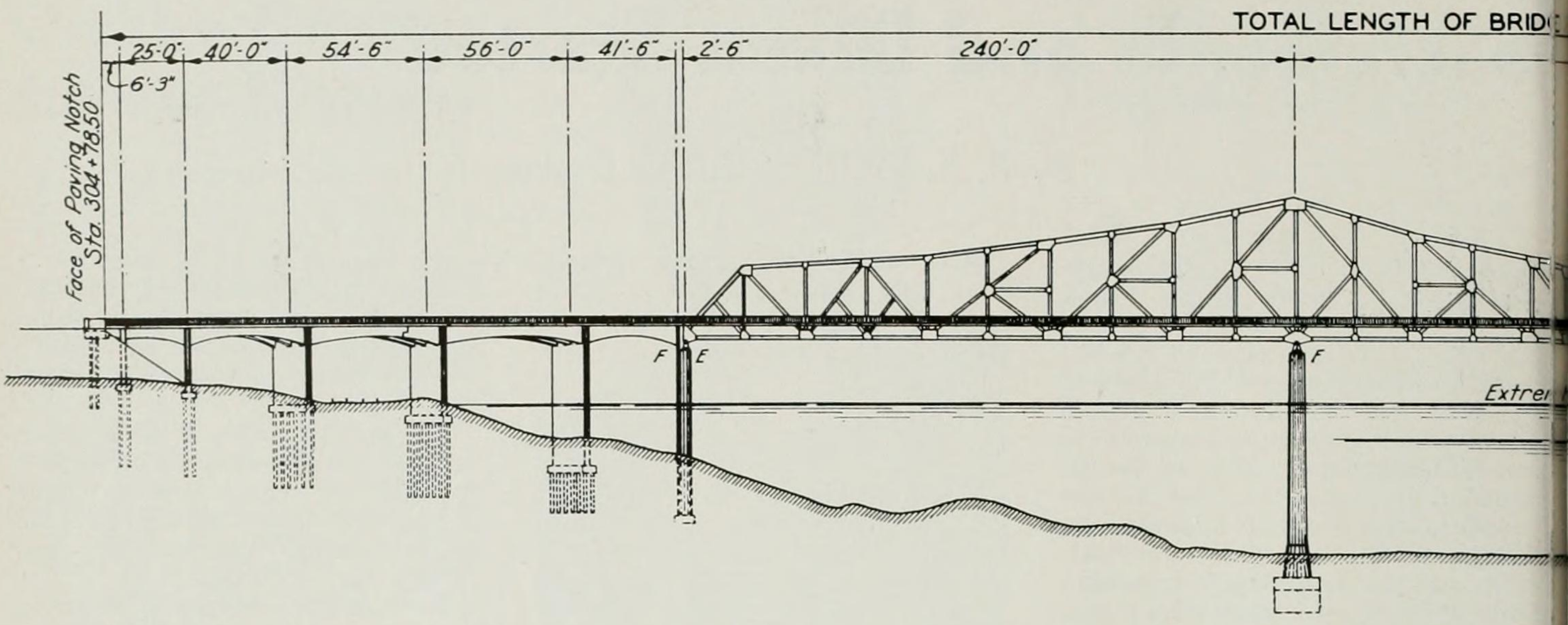
Two Steel Bridges Under Construction Across E



By A. J. MEEHA

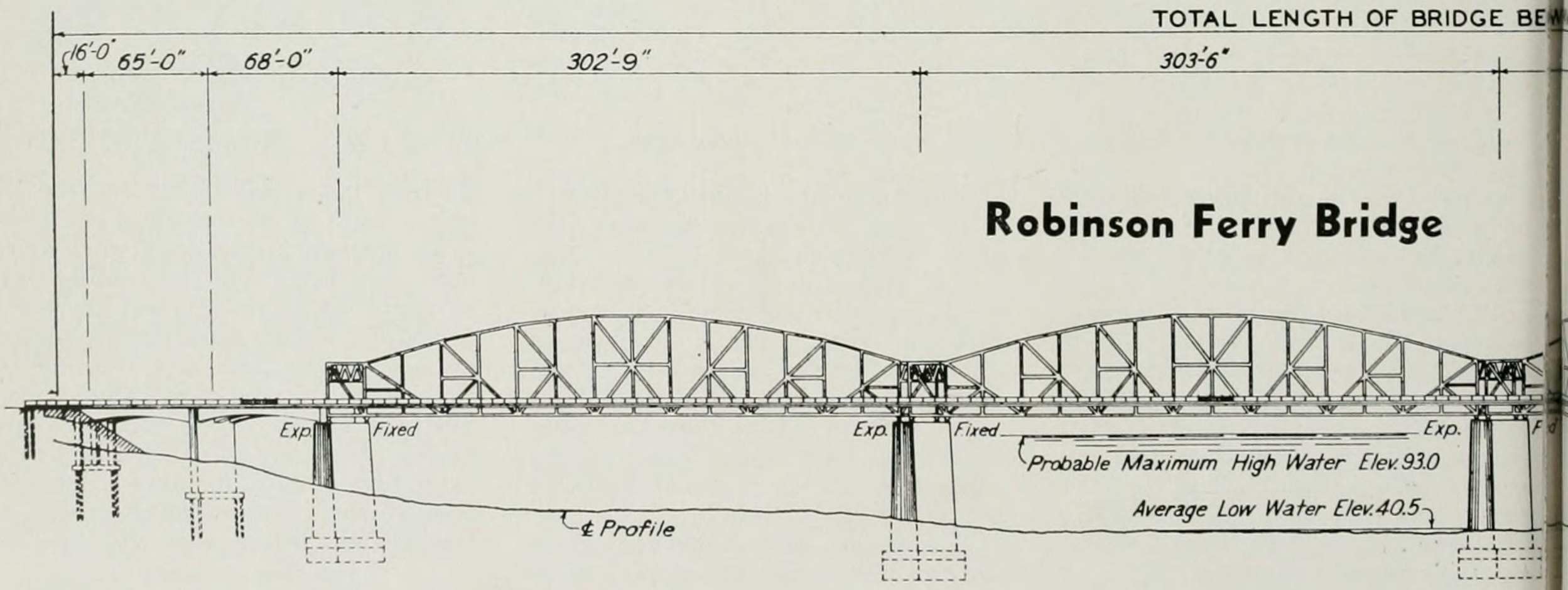
MOTORISTS driving north from the town of Scotia in Humboldt County on the Redwood Highway in July, 1941, will have the pleasure of traversing two new State bridges across the Eel River, contracts for which were awarded by Director of Public Works Frank W. Clark, last month.

One of the structures will be known as the North Scotia Bridge, crossing both the river and the railroad tracks of the Northwestern Pacific Railroad and the Pacific Lumber Company. The second structure, at a point about a mile farther on, will span the river at Robinson's Ferry. Between the two will be approximately three quarters of a mile new straight highway, which will materially shorten the existing roadway between the present antiquated bridges at Scotia and Robinson's Ferry, failure of which, due to truck overloading or speeding, would paralyze traffic, as there is no convenient detour.

For financing the new bridges approximately equal amounts of money will be contributed from Federal Aid and State funds. Incidental work will provide for grading, the installation of a conduit system for future lighting on the North Scotia Bridge and the ultimate removal of both the original bridges after detour use.

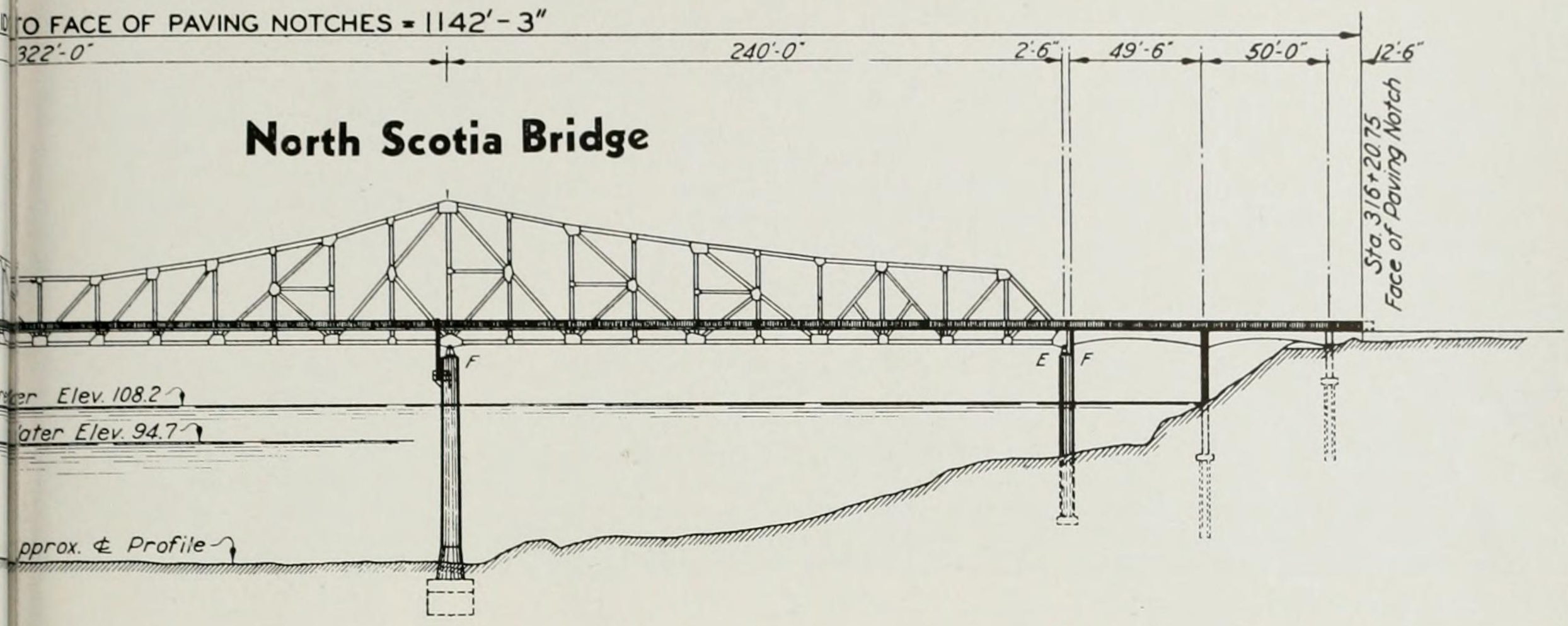
The bridge work was let in two contracts since each job was big enough to attract responsible bidders. Separate contracts attract more bidders and thus increase competition to the benefit of the State. They also speed up construction operations and open the projects earlier for public use.

On January 24, 1940, the low bid for the Robinson Ferry Bridge of



Robinson Ferry Bridge

ver on Redwood Highway in Humboldt County



ior Bridge Engineer

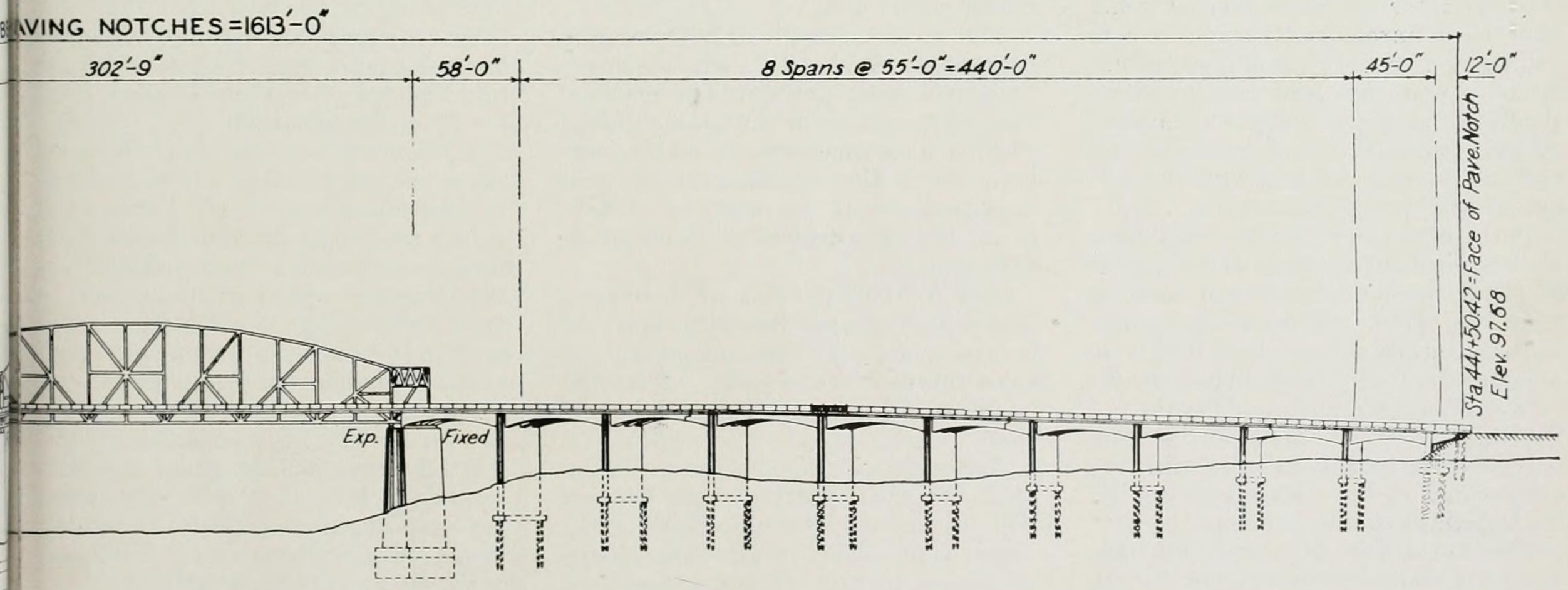
$455,580 was submitted by the contracting firm of Engineers Limited of San Francisco. On February 15, 1940, the low bid for the North Scotia Bridge of $330,000 was received from A. Soda & Son of Oakland.

In a rugged and almost inaccessible area five thousand feet above sea level in the San Hedrin Mountains of California's northwestern coastal range, the Eel River starts winding its way to the sea. The drainage basin of the Eel River is approximately 3100 square miles, much of which, being generously timbered, presents a drift problem at bridges. Normally the annual rainfall is one hundred inches in the upper fringes of the watershed. The casual observer is apt to judge the "might" of a stream by its width and in the case of the Eel River would easily overlook its potentialities.

However, Bridge Department hydrologists, after a detailed study of the region, report that the natural phenomena there are capable of startling possibilities. For example, with a simultaneous runoff from all forks of the river, the discharge forecast is the rather large, but not improbable, flow of 370,000 cubic feet per second for one hundred year cycles.

As a measure of flow comparison, the Sacramento River at the Capital City has an estimated maximum discharge at irregular intervals of approximately 100,000 cubic feet per second. Near Needles, California, the unregulated flow (unpublished) of the Colorado River is about 370,000 cubic feet per second at 65-year intervals.

The winding course of the Eel River



has been the arch foe of the motorist and the highway engineer alike by impeding the direct travel of the motorist and by presenting natural obstacles, costly to overcome, to the engineer who has the welfare of the motorist at heart, but whose efforts to help are woefully handicapped by insufficient highway funds.

Throughout the years, the Division of Highways has built and maintained the Redwood Empire Highway as it crosses and recrosses the Eel River and traverses many areas subject to slides. As funds became available, numerous improvements have been effected.

Previous to 1914, the crossing north of Scotia, in Humboldt County, was effected by means of ferrying and fording the river. Subsequent to this, were the county-built steel structures at North Scotia and at Robinson Ferry, one and a half miles north. These have long since outlived their usefulness. They have 17-foot roadways and for the past several years have been unreasonably expensive to maintain from the combined standpoint of painting, load and speed restrictions and the full-time employment of three shifts of watchmen on each of the two existing structures to enforce the posted limitations.

Both of the new bridges will have 26-foot roadways, ample for the next 20 years' traffic development in their vicinity. There will be a 4-foot sidewalk on either side of each bridge to accommodate the pedestrian traffic between the communities of Scotia and Rio Dell. The sidewalks on the truss portions will be cantilevered with the outer edges of the walks protected by steel railings of the baluster type.

The North Scotia Bridge will have three channel spans of structural steel, flanked by approach spans of concrete, whose footings will be supported on concrete piles. Access is provided to the interior of one of the main piers, where a self-recording water level gauge of the U. S. Geological Survey will be installed.

There is a certain similarity of layout in the plans of both bridges but the Robinson Ferry Bridge will be skewed throughout its entire length. Right angle crossings, as studied, revealed that while such a bridge would cost less in itself, the roadway approaches would be longer and introduce undesirable alignment conditions. The skew condition necessitated the use of "simple" type channel spans of steel, one end of each of which is "free" to move a small amount longitudinally. The floor panel lengths of these steel spans are so related as to secure "square" framing. This simplicity feature, and that obtained by masking the skew in vertical portals, has effectively reduced shop costs.

The river channel at both sites is bedrock overlaid with a shallow cover of gravel and cobbles. The original bridges here and in the vicinity have yielded long-time records which have been invaluable in determining the requirements of the new, as to adequacy of span lengths, foundation behavior, etc.

Due to the existence of developed real estate properties adjoining the bridge ends, it was impossible to raise the new grade sufficient for the adoption of the deck type of steel span.

Aside from the Robinson Ferry steel spans, all parts of both bridges will be of the "continuous" rigid frame type. This means that groups of spans—by the efficient disposal of a minimum amount of material in their make-up—will be so constituted, that their substructures and superstructures mutually interact to sustain loads.

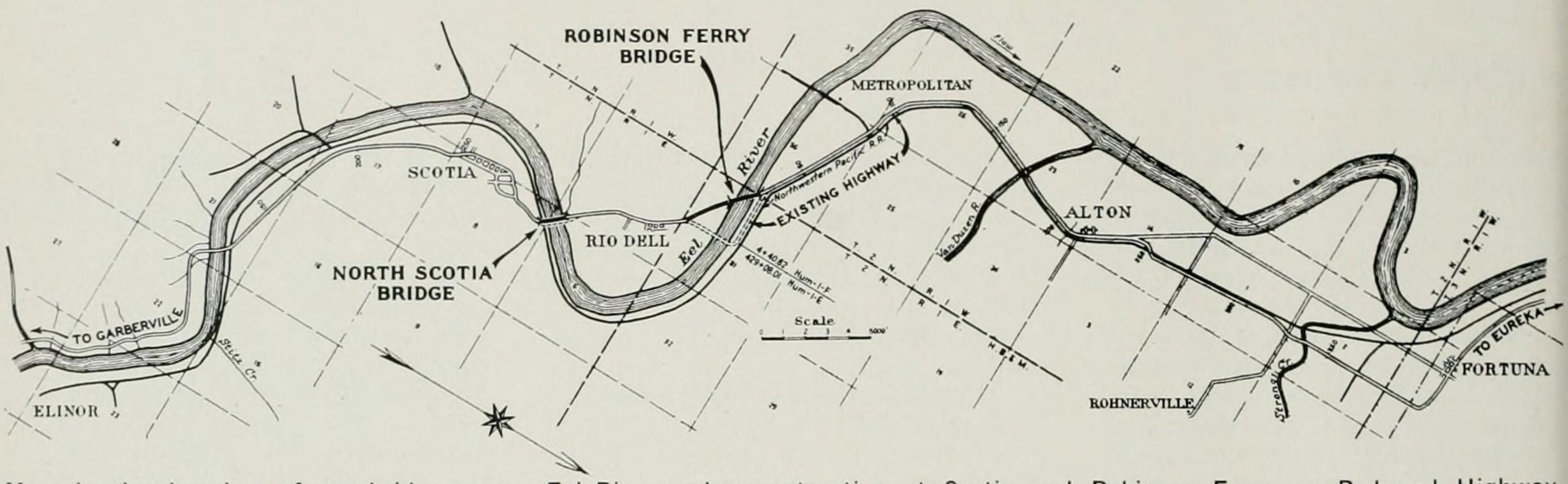
These structures were designed to support the maximum loading permitted by statute. The area in which they are situated has been the origin of numerous earthquakes, but these bridges will shake off earthquakes and laugh at "Ole Man River."

The contractors will be permitted to erect the main spans in the manner they choose, dependent upon their equipment and also upon the river stage at the time of field assembly. The spans are adaptable to erection by cantilevering, or by the use of falsework or a combination of these methods.

A new epoch of structural steel is at hand, employing alloy steels in a wide variety of uses. With sufficient price competition now procurable for these steels from nation-wide producers, most of the structural steel for these bridges has been selected from the alloy classification.

While this material initially costs more per pound than inferior steels, its adoption was predicated upon such ruling factors as self-liquidation from a corrosion resistant standpoint of less maintenance cost and reduction in dead weight due to its higher stress carrying capacity. Technically, numerous qualities may be enumerated in its behalf and difficulties of shop fabrication are not increased.

All bridge work is under the general direction of F. W. Panhorst, Bridge Engineer. The Designing Engineer of Bridges is L. C. Hollister, to whom the writer is assistant.



Map showing locations of new bridges across Eel River under construction at Scotia and Robinson Ferry on Redwood Highway.

City Chamber of Commerce.

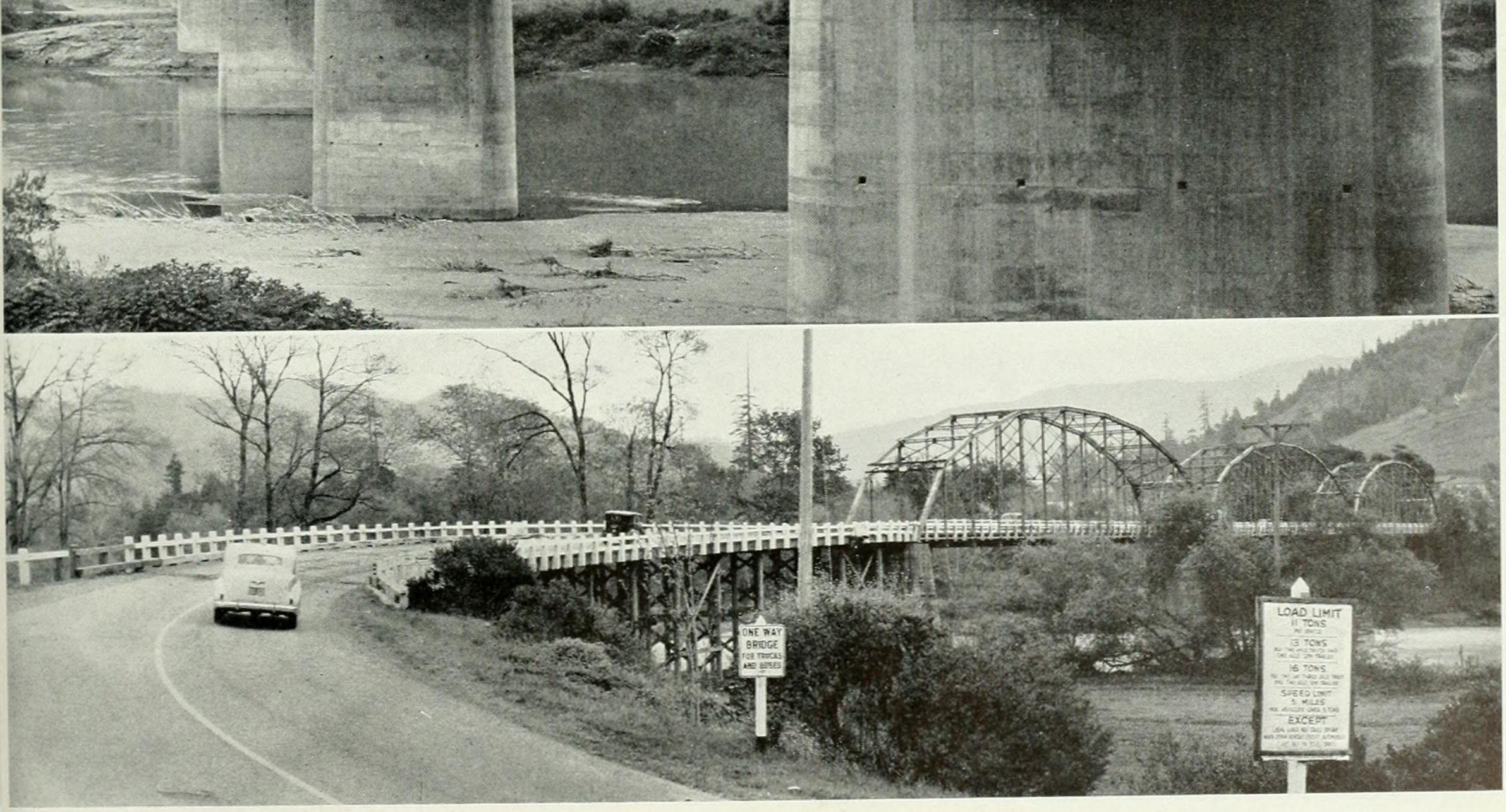
Following the address, the Indians and a group of Del Norte girls formed in two lines across the center of the bridge. Chairman Barrett then led his fellow commissioners and members of the official delegation through the "human barrier" and the Smith River bridge was officially dedicated to public traffic.

Later a buffet supper was served at the Oregon line with Supervisor McNamara and his board and the Chambers of Commerce of Crescent City and Smith River and the Chamber of Commerce of Del Norte acting as hosts.

Two years ago, in adoption of the State highway budget for the current biennium, the members of the Highway Commission selected as necessary improvements to the Redwood Highway, U. S. 101, the construction of several major bridges designed to forestall the possibility of bottlenecks restricting traffic flow over this popular route through the redwoods.

Included among these major structures were the bridges for the two crossings of the Eel River on both sides of Rio Dell, north of Scotia.

The Robinson Ferry bridge is the larger of these two structures across the Eel River, and is one of the most modern bridges on the State Highway System. Its overall length is 1,604 feet and, structurally, the bridge consists of three 300-foot steel truss spans, 12 reinforced concrete girder spans, totaling 676 feet, and two reinforced concrete cantilever spans of 12 and 16 feet respectively.



The massive structure shown above replaces unsafe Robinson Ferry Bridge across Eel River pictured below, posted for load limit

The spans are supported on reinforced concrete piers and bents. The roadway width of the concrete deck is 26 feet between curbs and the two sidewalks are each 4 feet in width.

NEW ALLOY STEEL USED

In the construction of both the Robinson Ferry bridge and the North Scotia bridge, Division of Highways Bridge Engineers effected considerable economy by the use of new and more scientific materials. The steel used in the large trusses of these bridges is a new structural alloy steel that has a strength one and one-half times that of ordinary structural steel and which is also much more rust-resistant. These factors mean economy in both construction and maintenance costs.

Approximately 2,520,000 pounds of this new structural alloy steel has gone into the trusses of the Robinson Ferry bridge. There are nearly 7,500 cubic yards of portland cement concrete and 945,000 pounds of bar reinforcing steel in the girders, piers, bents, and floor, and some 300 piles were driven for foundations of piers and bents.

$480,000 CONTRACT

The contract for the construction of this new crossing of the Eel was awarded by Frank W. Clark, Director of Public Works, on February 5, 1940, to the Engineers, Ltd., of San Francisco. The project has been financed by Federal Aid and State highway funds at a cost of about $480,000.

The North Scotia bridge is practically complete and is likewise a steel and concrete structure. In the case of this second crossing, the total length of the bridge is 1,137 feet, consisting of three steel truss spans with a combined length of 802 feet, seven reinforced concrete girder spans totaling 316 feet and two reinforced concrete cantilever spans with a length of 19 feet.

As in the case of the Robinson Ferry bridge the concrete deck of this structure is 26 feet between curbs and the sidewalks are each 4 feet wide.

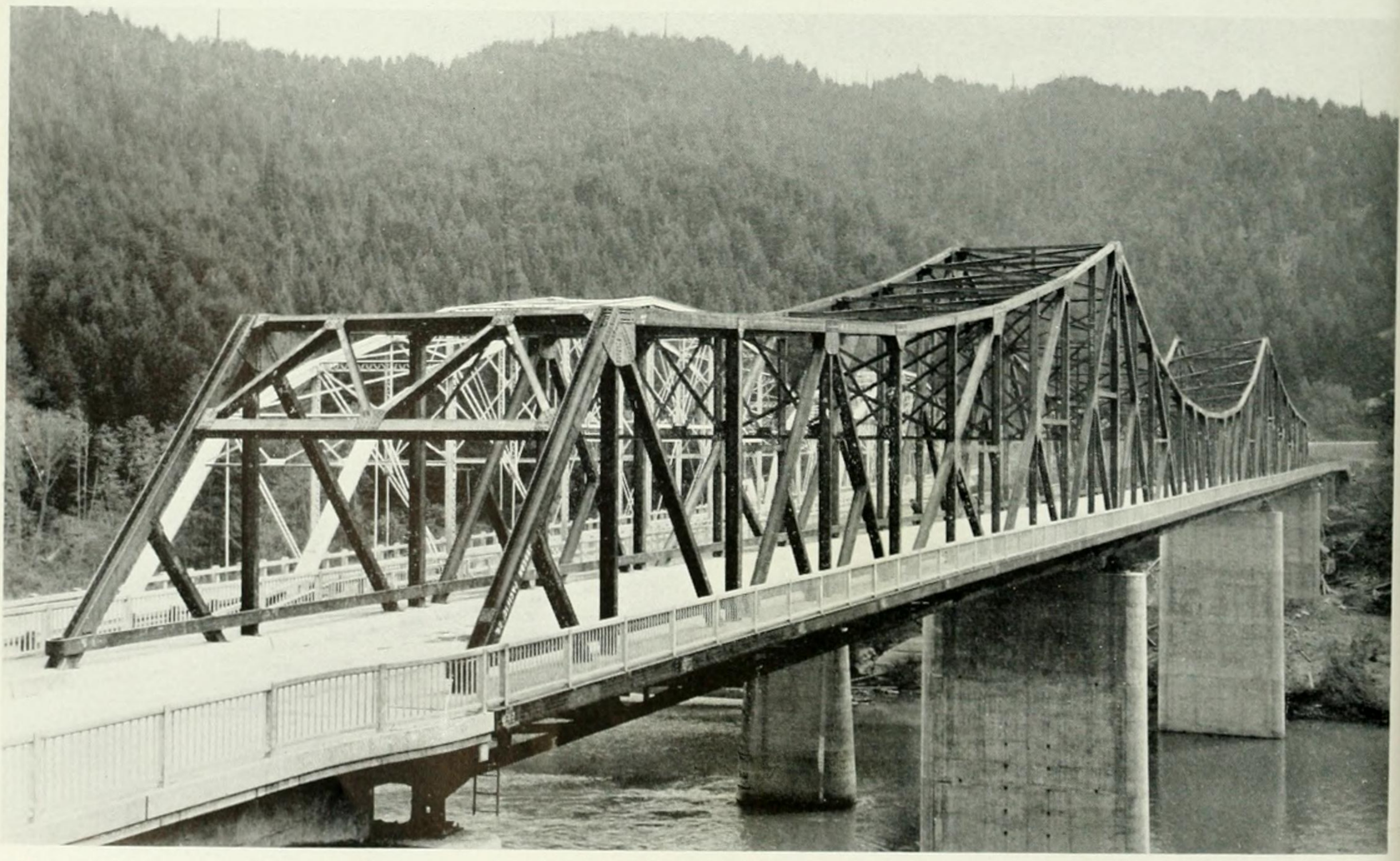
$348,000 CONTRACT

The same structural alloy steel was used in construction of this bridge as in the larger one at Robinson Ferry. The three truss spans of the north Scotia bridge required 1,950,000 pounds of structural steel and the concrete portions of the structure include 4,735 cubic yards of Portland cement concrete and 680,000 pounds of bar reinforcing steel. There are 137 piles as foundation support to the concrete piers and bents.

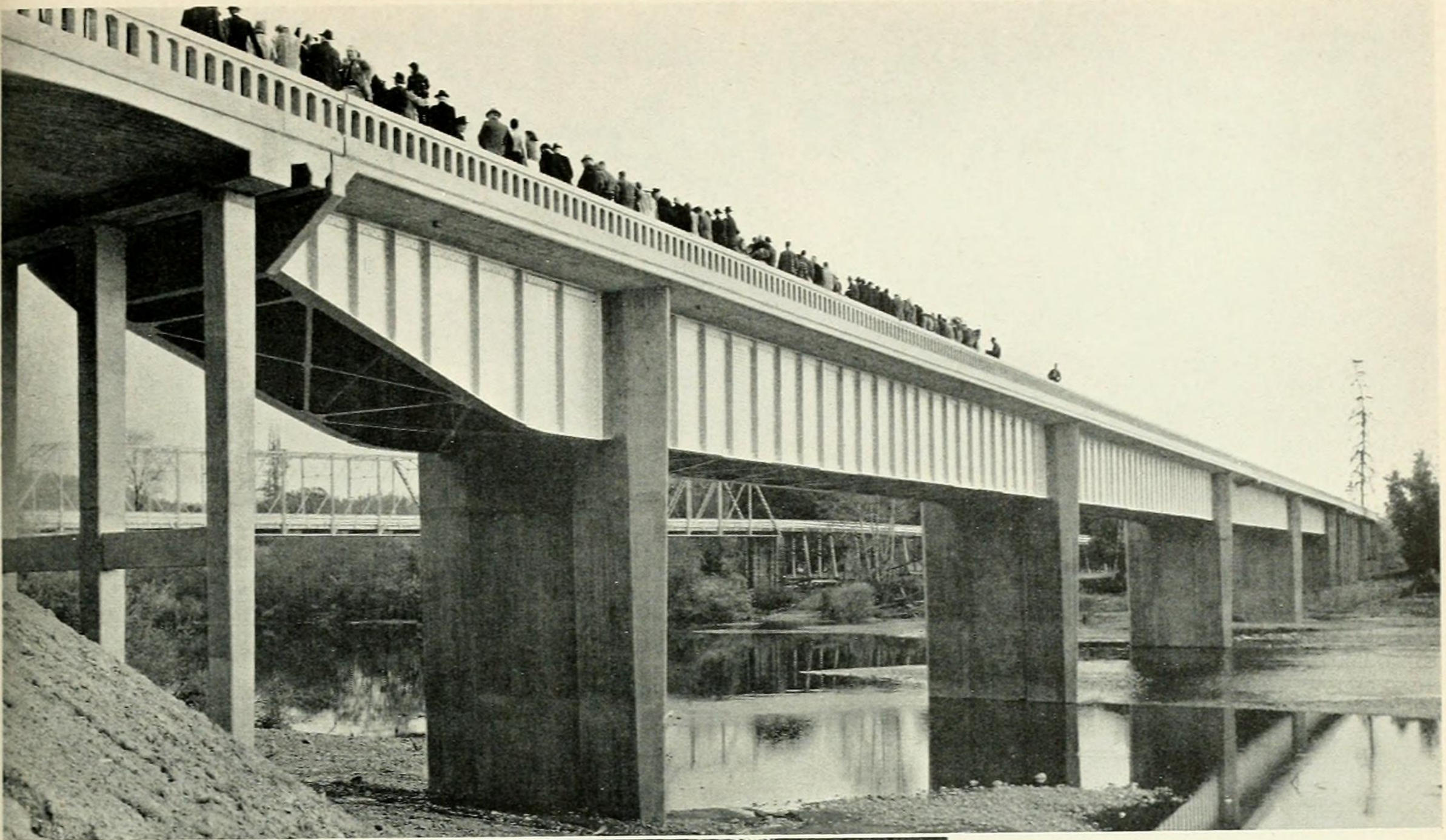
The contract for construction of the North Scotia bridge was awarded by Director Clark on February 20, 1940, to the firm of A. Soda and Son of Oakland. The cost of this bridge will amount to about $348,000 and the structure will be completed three months in advance of schedule.

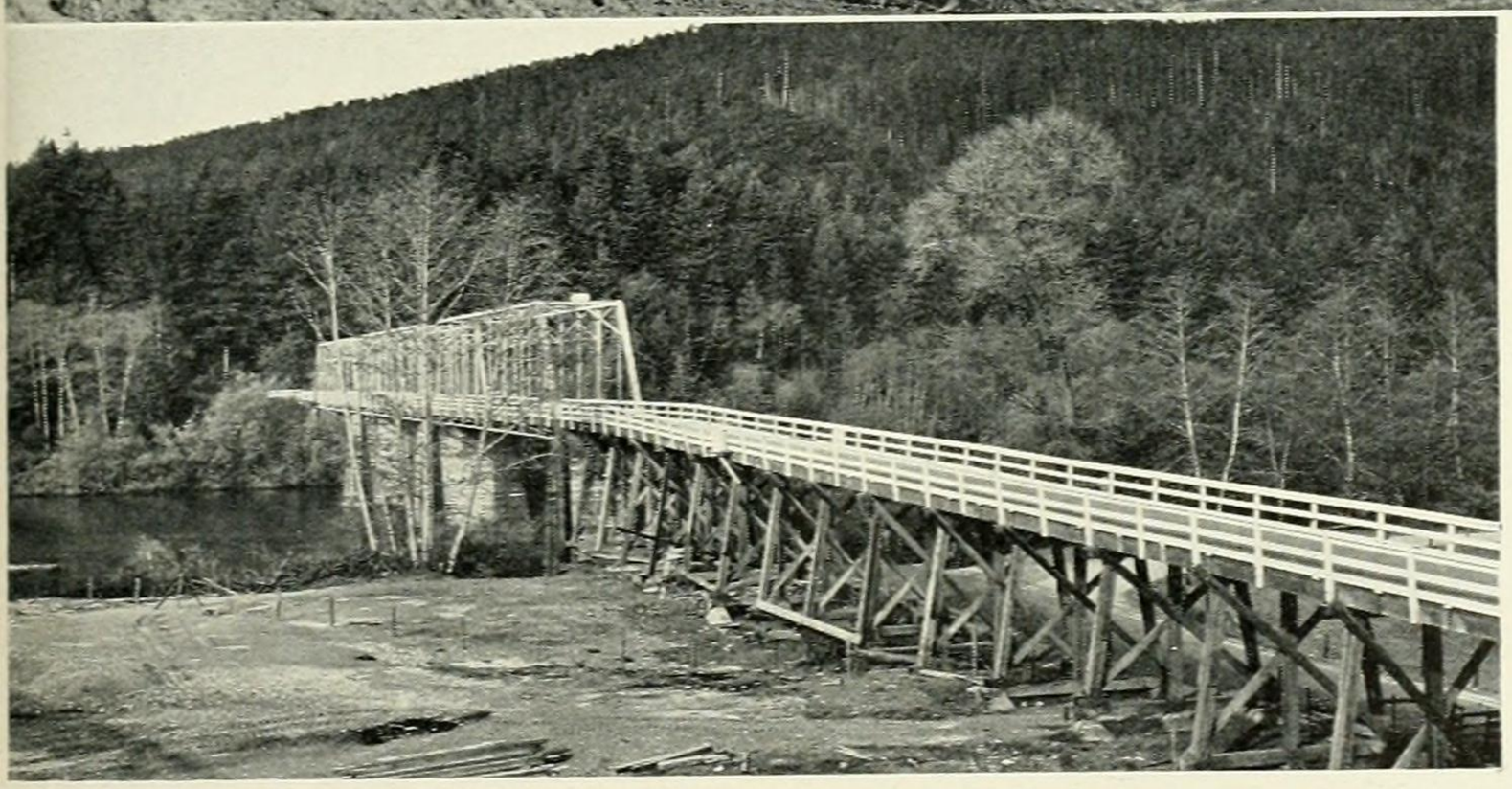
Construction operations on the approaches to the two bridges have been under way on the new line since June 20th, when a contract was awarded for grading and surfacing the permanent approaches and connections with the existing highway. There is included in the proposed budget, adopted by the Highway Commission on December 31st last and now pending before the State Legislature, a project providing $106,500 for grading and paving the 1.4 miles between the two bridges.

U. S. Highway 101 follows the



New North Scotia Bridge which supplants old span on the left that has been condemned as unsafe by Division of Highways





Contrasting views of new and old Smith River bridges exemplifying highway improvement in Del Norte County

Pacific shore line from Vancouver to the Mexican border and one of the most picturesque sections is that which lies along the rugged coast of Del Norte County.

Traffic over this route shows steady increases year by year and in keeping with the purpose of the California Highway Commission and the Division of Highways to steadily improve the portions located in Del Norte County, on January 11, 1940, Public Works Director Clark awarded to contractor Joseph Shaw a State highway contract for the construction of a steel and concrete girder bridge, together with the necessary approaches, across the Smith River, 9½ miles north of Crescent City.

ON REVISED ALIGNMENT

This new structure, placed on a revised alignment down stream from the old and narrow steel truss and timber trestle bridge, is a marked improvement to this section of U. S. 101.

The new structure is 1,050 feet in length and consists of four steel girder spans aggregating 660 feet, two cantilever steel girder spans with a total length of 90 feet, 12 reinforced concrete slab spans totaling 280 feet and four cantilever reinforced concrete slab spans.

The girders rest on reinforced concrete piers and bents on pile foundations and spread footings. The width of the concrete deck of the new bridge is 26 feet between curbs, which is a most decided improvement over the 16-foot width of the old bridge.

The construction of the bridge required 1,065,000 pounds of structural steel, and the 2,500 cubic yards of Portland cement concrete required 625,800 pounds of reinforcing bars.

Approaches to the new structure are three-tenths of a mile in length and the construction of the 30-foot roadbed necessitated the movement of 62,500 cubic yards of earth.

Some one told us that a C. E. ruined the mechanical calculator in the Drafting Room. He divided a number by zero and burned out the bearings.

First Maid: "How did you like working for that college professor?"

Second Maid: "Aw, it was a rotten job. He was all the time quarreling with his wife, and they kept me busy running between the keyhole and the dictionary."

Scotia Bridge

Parallel 2-lane Structure Corrects Traffic Deficiency

By GEORGE W. THOMSON, Resident Engineer

WITH THE opening of the South Scotia bridge over the Eel River on December 6, 1960, one more step was realized in the ultimate development of the Redwood Highway (U. S. 101) to freeway standards.

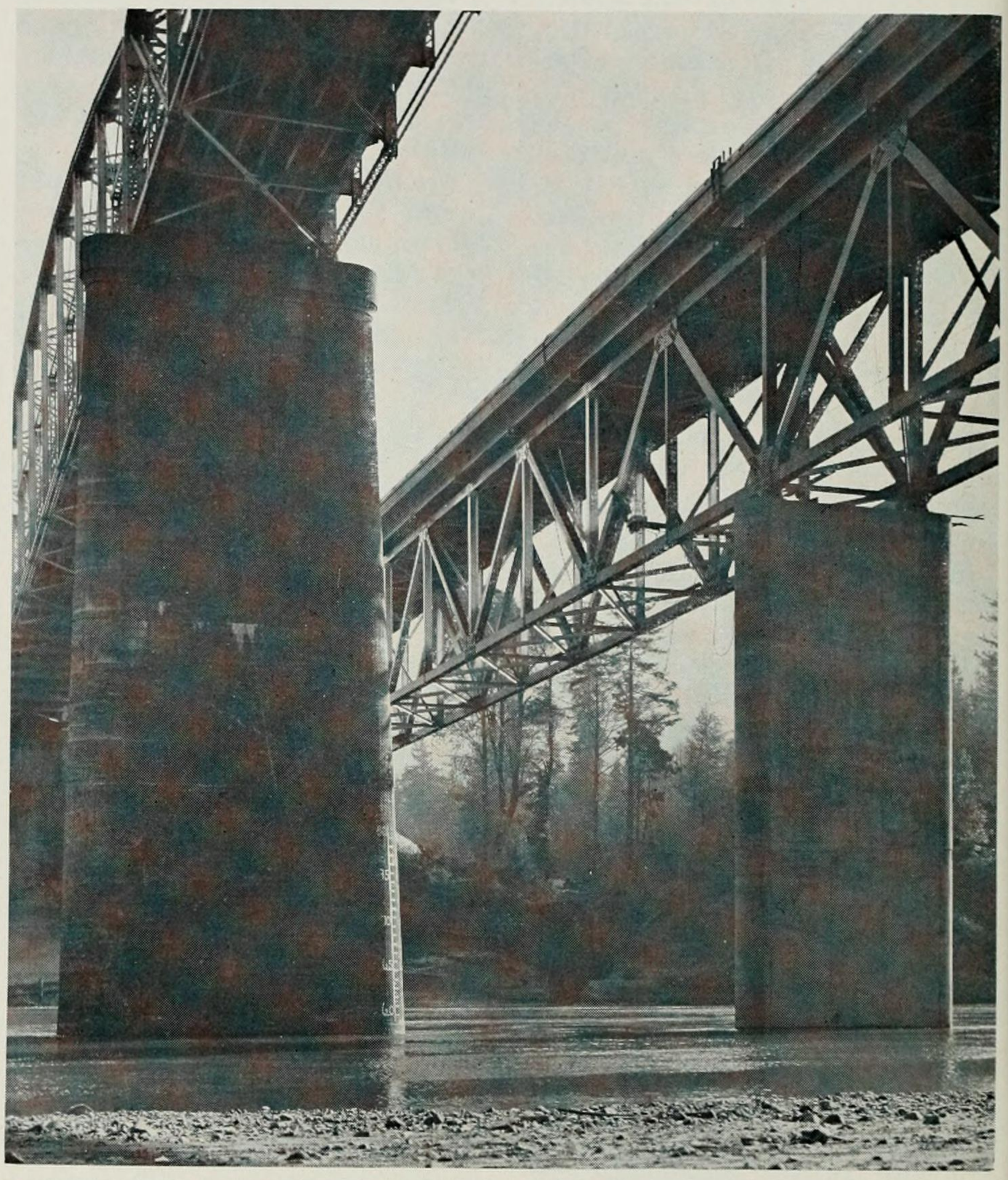
The project consists of a new parallel bridge with approach roadways 75 feet downstream from the existing Eel River bridge. The new bridge provides a 28 foot roadway for 2 lanes of southbound traffic while the existing bridge will continue in service providing one northbound lane. The project extends from 0.4 mile south to 0.2 mile north of South Scotia Bridge, approximately 3 miles south of the town of Scotia. The length of project is 0.72 miles.

The existing South Scotia Bridge was constructed in 1916 under State Contract No. 166 by Mercer and Fraser, Contractors, for the bid amount of $120,407. It consists of two 304-foot through pin-connected steel truss spans over the river channel, and reinforced concrete slab and girder approach spans, providing a minimum roadway width of 18 feet.

With the increase in size, weight, and speed of trucks over the years, it became necessary to post the bridge; this was done in 1937, consisting of "5 MPH on Bridge for Vehicles over 5 Tons"—it was also signed "One Way for Trucks and Buses". In 1940, the original timber deck on the truss spans was replaced with a reinforced concrete deck, and the structural steel floor system strengthened.

Some Structural Damage

On several occasions the truss members suffered structural damage, as the result of "tight squeezes" between logging trucks and cars meeting on the bridge. To protect the truss a pair of skid rails (corrugated metal plate guard rail section) were placed in 1952 on each side of the roadway, attached to the truss members at truck load height. Although the old bridge is structurally adequate for legal loads, the speed restriction posting for northbound traffic over the old bridge will remain in effect. Ultimately the old bridge will be replaced by a structure similar to the new bridge.



Under view of the new parallel South Scotia Bridge (right) over the Eel River. Located some 75 feet downstream from the old bridge (left), which was built in 1916, the new bridge is 1,000 feet long and has two spans (each 304 feet long) of continuous steel deck truss construction over the river channel.

The Eel River channel is about 600 feet wide at this location. Flow varies widely with season and run-off conditions. During the summer months the flow is only about 200 second-feet but during the winter rainy season it can be a different story. During the disastrous December 1955 flood the maximum discharge was estimated at 200,000 second-feet.

The new bridge consists of a two span continuous steel deck truss over

the river channel (2 @ 304′ 4″), matching the river spans of the existing bridge with welded steel plate girder approach spans (3 at each end of truss, averaging 64 feet). The total length of the bridge is 998′ 9½″. The alignment is tangent and parallel to the old bridge, except for a short section of curve to left at north end of the bridge. The first approach span on the north end of the bridge is over the single track mainline of the Northwestern Pacific Railroad, hence the structure designation "Eel River Bridge and Overhead".

Welded Sections

The Warren type steel deck truss has 10 panels @ 30′ 5″ per span. All members are welded H sections. Chords are parallel; truss depth is 30′ 0″; the 2 trusses are spaced @ 20′ 0″. A fixed bearing with 10″ diameter pin is used at center pier; rocker assemblies are used at end piers.

Two types of structural steel were used for the truss: ASTM Specification A242 for main stress carrying members with an allowance tension stress of 27,000 to 22,000 p.s.i. dependent upon plate thickness—the lower value for plates over 1½″; ASTM Specification A373 steel was used for all other members, with an allowable tension of 18,000 p.s.i. Both steels are suitable for welding the built up members. 510,000 lbs. of A242, and 663,000 of A373 steel were required. All connections are made with ⅞″ high strength bolts. The reinforced concrete deck is 6¼″ in thickness, and is supported by 5 stringers (27 WF @ 94) spaced @ 6′ 6″ per truss panel span. Floor beams and stringers are A-7 steel.

Approach spans consist of 4 welded steel girders, 39″ web depth, spaced at 8′4″ of A-7 steel.

The Bridge substructure consists of reinforced concrete abutments and piers on cast-in-place concrete and steel piling.

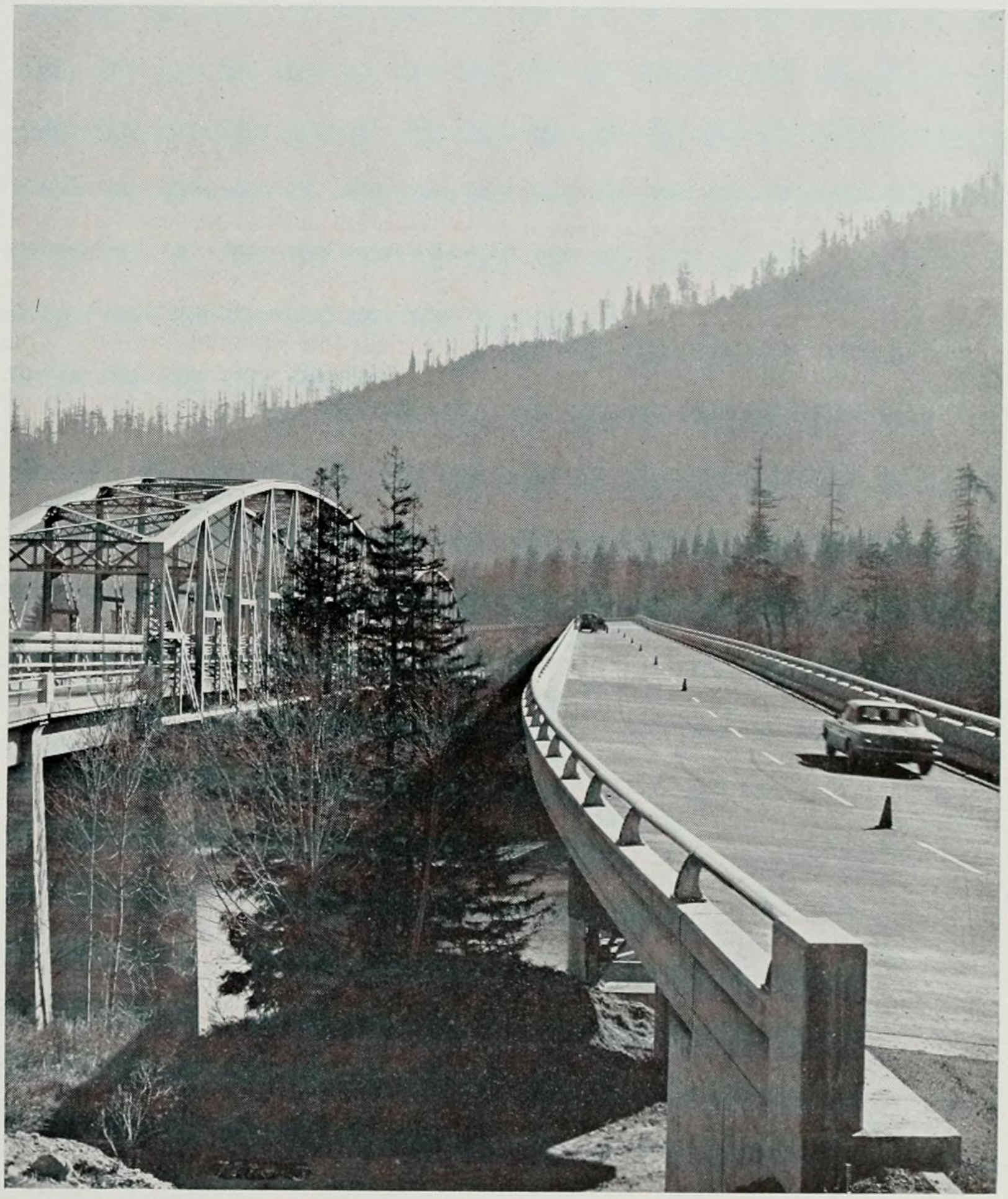
The bridge is designed for H20-S16-44 and Alternate loading, in conformance with American Association of State Highway Officials Specifications supplemented by Bridge Department specifications. It was designed by the Bridge Department of the Division of Highways at Sacramento under the direction of recently retired Bridge Engineer F. W. Panhorst.

The roadwork consists of approaches to the new bridge, transitions to existing two lane facility, frontage roads, creek channel alignment, and sacked concrete riprap bank protection for north end of south approach embankment.

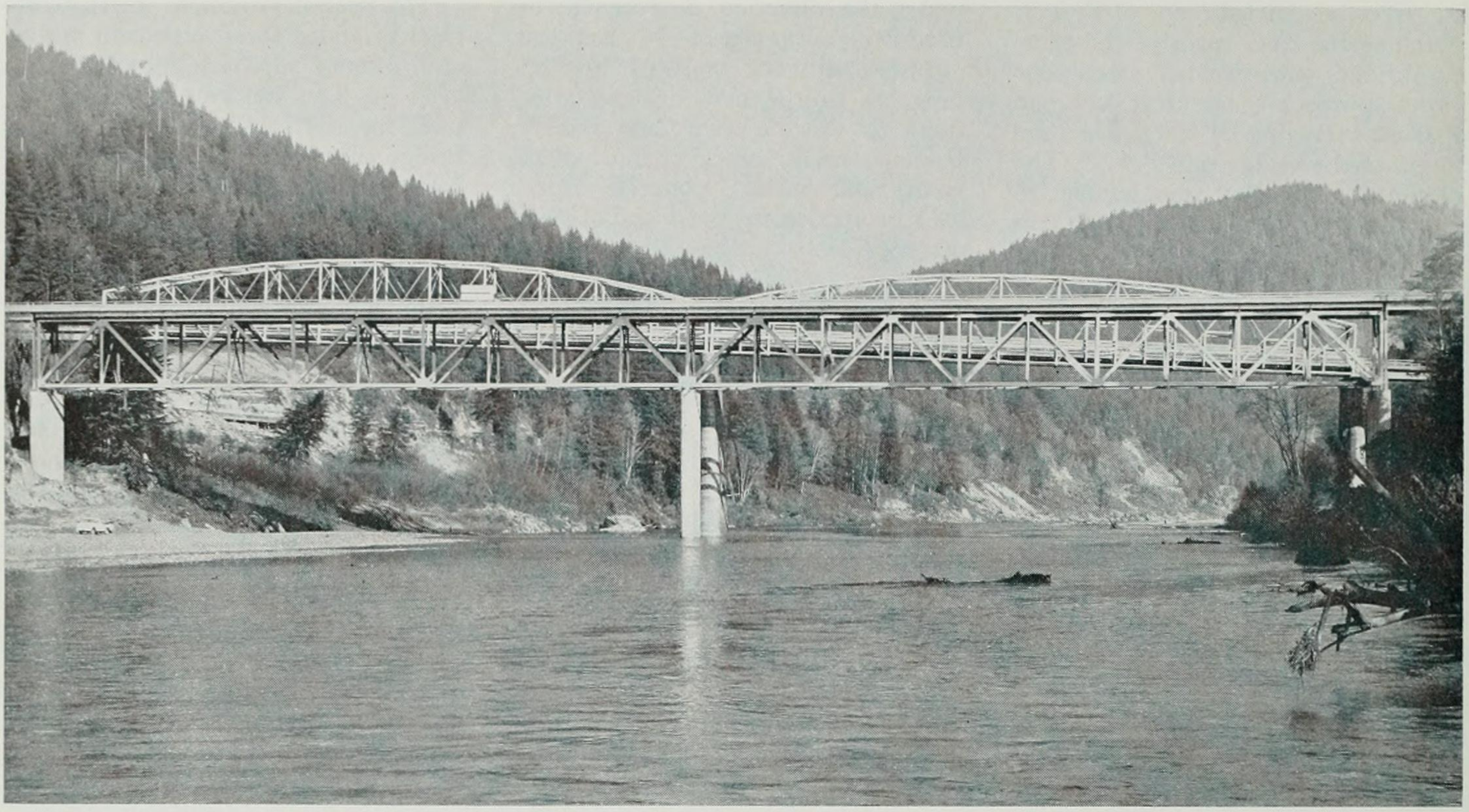
Contract Is Joint Venture

The contract was awarded to the joint venture firm of Erickson, Phillips and Weisberg of Concord; and Arthur B. Siri Inc. of Santa Rosa for the bid amount of $984,227 on May 22, 1959. Work started on the project on May 26. Erickson, Phillips & Weisberg did the bridge work; Arthur B. Siri Inc. handled the roadwork.

The Special Provisions for the contract provided for a settlement period at the south approach fill not to exceed 30 days before the driving of piles for the south abutment of the bridge. For varying depths the surface material at this location consists of silty sand mixed with forest debris, such as old logs and decomposed vegetation; this cover is underlain by solid material consisting of sand & gravel graduating to shale. The area at one time was the ancient river channel. It was found at the end of the 30 day period, that the fill was still settling; the height of the fill at this location is about 45′. The fill finally stabilized in about 75 days, with a total movement of 3.6 feet.



The new South Scotia parallel bridge (right) over the Eel River has a 28-foot roadway which carries two lanes of southbound traffic. Northbound traffic will use the old bridge (left).



Looking upstream at the new (front) and old (rear) South Scotia parallel bridges over the Eel River. Ultimately, the old bridge will be replaced by a structure similar to the new one.

All piles were driven to a 45 ton minimum bearing capacity, excepting abutment No. 1 which was to 60 tons. Steel piles (10 BP @ 42) were used at abutment No. 1 and river pier No. 5; at all other locations cast-in-place concrete piles were used, except at pier No. 6. Pier 6 is supported by a spread footing @ 6 TSF on a dense shale outcropping. Foundation requirements on this job varied considerably; it is noted that conditions encountered agreed closely with investigation and recommendations made by the Bridge Department Geology Section. Furnishing and driving piles was subcontracted to Raymond Concrete Pile Co. of Oakland.

River piers consist of constant section reinforced concrete shafts, 29′x6′, with 3′ radius noses, and a single hollow cell 16′x3′6″. The maximum pier height is 73′, pier No. 5. Conventional forming methods were used, pouring each pier in 3 lifts.

Falsework Towers

Two leg steel falsework towers at 60′ (even numbered truss panel points) were used to erect the structural steel. The average tower height was 65′; the tower legs were supported by steel plate pads on channel bottom. The falsework bents were used initially for span 4. When erection and bolt-up of span 4 was complete, the towers were removed, excepting one @ PP6 to retain camber, and repositioned in span 5; erection and bolt-up work was then continued. A 65 Ton capacity (4 axle) truck crane was used to erect structural steel; it was equipped with a 110′ boom and 25′ jib. It was necessary for the Contractor to ship this large crane by rail from the Bay Area to the job site, as a highway travel permit could not be issued due to poor alignment of Highway 101 north of Ukiah, and the heavy summer tourist traffic. A center of span erection camber of 4″ was provided in the 304′ spans. After all falsework was removed, and the concrete deck and curbs placed, the residual camber was found to average 1¾″.

The major roadwork items and the bridge, except for painting of structural steel, was completed in December 1960. The new bridge was opened to public traffic on December 6. The structural steel is being painted with an aluminum finish coat, to match the adjacent old bridge. All work was completed on March 2, 1961.

The approximate cost of the bridge work is $664,000; and the roadwork is $353,000. This is a California Federal Aid Primary Project, No. F-0118(2). The Federal funds amount to 55.12% of the total value of the work.

Ross Phillips of Erickson, Phillips and Weisberg was the Project Superintendent for the Contractor. The project was administered by the Bridge Department, Division of Highways under J. E. McMahon, Bridge Engineer. Representing the State in the field were Resident Engineer George W. Thomson, and District I Representative John Brown, Jr. (1959), and Leland Hadley (1960-61).

The California Highway Commission has adopted a freeway routing for a beltline freeway running north of Sacramento which will form a component part of a proposed freeway network in the metropolitan area.

The adopted route is 16.5 miles in length.