TOWER BRIDGE WINS NATIONAL AWARD

By EVERETT L. WALSH, Associate Bridge Engineer

FOR the second time in consecutive years a California bridge, designed by the State Division of Highways and built by the Department of Public Works, has won an award in the annual national competition held in New York by the American Institute of Steel Construction, Inc., for the most beautiful bridge built during the past year.

This honor was won by the Tower Bridge spanning the Sacramento River at Sacramento which was accorded second place in Group B, including bridges costing between $250,000 and $1,000,000. Group A included bridges costing $1,000,000 or more, and Group C those costing less than $250,000. A total of thirty-one bridges entered the contest.

A similar award in 1935 was won in Group C by the Eel River Bridge, a continuous steel girder structure on State Route No. 1, Redwood Highway, at Smith Point in Humboldt County.

The Tower Bridge award brings additional honor from the fact that this lift span structure entered into competition with bridges of all other types, and never before has a lift bridge been judged comparable in harmony of outline and proportion with arch and suspension bridges because the inherent graceful and symmetrical lines of the latter types have always been considered the most beautiful.

NOTED MEN ON JURY

Californians may well be proud, therefore, in having the most beautiful lift bridge in the United States. The awards were made by a jury of nationally known engineers and architects consisting of Messrs. Robert D. Kohn and Arthur Loomis Harmon, architects of New York; Professor William J. Krefeld of the College of Engineering, Columbia University; Mr. Howard C. Baird, consulting engineer of New York; and Mr. Kenneth Hayes Miller of New York, one of America's best known artists.

Records on the early Egyptian monuments prove that bridges were built during the time of Rameses II, 1350 B. C. In the days of King Arthur and his Knights of the Round Table, movable bridges were used as a protection against attack, by having drawbridges over moats around the castles.

The earliest lift bridges in the United States were located along the Erie Canal and were constructed in 1874. As population and water borne commerce increased, it became necessary to increase the size and efficiency of movable bridges. The design of such bridges has kept pace with the development of steam, gasoline and electrical power until today we have large fast moving types of bridges which meet the needs of modern necessity.

290-FOOT LIFT SPAN

The Tower Bridge at Sacramento represents all that is modern in engineering skill and bridge design. The bridge is 737 feet long with a roadway width of 52 feet and two sidewalks four feet wide. A roadway thirteen feet wide, protected by concrete curbs, is provided for the Sacramento Northern Railroad tracks.

The bridge consists of steel spans resting on concrete piers and abutments. The center lift span is 209 feet long and is supported by towers 160 feet high. West of the lift span is one 193-foot steel truss span and four 34-foot steel girder spans. East of the lift span is one 167-foot steel truss span and one 30-foot steel girder span. The overhead clearance of the lift span provides a maximum clearance above high water of 100 feet and a vertical clearance between fenders of 172 feet.

An advantage of this type of bridge is that it is very seldom necessary to raise the lift span to its fully raised position. The majority of vessels can pass under the structure when the lift span is only partially raised and thus avoid undue delay. The bridge can be fully opened and closed in approximately one and one-half minutes. The old bridge which was replaced at this location required six minutes to open and close completely.

The lift span mechanism is operated by power transmitted to the operator's house on the lift span by submarine cables placed at a minimum depth of 10 feet below the streambed. Flexible cables with sufficient slack to provide for the continuous flow of electrical energy when the lift span is raised to its maximum height are located in the towers.

In addition to the electric motors which provide the power for lifting the bridge, there is also an auxiliary gasoline motor which operates an electric generator. In case of a power failure, or if the electrical transmission line is broken for any reason, the gasoline motor will be ready to furnish power at a moment's notice.

The old bridge was built in 1910 at the same location, at the foot of M Street. It had long been an eyesore to the people of the State who entered Sacramento from the west. M Street, the Pennsylvania Avenue of California, runs directly into the State Capitol, which is flanked by the new Capitol Extension buildings and Capitol Park. It was unimpressive, to say the least, to have such an antiquated structure as the gateway to the beautiful capitol buildings and grounds. When the need for a new bridge became an absolute necessity due to traffic requirements, popular sentiment demanded that every effort be expended to design a structure which would be unexcelled in architectural and engineering beauty and thus conform to its natural setting.

NOVEL TOWER DESIGN

Simplicity is the chief characteristic of the bridge architecture. The principal departure from ordinary practice is the plating or covering of the tower truss members by steel plates which give the appearance of simplicity in mass. The plates cover the intricate lacing and cross members and produce a modernistic straight line effect which is pleasing to the eye.

To produce the illusion of artistically adequate pier size in the substructure and continue the simple straight line effect, the fender structure protecting the main pier has been offset a considerable distance back from the channel and extended the proper distance beyond the edge of the tower. The pier itself is not visible through the fender as the fender extends above the pier and effectively conceals it, thus giving the tower an apparent support of ample size.

This treatment of the fender system was handled in this manner because the plating of the towers creates such

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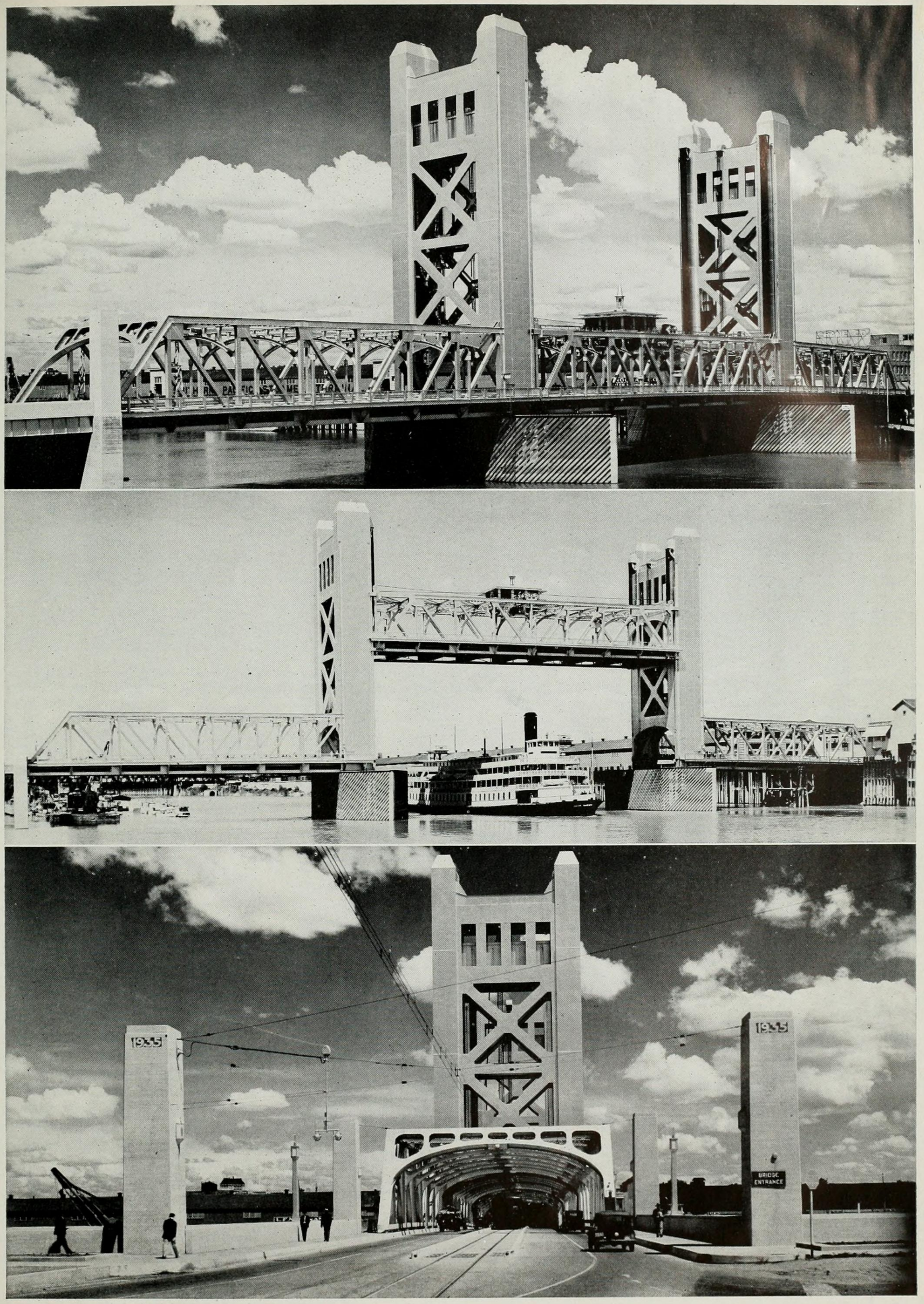


Tower Bridge at Sacramento, winner of award in annual national competition for most beautiful bridges built last year.

New "M" Street Bridge at Sacramento to be Under Construction in Spring

By **F. W. PANHORST,** Acting Bridge Engineer

AFTER many years of waiting it now appears that the narrow, dangerous and unsightly bridge over the Sacramento River at "M" Street, the westerly entrance to Sacramento, will soon be replaced by a new and modern structure. The budget of the State Division of Highways for the present biennium includes an item of $433,000 as the State's share for constructing a new bridge. Cooperating with the State, Sacramento county has allotted $100,000 of the county's share of the gas tax from the present fiscal year budget and $133,000 from the next fiscal year budget to be used in conjunction with the State funds for the new bridge.

F. W. PANHORST

The present bridge was built in 1910 by the Sacramento Northern Railway Company with financial cooperation from Yolo and Sacramento counties. The railway company secured at that time a 50-year franchise extending to 1960, which has 26 years to run. This bridge, not intended for the heavy highway traffic it now carries, but built primarily for railroad traffic and protected by a 50-year franchise, is to be replaced by a State bridge, built and operated by the State.

NEGOTIATIONS NECESSARY

This situation necessitated numerous conferences of State and railroad officials in order to arrive at an agreement satisfactory to both. The position taken by the railroad company was one of cooperation and an agreement satisfactory to both parties has been executed.

It must be remembered that no possible arrangement of tracks and highway could be such as to be entirely satisfactory to both railway and State. Naturally, the railway company would prefer to have a clear crossing not hindered by highway traffic, and the State would prefer a bridge with no railway interference, but neither the railway crossing nor the highway traffic could be eliminated.

It was, of course, suggested that the highway traffic should be carried over the tracks clear of all rail interference. Such a solution was possible, but the cost would be far in excess of available funds and the property damage to "M" Street due to the long run-off, as well as many other valid reasons which we will not attempt to enumerate here, made necessary the elimination of such an overhead structure.

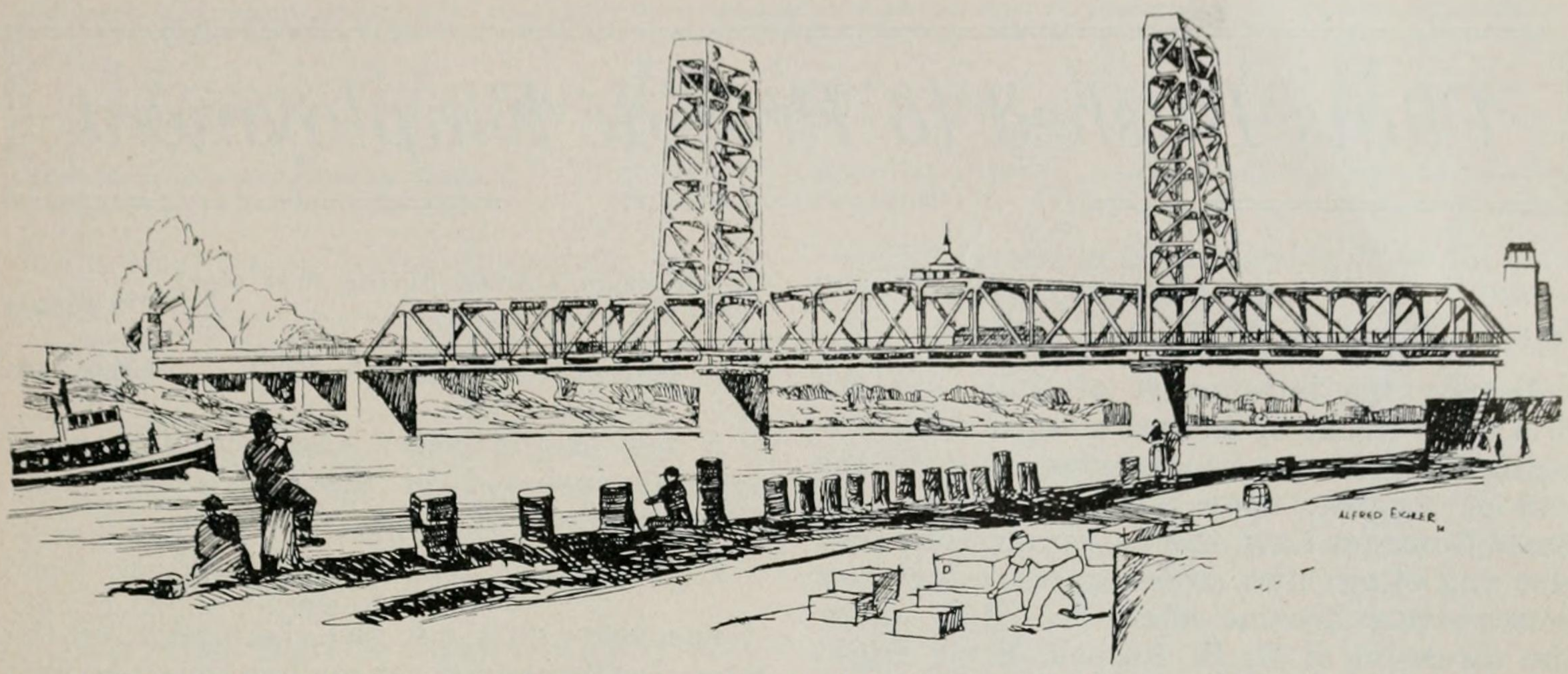
At a conference held December 22, attended by the railway company and State officials agreement was finally reached on the type of structure agreeable to both. The Department immediately began final plans and specifications so that actual construction may be started as soon as the hazard of spring high water has passed.

A combination railroad and highway bridge of the vertical lift type will be constructed. The accompanying sketch shows a typical cross section. The clear width between curbs will be 52 feet with the railway tracks in the center, vehicular traffic being protected by curbs which allow 13 feet for railway traffic. Two lanes of highway traffic in each direction will be provided with the outside lanes 10 feet in width and the interior lanes 9 feet and 6 inches. Four-foot sidewalks will be placed on each side of the bridge outside of the girders.

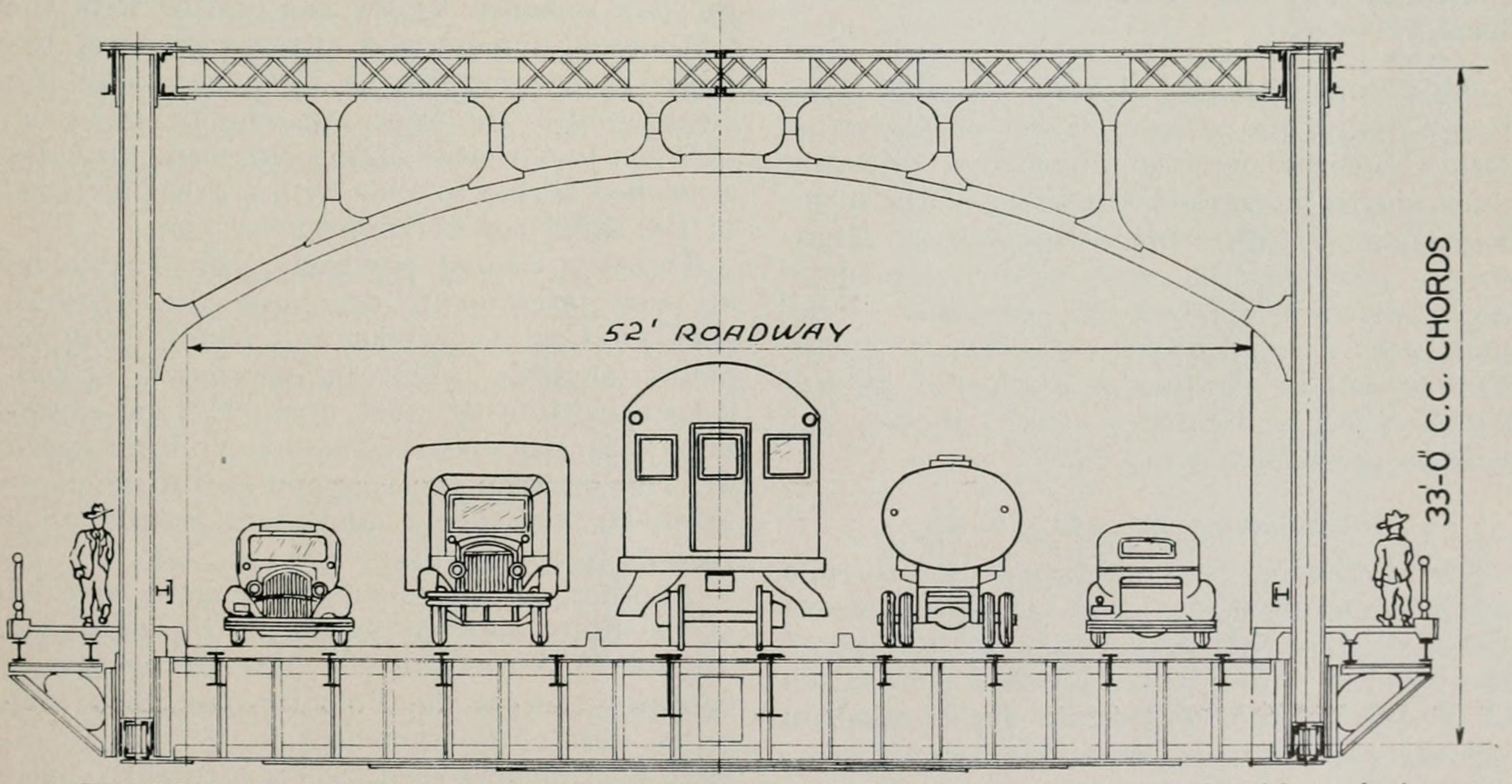
ALL NEW PIERS

Original plans provided for utilizing the present piers but detailed studies have shown that a more economical and satisfactory structure can be secured by building entirely new piers at new locations.

A hearing was held October 18, 1933, before a representative of the War Department and permit has been secured for a clear opening between fenders, for river traffic, of 170 feet and a vertical clearance, with span lifted, of



MODERN IN DESIGN and adequate to accommodate the greatly increased San Francisco-Sacramento traffic to and from the State Capital through the "M" Street gateway this new steel structure will replace the present old, narrow, unsightly bridge over the Sacramento River. It is a lift type bridge, the center span being raised vertically for passage of river craft. The new structure will have an over-all length of approximately 700 feet and cost $700,000. The above architect's drawing is not final in the detail of certain features and units.



TRAFFIC CAPACITY IS DOUBLED on the new "M" Street bridge as shown by this typical cross-section. The 52-foot roadway will accommodate four lanes of highway traffic, two on either side of the Sacramento and Northern Railroad track occupying the middle lane and separated by curbing. In addition, a 4-foot sidewalk for pedestrians is provided on each side of the roadway.

100 feet above high water. The grade of the bridge will be practically the same as at present with a lift span of 209 feet 6 inches in length flanked by two steel spans one 192 feet 6 inches and the other 165 feet in length.

The vertical lift type of structure was decided upon after considering all other possibilities.

NOVEL SURFACING FEATURE

A novel feature of the structure will be the use of light weight concrete for roadway slab and sidewalk. This concrete will weigh but 100 pounds per cubic foot while ordinary concrete weighs 150 pounds. The light weight concrete will give 3000 pounds per square inch compressive strength when 28 days old which is comparable to the heavier concrete now used. The lightness of weight is secured by using a special light weight aggregate.

The value, or economy, of using the light weight concrete is that it materially decreases

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CALIFORNIA
HIGHWAYS AND PUBLIC WORKS

"M" Street Vertical Lift River Bridge at Sacramento. A Unique Design with Architectural Treatmen

Official Journal of the Department of Public Works

AUGUST ~ 1934

Progress on M Street Bridge at Sacramento Promises Opening in Fall

By **W. A. DOUGLAS,** Assistant Construction Engineer of Bridges

IN 1910 the Sacramento Northern Railway Company constructed a through steel truss railway bridge across the Sacramento River connecting Sacramento and Yolo counties at the foot of M Street. With financial assistance from these two counties the bridge was provided with narrow roadways and sidewalks cantilevered out from the frames. The bridge was built with a swing span to accommodate river traffic. The operation of the swing span was slow and involved a considerable loss of time to vehicular traffic desiring to use the bridge.

In spite of the restricted roadways and delays due to slow operation, the bridge has served traffic, carrying the majority of travel between Sacramento and the San Francisco Bay region, the Redwood Highway and the West Side Highway to the north for 25 years. During the early part of this period the capacity of the two roadways was well in excess of the demands placed upon it. However, with the increase in density and speed of automobile traffic during the last 15 years thoroughfares which appeared broad and highly satisfactory prior to 1920 have become entirely too narrow and cramped for safe, comfortable travel.

Civic pride, too, had a hand in hastening the obsolescence of the 1910 bridge. With the bulk of passenger travel switching from rail and water to highways it has become increasingly important that an attractive as well as adequate highway entrance to the State's capital city be provided.

FOUR GOVERNMENTS COOPERATE

The pressure of local demand and highway necessity finally culminated in the provision of funds by the city, county, State and Federal governments in 1933 followed immediately by the necessary studies, preparation of agreements with interested and affected parties and the preparation of plans and specifications leading up to the advertising of the work June 1, 1934. An enlightening discussion of the multitude of problems and difficulties encountered in the preliminary stages of this project can be read in an interesting article entitled "New M Street Bridge at Sacramento to be under construction in the spring," written by F. W. Panhorst, acting bridge engineer, which appeared in the January, 1934, number of this magazine.

On June 27, 1934, eight proposals for the construction of the new M Street Bridge were received by the Division of Highways. The totals of the proposals ranged from the high bid of $1,025,224 down to the low bid of $907,365. Award was made on July 14 to the low bidder and the contract was duly approved on July 31.

Work began immediately on preparations to excavate for and pour the concrete river piers and to construct the temporary railroad shoofly trestle. The contractor's principal concern during the fall was the completion of the river piers before progress should be hampered by winter rises in the river level.

FOUR COFFERDAMS DRIVEN

Plans required that excavation for these piers be carried down through the silt, sand and gravel of the river bed to suitable foundation at elevation —50, or approximately 55 feet below the summer level of the river. To accomplish this work the contractor, after first predredging the pier sites, set up and drove 60-foot steel sheet pile cofferdams. Four of these deeper pier footings were required—two each for the two main or rest piers.

Due to interference with the operation of the swing span of the old bridge only two diagonally opposite cofferdams could be driven simultaneously. No unusual difficulty was encountered either in driving the cofferdams or excavating.

To balance the hydrostatic pressure it was necessary to pour a concrete seal approximately 24 feet in thickness in each cofferdam before the water could be pumped out. Each of the four cofferdams was about 30 feet in diameter requiring for the seal alone nearly 650 cubic yards of concrete. Five transit-mixers were used and each of the four seals was placed by continuous pouring from 18 to 22 hours.

With tight seals in place each cofferdam could be pumped readily and the piers com-

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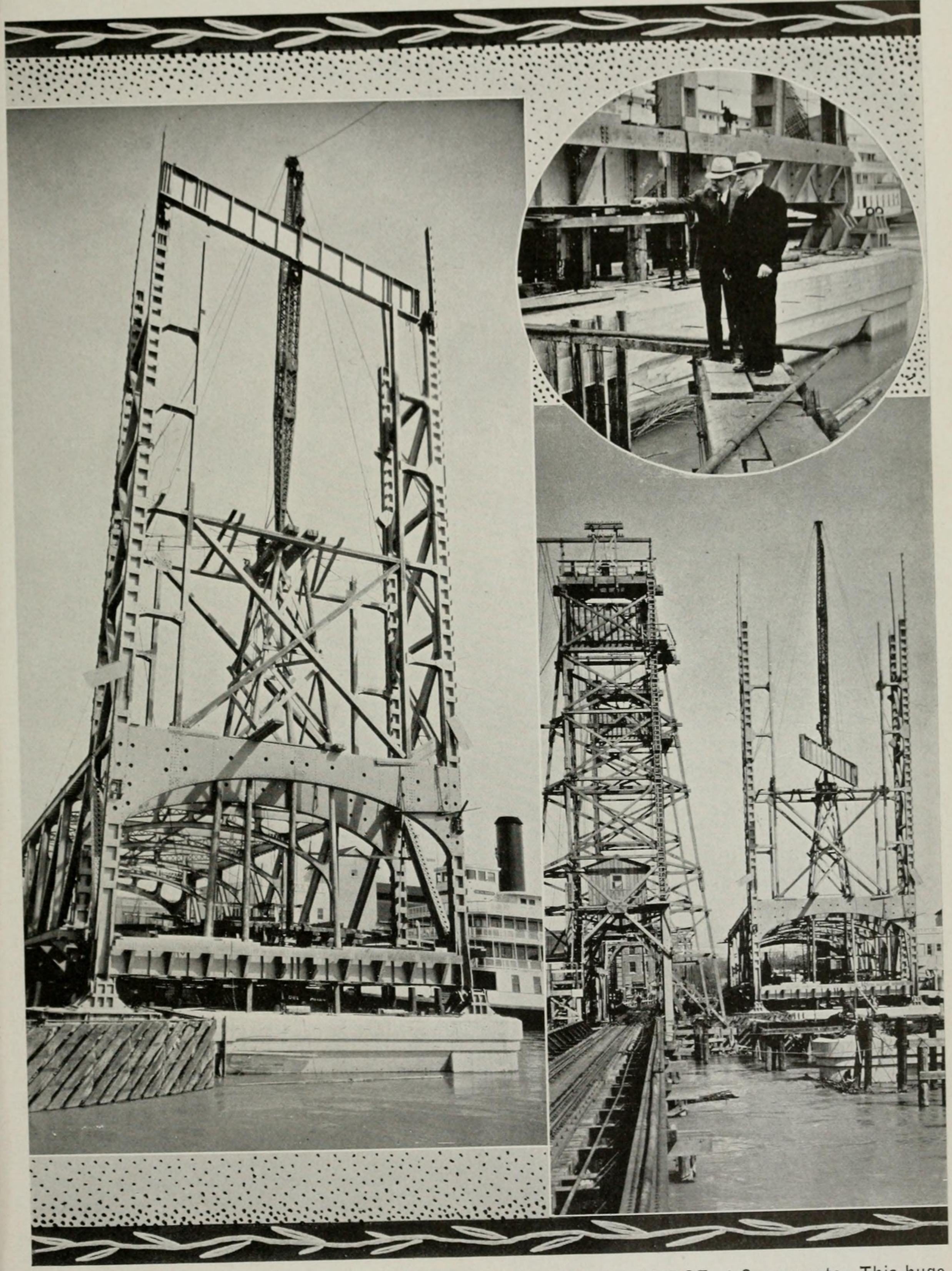

CONSTRUCTING EASTERLY LIFT TOWER OF M STREET BRIDGE at Sacramento—This huge steel structure has now been built to practically its full height which will be about 200 feet above low water. Inset shows Governor Frank F. Merriam inspecting massive bearings of the lift tower. Below, a view of the temporary wooden detour bridge and a derrick lifting one of the new tower girders into position.

M Street Bridge Spans 95 per cent Complete; Opening Set for November

By **G. W. THOMPSON**, Resident Engineer

THE M Street Bridge across the Sacramento at the foot of M Street in Sacramento is rapidly nearing completion and will soon provide an adequate and impressive highway entrance into the Capital City from the west.

The new bridge will accommodate two lanes of highway traffic in each direction with a single railroad track in the center. Concrete curbs on each side of the railroad protect the highway traffic. In addition, there is a four foot clear width sidewalk on each side of the bridge to carry pedestrian traffic. A heavy guard rail made of steel protects the pedestrians from highway traffic and an ornamental steel handrail is placed on the outside.

The two center piers supporting the approach span and lift span are set on large concrete blocks part of which were poured under water. Their total height is some 84 feet of which 40 feet is below the river bottom. They rest upon a foundation of gravel and boulders. Since these two piers flank the main river channel, they will be protected from barges and steamers by heavy creosoted pile fenders.

PIERS AND ABUTMENTS PLACED

Foundation for the rest of the piers and abutments consists of either Douglas Fir piling or reinforced concrete piling. The general contractor has recently completed the placing of the east and west abutments and west approach piers of which there are three. These piers and abutments, together with the main river piers, supporting the steel structure are now complete.

The superstructure consists of four short steel stringer spans, a 225 foot and 167 foot steel truss span, a 202 foot steel truss lift span which provides for a 97 foot vertical clearance above extreme high water, and a short combination reinforced concrete girder and steel stringer span connecting the front and rear wall of one of the end abutments, making a total length of about 738 feet.

The two approach spans, the lift span, and the lift span towers which rise to a height of 160 feet above the lower chord, are now 95 per cent erected and riveted. The towers will be the fourth highest structures in the city and will be covered with a sheet metal giving them a modernistic and imposing appearance. The entire steel structure is to be given a final coat of aluminum paint.

LIGHT WEIGHT CONCRETE

The deck and sidewalk of the steel spans and west approach stringer spans will be of lightweight concrete weighing under 100 pounds per cubic foot as compared to 150 pounds per cubic foot for ordinary concrete. This amounts to a saving in weight of 33 per cent and allows for a great saving in steel in the design of the steel trusses.

Some of the aggregate going into the concrete is so light that it will actually float on water, but the strength of the concrete made from it is little less than is obtained from the use of standard aggregates. A thin layer of topping is also placed for wear and finishing. Placing of this concrete is now in full swing with two spans complete.

Inside each tower and hanging by cables passing over large sheave wheels and connected to the lift span is a large steel box to be filled with concrete to balance the weight of the lift span so that raising and lowering of the span might be accomplished with much more ease and less power.

HEAVY BALANCE CHAIN

A large balance chain resembling a bicycle chain but weighing 515 pounds per lineal foot hangs from the counterweight box and is connected to the tower. This chain is so designed that the weight of the counterweight cable in passing from one side of the tower to the other as the lift span is raised or lowered will always be balanced by this chain.

Power for raising the bridge is supplied from two sources. The main motors are two one hundred horse power electric motors and the auxiliary motor is a sixty-seven horse power gas motor. Both sources of power are connected to the main gear box and hoisting drums. All switch boards, controls, and motors are located in the machinery house situated on top and in the center of the lift span.

An elaborate system of signals, sirens, bells, and gates has been developed as a precaution to safeguard the traveling public.

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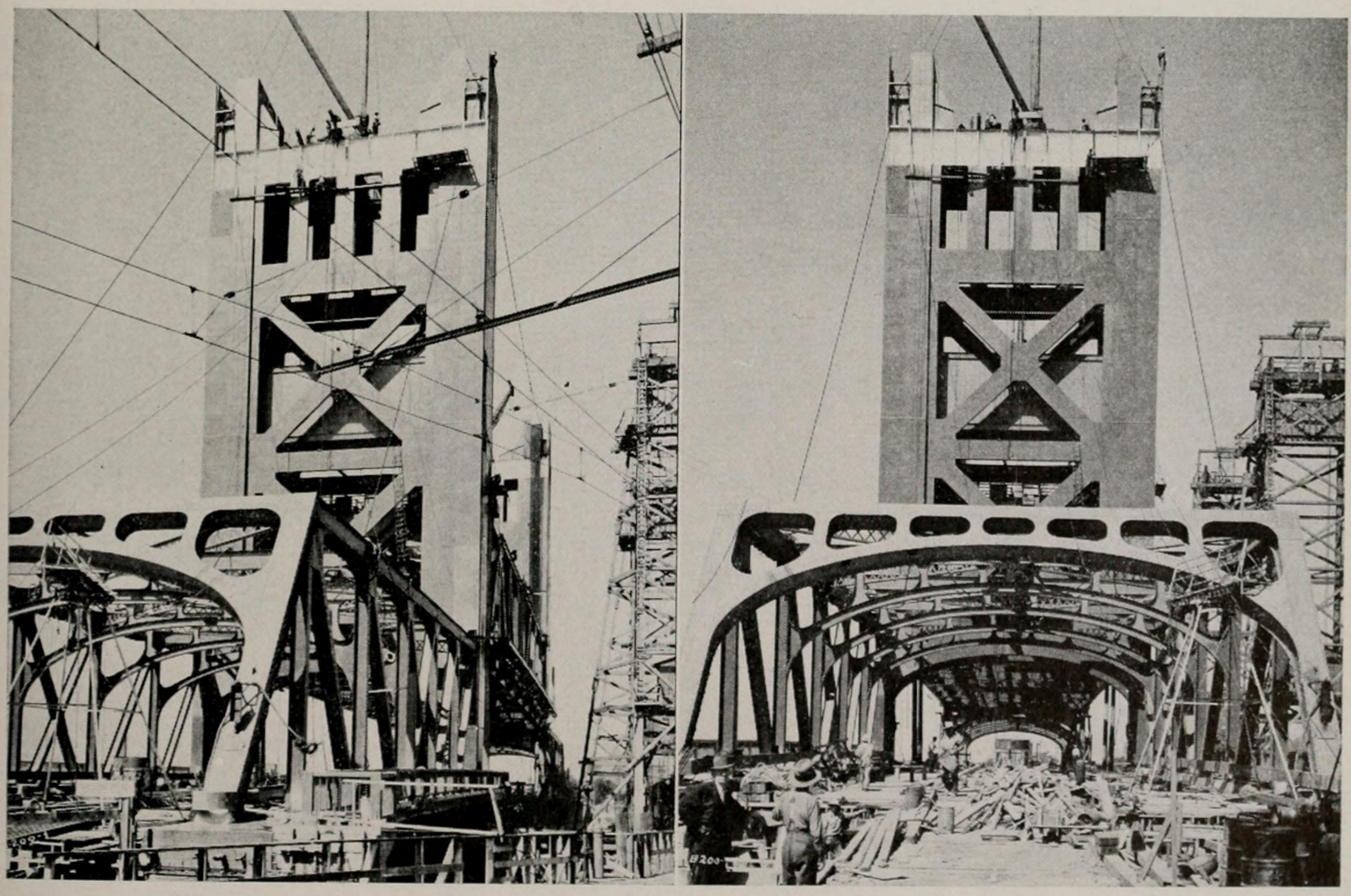
NEARING COMPLETION, the M Street bridge over the Sacramento River at the State capital is pictured with the 202-foot steel truss lift span in raised position still partially supported by false work.



CONSTRUCTION VIEWS of the tall massive looking lift towers rising 200 feet above the water and the rugged steel deck spans that provide a 52-foot roadway.

CALIFORNIA
HIGHWAYS AND PUBLIC WORKS

New Tower Bridge at Foot of "M" Street
Sacramento

Official Journal of the Department of Public Works
DECEMBER 1935

Governor Merriam Opens $994,000 Tower Bridge at M Street, Sacramento

UNEXCELLED for its architectural and engineering beauty and constituting an impressive western gateway to the Capital City, the unique and imposing Tower Bridge spanning the Sacramento River from the foot of M Street in the city of Sacramento formally was dedicated and opened to traffic by Governor Frank F. Merriam on the afternoon of Sunday, December 15, 1935.

Constructed at a cost of $994,000, the new structure, the only vertical lift span bridge on the California Highway System, replaces the old steel swing span built by the Sacramento Northern Railway in 1910. During the twenty-five years that the original M street bridge was in use, Sacramento's population expanded from 45,000 to approximately 100,000 and traffic increased 700 per cent in volume and 500 per cent in speed, making the old bridge with its nine-foot roadway cantilevered out from the trusses on either side of the structure not only entirely inadequate, but dangerous as well.

A COOPERATIVE PROJECT

The Tower Bridge, built by the State Department of Public Works in cooperation with the city and county of Sacramento and the Federal government, is 737 feet long, has a fifty-two foot roadway and two sidewalks, a thirteen-foot roadway in the center for the tracks of the Sacramento Northern Railway and two lanes for one-way traffic on each side of the tracks. Representing all that is modern in engineering skill, it will stand as an enduring monument to transportation progress and relieve traffic problems that had become a matter of grave concern to the state as well as to the city and the county of Sacramento.

Construction work on the Tower Bridge began in July, 1934, and was hailed by Sacramento and Yolo counties as the beginning of a new and greater bond between them.

At the outset, a problem of paramount importance that confronted Director Earl Lee Kelly of the State Department of Public Works, his engineers and the bridge contractors was that of detouring. The old M street bridge, built by the Sacramento Northern Railroad, carried a fifty-year franchise. It was necessary to provide not only for highway traffic but for a river crossing for the railway while the Tower Bridge was in course of construction.

After considering all feasible plans, the State spent approximately $12,000 in widening certain parts of the I Street Bridge to accommodate automobile traffic and built a temporary detour bridge about seventy-five feet north of the Tower Bridge to take care of the Sacramento Northern. This structure, built entirely of timbers with the exception of four spans of steel girders, rented for the purpose, cost $90,000.

Economizing to the utmost, the engineers made the grade of the detour bridge as low as possible, placing the steel girders just above normal high water. Exceptional rains last winter raised the Sacramento river to a point where, for a few days, driftwood endangered the temporary bridge, but this danger passed and there was no delay to railway traffic.

The Tower Bridge consists of a combination of steel and concrete spans. The central lift span is a 209 foot truss supported by two vertical towers 160 feet high. The approach span on the east consists of one 167 foot steel truss span and one 30 foot girder span. On the west, there is one 193 foot steel truss span and four 34 foot girder spans.

LIFT SPAN COUNTERWEIGHTED

The central lift span in its extreme high position has a clearance of 100 feet above high water and a horizontal clearance of 172 feet between the fenders. The total load of the lift span proper is estimated at 2,300,000 pounds. To avoid the necessity of lifting this great weight as a direct load, it is counterweighted by steel frames, filled with concrete. One of these frames is in each tower. They move in a direction opposite from that which the span moves. In raising the span, therefore, only enough electric energy is required to overcome the friction of the moving parts.

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TOWER BRIDGE DEDICATION SCENES—A view of the narrow old M Street swing span structure contrasts with several views of the modern new Tower Bridge with central vertical lift span that replaces it. The view of the dedication day crowd shows the lift span raised. In the official group, left to right, are: Director of Public Works Earl Lee Kelly; Mayor Ferguson; Governor Merriam; Assemblyman Desmond; President McCurry, Chamber of Commerce; Assemblyman Nielsen; Commander Kunz, American Legion; Secretary Dudley, Chamber of Commerce. Governor Merriam is shown releasing one of a thousand pigeons carrying messages to mayors of California.