WESTERN ENGINEERING

VOLUME 3

July to December 1913

Western Engineering
420 Market Street San Francisco, Cal.

in the sale of his oil, at no added expense. It is true that the difference is not great, but the error appears to be always in favor of the buyer, and when shipments of this size are made frequently, or the water content is greater than that shown in the case cited, the aggregate amount represented is not inconsiderable. Conditions on no two properties are exactly alike, and no set rule for handling oil in storage may be safely established, but the investigation outlined above is simple and may easily be carried out by the producer interested in securing the most efficient method for handling his oil in order that the highest possible return may be obtained from the buyer.

City Waterway Bridge, Tacoma

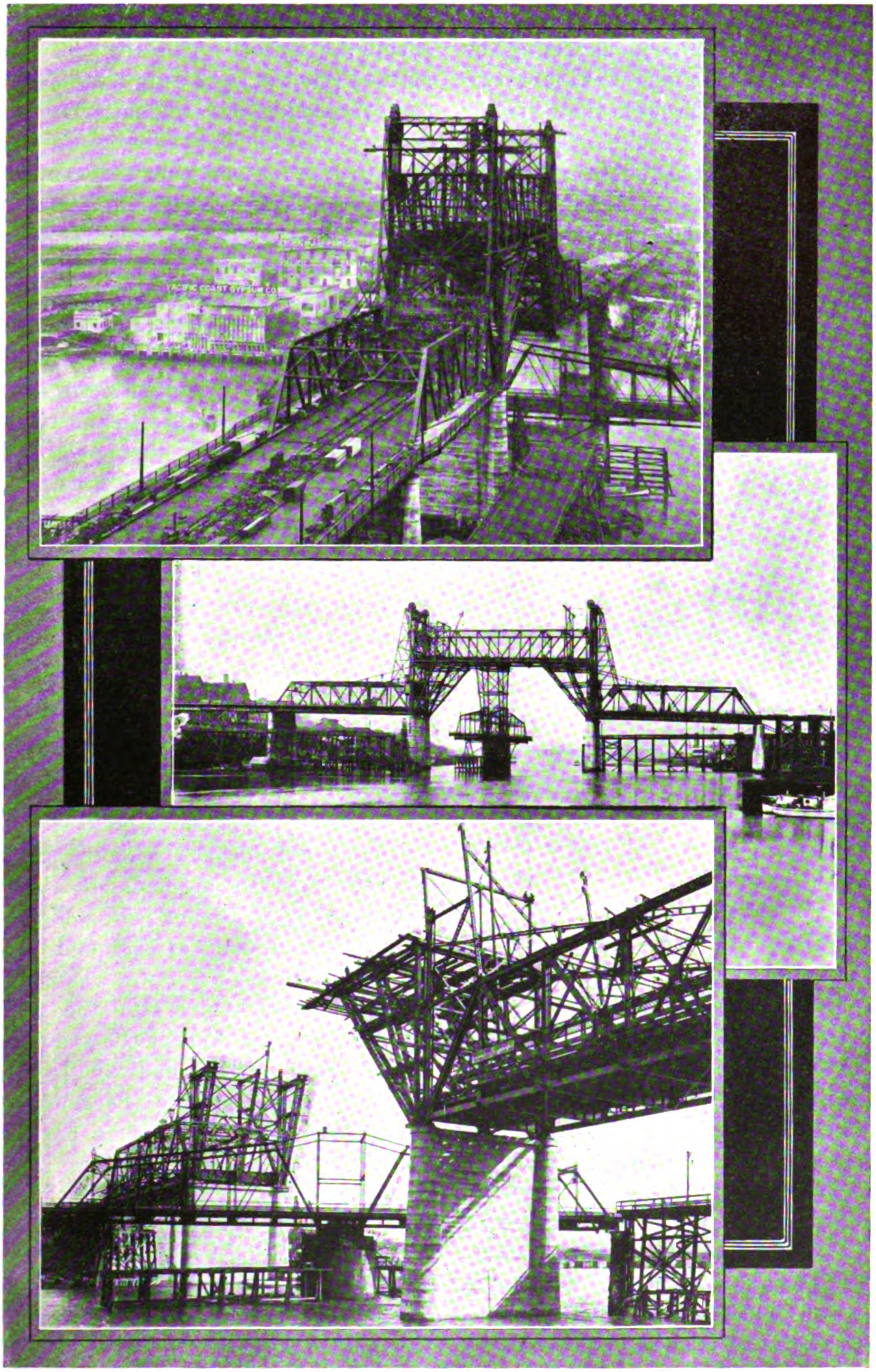
By JOHN LYLE HARRINGTON*

THE Waterway bridge in the city of Tacoma connects the business centre on the hill with the manufacturing centre on the tide flats, and occupies the line of Eleventh street. The upper deck has a 50-ft. clear roadway and two 10-ft. clear sidewalks, extending on a slight up-grade from A street to Cliff avenue, in order to clear the railway tracks on Cliff avenue, thence on a down-grade of from 2½ to 4% over the tracks of the Northern Pacific railway across the city waterway, and down to the clear level on the north side of the waterway. The lower deck has a 19-ft. 4-in. clear roadway and a 10-ft. sidewalk extending on a heavy grade from the top of the hill at Cliff avenue down to the city waterway, and turning back and widening down to the level of the railroad tracks and streets on the south side of the waterway. The approach on the north side consists of about 100 ft. of reinforced concrete retaining walls and about 575 ft. of steel girder and column viaduct. The north approach consists of timber trestle, and the main bridge over the river consists of two 190-ft. fixed truss spans and a 220-ft. vertical lift span, affording a clear waterway 200 ft. wide. The vertical clearance beneath the lift span at high tide is 60 ft. when the span is down and 135 ft. when the span is up, or, since there is 20 ft. of tide, the clearance is 80 ft. with the span down or 155 ft. with the span up at low tide.

A 16-ft. water main is brought up the shore piers, carried over the top of the trusses of the fixed spans, thence up the back of the towers and over the lift span, on a light truss provided for that purpose. The upper deck is paved with creosoted wood blocks or creosoted plank, which in turn are supported on creosoted ties. The sidewalks are all untreated plank. The double track street railway is placed in the centre of the roadway. The lower deck in the south approach is paved with untreated plank 4 in. thick.

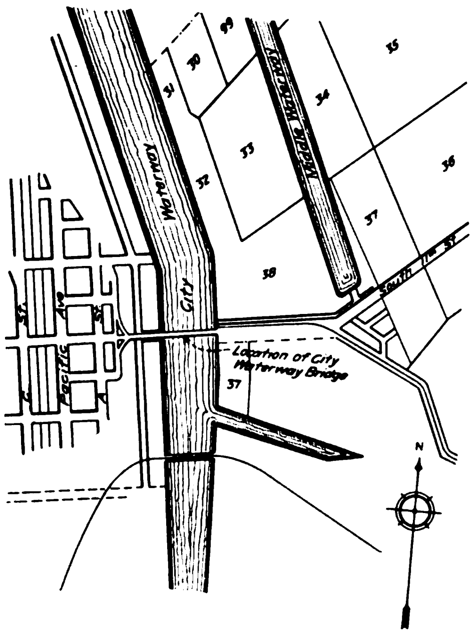
The piers are sunk by the open dredging process to about 35 ft. below low water, and the piles on which the

*Consulting Engineer, Kansas City, Missouri.



VIEWS OF THE TACOMA CITY WATERWAY BRIDGE IN VARIOUS STAGES OF CONSTRUCTION.

piers are supported, are carried to a depth of about 115 ft. below low water in the deepest case. The shafts of the piers consist of frustums of two cones, connected through their height by reinforced concrete webs. This construction was adopted to lessen the load on the piles and bases, for the shafts of the piers vary in height from 72 ft. above the bases of pier No. 4 to 90 ft. above the bases on pier No. 1.



POSITION OF CITY WATERWAY BRIDGE.

The lift span consists of a simple truss span suspended at its four corners by wire ropes which rise over cast steel sheaves 9 ft. in diameter and connect to concrete counterweights, which balance the span. Each corner of the span is suspended by sixteen 1½ in. diameter plow steel ropes, connected rigidly to the span and to the counterweight through a system of equalizing levers, by which the load is equally distributed over the entire group of sixteen ropes. The operating machinery is mounted in a house placed above the centre of the lift span. The machinery consists of four drums actuated through a train of gears by two street railway motors operating on 500 volts direct current. Each drum carries two ropes, one of which runs from the drum underneath a sheave on the corner of the span and connects to the top of the tower, while the other runs from the top of the drum over the same sheave at the corner of the span and connects to the bottom of the tower. All four drums are similarly connected, each to its corner. The turning of the drums winds the ropes leading to the tops of the towers and lifts the span, while the ropes leading to the bottom of the towers are paid off. Reversal of the direction of rotation of the drums brings the span back to its seat.

The motors are operated by series magnetic controller placed in an operator's cabin situated just north of the sidewalk, where the operator can have a clear view of both the waterway and the roadway. When the span reaches the upper and lower limit of its travel, the electric current is automatically cut off and solenoid brakes are automatically applied, but the operator has hand brakes as a safeguard.

In the fixed spans at each end of the lift span there are two electrically operated gates, which stop the traffic. Two are lowered, and at the same time swung across the roadway to stop traffic from going onto the span, and when the traffic on the span has been cleared the other two gates are closed. The gates are operated by the bridge operator from his cabin.

The site of this bridge was previously occupied by a light and inadequate swing span with a steel approach extending to Cliff avenue on the south, and a wooden approach extending to the tide flats on the north. Its position was much closer to the waterway than the present span, hence, in order to maintain traffic during the construction of the new bridge, a timber trestle was built parallel to the old structure and on its east side from Cliff avenue to the end of the swing span, and on its west side from the north end of the swing span down to the tide flats. The old draw span was then swung through adequate angle to meet these temporary trestles and traffic was maintained on this structure during the construction of the new bridge.

The structure was built by the city of Tacoma, of which Owen Woods is Commissioner of Public Works, and W. C. Raleigh is city engineer. The bridge was designed and its construction was supervised by Waddell & Harrington, consulting engineers, Kansas City, Missouri. The machinery and metal work for the superstructure was furnished by the American Bridge Co., and the International Contract Co. of Seattle were the contractors who constructed the substructure and erected the superstructure.

California State Roads

By S. J. VAN ORNUM*

IN 1910 the people of the state of California voted a bond issue of $18,000,000 for the construction of a system of state roads. A few states have voted larger amounts for the improvement of roads, as is the case in New York, which state has already expended $50,000,000 and has recently voted an additional $50,000,000. The bond issue of California, nevertheless, should be considered a progressive and constructive movement in supplying the fundamental basis of economical rural communication and transportation, and a factor of far-reaching importance in promoting the substantial development of the state.

The Highway Act provides for the improvement of "a continuous and connected state highway system running north and south through the state, traversing the Sacramento and San Joaquin valleys and along the Pacific coast by the most direct and practicable routes, connecting the county seats of the several counties through which it passes and joining the centres of population together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such state highway."

The extent of the undertaking can be better realized when one considers that approximately 2700 miles of highway must be constructed to conform with the requirements of the Highway Act.

The following general characteristics of the proposed road construction, adopted by the State Highway Commission, is described in an article in *Western Engineering* of September 1912 by Austin B. Fletcher.

1. A right-of-way at least 60 ft. in width.
2. Gradients not exceeding 7 per cent.
3. Open curves.

*Consulting Engineer, Pacific Bdg., San Francisco.

The City Waterway Bridge, Tacoma, Washington

The accompanying figures show two views of the new City Waterway Bridge at Tacoma, Wash., which has just been opened for traffic. The view on the left, Fig. 1, shows the west approach to the main structure and the closed drawbridge. The view to the right, Fig. 2, shows the drawbridge open, and the east approach truss. The bridge connects the business center of the city on the hill to the west, with the manufacturing center on the tidal flats at the east. It occupies the line of 11th St. and consists of a main deck with a 50-ft. clear roadway and two 10-ft. clear sidewalks, and a lower deck on the west side of the waterway, having a 19-ft. 4-in. roadway and one 10-ft. sidewalk, carrying 11th St. down to the water level.

The approach on the east side of the bridge consists of about 100 ft. of reinforced-concrete retaining wall, and about 575 ft. of steel-girder and column viaduct. The other approach consists of timber trestle, and the main bridge has two 190-ft. fixed truss spans and a 220-ft. vertical lift span, affording a clear waterway 200 ft. wide. The vertical clearance beneath the lift span at high tide is 60 ft. when the span is down, and 135 ft when the span is up. There being about 20 ft. of tide here, the clearance at low tide is 80 ft. with the span down, or 155 ft. with the span up. A 16-in. water main is carried from the ground, up the shore piers, and over the tops of the trusses of the fixed spans, then up the back of the towers and over the lift span on the light truss shown in the view. The bridge is paved with wood blocks and planks, and a double-track street railway is carried in the center of the roadway.

The piers are made up of the frustums of two cones connected by a reinforced-concrete web, the main solid portion of each cone being of mass concrete. They are carried in open coffer-dams to a footing of piles which have their heads about 35 ft. below low water and their points in some cases as deep as 115 ft. below low water

The lift span is of the Waddell & Harrington type of design, each span consisting of a simple truss span suspended at its four corners by wire ropes which rise over cast-steel sheaves at the top of the towers and connect to concrete counterweights to balance the span. The operating machinery located in the house on the top chord of the suspended truss is actuated by motors connected to the street-railway circuit. Electrically driven gates operated from the motor house close each of the approach spans before the bridge can be raised.

During the construction of the new bridge, traffic was maintained across the waterway by building a trestle on the south side of the west half of the bridge, and the north side of the east half of the bridge, and connecting these two trestles by an old low-level swing span, which was part of an old bridge on the line of 11th St. The remainder of the bridge was taken down to allow for the construction of the new bridge. The trestle and old drawbridge were removed on completion of the high-level bridge.

The bridge was built by the City of Tacoma, under the direction of W. C. Raleigh, City Engineer, and Owen Wood, Commissioner of Public Works. The bridge was designed and its construction was supervised by Waddell & Harrington, Kansas City, Mo. The machinery and metal work for the superstructure were furnished by the American Bridge Co., and the International Contract Co., of Seattle, constructed the substructure and erected the superstructure.

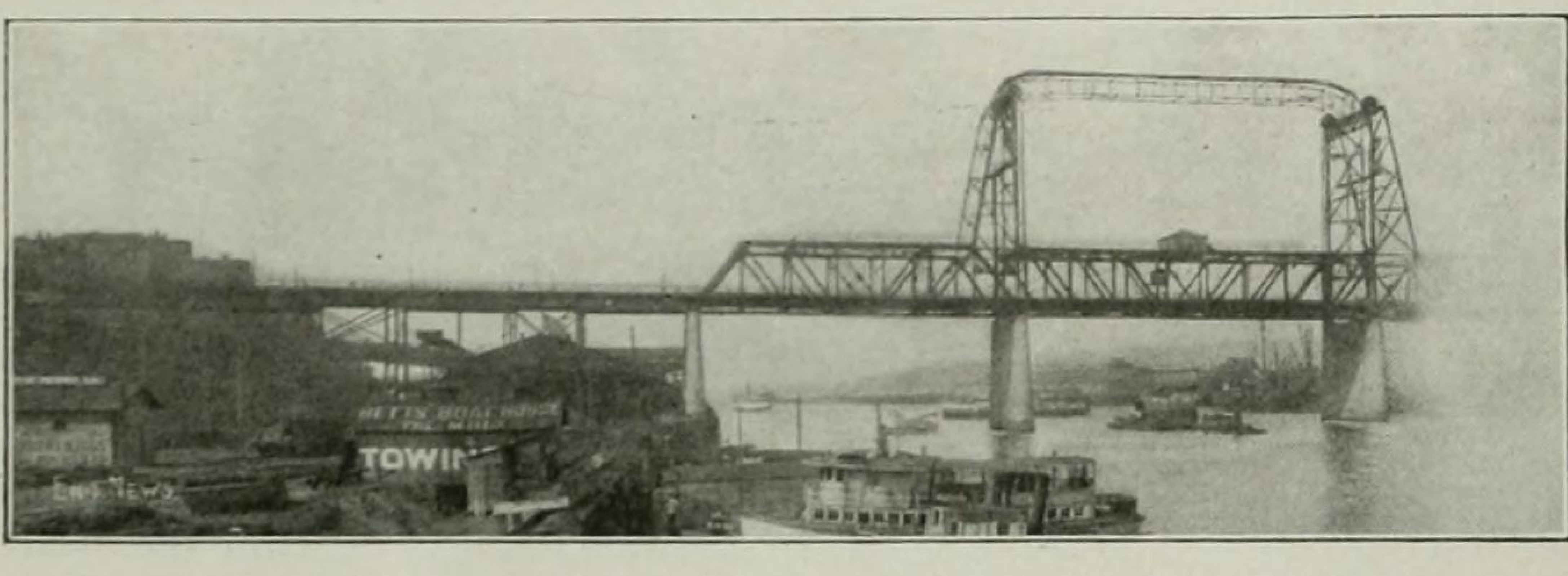


FIG. 1. WEST PART OF BRIDGE, SHOWING DRAWBRIDGE CLOSED

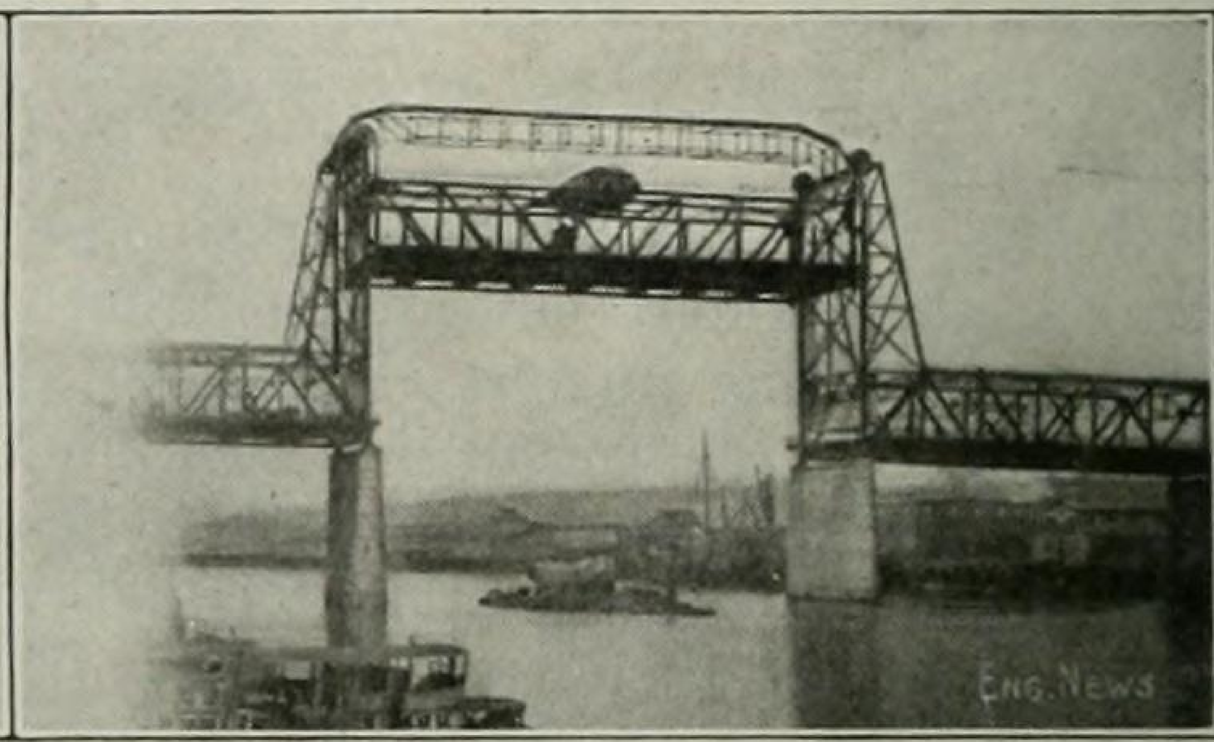


FIG. 2. EAST PART OF BRIDGE, SHOWING DRAWBRIDGE OPEN

FIGS. 1-2. THE CITY WATERWAY BRIDGE, TACOMA, WASH.

Street Accidents in London, England, cost the lives of 538 persons and injurieies to 16,651 more in the year 1912, according to statictics issued by the British Home Office. The greatest number of fatal accidents from any one class of street traffic was 182 deaths caused by motor omnibuses; electric cars caused 37 deaths; motor vehicles, 171; horse-drawn vehicles, 143, and horse-drawn omnibuses, 5. More than half the nonfatal accidents were due to motor omnibuses and other motor vehicles.

Grade-crossing Abolition in New Jersey must be done hereafter at the sole expense of the railways concerned, according to an act passed by the legislature near the close of the session. In a protest to Governor Fielder urging that the bill be vetoed, President Samuel Rea, of the Pennsylvania R.R., said:

It is important that the public should understand that in the passage of this bill a grave injustice has been done the railroads.

In the last 20 years the Pennsylvania R.R. has removed 110 crossings in the State of New Jersey alone, at an expense to the company of about $8,000,000, of $73,000 per crossing. There are very few crossings of its railroad at grade in any of the cities. The company is now engaged in the work of track elevation through the city of Rahway, and eastward. There remain, however, some 1200 grade crossings on the Pennsylvania system in this state, the removal of which at $50,000 per crossing would cost $60,000,000, an expenditure which would neither produce additional revenue, nor decrease expenses.

The removal of grade crossings should unquestionably continue. The need is for some impartial tribunal, which shall have authority to arbitrate between the municipality and the railroad company and to bring them into coöperation if they cannot agree. Power should be vested in some administrative board, acting judicially, to take up, on the application either of a municipality or a railroad company, or on its own initiative, the case of any grade crossing, and after a hearing to direct the elimination of the crossing and the particular manner in which it shall be done and how the expense shall be proportioned.

Generally speaking, such is the arrangement in New York, Massachusetts, Vermont and Ohio. With so many crossings still to be eliminated, it seems unfair and unwise to propose that the railroad companies should be burdened with eliminating grade crossings, many of which have been opened subsequently to the construction of the railroads, and against either the entire cost, or an undue proportion of the cost, of their strong protests.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design and to Methods and Costs of Construction

VOLUME XLI

January-June, 1914

THE MYRON C. CLARK PUBLISHING CO.
608 South Dearborn St., Chicago, Ill.

greatly increased. The effect of the freezing of the filling must also be considered.

REQUIRED WATERWAY.

The usual formula for a waterway for culverts is:

$$a = C A^{3/4}$$

in which

a = required area of culvert in square feet,
A = drainage area in acres,
C = a constant, depending on the length and character of the drainage area and may vary from about 0.3 to 2.0 in regions where the mean annual rainfall is about 50 ins.

The capacity of the culvert will be much greater if the wingwalls are flush with the abutments and flare about 30°, the sides and bottom of the culvert are smooth and straight, and the bottom has a good shape.

If reliable information covering a number of years can be obtained regarding the adequacy of the old bridge crossing the same stream, it is much more useful in determining the size of a culvert or bridge than any formula.

At Regina, the capital of Saskatchewan, the utility and works committee has authorized capital expenditure of over $2,000,000 during 1914. Principal items are: Water works, $487,752; disposal works and sewer extension, $373,665; street railway extensions, $250,000; pavements and sidewalks, over $500,000; electric light and power, $404,000.

Some Features of the Design and Construction of the City Waterway Bridge at Tacoma, Wash.

(Staff Article.)

The City Waterway Bridge connects the business center of Tacoma, Wash., with the manufacturing district on the tide flats. It occupies the line of 11th St., and consists of an upper and a lower deck. The upper deck has a 50-ft. clear roadway and two 10-ft. clear sidewalks. It extends on a slight up grade from A St. to Cliff Ave., in order to clear the railroad tracks at Cliff Ave.; thence on a down grade of from 2½ to 4 per cent over the tracks of the Northern Pacific Ry., across the City Waterway and down to the surface on the north side of the waterway. The lower deck has a 19-ft. 4-in. clear roadway and a 10-ft. sidewalk. It extends on a heavy grade from the top of the hill at Cliff Ave. down to the City Waterway; and then turns back on a down grade to the level of the railroad tracks and streets on the south side of the Waterway. The north approach consists of about 110 ft. of reinforced concrete retaining wall construction and about 575 ft. of steel viaduct, and the south approach consists of a timber trestle. The main portion of the bridge, which is over the river, comprises two 190-ft. fixed truss spans and a 220-ft. vertical lift span which affords a clear channel of 200 ft. When the lift span is down it has a vertical clearance above high tide of 60 ft., and when the span is up the clearance is 135 ft. The range of the tide at the bridge site is about 20 ft.

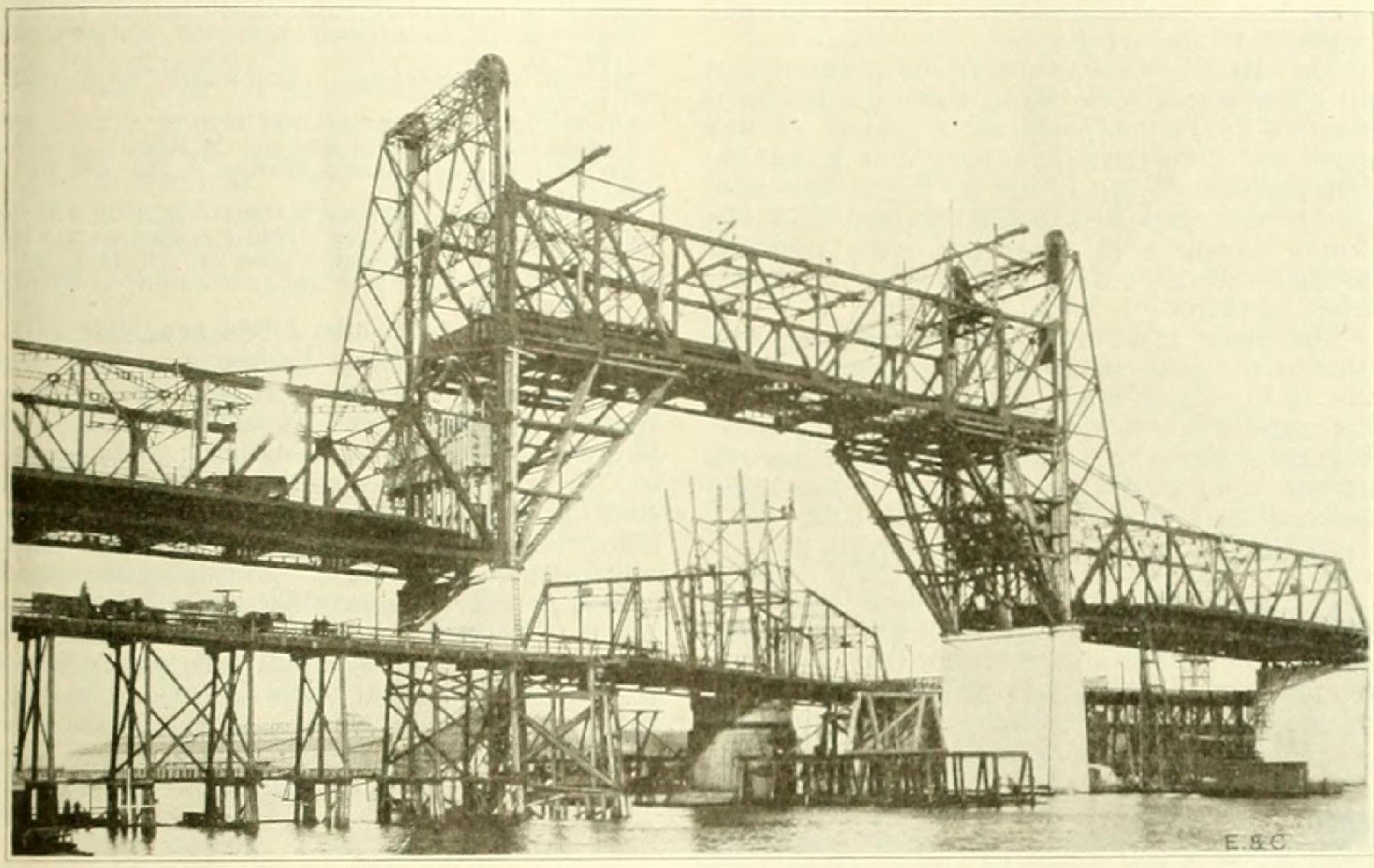


Fig. 1. View of City Waterway Bridge, Tacoma, Wash., Showing Method of Erecting Lift Span—View Also Shows Temporary Bridge With Old Swing Span.

A 16-in. water main is brought up the shore piers, and is carried over the top of the trusses of the fixed spans; thence up the back of the towers and over the lift span on a light truss which was designed to support it.

The upper deck is paved with creosoted wood blocks on creosoted planks, which are in turn supported on creosoted stringers. The surface of the sidewalk is constructed of untreated planks. The roadway carries a double-track street railway in addition to providing for highway traffic. The roadway surface of the lower deck of the south approach consists of untreated 4-in. planks.

DESIGN FEATURES.

The piers are built of concrete and rest on pile foundations. The pier shafts consist of frustums of two cones, and are connected throughout their height by reinforced concrete webs. This type of construction results in a considerable saving of material and greatly lessens the load on the pile foundations, as the pier shafts vary in height from 72 to 90 ft. above the bases.

The lift span consists of a simple truss suspended at its four corners by wire ropes, which are carried over cast-steel sheaves 9 ft. in diameter and connect to the concrete counterweights. Each corner of the span is suspended by 16 1½-in. diameter plow steel wire ropes, connected rigidly to the span and to the counterweight through a system of equalizing levers, by which the load is distributed equally over the 16 ropes. The operating machinery is placed in a house located above the center of the lift span. This machinery consists of four drums actuated through a train of gears by two street railway motors, operated by a 500-volt direct current. Each drum carries two ropes, one of which runs underneath a sheave on the corner of the span and connects to the top of the tower; while the other passes from the top of the drum over the same sheave at the corner of the span and connects to the bottom of the tower. All-four drums are similarly connected, and the span is lifted by revolving the drums, which wind up the ropes leading to the tops of the towers, the ropes which lead to the bottom of the towers being paid out at the same time. By reversing the direction of rotation of the drums the span is brought back to its seat.

The motors are operated by a series magnetic controller placed in the operator's cabin at the side of the north sidewalk.

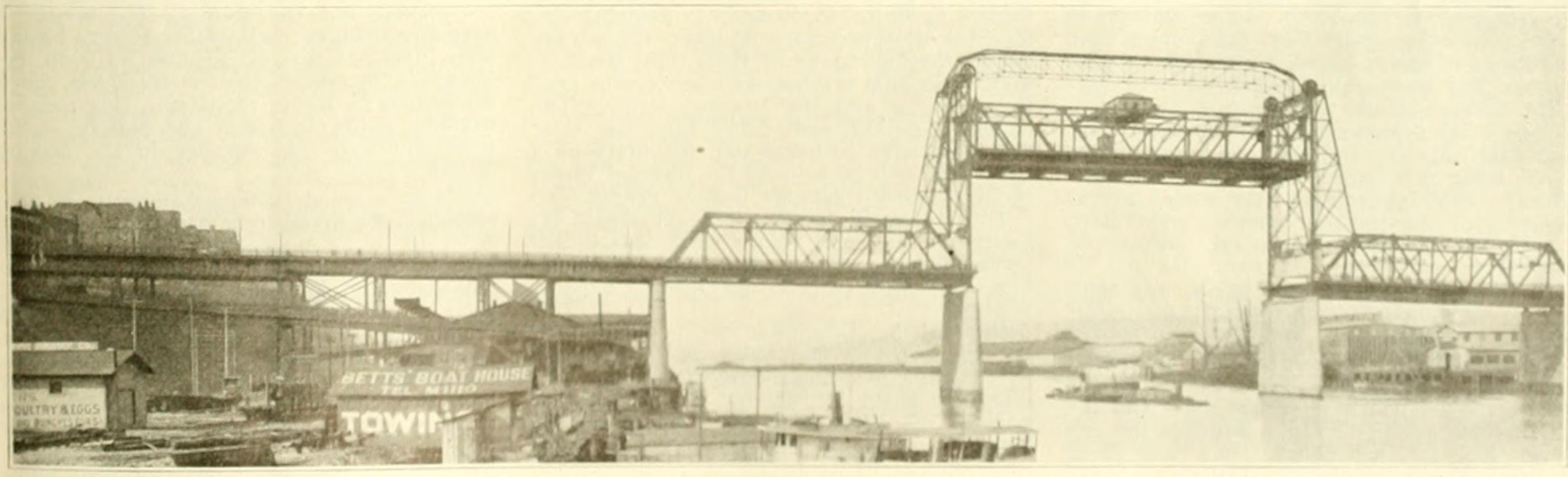


Fig. 2. View of Main Part of Completed City Waterway Bridge, Tacoma, Wash., Showing Type of Bridge and Lift Span in Raised Position.

When the span reaches the upper and lower limits of its travel the electric current is automatically cut off and the solenoid brakes are automatically applied. A hand brake is also provided as a safeguard.

In the fixed spans at each end of the lift span there are two electrically operated gates. Two of these gates are lowered and at the same time are swung across to roadway to prevent the traffic from entering the span;

and when the span has been cleared the other gates are closed. These gates are operated by the bridge tender from his cabin.

CONSTRUCTION FEATURES.

The site of this bridge was formerly occupied by a light swing span with a steel approach extending to Cliff Ave. on the south and a wooden trestle extending to the tide flats on the north. It had a much less clearance than the old structure; hence in order to maintain traffic during the construction of the new bridge a timber trestle was built parallel to the old bridge. This trestle extended on the east from Cliff Ave. to the end of the swing bridge and on the west from the north end of the swing span to the tide flats. The old draw span was then swung around to meet these temporary trestles, and traffic was maintained on this structure during the construction of the new bridge (see Fig. 1).

The piers were built by sinking timber cribs into the river bed. The material was then excavated by the open dredging process. The foundation piles were driven inside the cribs to a maximum depth of 115 ft. below low water. These piles were jetted into place, a hammer and two jets being used.

The erection of the viaduct and the two fixed spans presented no unusual features, the fixed spans being erected on falsework.

The methods used in erecting the lift span were somewhat unusual. By referring to Fig. 1 it can be seen that this span was erected on falsework, consisting of two wooden cantilever brackets which rested on the piers and were anchored at their tops to the adjacent spans. In this manner the lift span was erected at a sufficient height for the passage of vessels, this span being far enough above the old swing bridge to permit the operation of the latter. The two panels at each end of the lift span were supported by this cantilever falsework. The central panels were erected on falsework, which was constructed on top of the old swing span. Figure 1 shows this falsework being taken down after the erection of the lift span. It was built on the swing span with that span in the closed position. When the center panels were ready to be erected the swing span was opened, and blocking was placed on top of the falsework; the center panels were then erected on this blocking. As soon as the lift span trusses were self-supporting, the falsework on the swing span was removed, and the latter span was again put into service.

The machinery was placed in position and all adjustments were made while the lift span was in its raised position. As soon as this span was completed and paved—it being the last portion of the bridge to be completed—the swing span was again opened, and the center members of the tower were removed so that the lift span could be lowered to its traffic position.

The light truss span, which connects the tops of the towers of the lift span and carries the 16-in. water main, was erected from the lift span when it was in its highest position. Figure 2 shows a view of the main portion of the completed structure, the bridge being finished during the early part of 1913.

QUANTITIES OF MATERIALS AND COST DATA.

The work was let in two lump sum contracts. The cost of the steelwork and machinery, delivered at the bridge site, including the engineering fee, was $236,271. The cost of the substructure and that of erecting the superstructure, including the engineering fee, was $298,900. The total cost of the bridge therefore was $535,171. This cost includes such items as painting, wiring, street car tracks, pavement, machinery houses, gates, and incidental expenses.

The following distribution of the cost of the bridge to the city, together with the quantities and unit costs, are substantially correct:

Superstructure:
- Structural steel in truss spans, 2,560,000 lbs. at 4.1 cts.
- Structural steel in towers, 420,000 lbs. at 4.1 cts.
- Machinery on lift spans and towers, 182,000 lbs. at 13.7 cts.
- Cables and attachments, 42,000 lbs. at 17.5 cts.
- Metal in counterweights, 48,000 lbs. at 4.1 cts.
- Concrete in counterweights, 400 cu. yds. at $9.35.
- Motors and electrical equipment, total cost, $8,000.
- Creosoted timber, at $48 per M.B.M.
- Untreated timber, at $28 per M.B.M.
- Structural steel in approaches, 4 cts. per lb.

Substructure:
- Concrete in pier shafts, 4,300 cu. yds. at $10.00.
- Concrete in pier bases, 6,800 cu. yds. at $17.50.
- Piling for foundations, 33,000 lin. ft. at 40 cts.
- Concrete in pedestals under viaduct, $9.00 per cubic yard.
- Concrete in abutments, $10.00 per cubic yard.

The City Waterway Bridge was built for the city of Tacoma, Wash., Mr. Owen Woods, commissioner of public works, and Mr. W. C. Raleigh, city engineer. The bridge was designed and its construction was supervised by Waddell & Harrington, Kansas City, Mo., to whom we are indebted for the data contained in this article. The machinery and steelwork for the superstructure was furnished by the American Bridge Co. The substructure was built and the superstructure was erected by the International Contract Co., Seattle, Wash.

Sewerage

Features of Design and Financing of the Sanitary Sewerage System and Treatment Works at Vincennes, Indiana.

In November, 1913, a new system of sanitary sewers with arrangements for screening and sterilization were completed at Vincennes, Ind. Some of the details of design and financing are out of the ordinary and are, consequently, of general interest to sewerage engineers. The provision made for sewer ventilation, the design of the devices for sterilization and dispersion through a discharge pipe with multiple outlets in the Wabash River, and the construction by private funds under a municipal purchase agreement, are especially noteworthy. These features were made the subject of a paper by Mr. Robert C. Wheeler before the recent annual meeting of the Indiana Sanitary and Water Supply Association. The major portion of the paper follows:

Vincennes, Ind., is located on the east bank of the Wabash River, about 117 miles southwest of Indianapolis. The topography is very flat and the land slopes gradually downward away from the river. The area inside the city limits is about 2.75 square miles and the total difference in elevation between the extreme high and low points is not over 13 or 14 ft. The population in 1910 was 14,895 and the assessed valuation about $8,200,000.

Vincennes is a railroad center and a good business town, but in 1912, when this work was commenced, it did not have more than four or five miles of sanitary sewers, privately owned, and the greater part of the household waste was taken care of by means of cesspools and privies.

Owing perhaps to the fact that the city is built on a porous deposit of sand and gravel and that the public water supply is taken from the Wabash River and filtered, there has not been a serious epidemic of intestinal disease in recent years.

SEWERAGE SYSTEM.

In 1910, at the request of the State Board of Health, a movement was set on foot to obtain a sanitary sewerage system, and plans and specifications were made for a system to cover the whole city. This plan comprised about 60 miles of sewers, but owing to the difficulties in financing and other reasons, this was cut to about 40 miles, which cover the city very well, so far as it is built up at present. The system as constructed consists of about 40 miles of sanitary sewers, ranging from 8 to 30 ins. in diameter, a pumping station (as it is necessary to pump the sewage during the high stage of the river), sterilization works, and a submerged outlet with multiple orifices into the Wabash River. The pumping station and outlet into the river are about 1,700 ft. below the city limits, on a site which will be suitable for disposal works should further treatment become necessary.

The system is designed to have ample capacity, so that with future extensions it will serve the city when it shall have a population of 30,000, without paralleling existing sewers.

Disposal by Dilution.—The population of the larger towns and cities on the Wabash River watershed, above and including Vincennes, is about 175,000, and the dry weather flow of the Wabash River is approximately 2,000 cu. ft. per second at Vincennes. This is a dilution of 11 to 12 cu. ft. per second for each 1,000 of population located in the towns and cities of the watershed, which presumably will sooner or later have fairly complete sewerage systems. This ratio of dilution is considerably in excess of that legally established in the case of the Chicago Drainage Canal, viz., 3⅓ cu. ft. per second per 1,000 population.

This dilution is ample for the disposal of Vincennes' sewage, but care has been taken to prevent any possible nuisance at the outlet and to protect the people along the river below the outlet in case of an epidemic. There are no large communities for some ten miles below the outfall, and no communities taking water supply from the Wabash for more than thirty miles. Hence the freeing of the sewage from coarser solids and distributing it in the river in such a manner as not to cause local nuisance will probably be sufficient treatment for many years to come.

It seemed advisable, however, as an especial safeguard to the people below in case of an epidemic in Vincennes, to provide apparatus for applying a solution of hypochlorite of lime to the screened sewage when needed.

Screening and Sterilization.—The sewage is passed through two sets of bar screens having clear openings of ⅞ in. and 7/16 in. respectively, to remove the coarser solids which would tend to injure the pumps, clog the distributing outlet, to collect and putrify on the river banks, or be offensive in the flowing stream.

The screen and suction chamber is so proportioned as to allow a detention period of from 10 to 15 minutes or more. This will give time for the hypochlorite to react and will generally allow the sedimentation of any particles which are so large that they would readily clog the orifices in the outlet pipe.

The apparatus for applying the hypochlorite solution consists of a chemical mixing box, two chemical storage tanks with electrically-operated agitators, an orifice box for measuring the amount of solution to be applied, and a perforated pipe for distributing the solution in the screened sewage.

It is proposed to use from 75 to 125 lbs. of the commercial hypochlorite of lime to 1,000,000 gals. of the partially clarified fresh sewage, depending upon the character of the sewage. The screenings will be burned in an incinerator in the pumping station.

Dispersion in River.—The distributing outlet consists of a 24-in. cast-iron pipe, extending into the river about 300 ft. In the last 120 ft. are located five double outlets 6 ins. in diameter and about 30 ft. apart.

The purpose of this type of outlet is, first, to discharge the sewage under the water even in time of extreme low stage, so as to mix