Hinged Swing Spans Feature Unique Design of Big Creek Arch Bridge

By H. E. Kuphal, Associate Bridge Engineer

The completion of a reinforced concrete arch bridge across Big Creek, 40 miles south of Carmel, constituted the last link in a series of structures, inseparable elements of Coast Highway Route 56, between Monterey and San Simeon. Its construction introduced unusual problems in bridge design.

At the site of the crossing Big Creek meanders along the bottom of a deep "U" shaped canyon. Foundation exploration indicated that the steep, sloped canyon walls consisted of a badly fractured shale formation and that underlying the stream were beds of clay, sand and gravel of reasonable bearing value for the bridge foundations. The highway alignment at this location is immediately adjacent to the sea coast and approximately 90 feet above the bed of the stream.

In selecting a structure most suitable for this site foundation conditions were of course an important consideration, as was also the locale with its heavy fogs, rains and salt spray laden winds. In fact, the latter consideration ruled against a type of construction suitable for an inland site. Full consideration of these factors lead to the adoption of the reinforced concrete arch as the most suitable type for this location.

The arch structure comprises two main arch spans 177 feet 6 inches long across the canyon, and two tied half arches of 81-foot 6-inch span with 34-foot 6-inch swing spans which vault the canyon walls to the abutments at highway grade. The structure from abutment to abutment has a total overall length of 587 feet and provides a clear roadway width of 24 feet.

A unique feature of this structure involves the function of the swing spans which are hinged to the half arches. Foundation conditions at the bridge ends indicated that the design should anticipate settlement of the end abutments. This condition, should it occur, may be readily overcome by virtue of the hinges which permit jacking the swing spans back to grade without detriment to the half arches. In effect any settlement at the abutments is localized and the correction effected with the minimum of expenditure.

The half-arch spans supporting the ends of the swing spans are hinged at the lower end and held in position by means of a steel eyebar tie extending from crown to crown of the half arches. Hinging of the half arches at their bases was indicated to eliminate stresses which would be induced by elongation and contraction of the eyebar tie from temperature change.

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Big Creek Arch Bridge is a striking feature of one of the most scenic spots on the rugged coast line. Center—Sketch shows location of floating spans at both ends of the bridge. At bottom—Side view of the structure looking seaward from the floor of the wide, deep canyon.
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As a part of the construction sequence the eyebar ties were erected complete in place and, when under conditions of full dead load, were stressed by means of toggles located at the center pier. This operation released the falsework supporting the half arches and secured the half arches in the designed position against dead load deflection.

Each toggle was operated by a 125-ton hydraulic jack which in a measure indicates the magnitude of the dead load involved. After transfer of the dead load of the half arches to the eyebar ties, the ties were concreted for their full length in the girders of the deck floor system.

At each side of each pier an open joint provided in the deck structure exposed the ties to the action of the elements. For protection at these points the eyebars were wrapped with asphalt impregnated burlap and the whole encased in a copper sleeve.

The three 80-foot columns between the arches were designed as cantilevers fixed at the bottom and proportioned to resist equally any unbalanced live load acting on the half arches in combination with the temperature stress. The column bases were founded on spread footings designed for a maximum bearing load of 5 tons per square foot.

Design of the arch rib, that is, the selection of the curve or shape of the rib as seen in elevation is of prime importance. For certain conditions of loading and span length a rib of circular shape will prove satisfactory. However, where span length is great and loading conditions extreme the designer must resort to a more complex form of curve if the rib is to economically perform its function of delivering the applied dead and live loads to the supporting piers.

The Design Department, after study and investigation, has developed and adopted a curve for long span arch ribs which has the shape of a modified ellipse. This curve or shape which is made up of elliptical segments was used in the design of the main area ribs for the Big Creek structure.

The live loading used in the design comprised either the standard H-15 live loading, which consists of one 15-ton truck followed and preceded by 12.5-ton trucks at specified intervals, or one 40-ton shovel, the governing load being that which produced the maximum stress. Maximum design unit stresses for concrete and rein-

(May 1939) California Highways and Public Works

25,000 Miles of 4-Lane Highways Need in 25 Years

I N A PAPER presented at the 18th annual meeting of the Highway Research Board in Washington, D. C., on the sectional layout of multiple-lane highways, Wilbur H. Simonson, Senior Landscape Architect, U. S. Bureau of Public Roads, shows that 95 per cent of the State highway mileage in this country is of the primary two-lane type in which the trends in construction indicate a progressive widening of roadbed surfaces and shoulders, the flattening of crowns and of slopes of shoulders and gutters, as well as the flattening and rounding of cut and fill slopes and increasing right-of-way widths. These trends include a growing emphasis placed on the landscape development of highways.

The remaining 5 per cent of important improved highway mileage is of the multiple-lane type, which may be either undivided or divided in sectional layout. The undivided highway types of three-lane and of four or more lanes are compared with the divided highway type of four or more lanes.

"Three representative construction periods are used: 1932, 1934 and 1936. The projected trends into 1938 and the 1940's furnish a composite picture of current tendencies in the sectional lay-out of tomorrow's multiple-lane highways."

"According to the annual report of the American Association of State Highway Officials, as of July 1, 1937," says Mr. Simonson, "there were at that time 4704 miles of three-lane, 3082 miles of four-lane, and 221 miles of six-lane pavement. In other words, we had a total of about 8007 miles of multiple-lane highways in the United States in 1937."

"Of the 3303 miles of four- and six-lane widths, only 604 miles were divided so that traffic in opposing directions was separated by a raised parkway or median strip. Since the above report was prepared, some additional mileages of multiple-lane highway types have of course been constructed but exact figures are not yet available."
Six Highway "Musts" Stated by MacDonald

In CLOSING his address at the Dallas Convention of the American Association of State Highway Officials, Thos. H. MacDonald, Chief of the Bureau of Public Roads, stated that based on the highway planning surveys, we must have:

First, a reclassification of our highways;

Second, a provison for roads to serve all types of existing or developing traffic, and recognizing the fast, through traffic as distinct from local use;

Third, the beginning of special motor roads in congested areas leading from the hearts of the cities through metropolitan areas, designed to permit free flow of traffic separated from cross-traffic;

Fourth, the organization of a big mileage of local land-service roads to be brought rapidly to usable condition;

Fifth, the program of State and Federal-aid systems which lies between, on which work must continue with a constantly higher level of design standards for safe traffic service; and

Sixth, for these improvements, a radically new policy of land acquisition to be formulated and made effective in order to provide adequate space and to control unsightly and undesirable ribbon development.

These, he states, are partial details of a future program indicated by the data of the highway planning surveys, if these data are to be used intelligently in the immediate future.

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forcing steel were 1000 pounds per square inch and 18,000 pounds per square inch, respectively. An exceedingly high grade concrete was manufactured for the project; 28 day strengths ran as high as 6000 pounds per square inch.

The Contractor was C. O. Sparks and Mundo Engineering Company, and I. T. Johnson, Resident Engineer.