NATIONAL REGISTER DETERMINATION OF ELIGIBILITY:

HISTORIC BRIDGES IN CALIFORNIA:

CONCRETE ARCH, CONCRETE GIRDER, CONCRETE SLAB, CANTICRETE, STONE MASONRY, SUSPENSION, STEEL GIRDER AND STEEL ARCH

(THEMATIC)

CONSENSUS Determination of eligibility in September 1986

By FHWA and California State Historic Preservation Officer (SHPO)

Request for Determination
of Eligibility for
Inclusion in the National
Register of Historic Places

1. Agency Requesting Determination:
U.S. Department of Transportation
Federal Highway Administration
Attn: Bruce Cannon
California Division Administrator
P.O. Box 1915
Sacramento, CA 95809

2. Properties: Historic Bridges in California: Concrete Arch, Concrete Girder, Concrete Slab, Canticrete, Stone Masonry, Suspension, Steel Girder and Steel Arch

3. **LOCATION:** This thematic request for determination of eligibility concerns 118 historic bridges located throughout the State of California. Location -- by county, nearest city, highway, feature intersected, and UTM coordinates -- is identified for each structure in the attached "Bridge Rating Sheets."

4. **CLASSIFICATION:** The classification for this request for determination of eligibility is "thematic group." Each individual bridge is classified as a "structure."

5. OWNERSHIP:

BRIDGE NUMBER 33C-6; 33C-205
County of Alameda
121 Oak Street
Oakland, CA 94612

BRIDGE NUMBER: 1C-15

County of Del Norte
Public Works Department
700 5th Street
Crescent City, California 95531

BRIDGE NUMBER: 25C-99; 25C-116

County of El Dorado
360 Fair Lane
Placerville, California 95667

BRIDGE NUMBER: 11C-196

County of Glenn
Glenn County Courthouse
Willows, California 95988

BRIDGE NUMBER: 4C-12; 4C-26; 4C-75; 4C-155; 4C-189; 4C-239

County of Humboldt
County Courthouse
825 Fifth St.
Eureka, California 95501

BRIDGE NUMBER: 14C-35

County of Lake
255 Northforbes St.
Lakeport, California 95453

BRIDGE NUMBER: 53C-44; 53C-96; 53C-130; 53C-136; 53C-161; 53C-163; 53C-331; 53C-545; 53C-859; 53C-1010; 53C-1166; 53C-1179; 53C-1321; 53C-1375

City of Los Angeles
City Hall
200 N. Spring Street
Los Angeles, California 90012

BRIDGE NUMBER: 41C-6

County of Madera
Government Center
Madera, California 93637

BRIDGE NUMBER: 27C-51

County of Marin
P.O.Box 4186
Civic Center
San Rafael, California 94903

BRIDGE NUMBER: 10C-143

County of Mendocino
Courthouse
Lake Mendocino Drive
Ukiah, California 95482

BRIDGE NUMBER 38C-23

City of Modesto
City Hall
801 11th Street
Modesto, California 95353

BRIDGE NUMBER: 44C-82

City of Monterey
City Hall
Monterey, California 93940

BRIDGE NUMBER: 21C-2; 21C-17; 21C-42; 21C-46; 21C-51; 21C-58; 21C-95; 21C-9999

County of Napa
1195 Third Street Room 201
Napa, California 94558

BRIDGE NUMBERS: 53C-757; 53C-1041

City of Pasadena
City Hall
100 N. Garfield Avenue
Pasadena, California 91109

BRIDGE NUMBER: 19C-2; 19C-7

County of Placer
175 Fulweiler Avenue
Auburn, California 95603

BRIDGE NUMBER: 9C-71

County of Plumas
Road Department Office
Route 1, Box 279
Quincy, California 95971

BRIDGE NUMBER: 56C-55

City of Riverside
City Hall
3900 Main Street
Riverside, California 92522

BRIDGE NUMBER: 19C-67

City of Roseville
316 Vernon St.
Roseville, California 95678

BRIDGE NUMBER: 24C-67

County of Sacramento
County Administration Building
Room 304
827-7th Street
Sacramento, California 95814

BRIDGE NUMBER: 57C-2; 57C-361

County of San Diego
County Courthouse
220 W. Broadway
San Diego, California 92101

BRIDGE NUMBER: 57C-418

City of San Diego
City Administration Building
Community Concourse
San Diego, California 92101

BRIDGE NUMBER: 34C-44; Lake Alvord Bridge

City and County of San Francisco
City Hall, Room 260
400 Van Ness Avenue
San Francisco, California 94102

BRIDGE NUMBER: 37C-237; 37C-807

City of San Jose
City Hall
First and Mission
San Jose, California 95110

BRIDGE NUMBER: 49C-298

City of San Luis Obispo
City Hall
900 Palm Street
San Luis Obispo, California 93401

BRIDGE NUMBER: 35C-25; 35C-42; 35C-122; 35C-123

County of San Mateo
401 Marshall Street
Redwood City, California 94063

BRIDGE NUMBER: 51C-51

City of Santa Barbara
City Hall
De la Guerra Plaza
Santa Barbara, California 93102

BRIDGE NUMBER: 51C-39; 51C-43; 51C-225; 51C-226

County of Santa Barbara
105 E. Anapamu Street
Santa Barbara, California 93101

BRIDGE NUMBER: 36C-48; 36C-75

County of Santa Cruz
701 Ocean Street
Santa Cruz, California 95060

BRIDGE NUMBER: 6C-1; 6C-293; 6C-294

County of Shasta
Department of Public Works
1855 Placer Street
Redding, California 96001

BRIDGE NUMBER: 23C-18; 23C-76; 23C-77; 23C-92; 23C-96; 23C-98

County of Solano
Old Courthouse
Fairfield, California 94533

BRIDGE NUMBER: 20C-242; 20C-324

County of Sonoma
Room 117A
575 Administration Drive
Santa Rosa, California 95401

BRIDGE NUMBER: 38C-73

County of Stanislaus
1100 H Street
Modesto, California 95354

BRIDGE NUMBER: 29C-232

City of Stockton
City Hall
425 N. El Dorado Street
Stockton, California 95202

BRIDGE NUMBER: 8C-57; 8C-58

County of Tehama
9380 San Benita Avenue
Gerber, California 96035

BRIDGE NUMBERS: 46C-196; 46C-410

County of Tulare
Civic Center
Visalia, California 93291

BRIDGE NUMBER: 32C-44

County of Tuolumne
230 Green Street
Sonora, California 95370

BRIDGE NUMBER: 22C-3; 22C-35

County of Yolo
292 West Beamer Street
Woodland, California 95695

BRIDGE NUMBER: 4-17R; 4-101; 4-134; Dog Creek Bridge; 6-195Y; 7-78Y; 10-30; 10-31; 16-11; 17-7; 17-9; 21-5; 25-33; 25-45; 30-19; 37-74; 38-62; 40-6; 40-7; 44-12; 44-16; 44-17; 44-18; 44-19; 44-36; 44-56; 46-29; 51-110; 53-595/593; 53-42R; 53-622

State of California
Department of Transportation
1120 N Street
Sacramento, California 95814

6. REPRESENTATION IN EXISTING SURVEYS: Bridges in this thematic group were identified as part of a larger project to evaluate significant historic bridges in California, generally referred to as "The California Bridge Survey." This survey, funded by the Federal Highway Administration and implemented by the California Department of Transportation, is described in detail in Section 7 below. Significant truss bridges were treated in an earlier thematic Request for Determination of Eligibility, "Historic Truss Bridges in California," completed in July, 1985, and submitted to the Keeper of the National Register in November, 1985. Seventy-two California truss bridges were determined eligible for National Register listing on December 27, 1985.

7. DESCRIPTION

This request for determination of eligibility concerns 118 California highway bridges. Each individually meets criteria for listing in the National Register of Historic Places. Collectively, they illustrate the range of dates of construction, methods of construction, and uses to which bridges have been put in more than a century of California history.

These bridges are located throughout California, in a variety of topographical and cultural settings -- from the Coast Range of northwestern California to the southeastern California deserts, from remote wilderness areas to densely urban areas in San Francisco, Los Angeles, and San Diego.

This group of bridges is quite diverse, including a wide variety of bridge forms and types. The group is unified by several broad characteristics -- each is a highway bridge, i.e. carries vehicular traffic; and none is a truss, a bridge type considered in an earlier request for determination of eligibility.

Survey Methods

These 118 structures were identified and evaluated as part of a larger survey of historic bridges in California. This survey was funded by the Federal Highway Administration (FHWA) and conducted by professional cultural resource staff of the California Department of Transportation (Caltrans). The staff of the California State Historic Preservation Officer (SHPO) was involved in review of this work at various stages in the process. Principals in the inventory are: John Snyder, Chief Architectural Historian, Caltrans, Stephen Mikesell, historian, Caltrans, and Diane Pierzinski, Associate Environmental Planner, Caltrans.

Selection of this thematic group involved three basic steps: identification, documentation, and evaluation.

Identification At the outset of the California bridge survey, Caltrans, FHWA, and SHPO staff agreed to a two-phased survey strategy. During the first year, historic trusses were identified and evaluated. Significant examples of this bridge type were included in a 1985 thematic request for determination of eligibility. The second year effort was directed toward the remaining bridge types.

The initial step in identifying potentially eligible structures involved separating out those structures that were clearly not eligible. The three agencies in consultation developed criteria for this initial selection. Four bridge types -- trusses, masonry bridges, suspension bridges and concrete arches -- were seen as especially sensitive; all known examples of these types were inventoried. For the remainder -- concrete girders, steel girders, timber stringers, steel stringers and steel arches -- the initial cut was made by Caltrans staff after a careful inspection of highway bridge maintenance files. Properties were eliminated when they met certain criteria: they were less than 50 years old and not exceptionally significant; they were culverts, i.e. with spans of less than 20 feet, and not significant in other respects; they were modified to such an extent that the original design integrity was lost.

Identification was made easier by the existence of a computerized log of all state and local highway bridges, maintained by the Office of Structures Maintenance at Caltrans. The survey population was further diminished by excluding pedestrian, industrial, and railroad overcrossings and other bridges that do not actually carry highway traffic.

Documentation Essential data was gathered for each of the 998 bridges identified through the methods described above. This included: contractor; designer; date of construction; location of plans; documented relocation or structural modification; function of original highway route and significance to local and state transportation. Important archives consulted include: structures document archives at Caltrans, which contains plans for nearly all state and most local bridges; state construction contracts; county and city public works records; county board of supervisors minutes and county clerk records; and archives of local historical societies and museums. This information was computerized to facilitate easy retrieval and sorting by salient attributes.

Evaluation In consultation, Caltrans, FHWA, and the California SHPO agreed to utilize a quantitative evaluation system to help determine eligiblity for the three largest groups of bridges -- trusses, concrete arches, and concrete girders. After the initial selection, the inventory population included 432 trusses, 289 concrete arches, and 116 concrete girders. The remaining bridge categories included very few examples -- 35 concrete slabs, 12 suspension bridges, 11 tunnels, 47 stone masonry arches, 30 steel girders, and several types with fewer than ten representatives (steel arches, steel stringer, timber stringers, canticrete bridges, and box culverts). Caltrans staff elected to utilize traditional qualitative evaluation techniques for these latter bridge types, recognizing that the survey population was too small to produce meaningful statistics or to justify the expense of developing a formal computerized evaluative framework.

The evaluation methods for truss bridges are described in the aforementioned 1985 thematic request for determination of eligibility. The formal evaluation frameworks for concrete arches and girders are described below.

A large body of literature discusses the use of quantitative methods in the evaluation of historic resources, particularly with respect to historic residences, commercial structures and bridges.[1] Caltrans staff studied and tested several such systems, focusing upon those dealing specifically with historic bridges.

In consultation with FHWA and the California SHPO, Caltrans staff developed an evaluation framework that was based in large part upon an earlier system used by the Ohio Department of Transportation.[2] The Ohio system was modified, however, to reflect special circumstances in California and to correct perceived shortcomings in that earlier effort. The California system differs from the Ohio system in its treatment of integrity, significance of bridge designer, date of construction, design aesthetics and in several other areas. In making these modifications, Caltrans staff adapted some of the methods used by the Oregon Department of Transportation in its bridge survey[3] and by San Francisco Heritage in its survey and evaluation of commercial structures in San Francisco.[4]

Unlike bridge evaluation systems developed elsewhere, the California system utilizes different methods for the three most numerous bridge types -- trusses, concrete arches, and concrete girders. Practical as well as substantive considerations guided the decision to use three quantitative systems. Separate systems fit well into the two-year schedule, allowing for completion of the truss survey prior to initiating work on the remaining types. More important, the principals in the survey felt that evaluation could be more finely-tuned when discrete systems were utilized. Any system that was so general that it could deal with divergent bridge types might fail to recognize the qualities that define significance for the examples of each type.

The mechanism for the California truss, arch, and girder bridge evaluation systems are depicted below. General information on the truss system is included for comparative purposes. The arch and girder systems, which were used to evaluate bridges in this thematic group, are depicted in detail.

In each system, variables represents elements of bridge design or historical use which can define significance. The weighting system, i.e. the points assigned to each variable, serves two purposes: to transform ordinal into integer ratings, and to distinguish between variables as to relative importance.

COMPARISON OF TRUSS, ARCH, AND GIRDER SYSTEMS

Truss	Max. Pts.	Arch	Max. Pts.	Girder	Max. Pts.
Date	20	Date	20	Date	20
Designer/bldr.	12	Designer	12	Designer	12
Main span	8	Main span	8	Main Sp	8
Number spans	8	Total length	8	Tot.Leng	8
Surviving No.	20	Technological Merit	20	Tech.Mer.	20
Special Features	12	Special Features	12	Sp.Feat.	12
Aesthetics	10	Aesthetics	10	Aesth.	10
Trans./History	10	Trans./History	10	Tran/Hist	10
Integrity	-20	Integrity	-20	Integr.	-20

ARCH AND GIRDER EVALUATION SYSTEMS

Date (Same for arch and girder)

1910 and earlier	20
1911-15	17
1916-20	14
1921-25	11
1926-30	8
1931-37	4
1937-1945	0
1946+	-20

Designer (Same for arch and girder)

Major example of a significant designer	12
Minor example of a significant designer	6
Other	0

Main Span
Length (in feet)

Girder	Pts.	Arch Open	Pts.	Filled	Pts.
>=80	8	>=200	8	>=100	8
70-79	5	175-199	6	75-99	5
60-69	3	150-174	4	50-75	3
50-59	1	125-149	3	25-49	1
<50	0	100-124	2	<25	0
		75- 99	1		
		<75	0		

Total Length
Length (in feet)

Girder	Pts.	Arch Open	Arch Filled	Pts.
>=600	8	>=1000	>=200	8
300-599	5	500-999	100-199	5
200-299	3	250-499	50- 99	2
100-199	1	<250	<50	0
<100	0			

Aesthetics (Same for arch and girder)

Structure	
Excellent	5
Good	3
Fair	1
Poor	0

Setting	
Excellent	5
Good	3
Fair	1
Poor	0

5. Technological Significance (Same for arch and girder)

Excellent	20
Very good	15
Good	10
Fair	5
Poor/unknown	0

Special Features (Same for arch and girder)

Feature	Major	Minor	None
Decorative Lanterns	2	1	0
Decorative railings	2	1	0
Pylons	2	1	0
Decorative treatment of spandrel area (arch) or fascia (girder)	2	1	0
Distinctive texture (rustication; stone facing;etc.)	2	1	0
Pedestrian amenities	2	1	0

Transportation Significance/Historical Associations (Same for arch and girder)

National Significance	10
Statewide Significance	7
Local Significance	3
None/Unknown	0

Integrity (Same for arch and girder)

Location/Setting	
Excellent	0
Good	-3
Fair	-6
Poor	-9

Design/Materials	
Excellent	0
Good	-3
Fair	-6
Poor	-9

Feeling/Association.	
Excellent	0
Good	-1
Fair/Poor	-2

One should bear in mind that a quantitative system of this sort produces indicators, not indices, of significance. One can conclude with assurance that bridges with very high scores are quite significant, while those with very low scores are not significant. One may also discover a reliable significance threshold, a cut-off that separates significant from insignificant structures. In this system, for example, the cut-off appears to be about 48 points.

With any such system, however, quantitative analysis must be checked against expert opinion. With this system, for example, "length of span" is taken as a measure of the engineering difficult involved in the span. For most concrete arch bridges in the inventory, 100 feet is a reasonable test of a significant concrete arch span. This same measure, however, cannot adequately value the immense engineering achievement involved in a great span like the Bixby Creek Bridge, with a main span of over 340 feet, and a height of 260 feet above the streambed.

To ensure that such extraordinary circumstances were taken into account and ensure that standards were applied consistently, the quantitative evaluations were double-checked, using more traditional, intuitive methods.

In addition, the less numerous bridge types -- suspension, stone masonry, steel arch, concrete slab, and steel stringers -- were not subjected to quantitative analysis. Data for these bridges was, however, stored in a computer file, facilitating the same kind of sorting and analysis used for concrete girders and arches.

In conclusion, the 118 structures in this request for determination of eligibility are included as the result of a comprehensive inventory and analysis, using innovative quantitative techniques as well as traditional evaluation methods.

Summary of findings

The 118 bridges in this thematic group represent all phases in California transportation history and in bridge engineering since the late nineteenth century. Individual bridges are described in detail in the attached "Bridge Reports." The discussion below, augmented by Tables 1-5, outline some notable characteristics of this group.

TABLE 1 BRIDGES BY DATE OF CONSTRUCTION

Date	Thematic Group		Total Survey Group	
Pre-1900	4%	(4)	2%	(11)
1900-1910	16%	(19)	13%	(71)
1911-1920	36%	(43)	26%	(148)
1921-1930	29%	(34)	26%	(147)
1931-1940	14%	(17)	27%	(151)
1941+	1%	(1)	7%	(38)

TABLE 2 BRIDGES BY TYPE

Type	Thematic Group	Total Survey Group
Concrete Arch (Open)	41% (48)	20% (113)
Concrete Arch (Closed)	23% (27)	32% (176)
Concrete Girder	12% (14)	20% (116)
Concrete Slab	6% (7)	6% (35)
Masonry (Stone)	10% (12)	8% (47)
Steel Girder/Stringer	3% (3)	6% (36)
Suspension	3% (3)	2% (12)
Canticrete	2% (2)	1% (3)
Steel Arch	1% (1)	1% (7)
Timber Stringer	0% (0)	1% (3)
Other	1% (1)	3% (18)

TABLE 3: BRIDGES BY TYPE BY DATE

(THEMATIC GROUP)

	Pre-1900	1900-1910	1911-1920	1921-1930	1931-1940	1941+
MASONRY	3	4	4	1		
CONCRETE ARCH (closed)	1	12	10	1	1	
CONCRETE ARCH (open)		2	13	25	9	
CONCRETE GIRDER		1	9	1	3	
CONCRETE SLAB			4	2		1
STEEL GIRDER					3	
CANTICRETE			2			
SUSPENSION				3		
STEEL ARCH					1	
OTHER			1			

TABLE 4
BRIDGES BY DESIGNER

(THEMATIC GROUP)

	Pre-1900	1900-1910	1911-1920	1921-1930	1931-1940	1941
CONSULTING ENGINEERS OUT-OF-STATE		2	2			
CONSULTING ENGINEERS, CALIFORNIA	3	5	20	7		
COUNTY SURVEYORS OR CITY ENGINEERS		12	14	20	5	
DIVISION OF HIGHWAYS			6	7	11	1
UNKNOWN OR OTHER	1		1		1	

TABLE 5

EXAMPLES OF UNUSUAL BRIDGE TYPES

First concrete bridge in the United States

Lake Alvord Bridge, E. L. Ransome - 1889

Canticrete Bridges

Larkin Street Bridge, Leonard & Day - 1914
Seventh Street Bridge, Leonard & Day - 1916

"Thomas System" Three-Hinge Arch Bridges"

Parks Bar Bridge, Thomas & Post - 1912
Black Canyon Bridge, Thomas & Post - 1913
Rincon Hill Bridge, Thomas & Post - 1914

"Mushroom Slab" Bridges

Weber Creek Bridge, C. A. P. Turner - 1914
Sutter Road Bridge, E. T. Flaherty - 1915

First Freeway-to-Freeway Interchange

Four Level Interchange, Division of Highways - 1949

As shown in Table 1, all periods since the late nineteenth century are represented in this group. The distribution over time, however, is uneven, being something of a bell-shaped curve centered on the 1910s and 1920s. During these two decades, the initial California highway network was completed, including the state highway system as well as local roadways. Not until the freeway era of the 1950s and 1960s would this level of intensity in highway development be matched. In this sense, the distribution of the thematic group approximates that of highway bridge construction generally. The Thematic Group is somewhat skewed in favor of older bridges, relative to the distribution of the total survey population.

The types of bridges in this group, however, are less representative of the total population built over time, as shown in Table 2. It will be observed that over 64 percent of bridges in this thematic group are concrete arches, with 41 percent being open-spandrel arches. The records of the California Highway Commission and selected counties suggests concrete arches were not so heavily represented in the total population. Instead, for ordinary small crossings, concrete girder bridges and closed-spandrel arches were predominant. For exceptional crossings, however, the open-spandrel arch was preferred. The heavy representation of open-spandrel arches, then, reflects the exceptional quality of these bridges. They were monumental in scale and were more often adorned with architectonic detail befitting the prominence of the crossing. Open-spandrel concrete arches accounted for 20 percent of the survey population but 41 percent of the Thematic Group.

Table 3 offers some indication of the types of bridges that were built over time. The oldest bridges in the group are, with one exception,stone masonry arches. One should recall, however, that this figure is skewed by the absence of truss bridges, the typical bridge of nineteenth century California. The notable exception among nineteenth century bridges is the 1889 Lake Alvord Bridge, the first reinforced concrete bridge in the United States and by far the oldest concrete highway structure in California.

The temporal distribution of concrete bridges reflects changes in reinforced concrete technologies. The early twentieth century arches are all closed spandrel, earth-filled structures, either reinforced or plain concrete. The earliest open-spandrel arches in the state date to 1910. During the 1910s and 1920s, however, this form begins to emerge as the preferred bridge type, and by the 1930s, most large concrete arches were open-spandrel. Concrete slab and girder bridges were built throughout the twentieth century, as shown in this table.

Table 4 offers some indication of who designed these structures. Until about 1920, it was common for public agencies to hire private consulting engineers to design bridges. The California Highway Commission did very little of its own bridge design before 1920 and many county surveyors and city engineers were unable to keep up with the volume of design work for a rapidly expanding highway system. The prominent role of consulting engineers during this period is reflected in the bridges in this thematic group. One should not overlook, however, the pioneering work of some public service engineers in the early twentieth century. The work of J.G. McMillan of Santa Clara County and H.G. Parker of the City of Los Angeles are especially noteworthy.

After 1920, civil servants at the state and local level handled the bulk of bridge design work. Some of the most impressive structures in this thematic group are products of design teams assembled by public agencies. Most notable in this regard are the Los Angeles River bridges, designed by the Bureau of Engineering of the City of Los Angeles, and the Big Sur Arches, designed by the California Division of Highways.

Table 5 offers an indication of a special quality to the California non-truss bridges -- the presence of bridges of very unusual design. The bridges on this list reflect the continuing tradition of innovation in bridge design among California engineers, from E.L. Ransome's pioneering reinforced concrete arch of 1889 to the prototype freeway interchange, the Four Level Interchange, of 1949.

<u>Relationship to Properties Listed in or Determined Eligible for Listing in the National Register of Historic Places</u>

This thematic group includes bridges that meet the National Register eligibility criteria but are not currently listed in or determined eligible for listing in the National Register of Historic Places. Not included are truss bridges, dealt with in the 1985 thematic request for determination or previously listed in or determined eligible for listing in the National Register of Historic Places.

Also excluded from this thematic request for determination of eligibility are those non-truss California bridges that were previously listed in or determined eligible for listing in the National Register of Historic Places. Listed below are California non-truss bridges for which National Register eligibility has already been determined:

LISTED IN NATIONAL REGISTER

Name	Number	County	Crossing
Yosemite Cr. Bridge		Mariposa	Yosemite Cr.
Ahwahnee Bridge		Mariposa	Merced River
Clark Bridge		Mariposa	Merced River
Pohono Bridge		Mariposa	Merced River
Sugar Pine Bridge		Mariposa	Merced River
Tenaya Creek Bridge		Mariposa	Tenaya Creek
Happy Isles Bridge		Mariposa	Merced River

Stoneman Bridge		Mariposa	Merced River
(Listed as "Yosemite Valley Bridges")			
Clover Creek Bridge		Tulare	Clover Creek
Lodgepole Bridge		Tulare	Marble Fork
(Listed as "Generals' Highway Stone Bridges")			
Colorado St. Bridge	53C-107	Los Angeles	Arroyo Seco
Oaklawn Bridge	N/A	Los Angeles	RR Tracks
(Listed as Oaklawn Bridge and Waiting Station)			
Macy St. Underpass	53C-131	Los Angeles	RR Tracks
(Listed as part of Los Angeles Union Passenger Terminal)			
Carroll Canal Bridge	53C-1688	Los Angeles	Carroll Canal
Linnie Canal Bridge	53C-1689	Los Angeles	Linnie Canal
Howland Canal Bridge	53C-1690	Los Angeles	Howland Canal
Sherman Canal Bridge	53C-1691	Los Angeles	Sherman Canal
(The previous four bridges listed as part of Venice Canals Historic District)			
Cabrillo Bridge	57-215	San Diego	S.R. 163
(Listed as part of Balboa Park National Historic Landmark)			
Culvert	N/A	Santa Barbara	Canal
(Listed as part of La Purisima Conception National Historic Landmark)			
Pope Street Bridge	21C-109	Napa	Napa River
Alexander-Acacia Bridge	27C-150	Marin	Alexander Ave. Overhead

DETERMINED ELIGIBLE FOR NATIONAL REGISTER LISTING

Name	Number	County	Crossing
Crow Creek Bridge	33C-204	Alameda	Crow Creek
Gilman Road Bridge	37C-537	Santa Clara	Llagas Creek
Dry Creek Bridge	38-54	Stanislaus	Dry Creek
Arroyo Hondo Bridge	51-27Y	Santa Barbara	Arroyo Hondo
Arroyo Quemado Bridge	51-28L	Santa Barbara	Arroyo Quemado
York Boulevard Bridge	53-121	Los Angeles	I-110
Hough St. Overcrossing	53-276	Los Angeles	Hough Street
Sycamore Grove PUC	53-344	Los Angeles	I-110
26th Avenue OC	53-372	Los Angeles	I-110
Santa Fe Overcrossing	53-425	Los Angeles	I-110
Pasadena Avenue OC	53-426	Los Angeles	I-110
Avenue 43 Overcrossing	53-427	Los Angeles	I-110
Avenue 52 Overcrossing	53-428	Los Angeles	I-110
Via Marisol OC	53-429	Los Angeles	I-110
Avenue 60 OC	53-430	Los Angeles	I-110
Old Santa Fe OC	53-431	Los Angeles	I-110
Pedestrian Undercrossing	53-432	Los Angeles	I-110
Arroyo Drive OC	53-433	Los Angeles	I-110
Grand Avenue OC	53-434	Los Angeles	I-110
Orange Grove Avenue OC	53-435	Los Angeles	I-110
Prospect Avenue OC	53-436	Los Angeles	I-110
Meridian Avenue OC	53-437	Los Angeles	I-110
Fremont Avenue OC	53-438	Los Angeles	I-110
Third Santa Fe OC	53-439	Los Angeles	I-110
Marmion Way OC	53-445	Los Angeles	I-110
Figueroa Street UC	53-533L	Los Angeles	I-110

Fair Oaks Avenue OC	53-540	Los Angeles	I-110
Marmion Way Off Ramp	53-886S	Los Angeles	Arroyo Seco
Avenue 43 Off Ramp	53-985S	Los Angeles	Arroyo Seco
Avenue 60 Off Ramp	53-986S	Los Angeles	Arroyo Seco
Pedestrian Undercrossing	53-988T	Los Angeles	I-110
(26 previous bridges determined eligible as part of Arroyo Seco Parkway)			
San Luis Rey Bridge	57-43	San Diego	San Luis Rey River
Golden Gate Bridge	27-52	Marin	San Francisco Bay
Shafter Bridge	27C-74	Marin	Corte Madera Creek
Sir Francis Drake Bridge	27C-50	Marin	Corte Madera Creek
Glenwood Avenue Bridge	27C-72	Marin	Corte Madera Creek
Laguintas Avenue Bridge	27C-71	Marin	Corte Madera Creek
Norwood Avenue Bridge	27C-149	Marin	Ross Creek
Shady Lane Bridge	27C-78	Marin	Corte Madera Creek
Van Duzen River Bridge	4-97	Humboldt	Van Duzen River
Honcut Creek Bridge	16C-25	Yuba	Honcut Creek
Donner Summit	17C-52	Nevada	Donner Summit

Non-truss elements of the San Francisco-Oakland Bay Bridge -- suspension spans, tunnel, steel girder spans, and concrete girder spans -- were determined eligible as part of the San Francisco-Oakland Bay Bridge, included with the 1985 Thematic Group for Historic Truss Bridges in California.

8. STATEMENT OF SIGNIFICANCE

Summary

The central theme for this request for determination of eligibility is the evolution of bridges, other than trusses, as links in the California highway system. With respect to the formative California History Plan, these bridges relate to the theme of transportation and the subtheme of highway bridges. With respect to National Register eligibility criteria, these bridges are eligible under Criterion A, as important elements in the development of a highway transportation system, and under Criterion C, as distinctive examples of types, periods, and methods of construction, as works of master builders and designers, and as works that possess high artistic value. These bridges retain integrity of location, setting, design, materials, workmanship, feeling, and association, as required under National Register eligibility criteria. Applicable "areas of significance" as identified in 36CFR63 guidelines and in National Register inventory forms are engineering and transportation.

Nearly all bridges in this thematic group were built between 1900 and 1935. This was a watershed period in highway bridge construction technology and in the development of a state highway system. The most significant technological innovation was the perfection of reinforced concrete as a bridge construction material. Major advances were made as well in the use of metal wire and steel girders in bridge construction. The expanding state highway system was the engine behind these innovations in bridge design. By the end of this period, the highway bridge was distinctively different from the railroad bridge, bearing little resemblance to the railroad-type truss commonly built at the turn of the century.

To establish a context for evaluating the significance of the bridges in this thematic group, we will survey briefly the development of the California highway system, and look in greater detail at the development of the various bridge building technologies.

A. Bridge-Building Institutions

Until the 1880s, highway bridge building in California was a predominantly private operation. While a few counties built public bridges as early as 1855, it was not until 1874 that the State Legislature adopted a comprehensive program through which counties could establish road districts, road commissioners, and property taxes earmarked for road construction.[1] The ability of counties to execute bridge construction was enhanced by an 1893 state law mandating each county to seek the advice of its county surveyor on bridge design. This law had the effect of professionalizing the office of county surveyor and helped attract trained bridge engineers to the office.[2] The situation was also improved by the 1907 passage of the Savage Act, permitting counties to incur bonded indebtedness to finance road and bridge construction.[3] Underlying this spate of activity was the appearance of large numbers of automobiles on county roads and the general "Good Roads" Movement, which gained statewide exposure with the State Road Convention of 1893.[4]

Between 1889 and 1910, county surveyors and other local officials designed or authorized hundreds of highway bridges. The bridges they built in many cases reflect local traditions and the preferences of the county surveyor. Stanislaus County, for example, built truss bridges for all types of crossings long after this bridge type had fallen out of favor in other areas. Napa County, with a long tradition of stone masonry in building construction, continued to build masonry arches until World War I. Eight Napa County masonry arch bridges are included in this Thematic Group.

More typically, counties built trusses early in this period but shifted gradually to reinforced concrete. The experience of Santa Clara County is instructive in this regard. John G. McMillan, county surveyor between 1890 and 1914, preserved what appears to be a complete set of plans for bridges he designed. McMillan was a railroad surveyor in California and Central America, a mining engineer, and an engineer for Stanford University before his election as Santa Clara County Surveyor. His earliest bridges were "combination" (timber and steel) trusses or wooden trestles. In 1896, he began to build concrete bridges. He experimented with various unorthodox reinforcing systems, combining concrete and stone in an 1896 bridge, concrete and brick in another, and concrete with a steel arch truss in 1897. He was also quite sensitive to design considerations for bridges in pastoral rural areas, often working native rubble into the texture to create a "harmony" with the natural environment. Two such structures -- 37-74 and 37C-237 -- are included in this thematic group. Although his bridges were often eccentric, McMillan's transition from truss to concrete bridge design was typical of surveyors throughout the state.[5]

For all counties, the transition from metal truss to concrete bridge design included a certain amount of experimentation. San Mateo County, for example, decided in the late 1890s to built a number of short span concrete arches across small streams that traverse the area. The county surveyor, apparently unfamiliar with the principles of concrete construction, contracted with the San Francisco consulting engineering firm of D. Bromfield and C. Tobey to design these structures. The contract for one such structure was let in 1899. It was canceled, however, when the contractor declared that "the specifications were defective to such an extent that structure if built thereto would be utterly worthless." [6]. Perhaps because of such problems, the county surveyor installed a bronze marker on the first concrete arch to be completed, bearing the inscription "First Concrete Bridge Erected in San Mateo Co. 1900." This structure, 35C-25, spans Pilarcitas Creek on Main Street in Half Moon Bay and is included in this Thematic Group.

By 1910, most local governments, cities as well as counties, had gained the expertise to design concrete bridges on their own. The leaders in this regard were the city and county of Los Angeles. Arguably the first American city to experience persistent traffic jams, Los Angeles officials recognized early the need for improved arterial streets and viaducts to carry traffic across the Los Angeles River and adjacent railroad tracks. Prototype viaducts were built in 1910, including the massive Buena Vista (North Broadway) Bridge (53C-545), the oldest and likely the original open spandrel arch bridge in California, and the smaller Main Street Bridge (53C-1010). The Buena Vista Bridge was a prototype, not only for traffic planning and use of the open spandrel form, but for Beaux Arts detail and monumentality as well. City officials noted with pride that this structure was designed entirely by civil servant engineers.

The great engine for bridge construction was not local highways, for massive local programs such as that in Los Angeles were rare. Instead, the major impetus for highway bridge construction and innovation in bridge design, was the development of a state highway system.

The origins of the system trace back to the late nineteenth century. A statute enacted in the first session of the California legislature in 1850 empowered the state's Surveyor General to make suggestions for road improvements. Only one road -- the Lake Tahoe Wagon Road -- was built with state assistance before 1895.

In 1895, the State Legislature created the Bureau of Highways to study routes for potential state highways. Two years later, this agency was renamed the Department of Highways and given minor appropriations for acquisition of land and road improvements. In 1907, this department was incorporated into the larger Department of Engineering, along with water development, architectural services, and other public works agencies. In 1910, California voters approved the first of several multi-million dollar bond measures to finance large-scale highway construction. The 1911 Chandler Act passed by the State Legislature created an advisory board, the California Highway Commission, forerunner of today's California Transportation Commission, to establish policy and oversee expenditure of bond act money.[7]

The building of State highways at different time and in different counties called into service the work of county engineers, private consulting engineers, and the staff of the state highway department. In its first policy statement on bridge construction in 1912, the California Highway Commission requested that counties supply bridges that could connect with State-constructed roadways,[8] shifting the major burden for state highway bridge construction to the local level. Only rarely did the Highway Commission staff design bridges during the first two decades of the century. The oldest extant bridges designed by the state -- 10C-143, built in 1913, and 36C-48 and 6-195Y, both built in 1915 -- are included in this Thematic Group.

The building of U.S. 101 in Santa Barbara County illustrates how state highway construction influenced both local public officials and private consultants. This route was one of the earliest major north-south State highways, and nearly 100 miles of this route pass through Santa Barbara County. It crosses numerous deep ravines and arroyos; today, there are more than 100 bridges along U.S. 101 in Santa Barbara County.

The county spent hundreds of thousands of local tax dollars designing and building bridges for this route between 1910 and 1920. Designing these many structures taxed the abilities of county surveyors F. Flournoy and O.H. O'Neill. Neither was trained in bridge design and both pleaded with the county to provide them with more assistants to handle this task.[9] Unable to secure sufficient in-house expertise, they turned to consulting engineers in Los Angeles to design state highway structures. Offering a royalty of two and one-half percent of construction costs, Flournoy and O'Neill attracted the services of the better consulting firms -- Mayberry and Parker, Thomas and Post, and Edward T. Flaherty. In several instances, two or more firms submitted proposals for a single structure, enabling the Board of Supervisors to seek bids on multiple alternatives.

Even with these consulting services, the County was unable to keep up with highway construction. In 1917, the Board of Supervisors requested that the California Highway Commission prepare plans for a major structure across the Arroyo Hondo. This bridge afforded the small state Bridge Department staff its first opportunity to design a major span. The resulting structure, 51-27Y, previously determined eligible for listing in the National Register, was a structural and aesthetic success; it was recently bypassed and preserved in place.

It is not surprising that the Arroyo Hondo was a reinforced concrete arch, for the Highway Commission showed a preference for concrete bridges from the outset. In a 1912 policy statement pertaining to bridge design, the Commission asserted:

> Further, that the commission hereby declares itself in favor of concrete structures whenever such structures are consistently possible because of their substantial permanency.[10]

In addition to encouraging local agencies to design concrete structures, the Commission practiced this policy as well. In a 1920 study of the operations of the California Highway Commission, the U. S. Bureau of Public Roads identified 47 bridges designed by Commission staff. Of these, 39, or 82 percent, were of reinforced concrete.[11] The majority were small-span concrete girder bridges. Large spans were concrete arches.

By 1923, the California Highway Commission had grown weary of waiting for counties to complete structures. Assured of a predictable source of funding with the 1923 passage of a 2 cent per gallon gas tax, State Engineer, R.M. Morton "directed that the construction of all bridges, as well as their design, should, in the future, be under the direction of the Headquarters Bridge Department."[12] This directive shows the growing confidence the Commission placed in the design staff assembled by Bridge Engineer Harlan D. Miller. In 1924, Miller's staff included two office engineers, four designers, 12 draftsmen, 10 construction engineers, one cost estimator, and one specifications writer.[13]

After 1924, virtually all state bridges were designed by state engineers. A corresponding professionalization occurred at the local level. The role of the consulting bridge engineer was restricted to design of specialty structures, such as movable bridges, or very large structures, such as the Golden Gate Bridge. Financial arrangements were similarly well-established by the 1920s, with the state assuming responsibility for funding bridges on state highways and local governments funding strictly local structures, and with the Bureau of Public Roads (now Federal Highway Administration), supplying federal aid at both levels. Special arrangements were required, however, for special circumstances -- for very large and expensive structures, such as the Golden Gate Bridge, for bridges on federal lands, for bridges crossing county lines, and for bridges associated with federal flood control projects or with the various New Deal works projects, such as the Civilian Conservation Corps or Works Progress Administration.

Several conclusions may be drawn from the foregoing. First, the bulk of California highway bridges were designed by civil servants, either county surveyors or engineers in the Division of Highways (Caltrans). Some of the more interesting bridges, however, are those designed by consulting engineers in the early part of the century, when expertise was wanting in the civil service. These consultant-designed bridges are often the most innovative and are highly represented in this thematic group. Second, the typical bridge built in California between 1900 and 1935 was of reinforced concrete, with girders serving shorter spans and arches serving the larger spans. Not surprisingly, concrete bridges make up the bulk of this thematic group. Suspension bridges, while constructed on occasion in the nineteenth century and in greater numbers in the 1930s, have never accounted for more than a tiny fraction of California bridges. Stone masonry bridges are predominantly a nineteenth century type, built later only in selected regions of the state. Steel arches and steel girders have been utilized sparingly as highway bridges in California, chiefly since the 1930s.

B. Reinforced Concrete Arch, Girder, and Slab Bridges

Reinforced concrete -- concrete with embedded steel bars which bond with the concrete and provide tensile strength -- was first used as a building material in Europe in the late 1840s. Use of this building material in the United States dates to the mid-1870s. Early reinforced concrete structures built in the United States were large residences, warehouses, and sidewalks.[14]

Europeans were first to utilize reinforced concrete in bridge construction, building several arched bridges in the mid-1880s, using the "Melan System," which relied upon steel I-beam reinforcement, and the "Monier System," which used wire mesh reinforcement. The first American reinforced concrete bridge was an 1889 arch built in San Francisco, which used the twisted reinforcement bar developed by Californian E.L. Ransome.[15]

After 1900, European and American engineers went separate directions in reinforced concrete bridge design. Where European bridges tended toward the thin, elegant and non-historical designs of Robert Maillart, Eugene Freyssinet, and others,[16] American reinforced concrete bridges used bulkier arches decorated with historical detail.[17] Maillart pointed the way for a distinctively European reinforced concrete bridge, while the early designs of George Morison may be seen as typifying the American approach.

California reinforced concrete bridges are both typical and exceptional within the larger context of American structures of this type. Certainly they are as a group much closer to Morison's designs that to Maillart's.

What is distinctive about the California concrete bridges is that they are numerous and "home-grown." Owing to the high cost of steel on the West Coast and the ready availability of high-quality cement in California, concrete construction was economically feasible earlier in California than elsewhere. In absolute numbers and in proportion to the total number of historic bridges, reinforced concrete structures appear to be more numerous in California than in any other state in the union.[18]

The vast majority of California reinforced concrete bridges were designed by Californians. A few were the work of well-known out-of-state engineers: J.A.L. Waddell designed the Colorado Street Bridge in Pasadena and Bertram Goodhue helped design the Cabrillo Bridge in San Diego; both bridges are listed in the National Register. D.B. Luten designed the Orland Bridge (11C-196). Most California concrete bridges, however, were designed by engineers in the employ of California local government, state government, or by private consultants with offices in California.

These Californians left a distinctively regional imprint on the body of California concrete bridges. This imprint was often technological. California engineers were innovative and quick to patent their discoveries. Equally important, California engineers developed a comprehensive design aesthetic for bridges that could to conform to the desirable urban, rural, and wilderness environments in the state.

Pioneering work by Californians in reinforced concrete design began in San Francisco in the late nineteenth century. It was chiefly concerned with commercial and industrial buildings and secondarily with transportation features, such as sidewalks, roads, and bridges. The driving force behind this early phase of reinforced concrete work was Ernest L. Ransome.

Ransome arrived in San Francisco during the 1860s, fresh from apprenticeship in his father's iron-works factory in Ipswich, England. In San Francisco he supervised the Pacific Stone Company, which manufactured and marketed concrete blocks according to his father's patent. In the mid-1880s, Ransome began devising a number of innovative techniques in the use of plain and reinforce concrete, nearly all of which he patented. His patents included an 1882 expansion joint for concrete sidewalks, an 1884 twisted reinforcement bar, an 1884 concrete mixer, and an 1888 mold for pouring concrete tunnels.[19] Ransome also had a number of major commissions for buildings in Northern California, most in conjunction with architect George Percy.

In 1888-9, Ransome, probably in conjunction with Percy, designed the Lake Alvord Bridge in San Francisco's Golden Gate Park. The bridge was designed to carry a carriage road across a pedestrian pathway connecting the Haight Street entrance to the park to a newly-constructed Children's Playground. The bridge is remarkably unmodified and still in use. This, the first reinforced concrete bridge in the United States, passed almost without notice at the time it was built. The Board of Park Commissioners noted in their 1889 report that "Over the walk a very handsome bridge has been erected and the drive graded up to the crown." Ransome himself did not even mention the structure in his lengthy 1912 reminiscences on his early work in San Francisco. Apparently no plans exist today for this bridge so we cannot say with certainty how it was built. It is highly likely, however, that Ransome used his own patented twisted bar for reinforcement, as he did with most major commissions after 1884.

The Lake Alvord Bridge is highly significant in two regards. First, as noted it is the oldest reinforced concrete bridge in the United States, predating by four years the first "Melan-system bridge" built in the United States. Second, in his use of twisted bar reinforcement, Ransome pointed the way to the predominant twentieth century practice. The alternative system, developed by Joseph Melan and introduced in the United States by Fritz von Emperger, utilized heavy I-beam reinforcement. Interestingly, Ransome himself initially utilized I-beam reinforcement but developed the twisted bar because I-beams were expensive and, being smooth, would not bond adequately with the concrete.[20] While relatively few plans remain for reinforced concrete bridges built in California before 1905, it seems clear that California engineers did not adopt the Melan-system, popular elsewhere in the United States, but rather began and continued with the superior Ransome system of reinforcement.

The most likely forum for spreading word of Mr. Ransome's ideas about concrete bridge reinforcement was the Technical Society of the Pacific Coast, an eclectic organization for engineers, construction contractors, and other professionals in the San Francisco area.[21] Ransome was an active member of this organization, as were many of the other Northern California engineers who experimented in reinforced concrete bridge construction before 1910.

One engineer who was a member of the Technical Society and at the forefront of early reinforced concrete bridge design was John Buck Leonard. Leonard, born and educated in the Great Lakes area, came to California in the 1880s. For nearly two decades he worked for bridge building firms, including the Southern Pacific Railroad and Healy-Tibbetts & Co. In 1904, he set up his own office in San Francisco, specializing in concrete bridges and, to a lesser degree, in reinforced concrete buildings. His first bridge was a closed spandrel reinforced concrete arch across the Truckee River in Reno, Nevada, still standing. He continued designing closed spandrel arches of surprisingly large spans through 1911. The greatest of these was the 1911 Fernbridge on the state highway across the Eel River in Humboldt County. This massive structure includes seven 200 foot spans, to this day the largest closed spandrel concrete arch bridge in California (4-134). From the 1910s through the early 1920s, Leonard experimented with a "canticrete" system of reinforcement. Similar in some respects to the Melan system, a "canticrete" structure utilized a cantilevered truss of steel I-beams to provide a sidewall and floor substructure. The truss was designed to cut costs in form work. The greatest of these was the Seventh Street Bridge in Modesto, California (38C-42). A smaller canticrete bridges is the Larkin Street Bridge (44C-82) in Monterey. Late in his career, Leonard designed a number of very elegant open-spandrel arch structures using more conventional reinforcement systems. One example of this late period is the Chili Bar Bridge (25-33) on the American River.[22]

After about 1910, several important consulting bridge design firms operated from Los Angeles offices. One firm, Thomas and Post, was founded by William Thomas, one of the most creative of the early reinforced concrete bridge designers in California. Born in St. Louis, Missouri in 1876, Thomas studied architecture at the Chicago Art Institute. After working as a structural engineer on railroad terminals, Thomas moved laterally into railroad bridge engineering. By 1906, Thomas had moved to California to work with the Union Traction Company, an interurban line in Santa Cruz, California.

It was in the employ of this firm in 1906 that he devised the bridge that would thereafter be known as the Thomas System, or the Thomas Three-Hinge Arch. Thomas did not invent the three-hinge arch, an arch with hinges at each abutment and the crown; hinged arches had precedent in metal bridges and had been executed in concrete in Europe before 1906. Thomas was aware of

European precedents -- in a 1914 article, he listed twelve German bridges he studied before building his Santa Cruz structure. Thomas' innovation was to precast arch rings in molds on the ground, hoist these into place and fix them at the hinges. In time, Thomas, who set up a private practice in Los Angeles shortly after completing the Santa Cruz bridge, built dozens of such structures in California, chiefly in the Southern counties. Unfortunately, very few remain. The original Santa Cruz bridge remains but has been altered considerably and is not included in this thematic group.

The most impressive of the remaining Thomas System structures is the Parks Bar Bridge on State Route 20 (16-11). It is by far the longest of the extant Thomas arches and, at 685 feet total length, with a main span of 140 feet, is an impressive early concrete arch of any configuration. The bridge also typifies Thomas' approach to bridge aesthetics. Although he published many articles on bridge engineering, Thomas, a trained architect, was entirely silent on the issue of bridge architecture. We can infer his aesthetic principles, however, from his ouvre, with the Parks Bar Bridge being the best example. Thomas eschewed applied decorative features altogether. The beauty of his bridges is in the clean lines of the parabolic arches and in the straightforward lines of the piers and abutments. Even his railings were unadorned; Thomas designed only simple pipe railings, such as those found at Parks Bar. While he may be seen as simply overlooking architectural detail for his overriding interest in engineering innovation, a more likely explanation is that he saw a beauty in the lines of the bridge and intentionally eliminated applied decoration. To this extent, he was as forward looking in bridge architecture as he was in bridge engineering, anticipating the aesthetic approach utilized by the California Division of Highways in its famous arches of the 1930s. The Parks Bar is, in a phrase used by Thomas to describe a near-twin in Ventura County, "a pleasing structure, obviously strong and permanent."[23] Other Thomas Three-Hinge Arch bridges are 51C-39 and 57C-361, also included in this thematic group.

The Thomas System is important, not simply because it was three-hinged but for its use of precast concrete bridge members. Thomas also patented a reinforced concrete slab system, originally designed for warehouse used but adapted for bridge use. Only one example of this bridge type exists --41C-6, in Madera County.

Mayberry and Parker, another Los Angeles private consulting firm, designed many concrete arches in the first two decades of the twentieth century. Their contribution to the field, however, was primarily in the design of concrete girder structures. Similarly, Edward T. Flaherty, another Los Angeles-based bridge and structural engineer, designed some arch bridges but is best-known as the engineer responsible for introducing the "Slab-Mushroom Column" system patented by C.A.P. Turner to California. Apparently only two Turner

System bridges remain in the state. One was designed by Flaherty using patented Turner reinforcement (29c-232), in Stockton. The other, 25C-116, is an reinforced concrete arch, with the Turner mushroom-and-slab system used in the spandrel columns and deck.

In time, the momentum for bridge design passed from these consulting engineers to local and state civil servants. It is more difficult to assign individual responsibility for public structures, but certain individuals do stand out among the hundreds of individuals involved.

The California Highway Commission was from the outset staffed with talented bridge designers. Harlan D. Miller was the second state Bridge Engineer. Born and educated in Ohio, Miller, like many private bridge engineers of the period, began his career designing railroad structures. He later worked with a private engineering firm in San Francisco. In 1919, he joined the staff of the California Highway Commission, rising to chief of the bridge department in the early 1920s. It was Miller who directed that the department take over all state highway bridge design and construction and who presided over expansion in the department. Miller's lasting contribution was in the area of bridge architecture. He insisted that great attention be paid to those details that, in his view, defined a handsome structure -- railings, endposts, spandrel detail, and so forth. This tradition would continue after his death in 1926 and indeed became something of a signature for state bridges, particularly long-span reinforced concrete arches. One of Miller's most successful bridges is the Donner Summit Bridge, 17C-152.[24]

Miller's successor, Charles E. Andrew, came to California after work with the Oregon State highway department and with nationally-known bridge designer, Ralph Modjeski. Andrew, along with State Highway Engineer, C.H. Purcell, had been involved with the design of the handsome concrete arch structures along Oregon's Columbia River Highway, and brought this design aesthetic to the California Highway system.[25]

In 1928, Andrew outlined the design principles that guided the operations of his departments. "It has been said," Andrew observed, "that no objects in America more greatly mar the landscape than the bridges, and none in Europe are more attractive." The general American failure he attributed to "Lack of artistic training in engineers, limited resources, competition and haste in construction, undesirable or unsymmetrical location, inadequate materials, absence of state or municipal supervision." Andrew called for "higher ideals in bridge designing" and saw special opportunity for such structures along the scenic, remote reaches of the state highways. "It is the hope of the bridge engineer," he noted, "that the finished structure will be durable, pleasing in appearance, conform to the canyon or stream; so that both layman and engineer will gain the impression that bridge construction is being kept abreast with building of modern highways."[26]

The Division of Highways succeeded in answering Andrew's "higher ideals" with many of its wilderness bridges, but none succeeded so spectacularly as the series of early 1930s structures along State Route 1 between Carmel and San Luis Obispo, along the rugged and beautiful Big Sur coastline. Among these, the Bixby Arch (44-19) is best-known. Its fame as one of the most beautiful bridges in the United States owes in large part to the lightness of its form, especially the tapering parabolic arch ring which appear paper-thin at the crown. It is as well a pleasing complement to the rugged Big Sur coastline, expressing its own power and gracefulness but with a very slender profile.

Among municipal bridges, the viaducts across the Los Angeles River are especially noteworthy. These structures embody precocious transportation planning, combining grade separations with a set of arterial streets linking the downtown areas with residential suburbs. Many are also technologically innovative, such as the 4th Street Bridge, which was reported in professional literature for its innovation in a "fixed-hinge" design, and the Glendale-Hyperion Bridge, which accommodates an extremely complex traffic flow.

The Los Angeles Viaducts, however, are of particular interest for their success in addressing City Beautiful concerns for bridges as urban monuments. The case for the City Beautiful bridge was made forcefully in a 1913 article in The Architect and Engineer of California by H.G. Tyrrell. As a city grows, Tyrrell argued, bridges will proliferate at major crossings. These many bridges "will stand at almost every water crossing, either as an honor or as a shame to their originators." These bridges, in his view, should be treated as public monuments, like post offices or city halls, and decorated in the same manner. "The proper rule for the beautifying of public works is to adorn those structures which are of greatest public service." The adornment he had in mind was the Beaux Art classicism of the 1893 Chicago World's Fair. Given this sense of proper decorative, Tyrrell ruled out use of the truss, which he called an "abomination and should be avoided wherever possible", and recommended bridges that could be given decorative treatment, which in the technological vocabulary of 1913 meant the reinforced concrete arch.[27]

This same conception of the City Beautiful bridge was expressed earlier by Charles Mulford Robinson in his 1909 report, "The City Beautiful", to the Los Angeles Municipal Art Commission. He chided the city for erecting truss bridges as major river crossings, arguing they are "about as ugly as they can be. As these are replaced, handsome structures should be substituted... the concrete arch now makes practicable a bridge that is beautiful at no more cost than the old ugly iron bridge of the railroad type."[28] Very difficult and lengthy legal battles, taken even to the U.S. Supreme Court delayed construction of these bridges for several decades.

Passage of a large bond measure in 1923 made construction of viaducts possible. As the city prepared for the design of these many structures, it clearly had not forgotten the advice of the original City Beautiful advocates. City Engineer, John Griffin, promised the city council that traffic circulation practicalities and architectural sensibilites would go together in design consideration. "The character of the structures will be such as to excite favorable comment from visitors who enter and leave Los Angeles by the railways, and their construction will not only relieve traffic congestion, but will raise the status of Los Angeles as an enterprising, properly developed city."[29]

When the viaducts were essentially completed in 1932, the city engineer took time to reiterate the intent of the program and point to his success in achieving that. "The viaducts themselves have taken taken their place among the sightly structures of the city."

If one considers the total body of reinforced concrete bridges in California, from the stone-faced arches of J. G. McMillan to the great span wilderness bridges of the Division of Highways, to the ornamental urban monuments of Los Angeles, it is clear that Californians were particularly successful in adapting the reinforced concrete arch to a diversity of environments. They recognized the plasticity of concrete as a building material and the inherent beauty of the arch form, and developed different concrete arch designs for the varied environs of California. This may ultimately be the most important contribution of California bridge engineers to reinforced concrete bridge technology and to the cultural landscape of California.

C. <u>Stone Masonry Bridges</u>

The closed spandrel, earth-filled masonry arch bridge is one of the oldest types of man made structures used to cross rivers and valleys. Masonry arches were built as early as 3000 B.C. in China, though the Romans are most reknown for building numerous stone arch bridges which linked the Roman Empire with an extensive highway network.[30]

An early design feature of masonry bridge building from the Roman period was the use of a large stone arch ring with smaller material used in the spandrel walls. Generally, during this period arches built in Western Europe were either circular or elliptical shaped while in Eastern Europe and Asia the pointed (gothic) shape was often used. Although advanced in bridge engineering, the Romans constructed crude foundations. Commonly, loose stones were thrown in the river until a platform (pier) on which they could construct their masonry arches was achieved.[31]

Following the fall of the Roman Empire, masonry bridge building declined and was characterized by the construction of massive, crudely designed arches. However during the 16th to 17th centuries, bridge building began to exhibit greater refinement of design. This was due to improvements in foundation construction, increased use of wood pilings, and better skilled stone masons.

Following the 18th century iron, steel, and later concrete emerged as the preferred building materials for bridges. These materials allowed for the construction of other types of bridges, however, masonry bridge construction did continue with regularity to 1925.

Europeans are recognized for bringing the art of stone arch bridge construction to the United States. However, it was quickly realized that the masonry arch bridge so common in Europe was not adaptable to many river crossings here in the U.S. Their short spans and massive piers were too narrow to allow ice flows to pass and subsequently trapped floating debris.

Nevertheless, prior to about 1912, many masonry arches were constructed in this country wherever the right conditions existed. Some of these noteworthy bridges were: The High Bridge which served as a aqueduct in New York; the Cabin John Arch, built in 1864 in Washington D.C.; and the Memorial Bridge, built in 1912 to cross the Connecticut River.[32]

California's earliest bridges were built using local materials and a minimum of labor. Labor was in short supply in the mountainous areas of California. Often truss and suspension bridges were used to cross rugged terrain. Occasionally, simple timber stringer bridges incorporated masonry work in piers, abutments or wingwalls. Here stone from nearby fields or the streambed was utilized. California's stone masonry arch bridges are concentrated in Napa County.

The early depletion of the local timber, combined with numerous small creeks and a river that could be crossed with a short span or spans, set the stage for stone masonry bridge construction in the Napa Valley.

The prevalence of stone construction in the Napa Valley can be linked to a number of factors. First, the early settlers of the Napa Valley were largely from the rural provinces of Europe. Among these immigrants were experienced stonemasons who brought the building methods and technologies of their native lands. Their farms and vineyards called for building of fences, bridges, distilleries and cellars, and for this they used the techniques with which they were familiar.[33]

Second, the availability of appropriate natural resources: native stone was first quarried in Napa Valley in 1846 for the burrs, or millstones, used in the Bale Mill. Napa Valley's rock-ribbed mountains are abundant with limestone, sandstone and volcanic tuff. These stones presented cheap, available building material that could be handled rapidly for the construction of buildings and bridges. As many as thirteen quarries were located in the valley. Suitable building stone was also available in nearby fields and stream beds.

Third, the availability of abundant and inexpensive manual labor came from the indentured Chinese who came to work in the valley's vineyards and quicksilver mines. Since the mines ceased effective production within a very few years, and since extensive labor supplies were required in the vineyards only on a seasonal basis, ample manpower was usually present for the building of stone projects.

Achilles F. Grigsby, who arrived in Napa County in 1845 and became a County Supervisor in 1857, is credited by some as being the first to advocate use of local stone as a building material. The County's first stone arch bridge was built in 1860. The use of good quality local stone for buildings began about 1860 with the establishment of several quarries in the county. Stone work is displayed in a variety of structures in Napa Valley, in private dwellings, public buildings, wine cellars and bridges. Most of these stone structures are still sound and in use. The most prominent and numerous are the stone winery buildings. They are best described by Anne Roller Issler in the following terms: "Architecturally, the old stone wineries are the most interesting features of the county... the earliest wineries here were built of stone blocks quarried out of nearby hills, many borrowing in architecture from German schloss and French chateau, familiar to the pioneers from Germany, France, and Switzerland."[34]

Stone construction was used in many of Napa Valley's commercial and public buildings, ranging from the imposing County Court House in Napa to the Roman Catholic Church in St. Helena. The abundance of natural fieldstone and inexpensive labor combined to produce many miles of stone walls, retaining walls, terracing, and fences in 19th century Napa County.

By the turn of the century, Napa County was known as the "County of the Stone Bridge." Over 326 stone bridges and culverts were counted by 1914, including some of the largest in the western United States. Nearly all were built of quarried volcanic rock or mixed volcanic rock and sandstone. The most graceful of the structures of the period is the Pope Street Bridge in St. Helena. Built by R.H.Pithie in 1894, this bridge is currently listed on the National Register of Historic Places. Two years later, Pithie built the Putah Creek Bridge. At a cost of $19,500, this was the largest stone bridge built west of the Rocky Mountains and was referred to as the "Queen of the Stone Bridges". Presently, this three 70 foot span, native sandstone bridge lies beneath Lake Berryessa.

The method of building in Napa County followed a routine procedure. After the county engineer selected the site of a new bridge, the contractor would look it over, search the area for a proper stone source, and set up quarrying activity. The rough quarried stone was then carted to the site to be cut before the stones were set. (It was common for the stone masons families to camp for the summer at a bridge construction site while this process was being completed.) After the supporting masonry abutments or piers were constructed, temporary heavy timber falsework was erected in the arch shape. The arch ring itself was built of carefully hewn blocks of stone, each cut to a slight wedge shape so that the joints between blocks were at right angles to the ring. Thus, the joints are normal to the compressive force in the arch and each block is secured against falling. The arch ring was built outward from the footings to the center of the span, where the precisely shaped keystone was set into place. Earth or rubble fill was then placed to form the roadway. The fill was retained by retaining walls, called spandrel walls, built vertically above the edges of the arch ring.[35]

The arch shape is ideal for spans built of materials which have good compressive strength but little or unreliable tensile strength. All forces in a properly shaped arch are compressive. Early bridges were built without mortar in the joints. Later bridges used pozzolonic or portland cements to fill joints which reduced the amount of labor needed to hew the blocks to the precise fit needed for "dry" joint arches.

The abundance of stone masonry bridges in Napa County is due primarily to the design efforts of Oliver H. Buckman, the Napa County Surveyor. O.H.Buckman was born near Baltimore, Maryland on December 14, 1847. In 1855, his family moved to a farm in Iowa were he lived until he entered the State University of Iowa at the age of 25. He graduated in 1876 with a degree in civil engineering. In 1877, O.H.Buckman settled in Napa, California. His career began as a County surveyor in 1885. In 1896, he served as deputy county surveyor for a brief period and then again became the county surveyor. He remained in this position until about the time of World War I.[36]

Major stone masonry bridge contractors in the Napa valley were H.W.Wing, and his partner in many ventures, J.B.Newman. Both were expert stone masons who emigrated to America from England. They established the Napa Marble Works in 1878 which produced cemetery stones and vaults. J.B.Newman traveled to Europe around 1900 to study the latest techniques in stone cutting. As a result of his study abroad Newman's work crew had the most modern and efficient tools available at that time and was regarded as the most efficient group of tradesmen in the Valley.[37]

The stone masonry trade existed for nearly seventy years in Napa Valley. Up to World War I, stone masonry was used in the construction of Napa Valley's bridges and buildings. Several related factors can be linked to the demise of the stonework era in the valley. These include a change in the ethnicity of the population; the absence of inexpensive labor; and changes in building technology.[38]

The review of masonry bridges did not have the benefit of a analytical point system as was used for arch and girder bridges. There are only 47 stone masonry bridges included in the bridge inventory. To obtain information and detail, 95 bridges were examined. These additional bridges were either culverts or bridges under private ownership. These types of bridges (culverts) are not included in the survey. They were evaluated to help establish what influence masonry structures have in the State and to identify and evaluate the stone masons who constructed them.

An early goal of the survey was the elimination of insignificant bridges. Out of the 47 masonry bridges in the survey, 17 were immediately eliminated based on their total loss of integrity. These bridges had both sides widened (usually using a different technology) and a radical railing modification. The remaining 30 were subjected to a further review process which determined: 1) if one side had been widened (sometimes the parapet railing was salvaged and moved); 2) if the railing had been modified in some fashion altering the feeling as well as design; or, 3) if the bridge was less than 50 years old. These criteria eliminated another 17 bridges, leaving twelve bridges of potential for listing in the National Register. One, the Pope Street bridge, is already listed on the National Register. The remaining 12 bridges, after being reviewed on an individual basis, appear to meet the National Register criteria and are included in this thematic Request for Determination of Eligibility.

D. Suspension Bridges

In one respect, the suspension bridge is not a significant bridge type in California; very few have ever been built in the area. The quality of these bridges, however, compensates for the lack of quantity. From the pioneering spans of Andrew Smith Halladie in the 1850s to the great bridges of C.H. Purcell and J.B. Strauss in the 1930s, California engineers have left an important mark on the design of American suspension bridges.

The early history of metal wire suspension bridges in America is dominated by the work of Charles Ellet, Jr. and John A. Roebling.[39] Ellet is credited with introducing European ideas about wire suspension bridges to the United States in the 1830s, and with erecting the first successful span of this sort in 1842. Roebling built upon the foundation laid by Ellet, building the first long span suspension bridge in 1849, the great Niagra span in 1855, and completing the Brooklyn Bridge in 1883.

Andrew Smith Halladie was a contemporary of Ellet and Roebling but was, at least initially, not familiar with their work. Halladie was born in Scotland in 1836, the son of an inventor and engineer who had experimented with wire cable manufacturing in the 1830s.[40] A. S. Hallidie immigrated to California in 1852, at the age of 16. He first worked with wire cable in 1856, spinning a cable for pulling ore carts.[41] In

1857, he settled in San Francisco and established the first wire cable manufacturing facility in California. This firm was initially called A.S. Hallidie & Co., and was later called the California Wire Works.

Hallidie continued to manufacture wire cable in San Francisco until his death in 1900, all the while developing new applications for the product. His work in suspension bridge design should be understood in this context. His first suspension bridge was built in 1861, crossing the Klamath River at Weitchpect. He designed at least six more such bridges in California in the early 1860s. In 1863, he built the greatest of his structures, a great span across the Fraser River in British Columbia. With all such cases, including the Fraser River bridge, the structural metal was fabricated in San Francisco.

Lamentably, no surviving examples remain from Halladie's pioneering West Coast suspension bridge manufacturing and design. His experimentation in the use of wire cable is, however, commemorated by his most significant invention -- the cable car system of San Francisco, first devised in 1871 and in use today.

Only one mid-nineteenth century suspension bridge remains in California, the so-called Bidwell Bar Bridge in Butte County. Built in 1856, it actually predates Hallidie's involvement with suspension bridges or manufacture of wire cable.

This was originally a toll bridge, built by the Bidwell Bridge Company. In January, 1855, the company published specifications for the structure in an area newspaper. These, signed only by the secretary for the company, are remarkably detailed, specifying treatment for the cable wires and the use of a truss stiffener for the deck. Presumably, an experienced bridge designer was involved in preparing these but we have of record of that individual.

The contract for erecting the bridge went to a local firm, which in turn subcontracted to the Starbuck Iron Work, Troy, New York, for the towers and cables. The bridge had a remarkably long life. It became a county bridge in 1883 and a state bridge in 1909. It reverted to county ownership in 1938 and carried vehicular traffic until 1954. It then served as a pedestrian bridge until the late 1960s, when it was dismantled to avoid inundation by Lake Oroville.

The bridge was rebuilt in 1974 but not in a manner that would make it eligible for listing in the National Register of Historic Places. It was moved to a nearby but inappropriate setting, crossing a dry ravine where it once crossed a main channel of the Feather River. Worse, the structure is no longer suspended, i.e., no tensile stresses are carried by the cables. Rather, it is essentially a trestle, supported by a series of wooden bents. The cables and towers were rebuilt but are merely ornamental. Through this reconstruction, the California Department of Parks and Recreation rendered ineligible the last remaining example of a key period and method of construction in bridge design in California. The Bidwell Bar Bridge is not included in this thematic group but is mentioned to establish a historical context for other suspension bridges.

When Halladie stopped designing suspension bridges after the Civil War, there followed a period of nearly eighty years in which very few suspension bridges were constructed in California. California has no long span suspension bridges from what might be called the middle period of suspension bridge design in the United States, between the pioneering work of Roebling and Ellet in the 1850s and the resurgence of suspension bridge design in the 1930s. During this middle period, many of the greatest engineers in the United States were involved in designing suspension bridges -- John Roebling, J.A.L. Waddell, Ralph Modjeski, Gustav Lindenthal, O.H. Ammann, and others. During this period, many great spans were designed, particularly the set along the East River in New York City. Most major technical and aesthetic problems posed by the suspension bridge were resolved during this period.

California does have a small body of representatives from this middle period, but these are highly specialized applications of suspension bridge technology. What emerged was a class of bridge called the small suspension bridge. Using the length of main span and suspended dead load per linear foot of bridge and incorporating a stiffening truss into the floor system, an engineer could obtain a bridge suitable for light highway traffic. It was economical, simple to design and erect in the remote and rugged areas of California.

A local county surveyor or engineer could construct such a bridge with minimal equipment. The little power required was supplied by an ordinary farm tractor running along the road, and to which was attached the end of the hoisting rope. Two gin poles picked up conveniently at the location, were used in setting the towers and hoisting the main cables. All other material, timber and steel, was readily handled into position by the erection gang. This gang of bridge men was usually recruited from local labor, and except for the supervision, no previous experience was needed. Within this thematic three small suspension bridges have been found to be eligible. The Iowa Hill Bridge, The Upper Mattole Schoolhouse Bridge and the Colfax-Forrest Hill Bridge are representative examples of small suspension bridge types built during this middle period.

While California has no major suspension bridges from this period, it did benefit from lessons learned elsewhere. These lessons helped guide construction of two of the most successful suspension bridges in the world -- the Golden Gate Bridge and the San Francisco-Oakland Bay Bridge, or Bay Bridge. Both bridges have been determined eligible for listing in the National Register of Historic Places and, for this reason, are not included in this thematic request. These bridges are discussed here to help establish the historical context for other bridges.

Planning for the Golden Gate and Bay bridges began long before either was constructed. Vague schemes for bridging the San Francisco-Oakland and the San Francisco-Marin crossing surfaced almost as soon as settlement began on the remote San Francisco Peninsula. These plans were taken more seriously after 1910 when the technical feasibility of long suspension bridges had been demonstrated. Leaders in the San Francisco bay area were in agreement that the bridges could and should be built by the early 1920s. Another decade would pass, however, before the many interested parties could agree on particular designs and financial arrangements. By coincidence, two very different financial agreements were reached about the same time, making possible concurrent construction of the two massive structures.

The Bay Bridge benefited most directly from the earlier efforts of suspension bridge engineers on the East Coast. The City of San Francisco conducted hearings on proposals for a private toll bridge to Oakland. Many experienced engineers submitted plans -- Ralph Modjeski for a steel truss bridge; J.B. Strauss for a cantilever and bascule bridge; C.E. Grunsky and J.A.L. Waddell for suspension spans; and Gustav Lindenthal for steel truss spans.[42] In 1927, the San Francisco Board of Supervisors appointed a three-man board of engineers to study these proposals and to propose a preferred alignment. This board decided upon the two-bridge approach -- Oakland to Yerba Buena Island, Yerba Buena Island to San Francisco -- that was ultimately built.

When the State of California took over the project, Chief Engineer, C.H. Purcell adopted the team design approach that had characterized Division of Highways work since the early 1920s. In creating an Engineering Board, he drew from his own staff in state service, as well as Modjeski, Dean Charles Derleth, and others who had proposed private bridges.

By 1931, the Engineering Board has decided upon the essential components of the Bay Bridge -- cantilever spans across the eastern shipping channel and double suspension spans to the west. It is this latter element -- two separate suspension bridges joined by a central man-made anchorange -- that is the most significant innovation of the Bay Bridge in suspension bridge design.

In contrast to Purcell's team concept, design work on the Golden Gate Bridge was dominated by a single engineer, J.B. Strauss. In 1919, Strauss, already one of the most successful bridge engineers in the United States, was but one of several to submit preliminary plans for the Golden Gate crossing. His 1919 plan called for construction of what David Plowden calls "one of the most monstrous bridges ever conceived"[43] -- a massive cantilever carried on suspended cables.

This plan and others were ignored through the 1920s, although Strauss' plan was singled out for scorn by many San Franciscans. Strauss never forgot this lesson and thereafter made aesthetics one of the principal design considerations for the Golden Gate Bridge. He also became obsessed with the project, moving to San Francisco in 1921 and devoting a large part of his time to designing and advocating the bridge.

While Strauss made the Golden Gate Bridge into something of a personal mission, he was nonetheless a good bridge engineer who learned from others. His debt to other suspension bridges built in the 1920s and early 1930s can be seen in structural as well as aesthetic areas.

He learned, from the rejection of his earlier hybrid design and from the success of other designs, that architectural treatment was of special concern in a large suspension bridge, owing to the scale of the structure and to the inherently pleasing form of the suspended cable. He relied on the architect, Irving F. Morrow, for many important elements of the structure. Morrow and Strauss incorporated key elements from two 1931 structures by D.B. Steinman, elements which greatly enhance the beauty of the Golden Gate Bridge. First, they included Vierendeel truss supports on the upper towers, an element first used on Steinman's Waldo-Hancock Bridge. Second, they sheathed the trusswork in inflected steel, similar to Steinman's St. John's Bridge, giving to the towers rich shadows and depth.

In the final analysis, the bridge was the work of Strauss, Morrow, and Clifford Paine, Strauss' chief assistant. It success is attributed to many factors -- to the inflections of the steel, to the natural beauty of the Golden Gate, to the dramatic length of the bridge and height of its towers. Whatever the combination of factors, the Golden Gate Bridge is enormously appealing to engineers and to the general public and is one of the most popular bridges in the world.

E. Steel Girders and Steel Arches

Lacking a strong local steel industry, Californians have rarely used steel as the primary bridge-building material. Even in the post-war freeway era, when the steel girder freeway overcrossing proliferated elsewhere, relatively few steel girder spans have been built in California. Steel arch bridges are even less common.

Nonetheless, thirty steel girder and 7 steel arch bridges were inspected as part of the California Historic Bridge Survey. Three girders and one arch are included in this Thematic Group.

As a whole, California steel girder bridges lack the engineering boldness and/or architectural distinction that characterize the bridges in this Thematic Group. Most are short spans and suffer from the inherent aesthetic limitations of the riveted steel plate girder bridge. The three steel girder bridges included in this group, all built in the mid-1930s, are certainly exceptions to this rule, being bridges of great beauty and boldness.

The Smith Point Bridge (4C-239) was built by the Division of Highways in 1934 across the Eel River. It was an award-winning structure the year it was built, on the basis of both engineering and architectural considerations. This structure is a continuous steel plate girder, with a total length of 555 feet and two main spans of 120 feet each. The plate girders are haunched (i.e. shallow arched), accounting for the pleasing profile, as recognized by the American Steel Institute of Steel Construction in its 1934 awards for the "Most Beautiful Steel Bridge." The structure was also recognized as the first continuous steel girder bridge in the United States built on a curve.[44]

The Figueroa Street Viaduct, built in 1936, is similar in appearance to the Smith Point Bridge, being a haunched continuous steel plate girder bridge. This structure is distinctive in two major respects. First, its principal span of 200 feet is an exceptional achievement in this type of structure, reported to be the longest steel girder span in the United States at the time it was built.

Second, the bridge was literally and figuratively a link between two generations of transportation systems in Los Angeles. It was originally planned in the late 1920s, when City officials looked to a system of major boulevards and river viaducts as an answer to persistent traffic problems in the downtown area. Most of the viaducts from the late 1920s are included in this Thematic Group. For various reasons, however, the Figueroa Street Viaduct was not built until the mid-1930s. By this time, many officials in the city and the State Division of Highways had turned their attention to the so-called "parkway", or freeway, as the solution to many of the transportation problems in the area. By 1936, the first of these, the Arroyo Seco Parkway, was nearly completed. The Figueroa Viaduct was finally built, not at a conventional viaduct, but as a high-speed access from Los Angeles to the beginning of the Arroyo Seco Parkway. After World War II, both the viaduct and the north end of Figueroa Street were simply included within the freeway, becoming the link between the Arroyo Seco Parkway and the Harbor Freeway.[45]

The Sunset-Silver Lake Bridge (53C-136) is a more modest steel girder from a technological perspective, but it is an exceptional structure from an aesthetic standpoint. During the 1930s, the City of Los Angeles, in one of many major transportation improvement programs, established grade separations along several major boulevards, most notably along Sunset Boulevards. These grade separation structures speeded up traffic to levels approaching that of a controlled access highway. Consistent with design principles applied on a grander scale with the Los Angeles River viaduct program, city engineers made liberal use of applied decoration to beautiful these otherwise humble grade separation structures. The Sunset-Silver Lake Bridge is the most successful of these many structures.

The seven steel arch bridges in California were for the most part constructed after 1945. Several of these, such as the 1967 Cold Spring Arch (with a main span of 700 feet), will one day surely be listed in the National Register. The one steel arch included in this Thematic Group is the Sixth Street Viaduct, one of nine viaducts across the Los Angeles River.

The Sixth Street structure was the last of the viaducts to be designed and constructed and was by far the largest and most expensive of the group. It is classified a steel arch by convention in that its largest spans are twin 150 foot steel through arches. The remainder of the structure, the total length of which is 3546 feet, comprises concrete T-girder spans.

In addition to being the only steel arch bridge in this Thematic Group, the Sixth Street Viaduct represents a distinctive accomplishment in bridge architecture. Its detailing is Streamlined Moderne, as exemplified most distinctly in the large pylons at the western portals, in the decorative fascia girder, in the inflection at the river piers, and in the light standards throughout the structure. Other California bridges incorporate Moderne elements, as in the steel sheathing for towers of the Golden Gate Bridge. The Sixth Street Viaduct is exceptional, however, for the integrated use of Moderne detail.

FOOTNOTES

Section 7

1. A general discussion of quantitative methods in bridge evaluation can be found in Transportation Research Board, "Historic Bridges -- Criteria for Decision Making," Washington, D.C., 1983. See also, Stephen D. Mikesell, "Historic Preservation That Counts: Quantitative Evaluation of Historic Resources,", The Public Historian, Fall, 1986.

2. Ohio Department of Transportation, The Ohio Historic Bridge Inventory and Preservation Plan, Columbus, 1983.

3. Oregon Department of Transportation, "(Draft) Historic Bridges of Oregon," Salem, 1984.

4. Michael C. Corbett, Splendid Survivors: San Francisco's Downtown Architectural Heritage, (San Francisco, California Living Books, 1979).

Section 8

1. California Division of Highways, The Paths of Humanity: A Chronicle of California's Highway Development, Sacramento, 1966; Paul Bryan Israel, "Spanning the Golden State: A History of Highway Bridges in California," (M.A. Thesis, University of California, Santa Barbara, 1980).

2. Israel, op. cit., p. 41.

3. Division of Highways, 1966, p.; 4.

4. Israel, op. city., pp. 42-56.

5. "Memoir of John G. McMillan," ASCE, Transactions, 111 (1946), p. 1507; John G. McMillan, "Reinforced Concrete Bridges for County Roads," The Architect and Engineer of California, 17 (June, 1909), pp. 61-4; County of Santa Clara, Transportation Agency, Untitled, Undated, Scrapbook of Bridge Blueprints, Attributed to John G. McMillan.

6. County of San Mateo, Minutes, Board of Supervisors, Vol. 11, p. 252, October 16, 1899.

7. U.S. Bureau of Public Roads, "Report of a Study of the California Highway System," 1920, pp. 13-8.

8. Ibid., p. 63.

9. County of Santa Barbara, Minutes, Board of Supervisors, Vol. O, p. 234, September 29, 1915.

10. U.S. Bureau of Public Roads, 1920, p. 63.

11. Ibid. pp. 29-48.

12. Harlan D. Miller, "Enlarging Department Handles Design and Construction," California Highways, Vol. 1, No. 4, 1924, p. 3.

13. Ibid., p. 6.

14. Jasper O. Draffin, "A Brief History of Lime, Cement, Concrete and Reinforced Concrete," Journal of the Western Society of Engineers, Vol. 438, No. 1, 1942, pp. 14-47; Carl W. Condit, American Building: Materials and Techniques from the First Colonial Settlements to the Present, 2nd Ed. (Chicago, Univ. of Chicago Press, 1982), p. 14.

15. Condit, op. cit., pp. 173-5.

16. David P. Billington, "History and Esthetics in Concrete Arch Bridges," Journal of the Structural Division, ASCE, Vol. 103, No. ST11, 1977, pp. 2135-2138.

17. Elizabeth B. Mock, The Architecture of Bridges (New York, Museum of Modern Art, 1949).

18. Our conclusion that reinforced concrete bridges were more commonly constructed in California than elsewhere is based upon the results of various statewide historic bridge inventories. Among the dozen such studies available for our inspection, only the aforementioned Oregon study included concrete bridges in proportions approximating that of California. In Oregon as in California, concrete bridges constituted a larger proportion of the survey population than metal truss bridges. In all other states, metal truss structures far outnumber concrete structures.

19. Ernest L. Ransome and Alexis Saurbrey, Reinforced Concrete Buildings, (New York, McGraw-Hill Book Company, 1912), pp. 1-47.

20. Ransome and Saurbrey, p. 2; David Plowden, Bridges: The Spans of North America(New York, W.W. Norton & Co., 1974), p. 198.

21. Carroll W. Pursell, Jr., "The Technical Society of the Pacific Coast, 1884-1914," Technology and Culture October, 1976), pp. 702-17.

22. John W. Snyder, "The Bridges of John B. Leonard, 1905 to 1925," Concrete International, June, 1984, pp. 58-67.

23. W.M. Thomas, "The Thomas System of Three Hinge Arch Bridges," Southwest Contractor and Manufacturer, April 4, 1914, p. 9.

24. "Obituary: Harlan D. Miller," Engineering News-Record, Vol.

91, No. 18, October 28, 1926, p. 723.

25. "Charles E. Andrew, New State Bridge Engineer," California Highways, May, 1927, p. 12.

26. C.E. Andrew, "Bridges on California State Highways," California Highways and Public Works, July-August, 1928, pp. 2, 14.

27. Henry G. Tyrrell, "Bridges in Relation to the City Plan," The Architect and Engineer of California, August, 1913, p. 83.

28. Charles Mulford Robinson, "Los Angeles, The City Beautiful," Los Angeles Municipal Arts Commission, 1909, p. 3.

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32. Wilbur J. Watson, Bridge Architecture,William Heburn Inc., New York, 1927.

33. Robert Fredericks, "Nineteenth-Century Stonework in California's Napa Valley," The California Geographer, 1969, pg. 43.

34. Illustrations of Napa County, California with Historical Sketch, Smith and Elliot, Oakland, 1878.

35. Donald W. Alden, Historic Evaluation of Salvador Overflow Bridge on Big Ranch Road in Napa, California, 1986.

36. Paul Byran Israel, Spanning the Golden State: History of the Highway Bridge in California, M.A. Thesis, University of California, Santa Barbara, 1980.

37. History of Solano and Napa Counties, Historic Record Co., Los Angeles, 1912.

38. Fredericks, op. cit., pg. 47.

39. Plowden, op. cit., pp. 71-122.

40. Edgar M. Kahn, "Andrew S. Halladie as Writer and Speaker," California Historical Society Quarterly, XXV,1 (March 1946), p. 15.

41. Edgar Myron Kahn, "Andrew Smith Halladie," California Historical Society Quarterly, XIX,2 (June 1940), p. 146.

42. "San Francisco Bay Bridge Projects Total 17," _Engineering News-Record_, 97,18, 1926, p. 720.

43. Plowden, _op. cit._, p. 252.

44. W.A. Douglass, "California Steel Girder Bridge Wins Award in National Beauty Contest," _California Highways and Public Works_, June, 1935, pp. 2, 18-19.

45. Paul R. Watson, "Figueroa Street Viaduct Project in Los Angeles Crosses Two Railroads, River, and Highway," _California Highways and Public Works_, March, 1937, pp. 14-15, 27.

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10. GEOGRAPHICAL DATA

As mentioned in Item 3 above, the location for each bridge included in this thematic group is identified on the appropriate "Bridge Rating Sheet." In addition, the location is delineated on attached sections from USGS Quadrangle Sheets.

The precise boundary for each bridge is that defined in the appropriate Bridge Maintenance Report, as maintained by the Office of Structures Maintenance, California Department of Transportation. Except as noted below, the boundaries for each bridge include the width of the structure and its length from abutment to abutment, including piers and other elements of the substructure, the deck, and the superstructure.

11. PHOTOGRAPHS

Photographs of bridges included in this Thematic Group are attached to the appropriate Bridge Rating Sheets.

12. Prepared under the supervision of John W. Snyder, Chief Architectural Historian, Caltrans. Text by Stephen D. Mikesell, Caltrans. Compiled by Diane Pierzinski. The address for each:

California Department of Transportation
Division of Project Development
Office of Environmental Analysis
1120 N Street
Sacramento, California 95814

STATE OF CALIFORNIA—THE RESOURCES AGENCY

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
POST OFFICE BOX 942896
SACRAMENTO, CALIFORNIA 94296-0001
( ) 445-8006

JAN 12 1987

REPLY TO: FHWA 860919Z

Mr. Bruce E. Cannon
Division Administrator
California Division
Federal Highway Administration
P.O. Box 1915
Sacramento, CA 95809

File ~~430.82~~ 434.32

Dear Mr. Cannon:

Thematic Determination of National Register of Historic Places Eligibility
Historic Concrete Arch and Other Bridges in California

I have received your request for my concurrence in a determination that 118 highway bridges, reflecting concrete arch, concrete girder, concrete slab, canticrete, stone masonry, suspension, steel girder and steel arch designs, are eligible for inclusion in the National Register of Historic Places.

I am pleased to concur in your determination that these bridges, listed on pages 2-7 of the thematic study, are indeed eligible for inclusion in the Register and delighted to acknowledge the successful completion of what has been an ambitious, challenging and extremely useful enterprise. The sentiments I expressed to you in my letter of September 19, 1985 have not changed: I and my staff are proud to have been associated with this effort.

As was done in the case of the thematic determination on California truss bridges, this second phase thematic study should be forwarded to the Keeper of the National Register of Historic Places for official evaluation and addition to the list of properties determined eligible.

If you have any questions regarding this matter, please call Hans Kreutzberg, Deputy State Historic Preservation Officer, at 322-9621.

Sincerely,

Hans J. Kreutzberg for

Kathryn Gualtieri
State Historic Preservation Officer

570.1

CALIFORNIA DIVISION
P. O. Box 1915
Sacramento, California 95809

September 18, 1986

HPR-CA

File: ~~430.52~~ 434.32

Ms. Kathyrn Gualtieri
State Historic Preservation Officer
Department of Parks and Recreation
P. O. Box 2390
Sacramento, California 95811

Dear Ms. Gualtieri:

Enclosed is a Thematic Request for Determination of Eligibility for 118 California highway bridges. The bridges in this group were identified and evaluated as part of "The California Bridge Survey." This is the second thematic request to result from that survey. The first request, submitted to your office on August 20, 1985, and to the Keeper on December 4, 1985, was for 72 truss bridges identified as having potential for inclusion in the National Register.

Your concurrence in the determination that these 118 bridges individually meet the criteria, and are potentially eligible for the National Register, is respectfully requested.

Sincerely yours,

GEORGE S. WISHMAN

For
Bruce E. Cannon
Division Administrator

Enclosure

cc:
Caltrans, Attn: B. Blackmer
Caltrans, Attn: S. Mikesell
FHWA, D. Bolton
FHWA, G. Wishman

GSWishman:sp GSW

STATE OF CALIFORNIA-BUSINESS, TRANSPORTATION AND HOUSING AGENCY GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF TRANSPORTATION
1120 N STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-9448

File: 430.82

August 27, 1986

Mr. Bruce E. Cannon
Division Administrator
Federal Highway Administration
Sacramento, California

Dear Mr. Cannon:

As part of the Caltrans Bridge Survey, Caltrans has conducted studies which identified 118 bridges as having potential for National Register consideration. We have prepared the attached Thematic Request for Determination of Eligibility based on the studies, and recommend that the identified properties be found eligible. These structures are:

1C-15; 4C-12; 4C-26; 4C-75; 4C-155; 4C-189; 4C-239; 4-17; 4-101; 4-134; 6C-1; 6C-293; 6C-294; 6-195; Dog Creek Bridge; 7-78; 8C-57; 8C-58; 9C-71; 10C-143; 10-30; 10-31; 11C-196; 14C-35; 16-11; 17-7; 17-9; 19C-2; 19C-7; 19C-67; 20C-242; 20C-324; 21C-2; 21C-17; 21C-42; 21C-46; 21C-51; 21C-58; 21C-95; 21C-9999; 21-5; 22C-3; 22C-35; 23C-18; 23C-76; 23C-77; 23C-92; 23C-96; 23C-98; 24C-67; 25C-99; 25C-116; 25-33; 25-45; 27C-51; 29C-232; 30-19; 32C-44; 33C-6; 33C-205; 34C-44; Lake Alvord Bridge; 35C-25; 35C-42; 35C-122; 35C-123; 36C-48; 36C-75; 37C-237; 37C-807; 37-74; 38C-23; 38C-73; 38-62; 40-6; 40-7; 41C-6; 44C-82; 44-12; 44-16; 44-17; 44-18; 44-19; 44-36; 44-56; 46C-196; 46C-410; 46-29; 49C-298; 51C-39; 51C-43; 51C-51; 51C-225; 51C-226; 51-110; 53C-44; 53C-96; 53C-130; 53C-136; 53C-161; 53C-163; 53C-331; 53C-545; 53C-757; 53C-859; 53C-1010; 53C-1041; 53C-1166; 53C-1179; 53C-1321; 53C-1375; 53-42R; 53-595; 53-622; 56C-55; 57C-2; 57C-361; 57C-418.

The following Federal Highway Administration action is requested:

1. Your determination, in consultation with the State Historic Preservation Officer, that the properties listed above appear to meet the criteria of eligibility for listing in the National Register of Historic Places; and

2. Following consultation with the State Historic Preservation Officer, please forward the Thematic Request for

Determination of Eligibility to the Keeper of the National Register for determination of eligibility.

If you have any questions, please contact John Snyder at 445-9448.

Sincerely,

E. W. BLACKMER, Chief
Environmental Analysis

Attachment