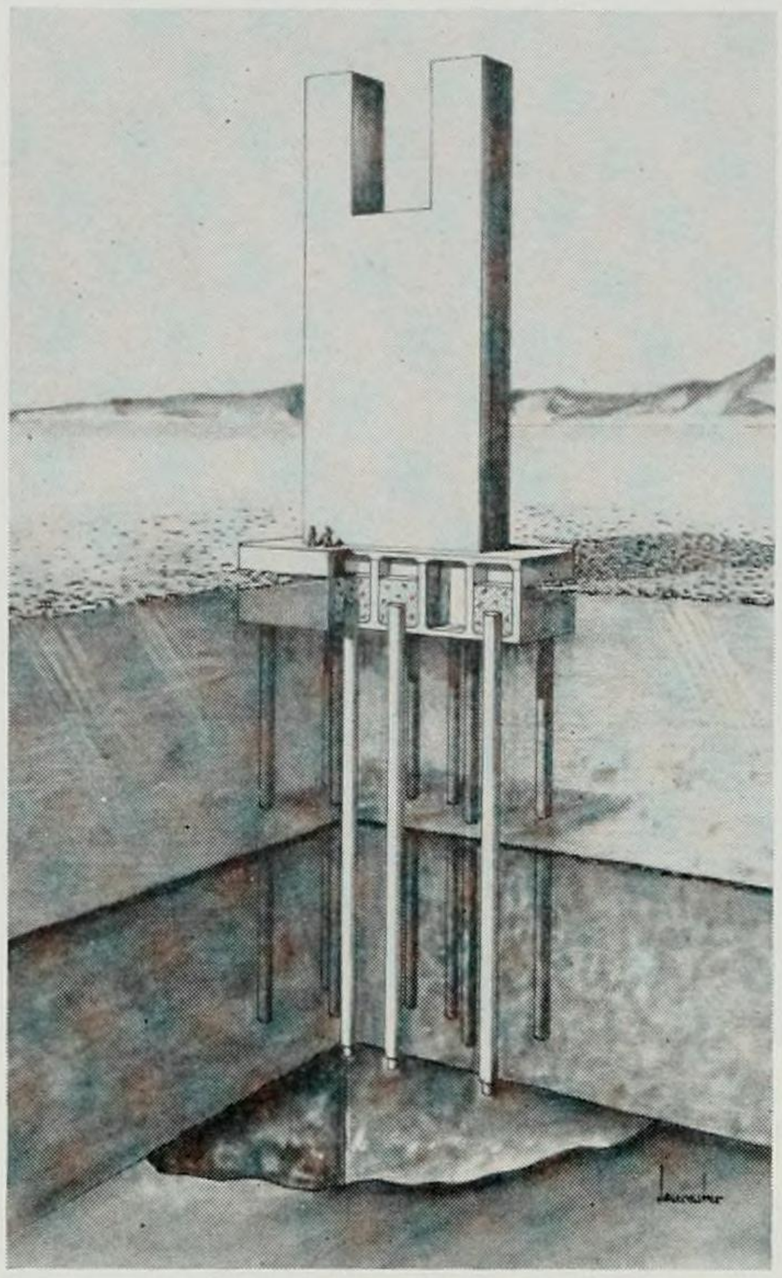
Bridge Progress

Benicia-Martinez Job Completion Scheduled for Summer of 1962

By L. C. HOLLISTER, Bridge Engineer—Special Projects

Sometime in the summer of 1962 the fourth bridge across Carquinez Strait will have been completed and opened to traffic. Three of these bridges are highway structures and the fourth is a railroad bridge supporting two tracks of the Southern Pacific Company's main line.

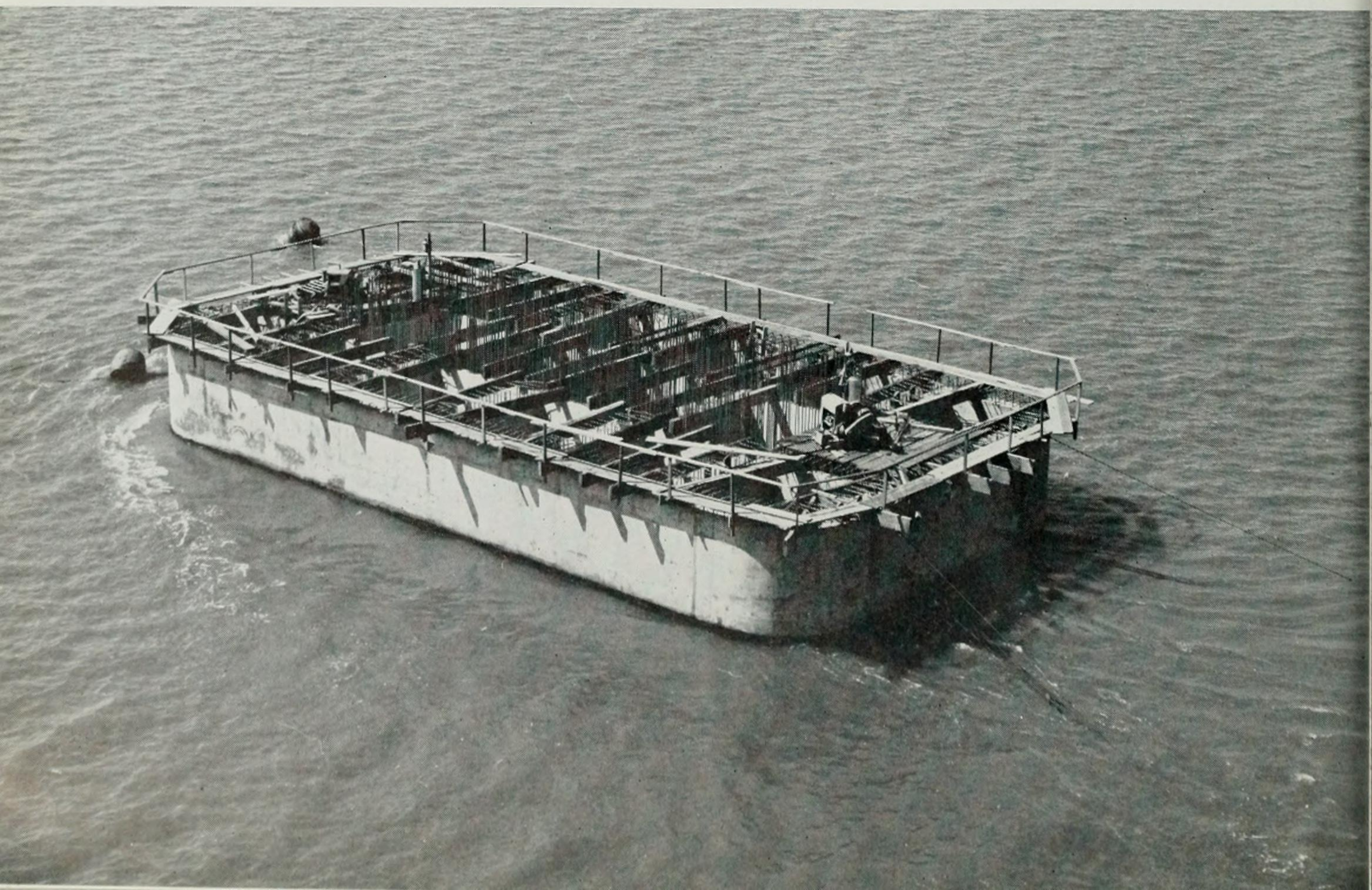


This sketch shows how each pier was constructed. The 10 steel caissons were lowered to bedrock and sunk about two feet into it. Then an additional 5-foot socket was drilled into the rock, and the steel caissons and socket filled with concrete. The tops of the caissons were then anchored to the footing block by placing concrete in the cell around the caissons. From a theoretical standpoint, the 10 caissons of each pier were designed for earthquake by applying a theoretical horizontal load equal to 10 percent of the dead load of the superimposed trusses and the pier with the force located at the center of gravity of this dead load. The caissons were assumed fixed to the footing at the top and at a point about 30 feet above bedrock at the bottom of the caisson.

PHOTO BELOW—The empty celled concrete box footing was constructed on land, floated into place and then securely anchored in exact position ready to receive the first 6-foot in diameter, 130-foot long steel caisson.

The Carquinez Strait is a magnificent body of water and a great asset to the State of California. But in spite of its great commercial, recreational and aesthetic value, it has always been a troublesome problem to both highway and railroad transportation.

General Vallejo, with his great land holdings extending from Benecia to Santa Rosa, was the first to recognize that some type of highway transportation would have to be established across the Carquinez Strait if his great empire was to grow and prosper. Accordingly, in about 1848 he made efforts to establish a ferry across the Carquinez Strait between Benicia and Martinez. It was not until 1853, however, that a successful ferry was put in operation between these points. This was the start of the great ferry systems that were to serve the San Francisco Bay area for so many years, and in July 1962 the opening of the Benicia-Martinez Bridge will draw the final



curtain on this picturesque era that many will remember.

Structure is Planned

In spite of the success of these ferries, men were dreaming and scheming of some way to cross the Carquinez Strait with a structure. There was considerable skepticism however, as attested by the following quotation from the January 1899 issue of the Contra Costa *Gazette*:

> "The possibility and impracticality of a bridge across Carquinez Strait has been discussed for a long time both by the Railroad Company and by the leading Bridge companies in California.
> "A bridge between Port Costa and Benicia has also been considered. The prospect of a bridge between these two places is so absurd on the face of it that no engineer or company has ever surveyed or even advanced the proposition to the Railroad Company. I think that unless some wealthy lunatic of a company comes along and builds a bridge, that a bridge across Carquinez Straits will remain unbuilt till the end of time."

In spite of this rather typically dim view which was held by many, a three lane highway bridge was built across Carquinez Strait and opened to traffic in 1927 by the American Toll Bridge Company. Following the completion of this highway bridge, the Southern Pacific Company opened its bridge to railroad traffic in 1930.

Bridging the Carquinez Strait has not been easy, however, and the difficulty has been mostly in the foundation construction. Bedrock in the Carquinez Strait lies approximately 130 feet below the water surface. At this elevation bed rock consists of tipped up layers of shale and sand stone. Over the bed rock lies 50 to 90 feet of mud, sand and gravel. The problem has therefore been to penetrate this overburden through rather swift and changing currents of water and establish some type of pier foundations on the bed rock below.

First Pier Construction

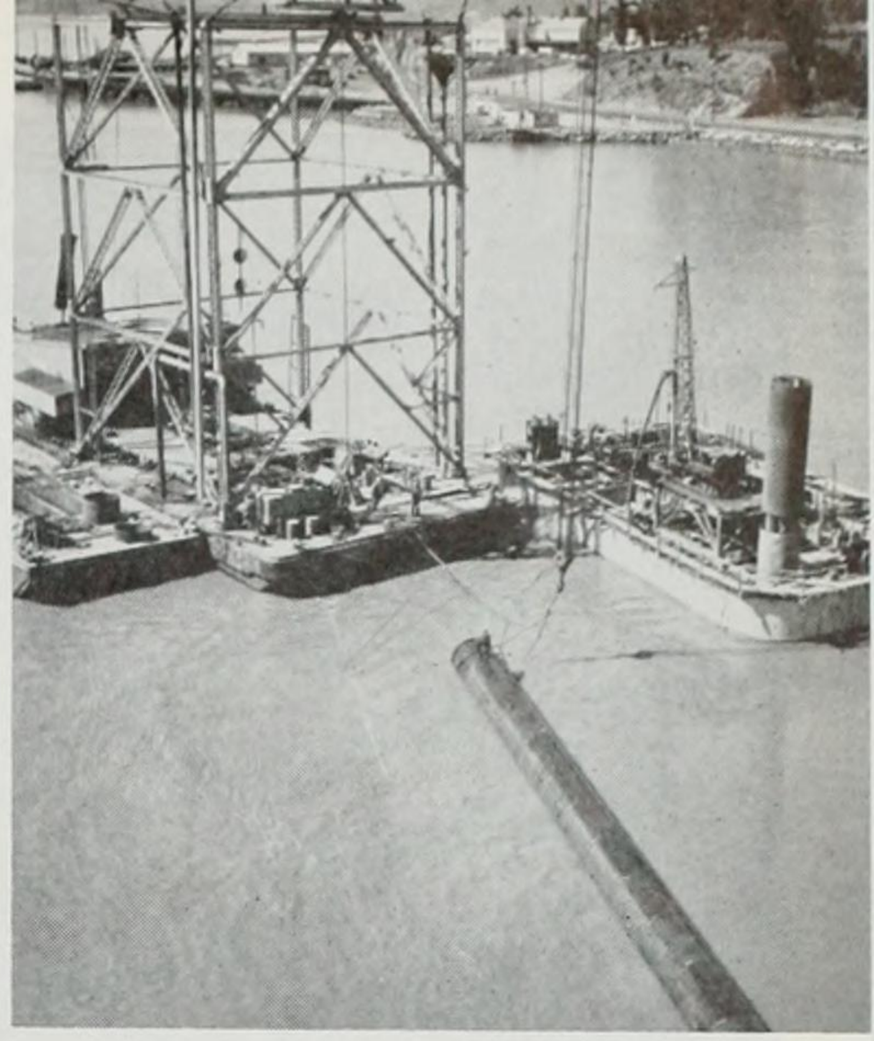
On the first Carquinez Bridge, piers were constructed of two 40 foot square footing blocks topped by a 30 ft. diameter cylinder. Each of these casissons was constructed of timber and held in position by a floating cage, which was in turn anchored in position. The caisson with its timber sides was sunk by adding concrete or weight on top and by excavating the material at the bottom, allowing it to gradually settle through the mud and gravel overburden until it came to rest on bed rock. The inside was then filled with concrete which became the foundations for the first Carquinez Strait bridge. The walls and excavating cells in the lower portion of these caissons were constructed of timber and after reaching bedrock the open cells were completely filled with concrete.

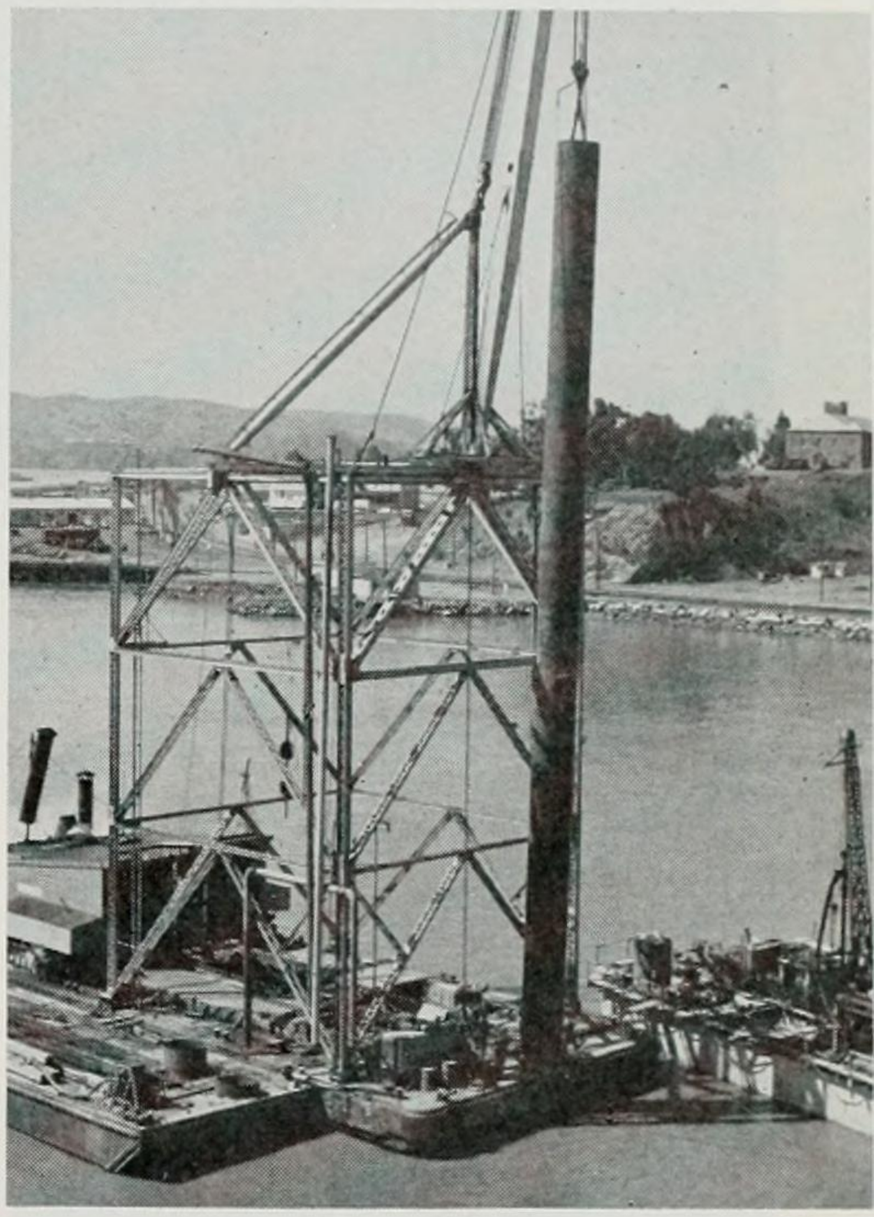
This was a slow, tedious and even hazardous process in the rather treacherous waters of Carquinez Strait.

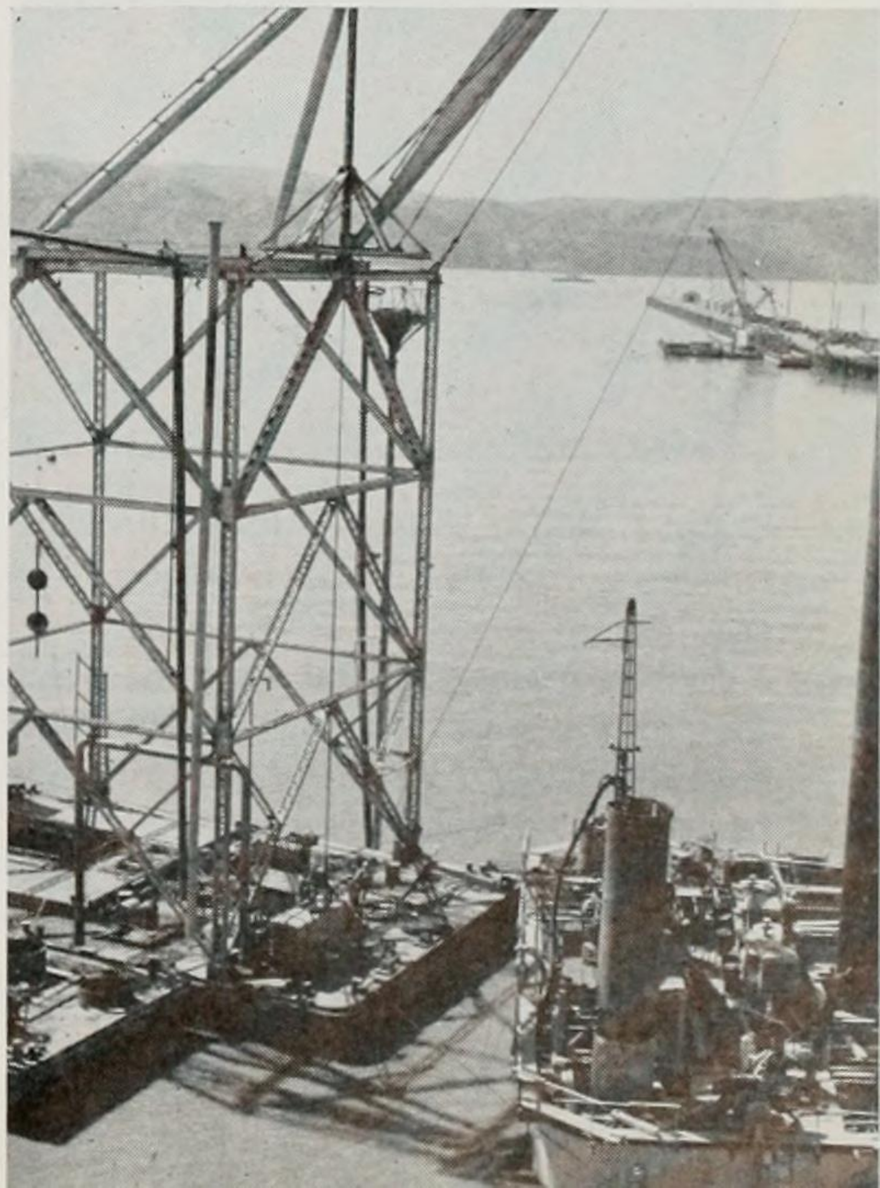
The Southern Pacific Company chose to use a somewhat different and perhaps a much safer method of pier construction. At each of their piers a ring 80 feet in diameter of steel sheet piles was driven and the interior filled with sand to an elevation well above high water. On each of these "sand islands", as the method is called, the bottom portion of the concrete pier was constructed. Through dredging chambers constructed in each pier, the material from under would be excavated and pier allowed to sink. Adding concrete at the top and excavating at the bottom, the pier would finally be brought to bear on bedrock at the bottom. While this method was much less hazardous it was very costly.

Improved Method Used

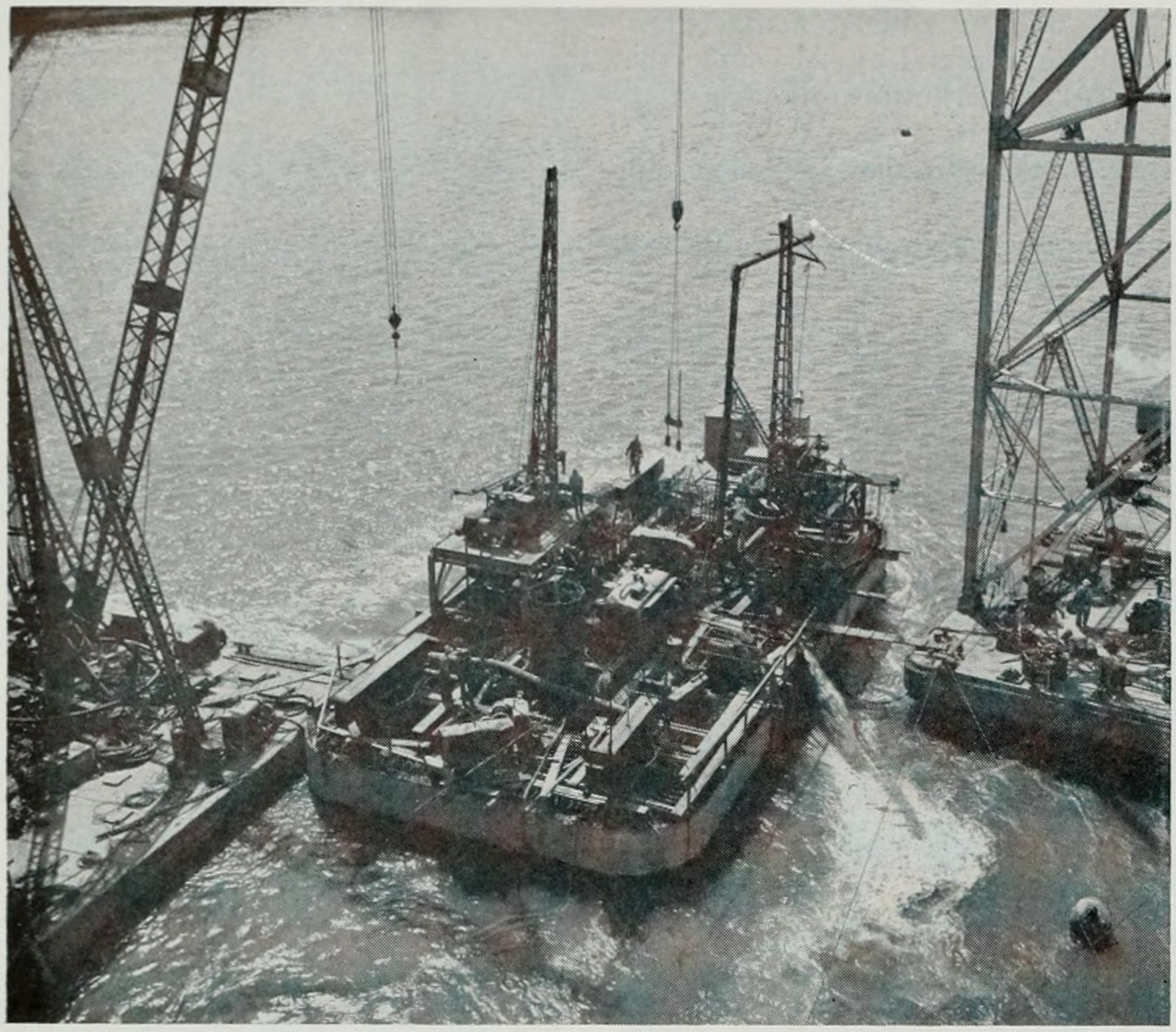
At the second parallel Carquinez Bridge (1955-58), an improved method was used which cost much less and still incorporates adequate safety features. This time the bottom 31 feet of the pier with its cutting edges was built in a dry dock and then floated into position where it was anchored. The concrete walls of the piers were then extended upward and as weight was added the pier sank through the water until it entered the mud line. At this point the timber bottoms to some of the 18 cells which had been constructed in the caisson would be removed and the mud excavated from under the caisson. Excavation and con-

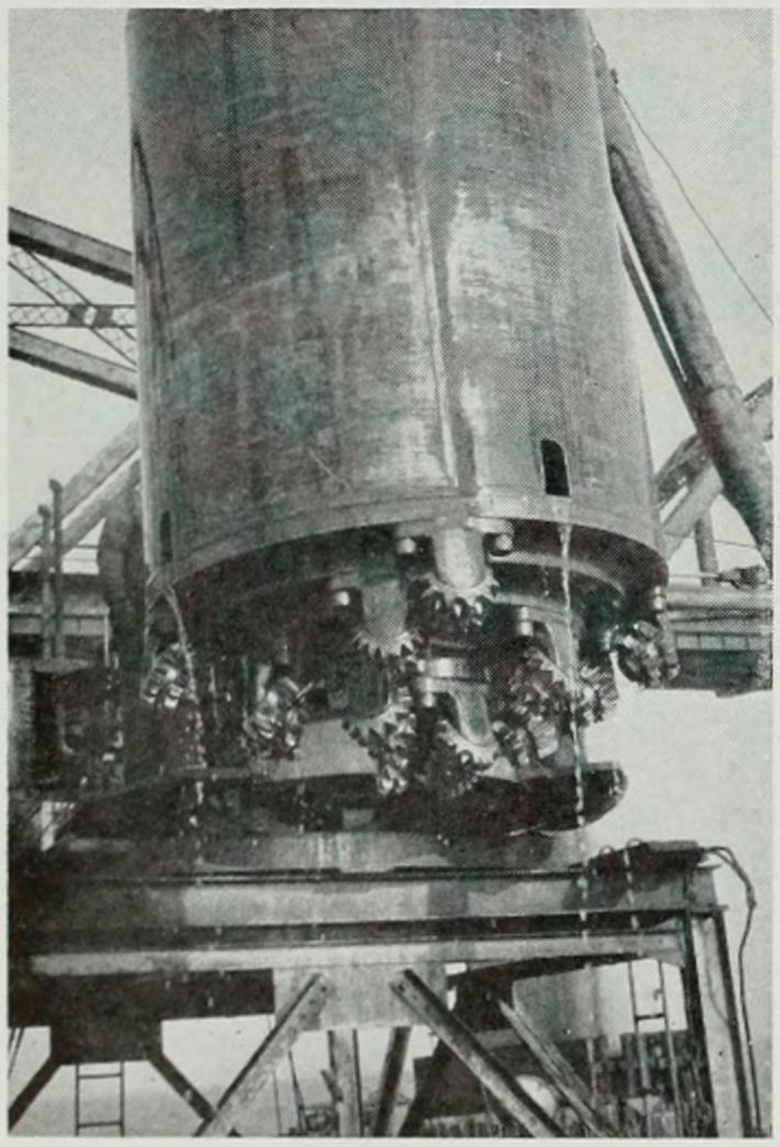






PHOTOS RIGHT—The 6-foot-diameter steel caissons were fabricated at the Benicia plant of the Yuba Consolidated Industries and floated to the pier site (top) where they were picked up by the "Judy Ann," a floating crane (center) and placed in one of the pier cells (bottom).





PHOTOS ABOVE AND LEFT—In these pictures the drill rig and air lift pump are at work removing material from the inside of a caisson. The drill is made up of 12 gear like roller cones which cut into either the over burden or bedrock as they are rotated by the drill rig. Pressure on the rollers is adjusted as needed by adding or subtracting ballast in the steel shell which houses the rollers. An air lift pump picks up the excavated material and discharges it into the bay.

creting would thus continue allowing the pier to sink until bedrock was reached.

Pier construction at the Benicia-Martinez Bridge was planned with an entirely new concept in mind, making use of new ideas, new equipment and new methods of construction. (See May-June, 1960, issue of *California Highways and Public Works.*)

The footing was so designed that it could be built on shore and floated into place, anchored in position, and then through predesigned openings in the bottom of the pier lower steel caissons each six feet in diameter. The mud, sand and gravel from the interior of these caissons was then drilled and pumped out until the steel cutting edge had penetrated into the bedrock about two feet. At this point a 5 ft. diameter socket was drilled an additional five feet into bedrock. A heavy reinforcing cage was then placed in the drilled rock socket and extended 13 feet up into the caisson. The socket in the rock and the caisson were then filled with concrete which anchored the concrete filled steel caisson securely into the bedrock.

Placing of Caissons

The four-corner caissons were the first to be placed while the box footing was still in a floating position. After the four corner caissons were concreted in and anchored to bedrock, then heavy steel beams with hangar rods would be placed over the four corner caissons at high tide. As the tide receded the beams would come to rest on the four caissons. At this point the box footing would change from a floating condition to a supported condition. Water was then pumped into other cells of the box footing in sufficient quantity to act as a ballast and prevent the box footing from raising off the four corner supports at the next high tide.

With the footing thus supported on the four corner piles, the remaining six caissons were installed and anchored to the bedrock at the bottom and to the box footing at the top. The support of the box footing was then transferred to these six caissons and the beams and hangar rods removed from the four-corner caissons. These caissons were then anchored to the footing by placing concrete in the cells. The footing at this stage became supported for the first time by all 10 caissons.

Construction from this point on was more conventional and consisted of placing the concrete slab over the top of the footing block and then extending up 90 to 130 ft. with a concrete shaft to form the seats for the steel trusses.

Rapid Construction

There are 9 of these piers and the average time to construct each one was about three months. This is a rather rapid rate for deep water pier construction and it is therefore believed that this method will have extensive applications in future deep water bridge construction where conditions are favorable or similar to those encountered at the Benicia-Martinez Bridge. Yuba Consolidated Industries, Inc., who are the contractors for both the substructure and superstructure have done an excellent job of sinking these caissons and should complete the foundation work about four months ahead of their contract time schedule.

The design and fabrication of the steel trusses like the design of the

foundations made use of new materials and new fabricating techniques. The Carquinez and the Benicia-Martinez Bridges are the first two major bridge structures to make use of new high strength steels and to use welding as a means of fabricating truss members.

The truss spans at Benicia-Martinez are 528 feet between supports. This span length is much smaller than the 1,100 foot span at Carquinez but nevertheless is sufficiently long to make any reduction in the weight or dead load pay excellent dividends. The use of a newly developed high strength steel in the trusses reduced the amount of steel required and thereby reduced the amount of weight to be supported by the trusses. In addition the truss members were fabricated by welding rather than by riveting which resulted in additional savings in weight. High strength bolts with gusset and splice plates were used at the joints to fasten together the welded members entering the joint.

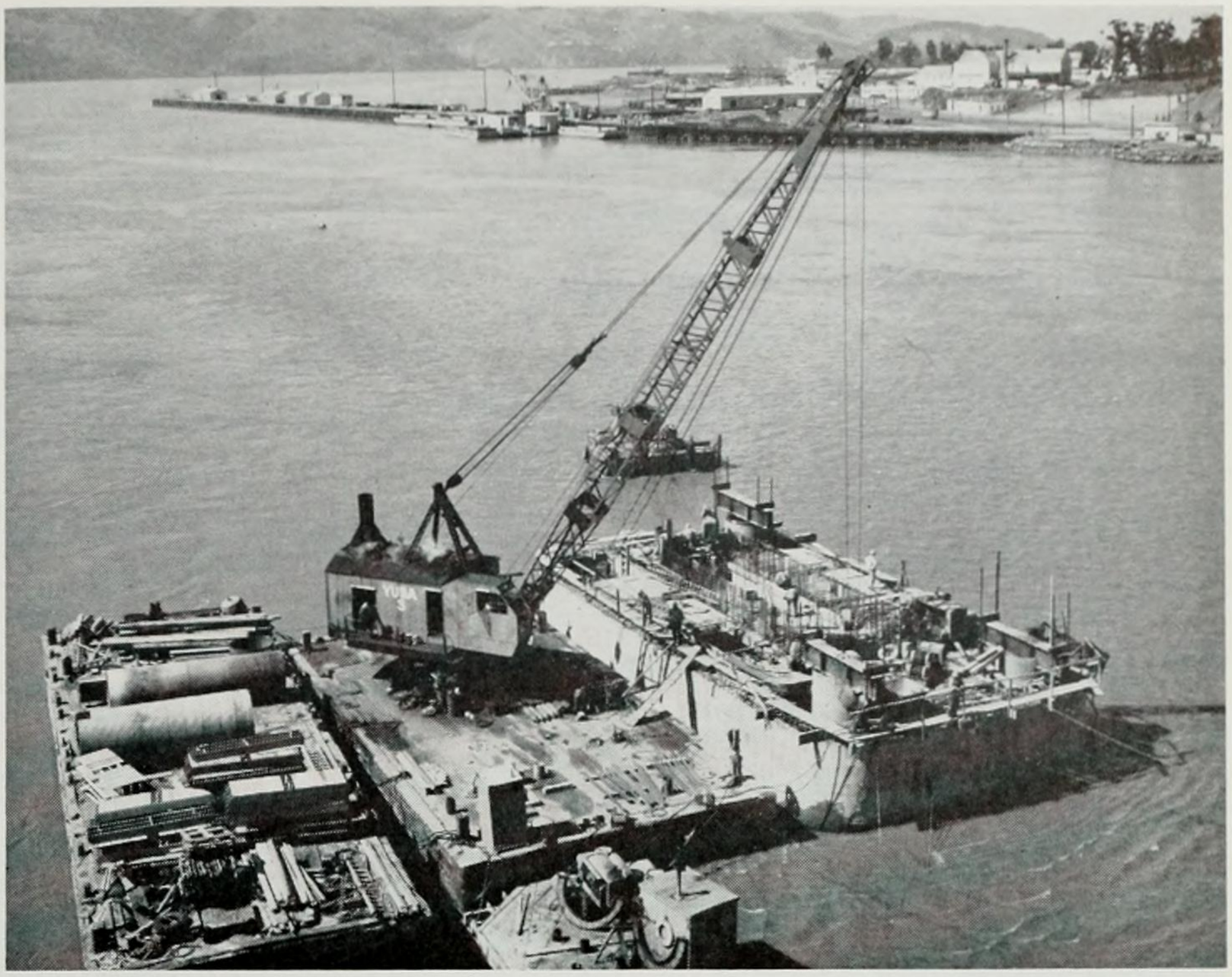
Three Types of Steel Used

As was done in the design of the Carquinez Bridge, three types of steel were used in the makeup of truss members. Two grades of these steels carried the American Society of Testing Material's designation A7 and A373 for the usual structural grade and A242 for the higher strength low-alloy steel. The exceptionally high strength steel is referred to as T-1 by the manufacturer. The following table shows the comparative tensile strength of these steels:

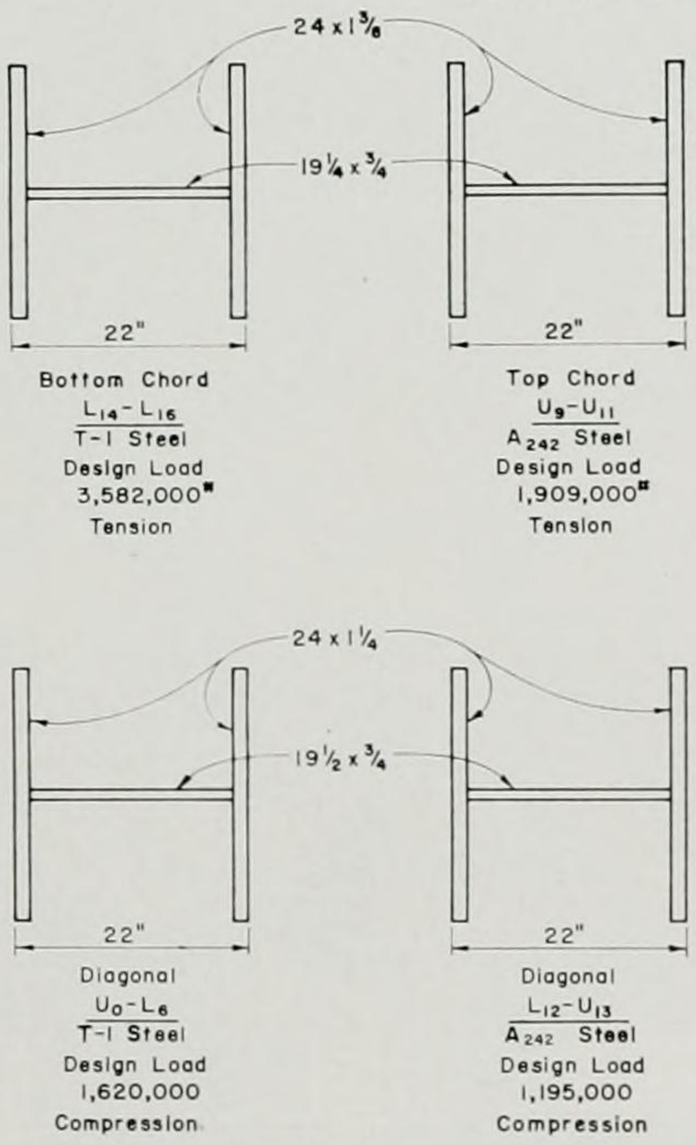
Type	Allowable Tensile Stress
A7 and A373	18,000 p.s.i.
A242—up to ¾" thick	24,000 p.s.i.
over 1½" thick	22,000 p.s.i.
T-1—all thicknesses	45,000 p.s.i.

The choice of steel for each member was based on maintaining minimum plate thicknesses. That is, T-1 steel was used until the minimum plate thickness requirements governed, then A242 steel was used. The same criteria governed the choice between A242 and A7. Unfortunately A242 steel loses efficiency in the thicker plates as can be seen from the above table of allowable tensile stresses.

Since all members were fabricated by welding, it was possible to provide



In this picture heavy steel beams are being placed over the four corner caissons. When these beams are in a predetermined position, the box footing is allowed to seat itself and hang from the beams as the tide goes out. At this point the footing changes from a floating to a supported condition and vertical or horizontal movement is no longer detected.



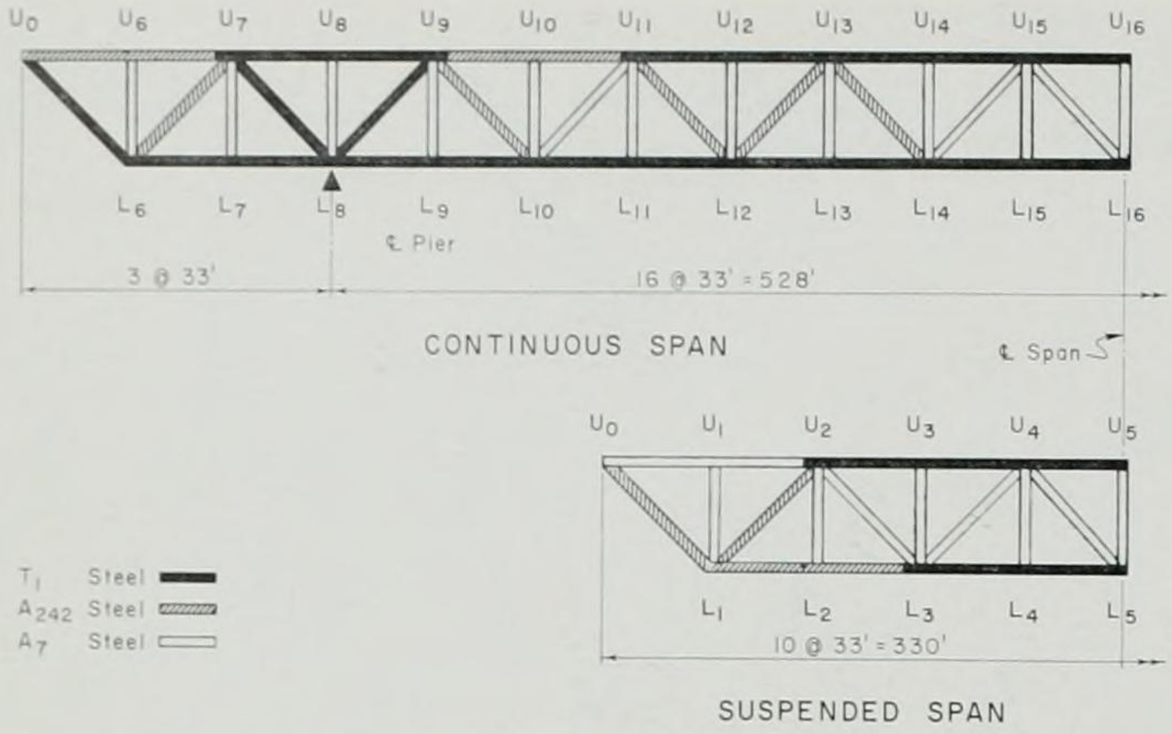
TYPICAL TRUSS MEMBER MAKE-UP

This sketch illustrates how the truss members were fabricated by welding 3 plates together. The two top tensile members are the same size and weight yet the one fabricated from T-1 steel has almost twice the capacity of its A242 steel prototype, demonstrating how use of extra high strength steel saved a considerable tonnage of metal.

a very economical means of compensating for loss in net section caused by bolt holes at the joints. For instance in tension members fabricated from T-1 steel, the flange plates were increased in thickness at the joints for a distance one foot outside the gusset plate, at which point a butt weld was made. For tension members fabricated from A242 steel, the flange plates at the joints were made of the higher strength T-1 steel to compensate for the loss in section, and the two types of steel were butt welded together about one foot outside the joint. These new design procedures making use of welded truss members saved worthwhile amounts of steel in the tension members of the truss. Large amounts of steel were also saved by using extra high strength T-1 steel wherever practicable. For instance, it is estimated that 7,168,000 lbs. of T-1 steel in the trusses replaced 12,320,000 lbs. of A242 steel.

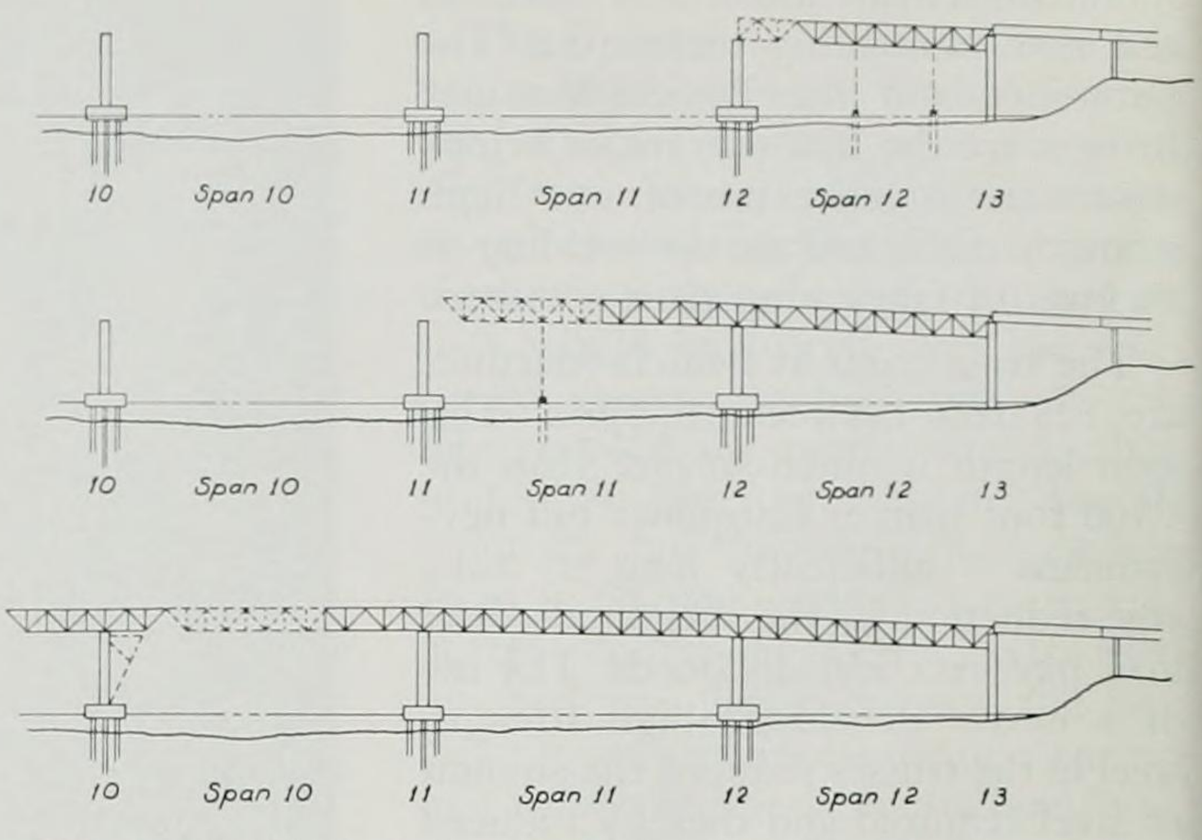
Price Difference Small

The three types of steel used carry different price tags but the differential price between the various grades of steel is sufficiently small to result in

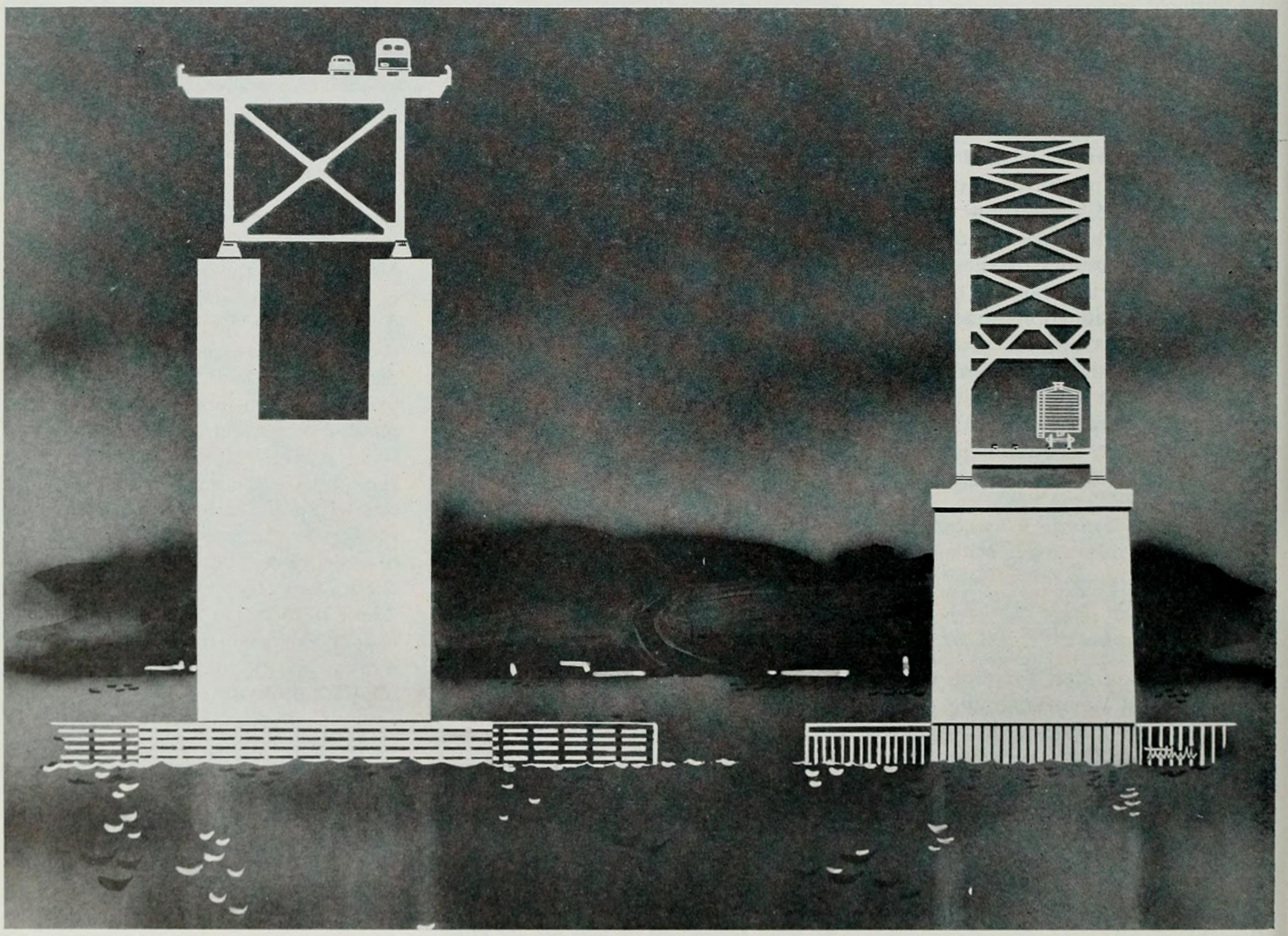


BENICIA-MARTINEZ BRIDGE

Truss layout showing the location of the 3 types of steel used in the trusses. The 10 truss spans which measured 4,884 feet were designed for maximum duplication, there were 24 half suspended spans and 16 half continuous spans as shown above, making for considerable duplication in the fabricating shop.

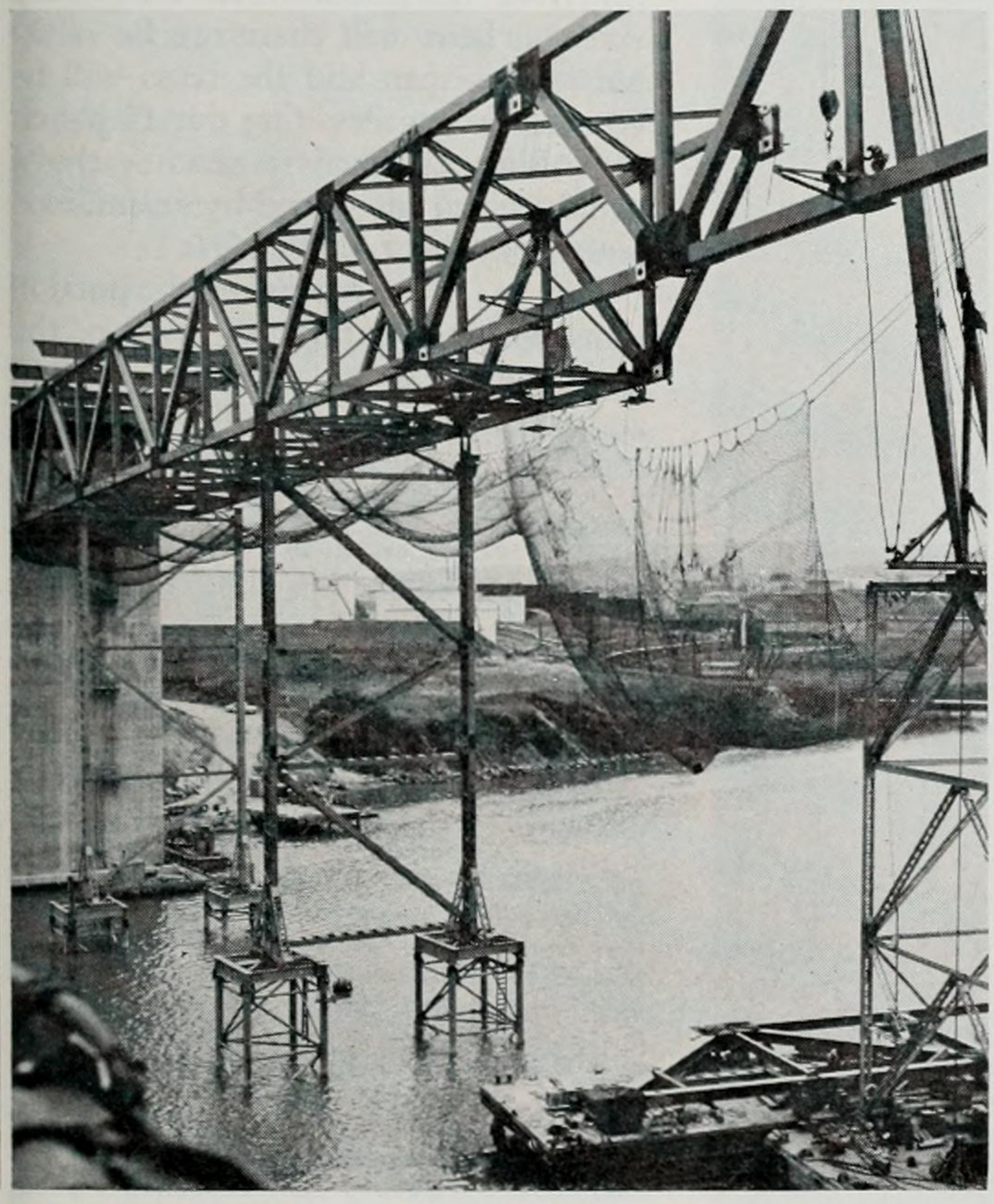


Sketch Showing Truss Erection Procedure. Two temporary erection bents were used in the erection of Truss Span 12, the first to be erected. Truss Spans 3 to 9 inclusive will use one temporary bent and Truss Span 10 which is over the navigation channel will not use any of the temporary bents in the water but will use one inclined bent at Pier No. 10.

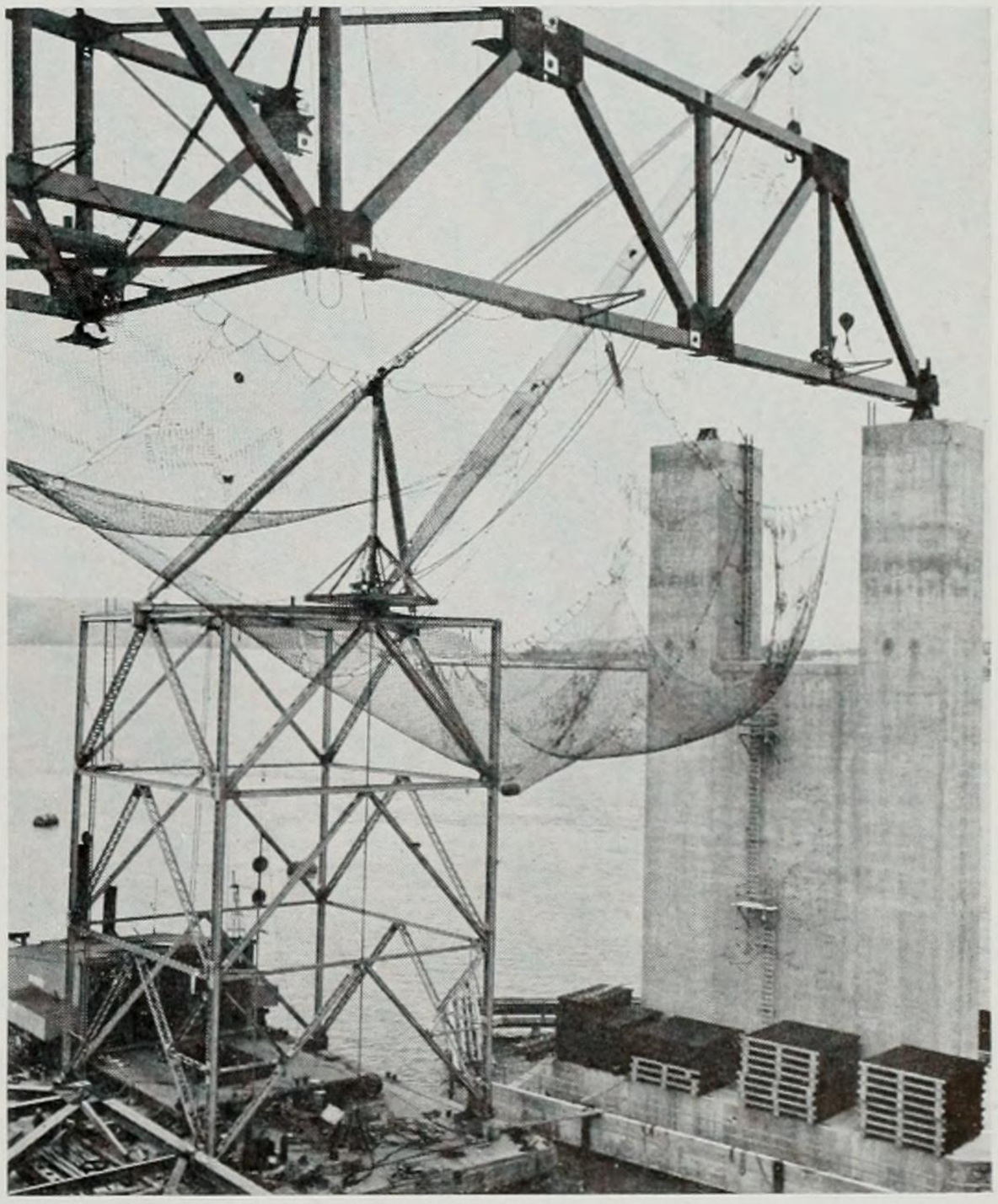


This sketch shows the relation of the new highway structure to the existing Southern Pacific Co. Bridge and the relative height of the highway deck above the water level. Maximum vertical clearance at the navigation channel between low steel and water is 138 feet on the highway bridge and 70 feet on the railroad bridge. The railroad bridge requires a vertical lift span for the passage of river traffic. Highway traffic will be about 178 feet above water at the highest point.

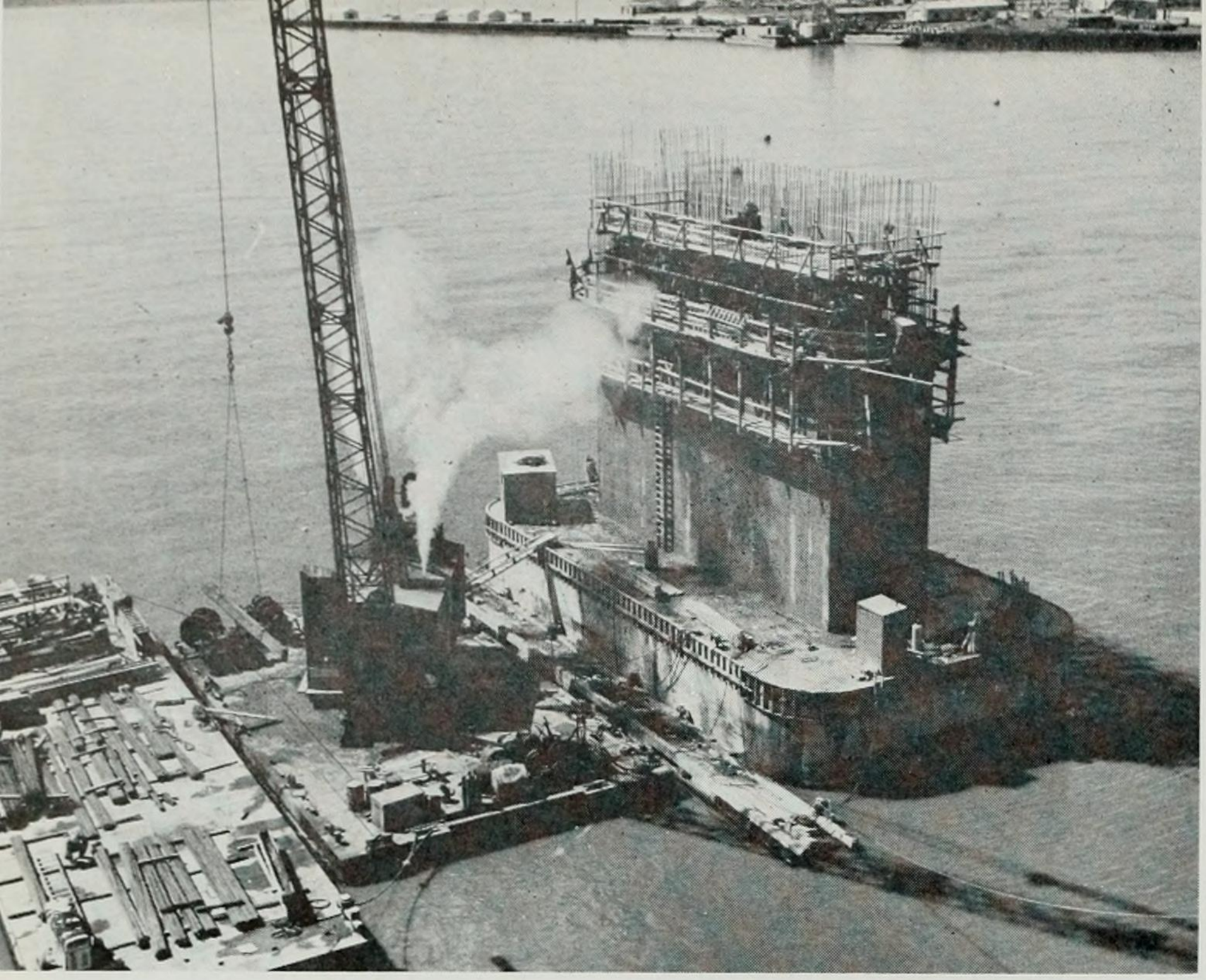
The highway bridge in the foreground commences to take shape. Nearly all of the piers are in place and ready to receive the steel trusses. Start of steel truss erection in Span No. 13 can be seen to the right.

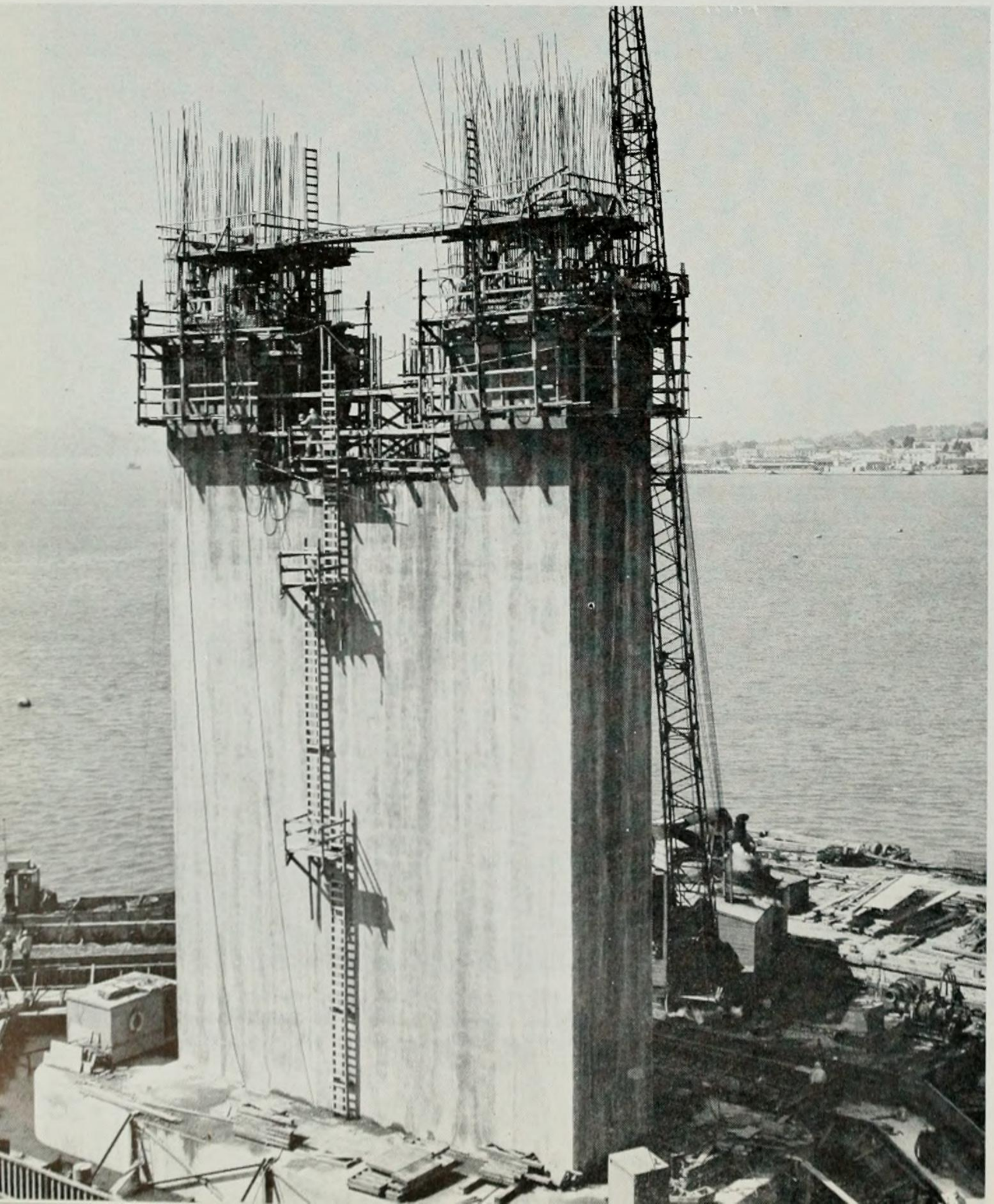


Steel erection on Span No. 12, the first truss span to be erected, is shown with the two temporary erection bents in place. One 4-panel section of the far truss remains to be lifted in place to complete the span.



This sketch shows the "Judy Ann", a heavy floating erection crane. This crane was used by the contractor to erect the Richmond-San Rafael Bridge. Safety nets are used to protect the ironworkers.





substantial cost savings by using the highest grade of steel practicable for the particular member in question.

The successful bid price per pound for the three grades of steel was as follows:

A7 and A373	18.57¢
A242	21.74¢
T-1	34.48¢

Erection of the steel trusses was started in May, 1961 and it is expected that the steel erection and concrete slab construction of the Superstructure should move along quite rapidly.

The truss erection method used by the Yuba Consolidated, Inc., makes use of temporary bents supported by steel H piles, as shown in the accompanying sketch of erection procedure.

Two of these bents were used in the erection of Span 13, the first truss span to be erected. Only one falsework or temporary bent will be used in each of the remaining spans.

Temporary Bent Omitted

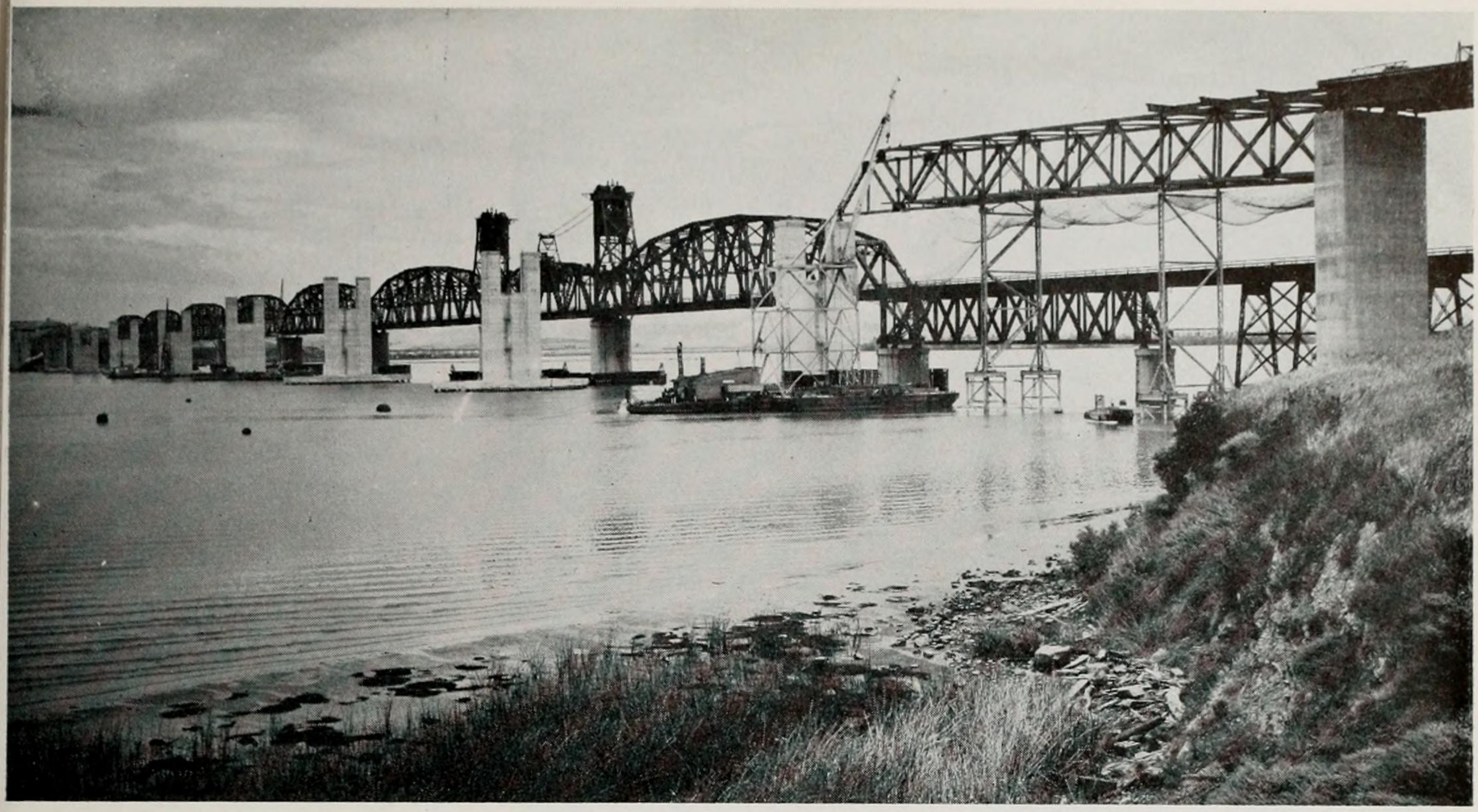
Span 11 which is opposite the Southern Pacific Company's vertical lift span must be kept open at all times for river navigation. The temporary erection bent will therefore be omitted in this span and the truss will be erected by cantilevering out 13 panels from Pier 11 until it reaches the 4 panel section supported by an inclined temporary bent at Pier 10.

Where the cantilevered portion joins with the supported portion, the deflection will be as much as 8′-6″ and the two sections will be brought together by using hangar rods and jacks. The remainder of the spans from Pier 10 will be erected in the same manner as Span 11 using one temporary bent.

The total project involves seven contracts as follows:

. . . Continued on page 30

PHOTOS LEFT—After completion of the box footing the cellular concrete stem of the pier, which rises about 100 to 130 feet above the footing, is started. The concrete stem is poured by the "slip form" method. The "slip form" method is a continuous 24 hour per day operation in which the form is jacked up at the rate of above 10 inches per hour. As the concrete at the bottom sets up and develops strength and hardness, the form is jacked free and the concrete stands exposed and unprotected. It required approximately 5 working days to pour each stem from the footing block at the bottom to the truss supporting surface at the top.



This photograph, taken in May, 1961, shows the pier construction which had been completed and initial superstructure work underway on the Benicia-Martinez Toll Bridge across the Carquinez Strait. The existing lift-span railroad bridge is in the background.

Two timber bridges were destroyed by fire—one west of Blythe on US 60 and the other east of Amboy on US 66. Local detours were provided at these sites pending construction of new bridges.

Engineering investigations were made as required by law and at the request of the local authorities on 40 city and county bridges, for the purpose of establishing their load capacity. Fifteen public hearings were held to post 21 of these bridges for less than legal loads.

New construction made it possible to drop four structures from the list of bridges posted for reduced speeds. On June 30, 1961, there were three bridges and three ferry crossings on the State Highway System which were posted for reduced loads and 34 posted for reduced speed.

The accompanying list of bridges shows all structures of the state highway system. Structures having assorted types and lengths of spans are shown by number and lengths on the basis of the main span, but areas have been segregated and appear under the various type headings. Areas of bridges are based upon the clear width of roadway between curbs plus the clear sidewalk width.

Bridge Maintenance Painting

Five maintenance painting contracts involving nine separate structures were completed, using the new green colors. In addition, three bridges on US 40 near Davis were finished in green. Total allotment for the maintenance painting contracts was about $196,000. Twenty-seven new bridges were also painted under construction contracts. Painting work on the Benicia-Martinez Bridge across Carquinez Strait and the West Branch Feather River Bridge started during the year.

A comparatively new device, which propels small metal spheres at high velocity at the steel surface, is being used in the fabricator's shop to clean much of the steel for the Benicia-Martinez Bridge. The machine eliminates labor in the cleaning process. There is increased use of airless spray methods which reduces to minimum the paint loss through spraying.

Compilation of a more complete record of the humidity range throughout the State has been undertaken to provide for more accurate forecast of the needs in each area and to assist in establishing specifications to meet these requirements.

Special Studies

Activity in structural research increased with the completion of the field phase of testing on the Box Girder Research Project in Oakland. This project, to determine structural characteristics of a concrete box girder bridge, is a joint effort of the Division of Highways and the University of California.

During the past five years, the Bridge Department has participated actively in the development and use of electronic-computed and data processing services. In collaboration with the Planning Survey Department, a library of computer programs has been developed to serve needs peculiar to bridge design and construction. The computor programs relate to structural analysis and design, and materials quantity calculations. They include services for composite steel-concrete girder design, prestressed concrete girder design, concrete column analysis, moment distribution,

Bridge Opening

New Span Joins Benicia, Martinez; Ends 115-year-old Ferry Service

On September 15, the Benicia-Martinez Toll Bridge was opened to traffic.

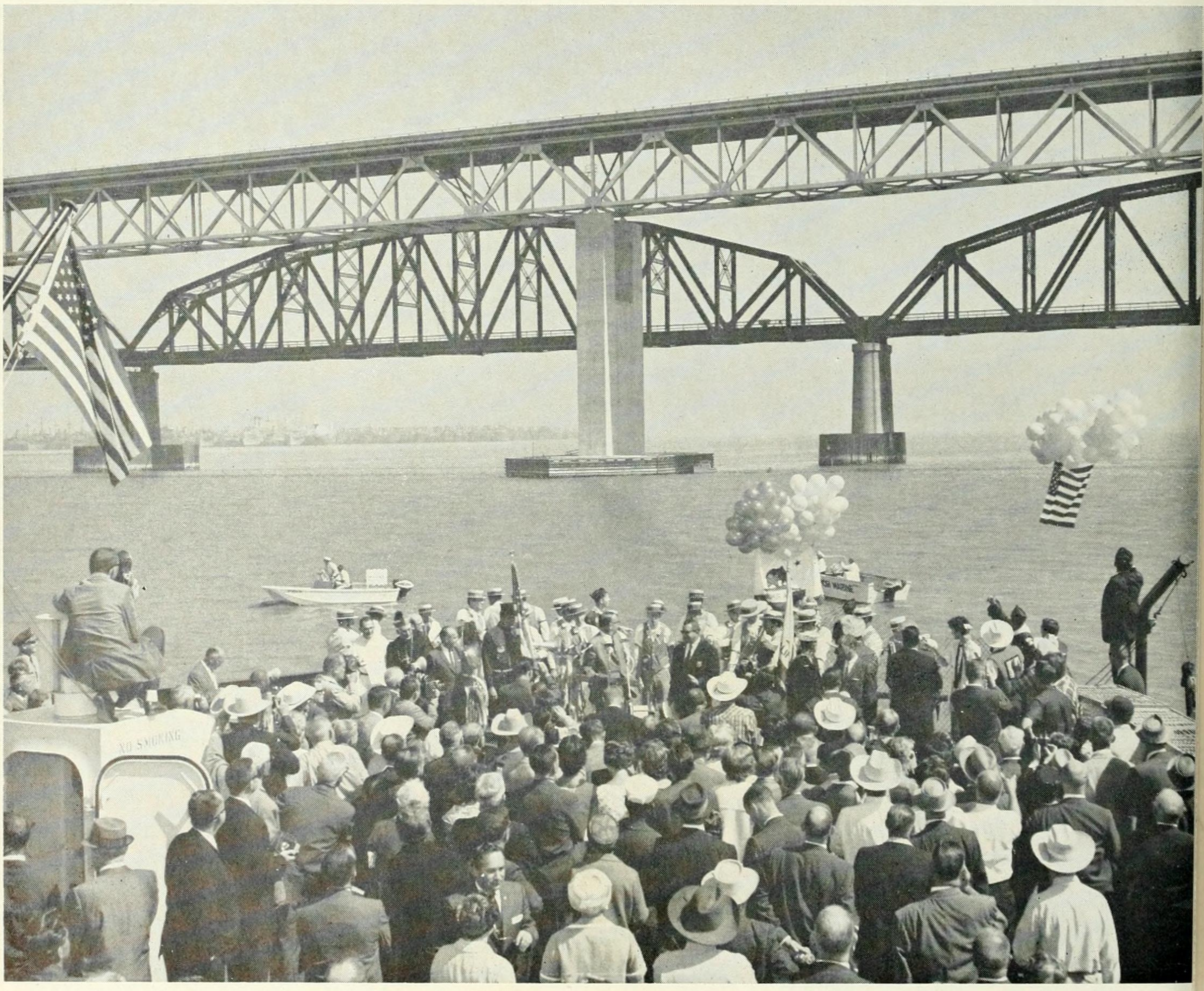
Governor Edmund G. Brown's official proclamation of this fact delivered from the deck of the ferryboat *Carquinez* below the bridge at the stroke of noon, was followed by a blast of horns and whistles, the cheers of spectators and a cloud of released balloons and homing pigeons.

A flight of delta-winged Air Force jets swooped overhead a few moments later and, as if to complete the scene, a gray military transport chose at that moment to slip beneath the central span of the structure.

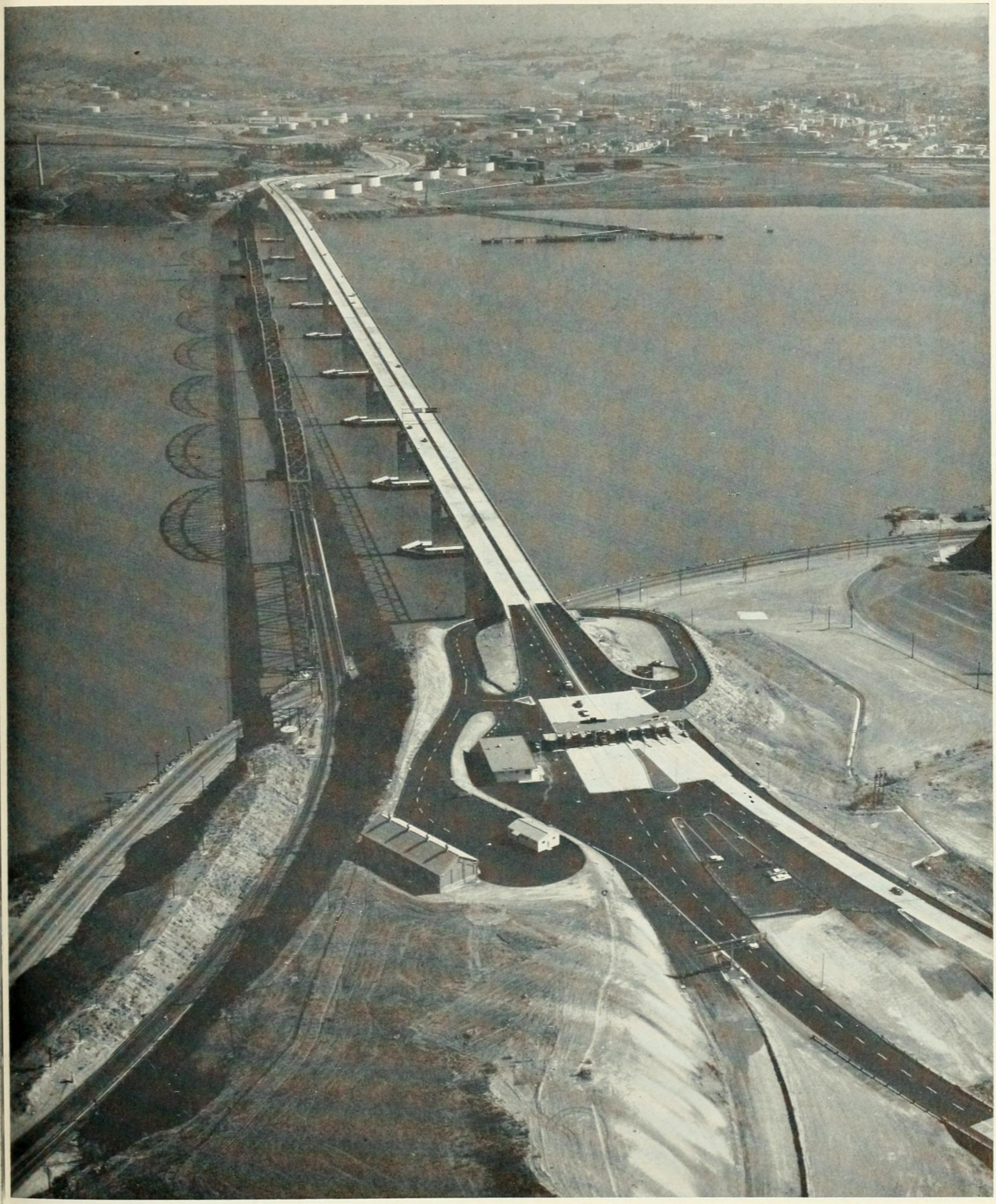
Throughout the day, parades, picnics, street dancing and sport events took place in Benicia and Martinez. All auto traffic was allowed toll free over the bridge until midnight of the first day.

Thus, after three years under construction, the new $27,500,000, 6,215-foot bridge and its freeway approaches were officially opened, carrying State Sign Route 21 across the Carquinez Straits.

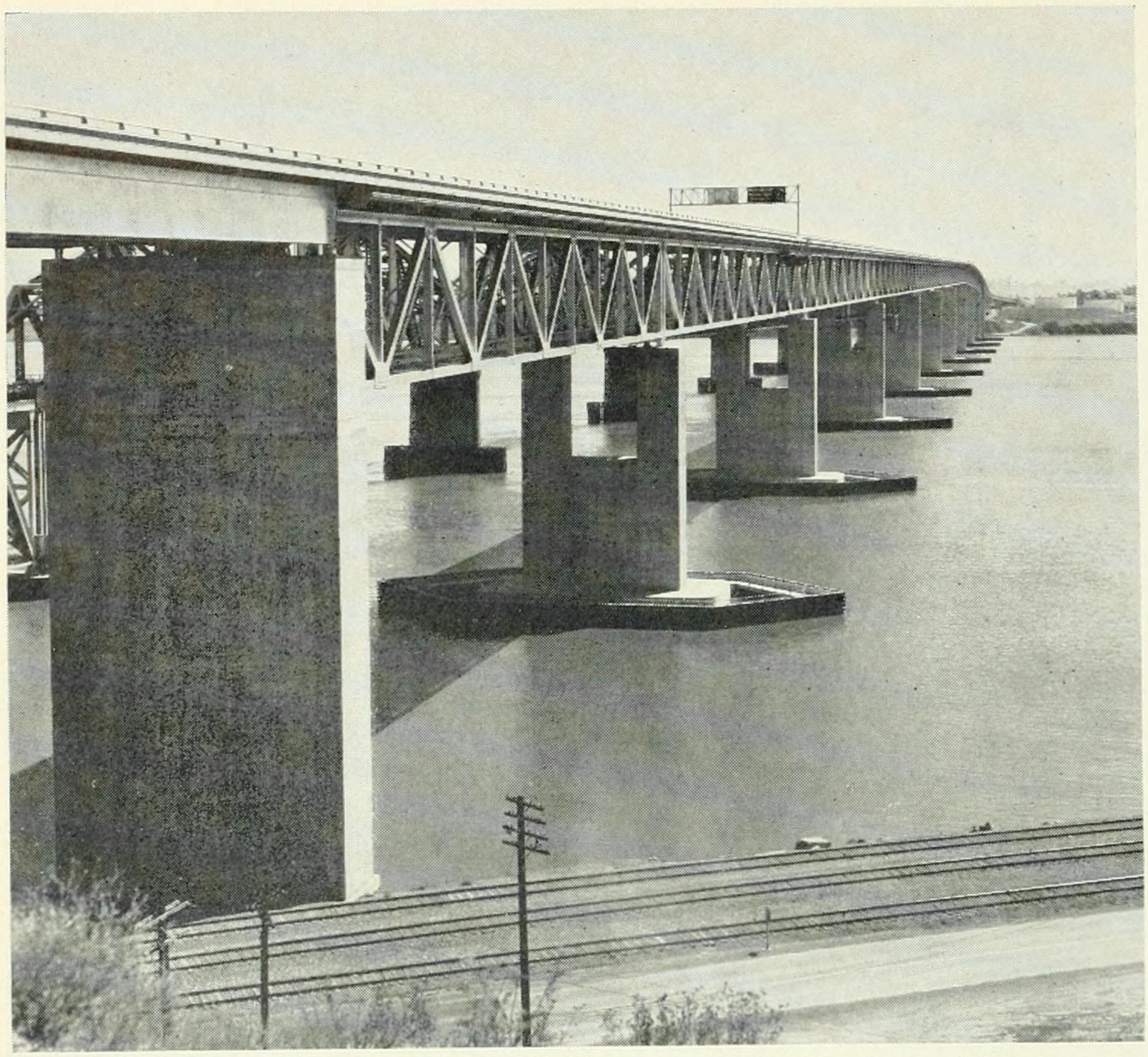
There was also a sad note to the ceremony. It marked the last voyage between Benicia and Martinez of the



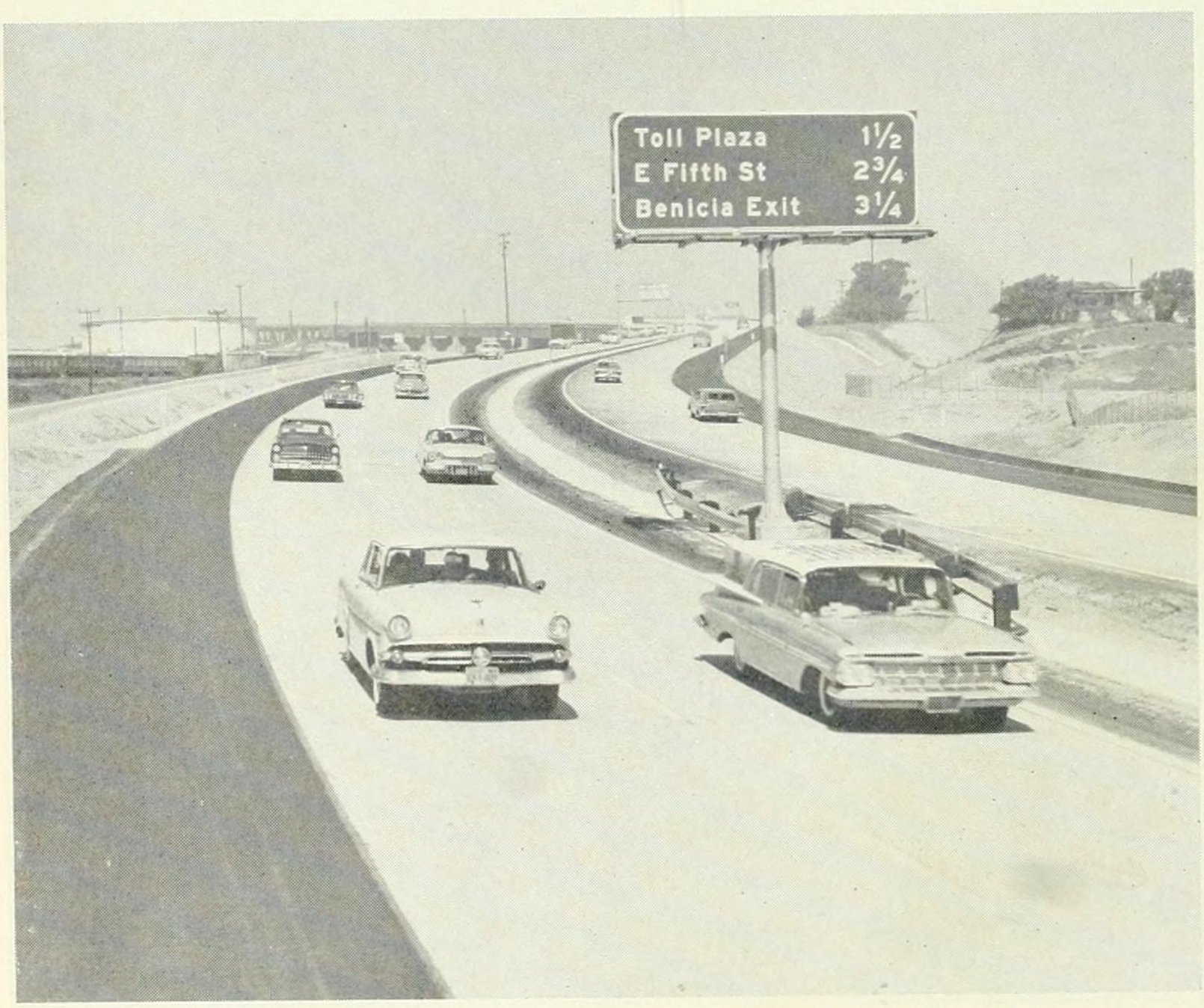
Governor Edmund G. Brown, behind the microphones (center), announces the Benicia-Martinez Bridge to be officially opened as released American and Stat Flags rise into the air borne by balloons.



An aerial of the new Benicia-Martinez Bridge taken a few days after it was opened to traffic. The view is southward toward the City of Martinez in the distance.



The new bridge has a vertical clearance of 138 feet above the water and is 6,215 feet long. This photo is looking south from the Benicia side.



The freeway approach to the bridge at the Martinez end, looking north toward the bridge visible in the background.

Motor Vessel *Carquinez* and the end of the oldest ferry service in the Bay area, which had been in operation for 115 years. (See "Last Ferry" on page 5.)

Long envisioned by civic and state officials and highway planners, the new bridge is another important link in the interstate highway system and will provide an outlet to the north for one of the fastest growing areas in California. It provides a direct connection to the Sacramento Valley and points east and north for cities such as Martinez, Concord, Walnut Creek, Dublin and San Jose, as well as metropolitan Oakland.

As a section of Interstate Route 680, it also constitutes a key link in the circumferential freeway route around the San Francisco Bay area which includes U.S. 40 and the proposed Junipero Serra Freeway on the Peninsula.

Constructing of the bridge was made possible by the Legislature in 1955 when it authorized the California Toll Bridge Authority to issue $80 million in bonds to finance a second parallel Carquinez Bridge and the Benicia-Martinez Bridge.

The second Carquinez Bridge was completed in November 1958. First contract on the Benicia-Martinez Project was awarded in August 1959.

The Benicia-Martinez Bridge has four lanes of traffic with a 10-foot-wide median separating opposing lanes.

It has a 138-foot vertical clearance for navigation.

Some novel money- and time-saving methods were used in construction of the bridge. For example, the concrete pier footings were built on shore, floated into place, anchored and sunk into position.

The concrete piers were constructed by the new slipform method, a 24-hour continuous operation in which the form was jacked up at the rate of about 10 inches an hour until the 100- to 130-foot-high stems were completed.

The major contracts in the construction of the bridge were a $5,769,000 contract for the substructure and an $8,469,000 contract for the superstructure, both awarded in August 1959.

Last Ferry

Benicia-Martinez Service Ends After Opening of New Toll Bridge

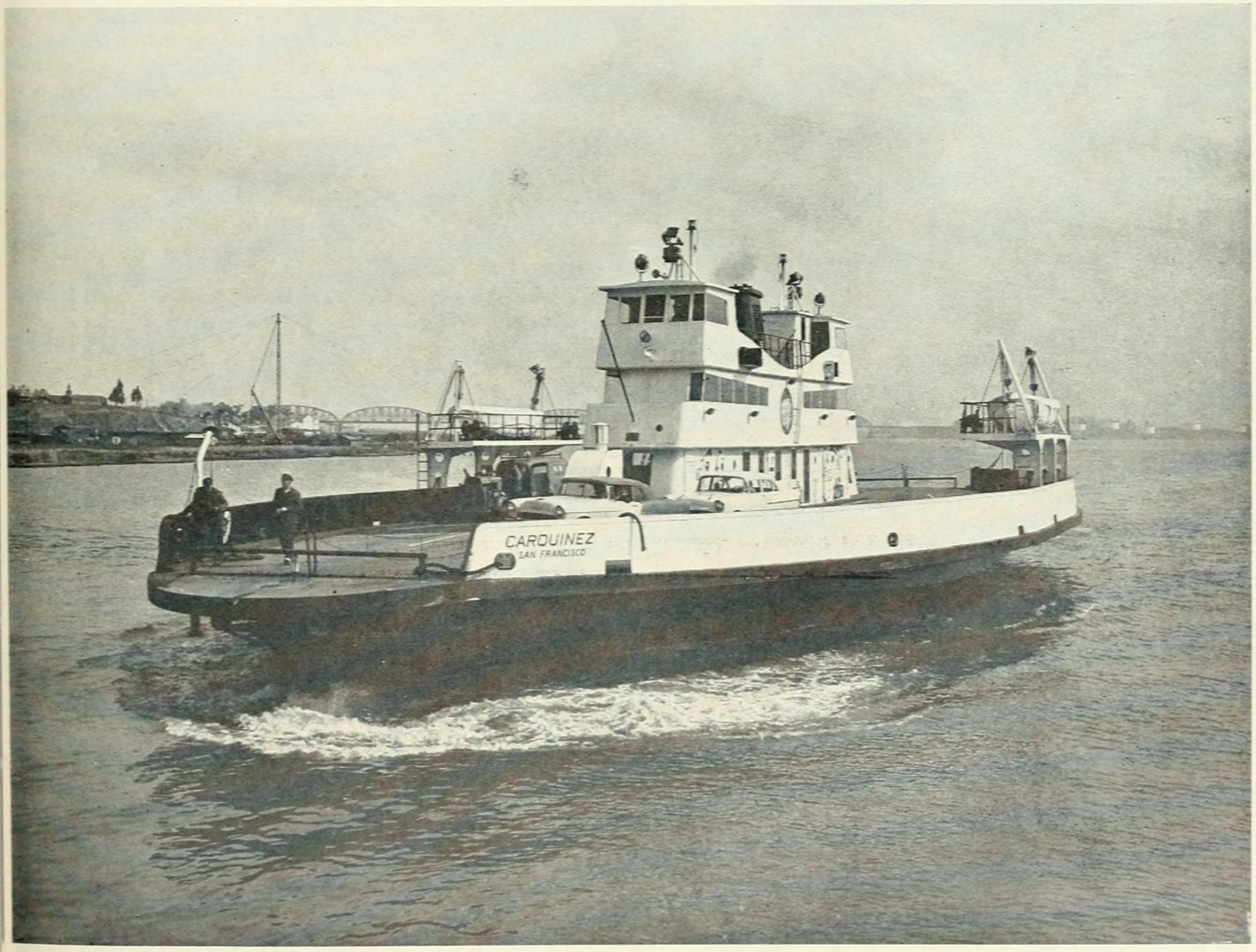
By J. J. TEUSCHER, Administrative Section, District X

On September 15, 1962, the Benicia-Martinez Ferry made its last trip across the Carquinez Straits. This date marked not only the end of the state-operated ferry system, but also the end of 115 years of ferry service in the San Francisco Bay area (except for a new Tiburon commuter vessel). On that date the new Benicia-Martinez Bridge was opened to the public.

In 1847 General M. G. Vallejo deeded a portion of his holdings on the Carquinez Straits to Dr. Robert Semple and Mr. Thomas O. Larkin for $100 on the condition that (1) the city to be established there be called either Francisca or Benicia, and (2) that a ferry be established to belong to Robert Semple until 100 families lived in the town—then the proceeds were to be devoted to the public schools.

General Vallejo's stipulations were immediately carried out. The town was named Francisca (shortly to be renamed Benicia) and a ferry was put into operation. The first ferry was a scow built by Charles Heath for Dr. Semple. Since the currents in the Carquinez Straits were very strong, the ferry would usually end up down-

The *M.V. Carquinez* has been sold to the State of Florida for $86,001. It will be used as a part of the State of Florida's ferry system across the mouth of the St. Johns River on the Atlantic Coast east of Jacksonville.



The "Carquinez" makes one of her last runs across the strait between Martinez and Benicia.

stream some distance from Benicia forcing the customers to walk back to the town. The second ferry was a sloop-rigged vessel with a green bow and long protruding horns (appropriately named the *Green Horn*). The second ferry improved on the service by landing not so far downstream.

Rate for Horses

Of interest is the following item in the July 31, 1847, issue of the *Californian* published at San Francisco:

> "*Ferry at Benicia City*
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> In establishing the rates of ferriage across the Bay, I have reference to the gentle horses which might be led onto the boat. But as wild horses and mares have to be hauled in, I have been under the necessity of charging fifty cents each, more than for tame horses."

Preceding this appearance of this article an event of note took place during a routine crossing of the straits. A sudden squall appeared, causing the boat to pitch. Some of the horses became alarmed and started to kick. Part of the boat gave way, plunging the horses into the water. Many were drowned while some others reached shore. Among the ones that reached land was General Vallejo's prize white mare. General Vallejo promptly called the island on which she landed, "Isla de la Yegua" or "Mare Island."

With gold excitement at its height in 1849, Semple's ferry became a very profitable enterprise. He averaged $50 a day even though he had to operate the ferry by himself—his help had taken off for the gold fields. He was offered $3-$5 per man to cross the straits and had up to 30 customers waiting at a time.

First Steam Ferry

In the early 1850's, Captain O. C. Coffin operated the first steam ferryboat across the straits. He later built this up to three boats and continued operation until the Central Pacific Railroad built its train carrying ferries. Also in the early 1850's, Semple had constructed a steam ferryboat which he named the *Colusa*. The steam engines for the boat were not of the same size, but with cogwheels and other necessary parts, the men thought they had the powers of the engines equalized. As the boat started to move, the larger engine overpowered the smaller one, thus moving the boat in a wide circle. The mechanical difficulties were soon corrected and the boat proceeded to Colusa. Her first trip was her last—the engines were disposed of and she was converted to a barge.

When the Central Pacific Railroad put into operation its two huge ferries in 1879, the railroad distance between Sacramento and San Francisco was reduced by 60 miles. These two ferries, the *Solano* and the *Port Costa* were the largest in the world. The *Solano*, carrying both passenger and freight trains, was 420 feet long, 116 feet wide, and 17 feet high. It had a displacement of 5,450 tons and could carry 2 locomotives and 24 passenger cars or 2 locomotives and 36 freight cars. The *Contra Costa* was added to the service in 1914. It was 13 feet longer and 2 feet higher than the *Solano* and had a displacement of 7,198 tons.

Funds Provided

When Captain Coffin was forced to give up his ferry line between Benicia and Martinez due to railroad competition, the two towns were without a direct connection until the State Legislature provided funds for connecting the several county seats with state highways. State Sign Route 21 was entitled to some of these funds as it connected the county seats of Fairfield, Oakland, San Jose and Martinez.

In 1915 the Martinez-Benicia Ferry Company operated the paddle-wheel boat *City of Seattle* (built in 1888). It was operated until 1943 until taken over by the U.S. Navy for use between Mare Island and Vallejo. The company built the *City of Martinez* in 1917, which was used until 1929 when it was replaced by the *Issaquah*.

The American Toll Bridge Company took over the ferry system in 1929 and operated it until 1939 when the State of California bought the Carquinez and Antioch Bridges and announced that it would no longer operate the ferry, as traffic would be diverted across these two bridges. Objections were raised to this plan so the ferry was offered to Solano and Contra Costa Counties, the Cities of Benicia and Martinez, and to the ferry employees, in that order. Subsequently the ferry system became the property of the City of Martinez.

Ferries Traded

The City of Martinez traded the *Issaquah* for the *Charles Van Damme* and also acquired the *City of San Rafael* from the government. After World War II the *Charles Van Damme* was tied up and the *City of San Rafael* became the regular ferry. With the condemnation of the *City of San Rafael* in 1953, the year the State of California took over the ferry as part of the state highway system, the *Charles Van Damme* was the only ferry in operation across the Carquinez Straits. In 1955 the *Charles Van Damme* was damaged and subsequently condemned.

From early in 1955 to late in 1956 the only ferry between Benicia and Martinez was a passenger ferry. In November 1956 the *Carquinez* was built and placed in service until the cessation of ferry operation September 15, 1962.

It is estimated that more than 4 million vehicles have crossed the Carquinez Straits between Benicia and Martinez since the system started. It is not possible to estimate the number of individual passengers who have made the crossing but the figure would undoubtedly exceed 6 million for the 115 years of operation.

NOTE: The author is indebted for many of the historical facts in this article to LeNoir Miller's "Railroad Ferry Days" in the Benicia Arsenal Magazine, March 1951, and to Jacqueline McGart Woodruff's book *Benicia—the Promise of California*, 1947.

EMPLOYEES REASSIGNED

All 24 of the men employed on the Benicia-Martinez Ferry which discontinued operation on September 15 have been offered other jobs with the State Division of Highways, and 19 of them have accepted.

Personnel Officer Marian Smith of the division said that as a result of several months of conferences between highway officials at the Stockton district office and the ferry employees, jobs were located for the 19 who were interested. Of the remaining five, two are retiring from state service and three have resigned for other employment.

After the shutdown of the ferry service the men will transfer to jobs as drawbridge operators, Sacramento Delta ferry operators, or highway maintenance men (two of them on the new toll bridge).

4,016,930 vehicles; the toll revenue amounted to $1,538,851.70. For the same period, the traffic on Dumbarton Bridge was 2,953,758 vehicles, with a toll revenue of $1,169,311.80. These traffic figures compared to those of the previous year, show traffic increases of 10.2 percent and 19.2 percent, respectively, over the preceding year.

The temporary toll plaza facility at Dumbarton Bridge was improved by adding another toll lane and the installation of electronic toll collection equipment. The temporary plaza was continued in use because of the need for additional time to permit the embankment to settle at the site of the permanent toll plaza on the east approach.

The lift span operation was continued at both bridges, as required by federal law. During the year there were 2,189 lifts at the San Mateo-Hayward Bridge and 1,158 lifts at the Dumbarton Bridge.

The Division of San Francisco Bay Toll Crossings continued operations which will ultimately result in increasing the width of the San Mateo-Hayway Bridge and replacement of the lift span by a high-level structure.

Carquinez Bridge

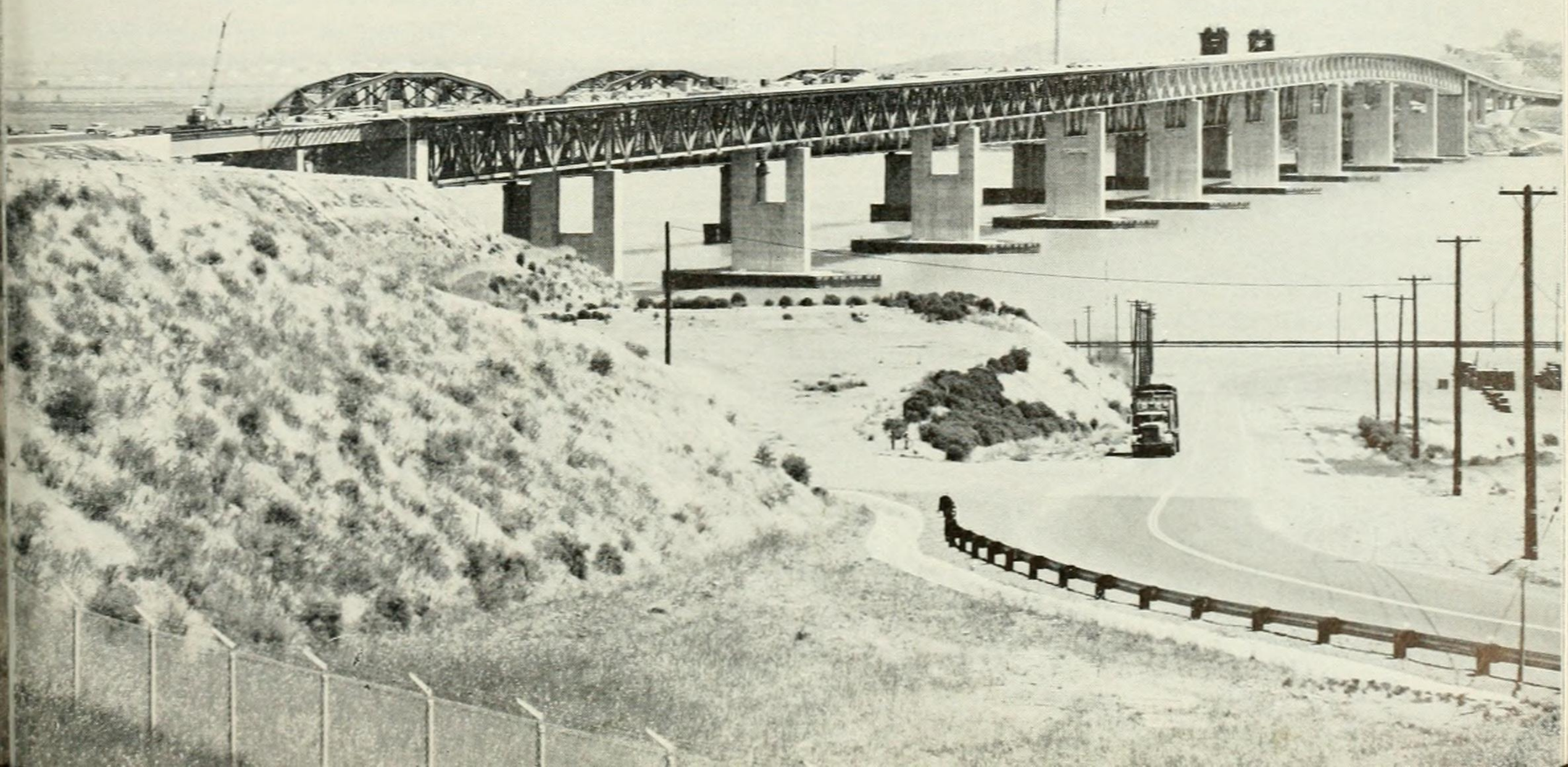
A total of 14,104,471 vehicles used the Carquinez Bridges during the year, and $4,797,666.50 was collected. This was a traffic increase of 5.03 percent over the previous year, and a revenue gain of 4.79 percent. In January 1962, a tow service was established at the Carquinez Bridges to reduce congestion due to stalled cars and to increase safety for the motoring public.

Richmond-San Rafael Bridge

The total traffic on the Richmond-San Rafael Bridge during the year was 3,737,890 vehicles, and revenue amounted to $3,115,419.55. These figures represent increases of 7.8 percent and 7.0 percent, respectively, over the preceding year.

Two repair contracts were completed during the year, one to repair serious damage to a timber fender resulting from a ship collision, and the other to replace a prestressed concrete girder which was also damaged by collision with waterborne traffic.

The new Benicia-Martinez Bridge across the Carquinez Straits between Sonoma and Contra Costa Counties. The highest span has a 138-foot vertical clearance for navigation. The Southern Pacific Company's lift span is visible beyond.



California Highways and Public Works
DIVISION OF HIGHWAYS
P. O. BOX 1499
SACRAMENTO, CALIFORNIA

RETURN REQUESTED