STATE OF DELAWARE

STATE HIGHWAY DEPARTMENT

DELAWARE CROSSING DIVISION

THIRD ANNUAL REPORT

JANUARY 1951

January 31, 1951

Honorable Elbert N. Carvel
Governor of Delaware
Dover, Delaware

Dear Governor Carvel:

In accordance with the Act authorizing the State Highway Department to construct a crossing over the Delaware River, the Annual Report of the activities of the Department in connection with the construction of The Delaware Memorial Bridge is respectfully submitted.

Very truly yours,

STATE HIGHWAY DEPARTMENT

J. Gordon Smith
Chairman

GENERAL OVERALL VIEW LOOKING EAST SHOWING PROGRESS—JANUARY 1, 1951

State of Delaware

State Highway Department

DELAWARE CROSSING DIVISION

THIRD ANNUAL REPORT

January 1951

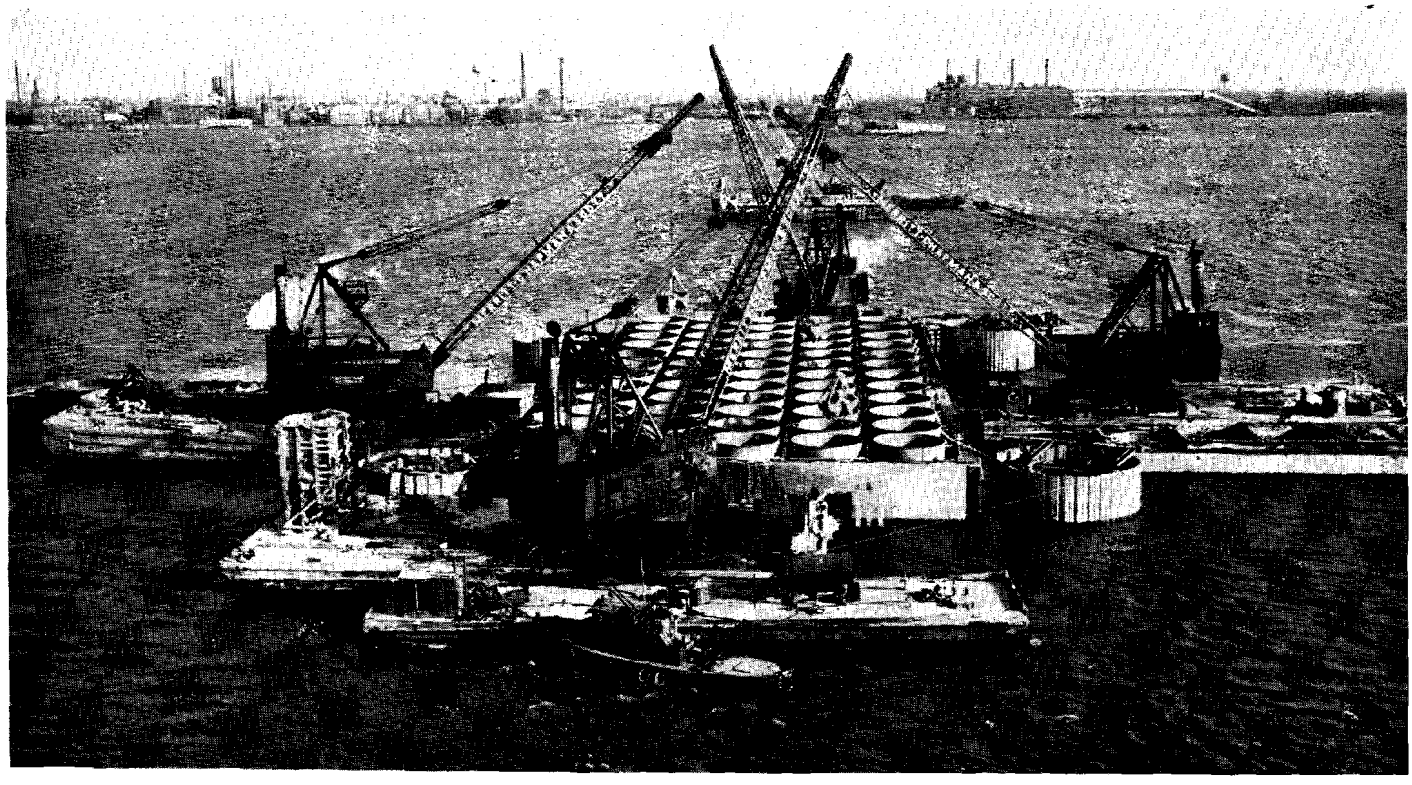
The year 1950 marked the completion of 83% of the total contract work to be done on The Delaware Memorial Bridge. Progress to date can be generally classed as satisfactory. Some delay in the completion of contracts was experienced. The most serious delay developed during the month of May when a strike was called on the open-shop contractor placing the earth embankment on the West Approach. Foundation operations and steel erection were in the hands of union contractors and consequently these operations were stopped in sympathy. Foundation operations were delayed approximately two weeks and steel erection for two weeks, plus an additional two days. Delays to the contractor in getting reorganized caused additional delay before full-time operations could be resumed.

Unfavorable weather conditions existed during the month of May when 22 days of rain was a factor in the progress of both steel erection and foundation construction.

A jurisdictional strike occurred during the month of July which incurred a delay of only 1½ days—the strike was against the steel contractor.

The paving of the bridge-roadway slab on the New Jersey side of the river was delayed in starting due to difficulty in obtaining cement. The difficulty was overcome when the Governor of Delaware was successful in having the contractor obtain his cement commitment.

Progress during the months of November and December was delayed due to unfavorable weather conditions. High winds, rain and cold weather prevailed during this period.



DREDGING AT WEST PIER WITH FOUR DERRICKS—FEBRUARY 4, 1950

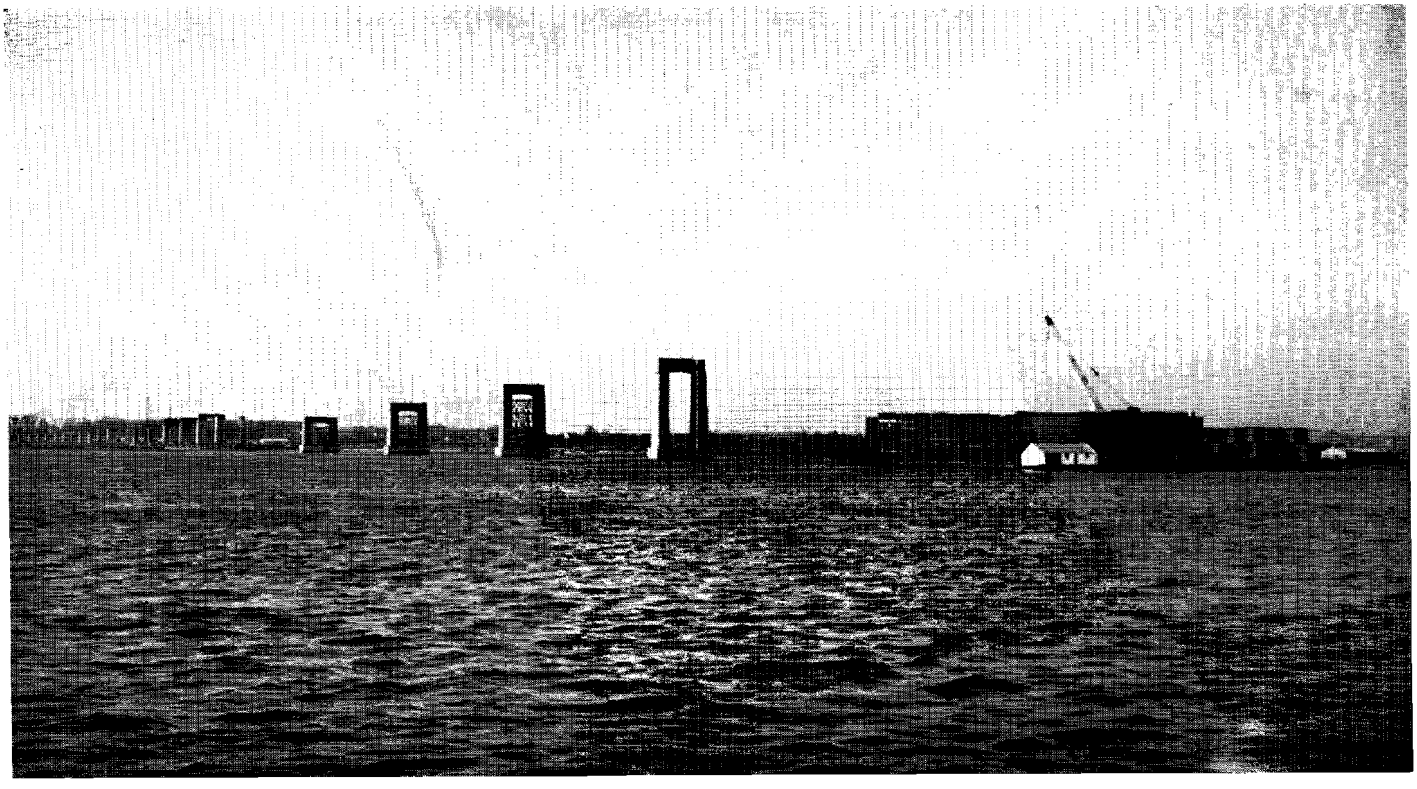
CONTRACT NO. 2—Tower Piers and Anchorage Foundations

The construction of the two tower piers and the two foundations for the anchorages was started during 1949 and at the beginning of 1950 had been well advanced. The tower piers were constructed with the use of open dredge steel caissons 69 feet in width and 116 feet in length. The caisson for the easterly pier was carried down to a stratum of firm red and gray clay and sealed at a depth of 115.65 feet below the datum plane which is approximately mean-low tide. This was about 3 feet below the plan depth and was necessary in order to remove some softer material overlying the clay at one corner of the pier. Work on this pier was completed on April 26, 1950. The caisson for the westerly pier was also founded on a stratum of red and gray clay and was sealed at a depth of 86.86 feet below the datum plane, the plan depth being 87 feet. Work on this pier was completed on March 15, 1950.

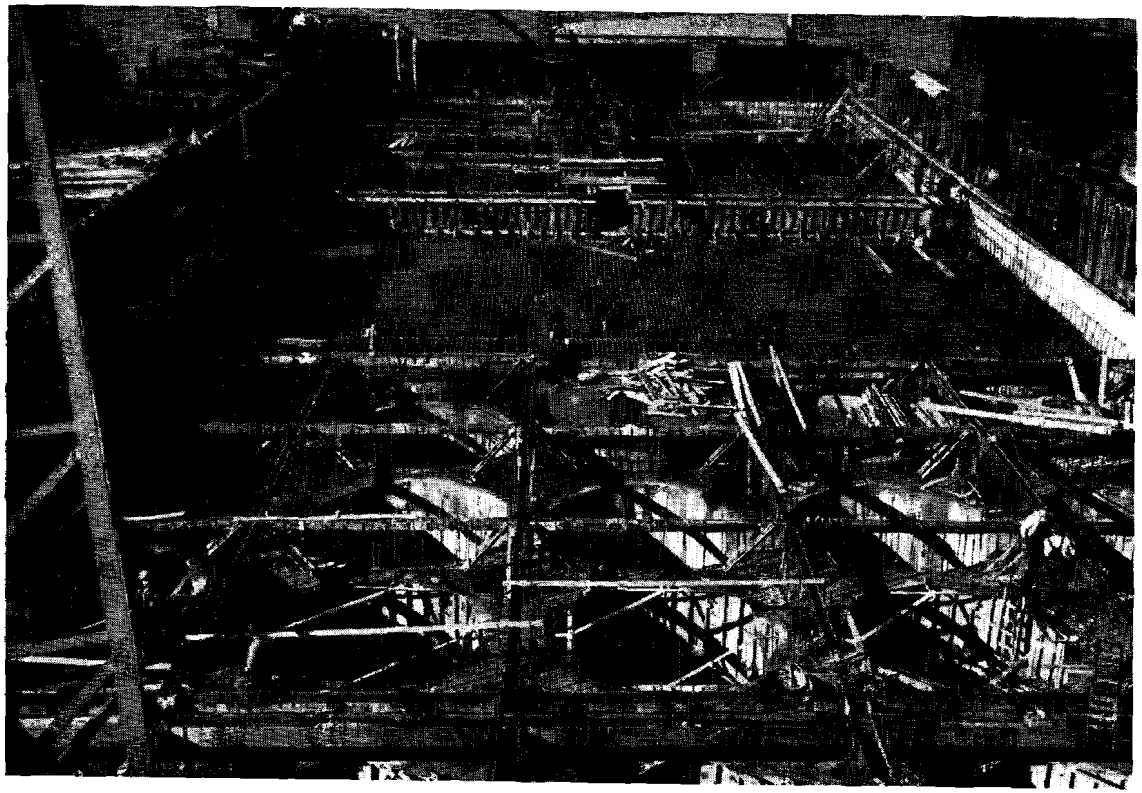
The foundation for the westerly anchorage again was constructed with an open dredge steel caisson, 95 feet in width and 221 feet in length, probably the largest such caisson ever constructed. In this case the caisson was founded 92.68 feet below the datum plane on a stratum of gray clay and fine sand. This was approximately 3 feet above the plan depth. All work was completed on May 4, 1950.

The lower sections, or cutting edges of all three caissons, were assembled by the New York Shipbuilding Company at their Camden Plant, launched and towed to the bridge site.

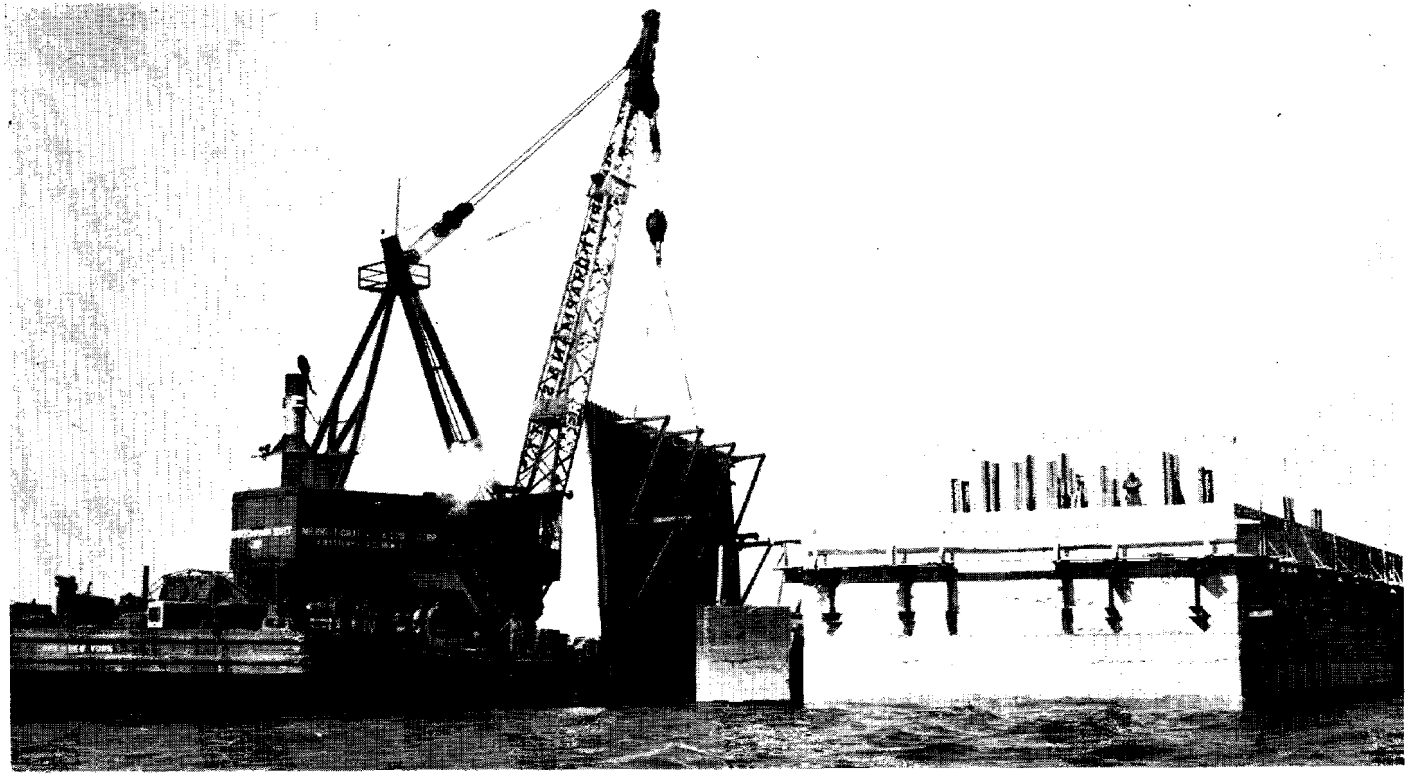
Due to the short supply of plate steel, of which large quantities were required for the caissons, the foundation for the easterly anchorage was constructed by use of a cofferdam. The site of the pier was predredged to a depth of approximately 40 feet. Then four units of structural steel framing were assembled on barges and successively placed in the water at the proper location. These frames served as interior bracing of the cofferdam after it had been sealed and the water pumped out. Steel sheet piling was driven around the framing after which the material inside the sheet piling was dredged to the plan elevation of 70 feet below the datum plane. The cofferdam was sealed with a layer of concrete 32 feet in thickness which was placed underwater in a continuous operation lasting 117½ hours. During this



WEST APPROACH PIERS WITH CAISSON IN FOREGROUND—DECEMBER 3, 1949



COFFERDAM EASTERN PIER—TOP OF OPEN WELLS AT +5.0′—DECEMBER 7, 1949



SHOWING REMOVAL OF A PORTION OF THE COFFERDAM FROM AROUND COMPLETED PIER AT APPROXIMATE ELEVATION 28.0'—MARCH 9, 1950

time approximately 27,000 cubic yards of concrete were mixed and deposited through steel pipes to the bottom of the excavated area. After this concrete had gained sufficient strength, the overlying water was pumped out and the balance of the foundation constructed in the open air. After the construction had been completed above the high water level, the water was permitted to flow inside the cofferdam and the steel sheeting then cut off at the level of the concrete seal and removed. Work on this foundation was completed on January 24, 1950.

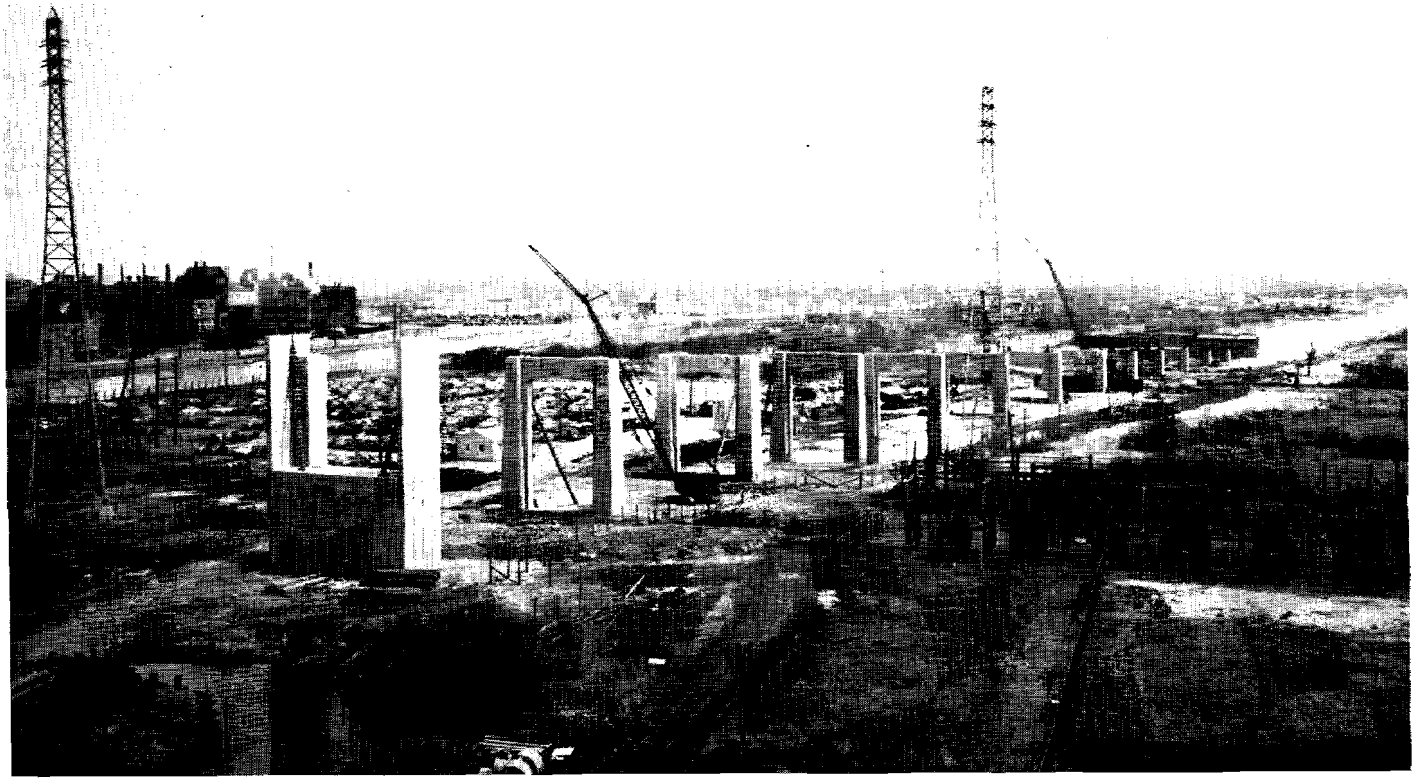
The concrete for all the piers was mixed in two floating mixer plants, the sand and gravel being barged down the river from Morrisville, Pennsylvania, and the cement shipped in bulk from five cement plants all located in the Lehigh Valley district of Pennsylvania. Approximately 150,200 cubic yards of concrete, 10,200 tons of structural steel and 2,400 tons of reinforcing steel were required to construct the four piers.

The contractor for this work was Merritt-Chapman & Scott Corporation of New York City.

CONTRACT NO. 3A—Approach River Piers

The construction of the six approach piers located in the river, four on the Delaware side and two on the New Jersey side, was done largely during 1949 although they were not entirely completed until April 25, 1950.

These piers are all founded on timber piles principally yellow pine, varying from 35 feet to 65 feet in length. Steel cofferdams were used in each case. After the cofferdam was in place, the material inside was excavated to below the level of the pier base, the piles driven and a three foot blanket of sand placed over the mud on which the underwater concrete seal was poured. After the seal had gained sufficient strength, the water inside the cofferdam was pumped out, the piles cut off at grade and the balance of the pier base constructed in the open air. When the construction had been completed to above the high water level, the space within the cofferdam was allowed to fill with water and the sheet piling pulled out. Standard construction methods were used to build the pier shafts and arched ties.



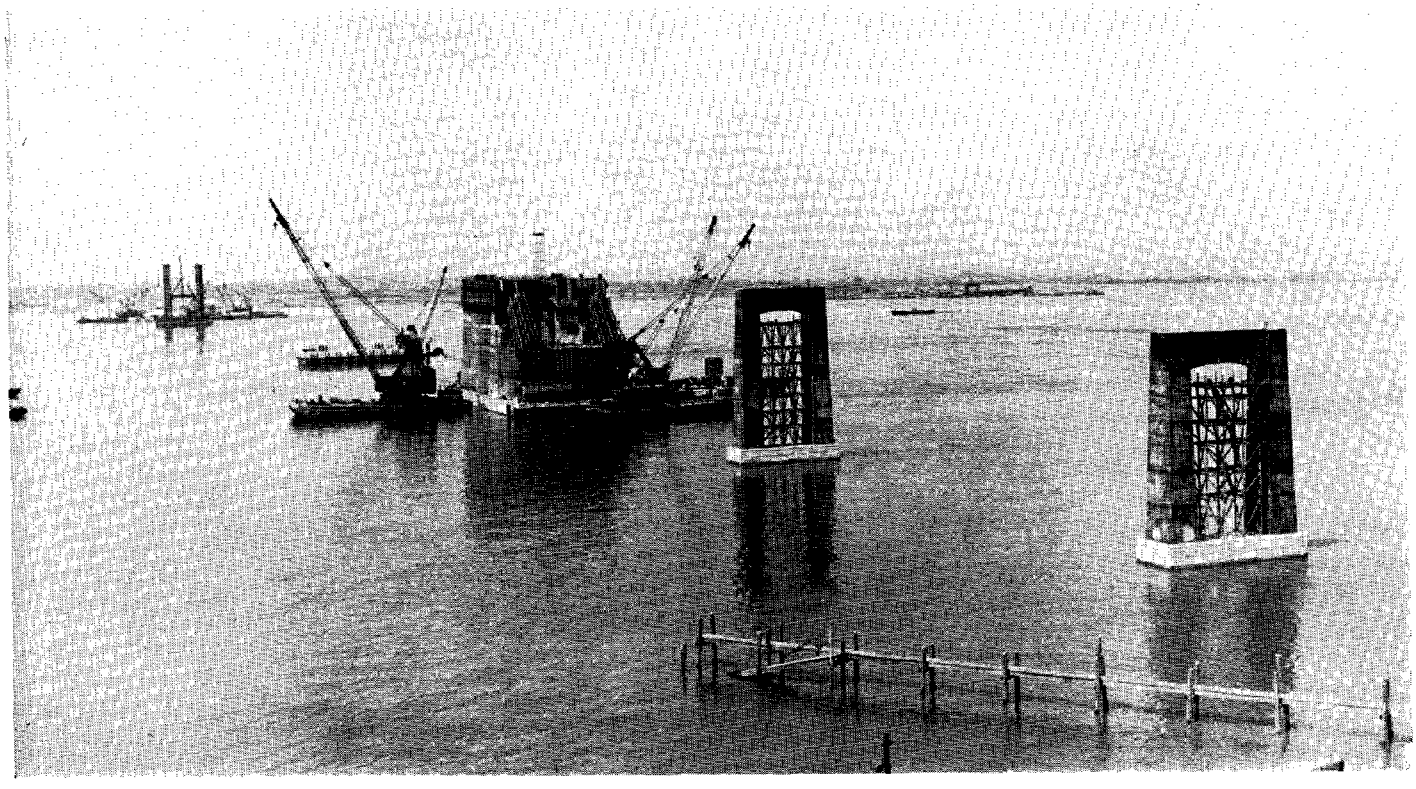
SHOWING COMPLETED EASTERN PIERS AND ABUTMENT—APRIL 10, 1950

Approximately 15,400 cubic yards of concrete, 46,450 lineal feet of timber piles, and 330 tons of reinforcing steel were required for this contract. This work was also done by Merritt-Chapman & Scott Corporation using floating equipment concurrently with the work under Contract No. 2. The piers were completed on April 25, 1950.

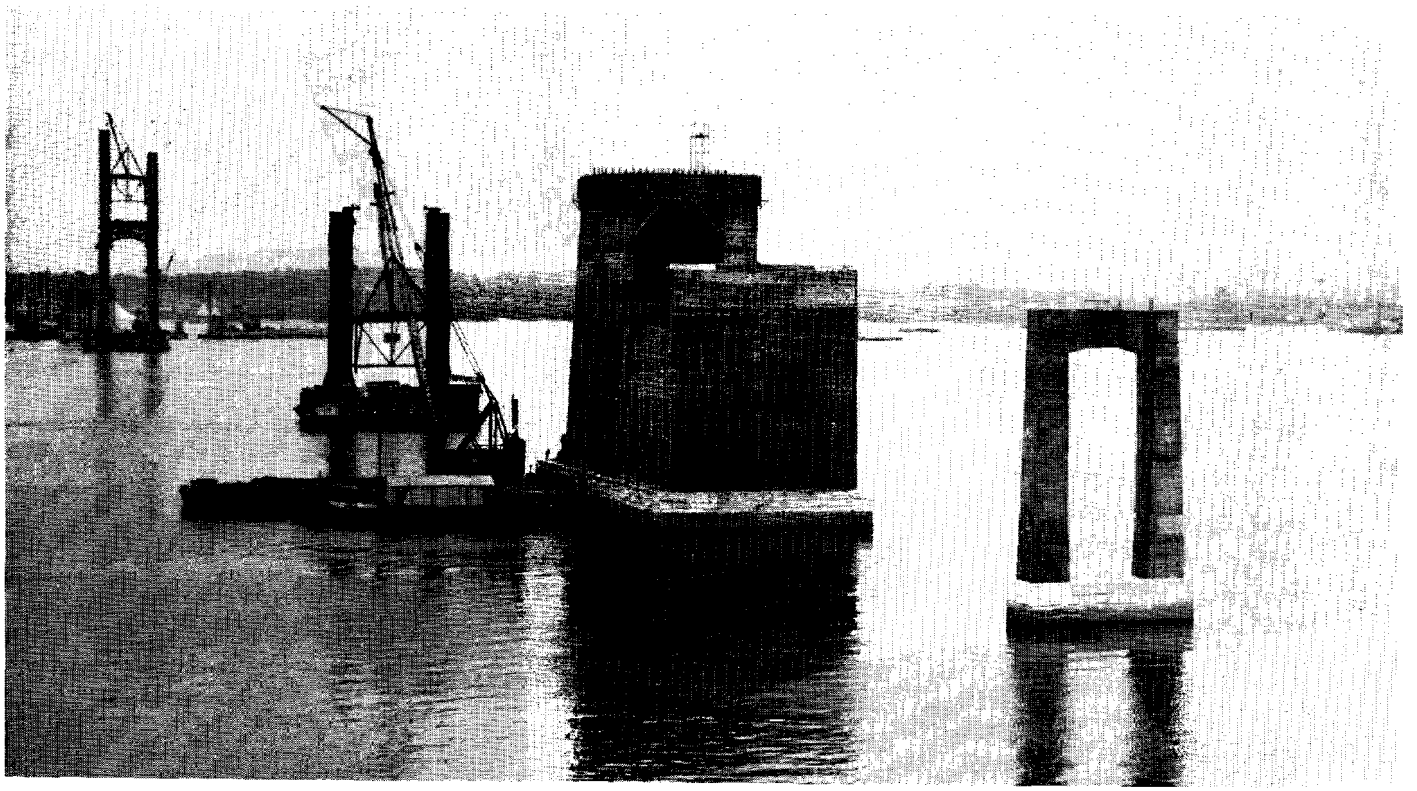
CONTRACT NOS. 3B and 3C—Approach Land Piers

The approach land piers on both sides of the river are founded on wood piles and are similar in outline. The pier footings on the New Jersey side were constructed in open excavations with the ground water elevation lowered by means of a series of surrounding well points. The wood piles were driven with the aid of water jets in order to break through a hard stratum of material overlying the desired bearing stratum. On the Delaware side, the pier footings were constructed in cofferdams formed with steel beams driven vertically at prescribed locations with timber panels inserted between them as the excavation advanced through the material which, under Contract No. 21, had previously been deposited over the marsh mud. Contrary to expectations very little water flowed into these excavations so that practically no pumping was required. The pier shafts on the Delaware side were constructed in lifts up to 30 feet in height. Other than this, standard construction methods were used on both sides. All concrete on the Delaware side was mixed at the Warner Central Mix Plant and trucked to the site. On the New Jersey side the concrete was mixed at the site.

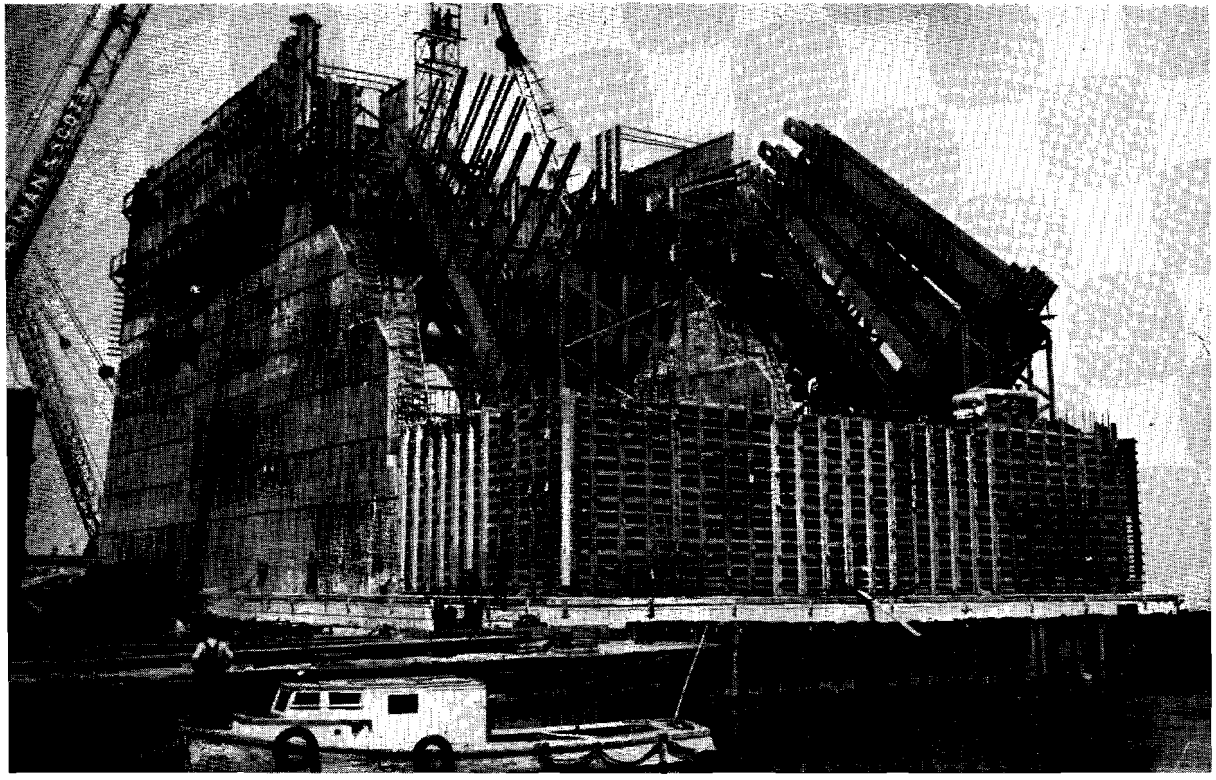
The New Jersey piers were constructed by Lewis and Bowman of Goldsboro, North Carolina, using about 7,960 cubic yards of concrete, 92,260 lineal feet of timber piles, and 300 tons of reinforcing steel. They were completed on March 10, 1950. The Delaware piers were constructed by The Conduit & Foundation Corporation of Philadelphia, Pennsylvania, using about 8,230 cubic yards of concrete, 76,530 lineal feet of timber piles and 225 tons of reinforcing steel. These piers were completed on April 17, 1950.



GENERAL VIEW LOOKING WEST—APRIL 20, 1950



SHOWING PLACING OF FORMS FOR LIFT OF EAST ANCHORAGE WITH CONCRETE COMPLETED TO TOP OF LIFT ON NEW JERSEY END—JUNE 22, 1950



SHOWING NORTH ANCHORAGE STEEL COMPLETELY ERECTED AND SOUTH ANCHORAGE STEEL IN PROCESS OF ERECTION ON PIER D—APRIL 17, 1950

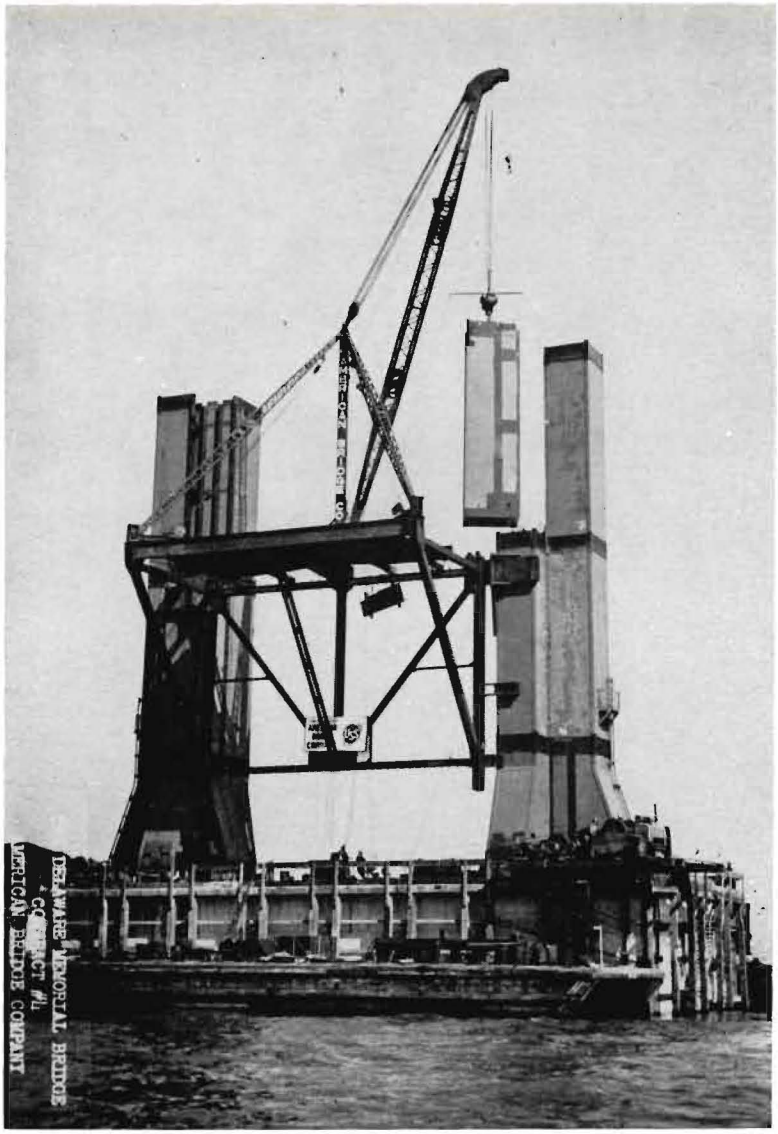
CONTRACT NO. 3D—Anchorage Blocks

The anchorage blocks were built by the Merritt-Chapman & Scott Corporation so that they were started before the foundations constructed under Contract No. 2 were entirely completed. No unusual construction was involved in this work other than the heights to which the forms and concrete had to be placed. The concrete supporting the cable saddles reaches up to elevation +154 feet and was all placed with the floating derricks. Steelwork was embedded in the concrete forming independent connections for each of the 38 strands making up the two main cables.

Approximately 46,460 cubic yards of concrete and 820 tons of reinforcing steel were used and 900 tons of structural steel forming the cable anchors. Work under this contract was completed on August 18, 1950.

CONTRACT NO. 4—Towers and Suspended Steelwork

Work under this contract covers two parts which are separated by the construction of the cables and the placing of the suspenders. The first part was the erection of the two towers which rest on the tower piers at elevation +20 feet and reach up to elevation +435 feet. The towers each contain about 4,125 tons of steel and while identical in construction the west tower was fabricated at the Ambridge, Pennsylvania Plant, and the east tower at the Gary, Indiana Plant of the American Bridge Company. Erection of the west tower started on March 17, followed by the east tower on April 26, 1950. The first two tiers were erected with a floating derrick which then was used to assemble a creeper traveler which was used to erect the balance of the steelwork. The traveler consisted of a bracket-shaped steel frame temporarily attached to the permanent steelwork near the top of each even-numbered tier of tower steel. A standard stiff-leg derrick was mounted on this frame which was used to hoist the tower sections and set them in place. All rivets were heated in forges resting on scaffolds surrounding the tower legs which were progressively raised as the riveting was completed. The rivets for the interior connections were shot inside through flexible steel tubes by means of compressed air. The last sections of tower steel were erected on August 24, 1950.



SHOWING ERECTION OF ONE SECTION OF 3RD TIER OF DOWNSTREAM TOWER AT WEST PIER, AND DETAILS OF ERECTION TRAVELER.
APRIL 12, 1950

CONTRACT NO. 5—Cables and Suspenders

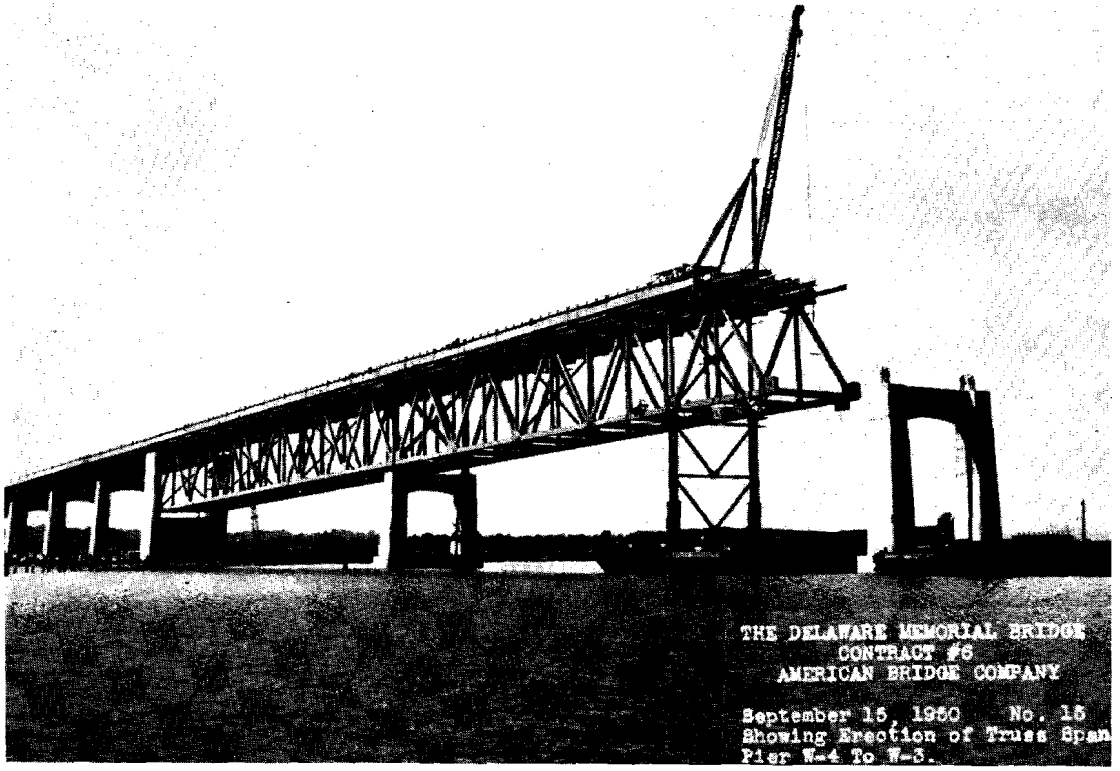
The first operation of this contract was the construction of the foot bridges, or working scaffolds. Each foot bridge is supported on four wire ropes spanning from anchorages to towers and from tower to tower parallel to and about three feet below the unloaded position of the cables. These ropes will later be cut into shorter lengths for use as suspenders. The foot bridge deckway is woven wire fencing attached to timber cross pieces and stretched sufficiently tight to support the workmen without sagging unduly. The foot bridge ropes were first laid on the river bed from reels mounted on barges and towed from pier to pier. They were then hoisted one at a time into position and connected to the anchorages and tower tops.

The cables are constructed by pulling a succession of wire loops from wire reels mounted on one anchorage over the towers to the other anchorage. At the far anchorage the wire loops are placed around circular spool-shaped shoes which are connected to the steelwork embedded in the anchorage concrete. At the near anchorage the wire leading to the wire reel is successively placed around a similar shoe forming other loops to be pulled to the far anchorage. This operation is repeated until the required number of wires are in place to form one unit or strand at which time the wire leading to the reel is cut and the end spliced to the end which initially came off the reel thus forming an endless wire similar to a skein of yarn. Nineteen such strands each containing 218 loops, or 436 wires, make up each cable. The loops of wires are pulled from anchorage to anchorage by flanged wheels attached to an endless hauling rope both parts of which are supported from timber frames spaced at intervals along the foot bridges and, at each anchorage, pass around a reversible drive machine. In the completed cables, all wires from one anchorage saddle over the towers to the other anchorage saddle lie parallel to each other and from the anchorage saddles to the points of attachment to the embedded steelwork, the wires splay out to their separate connecting shoes.

Cable spinning started late in October and at the end of 1950 was about 85% complete. About 3,400 tons, or 12,850 miles of wire are required for the two cables. The cable wire and suspender rope was manufactured at the Trenton, New Jersey Plant of the American Steel and Wire Company. All work at the bridge site is being done by the American Bridge Company.

TOWER CONSTRUCTION PROGRESS—JULY, 1950

FOOT BRIDGE AND TRUSS SPAN CONSTRUCTION—OCTOBER, 1950


THE DELAWARE MEMORIAL BRIDGE
CONTRACT #6
AMERICAN BRIDGE COMPANY
September 15, 1960 No. 15
Showing Erection of Truss Span
Pier W-4 To W-3.

CONTRACT NO. 6—Approach Superstructure Steelwork

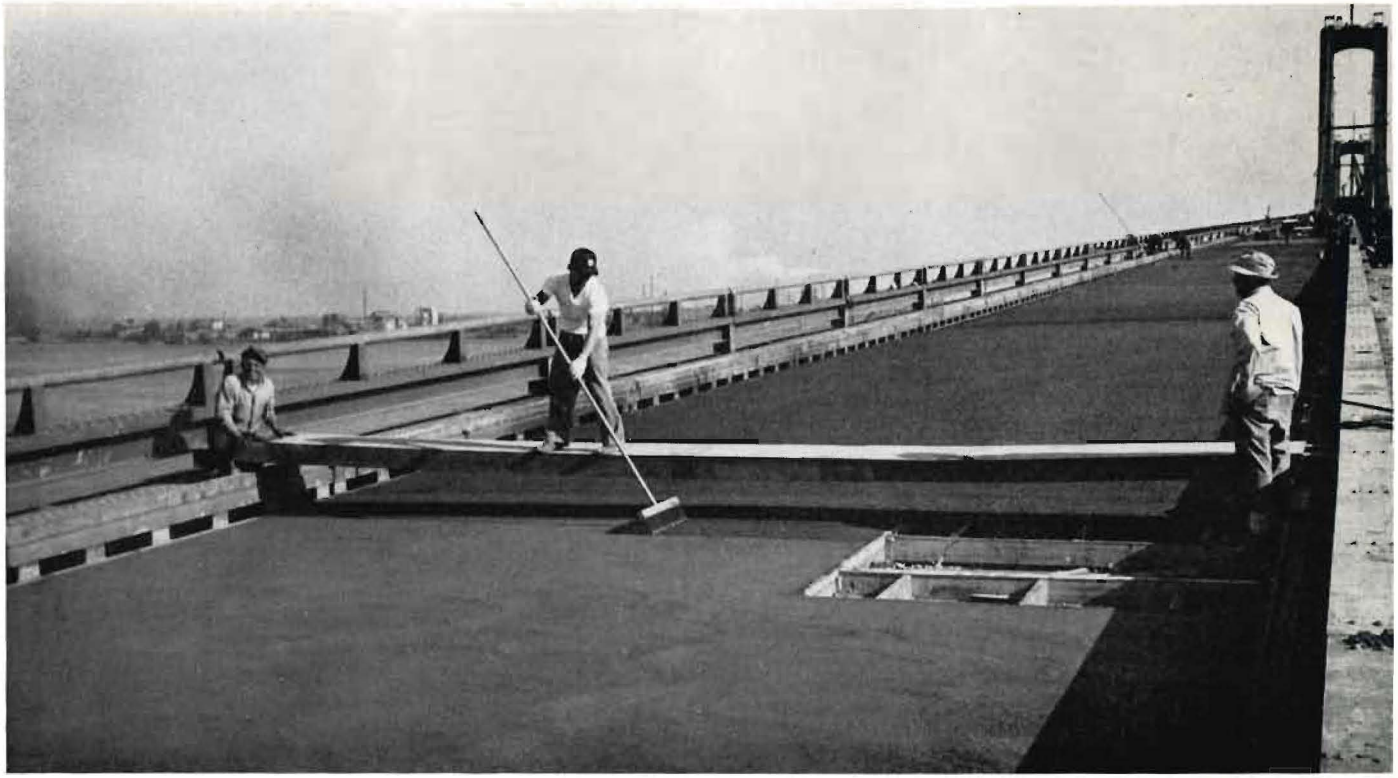
The Approach viaducts on both sides consist of five deck truss spans each 340 feet in length extending from the anchorages to Piers E5 and W5, and from these piers to the abutments a series of continuous plate girder span units varying from 283 to 470 feet in length.

The girder span steelwork was erected with caterpillar cranes working on the ground, starting at the abutments and progressing towards the river. With the erection completed to Piers E5 and W5, travelers consisting of stiffleg derricks mounted on steel frame platforms were assembled on the erected steelwork and progressively moved forward to erect the tower spans. The first span was erected on temporary supports, falsework bents in turn at 1/6, 1/3 and 2/3 of a span length. The remaining four spans were erected by cantilevering from the previously erected span with a single falsework bent located at 2/3 of the span length. Upon completion of each span, the off-shore end was raised with hydraulic jacks to release the load carried by the falsework bent and at this time temporary connections to the adjacent span were removed. The end of that span was then lowered to its final position on the pier top.

Erection of the approach steelwork was essentially complete at the year's end, the Delaware Approach having been started on February 15, and the New Jersey Approach on March 14. The American Bridge Company is the contractor for this part of the work.

CONTRACT NO. 7A—Anchorage Tops

Bids for this work were received on June 15, and an award made to Lewis and Bowman, Inc. at an estimated cost of $1,132,550. Construction cannot be started until completion of the main cables.



APPLYING BROOM FINISH ON CONCRETE DECK WEST APPROACH—NOVEMBER 1, 1950

CONTRACT NO. 7B—Concrete Deck

The contract for the work was awarded to The Whiting-Turner Contracting Company of Baltimore, Maryland, at an estimated cost of $1,043,329. Construction started on August 1, and was approximately 42% complete at the year's end. The placing of the concrete roadways began at the abutments and progressed towards the anchorages. Central-mix concrete is delivered to the bridge deck as far out as the completed roadways will permit from which point small gasoline-driven buggies transport the concrete to dumping platforms spanning the roadway. The concrete is finished by machine and hand operations in the typical highway manner.

CONTRACT NO. 11—Tower Elevators

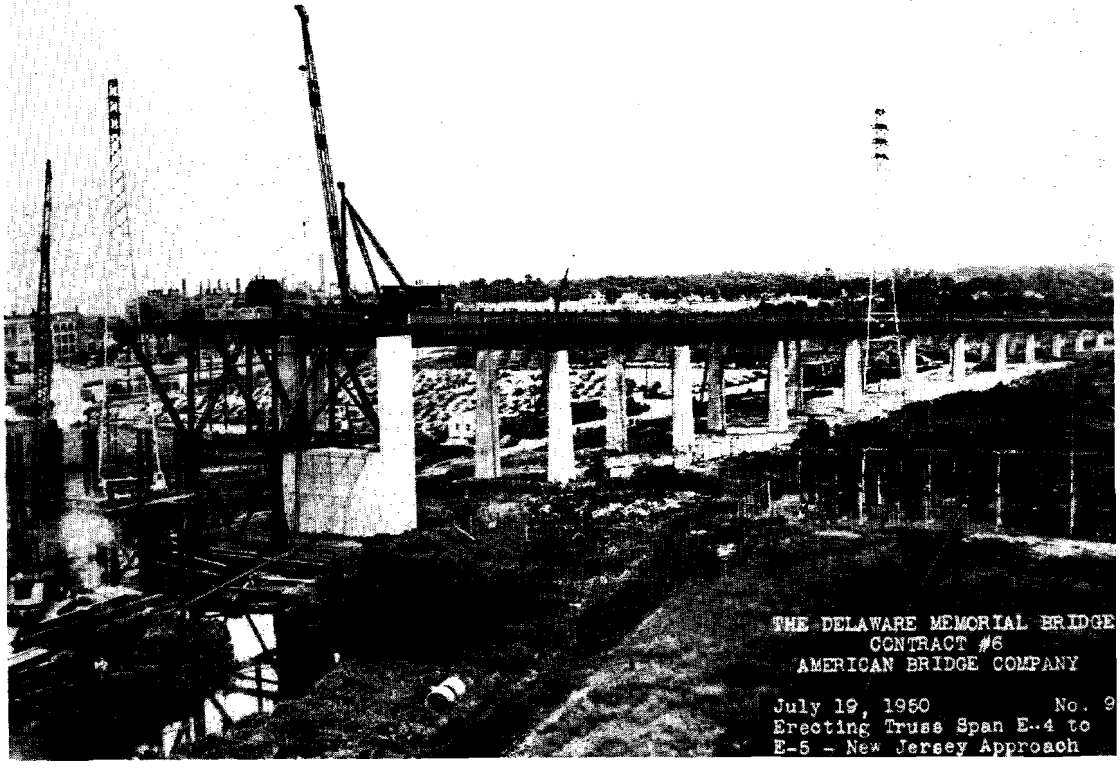
This contract covers the installation of a small maintenance and inspection elevator in one cell of each tower by the Otis Elevator Company of Philadelphia, Pennsylvania. The materials were placed inside the towers during their erection and at the end of the year the installation was about 50% complete. This work is to cost $32,985.

CONTRACT NOS. 12 and 14—East and West Approach Grading

The work under these contracts was started in 1949, but was interrupted during the early months of the year when weather conditions prevented suitable work being done. The grading of the West Approach was completed on August 2, and the East Approach on October 28. Henry C. Eastburn and Son of Newark, Delaware, was the contractor for both sides.

CONTRACT NO. 16—Pennsylvania Railroad Overpass

Bids for this work were received on May 23, and the contract awarded to The Conduit & Foundation Corporation of Philadelphia, Pennsylvania, at an estimated cost of $194,455. Construction started on July 19, and was about 73% complete at the end of the year. The Overpass consists of three continuous I beam spans supported on concrete piers and abutments which in turn are founded on Raymond Concrete Piles.


THE DELAWARE MEMORIAL BRIDGE
CONTRACT #6
AMERICAN BRIDGE COMPANY
July 19, 1950 No. 9
Erecting Truss Span E-4 to
E-5 - New Jersey Approach

CONTRACT NO. 19—Administration Building. Toll Booths and Toll Collection Equipment

The Toll Plaza is located on the Delaware side about 800 feet east of New Castle Road. The Administration Building is on the north side of the approach roadway and will consist of a one-story steel frame and brick structure with partial basement for storage rooms and the heating plant. The Toll Booths will be prefabricated and will contain the usual electrical registering equipment and traffic classification signs. Axle counting treadles will be installed in the roadway to check the transactions registered by the toll collector.

Construction started on October 16 and was 5% complete on January 1, 1951. The contract is being performed by the Cantera Construction Company at a total cost of $278,447.

FUTURE CONTRACTS

Work not yet under contract includes:

1. Fender System—Tower Piers
2. Field Painting Steel Superstructure
3. Navigation Lights and Beacons
4. Concrete Paving Land Approaches
5. Approach and Bridge Lighting
6. Revision of Deepwater Range Lights

These contracts will be let early in 1951 in time to meet the opening date of the project.

FINANCIAL STATEMENT

Attached are copies of the Secretary's Financial Statements as of January 1, 1951, as follows:

1. Balance Sheet
2. Construction Cost in Progress Statement
3. Statement of Unfinished Contracts
4. Statement of Finished Contracts

Respectfully submitted,

J. GORDON SMITH
Chairman State Highway Department

BALANCE SHEET
DELAWARE MEMORIAL BRIDGE
DELAWARE CROSSING DIVISION
As of January 1, 1951

(EXHIBIT A)

ASSETS		
CURRENT ASSETS		
Equitable Trust Company (Trustee)		$ 8,389,549.63
Investments (Cost Value)	$6,658,630.00	
Cash	1,730,919.63	
Delaware Memorial Bridge Revolving Fund		103,830.81
TOTAL CURRENT ASSETS		$ 8,493,380.44
CAPITAL ASSETS		
Construction Cost in Progress		$32,644,223.99
TOTAL ASSETS		$41,137,604.43
LIABILITIES AND CAPITAL		
CAPITAL LIABILITIES		
Bonded Debt and Authorization		$40,000,000.00
CAPITAL		
Profit on Sale of Bonds	$ 200,000.00	
Trustee's Income Account (Earnings Net)	126,962.94	
Earnings Transferred to Principal Account	810,641.49	
TOTAL CAPITAL		$ 1,137,604.43
TOTAL LIABILITIES AND CAPITAL		$41,137,604.43
NOTE: Contractual Liability	$6,593,465.17	

CONSTRUCTION COST IN PROGRESS STATEMENT
DELAWARE MEMORIAL BRIDGE
DELAWARE CROSSING DIVISION
As of January 1, 1951

(EXHIBIT B)

	Previous Transactions	Month of December Transactions	Totals to Date
DISBURSEMENTS AND OTHER DEBITS			
SALARIES AND WAGES			
Salary of Director	$ 37,499.94	$ - -	$ 37,499.94
Engineering Services			
Howard, Needles, Tammen & Bergendoff	1,542,327.45	—	1,542,327.45
Aero Service Corporation	3,770.00	—	3,770.00
Coverdale & Colpitts	15,000.00	- -	15,000.00
The Haller Testing Labs., Inc.	12,284.06	137.45	12,421.51
Pittsburgh Testing Lab.	15,368.30	1,433.77	16,802.07
Delaware State Highway Dept.	2,141.25	- -	2,141.25
E. I. du Pont de Nemours Co.	10,569.75	—	10,569.75
Sprague & Henwood, Inc.	1,724.00	- -	1,724.00
Raymond Concrete Pile Co.	742.50	—	742.50
Legal Fees	66,376.14	500.00	66,876.14
Accountant Fees	4,030.00	- -	4,030.00
Equitable Trust Company (Trustee)	95,656.40	9,577.21	105,233.61
Miscellaneous	47,047.26	1,619.00	48,666.26
Total Salaries and Wages	$ 1,854,537.05	$ 13,267.43	$ 1,867,804.48
OFFICE EXPENSE	32,923.53	358.60	33,282.13
TRAVEL	1,188.83	17.14	1,205.97
OPERATION	3,522.43	64.56	3,586.99
REPAIRS & REPLACEMENTS	384.02	—	384.02
EQUIPMENT	12,147.06	103.20	12,250.26
OTHER COSTS			
Interest on Bond Issue	4,000,000.00	—	4,000,000.00
Acquisition of Property	233,165.00	31,250.00	264,415.00
Contracts	25,347,375.93	1,075,516.63	26,422,892.56
Insurance	1,366.00	37,156.05	38,522.05
Miscellaneous Recoveries	119.47	—	119.47
Total Other Costs	$29,581,787.46	$1,143,922.68	$30,725,710.14
TOTAL CONSTRUCTION COST TO DATE	$31,486,490.38	$1,157,733.61	$32,644,223.99

STATEMENT OF UNFINISHED CONTRACTS
DELAWARE MEMORIAL BRIDGE
DELAWARE CROSSING DIVISION
As of January 1, 1951

(EXHIBIT C)

Contract Number		Estimated Contract Amount	Payments	Balance Outstanding
None	Pittsburgh Testing Laboratories	$ 27,196.00	$ 16,802.07	$ 10,393.93
None	The Haller Testing Laboratories, Inc.	20,100.00	12,421.51	7,678.49
2	Merritt-Chapman & Scott Corporation	11,494,586.00	11,452,592.71	41,993.29
	Extra Work Orders	62,814.42	62,814.42	—
3B	The Conduit & Foundation Corporation	609,520.00	523,507.50	86,012.50
	Extra Work Orders	431.39	388.25	43.14
4	The American Bridge Co.	6,119,300.00	4,074,486.12	2,044,813.88
	Flame Cleaning	68,700.00	51,004.80	17,695.20
5	The American Bridge Co.	2,311,985.00	748,590.89	1,563,394.11
6	The American Bridge Co.	5,299,805.00	4,743,557.79	556,247.21
	Extra Work Orders	289.81	260.83	28.98
	Flame Cleaning	60,600.00	53,445.60	7,154.40
7A	Lewis and Bowman, Inc.	1,132,550.00	- -	1,132,550.00
7B	Whiting-Turner Contracting Co.	1,043,329.00	306,600.40	736,728.60
11	Otis Elevator Company	32,985.00	14,843.25	18,141.75
16	The Conduit & Foundation Corp.	194,455.00	97,718.51	96,736.49
19	Cantera Construction Co.	278,445.00	4,591.80	273,853.20
	TOTALS	$28,757,091.62	$22,163,626.45	$6,593,465.17

STATEMENT OF FINISHED CONTRACTS
DELAWARE MEMORIAL BRIDGE
DELAWARE CROSSING DIVISION
As of January 1, 1951

(EXHIBIT D)

Contract Number		Contract Amount	Payments	Underrun or Overrun*
21	Citro & Sons, Inc.	$ 22,500.00	$ 21,965.06	$ 534.94
1	Sprague & Henwood, Inc.	33,400.00	33,206.28	193.72
None	E. I. du Pont de Nemours	32,000.00	31,450.50	549.50
None	Delaware Power & Light Co.	4,882.98	4,882.98	—
None	Deepwater Light & Power Co.....	51,263.54	51,263.54	—
3A	Merritt-Chapman & Scott Corp.....	1,291,240.00	1,223,394.60	67,845.40
	Extra Work Orders	402.26	402.26	—
3C	Lewis and Bowman	709,650.00	697,406.63	12,243.37
	Extra Work Orders	154,151.50	154,151.50	- -
	Claim for Delay to Contract Work	10,000.00	10,000.00	- -
3D	Merritt-Chapman & Scott Corp.....	1,830,000.00	1,854,638.10	24,638.10*
	Extra Work Orders	2,308.32	2,308.32	—
12	Henry C. Eastburn & Sons.....	56,210.00	55,125.64	1,084.36
14	Henry C. Eastburn & Sons.....	134,101.00	147,116.02	13,015.02*
	Extra Work Orders	1,178.26	1,178.26	—
	TOTALS	$4,333,287.86	$4,288,489.69	$44,798.17