

Caltrans' Historic Bridges Inventory Update: Concrete Box Girder Bridges



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Attachment: Inventory and Evaluation Forms
(DPR-523 Forms)

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Cover photo: Bridge 10-0123, State Route 1 over Greenwood Creek

Summary of Findings

This report presents the findings of an evaluation of 24 bridges for the purpose of updating portions of Caltrans' statewide historic bridge survey, completed in 1986-88. This report evaluates pre-1960 concrete box girder bridges. Based on the fieldwork conducted from February to May of 2003, of the 24 bridges evaluated, the six bridges listed below appear to be individually eligible for listing on the National Register of Historic Places, and are also considered to be historical resources for the purposes of compliance with the California Environmental Quality Act (CEQA). All six of these bridges were found to meet National Register Criterion C, at the local level of significance.

Individually eligible

35C0018	Pescadero Road over Pescadero Creek (1), San Mateo County
35C0053	Pescadero Road over Pescadero Creek (2), San Mateo County
36C0110	Stockton Ave. over Soquel Creek, Capitola, Santa Cruz Co.
44C0051	Bradley Road over Salinas River, Monterey County
53-0382	College Street over Highway 110, Los Angeles
53-0739	Mullholland Drive over Highway 405, Los Angeles

In addition, the Highway 1 bridge over Greenwood Creek in Mendocino County (bridge 10-0123) was found eligible for National Register listing by a consensus determination in October of 2003. The Greenwood Creek Bridge was evaluated based on a draft version of this report, in order to meet the schedule for a project involving replacement of this bridge. The evaluation forms for the Greenwood Creek Bridge have been retained in the present report, as they provide a useful comparison with the other box girder bridges.

Project Description and Scope of Survey

In 1986-88, the California Department of Transportation (Caltrans) carried out a statewide survey of historic bridges and identified bridges that meet the criteria for National Register listing. Because of the 50-year threshold for National Register listing, the original survey evaluated only those bridges that were constructed prior to 1936. Caltrans is now updating that survey, including the evaluation of roadway bridges constructed prior to 1960. This update includes bridges on state highways as well as bridges owned by local governments. The 1960 cut-off date was chosen so that the results of the survey will remain valid for several years after the completion of the survey.

For the purposes of the statewide historic bridge survey update, the population of pre-1960 bridges is being divided by bridge type, with separate evaluation reports for each type. This report evaluates concrete box girder

bridges. Box girder bridges were not evaluated in the original survey, since the type was introduced in California in the mid-1930s and only one box girder bridge (36C0110) was 50 years old at the time of the original survey.

Previous historic property surveys, carried out for specific transportation improvement projects subsequent to the original statewide survey, have identified a total of 14 concrete box girder bridges which are eligible for National Register listing:

- Four as contributors to the four-level interchange in Los Angeles (53-0622F, 53-0622G, 53-0622L, and 53-0622R), all built in 1949.
- Three as contributors to the Arroyo Seco Parkway in Los Angeles and Pasadena (53-0276, 53-0344, and 53-0986S), built in 1939 and 1940.
- Two as contributors to the Cabrillo Freeway in San Diego (57-0085 and 57-0217Z), built in 1947.
- Five individually: 10-0123 in Mendocino County, as mentioned above (1956), 33-0039 in Alameda County (1947), 44-0121 in Monterey County (1954), 53-0468 in Los Angeles County (1940) and 57C0009 in San Diego County (1940).

In addition, one box girder bridge (34-0120Y, built in 1937) is listed on the National Register as a component of the San Francisco-Oakland Bay Bridge.

The 24 bridges evaluated in this report represent the potentially significant examples of this bridge type which have not been previously evaluated. They include the earliest bridges, the longest spans, and most technically and aesthetically important examples from among the approximately 600 extant box girder bridges built in California prior to 1960. The remaining box girder bridges either lack integrity due to post-1959 alterations or are typical examples of the type which do not possess historic or engineering significance. These bridges are considered to be ineligible for National Register listing. The selection of bridges to be individually evaluated was made by Caltrans' architectural historian Andrew Hope, based on a review of bridge inspection reports, construction drawings (including plans for alterations), photographs, magazine articles, maps, and other sources.

Research and Field Methods and Evaluations

In preparation for this survey, Caltrans forwarded to Myra L. Frank and Associates information about the 25 bridges in this report, including selected as-built plans, bridge inspection reports, and copies of articles published in *California Highways and Public Works*.

Background research for this survey included the following sources:

- The National Register of Historic Places website (www.cr.nps.gov/nr)
- State Office of Historic Preservation Historic Properties Inventory
- California Historical Landmarks (State of California, 1996)
- California Points of Historical Interest (State of California, 1992)
- Caltrans Historic Bridge Inventory (Caltrans, March 5, 1987)
- Historic Highway Bridges of California (Caltrans, 1990)
- Los Angeles Public Library catalog, and Photo and Regional History databases

Information on bridges outside of Los Angeles County was obtained through the internet and requested from various local historical societies. Specific information gleaned from these sources is noted in the DPR-523 forms for the individual bridges.

Between February and May 2003, the 25 concrete box girder bridges included in this report were visited by qualified architectural historians working for Myra L. Frank and Associates, Inc. On-site field work included a complete visual examination of each structure, and at least ten digital photographs were taken of each structure.

The survey report submitted to Caltrans in August 2003 concluded that seven bridges appear to be eligible for National Register listing, including the Greenwood Creek Bridge (10-0123), five of the six bridges found eligible in this final version of the report, and the Oak Grove Drive Bridge in Pasadena (53C1829). The report was revised by Caltrans' architectural historian Andrew Hope between September 2003 and April 2004. Based on peer reviews by Caltrans staff and a reassessment of the report's original conclusions, two changes were made to the eligibility determinations. The evaluation of the Oak Grove Drive Bridge was changed from eligible to ineligible for National Register listing, as this bridge does not appear to be sufficiently distinctive to meet National Register Criterion C. In addition, the evaluation of the Pescadero Creek Bridge (35C0053) was changed from ineligible to eligible, since this bridge's loss of integrity does not appear to be so great as to preclude its eligibility for National Register listing.

Public Participation

In early April 2003, letters were sent by Caltrans to the county planning departments of each county in California, nine cities, and 58 historical societies and historic preservation groups, informing them of the statewide historic bridge survey update and inviting their comments. Letters were sent

to the following counties and cities where there are box girder bridges which are evaluated in this report:

- City of Los Angeles, Cultural Heritage Commission
- City of Pasadena, Design and Historic Preservation
- Los Angeles County Department of Regional Planning
- Los Angeles County Department of Public Works
- Mendocino County Planning Department, Ukiah
- Mono County Planning Department, Mammoth Lakes
- Monterey County Planning Department, Salinas
- Sacramento County Planning Department
- San Mateo County Planning Division, Redwood City
- Santa Cruz County Planning Department
- Tuolumne County Community Development Department, Sonora
- Ventura County Planning Division, Ventura

In addition, letters were sent to the following organizations which may also have an interest in these bridges:

- Los Angeles Conservancy
- Mendocino County Historical Society
- Monterey County Historical Society, Salinas
- Pasadena Heritage
- Sacramento County Historical Society
- San Mateo County Historical Association, San Mateo
- Tuolumne County Historical Society, Sonora

Of these groups, only the Tuolumne County Historical Society responded, requesting an opportunity to review and comment on the evaluation of Tuolumne County bridges. A draft of this report was sent to the historical society on April 2, 2004. No response was received as of May 7, 2004.

In addition, architectural historian Don Napoli of Sacramento requested to review and comment on the draft reports for this update of the statewide historic bridge survey. A draft of this report was sent to Mr. Napoli on April 1, 2004. No response was received as of May 7, 2004.

Historic Overview

Reinforced Concrete

Reinforced concrete was first used for bridge construction in California in 1888, with the construction of the Lake Alvard Bridge in San Francisco's Golden Gate Park. Designed by the engineer Ernest Ransome, this arch

bridge was the first reinforced concrete bridge in the United States [Mikesell, 1990: 72]. Prior to 1910, almost all of the concrete bridges constructed in California were arches.

By the second decade of the twentieth century, reinforced concrete had become the preferred material for new bridge construction in California, owing in part to the lack of steel production on the West Coast and the cost of transporting steel from Eastern states or other countries. At the same time, the proportion of concrete arch bridges declined dramatically, while slab and T-beam bridges became more popular.

Concrete bridges account for more than two-thirds of all extant California bridges constructed prior to 1960, and more than 90% of the bridges constructed from 1960 to the present. Although these percentages may be influenced by a greater survival rate for concrete bridges compared to those constructed of other materials, it is clear that bridge construction in California has been dominated by concrete for nearly 100 years.

Box Girder Bridges

The concrete box girder was initially developed by the French engineer Eugene Freyssinet during the 1920s, and the earliest bridges of this type were constructed in Europe [Hope, 1998]. The earliest examples in the United States date to the 1930s. The box girder may be seen as a refinement of the T-beam bridge, in which the T-beams are transformed into hollow cells by the addition of a continuous soffit across the bottom of the structure. A cross-section of a typical three-cell box girder bridge is shown below, in comparison with a typical T-beam bridge.

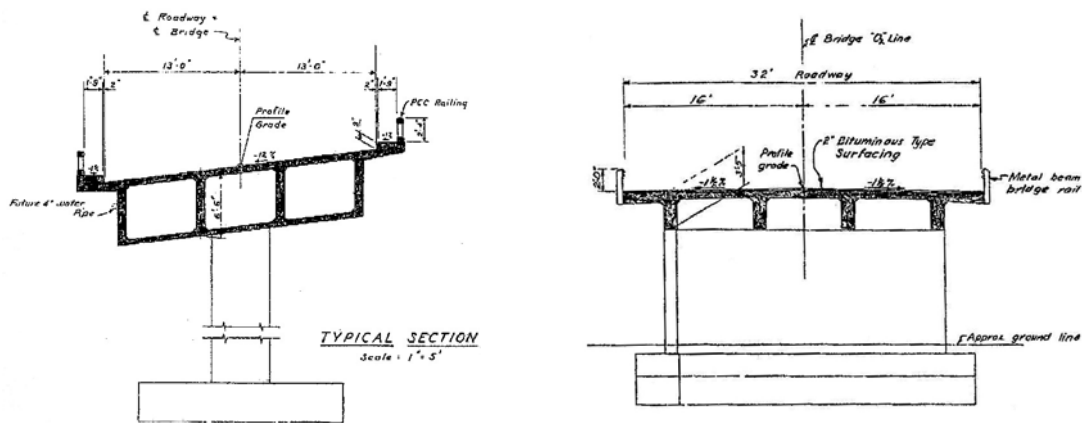


Figure 1: Sections of a three-cell box girder bridge and a T-beam bridge.

The box girder structure is an improvement of the T-beam in that the rectangular shape simplifies the exterior formwork required, while the formwork for the interior of the cells, which would not be visible, could be constructed of inferior lumber and was often left in place. This resulted in some reduction in cost, since the labor-intensive construction and removal of formwork is a major expense in reinforced concrete bridges. In addition, the box girder design can have a shallower depth and use less material for a given span than the T-beam. The box girder bridge also has greater rigidity in resisting torsion, which is an advantage for bridges that have curved alignments. A 1938 article in *Engineering News Record* noted that hollow box girders “undoubtedly have the strongest section that can be made with a given quantity of material” [Easterday, 1938: 339].

Concrete box girder bridge construction began in California in the mid-1930s. The earliest extant example (bridge 36C0110 in Capitola, Santa Cruz County) dates to 1934, although it is possible that slightly earlier bridges of this type were constructed but have since been replaced. There are presently only 12 box girder bridges in the state that were built prior to 1940, and thirty dating to 1946 or earlier. Some of these early examples show the transition from the T-beam to the box girder structure, having separate box girders (such as bridges 35C0018 and 35C0053 in San Mateo County) or employing both the box girder and T-beam in a single structure (such as bridge 53-0382 in Los Angeles). In addition, construction drawings for many of the earliest examples show the steel reinforcement concentrated at the bottoms of the vertical walls which form the box girder cells, similar to the placement of reinforcement in a T-beam bridge. Later designs use the entire bottom soffit of the box girder as a structural component, with the reinforcement more evenly spaced across the entire width of the box girder.

The box girder became more widely used in California after World War II, with 120 examples dating to the seven-year period from 1947 through 1952. After 1952, the number of box girder bridges increased dramatically, with more than 400 constructed in the seven-year period from 1953 to 1959. From 1960 on, the box girder has been by far the most common type of bridge constructed in California, accounting for more than half of the concrete bridges and nearly half of all bridges. There are presently more than 7,500 concrete box girder roadway bridges in California.

In comparison, the construction of concrete arch bridges virtually ceased after World War II, with fewer than 30 extant examples from 1946 to the present. Similarly, the construction of T-beam bridges has fallen dramatically, from nearly half of all bridges in the 1920s to fewer than 20 percent of the bridges constructed since 1960. The construction of concrete slab bridges has also

declined significantly with the rise of the box girder type, but has remained relatively constant in recent decades, at about one-quarter of all new concrete bridges. This type is still used where spans are relatively short and where a minimal depth of structure is desired.

The box girder bridge was preferred over the T-beam where long spans were required. By 1940, box girder spans of more than 130 feet had been built. There are presently 13 pre-1960 box girder bridges with spans of 130 to 160 feet, and one (bridge 53-0739 in Los Angeles) with a span of 235 feet. In contrast, there are only two extant T-beam bridges with spans greater than 130 feet (145 feet and 202 feet), both of which were built in the early 1940s.

The more than 600 pre-1960 box girder bridges are predominantly in Southern California. Almost half (48%) are within Los Angeles County, and nearly two-thirds are in the seven southernmost counties of Ventura, Los Angeles, Orange, San Bernardino, Riverside, San Diego, and Imperial. 85% of these bridges are on state highways, with only 15% on local roads. The prevalence of the box girder bridge in southern California and on state highways is largely due to the fact that this was the preferred bridge type by the Division of Highways (now Caltrans) during the initial period of freeway construction. The 24 box girder bridges evaluated in this report reflect the geographical distribution of the population as a whole, in that 13 are in Los Angeles County and 16 are in the seven southernmost counties.

Prestressed concrete was introduced in California bridge construction in the early 1950s. Prestressing is a method of increasing the strength of a concrete girder or other structural member by inducing an internal compression force within the girder. This is typically accomplished by holding the steel reinforcement (rebar) in tension during the setting of the concrete. When the concrete is set and the tension is released from the rebar, the resulting contraction of the rebar induces a compression force in the concrete which surrounds and is bonded to the rebar. Prestressing was first applied to beam and slab bridges. There are only ten extant prestressed box girder bridges in California that are known to have been constructed prior to 1960. The oldest of these, dating to 1954, is the John Street Overcrossing in Salinas, Monterey County (bridge 44-0121), which was determined eligible for National Register listing in 2003 based on its significance as the state's earliest example of a prestressed box girder bridge. The nine other pre-1960 prestressed box girders were all built in 1958 and 1959, when prestressing had become a common technique, and they are not individually significant.

Resource Significance

None of the bridges evaluated in this report are significant under National Register Criterion A, as they are not associated with significant historical events other than, in some cases, the construction of the interstate freeway system. The significant early freeways in California, the Arroyo Seco Parkway in Los Angeles County and a segment of the Cabrillo Freeway in San Diego, have already been identified and found eligible for National Register listing, and the National Register eligibility of the post-World War II freeway system is not being considered as part of the statewide historic bridge survey update.

None of the bridges evaluated in this report are significant under National Register Criterion B, as they are not associated with significant persons in local or state history.

Significance under National Register Criterion C is therefore emphasized in evaluating these 24 bridges. Box girder bridges may be significant under Criterion C for their age, technical accomplishment, or aesthetics. These qualities are discussed below, followed by a matrix which compares the significance of the bridges in each of these three categories plus the additional category of integrity. With the exception of the age ranking, the qualities ranked in the matrix are somewhat subjective. The intent of the matrix is not to specifically identify which bridges are eligible or ineligible for National Register listing, but to assist in making National Register evaluations by indicating which bridges are potentially more significant in each of the three categories.

Age

For the purposes of the statewide historic bridge survey update, Caltrans and the State Office of Historic Preservation have agreed, in a meeting on February 26, 2003, that bridges constructed prior to 1960 will be treated as meeting the 50-year threshold for National Register eligibility. Significant bridges constructed in the 1955-59 period therefore do not require exceptional significance to be considered eligible for National Register listing. The earliest examples of box girder bridge construction in California, representing the pioneering period for this bridge type, are potentially significant under Criterion C. Those scoring high for age in the matrix on page 12 were built from 1934 through 1946. With the exception of the eight bridges dating to 1940, there are no more than five extant box girder bridges dating to any one year during this period. The medium score is for bridges built from 1947 through 1952. The number of extant bridges built during this period ranges from 11 in 1947 to a high of 26 in 1951. Bridges built after 1952 scored low in this category, as the box girder type had become the most common bridge

type in the state from that date to the present. The number of extant bridges built during this period ranges from 40 in 1953 to more than 100 in 1959.

Technical significance

Box girder bridges ranked high for technical merit include those with the longest spans (or the longest spans for their construction date) and those with unusually slim profiles relative to their span length. Only 14 bridges out of the total population of more than 600 pre-1960 box girders have spans of 130 feet or more. Three of these lack integrity due to post-1960 alterations, but the other eleven are evaluated in this report.

For box girders of constant depth, the girder depth is typically 5.5% to 6% of the span length. However, for girders with a tapered profile, the depth at mid-span can be substantially less than 5.5%. A few bridges with unusually slim profiles and a minimal girder depth at mid-span are rated high for technical significance, in addition to bridges with long spans.

Aesthetics

Two of the 24 bridges evaluated in this report (36C0110 and 53-0382) have some art deco or moderne ornamentation. Both were built in the 1930s. In addition, one bridge (53C1829, built in 1955) has piers with applied rustication in imitation of stone masonry, designed to be compatible with its dramatic setting. These three bridges were given high scores in the aesthetic category. While none of the other bridges have applied ornamentation in the traditional sense, several do achieve a high degree of aesthetic distinction, exemplifying the ideals of mid-20th century modern design, and are also given high scores for aesthetic distinction.

During the period when the box girder was growing into the favored type for California bridges, a new aesthetic sense was replacing the older notions of enhancing the beauty of a structure through the use of applied ornament. Instead, this new aesthetic emphasized simplicity, clean lines, and a sleek, minimalist appearance. This was achieved in the design of box girder bridges in several ways. Compared to earlier T-beam bridges, box girders had relatively long spans, and therefore fewer piers, and typically had a shallower superstructure. This emphasized horizontality and gave the bridge a distinctively lighter, soaring quality that was much admired by bridge designers of the period. The horizontal emphasis was further enhanced by cantilevering the bridge deck beyond the edge of the box girder, to visually reduce the size of the girder and create a horizontal shadow line. In some bridges, the piers were reduced to single, round columns, and the bent caps were placed within the depth of the box girder structure to eliminate visual breaks in the horizontal continuity of the superstructure. Attention was also

given to the design of railings that would reinforce the horizontal emphasis, and the elimination of distracting details.

Among the pre-1960 box girders, one that incorporates these modern aesthetic qualities to a notable degree is the Alameda Creek Bridge in Niles Canyon, Alameda County, shown below. The box girder is reduced to a single cell, forming a curved spine which supports the boldly cantilevered bridge deck. This bridge was determined eligible for National Register listing in 1998. Another distinctive example is the Greenwood Creek Bridge in Mendocino County (10-0123), shown on the cover of this report, which was determined eligible for National Register listing in 2003.



Figure 2: Alameda Creek Bridge (33-0039) in Alameda County, built in 1948. (Photo from California Highways and Public Works, March-April 1948, p. 40.)

For some box girder bridges, a graceful appearance was achieved by incorporating a gentle curve to the underside of the superstructure, with the girder tapering to a minimum depth at mid-span. Examples include the Salinas River Bridge in Monterey County (44C0051) and the Mullholland Drive Overcrossing in Los Angeles (53-0739).

Additional refinements in the design of box girder bridges were made in the 1960s and later. One notable refinement was to slope the sidewalls of the box girder inward, so that the girder was narrower at the bottom than the top. This increased the portion of the girder which was in shadow, reducing the perception of size and mass relative to its span. In addition to the sloped side walls, rounded corners were introduced at the bottom of the girder, giving the structure a “bathtub” cross-section. Although box girder bridges with this type of section have become the standard in California, these refinements do not appear in any of the state’s pre-1960 box girder bridges.

Integrity

With more than 600 pre-1960 box girder bridges in California, determining which examples appear to be eligible for National Register listing involves making fine distinctions from among a large population of similar properties. For this reason, a relatively high threshold for integrity was used in determining which bridges to evaluate and which appear eligible for National Register listing. Bridges that are noted as having high integrity in the matrix appear unaltered. “Minor loss” refers to the addition of relatively unobtrusive features such as chain-link fencing. “Some loss” typically refers to replacement of the original railings or alterations to the columns. Bridges that have been widened are considered to have suffered a substantial loss of integrity.

Matrix of potential significance of concrete box girder bridges

Bridge No.	Age	Technical	Aesthetic	Integrity
10-0123	low (1956)	medium	high	high
10-0181	low (1958)	medium	medium	high
10-0236	high (1938)	high	medium	some loss
24-0080	med. (1952)	medium	medium	some loss
32C0007	low (1957)	high	low/med.	high
35C0018	high (1937)	medium	medium	high
35C0053	high (1937)	medium	medium	some loss
36C0110	high (1934)	medium	high	high
44C0051	high (1940)	high	med./high	some loss
47-0020	high (1940)	low	medium	some loss
52C0079	high (1940)	high	medium	high
53-0317L	med. (1950)	low/med.	low	substantial loss
53-0382	high (1939)	medium	high	minor loss
53-0623G	med. (1949)	medium	low	some loss
53-0623H	med. (1949)	medium	low	some loss
53-0623L	med. (1949)	medium	low	some loss
53-0623R	med. (1949)	medium	low	some loss
53-0739	low (1959)	high	high	some loss
53-0891	low (1954)	med./high	low	high
53-1010	low (1956)	med./high	low	high
53C0076	med. (1952)	medium	low	substantial loss
53C1341	med. (1949)	medium	medium	high
53C1709	med. (1952)	high	low	high
53C1829	low (1955)	med./high	high	minor loss
54C0165R	high (1939)	high	low	high

Findings and Conclusions

Of the 24 concrete box girder bridges evaluated in this report, the six listed below appear to be individually eligible for National Register listing.

35C0018	Pescadero Road over Pescadero Creek (1), San Mateo County
35C0053	Pescadero Road over Pescadero Creek (2), San Mateo County
36C0110	Stockton Ave. over Soquel Creek, Capitola, Santa Cruz Co.
44C0051	Bradley Road over Salinas River, Monterey County
53-0382	College Street over Highway 110, Los Angeles
53-0739	Mullholland Drive over Highway 405, Los Angeles

One bridge, the Highway 1 span over Greenwood Creek in Mendocino County (10-0123), was previously determined eligible for National Register listing, based on a draft version of this report. Evaluation forms for the Greenwood Creek Bridge have been retained in this report, as they provide a useful comparison with other concrete box girder bridges.

Of these seven bridges, four (35C0018, 35C0053, 36C0110, and 53-0382) are significant primarily as early examples of the type, from the pioneering period of the box girder bridge in California. Two of the bridges (44C0051 and 53-0739) are significant primarily for their technical achievements, exhibiting notably long spans for their construction date and an unusually shallow structure depth. The remaining bridge (10-0123) is significant for its design and aesthetic qualities. Most of those bridges which are significant as early examples of the type or for their technical achievements also possess aesthetic distinction when compared to the entire population of pre-1960 box girder bridges.

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