When the falsework was in place, the reinforcing units were constructed (Slocum, 1907).

As previously mentioned, the reinforcing material used in the Grand Avenue Bridge and other concrete-arch bridges along the cut consisted largely of discarded railroad material including rails, fish plates, bolts and other scrap, in addition to standard reinforcing bars. In general, each arch unit consisted of a rail following the extrado of the arch bolted to the crown of a rail following the intrado of the arch. Reinforcing units were generally placed 3 feet apart. Rail reinforcing was augmented by standard reinforcing placed 1 foot apart longitudinally, and 2 feet apart transversely. Where the rails separated, bent plates or lacing was inserted and bolted to the rail flanges, forming an arch unit. The arch units were spliced into adjacent piers or abutments. Pier reinforcing consisted of vertical rails which were bolted to short pieces of rail and spliced into the arch units. Abutment reinforcing consisted of laced bent plates. After connecting rail units along the entire length of the bridge, concrete was poured into the forms (Slocum, 1907) (Figure 4).

On the bridge deck, standard high board fence barriers were installed along the north and south sides. The fences were typically installed along the majority of bridges crossing the New Haven Cut, including the Grand Avenue Bridge. New Haven Railroad staff lamented the decision to install the fences selected by the City of New Haven Engineers Office and claimed "a grave consideration of aesthetics was not made in the design of the fence, although much grace could have been added to all these structures if fence of another type could have been used" (Slocum, 1907). To date, a standard high board fence is located along the north side of the bridge deck.

Designers and Builders

The New Haven Railroad's in-house engineers designed the Grand Avenue Bridge. E.H. McHenry, Vice President of Engineering and W.H. Moore, Chief Engineer of Bridges led the design team. The railroad company devised typical plans for the reinforced concrete crossings at Fair, Chapel and Court streets and Grand Avenue, and most likely devised typical plans for the concrete crossings at Union and Crown streets, as well (Slocum, 1907).

A team of contractors assembled the Grand Avenue and other bridges along the New Haven Cut. The team was led by general contractor and builder C.W. Blakeslee & Sons and also included the Yale Safe and Iron Company, Aberthaw Construction Company and Warren Brothers.

The Yale Safe and Iron Company of New Haven manufactured the rail reinforcement. The company was formed in 1885 from the New Haven-based Yale Manufacturing Company and had a plant and forge in central New Haven that successfully fabricated the iron work for a wide range of structures throughout the New York metropolitan region. As of 1896, these included the Montana Flats building in New York City and multiple buildings in Connecticut, including iron work for Yale University dormitories, the State Normal School and multiple public and religious schools in New Haven (Anonymous, ca. 1895).

Aberthaw Construction Company of Boston, Massachusetts fabricated the standard rod reinforcement. The firm was founded in 1894 and were pioneers in the use of reinforced concrete construction in the U.S. Aberthaw gained widespread recognition through its construction of Harvard University Stadium in 1903, the first large reinforced concrete structure in the U.S. Shortly afterward, the firm contracted with the New

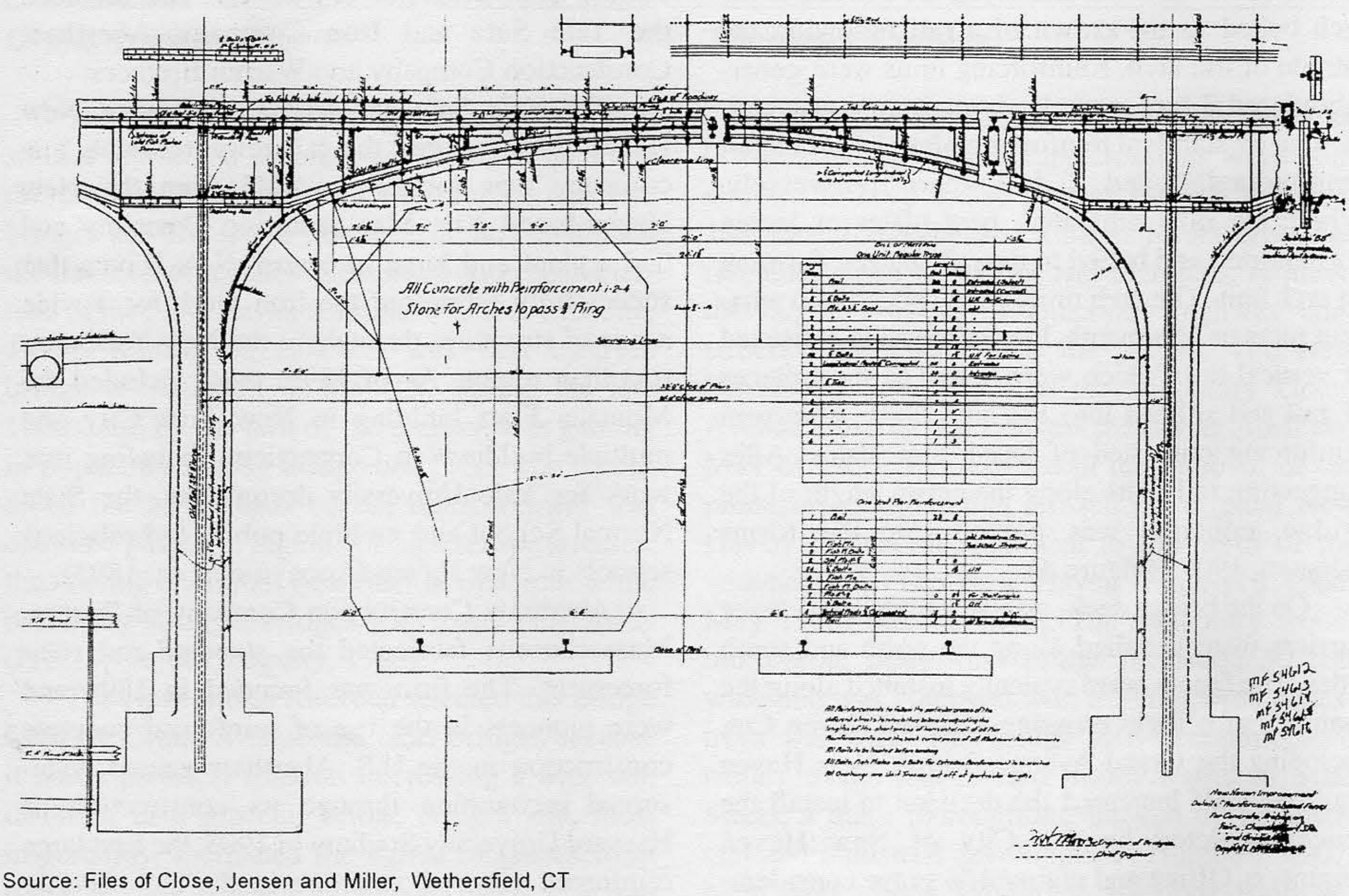
Haven Railroad to supply reinforcing rods for the concrete-arch bridges, and continued to flourish as leaders in reinforced concrete construction, completing multiple large-scale projects during the early decades of the 20th century, including the Boston Christian Science Publishing House in 1929 (www.mit.edu).

Another Boston firm, Warren Brothers, oversaw the bitulithic paving of the bridge deck. Warren Brothers was established by Frederick J. Warren and other members of the Warren family around the turn of the century. The firm assisted in the development of hot-mix, or bitulithic, paving which consisted of asphalt binder, sand and stone, and improved upon other asphalt paving products then available in the U.S. During the 1900s, Warren Brothers was awarded two patents for their bitulithic mixes, securing their place as innovators in modern road building and paving (Harman, et al., 2001).

Changes Over Time

Over time, the Grand Avenue Bridge has undergone many changes. In the 1960s, the New Haven Railroad, builders of the Grand Avenue Bridge, went bankrupt as competition from interstate highways, air travel, high rates of taxation and diminishing passenger and freight service brought financial ruin to the once powerful company. By 1969, the New Haven Railroad was purchased by Penn-Central Corporation and under Penn-Central, the railroad infrastructure continued to deteriorate until the corporation declared bankruptcy in 1970 (Adams, 1996). Bankrupt passenger lines were incorporated into the federally-sub-

Detail of Reinforcement and Fence for Concrete Arches on Fair, Chapel and Court Streets, and Grand Avenue



Source: Files of Close, Jensen and Miller, Wethersfield, CT

Figure 4

sidized National Railroad Passenger Corporation, or Amtrak, in 1971, and bankrupt freight lines were incorporated into Conrail in 1976 (Adams, 1996). In 1982, rail operations ceased on the Northampton Division, necessitating removal of tracks beneath the Grand Avenue Bridge and commencement of the eventual conversion of the right-of-way into a recreational trail (Farmington Canal Rail-to-Trail Association, nd). In 1983, Metro-North Railroad assumed control of commuter operations and continues to maintain the four active tracks beneath the Grand Avenue Bridge for itself and other users, including Amtrak. The railroad cut is now owned by the State of Connecticut.

In addition to ownership changes and right-of-way abandonment, the Grand Avenue Bridge has undergone physical alterations. By the 1990s, the western pier of the bridge was no longer actively used for storage of railroad materials. After 1990, doors and windows documented in the western pier appear to have been removed. During this period, the high board fence on the south side of the bridge was most likely removed and replaced with the modern concrete barrier.

Summary

Despite these alterations, ConnDOT and the CHC have concurred that the Grand Avenue Bridge is National Register-eligible under Criteria A and C for its state and local historic and engineering importance. As previously stated, the Grand Avenue Bridge survives as a good example of early 20th century reinforced concrete construction in Connecticut. It was built by the New Haven Railroad during a period of great scientific advancement and is the last remaining, intact reinforced concrete-arch bridge over the New Haven Cut. The crossings at Union Street, Crown Street, Chapel Street and Court Street have been replaced with modern bridges while the eastern-most arch of the Fair Street crossing has been retained over a maintenance and emergency road.

The Grand Avenue Bridge was constructed by a pioneering group of builders in the 1900s. While C.W. Blakeslee & Sons were among the first to establish pre-mixed concrete plants in the New Haven area, Boston-based Aberthaw Construction Company and Warren Brothers were also considered experts in the structural and road building fields. Aberthaw Construction Company was among the first to build reinforced concrete structures in the U.S. while Warren Brothers patented bitulithic-paving techniques that had an important impact on the quality of paved roads throughout the northeast. The Grand Avenue Bridge is also architecturally significant because the bridge is reinforced with both standard material and recycled rails.

Proposed Bridge Replacement

Within the next few years, the Grand Avenue Bridge will be replaced with a pre-cast, prestressed concrete beam structure that will measure 98 feet long and 44 feet wide. The new crossing will be supported on a new west abutment and center pier while the east abutment, which is already incorporated into the railroad cut's east retaining wall, will be reconstructed to support the replacement structure. South of the bridge, structural beams with a cast-in-place concrete deck will be erected to carry utilities across the railroad cut. The new bridge is being designed for ConnDOT by URS Corporation. Close, Jensen and Miller, P.C. of Wethersfield, Connecticut is providing design oversight. Bridge replacement is slated to occur in 2004.

Major Bibliographic References

Books and Articles

Adams, Arthur G. *The Hudson River Through the Years*. New York: Fordham University Press. 1996.

Anonymous. *Connecticut: 1639-1895.* Newark, NJ: Consolidated Illustrating Company. ca. 1896.

C.W. Blakeslee & Sons, Inc. *A Century of Heavy*

Construction by C.W. Blakeslee & Sons, Inc. Thorugh Three Generations. 1944. On file at the New Haven Colony Historical Society, New Haven, CT.

Farmington Canal Rail-to-Trail Association. "Farmington Canal Greenway." No date.

PAC Spero & Company. *Delaware Historic Bridges Survey & Evaluation*. Newark, DE: Delaware Department of Transportation, 1991.

Slocum, C.L. "The Highway Bridges of the New Haven Improvements," *Proceedings of the Connecticut Society of Civil Engineers*. 1907. pp. 46-61.

The New Haven Cut. February 1906; April-May 1906. On file at New Haven Colony Historical Society, New Haven, CT.

Trumbull, John F. "The New Haven Cut," *Proceedings of the Connecticut Society of Civil Engineers*. 1907. pp. 62-78.

Reports

Harman, Thomas, John R. Bukowski, Francis Moutier, Gerald Huber and Robert McGennis. "The History and Future Challenges of Gyratory Compaction 1939 to 2001."

New York, New Haven & Hartford Railroad Company. General Statement of the Affairs of the New York, New Haven & Hartford Railroad Company, Year Ending June 30, 1905. On file at New Haven Colony Historical Society, New Haven, CT.

Roth, Matthew and Bruce Clouette. "State of Connecticut Department of Transportation Historic Bridge Inventory Form – Grand Avenue Bridge, New Haven, CT." On file at Connecticut Department of Transportation, Newington, CT.

Maps and Plans

New York, New Haven & Hartford Railroad Company. "Right-of-Way and Track Map. New York, New Haven & Hartford Railroad Company." 1915. On file at Dodd Research Center, University of Connecticut, Storrs, CT.

New York, New Haven & Hartford Railroad Company. New Haven Improvement Bridge Plans for Concrete Arch Bridges on Fair, Chapel & Court Streets and Grand Avenue. On file at Close, Jensen & Miller, P.C., Wethersfield, CT.

Web Sites

Aberthaw Construction Company:
Web site consulted December 14, 2001 at www.mit.edu/aft/Athena/dept/libdata/libdepts/i/www_annex1/rvc_anne.../60-23con.htm.

New York, New Haven & Hartford Railroad Company: Web site consulted May 23, 2001 at www.nhrta.org/htdocs/history.htm.

Submitted by:

Allison S. Rachleff
Senior Architectural Historian
Earth Tech/TAMS
New York, New York

—

Under contract to:

Connecticut Department of Transportation
Office of Environmental Planning
Bureau of Policy and Planning
Newington, Connecticut
On Call Agreement No. 9.07-01 (99)
Project Number 92-412 (170-732)
Bridge No. 03874 (Grand Avenue Bridge)
Replacement Project
New Haven, Connecticut

Thames Shipyard Floating Dry Dock. New London, Connecticut

A floating dry dock is a vessel that can be submerged to receive a ship onto its deck or platform. The ship is then supported by blocks and the dock raised clear of the water to expose the ship's hull for examination, maintenance and repair. Origins of the design are obscure. The technology may have evolved from 18th century methods of examining ship bottoms. These included careening or supporting a vessel alongside a dock in an area that had an extensive tidal range. Dry docks were an improvement over earlier methods for obtaining access to normally submerged portions of the hull. This allowed work to proceed continuously and independently of the rise and fall of the tide.

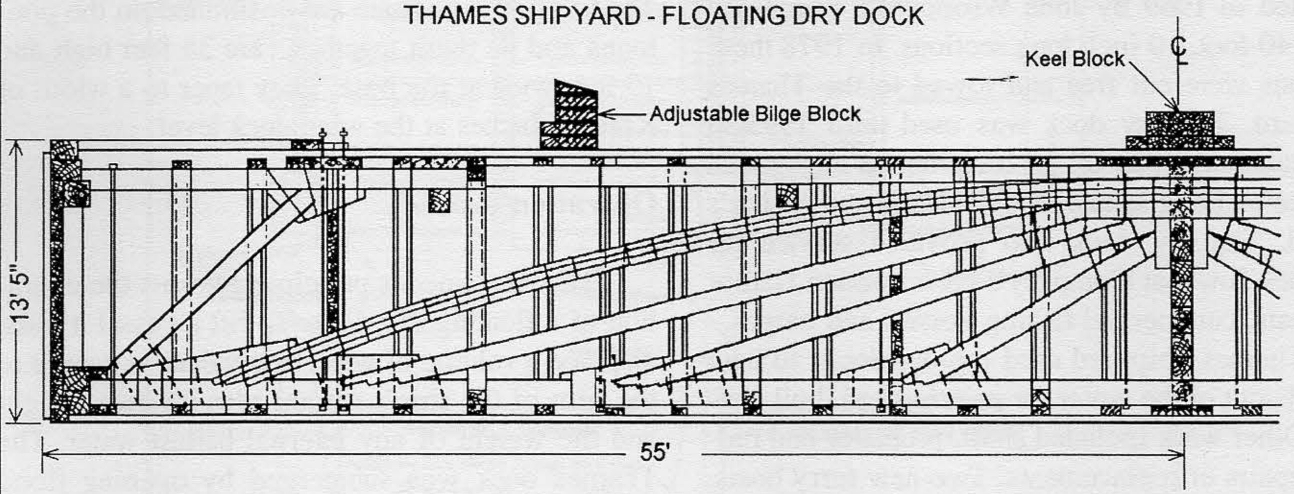
The Philadelphia Navy Yard claimed to have had the world's first floating dry dock. It was placed into service in June 1851. However, an 1841 patent by Dodge and Burgess illustrates a number of design features found in the Philadelphia floating dry dock and claims they were common. The patent states: "It will be remembered that we have described parts which have long since been used in floating dry docks and that therefore we do not claim them as our invention." The Philadelphia floating dry dock may have been the largest floating dry dock built to that time, but the Dodge and Burgess patent casts doubt on the claim that it was the first.

The floating dry dock offers advantages over traditional graving or basin dry docks. It may be built in a low-cost yard and floated to a location where it is needed. This type of dock does not permanently use valuable waterfront property. Sections may be added to accommodate larger ships and it can be used to transfer vessels from the water to a shore side yard. Floating dry docks must be designed to have adequate longitudinal, transverse and local strength and stability. These design standards are set forth by Lloyd's Register of Shipping Rules and Regulations. The pontoon has to be designed to distribute the concentrated load of the ship along the dock's centerline and transfer this load to the buoyant support of the water by means of its transverse strength. The subject dry dock's design significance lies in the methodology used to accomplish this transferal by means of complex wood trusses within the pontoon.

The Thames Shipyard Floating Dry Dock

Thames Shipyard and Repair Company has a

THAMES SHIPYARD - FLOATING DRY DOCK



Half-Sectional Elevation of Transverse Truss

Note: The truss is engineered to transfer the weight of the vessel from the keel and bilge blocks to the water surrounding the pontoon.

Detail of Pontoon for 10,000 ton Floating Dry Dock
Sun Shipbuilding Company
Chester, Pennsylvania

Corel50 Adaptation by R.C. Stewart

marine machine shop and shipyard facilities adjacent to the Cross Sound Ferry Terminal in New London, Connecticut. The company's dry dock was located about 900 feet northeast of the New London railroad station adjacent to the ferry terminal.

The dry dock allowed Thames Shipyard to raise vessels out of the water so that repairs, maintenance and painting could be performed on their hulls and submerged portions.

The dry dock was taken out of service in 1995 and tied up with its "pontoon" or underwater portion submerged. Its pontoon, constructed of timber, was attacked by ship worms and developed serious leaks. While the dry dock's upper section or "wing walls" were made of sound steel, the whole structure could not be economically repaired and it was decided to scrap it.

Thames Shipyard's dry dock was a pontoon or "Rennie" structure. It consisted of three sections cut from a much longer sectional dry dock which originally measured 450 feet in length. The subject dry dock was originally part of a 10,000 ton, 11 section, floating dry dock built and owned by Sun Shipbuilding Corp. of Chester, Pennsylvania. Sun Shipbuilding designed it in 1921 and constructed it in 1936. The Belmont Iron Works fabricated the wing walls and trusses. In 1975 Thames Shipbuilding, a Connecticut firm founded in 1969 by John Wronowski, purchased three 40 foot, 10 inch long sections. In 1978 these sections were cut free and towed to the Thames shipyard. The dry dock was used until 1995 to maintain and repair all the local ferries engaged in service to Long Island, Block Island and Fisher's Island. The dry dock also provided service for Thames Towboat Company's New London Harbor tugboats, commercial fishing vessels and barges.

Thames Shipyard used the dry dock to haul vessels out of the water for painting and hull plating. Other work included shaft, propeller and rudder repairs or replacements. Two new ferry boats, the *New London,* launched in 1978 and the *Paul A. Wronowski* launched in 1980, were built at Thames Shipyard and launched using the dry dock.

General Description

Floating dry docks consist of two main parts - wing walls and pontoons. The pontoon is a watertight floatation chamber that must displace the weight of the vessel and the dry dock. By means of its transverse strength, the pontoon transfers the concentrated load of the ship being supported along the dock's centerline and distributes it to the uniform buoyant support of the surrounding water.

Floating dry docks are classified into three main types. The caisson, box or one-piece is a common type. A second category is the sectional dry dock. The Thames Shipyard dry dock represents the third type, a pontoon or "Rennie" structure. Rennie dry docks have continuous wing walls with sectional pontoons. Since longitudinal strength in a Rennie structure is derived solely from the wing walls, this type is generally weaker than a one-piece dock in which the wing walls and pontoon form an integral structure. Rennie type dry docks are generally built to heavier specifications than one-piece docks. Double transverse bulkheads are needed at the pontoon section gaps and, to achieve minimal longitudinal strength, wing walls must be heavily constructed.

Each pontoon on the Thames Shipyard's dry dock is 110 feet wide and 40 feet, 10 inches long. The pontoons measure 13 feet - 5 inches in depth. The wing walls, which are positioned on the pontoons and tie them together, are 35 feet high and 13 feet wide at the base. They taper to a width of 8 feet, 6 inches at the wing deck level.

Operation

The Archimedes principle governs the operation of a floating dry dock. To lift a vessel it must displace a volume of water equivalent in weight to the sum of the ship's weight plus its own weight and the weight of any internal ballast water. The Thames dock was submerged by opening flood valves to allow water into the pontoons. As the dock submerged, the dockmaster controlled list, trim and deflection of the dock by regulating the rate of flooding of the individual pontoons.

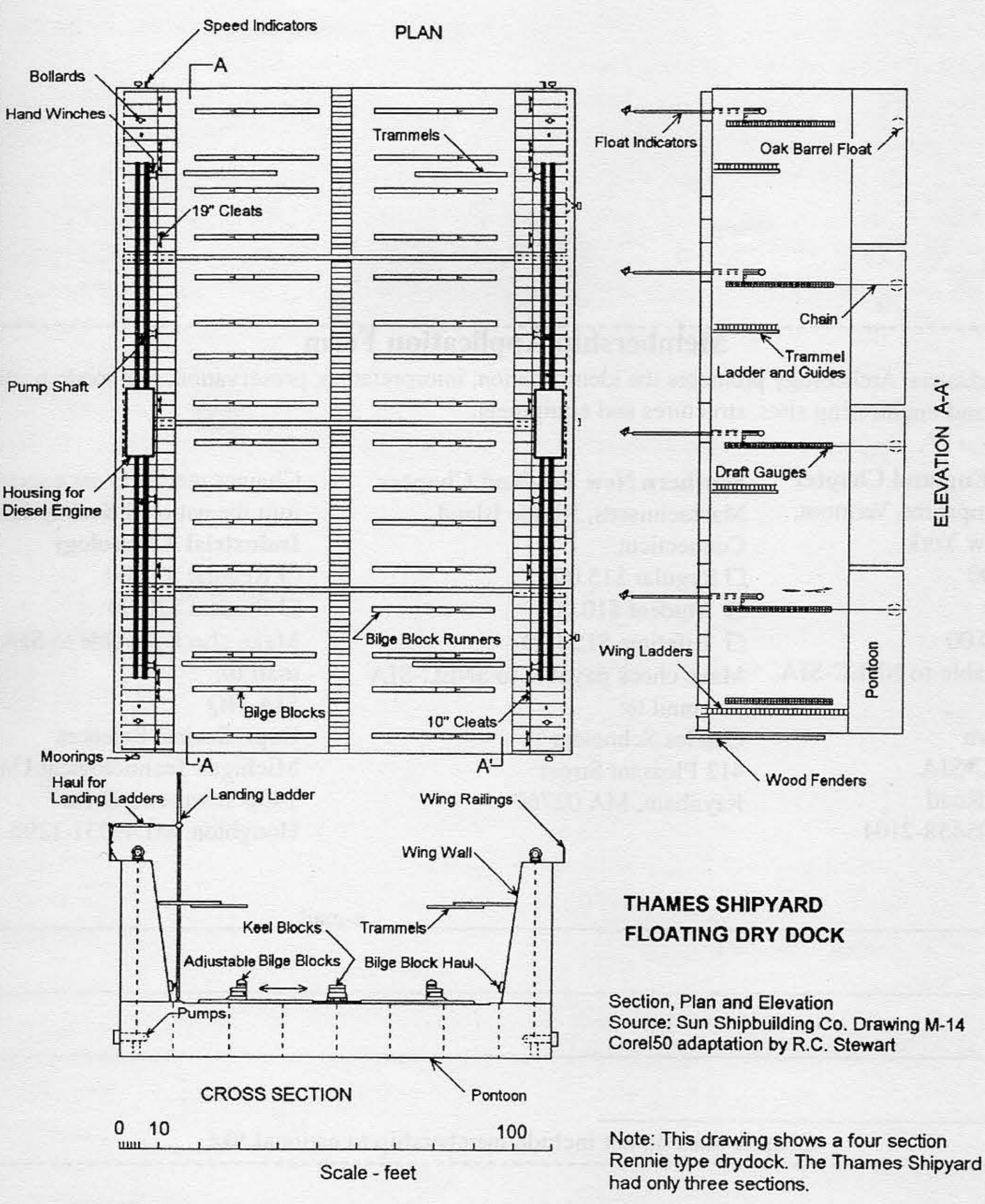
Besides flood valves each compartment had pumps which were used to correct the degree of submergence. The dry dock had a water level and draft indicating system that showed water levels in each ballast tank. Another system showed the draft of the dock at several locations as it submerged or rose.

The pumps were connected by shafts and bevel gears running along the wing walls to a diesel engine located centrally on each wing wall.

Conclusion

The construction of the transverse trusses in the pontoons is a rarely seen example of precision joinery of large timbers. Most of the members of the truss measured 10 by 10 inches and exhibited tolerances normally found in much smaller structures. The type of construction seen in the Thames Shipyard dry dock is obsolete and artisans capable of the type of precision heavy joinery are rare. The wood construction seen in this dry dock is vanishing–replaced by welded steel structures. Thames Shipbuilding deserves commendation for supporting recordation and photo recording of this structure.

Robert. C. Stewart
West Suffield, Connecticut



THAMES SHIPYARD FLOATING DRY DOCK

Section, Plan and Elevation
Source: Sun Shipbuilding Co. Drawing M-14
Corel50 adaptation by R.C. Stewart

Note: This drawing shows a four section Rennie type drydock. The Thames Shipyard had only three sections.

Membership Application Form

The Society for Industrial Archeology promotes the identification, interpretation, preservation, and modern utilization of historic industrial and engineering sites, structures and equipment.

Northern New England Chapter
Maine, New Hampshire, Vermont, Northeastern New York
❒ Regular $10.00
❒ Student $5.00
❒ Lifetime $100.00
Make check payable to NNEC-SIA and mail to:
Herman C. Brown
Treasurer, NNEC-SIA
250 West Shore Road
Grand Isle, VT 05458-2104

Southern New England Chapter
Massachusetts, Rhode Island, Connecticut
❒ Regular $15.00
❒ Student $10.00
❒ Lifetime $150.00
Make check payable to SNEC-SIA and mail to:
Charles Schneider
412 Pleasant Street
Raynham, MA 02767

Chapter members are encouraged to join the national **Society for Industrial Archeology**
❒ Regular $35.00
❒ Student $20.00
Make check payable to SIA and mail to:
SIA-HQ
Dept. Socieal Sciences
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295

Name: ______________________________ e-mail: ____________________

Address: ____

____

Phone: ______________________

Chapter dues do not include membership to national SIA.