THE CEMENT ERA

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What Does Your Hauling Cost?

The infamous Increased Cost of Living has affected the horse as well as his owner—and the excess is added on to haulage charges.

The contractor who watches his costs closely is apt to have periodical spells of the "blues" over the large and increasing percentage of his money which goes for hauling.

He buys cement, stone, sand and other naterials at a reasonable price at the car, he mill, the warehouse, the pit; but by he time they get onto the job the figure as gone up amazingly.

And it worries him.

In this issue we will try to tell, as well s we can, some of the economies which an be effected in the hauling of materials y the use of motor trucks.

We are willing to confess that this tory of the motor truck has almost caried us off our feet. Our original thought as to have it occupy a page at most, elling you what our class of readers *might o* with this means of transportation. We xpected to have to raw most of it from ur imagination, our revision, our inner con-iouness. We expected be compelled to generlize, to philosophize.

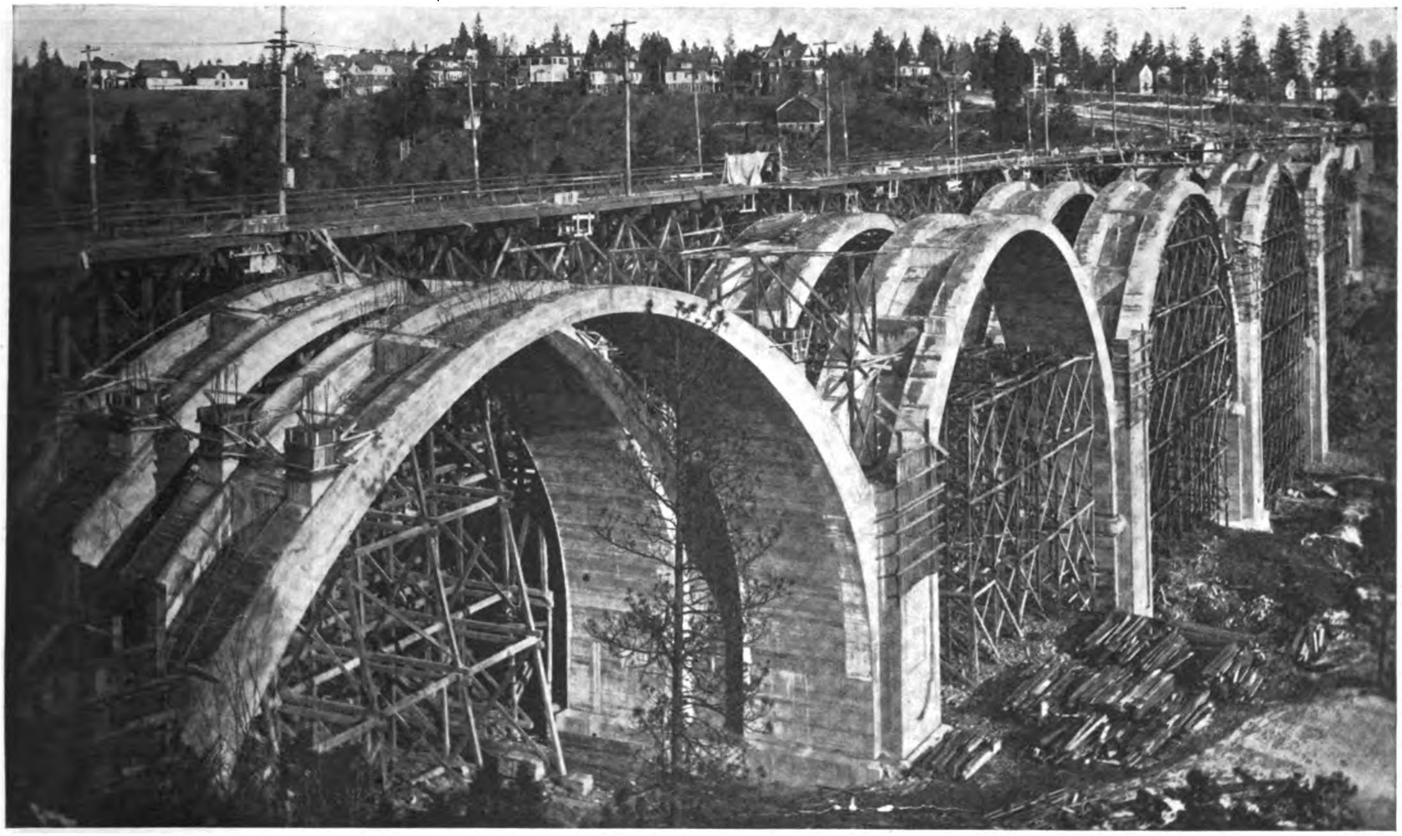
Instead, we have been almost overwhelmed with specific facts regarding what our clients actually *have done* with motor trucks.

This has been a revelation to us, and we believe it will be to all of our readers except the comparatively few who have alread abandoned the horse as out of date. It will serve as an inspiration to the large majority, showing them possibilities which they have not thought of before.

The automobile as a pleasure vehicle may be only for the man who has money to spend freely; but our investigation seems to demonstrate beyond question that when the motor is attached to a working body and put out on the job it can prove its economy every time.

We have found it to be a tremendously big subject. But we have delighted in digging into it—and we believe our readers will be interested in our presentation of it.

We have not exhausted the topic by any means, and shall very likely have more to say on it from time to time. Write us some of your own experiences—you who have used motor trucks. Send us photographs. Offer suggestions. Let us all together work out a means for an appreciable saving in the item of haulage for construction work.



Arch Ribs of Latah Creek Bridge, Spokane, Wash.

Latah Creek Bridge at Spokane

Long Series of Arch Ribs Makes Structure of Beauty and Economy

THE main ribs have been completed on the Latah Creek bridge at Spokane, Wash., as is shown by the accompanying illustration.

This bridge is one of the principal pieces of construction now in progress in the development of Spokane. It extends from the intersection of Seventh avenue and Winona street to Sixth avenue and Coeur d' Alene street, connecting the fast growing portion with the older and principal parts.

This bridge replaces an old wooden trestle which has about served its period of usefulness, being entirely inadequate to the service now demanded of it. The old bridge has been retained, however, until the new one can be constructed, as the traffic is such that it could not be taken care of if interrupted at this point. The new bridge is placed to one side of the old one, the latter being used also in part to handle materials and for general construction purposes.

The Latah Creek Valley is a beautiful wooded depression between basaltic cliffs, the creek lying about 150 feet below the surface of many of the streets on either side of the ravine and about the same distance below the surface of the bridge under construction. Standing on the present bridge or on the bridge under construction, one may see a great many miles up or down this ravine, and from points all the way from one to seven miles up and down the valley one may see this bridge, so that it is going to present a beautiful view when completed.

The bridge is of the rib type of construction, the main arches being composed of four ribs, the outer pair on each side being connected with a diaphragm wall. There are seven main arches, two of them being of 150-foot span, these flanked with two arches of 135-foot span. There is then one span of 128 feet, and the bridge is completed by a span of 54 feet at each end. On these main arches are constructed small spandrel arches, four of them on each arch, and on these a roadway system of slab and girder construction. The roadway is 45 feet wide and is built to accommodate a double track street railway. There is a 7-foot sidewalk on each side, and the bridge will also carry water mains, gas mains and all kinds of public utilities.

The concrete plant is located at the east end of the present bridge. It consists of a Smith No. 2 mixer, set under gravel and sand bins of about 200 yards capacity each. The sand and gravel are obtained from a pit not far from the bridge and are hauled to the bridge in two large Pierce-Arrow motor trucks, being dumped into a hopper from where the aggregate is elevated by bucket belts into the bins above. The concrete is then taken from the Smith mixer in dump cars by means of a gasoline motor, and transported to different positions on the old bridge, and spouted into place.

The arch ribs or rings are poured simultaneously and no attempt has been made to build up one arch and move the falsework to the other position for the other arch rib.

For the use of the contractor, a portion of the old bridge has been fenced off and traffic has been confined to the balance of the bridge.

The bridge will be completed with an ornamental concrete railing and concrete lighting standards.

The bridge will contain 24,700 cubic yards of concrete and about 700 tons of steel. The contract price is $416,000.

The construction of the bridge is under the direction of Morton Macartney, city engineer, Spokane, Wash., with Waddell & Harrington, Kansas City, Mo., as consulting engineers.

The Latah Creek Bridge, Spokane, Wash.

By J. F. Greene*

A concrete bridge of pleasing design and monumental size is now under construction across Latah Creek, in Spokane, Wash. As shown in the plan in Fig. 1, the new bridge is so located that its center line parallels an adjacent old timber trestle which is in such precarious condition as to demand replacement. The new line is curved at one end so as to connect two different streets on opposite sides of the valley.

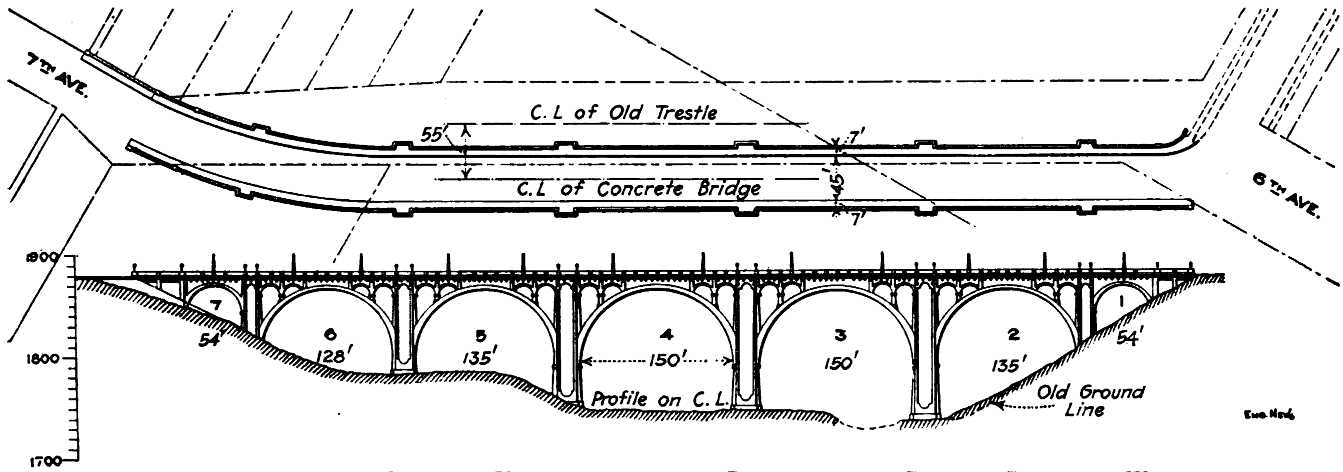


Fig. 1. Plan and Outline Elevation of the Latah Creek Bridge, Spokane, Wash.

The Latah Creek Bridge is 940 ft. long and consists of seven arch spans, varying in length from 54 to 150 ft. clear span. Two of the arches at the west end are on the curve; with their piers on radii. It has a 45-ft. roadway, with two 7-ft. sidewalks and carries a double track for heavy interurban railway cars. Each arch consists of four arch ribs, carrying the roadway slab on spandrel columns and arches.

In the determination of span lengths for the arches, architectural considerations were given much weight and an effort was made to effect a combination which was adapted to the ground line and site. The intrados and extrados curves are many centered, and were so laid out as to give a neutral axis which conformed very closely with the thrust line under dead load. The thickness of the arches are such that under any system of loads the line of resistance lies within the middle third, and the maximum stress is below 500 lb. per sq.in. Steel rods are added for temperature stresses.

Foundations—Before beginning the design, test pits were sunk which disclosed a bed of hardpan below the creek bottom and a very compact sand at other points. As a result of loading tests upon the sand, the maximum pressure of 6 tons per sq.ft. was determined upon and heavy reinforced-concrete spread foundations were designed for this condition. In Pier 1, located on the east bank, in addition to the base shown on the plan, a cut-off wall 10 ft. deep, 6 ft. wide at the top and 3 ft. wide on the bottom was built along the west edge of the pier. During excavation for this pier, the sand along the east face stood without sheeting for a depth of 30 ft.

Piers—The piers are of the box type, with solid longitudinal sections in line with the arch ribs and connecting curtain walls. Below the level of the sidewalks they are solid.

Arches—The arch ribs are spaced 16 ft. 6 in. c. to c. and in all the spans are 5 ft. wide for the outer two ribs and 6 ft. wide for the inner two. They vary in thickness with the length of the span. Each outer rib is connected to the adjacent inner one by a thin slab at the intrados, but the inner two ribs are not connected except by the floor slab. As shown in Figs. 2-3, this floor slab is of reinforced concrete, carried on beams between the arch ribs and the spandrel arches and dropped down below level to allow space for the railway track. A waterproofing mat consisting of three alternate layers of burlap and asphalt cover this slab; a waterproofing cover of 2½ in. of concrete and a 1-in. sand cushion for 4 in. creosoted-wood blocks rest on top.

The two arches on the curve are of interesting design. In them the piers are on radial lines and the four arch ribs are straight, parallel and of varying length, as shown

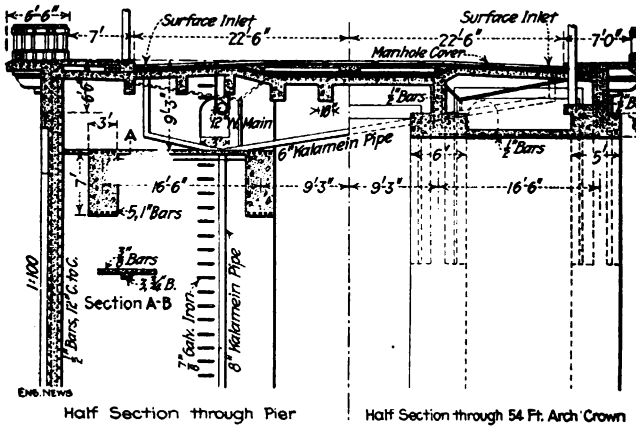


Fig. 2. Cross-section through Floor of Typical Arch

in Fig. 3. The curve is made in the transverse floorbeams spanning across the longitudinal beams, which are in line with and above the arch ribs.

Expansion Joints—In the spandrel walls, expansion joints are provided at the ends of each panel and concealed behind pilasters. The design of spandrel arches is one about which there is considerable difference of opinion among engineers. In the Connecticut Ave.

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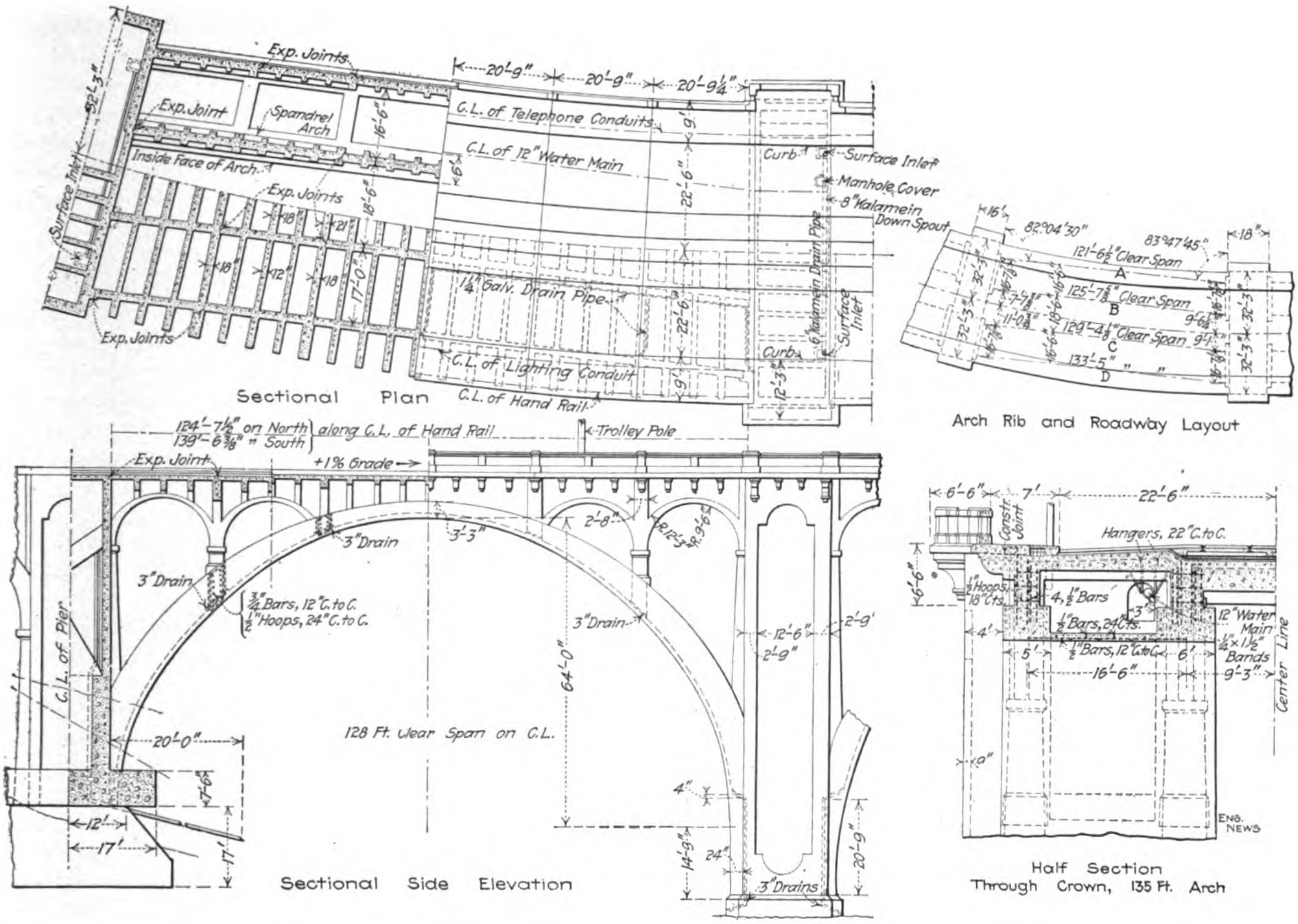

Fig. 3. Details of Arch on Curve

Bridge, at Washington, D. C.,* and the Monroe St. Bridge at Spokane,† the simple treatment of the longitudinal faces of spandrel walls eliminated pilasters for concealing expansion joints. A fall in temperature, which lowers the main arch, draws the spandrel arches away from the piers, provided that there are no joints between the pier and crown of the arch.

In the Connecticut Ave. Bridge joints were left at the crown of each of the spandrel arches, which are visible at a distance of several hundred feet. On the Monroe St. Bridge, joints were placed at the third points and steel enough placed in the walls from joint to joint to take up the thrust of the two outside arches. Unconcealed joints are unsightly and even concealed joints are objectionable because it is exceedingly difficult to prevent leaks from these points.

Minor Details—Surface drains are provided at each pier and sub-drains for the expansion joints lead into these main drains. Provision has been made for a 12-duct line for the Washington Water Power Co., an 8-duct line for the telephone company; for a 12-in. water main, and for a 12-in. gas main. Ornamental cast-iron posts resting on a concrete handrail support lights on the piers.

Construction

Materials—The aggregate, consisting of screened gravel, ranges in sizes from 2½ to ¼ in. with an average percentage of voids equal to 37. The sand, screened from the same pit, is well graded and with a uniform percentage of voids equal to 33. At times owing to the difficulties of hauling over wet roads or a demand in excess of the capacity of the gravel plant, a crushed rock, showing voids of 45%, was used.

To eliminate the necessity for excessive cement-storage capacity at the bridge, an inspector was sent to sample the cement placed in storage at the mill, the cement being shipped upon the expiration of the time required for 30-day tests; and this cement was frequently taken directly from the cars to the mixer, thereby eliminating rehandling.

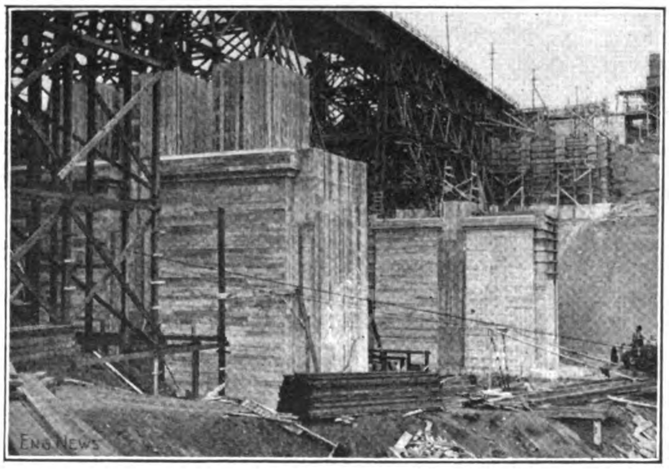

Fig. 4. View of Piers during Construction

*"Engineering News," June 1, 1905, p. 571.
†"Engineering News," Sept. 2, 1909, p. 241.

PLANT—The concrete plant is located at the east end of the bridge and consists of a storage bin for sand and rock, a half-yard batch mixer, a cement shed of 2000 bbl. capacity located on a railroad siding, and adjacent to the mixing plant, and an industrial railway running along on the south half of the trestle with turn-outs, and hoppers for depositing the concrete in the arches and piers.

LAYING CONCRETE—The concrete after mixing, was loaded into a train of two two-yard side-dump cars and drawn to the proper location by a gasoline locomotive. After dumping through holes cut in the deck of the old wooden trestle, the concrete flowed through open steel chutes to place.

This method of concreting produced an atmosphere of continual turmoil with the contractor owing to a natural desire to use an excessive amount of water. The water was measured in a tank with a float attachment, controlled by a 2-in. valve, and the amount was under the control of the operator. Any tendency of the concrete to stick in the mixing hopper or in the cars, or to clog in the chutes, is most readily offset by the addition of water, and a fluid mix requires little or no handling upon final deposition. During the construction of the piers, which contained about 40 yd. of concrete for each lineal foot of depth, the concrete was placed in layers of a foot at a time and an interval of an hour would elapse between the completion of pouring upon a section and the beginning of another pouring upon the same section. During this interval any excessive water in the concrete would rise to the surface and lie in pools thereon. Such a condition resulting from this or other causes is bad for several reasons. First, because this water, standing long enough to clear, deposits a layer of scum or laitance such as one may see upon a pier deposited under water; secondly, the new concrete crowds the water ahead of it, and this water in its movement washes the cement from the aggregate over which it passes. If it passes near a form, even though that portion of the concrete be spaded, streaks of wash sand will be visible upon the removal of forms. If the mixture as it is being deposited is so liquid that it will flow into place with little or no shoveling, it is very probable that there are pockets of grout, and of rock, and that there is not a uniform aggregate. Whether concrete poured with an excess of water, such as one sees on many of the jobs in which the chuting system is employed will equal in life that which just quakes under foot and no more, time alone will tell.

Under the system of inspection adopted, one man placed at the mixer, watched the measuring and mixing, checked the receiving and use of cement, and took void tests on sand and rock at two-hour intervals during the runs. From these void tests the quantity of concrete placed each day was determined and checked against the estimated amount of the run figured from the dimensions in place and a variation of more than 1% was investigated. A second inspector, located at the point of placing supervised the spading and working up of the concrete.

METHOD OF CONCRETING—The arches were concreted with voussoit sections, eight to each pair of ribs, and three keys, one at the crown and one at each third point. Each of the third point keys contained a 12x12-in. reinforced-concrete strut as a hinge. In every case, owing to the settlements of the falsework, these struts developed open cracks on the top side. The keys were composed of the same aggregate, 1 : 2 : 4, as the rest of the arch ring, but were placed very dry to reduce shrinkage.

In the process of concreting, the crown sections of the arches were placed first. As several of the arches were upon filled ground and settled 0.06 ft. under load, and as under this rib system no provision had been made to relieve the compression of the ribs owing to the settlement, there was a bulging at the third points which had to be relieved.

FORMS—The forms for the piers consisted of panels 5 to 7 ft. high, with vertical sheeting, 2x10-in. tongued-and-grooved pieces, and 3x8-in. horizontal waling spaced 4 ft. c. to c. The walings are tied by twisters of ¼-in. galvanized wire spaced 4 ft. c. to c., pulling against spreaders which are inserted between forms and removed as the concrete level rises. An objection to vertical sheeting on pier work is that the vertical board marks accentuate the horizontal joint marks between different day's runs.

The side forms for the arches were framed on the ground in panels with both the extrados and intrados cut to curve. These forms were tied together across the top with 2x8-in. planks, cleated to the lagging at the bottom and tied with galvanized-wire twisters at an intermediate level. The forms for the inner walls of the arch ribs were held up by temporary legs resting on the lagging and were removed as the concreting progressed, the weight of the forms coming upon the 2x8-in. ties which connected the outer forms. The lagging for the extrados was nailed on the backs of the side forms.

FALSEWORK—The falsework consisted of 8x8-in. posts spaced about 14 ft. centers longitudinally, and 5 ft. centers transversely. Upon these posts were placed corbels, 3 ft. long cut to curve, over which was built up a rib consisting of seven planks 1⅝ in. by 12 in. by 16 ft., nailed together and bolted with ⅝-in. bolts spaced 18 in. c. to c. It was intended that these ribs should carry the load to the posts by arch action, and provided that the ends of the ribs could have been fixed, there was sufficient section to do the work safely. During the process of adjusting the lagging it was found possible to take the arch out of these ribs with light wooden wedges, and in view of this, the contractor was required to reduce the spans of the ribs to one-third the original length by inserting 4x6-in. struts running from the bottoms of the ribs to the adjoining posts.

The erection of falsework was undertaken upon Arch 6 first, located at the west end of the bridge and upon a curve. This arch has a span of 128 ft. on center line, with its west face at springing line upon a radial line forming an angle of 82° 4′ with the center line. Both of these conditions, namely the beginning of the work and the peculiarity of the span, combined to make the unit cost of erection of falsework in this span 3.2 times that of Span 4, and the labor cost on forms 1.4 times that of Span 4. From a standpoint of economy, it seems evident that radial piers are not desirable.

CONSTRUCTION METHODS—A comprehensive cost report of the job has been kept; a daily report, embracing total quantities and cost for each individual portion of the work, and a monthly report upon which the totals for the month are drawn off, the unit pieces for the different classes figured and the percentages of the completed portion to the whole estimated. Duplicates of all reports are made, one copy for use at the bridge, and one for the city engineer's office files.

A diary is also made out daily containing a record of accidents, discussions and disagreements, and whatever else that might prove of use or interest.

Personnel

The contractor for the bridge is J. E. Cunningham, of Spokane; the contractor's superintendent, J. C. Stack. The design and construction of the bridge were under the direction of Morton Macartney, City Engineer, the design having been made by W. S. Malony, and checked by Waddell & Harrington, Consulting Engineers, of Kansas City, and the construction in charge of J. F. Greene, with W. H. Fisher as assistant. The contract price for the whole structure was $416,000.

A 200-Mile, 90,000-Volt, Direct-current Power Transmission Project in Sweden and Denmark

The Danish government, to meet the increasing demand for electric power in Copenhagen, for some time has been negotiating with the Swedish government for the sale and transmission of electric current from the new large hydro-electric station recently built by the latter at Trollhättan. The report of the engineers, retained by these governments to study the feasibility of the project, has now been made and is abstracted in the *Electrical World* of Feb. 8, from which the following is arranged.

Line of the Proposed Trollhatten-Copenhagen 90,000-volt Direct-current Transmission Line

The Trollhättan plant is now equipped with eight 10,000-hp. turbine units, with space provided for two more of the same capacity. It is proposed to transmit to Copenhagen this spare 20,000 hp. At the outset additions to the existing steam plant were considered, but it was found that the cost of generating such a local supply would be made up of a fixed annual charge of $5 per kw., plus 0.4c. per kw.-hr.

In order to make the transmission project feasible, a nearly continuous load was found necessary on account of the large expenditure in the transmission line. It was found that about a third of the local maximum demand, or 11,600 kw., could be maintained during 5200 hr. per year, or for some 14 hr. per day, giving a load factor of nearly 60% for this portion of the local service. The 11,600 kw., with transmission losses, corresponds to about 20,000 hp. at the Trollhättan plant, and this would absorb the output of two generating units not yet installed.

The route of the proposed line, shown in the accompanying sketch map, would be along the west coast of Sweden, from Guthenburg to Helsingbörg over the Strait of Oresund to Helsingör, and along the coast of Den-

Estimated Cost of Generating and Transmitting Electric Power; Trolhattan-Copenhagen Project

	Alternating Current Cost of Installation	Alternating Current Annual Expenses	Direct Current Cost of Installation	Direct Current Annual Expenses
Generating station:—				
Two 10,000-hp. turbines and auxiliaries	$81,000	$7,600		
Three-phase generators	70,500	6,600		
Transformers at Trollhättan	31,500	2,950		
Switch gear	27,000	2,650		
Wages, oil and supplies	....	3,200		
	$210,000	$23,000		
Changes for turbines			$40,500	$3,400
Isolating machinery			2,700	200
			$43,200	$3,600
Four 5000-hp. turbines			$81,000	$7,600
Direct-current generators and auxiliaries			216,000	21,400
Wages, oil and supplies			....	3,200
			$297,000	$32,200
Transmission line:—				
Iron poles, including erection, at $1350 per mile	$275,000	$27,200		
Insulators, at $390 per mile	80,000	7,900		
Iron cable, at $87 per mile	17,900	2,500		
Copper conductors, at $1525 per mile	310,100	21,000		
Wages for linemen	....	2,200		
	$684,000	$60,800		
Poles, including erection			$125,100	$13,000
Insulators			31,900	3,200
Iron cable			17,800	2,500
Copper conductors			166,200	11,300
Wages for linemen			....	2,200
			$341,000	$32,200
Three transformer stations:—				
Buildings	$40,500	$3,400		
Transformers	81,000	7,600		
Instruments	30,500	3,000		
Auxiliaries	40,500	4,200		
Wages and supplies	....	4,000		
	$192,500	$22,200		
Submarine cables:—				
Four cables, each 3.4 miles, at $5780 per mile	$78,600	$14,200		
Loading on steamer, laying and splicing	20,000			
Freight and marine insurance	5,400			
Anchorage at cables	9,500			
	$113,500	$14,200		
Two cables, each 3.4 miles, 150,000 circ. mils			$24,600	$5,400
Laying of cables, etc.			18,900	
			$43,500	$5,400
Frequency-converter station:				
Three frequency changers, 25 cycles to 50 cycles; total 11,600 kw	$122,000	$11,400		
Switch gear	13,500	1,300		
Wages, oil and supplies	....	3,200		
Incidentals	27,000	3,200		
	$162,500	$19,000		
Direct-current motors and auxiliaries			$221,000	$22,000
Three-phase generators			51,500	4,800
Switchboard and switch gear			10,800	1,100
Wages and supplies			....	3,200
Incidentals			54,000	6,200
			$337,300	$37,300
Incidentals	$231,500	$24,100	$140,000	$14,400
Total	$1,593,000	$163,300	$1,202,000	$125,100
Total per kw.	....	$15.66	....	$11.16