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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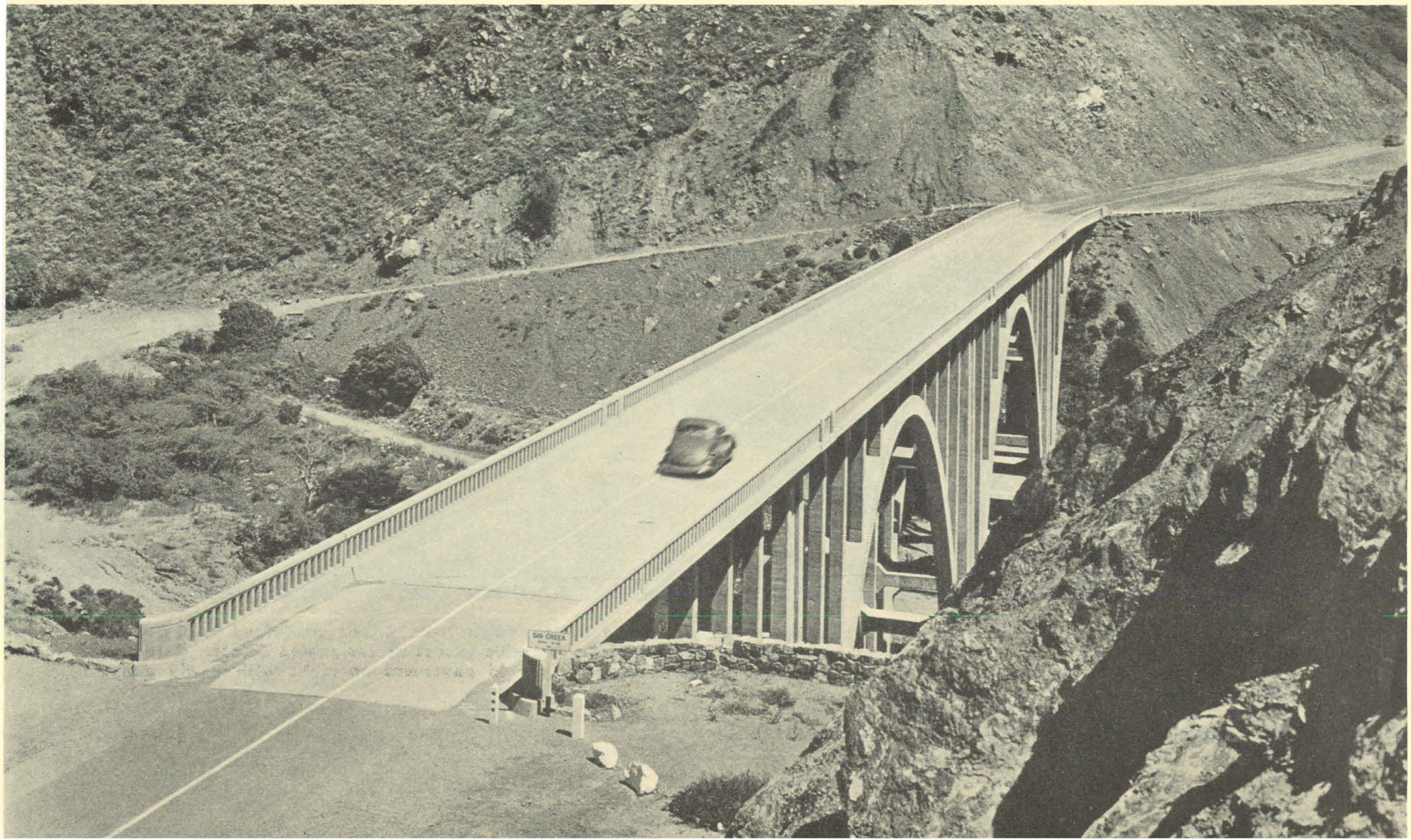
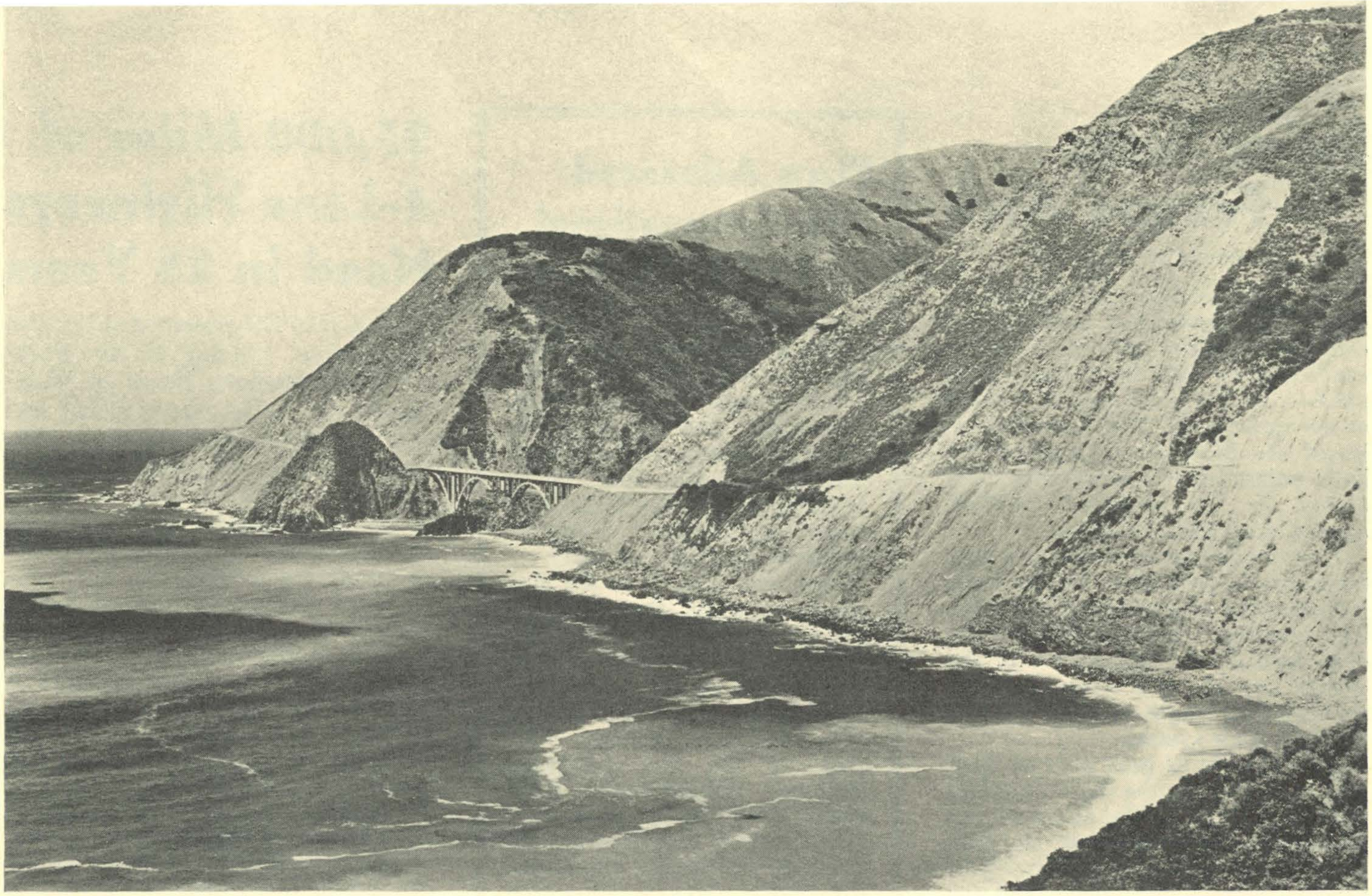
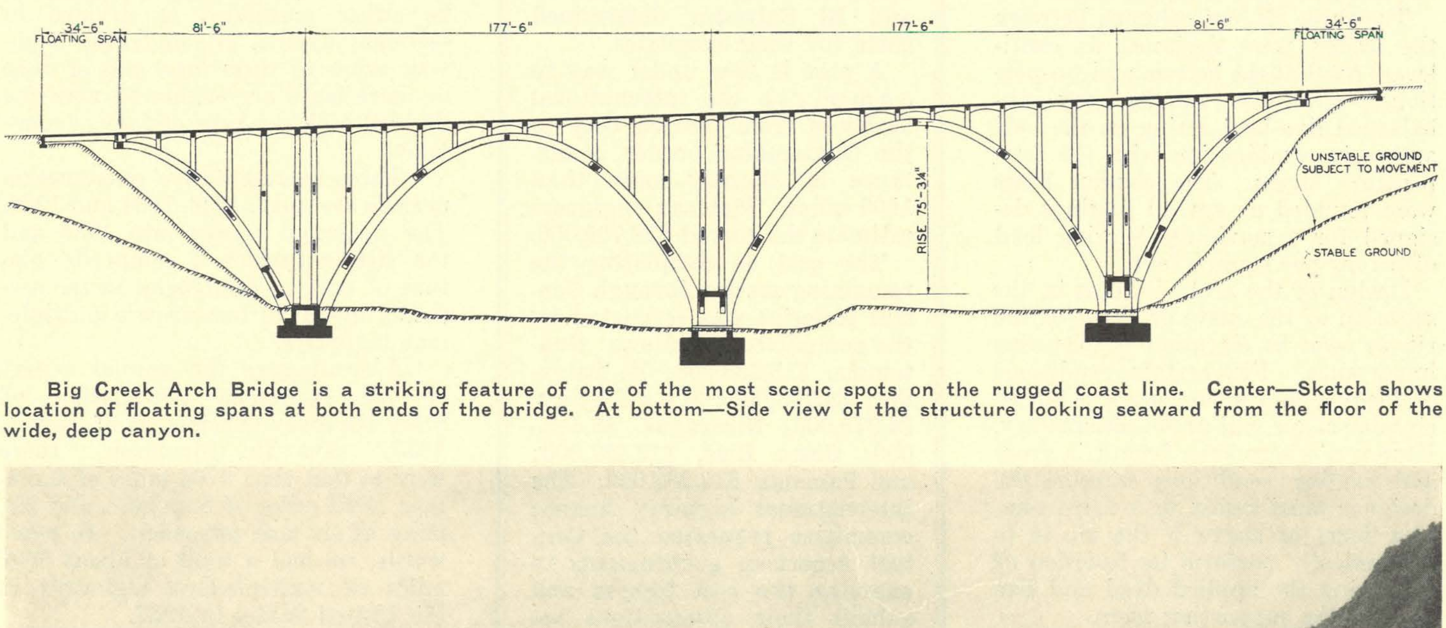
Reinforced concrete arch bridge on San Simeon-Monterey Coast Highway at Big Creek Canyon carrying highway 90 feet above bed of stream.







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.

Swing Spans Feature Arch

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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-

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Plans Advanced for International Pacific Highway

Added impetus to the International Pacific Highway which will eventually link Fairbanks, Alaska, with Buenos Aires, Argentina, was given when highway experts of the United States, Central and South America met at the Third Pan American Highway Congress at Santiago, Chile, recently.

Financial experts at the congress estimated that $78,308,000 would construct the highway from Mexico City to Panama. This figure was based upon latest technical information applied to surveys initiated by the Pan American Highway Confederation and made jointly by the U. S. Bureau of Public Roads and engineers of Guatemala, Honduras, Nicaragua, Costa Rico and Panama. Engineers of Mexico and El Salvador determined costs for their countries.

A plan is now under way to complete the international highway from Mexico City to the Guatemalan border, a distance of slightly more than 1000 miles. Mexican engineers estimate the cost at $22,709,000.

The cost of completing the remaining section through Central America was estimated by the committee as follows: Guatemala, $13,803,000; El Salvador, $4,293,000; Honduras, $4,375,000; Nicaragua, $8,418,000; Costa Rica, $12,427,000; and Pamama, $12,283,000. The international highway finance committee requested the Central American governments to examine the cost figures and submit their observations before February 1, 1940.

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

IN 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.

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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 provision 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.

Swing Spans Feature Arch

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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.

In Memoriam

HOWARD SPENCER HAZEN

The Division of Architecture suffered a great loss April 13, 1939, in the death of Howard Spencer Hazen, who had served as senior architectural designer in the office of that division since 1926.

Mr. Hazen was born in LaSalle, Illinois, educated in the schools of that community, and graduated in Civil Engineering from the University of Illinois. Becoming interested in architecture, he pursued the study of this subject at the Massachusetts Institute of Technology in Boston and later at Harvard University.

His professional career covered a wide field of activity, first in Boston and later in Chicago.

In 1924, he came to Sacramento at the instance of James S. Dean of Dean & Dean, Architects, and was associated with that firm in the design of many important structures, including the Sacramento Memorial Auditorium, the Sacramento Junior College, and the Westminster Presbyterian Church.

In the office of the Division of Architecture he was responsible for the design of several complete State institutional groups, of which the San Diego State College, the Camarillo State Hospital, and the California Institution for Women are outstanding examples.

Always self-effacing, he was possessed of cultural attainments beyond the knowledge of any except those most intimately acquainted with him. Art, music, literature, and science shared in the use of his leisure moments without excluding the friendly human touch or the keen sense of humor so deeply appreciated by all who knew him. A great void exists where he once stood.

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

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"Based on information gathered in the highway planning surveys, however, it is now apparent that 25,000 miles of new four-lane highways may have to be built in the next 25 years to accommodate the automobile traffic of the nation. This is an average of 1000 miles of new construction each year in addition to the existing mileage of the multiple-lane type now in use. Therefore, the sectional lay-out of multiple-lane highways is increasingly important."

Grade Separation Projects Total $11,000,000

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for which were in many cases much less complete than we would have desired, the contractors have cooperated to the end that we have secured very satisfactory jobs and the claims for additional compensation were reduced to a minimum.

The local district office of the Bureau of Public Roads was also an important factor in accomplishing the work under these programs. Their representatives were always available for consultation and furnished invaluable assistance in programming, designing, and constructing the grade separation projects.

Without such splendid cooperation all over California through the last four years, the State would have been hampered in getting this large program under way.

With the two earlier programs nearing completion, we are now in the process of formulating a program to utilize with the greatest possible benefit the allocation of about $1,800,000 to be spent during the 1940-1941 Fiscal Years. It appears that with this money there will be added to the previous sixty-eight projects about ten additional separations.

AID TO UNIVERSITY

PURDUE UNIVERSITY

Engineering Experiment Station
Lafayette, Indiana

California Department of Public Works
P. O. Box 1499
Sacramento, California

Gentlemen:

We are very much interested in obtaining copies of "California Highways and Public Works" for use as references by our staff of the Joint Highway Research Project. We are doing research work on various highway problems under a co-operative agreement between Purdue University and the Indiana Highway Commission. As a result, we would appreciate being placed on the mailing list for the above mentioned publication.

Very truly yours,

(Signed)
K. B. Woods
Assistant Director