

# Orthotropic Steel Deck Bridges Landmarks of Our Infrastructure in California 1965-2009



**A quick tour !**

**Monday, September 21, 2009  
at 2:00 pm session title  
"Steel Bridge Topics"**



**Alfred R. Mangus, PE - Caltrans, USA**

## ORTHOTROPIC BRIDGES OF CALIFORNIA

by Alfred R. Mangus - CALTRANS

Slab Bridge  
Advanced Bridge  
Systems, Redding

Braille Trail Pedestrian  
Bridge - Santa Rosa  
Water Authority  
Santa Rosa [ 1977 ]

# 8 Sacramento River Bridge  
Colusa [ completed 1985 ]  
Bridge Number 15C -01

#2 Ulatis Creek Test Lane  
Bridge West Bound I-80  
Lane #3 only [ 1966 ]  
Bridge Number 35-0054

#7 the redecking of the  
Golden Gate  
Bridge [ completed  
deck in 1985 ]

#10 Suspension Bridge at  
Carquinez Straits I-80  
Ruck-A-Chucky - Curved  
Cable Stayed [ unbuilt ]  
Auburn

# 11 Proposed East  
Replacement Span  
I-80 San Francisco  
Oakland Bay Bridge

Four BART Bridges  
Berkeley [ 1972 ]

#9 Maritime Off-Ramp  
Bridge Number 33-0623S  
Oakland [ 1997 ]

Southern Crossing  
Tied Arch [ unbuilt ]

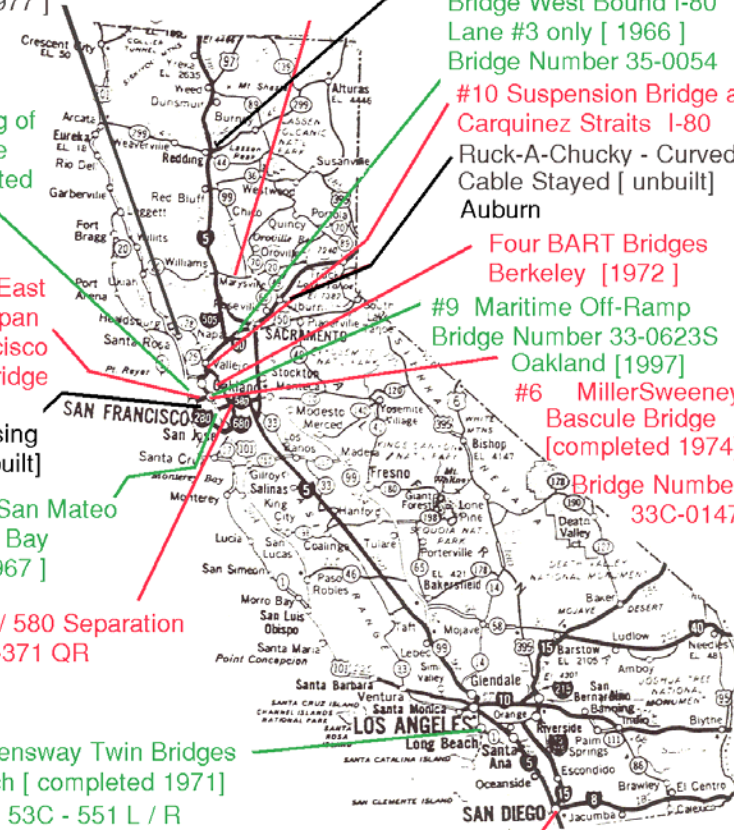
#6 MillerSweeney  
Bascule Bridge  
[ completed 1974 ]  
Bridge Number  
33C-0147

#3 Hayward - San Mateo  
San Francisco Bay  
[ completed 1967 ]

#1 Route 680 / 580 Separation  
Bridge No. 33-371 QR  
Dublin [ 1965 ]

# 5 Queensway Twin Bridges  
Long Beach [ completed 1971 ]  
Bridge No. 53C - 551 L / R

#4 San Diego Coronado Bay Bridge [ completed 1969 ]  
Bridge No. 57-0857





**About 650,000 Bridges = USA**

**About 100 ORTHOTROPIC  
ORTHOgonaly + AnisoTROPIC = in  
USA**

SCALE MODEL OF THE NEW EAST  
SFOBB ORTHOTROPIC PORTION  
[ SETTING ON A MIRROR]

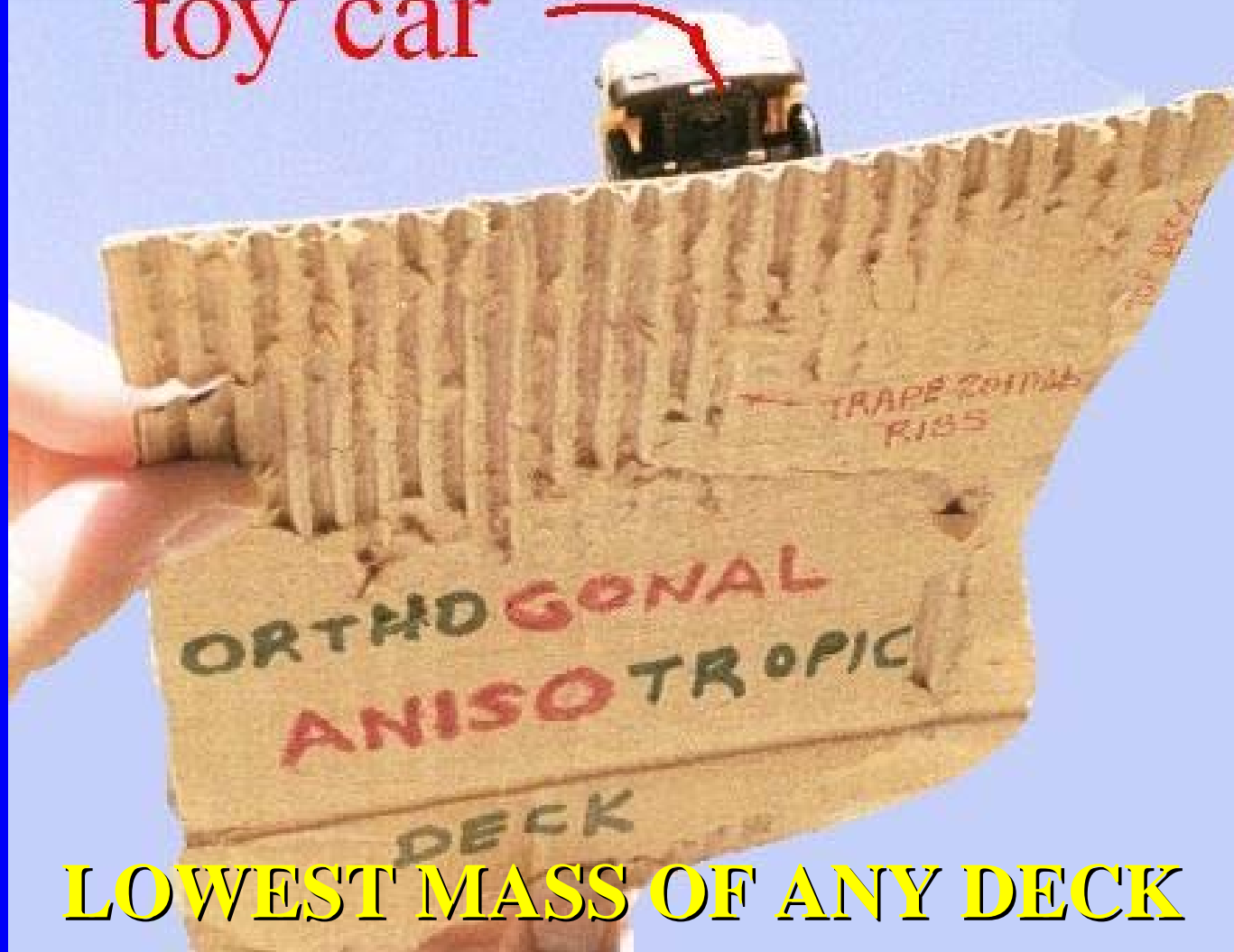


**About 25% of USA's Orthotropic  
Bridges are in CA**



# STRUCTURAL BEHAVIOR

## CARDBOARD ANALOGY toy car

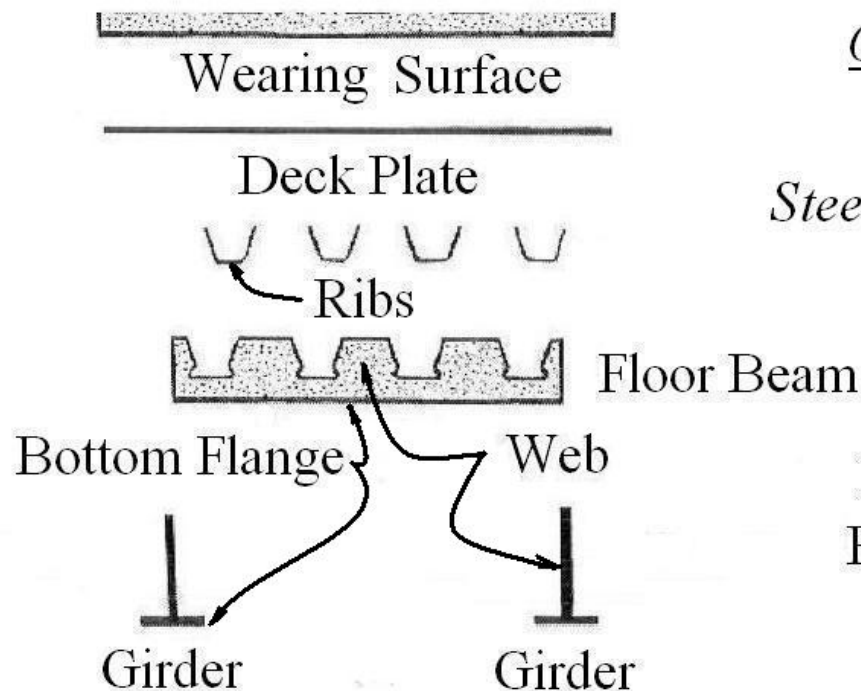


**LOWEST MASS OF ANY DECK**



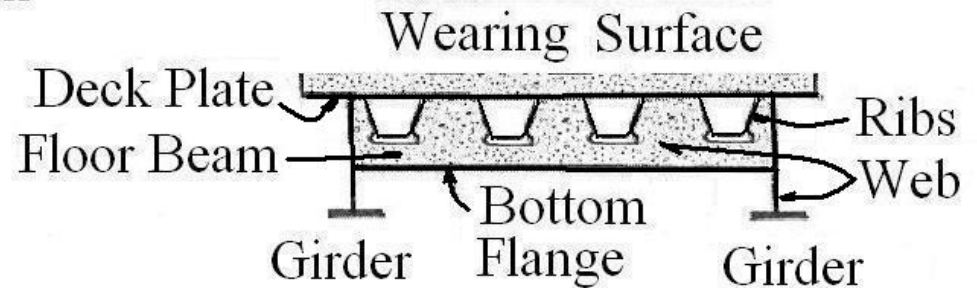
**[used in high Seismic Zones; Movable Bridges]** 3

# STRUCTURAL BEHAVIOR DESIGN CONSIDERATIONS



## ORTHOTROPIC STEEL DECK EFFICIENCY

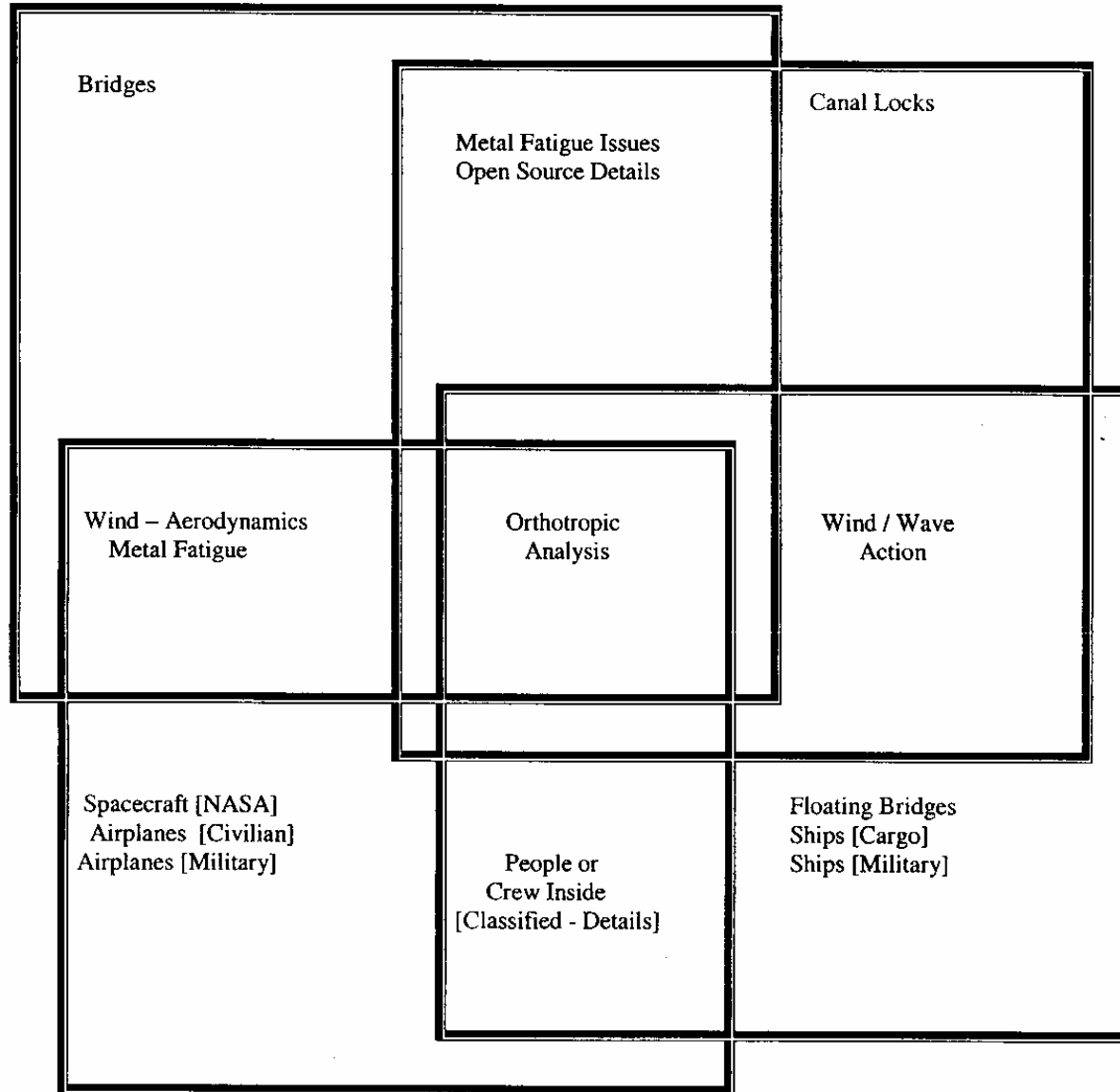
*Steel Deck is: top flange of the ribs  
top flange of the floor beams  
top flange of the girders*



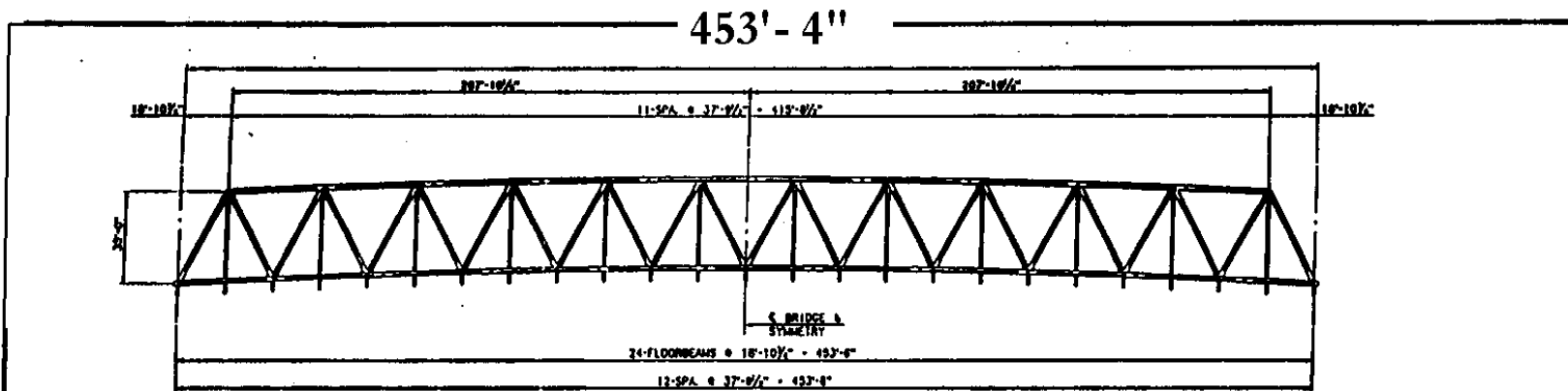
## LOWEST MASS OF ANY DECK



[used in high Seismic Zones; Movable Bridges]



## ORTHOTROPIC BRIDGES VS OTHER USES

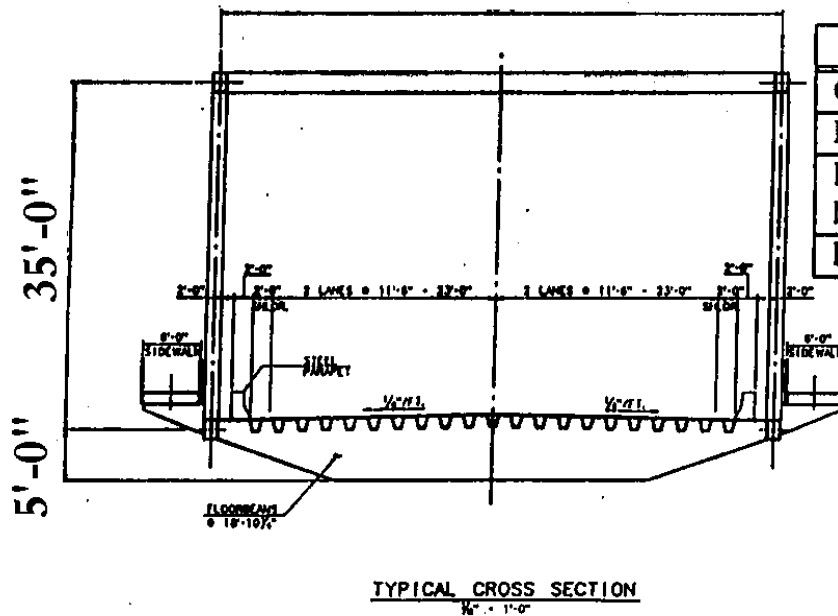


55'-0"

ELEVATION  
1" = 30'-0"

TABLE 1 - WEIGHT OF DECKS FOR THROUGH TRUSS ALTERNATIVES

Deck Type	Deck Weight(Kips)
Orthotropic Plate	1520
Light Weight Concrete Deck -8"	3001
Partial-filled Steel Grid Deck with Monolithic Overfill	2456
Exodermic Deck	2198



TYPICAL CROSS SECTION  
1/2" = 1'-0"

THOMAS A. FISHER, P.E., HNTB Corporation,  
Fairfield, New Jersey

IBC-98-66

INTERNATIONAL  
BRIDGE CONFERENCE

The Conference on Bridges  
OFFICIAL PROCEEDING  
18<sup>TH</sup> ANNUAL INTERNATIONAL  
BRIDGE CONFERENCE AND EXHIBITION  
June 15-17, 1998  
Pittsburgh Hilton and Towers  
Pittsburgh, Pennsylvania, USA

TRUSS ALTERNATE  
WITH ORTHOTROPIC DECK

CITY OF BOSTON

CHELSEA STREET  
BRIDGE REPLACEMENT

SCALE 1 AS SHOWN PLATE NO. 8

HNTB



# TYPE SELECTION ORTHOTROPIC STEEL DECK VS OTHER SYSTEMS

## TYPE SELECTION

### ORTHOTROPIC STEEL DECK VS OTHER SYSTEMS

Deck Type	453-ft x 55ft	Deck Weight(Kips)
Orthotropic Plate		1520
Light Weight Concrete Deck -8"		3001
Partial-filled Steel Grid Deck with Monolithic Overfill		2456
Exodermic Deck		2198

THOMAS A. FISHER, P.E., HNTB Corporation,



CHELSEA BRIDGE BOSTON

Deck Type Analyzed and fully engineered for comparison	Lift Span Total Weight (tons)	Advantages	Disadvantages
Orthotropic Steel Deck	760	Lowest self-weight results in cost savings for towers, foundations, motors, cables etc.	Lack of current codes, designers required to do their own research and develop their own design software
Exodermic Deck (Patented system)	1099	Owner does not have to worry about design, which is provided by manufacturer	Patent holder becomes a “sole supplier”, which requires a waiver from FHWA
Partially-filled steel grid deck with monolithic overfill	1228	Older historic system where lifespan has been up to 75 years	Has a much higher dead load than orthotropic decks
Lightweight (100 pcf) Concrete Deck – 8 inches thick	1501	Non-proprietary system	Limited number of suppliers for lightweight aggregate. Not much dead weight savings

This table is based on one originally created and published by Dr. Thomas A. Fisher of  
HNTB Corporation





## TYPE SELECTION

# ORTHOTROPIC STEEL DECK VS OTHER SYSTEMS Re-Decking Statistics by Roman Wolchuk, PE

Table 1. Selected Completed Orthotropic Redecking Projects in the U.S. and in Canada

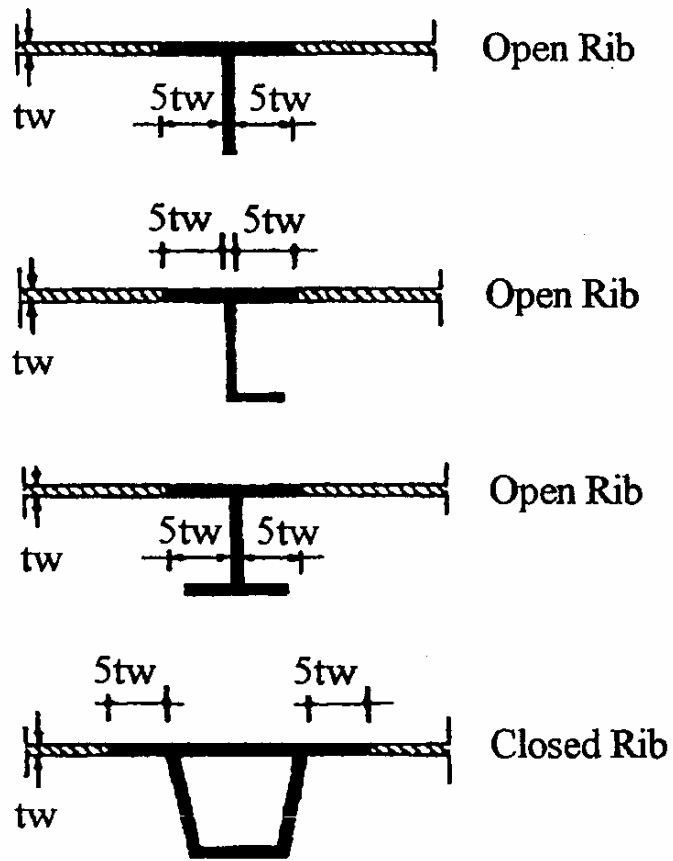
Bridge	Lions Gate Vancouver <sup>a</sup>	G. Washington N.Y.C.	Golden Gate S. Francisco	Throgs Neck V. N.Y.C.	Ben Franklin Philadelphia	Champlain Montreal
Year	1975	1978	1985	1986	1987	1993
Old deck weight (psf)	100	106	104	107	123	110
New deck weight (psf)	61	60	79	83	89	82
Redecking cost (\$/sf) <sup>b</sup>	47	40	70	72	79	110
Deck integration with main members	Yes	No	No	No	Yes	Yes
Redecking work	Night	Night	Night	Night	Day	Night

<sup>a</sup> The 1975 orthotropic roadway is currently being replaced by a new widened orthotropic deck.

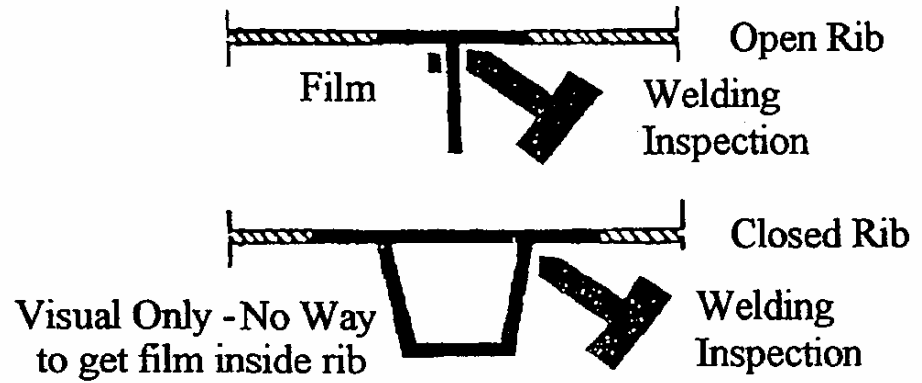
<sup>b</sup> Excluding bridge repairs, inspection walkways, utilities relocation and other items not related to roadway redecking

**20 % TO 40% weight reduction on deck**

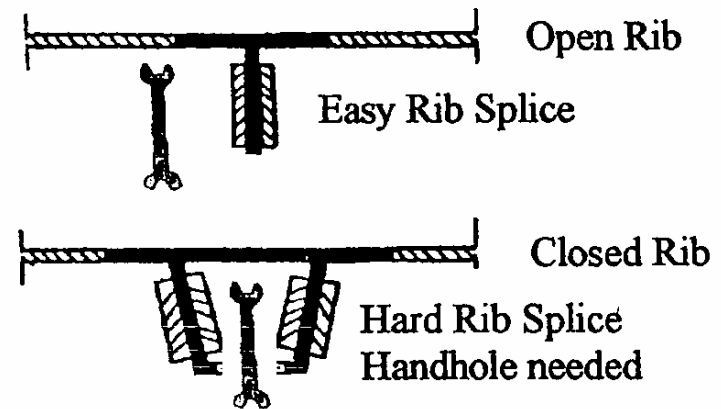




Design Issues - Efficiency



### Fabrication Efficiency



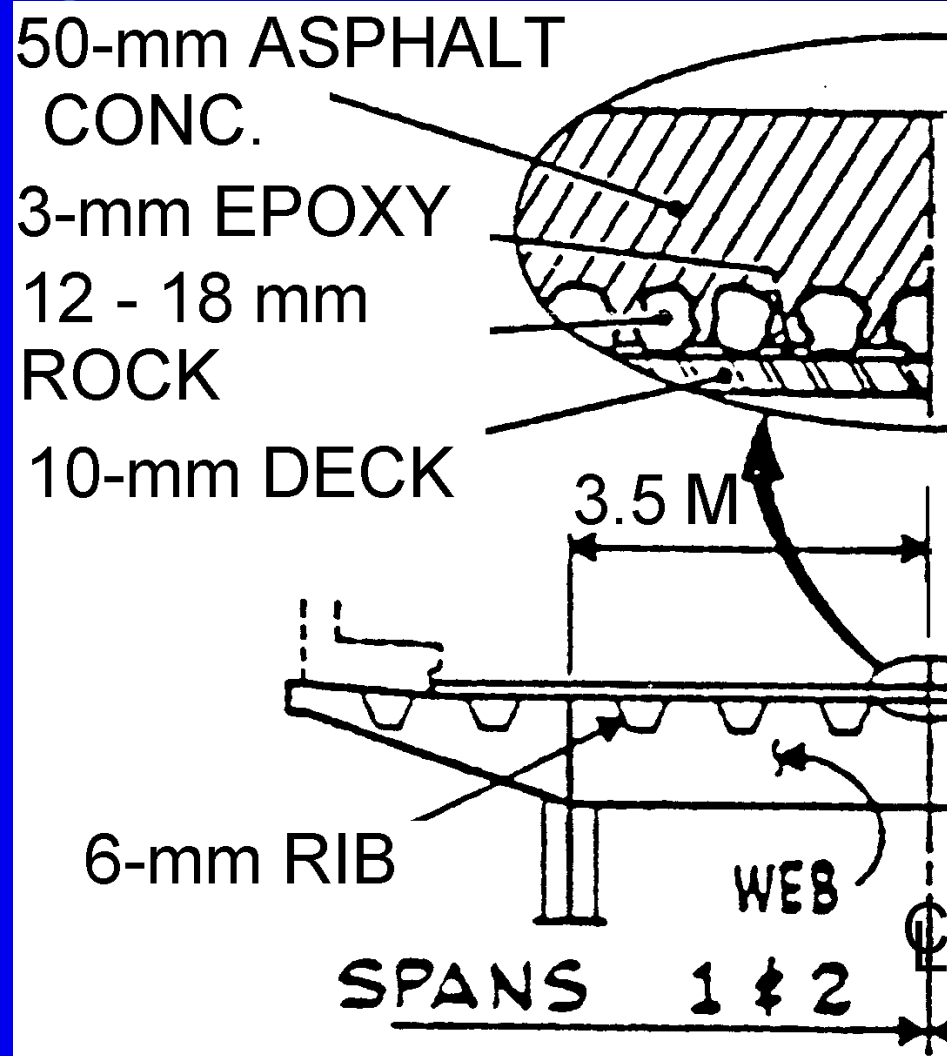
### Construction Efficiency

- Three issues in choosing a rib
- Design – Fabrication – Construction



**33-0371G**

**680 / 580 TEST BRIDGE DUBLIN - 1965**



**33-0371G**

**680 / 580 TEST BRIDGE DUBLIN - 1965**

WEARING SURFACE  
TEST MATERIAL  
FAILURE

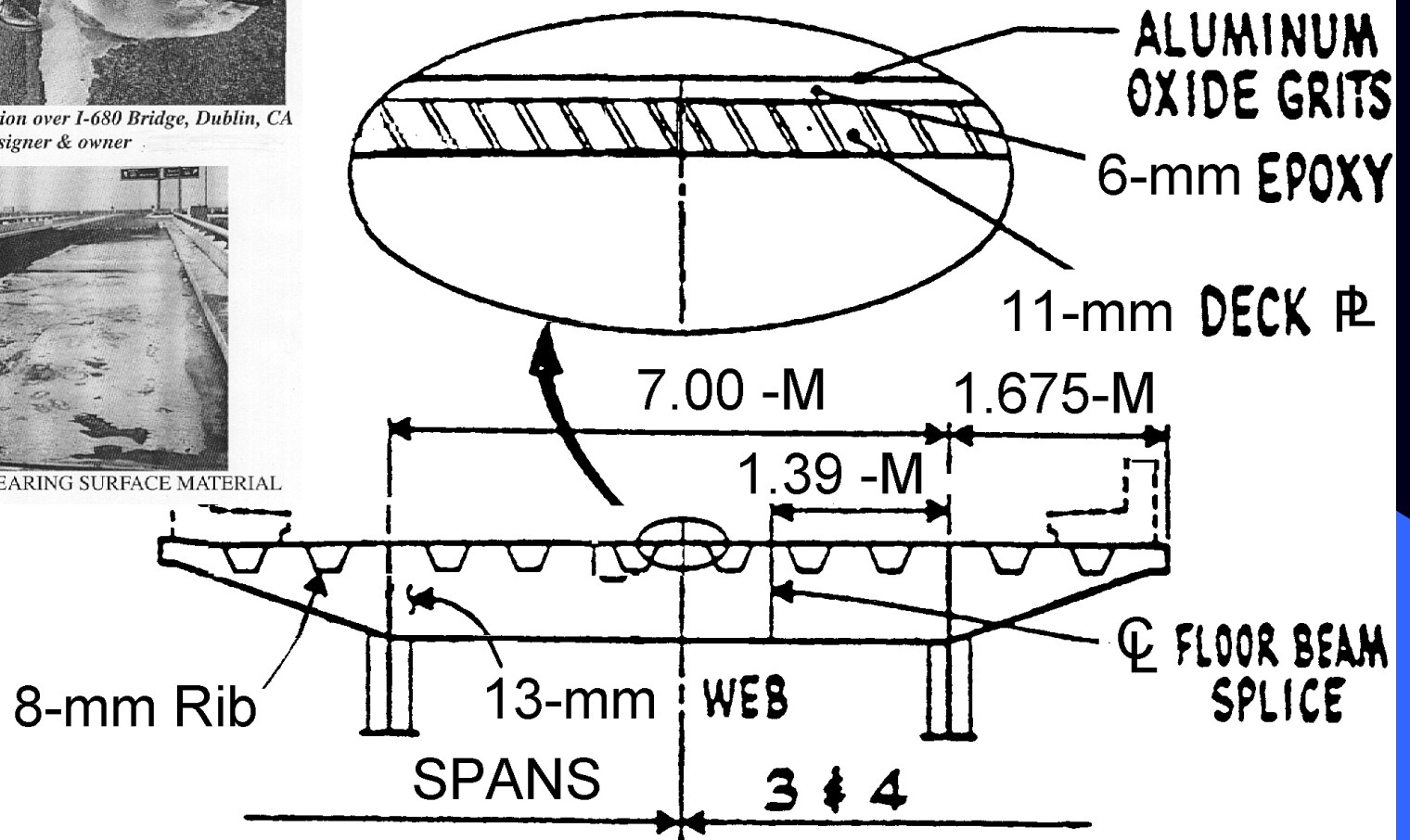
Both photos Courtesy  
of AISI  
American Iron and  
Steel Institute &  
CALTRANS



The I-580 Grade Separation over I-680 Bridge, Dublin, CA  
CALTRANS is the designer & owner

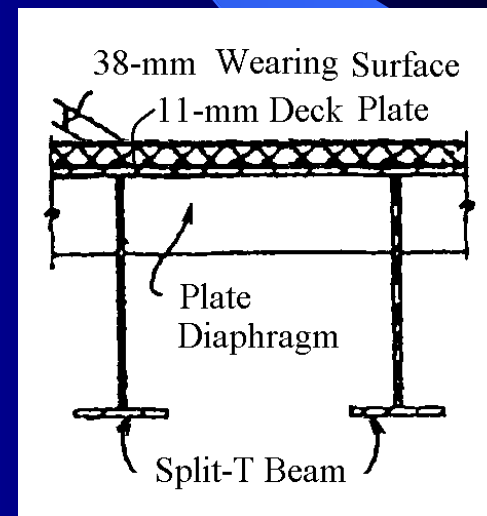
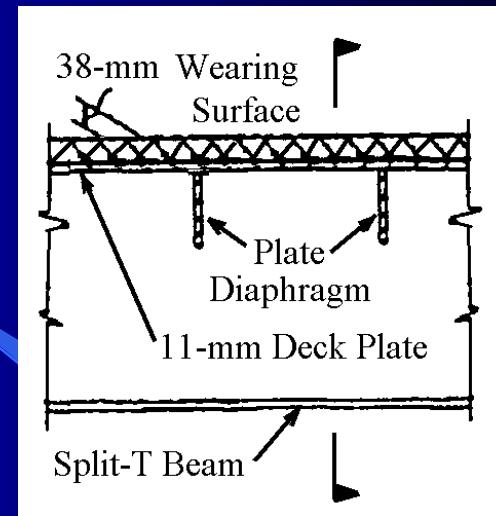


REMOVAL OF FAILED WEARING SURFACE MATERIAL



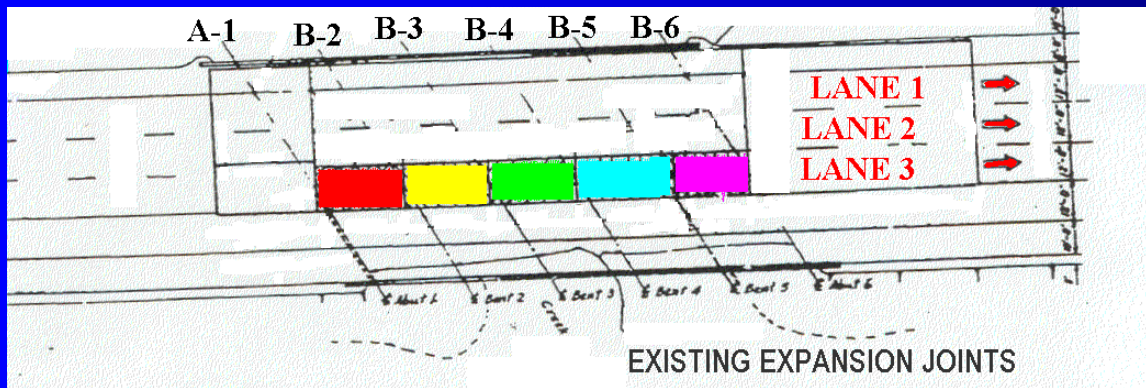
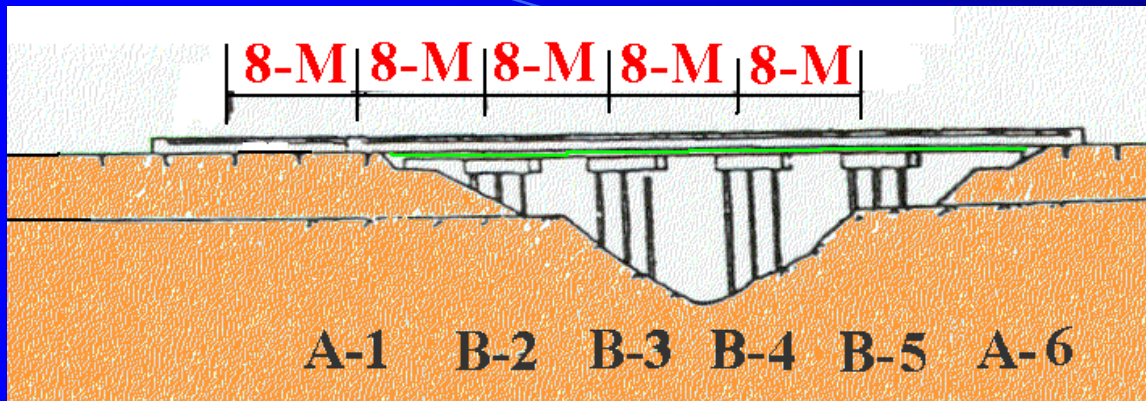
**33-0371G**

**680 / 580 TEST BRIDGE DUBLIN - 1965**

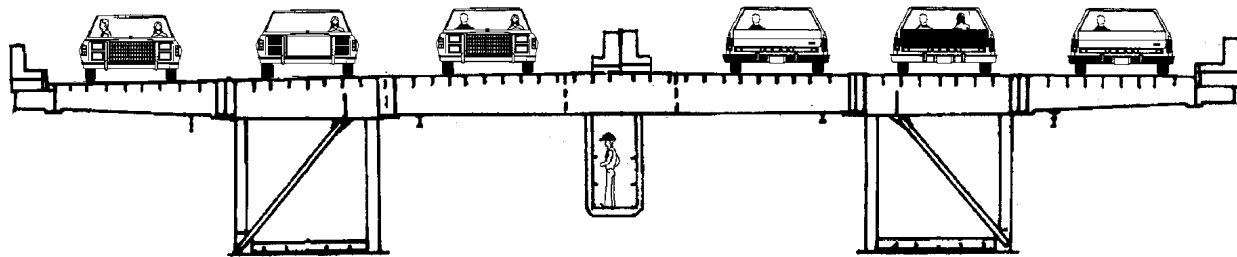
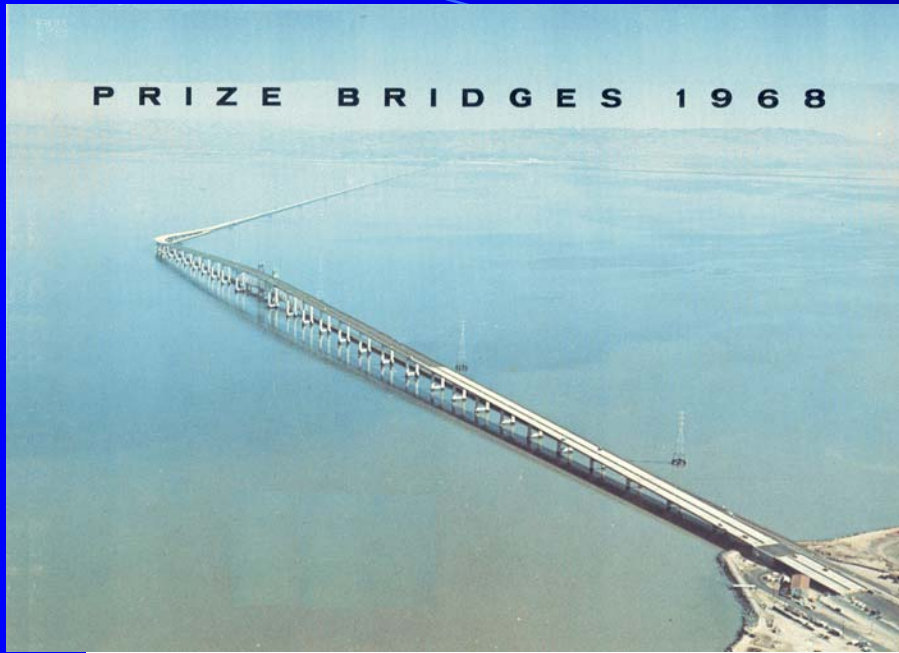


# LATIS CREEK TEST BRIDGE #23-0052R

## VACAVILLE - 1966



# ULATIS CREEK TEST BRIDGE #23-0052R VACAVILLE - 1966



STATE OF CALIFORNIA  
DEPARTMENT OF PUBLIC WORKS  
Division of  
San Francisco Bay  
Toll Crossings

**SAN MATEO - HAYWARD BRIDGE**  
**-0054, Opened OCTOBER 31, 1967**



*F. J. J. J.*  
 ACTING CHIEF - DESIGN DEPT.  
 DATE APPROVED: FEB 11 1968

### MATERIALS

- Corrosion Protection  
 A. Sprayed metallic zinc by Metallizing Company of America or equal (3 mils minimum)  
 B. Zinc-filled self-curing inorganic coating Carbo Zinc II or equal (3.5 mils minimum)

**ROAD SEAL**  $\Delta$   
 a. For modified epoxy resin, Carbozastic 12 or equal (40 mils minimum). While the epoxy resin is still liquid a fine sand, with the following gradation, shall be dropped into the resin.

Sieve No.	Sand Gradation	
	% Retained	% Passing
No. 20	0	100
No. 30	25-50	60-70
No. 40	50-80	30-40
No. 50	51 max.	3 min.

- TEST SEAL**  
 a. Liquid asphalt SS 18 of the manufacturer's 10 gallons per square yard  
 b. Epoxy asphalt, applied hot. Shell or equal  
**Surface Course**  
 a. 1 1/2" asphalt concrete  
 b. 1 1/2" Epoxy asphalt concrete, applied hot. Shell or equal

#### TABULATION OF TEST SPECIMENS $\Delta$

Specimen Number	Preparation			Testing		
	Corrosion Protection	Base Coat	Test Coat	Surface Course	Shear Test	Adhesion Test
1	A	B	C	X	X	X
2	A	B	C	X	X	X
3	A	B	C	X	X	X
4	A	B	C	X	X	X
5	A	B	C	X	X	X
6	A	B	C	X	X	X
7	A	B	C	X	X	X
8	A	B	C	X	X	X
9	A	B	C	X	X	X
10	A	B	C	X	X	X
11	A	B	C	X	X	X
12	A	B	C	X	X	X
13	A	B	C	X	X	X
14	A	B	C	X	X	X
15	A	B	C	X	X	X
16	A	B	C	X	X	X
17	A	B	C	X	X	X
18	A	B	C	X	X	X
19	A	B	C	X	X	X
20	A	B	C	X	X	X
21	A	B	C	X	X	X
22	A	B	C	X	X	X
23	A	B	C	X	X	X
24	A	B	C	X	X	X
25	A	B	C	X	X	X
26	A	B	C	X	X	X
27	A	B	C	X	X	X
28	A	B	C	X	X	X
29	A	B	C	X	X	X
30	A	B	C	X	X	X
31	A	B	C	X	X	X
32	A	B	C	X	X	X
33	A	B	C	X	X	X
34	A	B	C	X	X	X
35	A	B	C	X	X	X
36	A	B	C	X	X	X
37	A	B	C	X	X	X
38	A	B	C	X	X	X
39	A	B	C	X	X	X
40	A	B	C	X	X	X

X Indicates primary test  
 O Indicates secondary test to be performed if specimen has not failed during primary test.

### GENERAL NOTES

- The purpose of these laboratory tests is to evaluate representative samples of deck overlay materials for use in surfacing orthotropic steel plate deck.
- All test specimens shall be prepared in accordance with the appropriate manufacturer's detailed specifications and procedures for the fabrication, application and curing of materials, or in accordance with the Division's Standard Specifications.
- All test specimens shall be returned to the Division for inspection after testing.
- The results of all tests shall be carefully recorded and compiled into a final report.

### PREPARATION OF TEST SPECIMENS

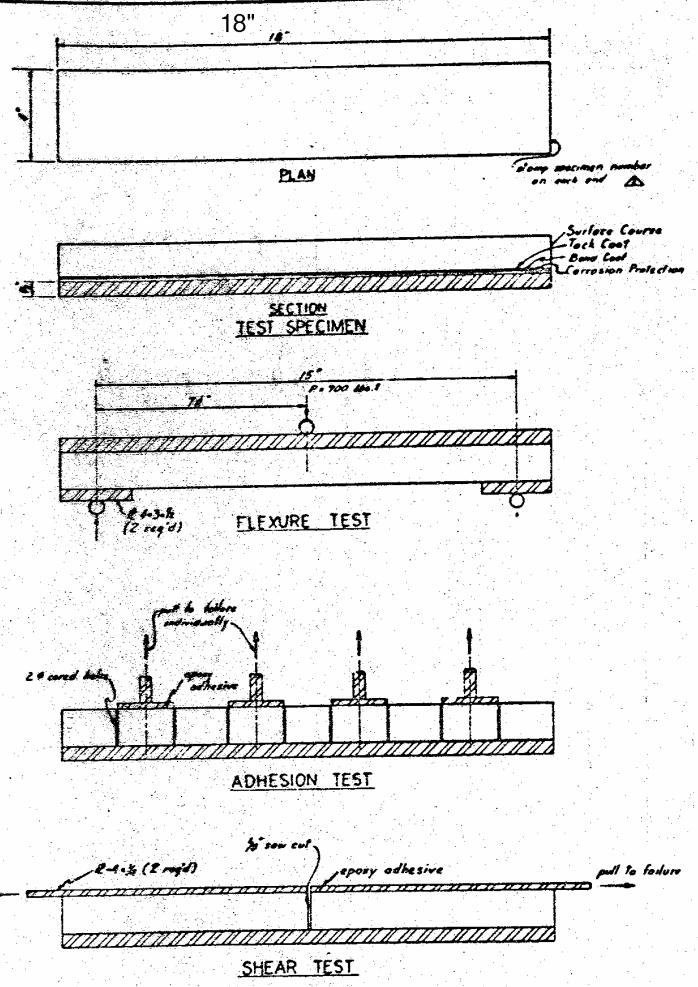
- Steel plates for test specimens shall be ASTM-A36 structural steel (Plate 48 plates).
- Five test specimens of each combination of materials shall be prepared and tested as tabulated herein.

### TESTING PROCEDURE

- Flexure Test:**  
 The cyclic load for flexure test shall be sufficient to produce a stress of 40,000 p.s.i. in the extreme fiber of the steel plate in contact with the overlay material. The cyclic flexure load shall be applied at a rate between 5 and 50 cycles per second. The test shall be continued until the overlay material shows signs of severe cracking, at which time the total number of cycles shall be recorded. Flexure test shall be stopped after 1,000,000 cycles.
- Shear Test:**  
 Shear test shall be conducted at two different load rates as shown below in tabulated section.  
 Fast - sufficient to cause failure within 2 seconds.  
 Slow - maximum of 0.0002 inch per second  $\pm$  20%.  
 Record failure load in p.s.i. and location of failure plane.
- Adhesion Test:**  
 Adhesion test shall be conducted at a load rate of 20 pounds per second  $\pm$  20%.  
 Record failure load in p.s.i. and location of failure plane.
- All tests shall be conducted at 72  $\pm$  2  $^{\circ}$ F.
- Determine density of the surface course of each specimen.



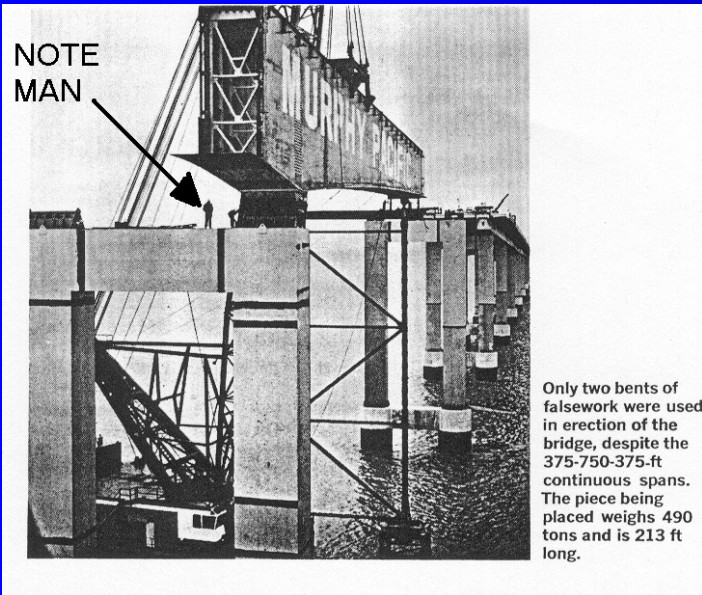
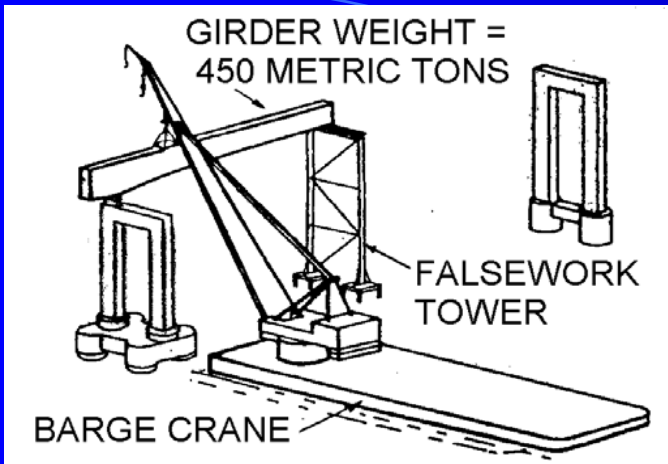
SAN MATEO-HAYWARD BRIDGE IMPROVEMENTS	
SURFACE STEEL DECK	
LABORATORY TESTS FOR STEEL DECK OVERLAY	
DATE: 12/1/67	BY: [Signature]



STATE OF CALIFORNIA  
 DEPARTMENT OF PUBLIC WORKS  
 Division of  
 San Francisco Bay  
 Toll Crossings

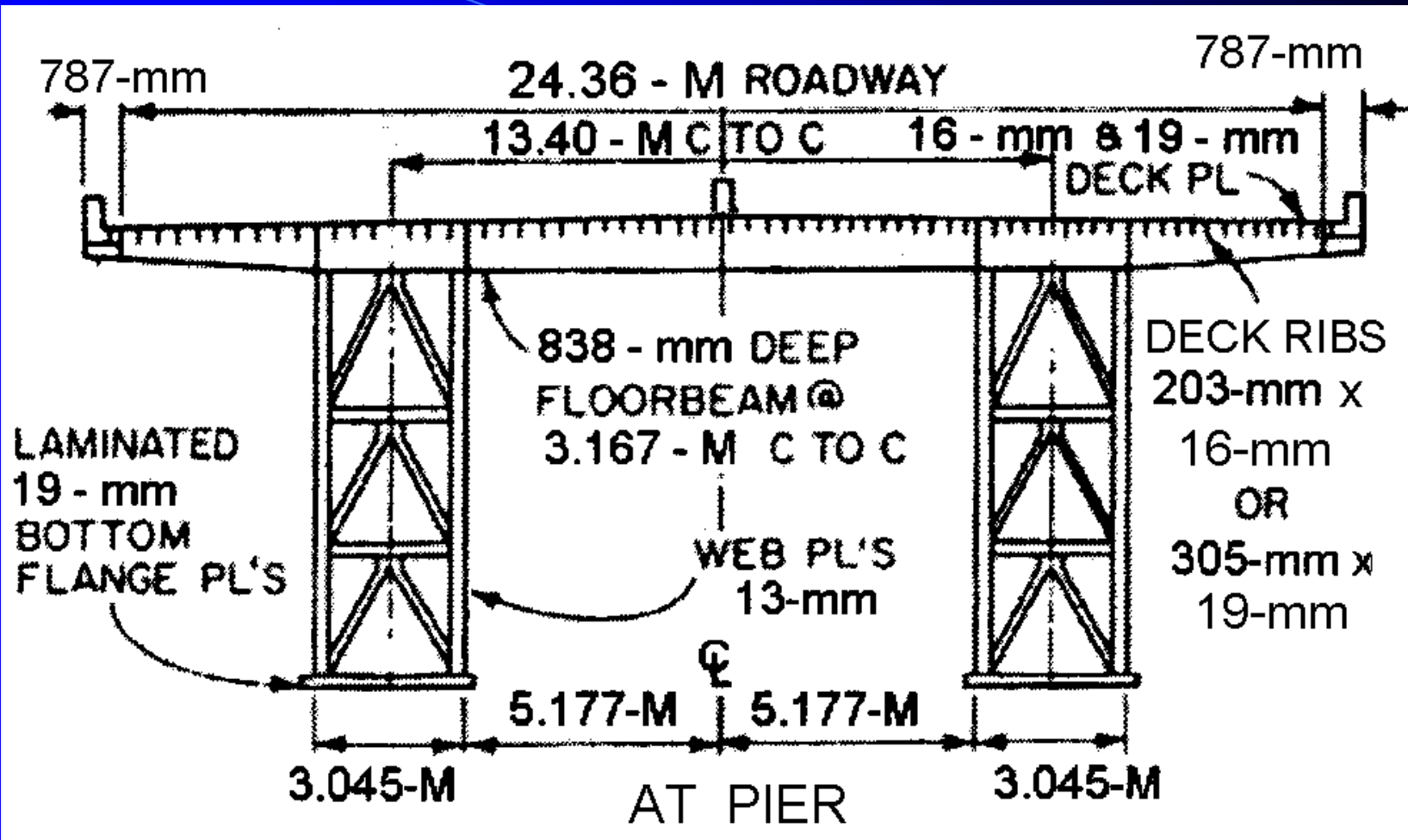
FIGURE 1

# SAN MATEO - HAYWARD BRIDGE



STATE OF CALIFORNIA  
DEPARTMENT OF PUBLIC WORKS  
Division of  
San Francisco Bay  
Toll Crossings

**SAN MATEO - HAYWARD BRIDGE**  
**500-ton Barge Crane Marine Boss** 18



STATE OF CALIFORNIA  
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 Toll Crossings

**SAN MATEO - HAYWARD BRIDGE**  
 # 35-0054, Opened OCTOBER 31, 1967<sup>9</sup>

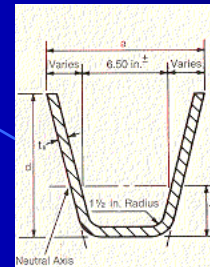
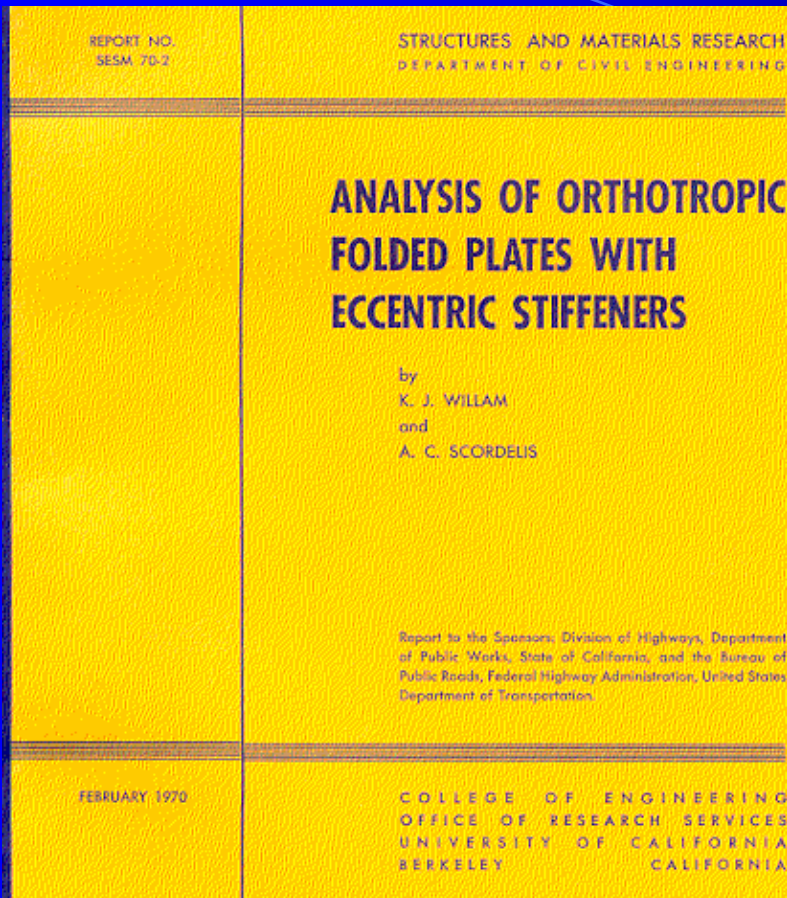


Table A

The addition of the 12-, 13-, and 14-in. deep ribs will permit the designer to reduce the number of stiffeners required and increase transverse floor beam spacing, thus reducing fabricating costs.

## BETHLEHEM STEEL CO. SEPT 1971

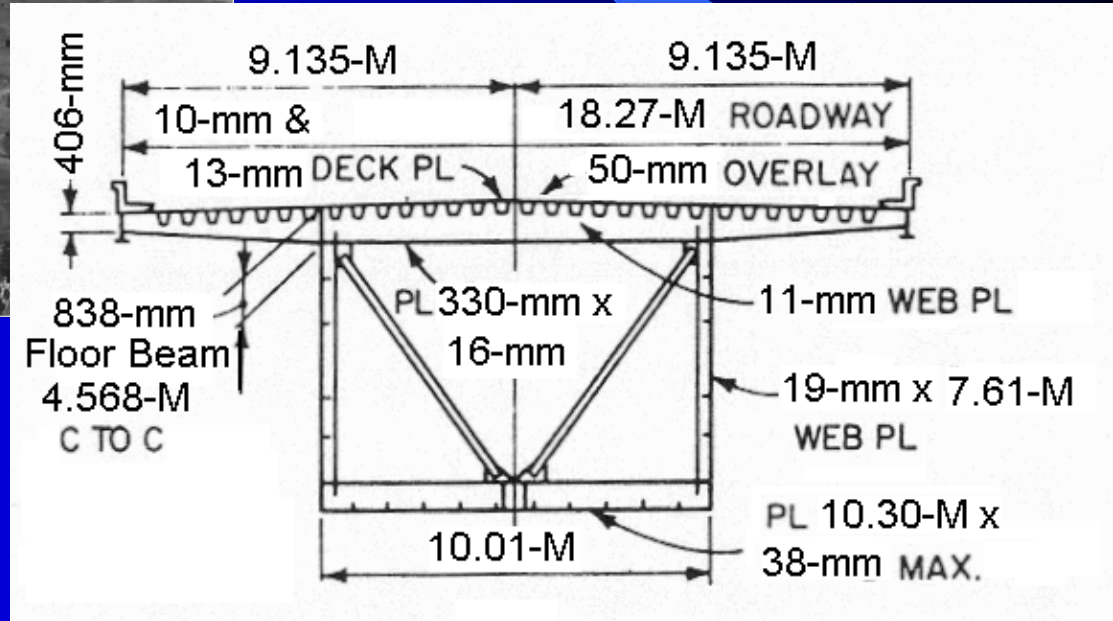
### Properties and Dimensions of Bethlehem Standard Ribs

Standard Rib Designation	Depth of Rib d in.	Width at Top a in.	Rib Thickness t <sub>r</sub> in.	Weight Per Foot lb.	I <sub>xx</sub> in. <sup>4</sup>	Y <sub>xx</sub> in.
115	11.0	13.38	5/16	30.09	110.4	4.52
116			3/8	35.94	131.0	4.54
117			7/16	41.75	151.0	4.57
125	12.0	14.00	5/16	32.33	140.2	5.00
126			3/8	38.62	166.4	5.02
127			7/16	44.88	192.1	5.05
135	13.0	14.63	5/16	34.54	174.7	5.48
136			3/8	41.31	207.6	5.51
137			7/16	48.01	239.7	5.53
145	14.0	15.25	5/16	36.75	214.4	5.97
146			3/8	43.96	254.8	5.99
147			7/16	51.10	294.4	6.02

# OPEN OR CLOSED RIBS ????

## ISSUES





STATE OF CALIFORNIA  
 DEPARTMENT OF PUBLIC WORKS  
 Division of  
 San Francisco Bay  
 Toll Crossings

# SAN DIEGO - CORONADO BRIDGE

## # 57-0857 Opened 1969 – 40 Years

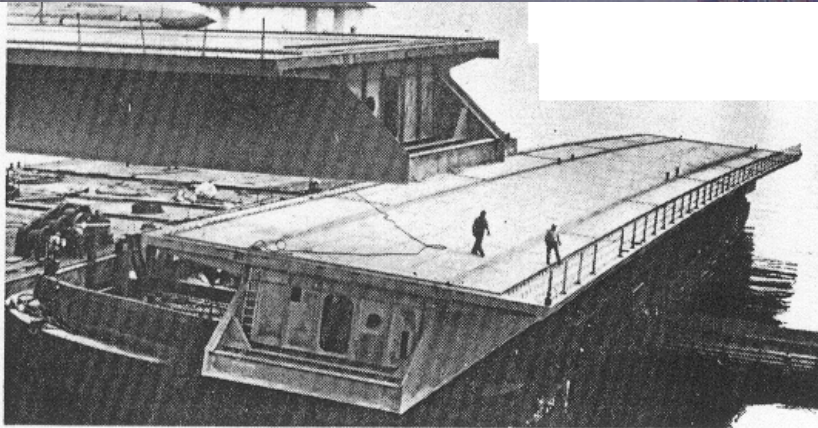


STATE OF CALIFORNIA  
DEPARTMENT OF PUBLIC WORKS

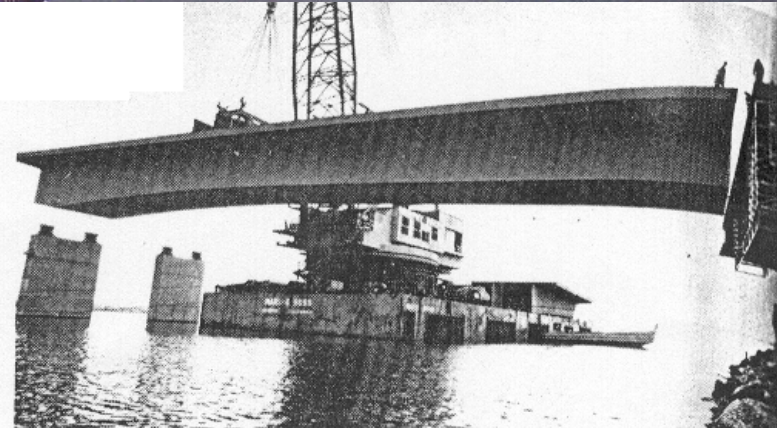
Division of  
San Francisco Bay  
Toll Crossings

# SAN DIEGO - CORONADO BRIDGE

# 57-0857 Opened 1969 – 40 Years



**Bridge sections** are barged 400 miles from prefabricating yard.

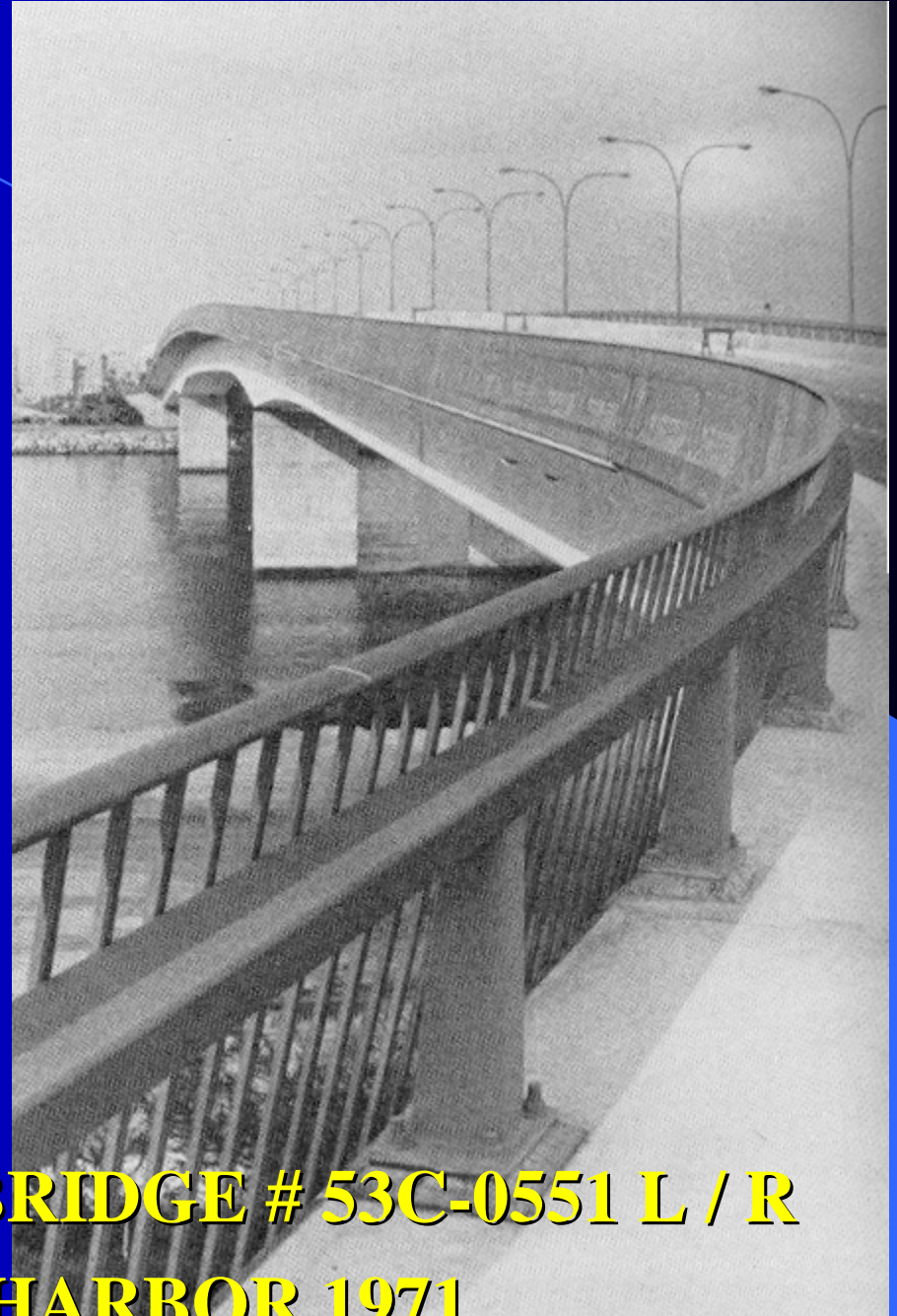
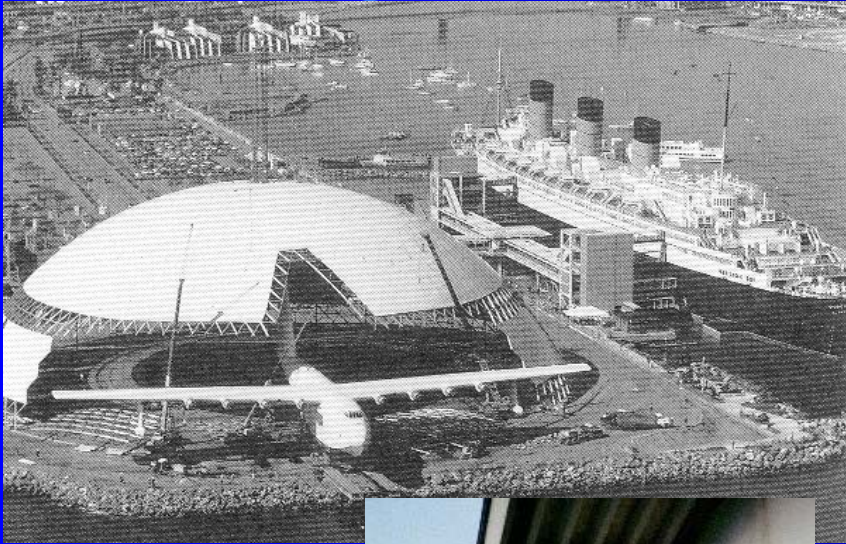


**Crane positions girder** for bolting to adjacent bridge section.

**Prefab steel bridge girders are biggest ever lifted**

CITY OF  
LONG  
BEACH

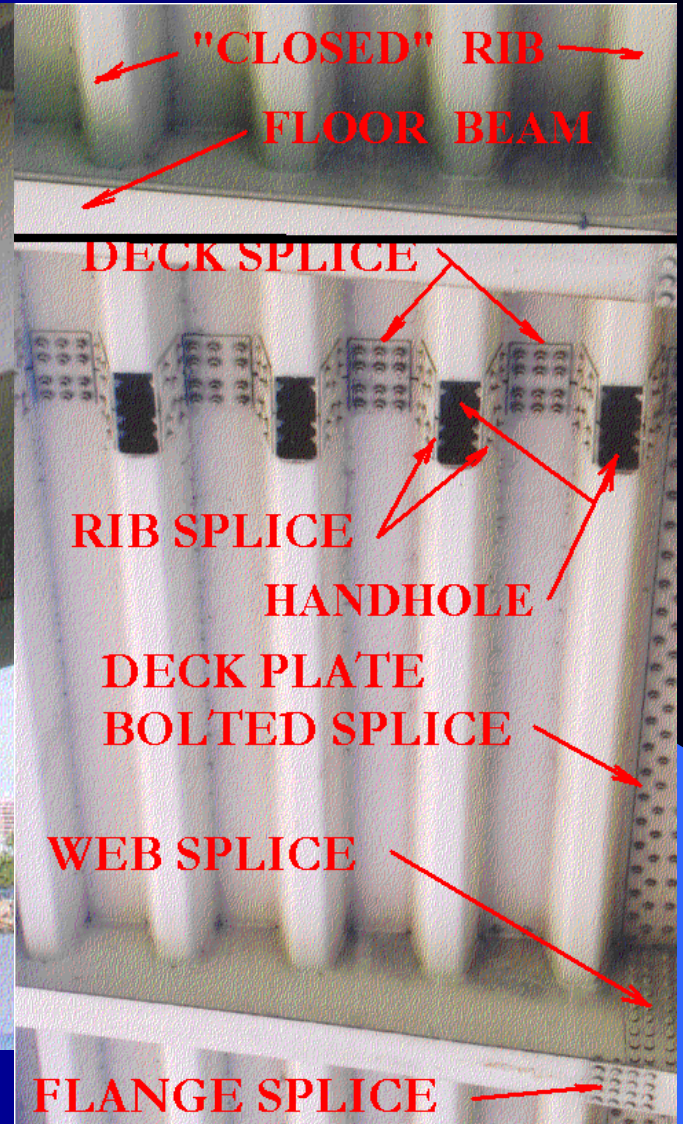
**QUEENSWAY BRIDGE # 53C-0551 L / R**  
**LONG BEACH HARBOR 1971**



CITY OF  
LONG  
BEACH

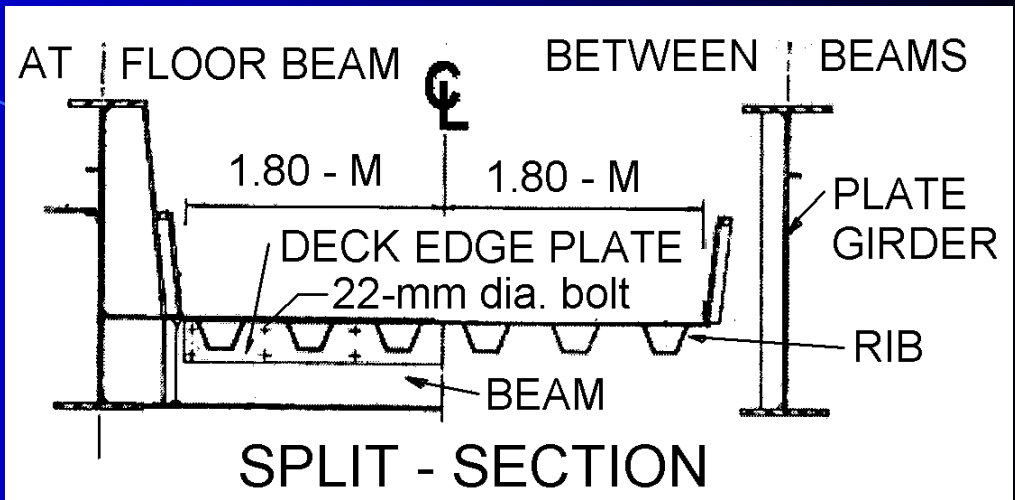
**QUEENSWAY BRIDGE # 53C-0551 L / R**  
**LONG BEACH HARBOR 1971**





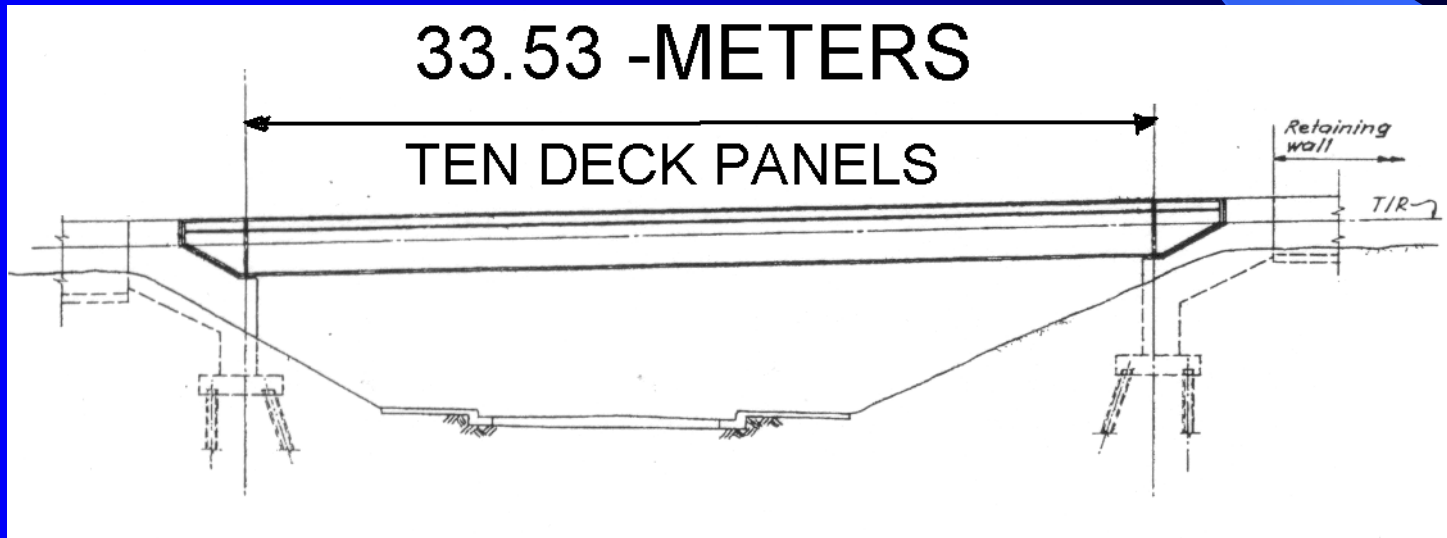
CITY OF  
LONG  
BEACH

**QUEENSWAY BRIDGE # 53C-0551 L / R**  
**LONG BEACH HARBOR 1971**



**GOLDEN GATE AVENUE**

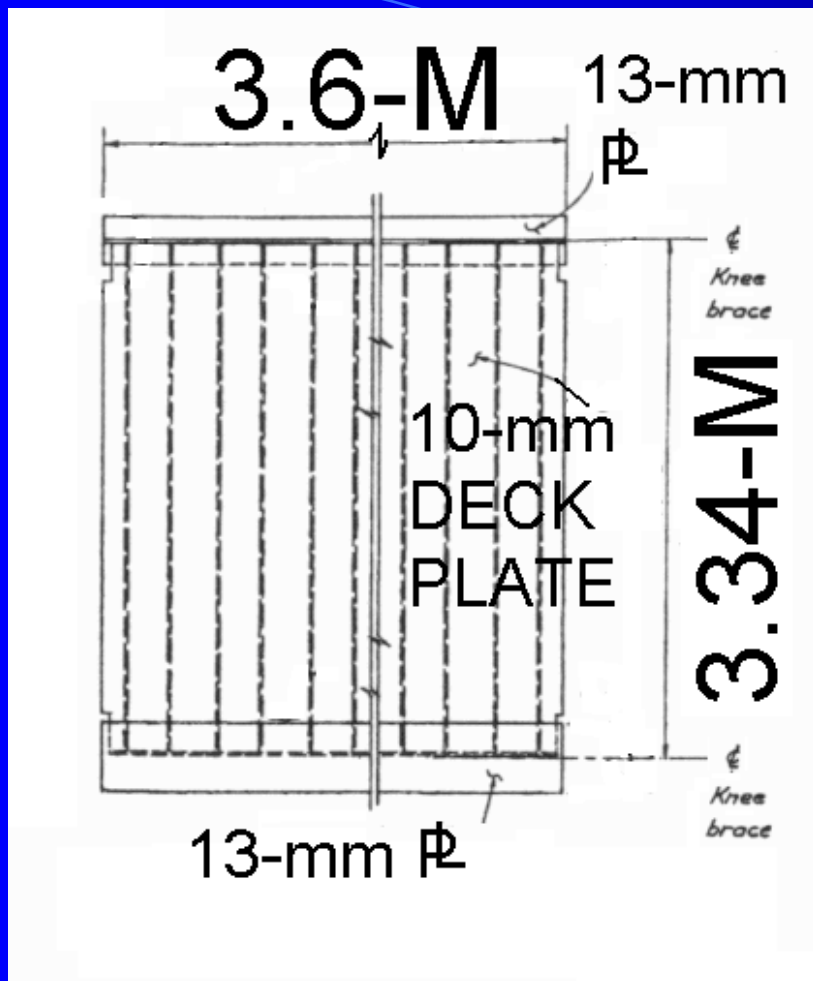
**CROSS SECTION OF BRIDGES**



BART  
Bay Area  
Rapid Transit

**BART--- WEATHERING STEEL BRIDGES**

**# A-096 A & B == BERKELEY 1972**



**PANELIZED DECK**

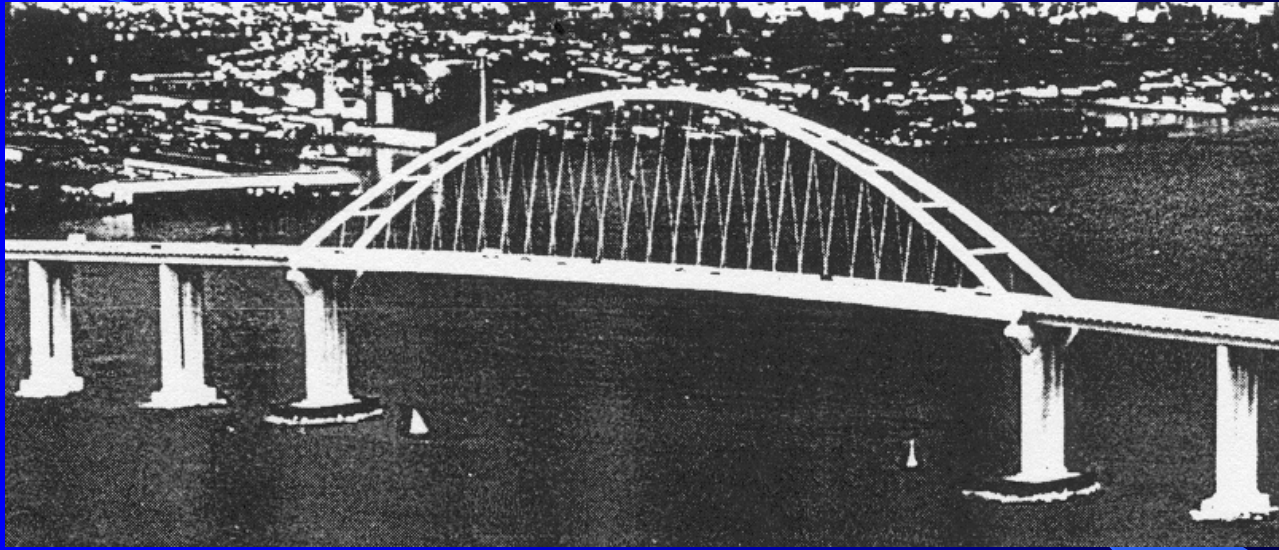
**BELOW DECK PHOTO**

**BART--- WEATHERING STEEL BRIDGES**

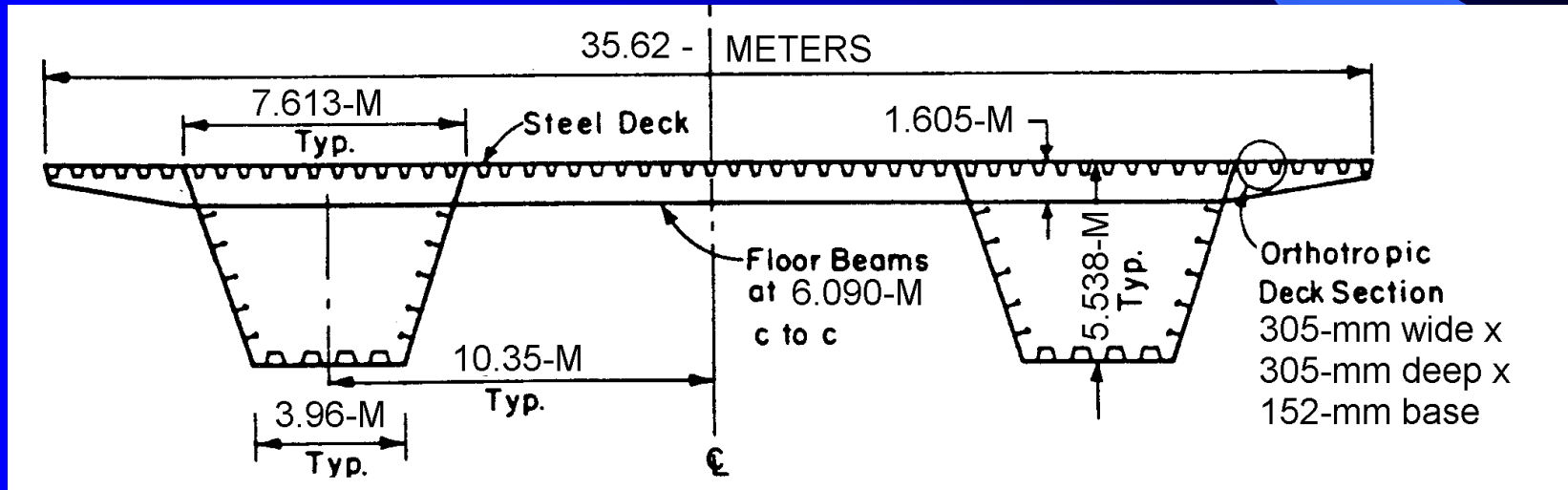
**# A-096 A & B == BERKELEY 1972**

BART

Bay Area  
Rapid Transit

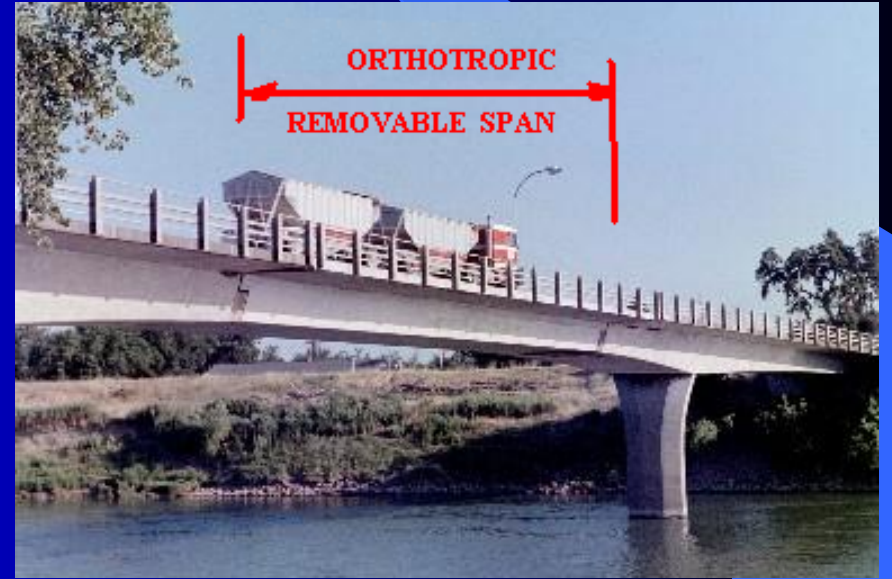


## BASKET HANDLE TIED ARCH



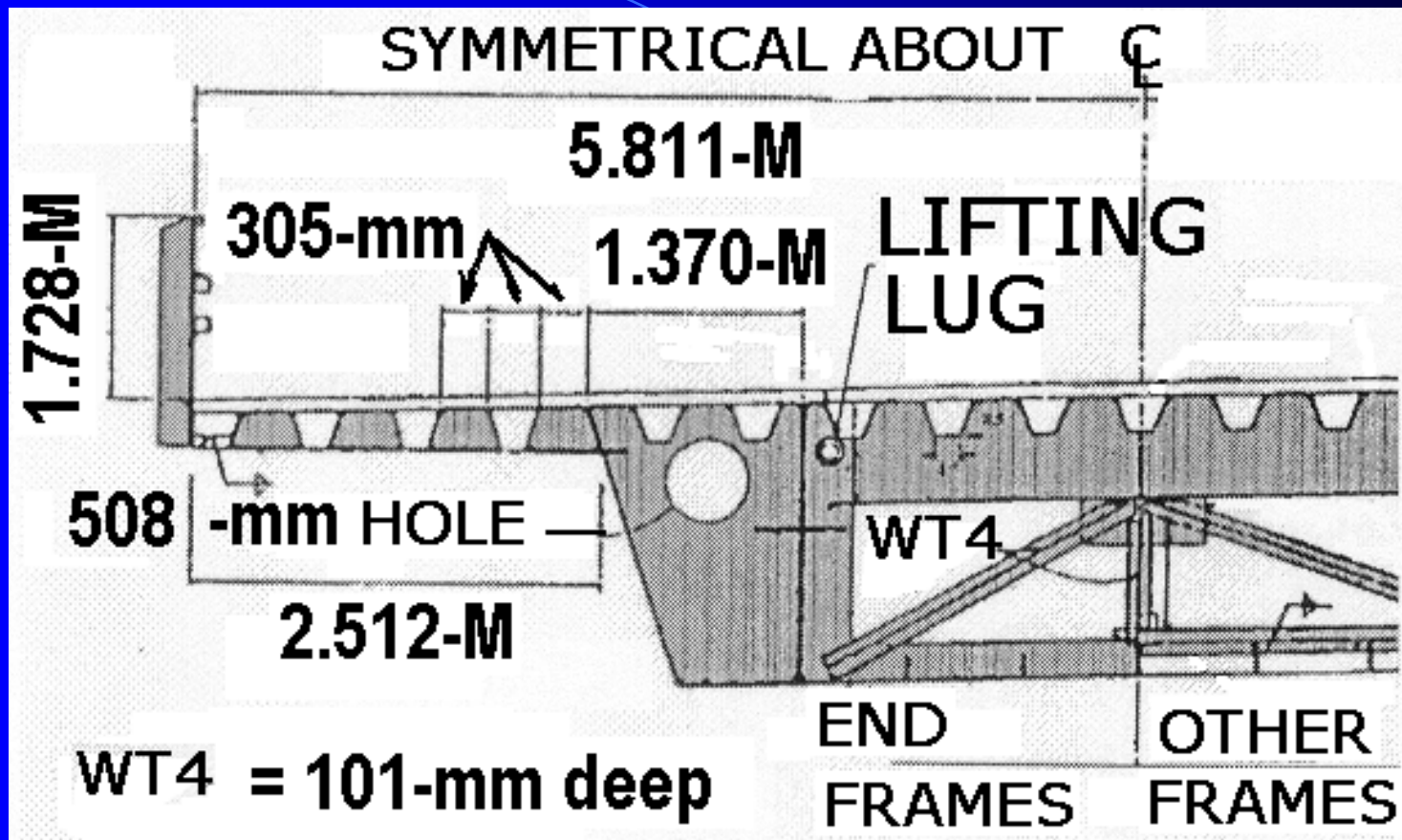
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Division of  
San Francisco Bay  
Toll Crossings

**SOUTHERN CROSSING -- BAY TOLLS**  
**14.5 MILES LONG 1972**



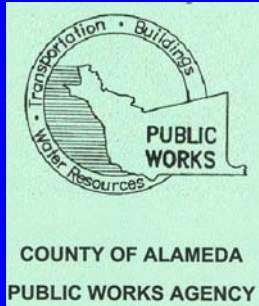
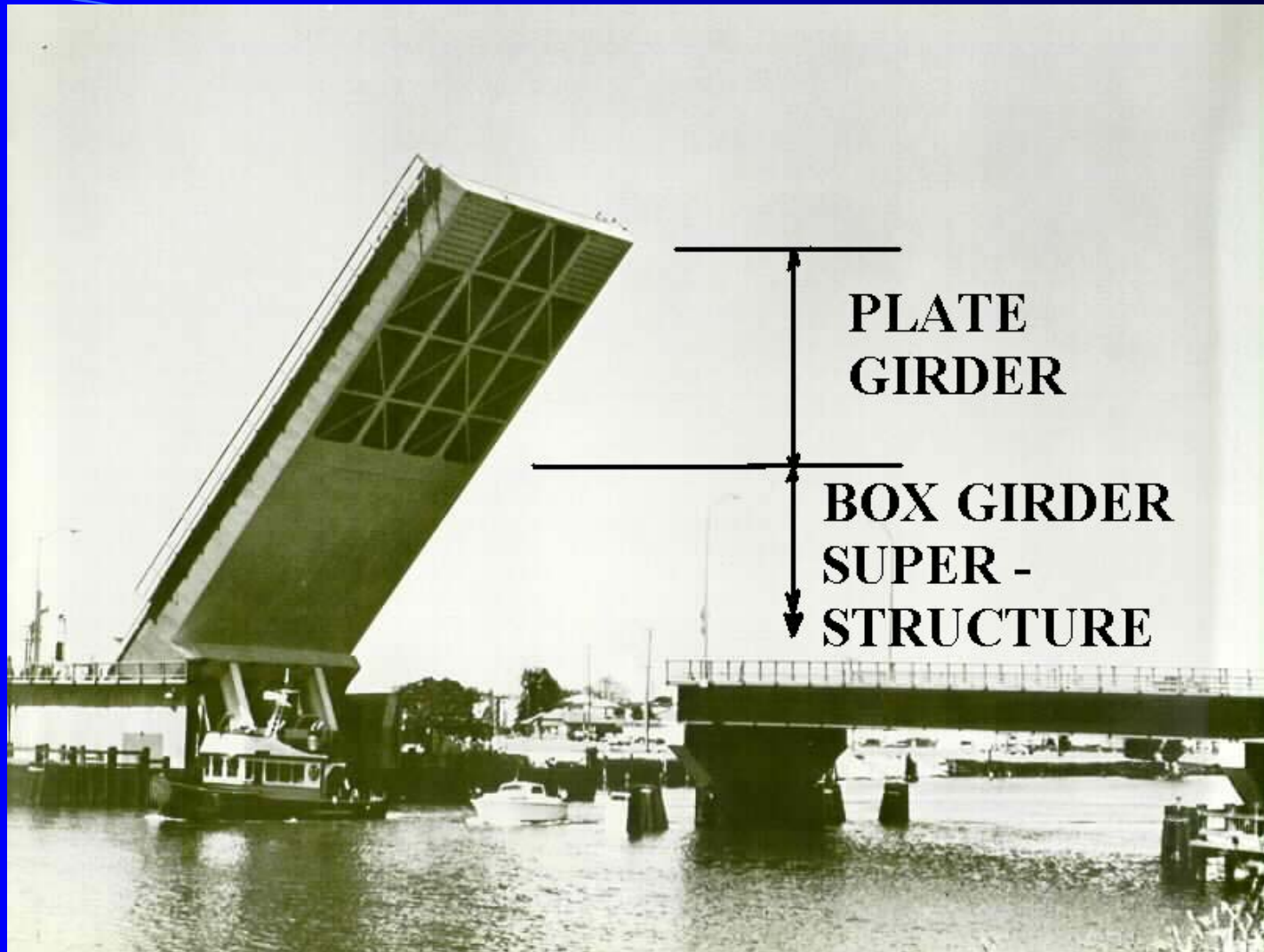
COLUSA  
COUNTY

# COLUSA BRIDGE OVER SACRAMENTO RIVER, # 15C-0001 COLUSA COUNTY 1972<sub>9</sub>

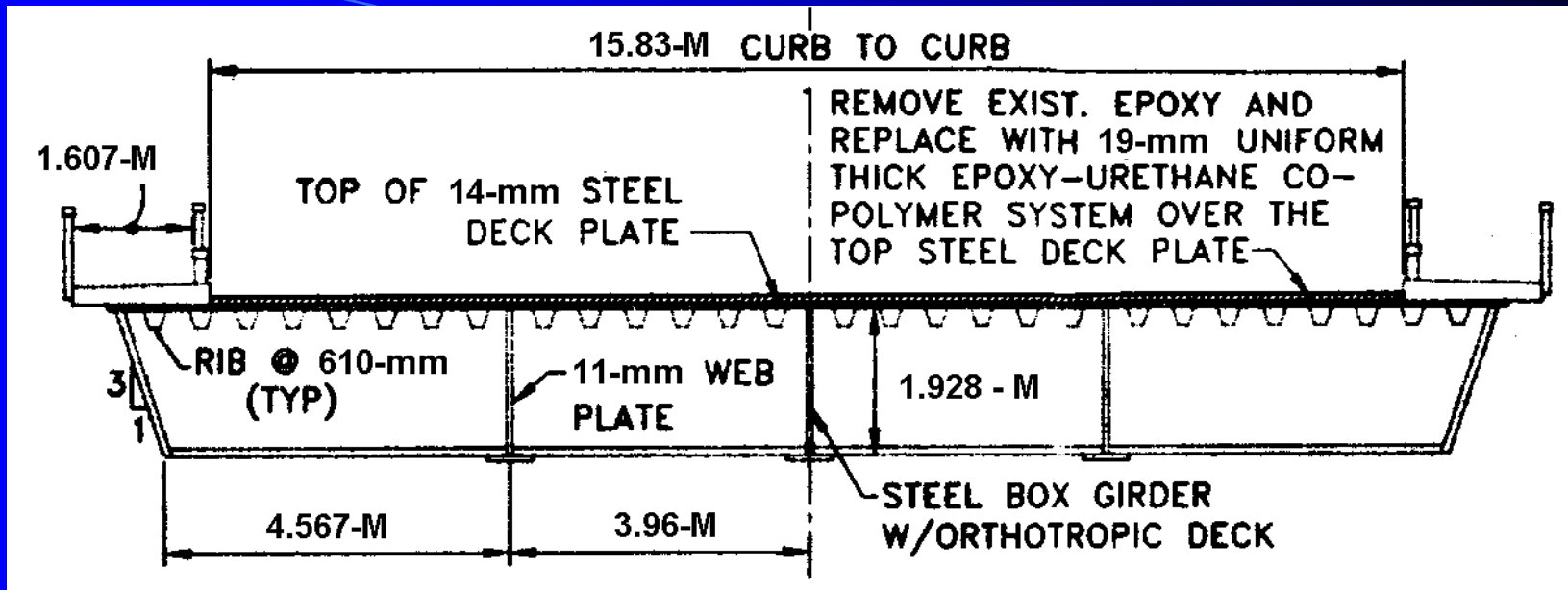


**COLUSA BRIDGE OVER SACRAMENTO RIVER, 15C-0001 COLUSA COUNTY 1972**

COLUSA  
COUNTY

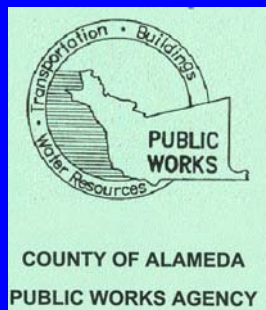


# **MILLER SWEENEY BASCULE BRIDGE # 33C-0147, ALAMEDA COUNTY 1973**

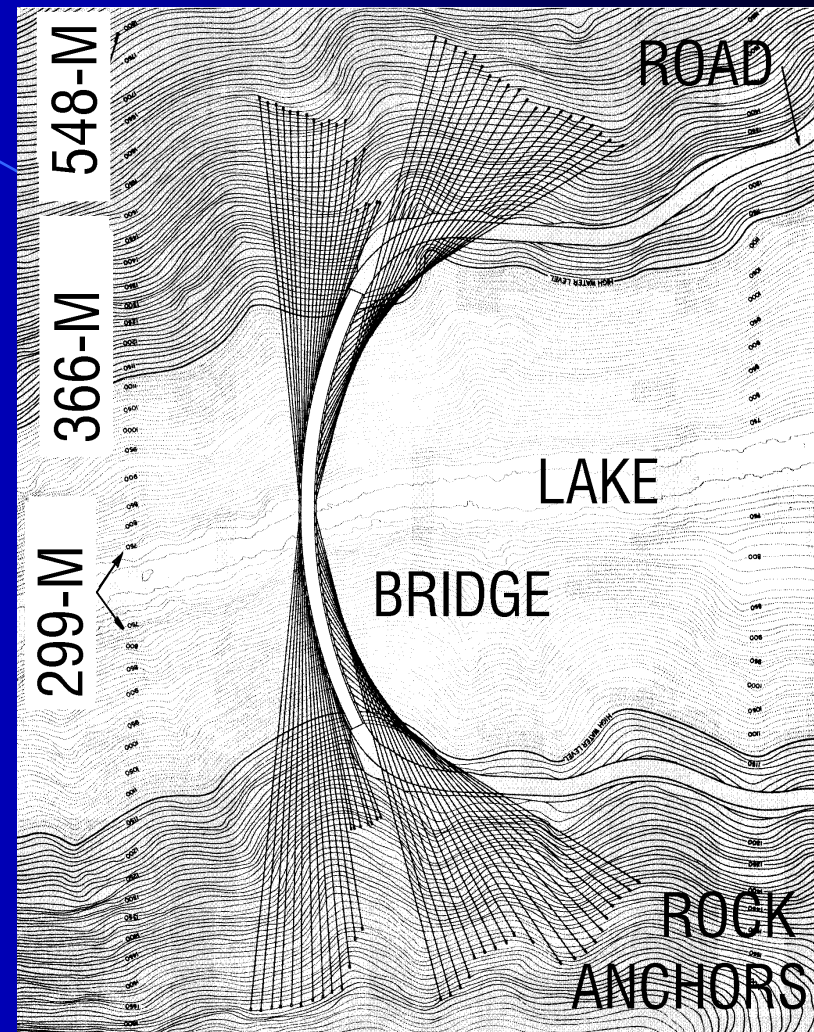
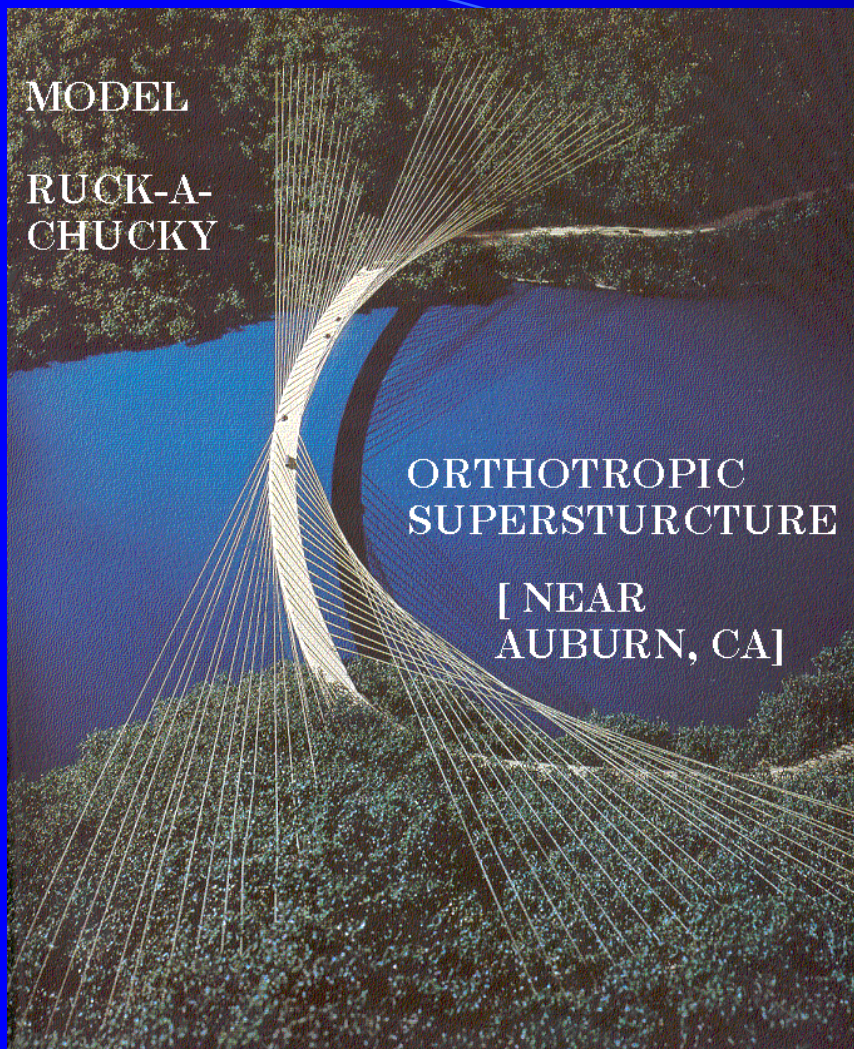


# MILLER SWEENEY BASCULE BRIDGE

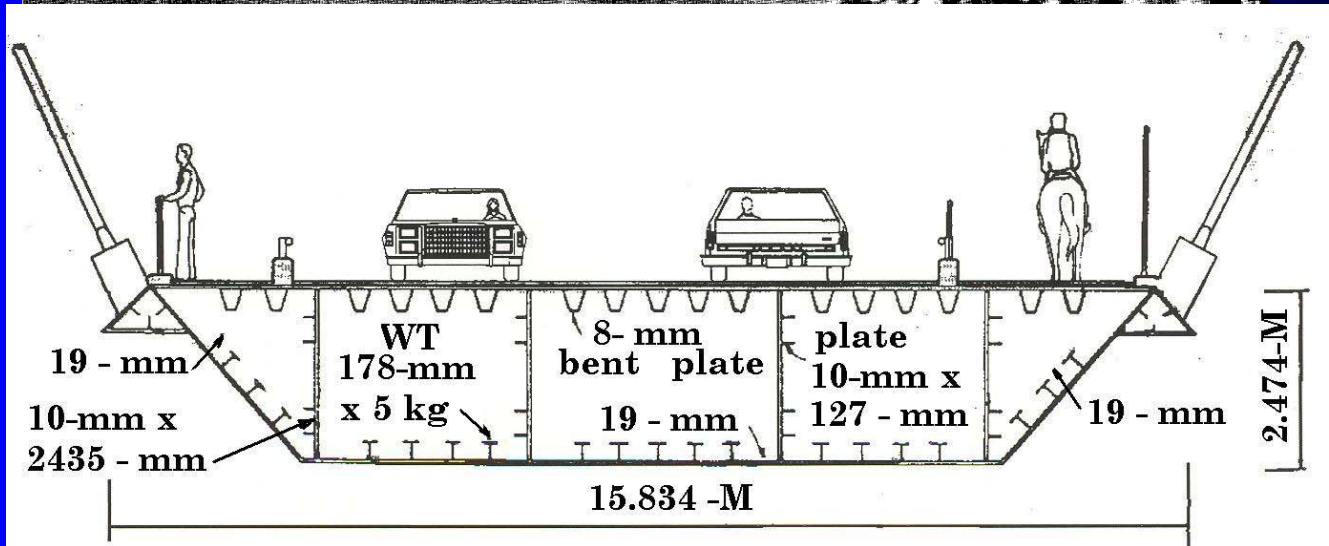
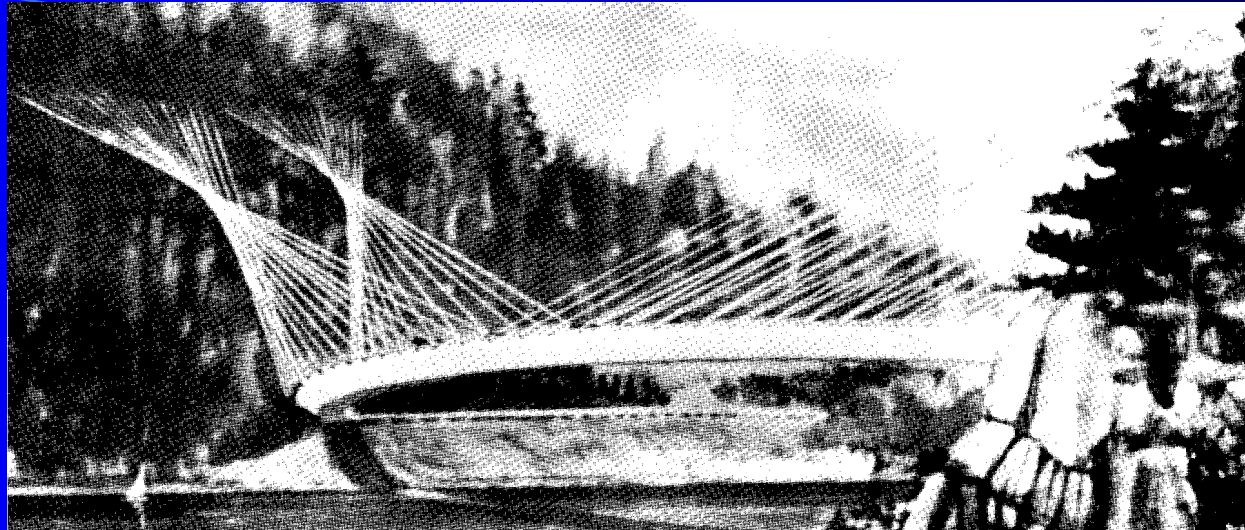
## 33C-0147, ALAMEDA COUNTY 1973



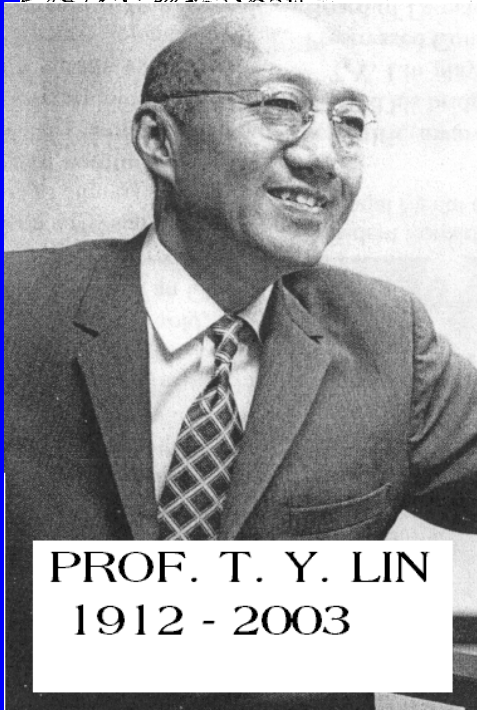
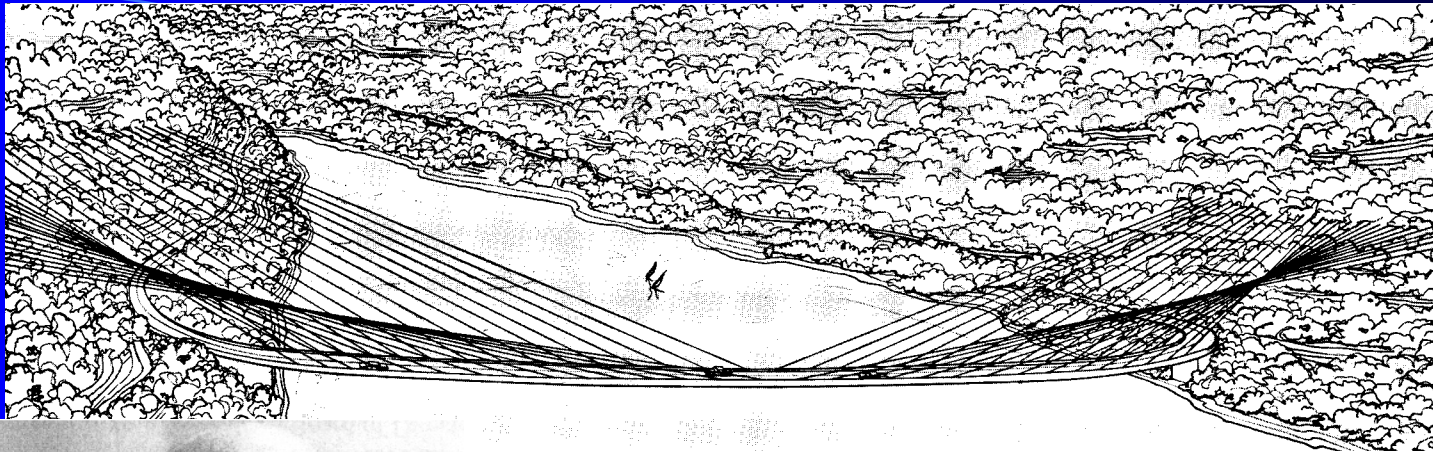




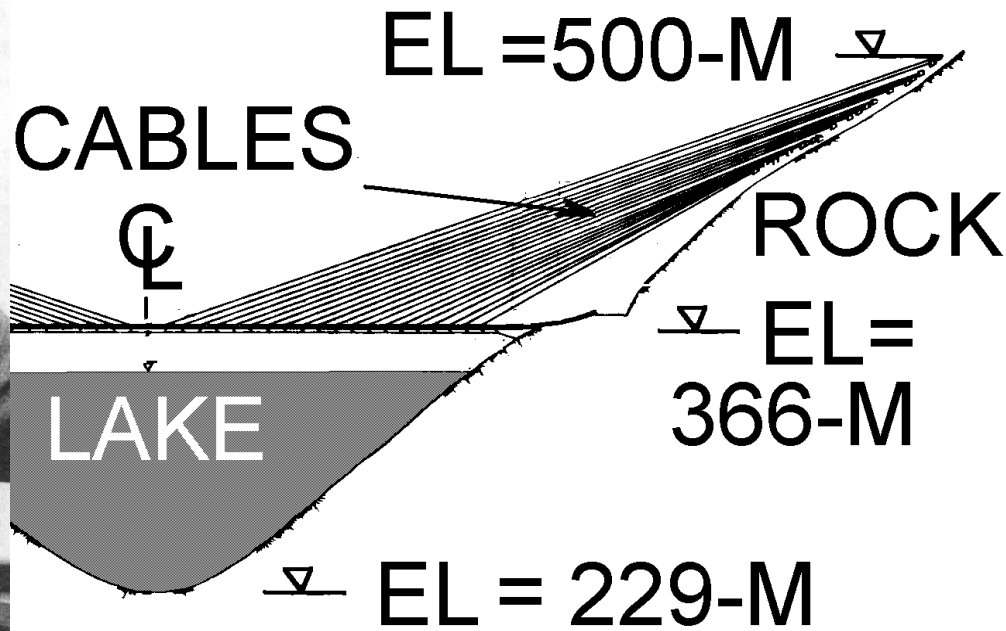
**PROPOSED RUCK-A-CHUCKY BRIDGE  
OVER AUBURN DAM LAKE, 1976**



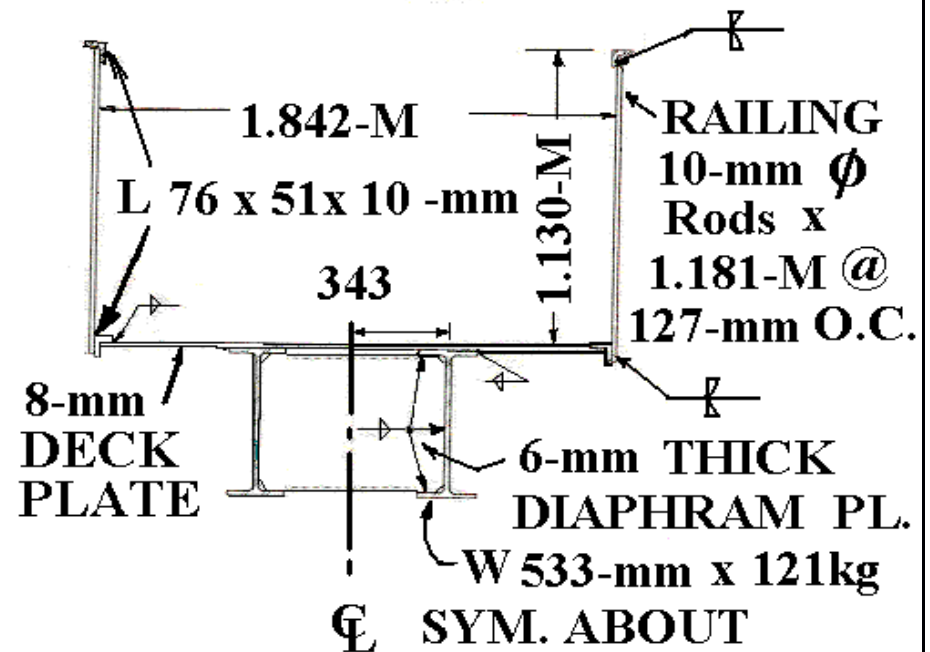
## PROPOSED RUCK-A-CHUCKY BRIDGE OVER AUBURN DAM LAKE, 1976



PROF. T. Y. LIN  
1912 - 2003

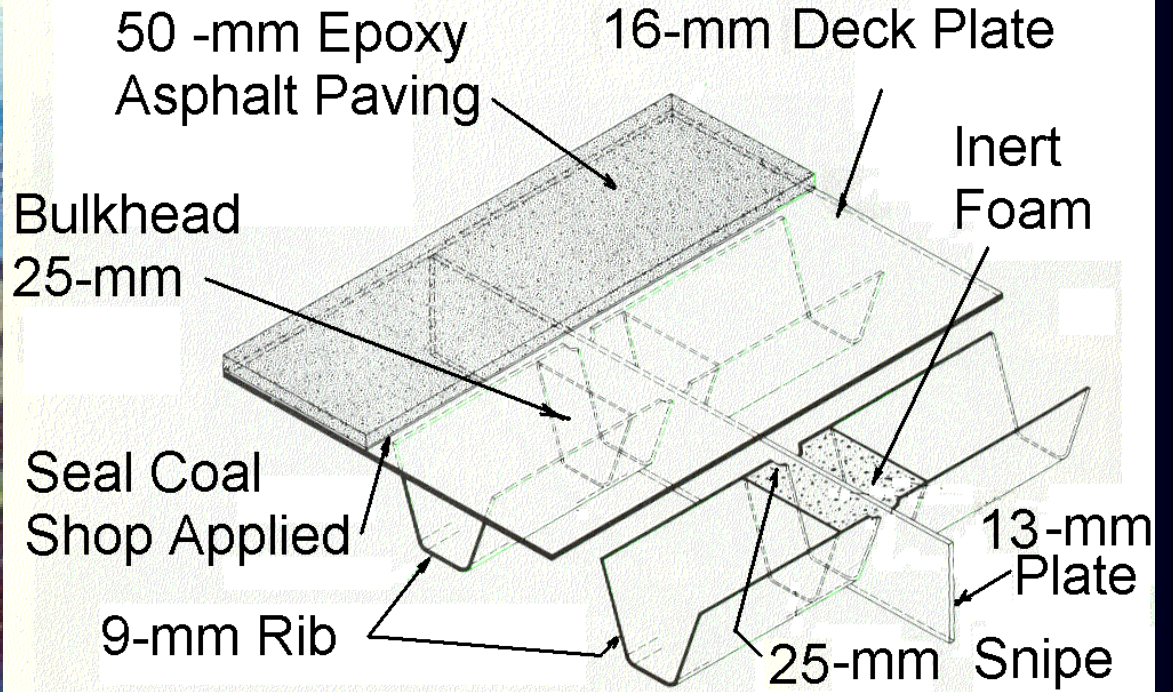
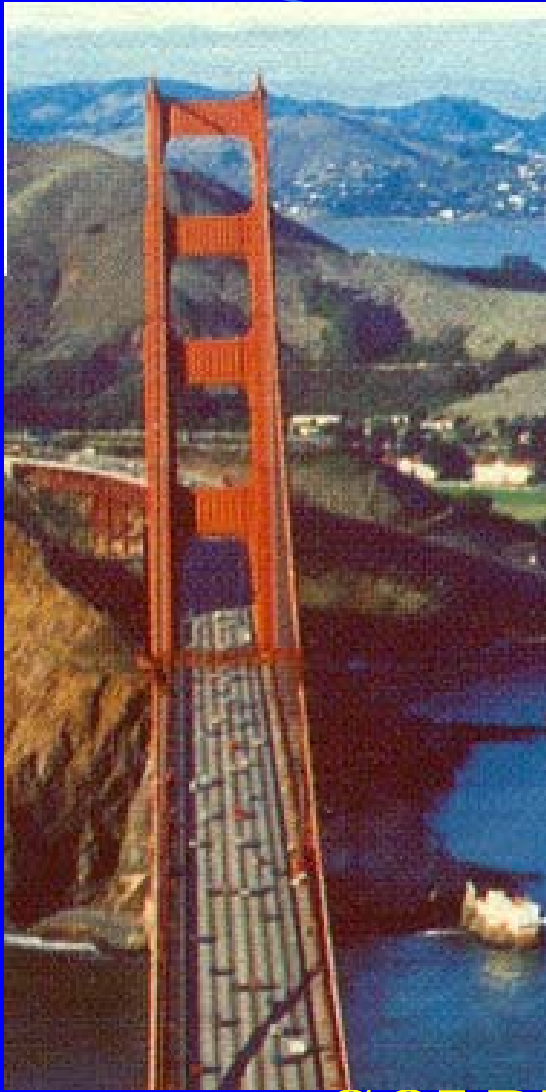


# PROPOSED RUCK-A-CHUCKY BRIDGE OVER AUBURN DAM LAKE, 1976



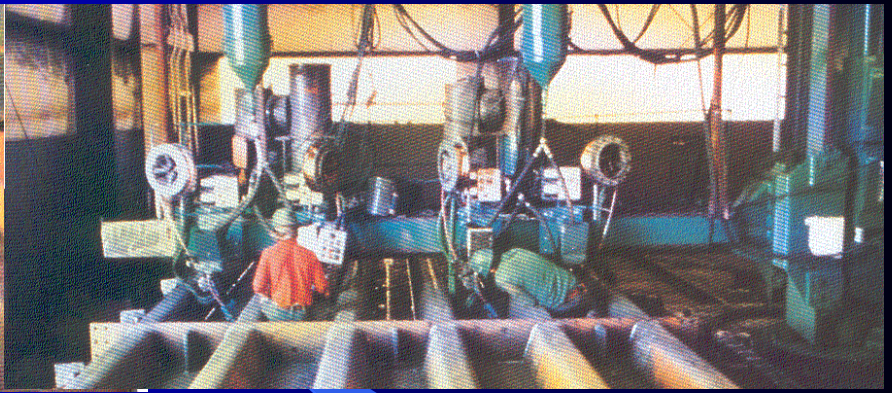
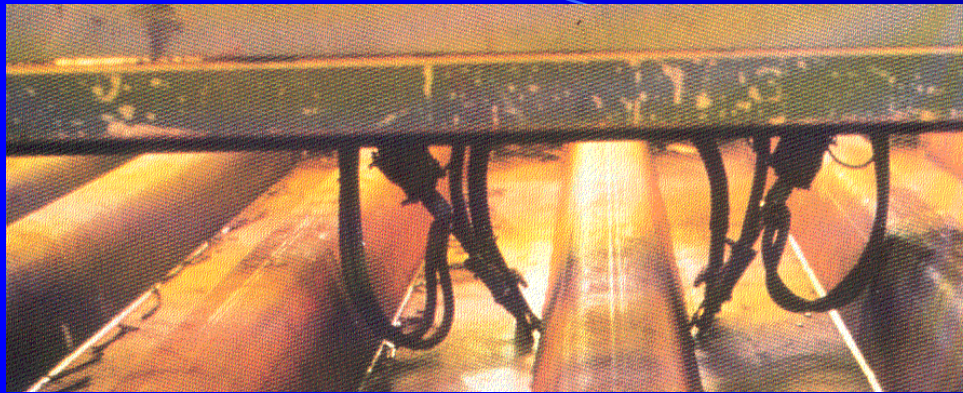
[Photos Summer 2001]

## BRAILLE TRAIL PEDESTRIAN BRIDGE OVER CREEK, 1977

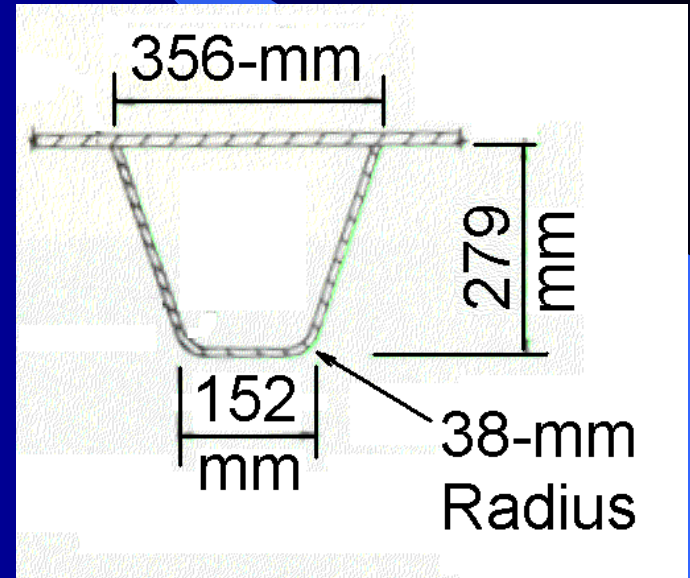


# **GOLDEN GATE BRIDGE DECK REPLACEMENT , 1985**

GOLDEN GATE  
BRIDGE,  
HIGHWAY &  
TRANSPORTATION  
DISTRICT



— Finished deck panel — shipment to site.

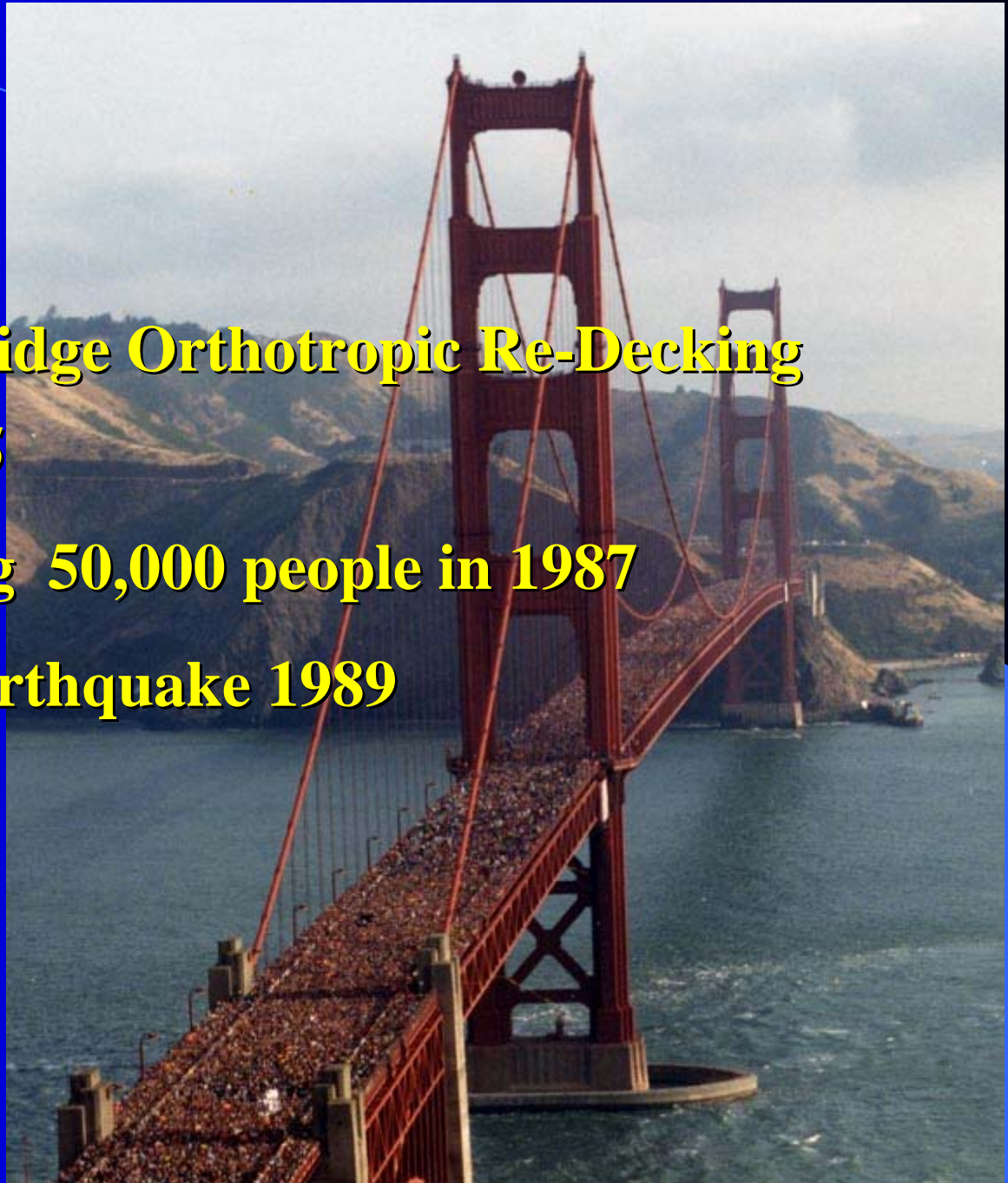


# GOLDEN GATE BRIDGE DECK REPLACEMENT , 1985

GOLDEN GATE  
BRIDGE,  
HIGHWAY &  
TRANSPORTATION  
DISTRICT

- **Golden Gate Bridge Orthotropic Re-Decking Completed 1985**
- **Largest Loading 50,000 people in 1987**
- **Loma Prieta Earthquake 1989**

GOLDEN GATE  
BRIDGE,  
HIGHWAY &  
TRANSPORTATION  
DISTRICT





A publication of the James F. Lincoln Arc Welding Foundation



# Steel Bridge Report

Prepared by Construction Marketing • Bethlehem Steel Corporation • Bethlehem, PA 18016

## Cypress Reconstruction - Contract E Bethlehem Steel & Universal Structural, Inc.



This 3-cell steel "rib" section

### BACKGROUND

On Tuesday, October 1, 1995, a major earthquake struck the northern California San Francisco Bay Area. The earthquake, measured on the Richter Scale at magnitude 6.9, destroyed a variety of structures in the area. The damage to the long, two-level freeway in San Francisco caused by the earthquake occurred to the I-880 Corridor, a two-thirds of a mile of this key freeway, linking San Francisco and San Jose, California. The earthquake identified the need to reconstruct the freeway.

After a good deal of study, the California State Transportation (CALTRANS) decided to provide into seven contract areas. The I-880 interchange on the south side of the I-880 interchange on the value of these contract



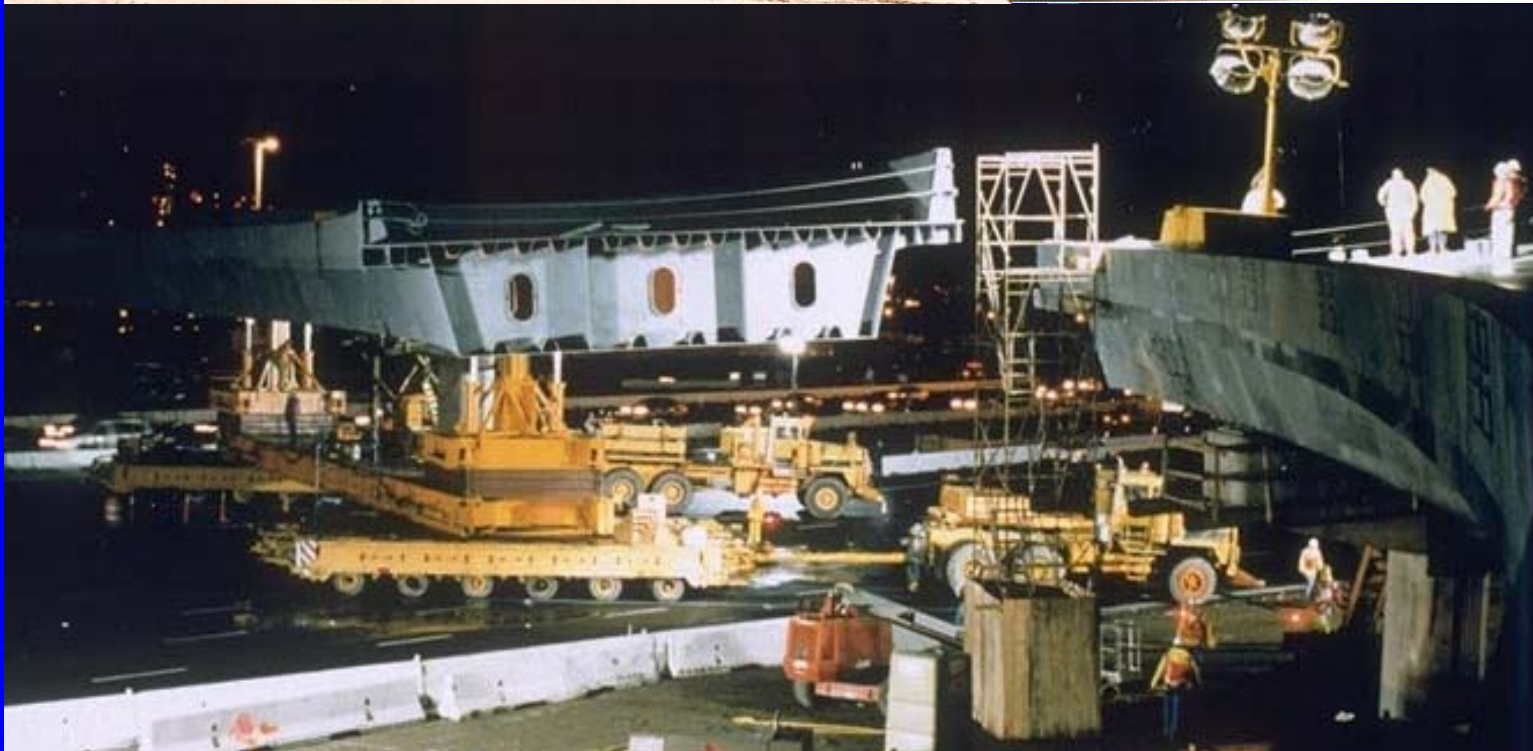
2am on Feb 4 1996



# MARITIME OFF-RAMP BRIDGE #33-0623S

## “HORSESHOE” , 1997





## MARITIME OFF-RAMP BRIDGE #33-0623S

“HORSESHOE” , 1997

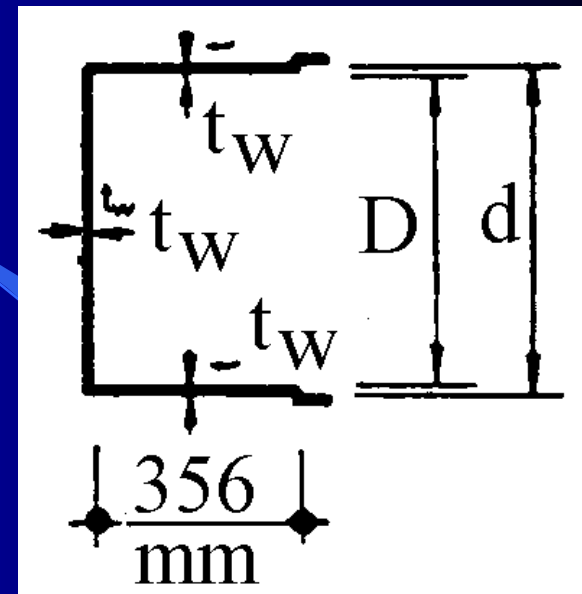
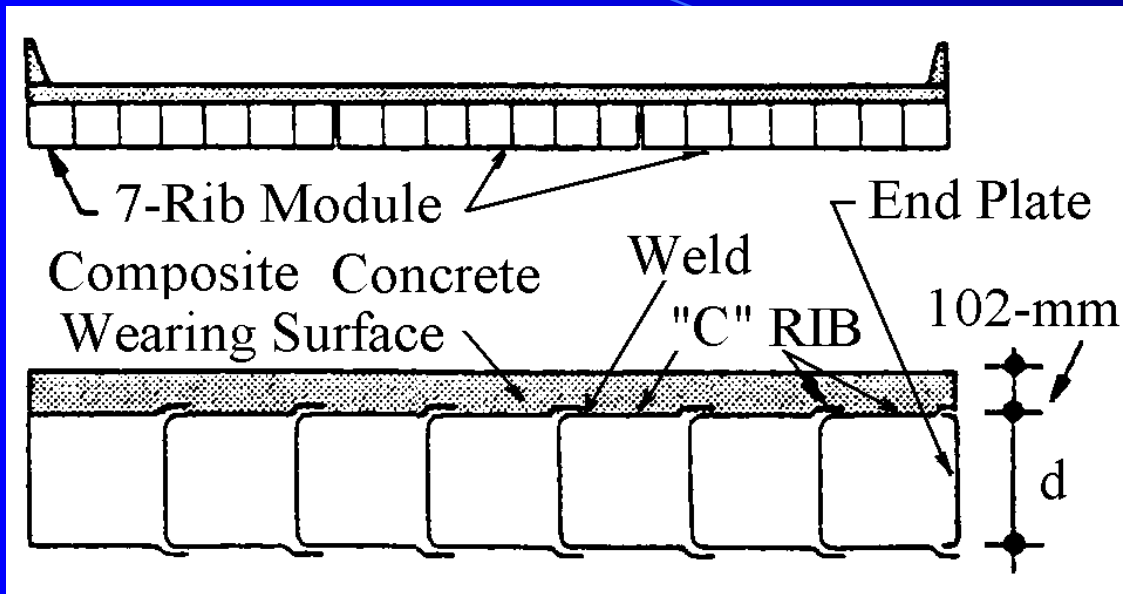




**MARITIME OFF-RAMP BRIDGE #33-0623S**

**“HORSESHOE” , 1997**





courtesy of Advanced Bridge Systems Inc.,  
 [Jiri Strasky, Consulting Engineers]

**“PATENTED” SLAB BRIDGE, REDDING**  
**APPROVED BY CALTRANS , 1998**





**Preassembly**  
**Float-in >**



**US Navy Nicolas Island, CA floating dock**

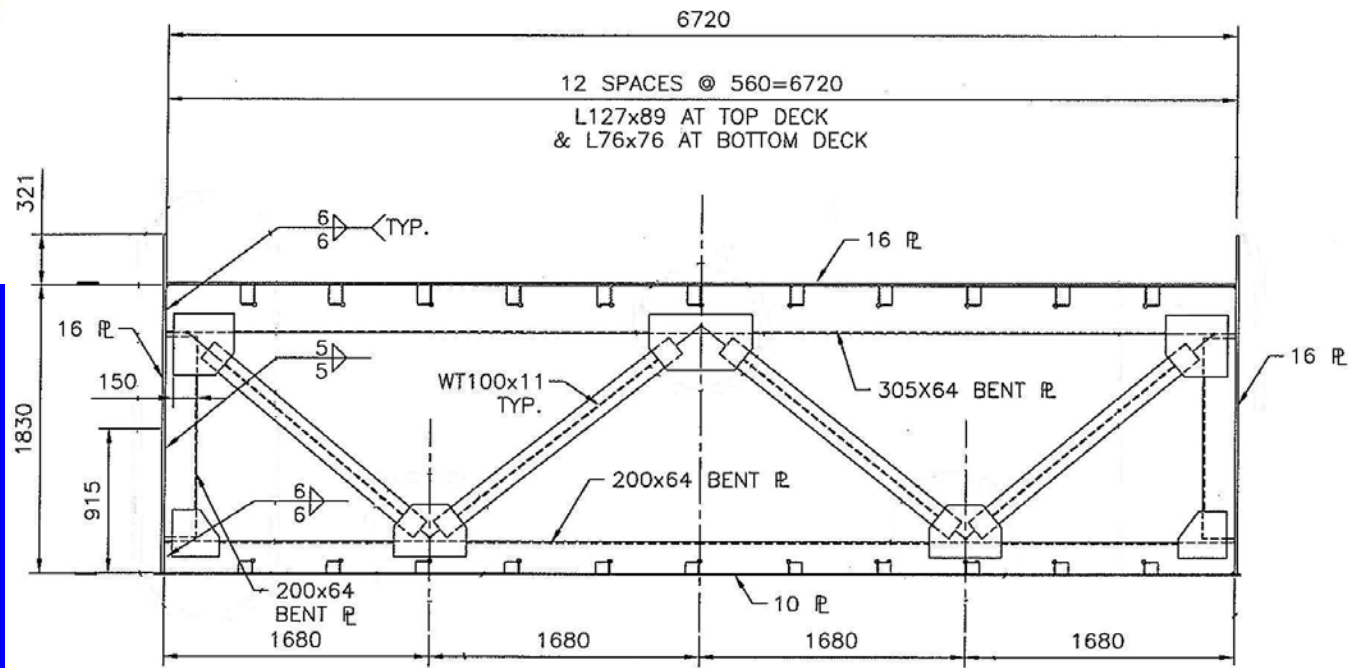
- **Design Build NOVA Group + Winzler and Kelly Engineers of San Francisco. Pontoons are 52.995-M x 6.7250-M.**



**US Navy Nicolas Island, CA floating dock Design Build NOVA Group +**



**Winzler and Kelly Engineers of San Francisco.  
Pontoons are 52.995-M x 6.7250-M.**



Dimensions in mm





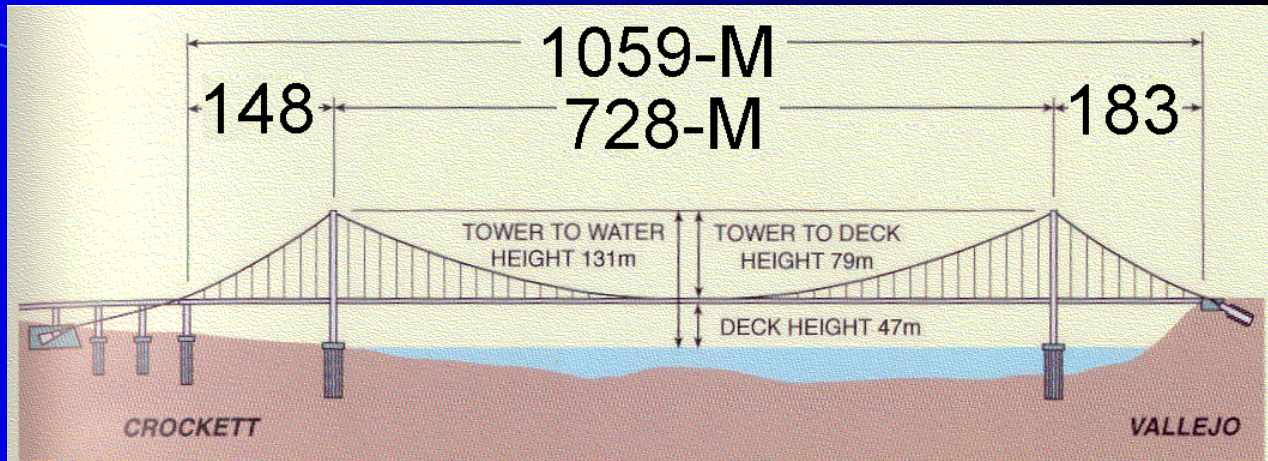
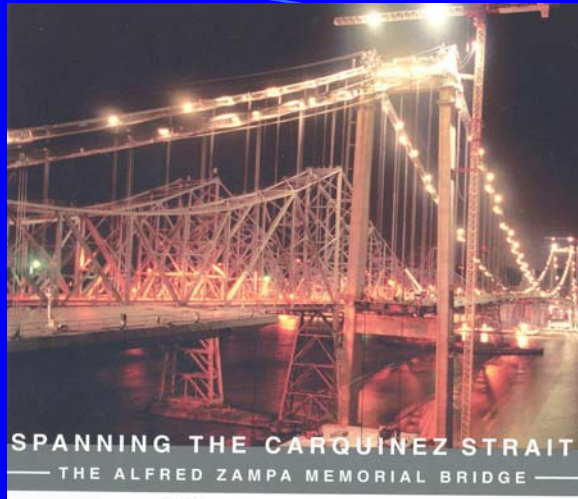
**US Navy Nicolas Island, CA floating dock**

**Design Build NOVA Group +**

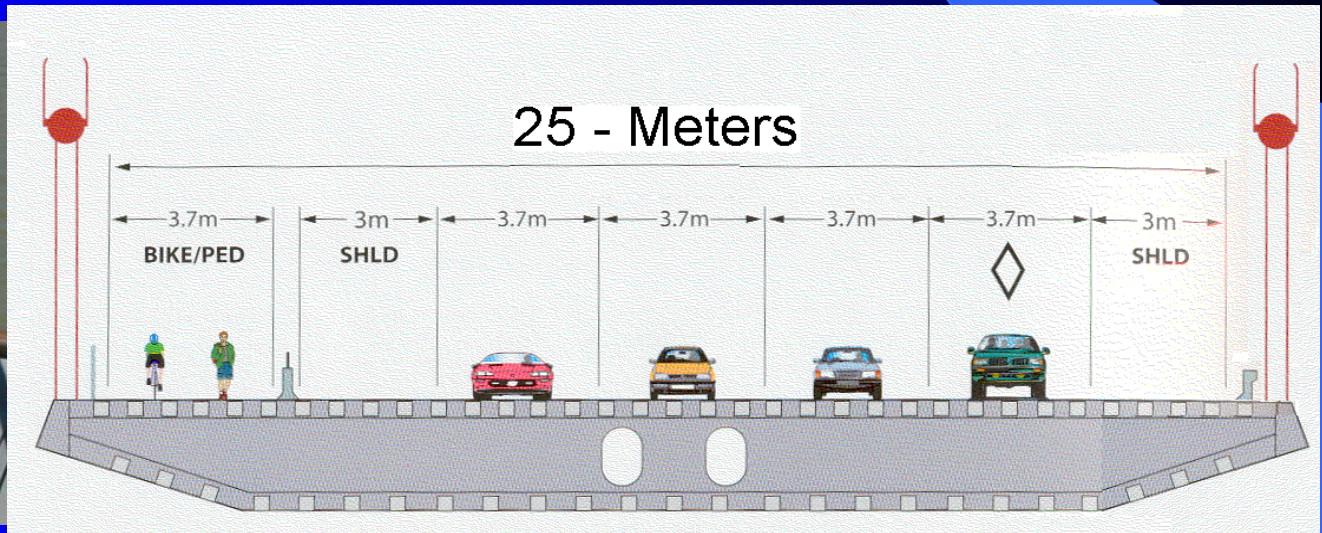
**Winzler and Kelly Engineers of San Francisco.**

**Pontoons are 52.995-M x 6.7250-M.**





California Department of Transportation, (Caltrans). (2003). *Spanning the Carquinez Strait – The Alfred Zampa Memorial Bridge, Oakland, California*, 93 pages.



I-80 WB CARQUINEZ STRAITS, CROCKETT  
ALFRED ZAMPA MEMORIAL BRIDGE #28-0352L

OBG = Orthotropic Bridge Girders

Construction schedule

Item \ Year month	2000												2001												2002												2003												2004				
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Foundation, tower	█																																																				
Cable erection																									█																												
Fabrication of OBG																									█																												
Erection of OBG																																					█																
On-deck work Wearing Surface																																																	█				



**I-80 WB CARQUINEZ STRAITS, CROCKETT  
ALFRED ZAMPA MEMORIAL BRIDGE #28-0352L  
COURTESY of IHI Corporation PAPER**







**I-80 WB CARQUINEZ STRAITS, CROCKETT**

**ALFRED ZAMPA MEMORIAL BRIDGE #28-0352L**





**I-80 WB CARQUINEZ STRAITS, CROCKETT  
ALFRED ZAMPA MEMORIAL BRIDGE #28-0352L**



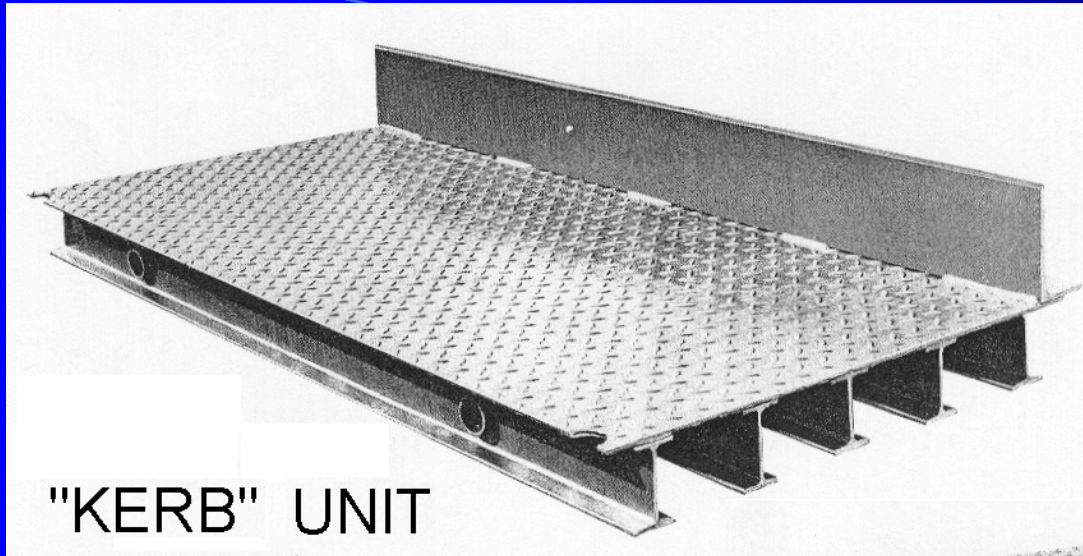
**About a 60-Minute drive from Sacramento**



**I-80 WB CARQUINEZ STRAITS, CROCKETT  
ALFRED ZAMPA MEMORIAL BRIDGE #28-0352L**

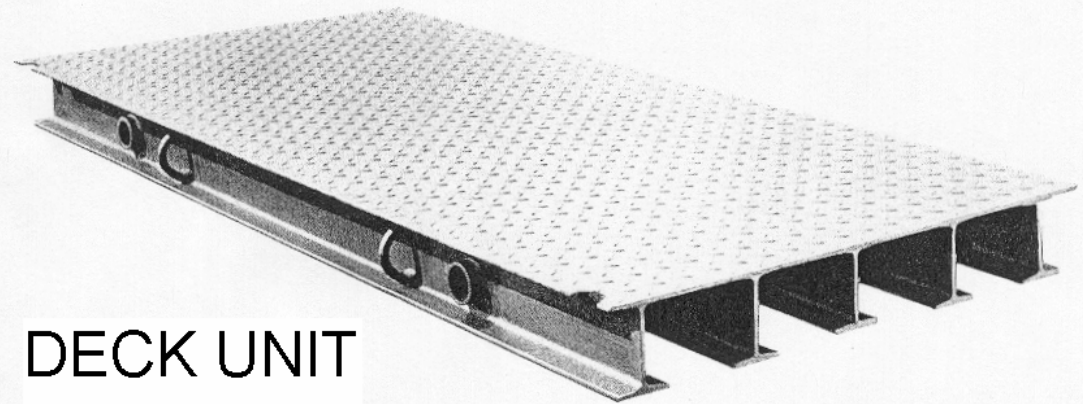
**View from “The Dead Fish” Restaurant**





"KERB" UNIT

Images Copyright  
ACROW



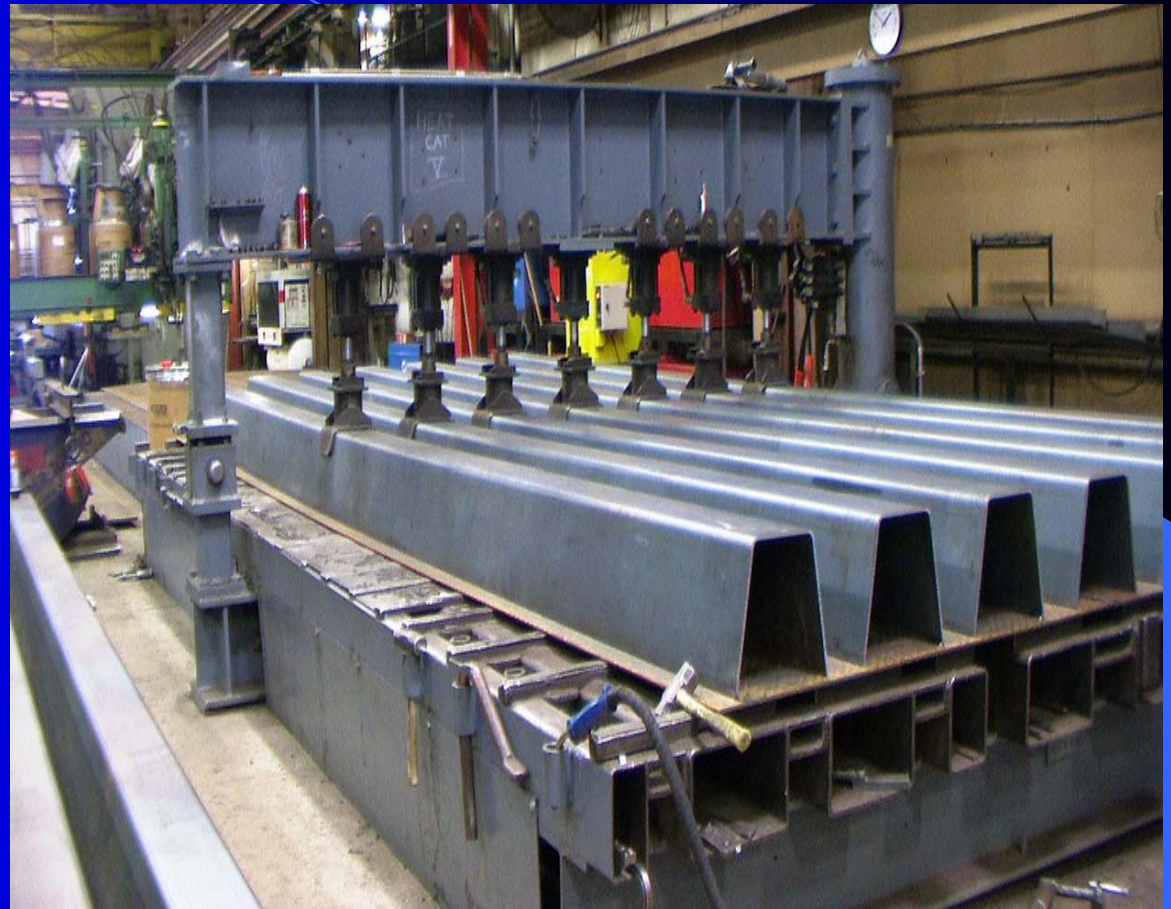
DECK UNIT

**“Temporary” bridge for state of California or other government agency use. ACROW uses “chequered” steel deck welded to closely spaced “W-Beam” ribs**



# Truck Scale = Ribs Attached to Deck Plate

Mettler Toledo  
Vehicle Scale  
Production Facility  
Columbus, Ohio  
Images Copyright  
Mettler Toledo

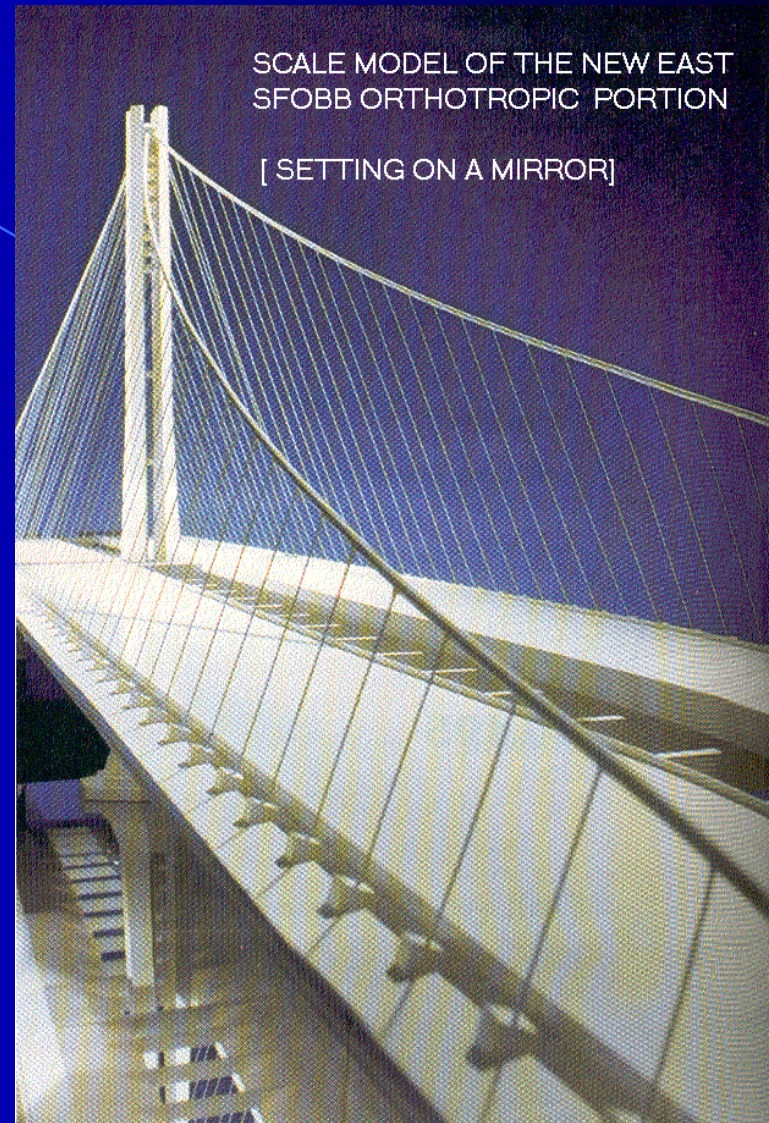


- Camber press down for Ogden Welder
- on table two (2) for eliminating ponding

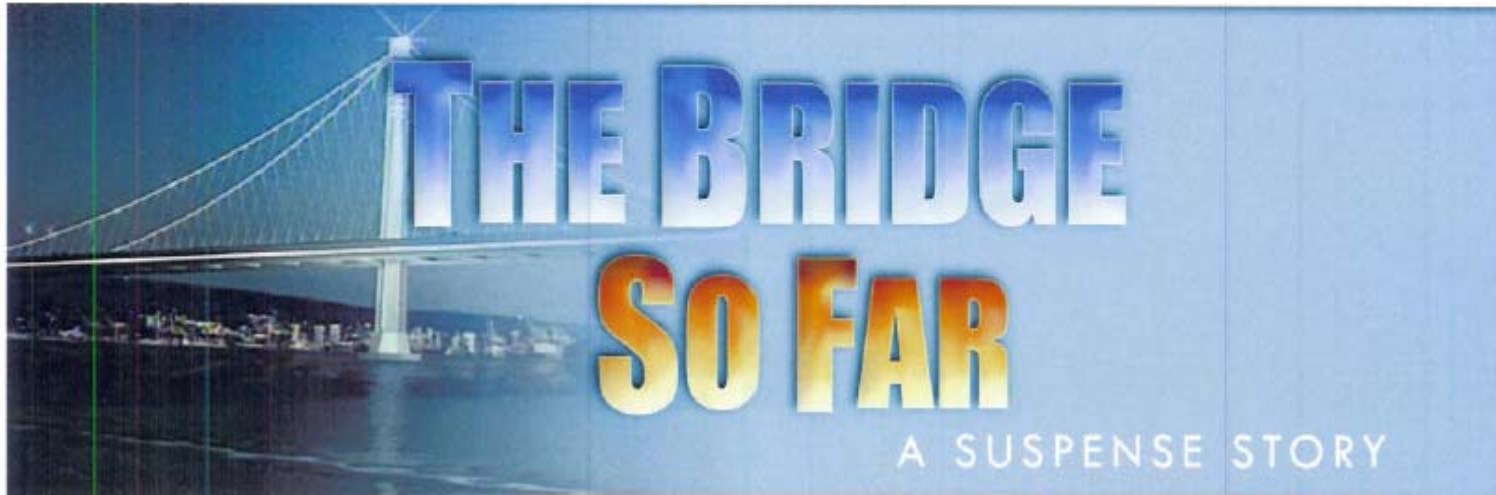


### 1989 Loma Prieta Earthquake Damage

- Most \$\$\$\$\$ Damage of any California earthquake in the 20th Century
- Major improvement for ductility design



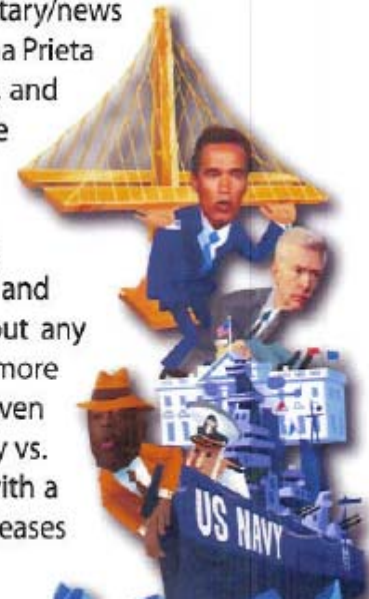
## NEW EAST SPANS OF SFOBB



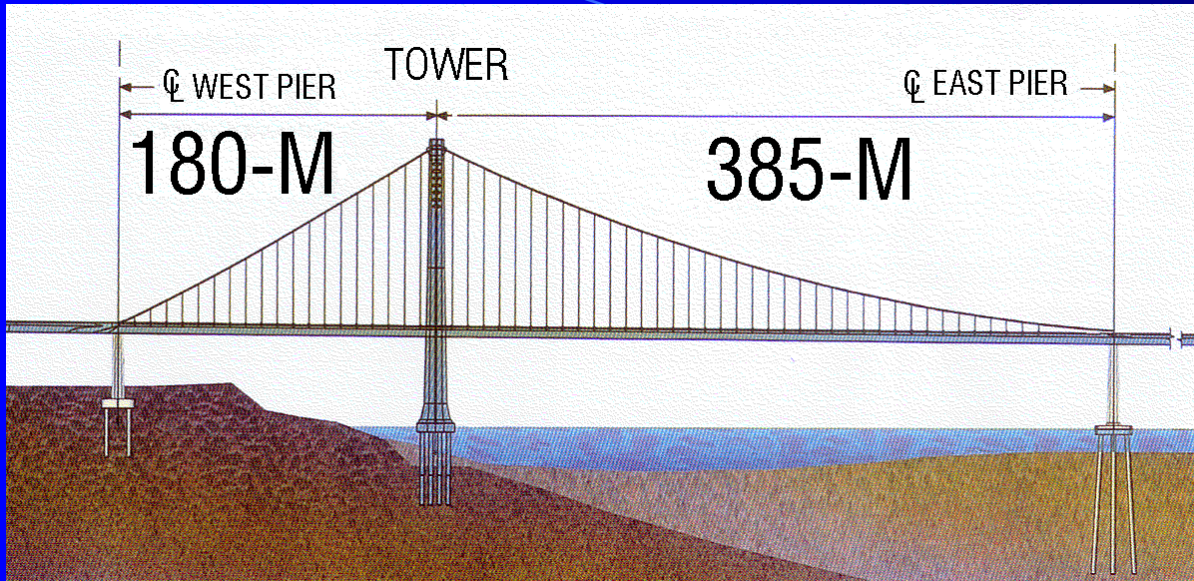
<http://www.thebridgesofar.com/>

"The Bridge So Far -- A Suspense Story" is an entertaining one-hour documentary on the often outrageous and always controversial history and status of the San Francisco-Oakland Bay Bridge. Tragic, frustrating, comical, and historic, this entertaining documentary/news special follows the Bridge from its original construction through the 1989 Loma Prieta earthquake up to the present day. It recounts the progress, delays, setbacks, and politics during the design and construction of a new, safe bridge to re-complete the connection across the Bay between San Francisco and Oakland.

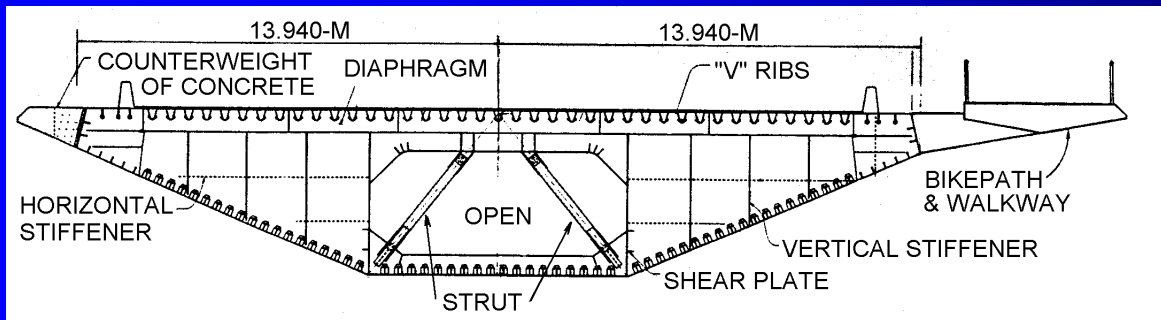
Sponsored by Professional Engineers in California Government (PECG), the documentary's genesis was a concern by PECG leaders that this major and historic infrastructure project would be constructed and completed without any photographic record. However, it quickly became clear that this was much more than a huge design and construction project. It was local, regional, state, and even federal politics; dollars and delays; finances and finger pointing; the U.S. Navy vs. Caltrans; northern vs. southern alignments; skyway vs. suspension bridge, with a bikeway; conceptual changes during construction; and monumental cost increases caused by such far-flung factors as the upcoming Olympics in China.



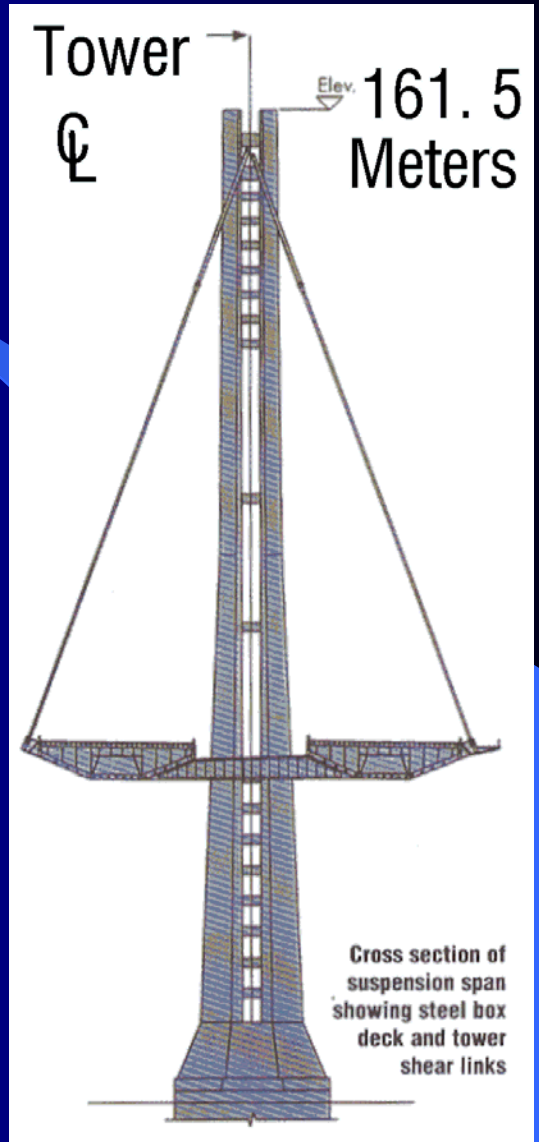
**NEW EAST SPANS OF SFOBB**



## ELEVATION

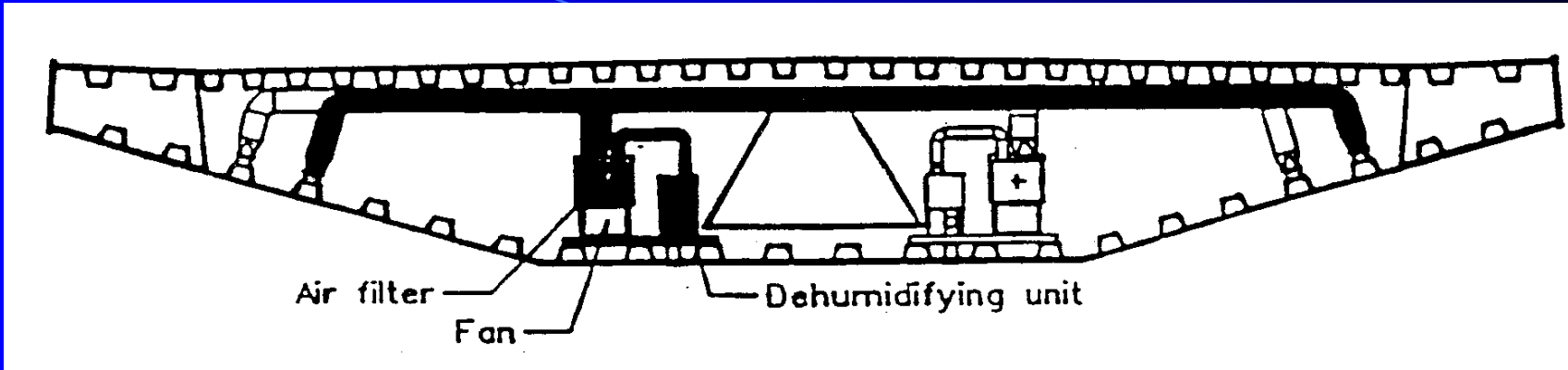


## HALF - SECTION

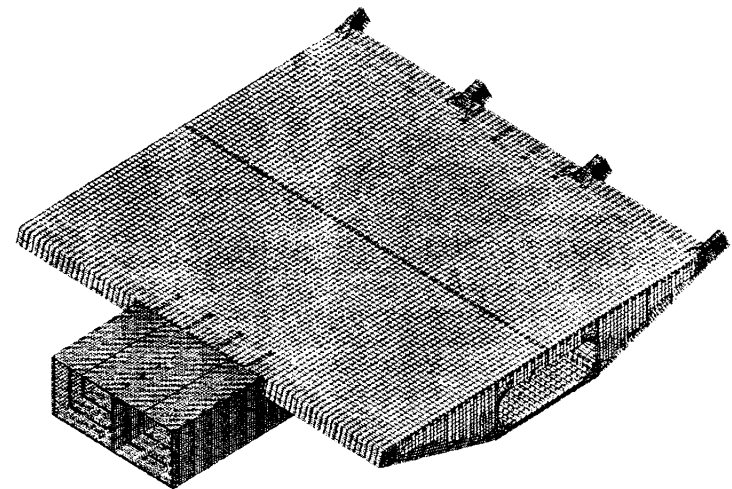
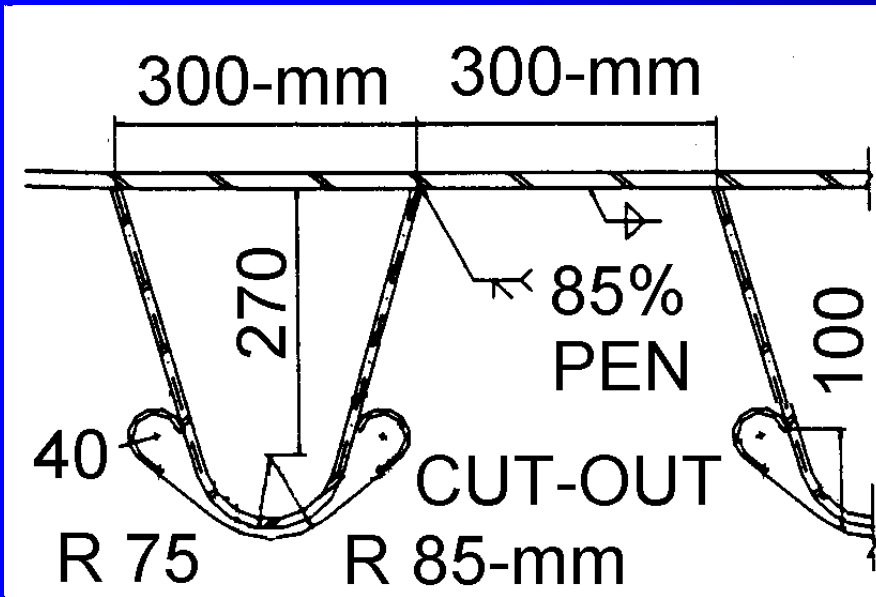


# NEW EAST SPANS OF SFOBB





**FEATURES DIFFERENT THAN OTHER CALIFORNIA BRIDGES**



Finite Element Model of a Typical Segment of the Superstructure



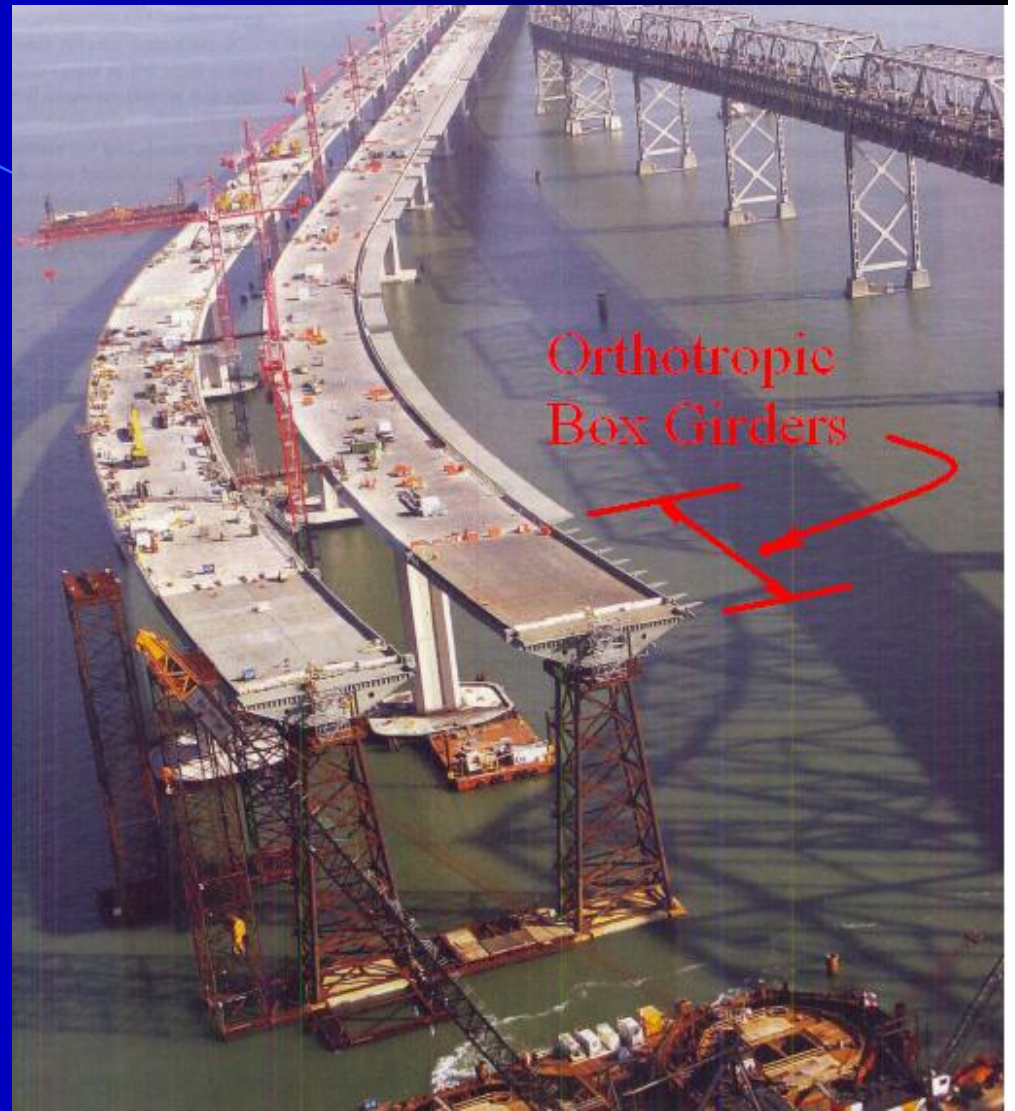
**NEW EAST SPANS OF SFOBB**



**Lift of Skyway Orthotropic Spans – Fabricated by Universal Structures Inc and Oregon Steel**



# **NEW EAST SPANS OF SFOBB**



**Lift of Skyway Orthotropic Spans – Fabricated by Universal Structures Inc and Oregon Steel**



# **NEW EAST SPANS OF SFOBB**



Fabrication in China

# NEW EAST SPANS OF SFOBB





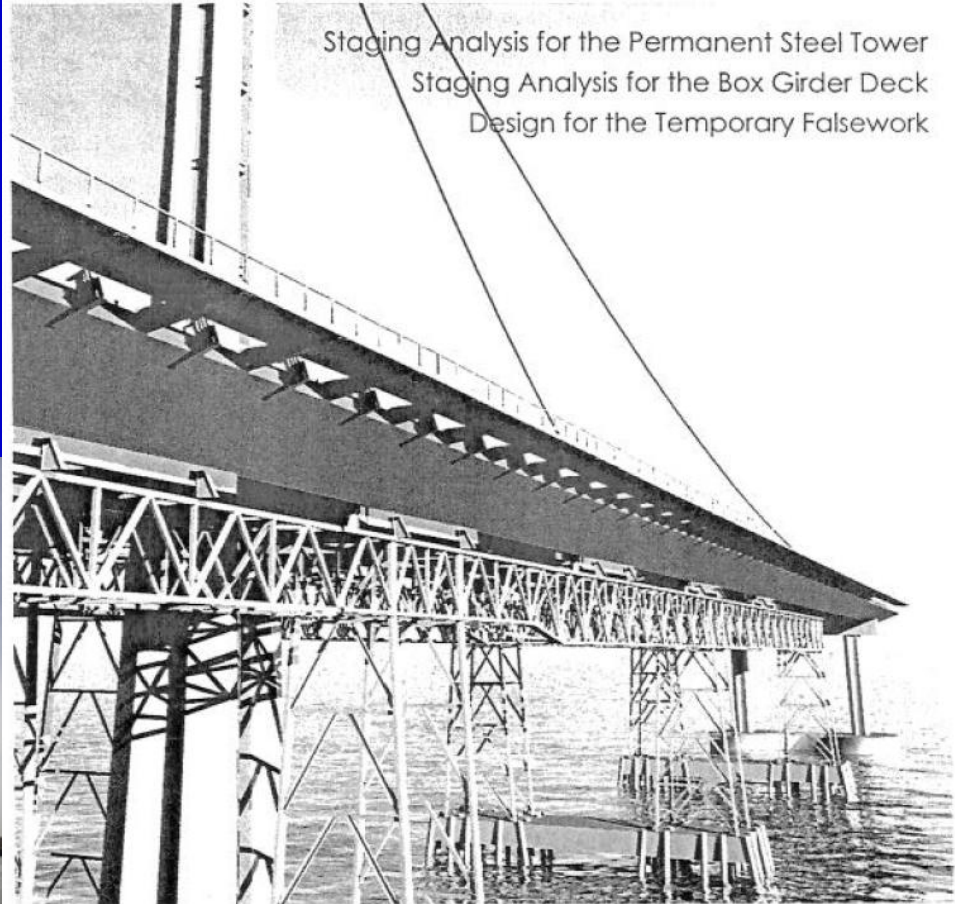
**RIB DETAIL**

**1700 TON FLOATING CRANE**



KCBL is providing engineering services to the American Bridge/Fluor Joint Venture for the **San Francisco-Oakland Bay Bridge.**

Key design elements include:



Staging Analysis for the Permanent Steel Tower  
Staging Analysis for the Box Girder Deck  
Design for the Temporary Falsework



Klohn Crippen Berger

[www.klohn.com](http://www.klohn.com)



# NEW EAST SPANS OF SFOBB

## Bridge NAME

## Deck Area (Sq. meters)

3.	Dublin 580/680 Test [ 1965]	1011
4.	Ulatis Creek Test [1966]	441
5.	San Mateo – Hayward [1967]	43,533
6.	San Diego – Coronado [1969]	9467
7.	Queensway Twin [1971]	10,256
8.	Southern Crossing [1971]	Not Built
9.	Four ---- BART Rail [1972]	473
10.	Colusa [1972]	372
11.	Miller – Sweeney [1973]	722
12.	Ruck – A – Chucky [1976]	Not Built
13.	Braille Trail Pedestrian [ 1977]	33
14.	Golden Gate redecking [1985]	35,934
15.	Maritime Off-Ramp [1997]	7,921
16.	Slab [1997]	Unknown
17.	Alfred Zampa @ Carquinez [2003]	30,586
18.	SFOBB Self Anchoring [2007]	32,500

**TOTAL 17 California Bridges**

**173,249**

**Millau Viaduct, France [2005]**

**184,800**

**Normandie  
Cable-Stayed**



**Millau  
Viaduct  
Cable-Stayed**



## 2009 Deck Area

California's 17 Orthotropic Bridges = 173,249 square meters  
[163,696 sq miles 36,756,666 people ]

South Korea Orthotropic Bridges = 688,800 square meters  
[ 38,622 sq miles 48,379,392 people ]

Special thanks my Office Chief  
Mr. Vong Toan, PE Supervising  
Bridge Engineer for his support  
and Yeong-Jong [SAS] Bridge photo.



# 25 to 29 August 2008 INTERNATIONAL ORTHOTROPIC BRIDGE CONFERENCE SACRAMENTO, CALIFORNIA, USA

*Hosted by the ASCE American Society of Civil Engineers, Sacramento Section*



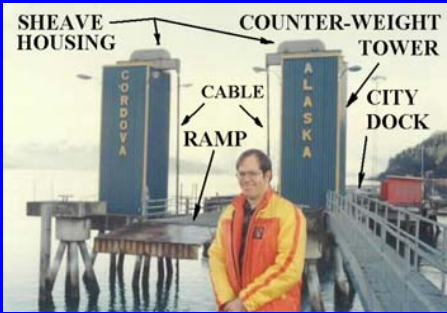
*The new end spans of San Francisco Oakland Bay Bridge [SFOBB] , and Alfred Zampa Memorial Orthotropic Bridges at Carquinez Straits are part of conference bus tour [For updated information, see [www.orthotropic-bridge.org](http://www.orthotropic-bridge.org) [asce@asce-sacto.org](mailto:asce@asce-sacto.org)*



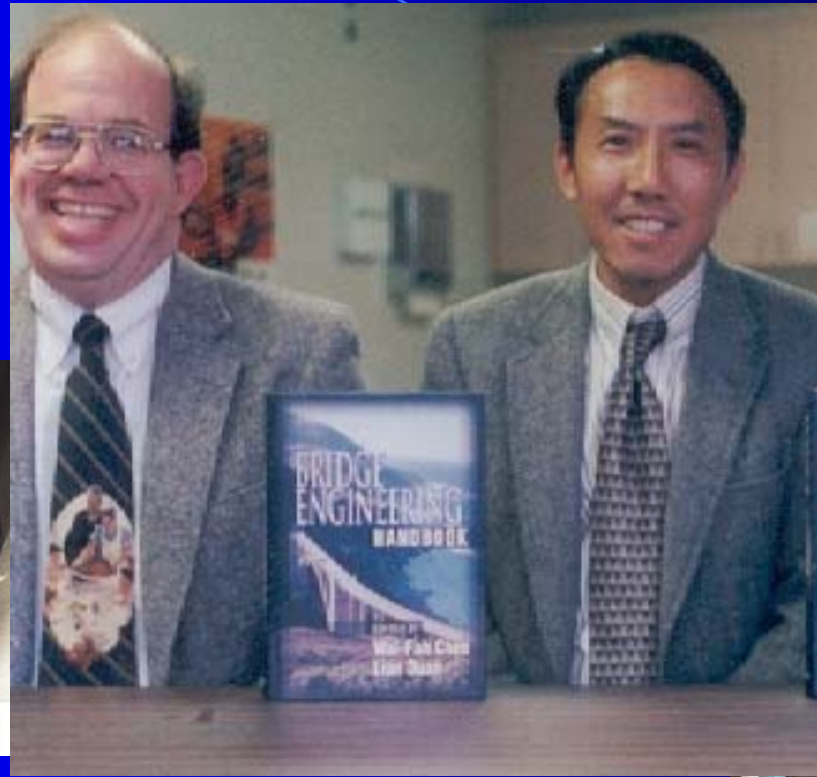
## 3<sup>RD</sup> OBC Conference 2012 Sacramento??



**AUTHORS OF  
ORTHOTROPIC STEEL DECK BRIDGES - CHAPTER 14**



**Cordova Alaska Ferry Terminal**



**Battle Creek = Salem, OR**



**At Jesse Engineering, Tacoma WA**



**with Tim Moore, PE WASHDOT Tacoma Narrows 3**

**A few of the orthotropic bridges in Western States**

**AL MANGUS, PE DR LIAN DUAN, PE Chair Caltrans Steel Bridge Comm.**



**QUESTIONS ?**