



Workshop on Wind Induced Vibration of Cable Stayed Bridges,
St. Louis, MO. April 27, 2006

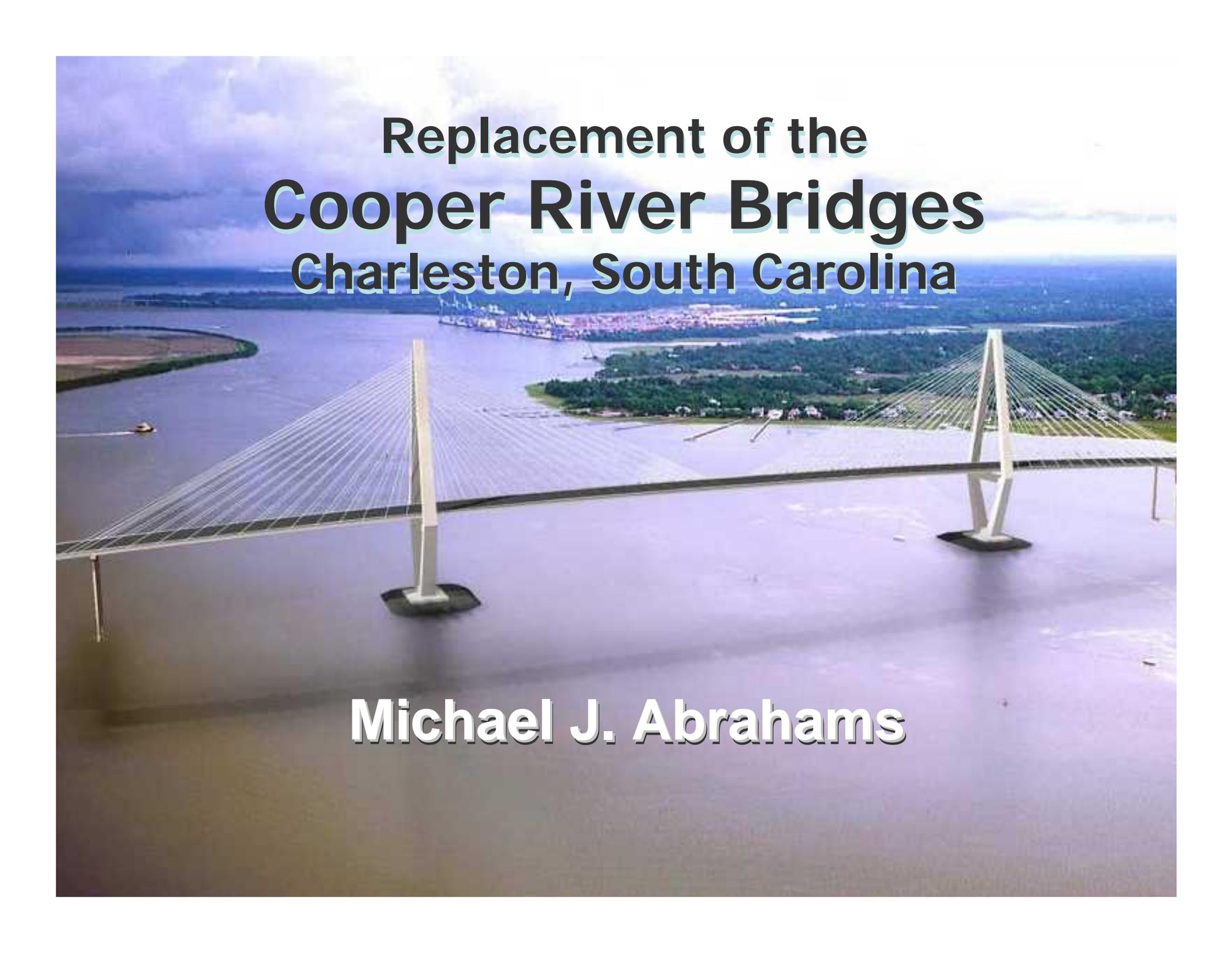
Rain-Wind Vibration: Different Approaches at Different Locations

Michael J. Abrahams, P.E.

Vijay Chandra, P.E.

Ruchu Hsu, P.E.

Parsons Brinckerhoff



**Replacement of the
Cooper River Bridges
Charleston, South Carolina**

Michael J. Abrahams

Cable Stay Span

- ❖ Diamond Towers
- ❖ Roadway – 200 Feet Above Water
- ❖ 1546 Foot Long Span
- ❖ Tower Height – 570 Feet
- ❖ Longest Span in North and South America
- ❖ 140 Feet Wide Section – 8 Traffic Lanes Plus Pedestrian/bicycle Lane

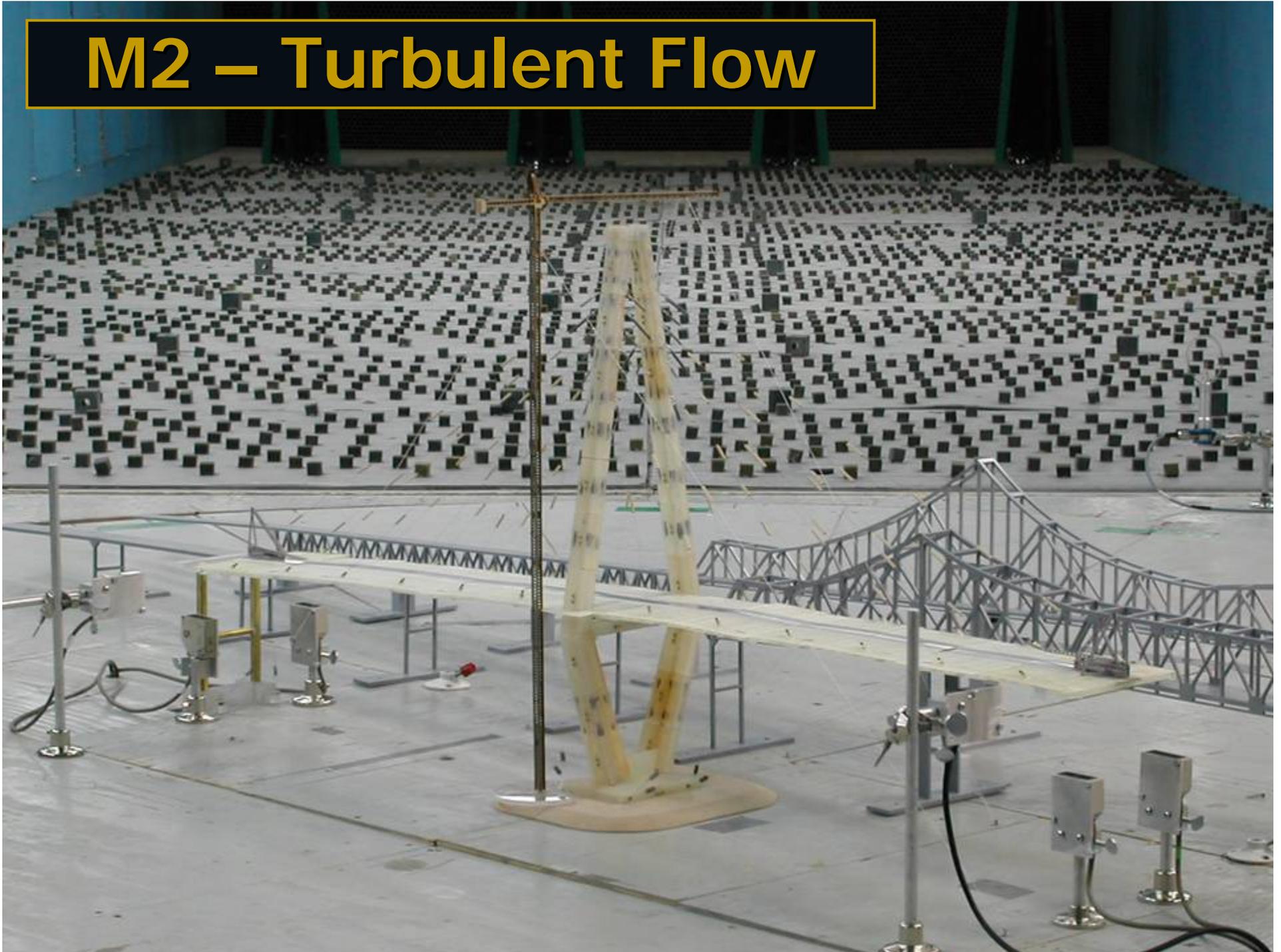






Wind Tunnel Testing

M2 – Turbulent Flow



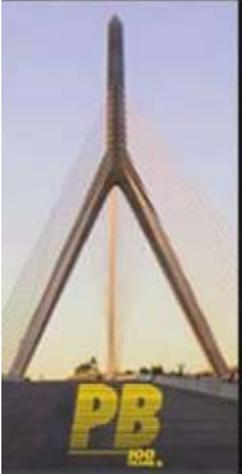




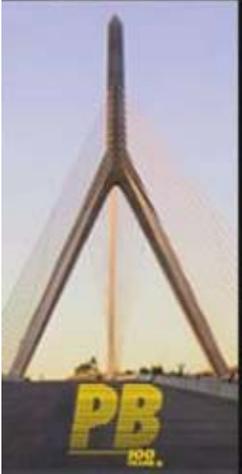
Stay Cable System Features

- ❖ Freyssinet Monostrand, Isotension System
- ❖ Extensive System Testing Program (PTI)
- ❖ Freyssinet on Design – Build Subcontract
- ❖ Joint effort PB- Freyssinet - PBC
- ❖ Early Stage Parametric Excitation Study
- ❖ Early Integration of Damping System
- ❖ Provisions for Cross-ties

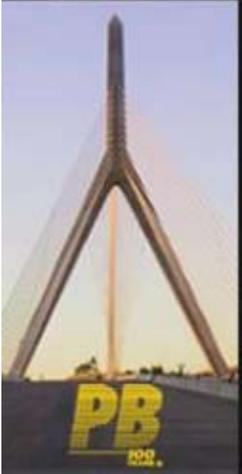
Strand Erection

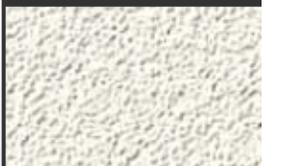


Welding of Stay Pipes



Lifting of Stay Pipe







Upper Anchorage Inside Tower

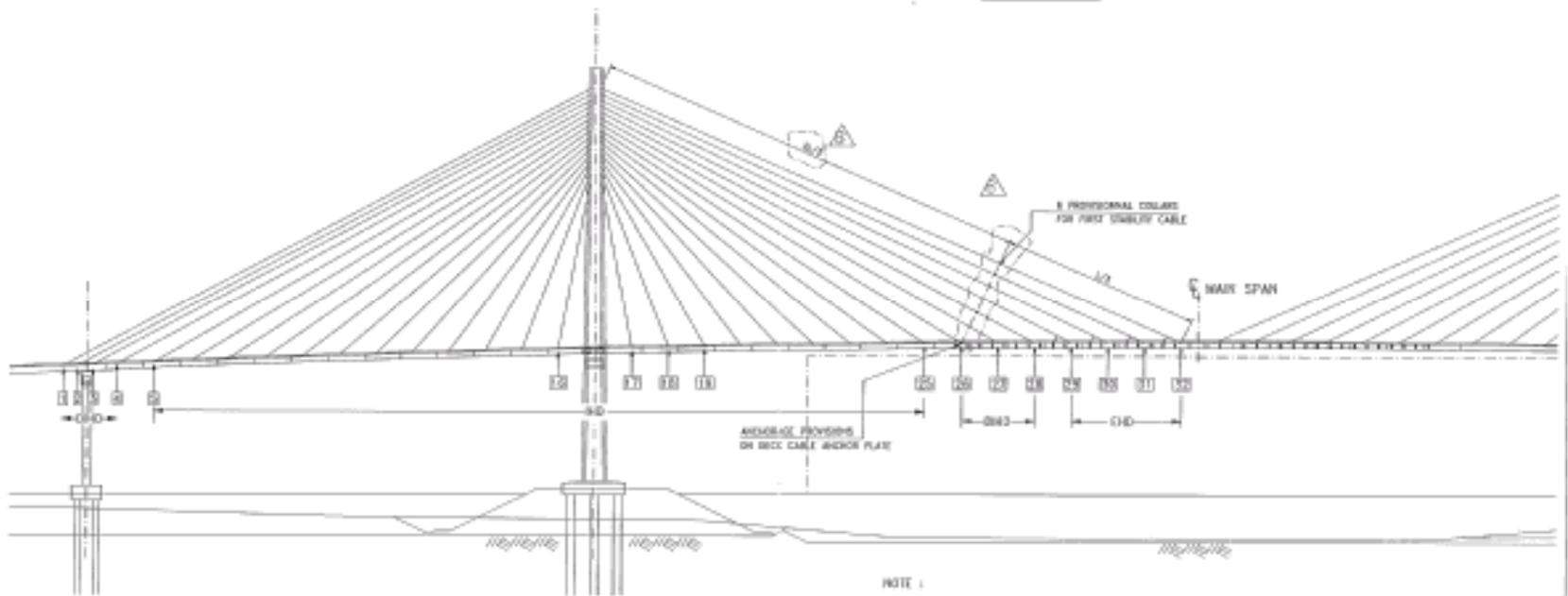


Vibration Suppression Devices

STAY CABLES VIBRATION SUPPRESSION DEVICES
GENERAL ARRANGEMENT

SIDE SPAN

MAIN SPAN



TOTAL QUANTITY

- DAMPER IHD : $(12+3) \times 4 = 64$
- DAMPER DIHD : $(4+3) \times 4 = 28$
- DAMPER EHD : $4 \times 4 = 16$
- STABILITY CABLES COLLARS $8 \times 4 = 24$

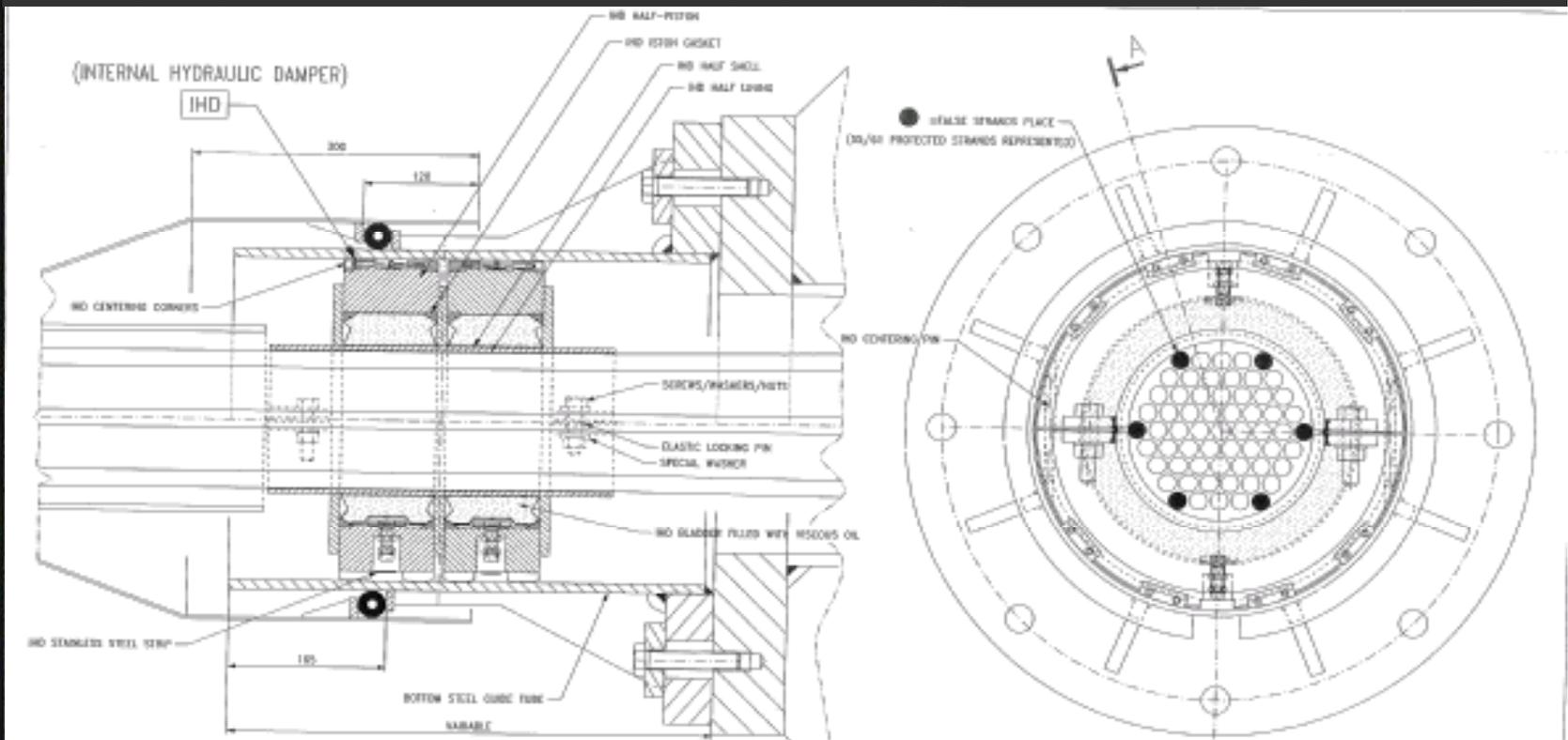
NOTE :

- IHD : INTERNAL HYDRAULIC DAMPERS HOUSED IN GUIDE TUBE
- DIHD : INTERNAL HYDRAULIC DAMPERS DOUBLE CELL HOUSED IN GUIDE TUBE
- EHD : EXTERNAL HYDRAULIC DAMPERS ON STRUCTURAL STEEL FRAME
- MINIMUM STATIC FORCE AT STABILITY CABLE ENTRY ANCHORAGE IS EQUAL TO 150 KN AT SLS

NO.		DESCRIPTION		QUANTITY	UNIT
1	1	COOPER ARBER ORBIC		8	PIECES
2	1	STAY CABLES - 8.62" STRANDS		8	PIECES
REVISIONS					
NO.	DATE	BY	REASON	APPROVED	DATE
1	01/20



Internal Hydraulic Dampers

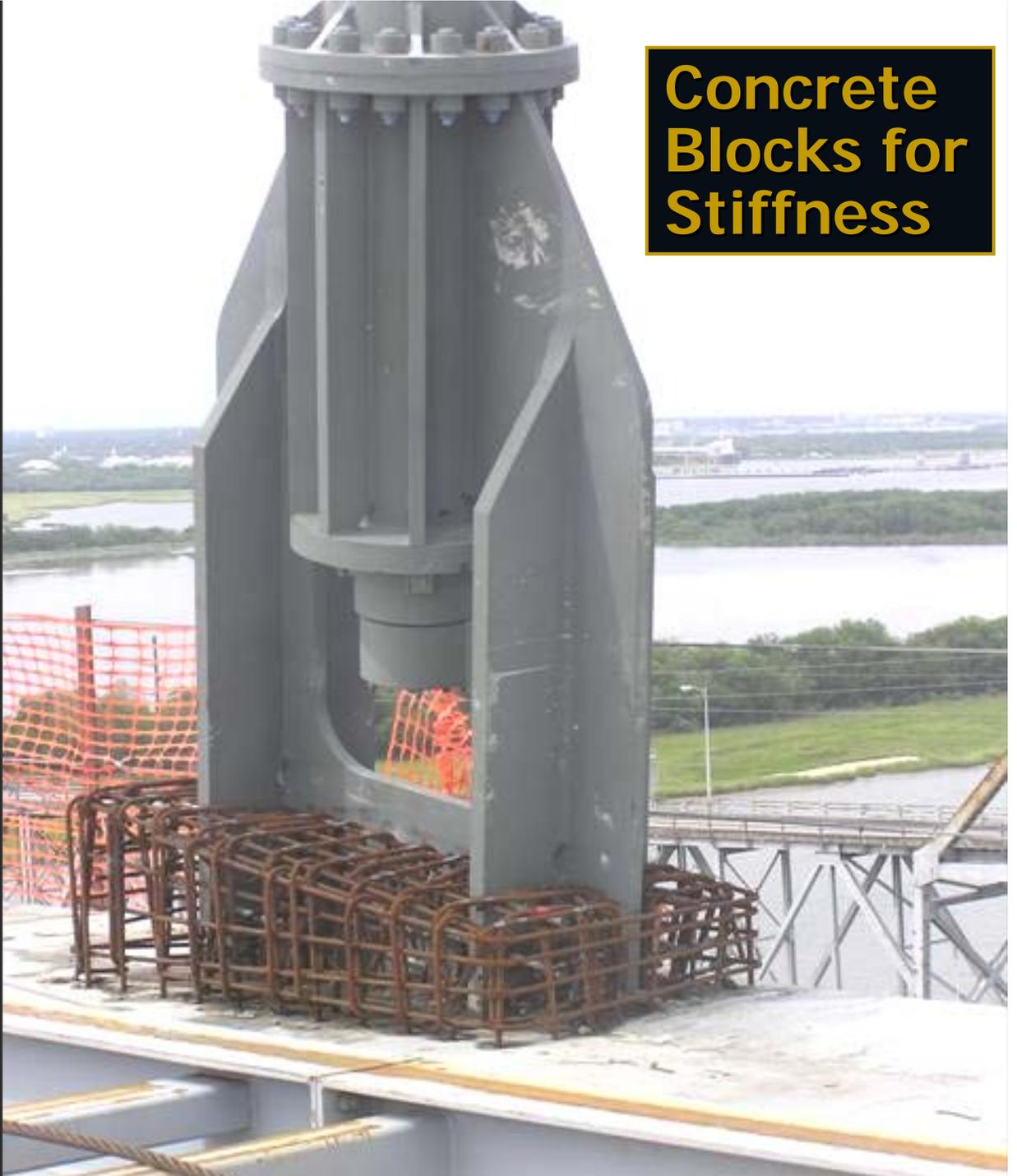


REF./DESIGNATION	MATERIAL	MIN. TENSILE STRENGTH	MIN. YIELD STRENGTH	CORROSION PROTECTION
HD SHELL	A516 GR 55	> 50ksi	> 30ksi	HD DP GALVANIZED 0.110 IN ² GALVAST/ASTM A103-88 + PAINT AS PER SPEC
HD PISTON	NOPE			NOT APPLICABLE
CENTERING PIN	A307 GR 2	> 60ksi	> 30ksi	NOT DP GALVANIZED 0.110 IN ² GALVAST/ASTM A103-88 + PAINT AS PER SPEC
SCREWS + WASHERS + NUTS	CLASS 8.8			ELECTRODEPOSITED COATING OF ZINC AND BISMUTHATED Fe/ZnO ppm 8 steel 304 ASTM B625-82
DAMPER	PVC/HD			NONE
HALF LINK	NOPE			NOT APPLICABLE
STAINLESS STEEL STRIP	2 1/2" DIA 316			NONE
ELASTIC LOCKING PIN				ELECTRODEPOSITED COATING OF ZINC AND BISMUTHATED Fe/ZnO ppm 8 steel 304 ASTM B625-82
SPECIAL WASHER	A307 GR 2			ELECTRODEPOSITED COATING OF ZINC AND BISMUTHATED Fe/ZnO ppm 8 steel 304 ASTM B625-82
CENTERING CORNERS	NOPE			NOT APPLICABLE
PISTON GASKET	NOPE			NOT APPLICABLE

PROJECT	COOPER RIVER BRIDGE	OWNER	ARHES
FILE	STAY CABLES - 0.62" STRANDS	DESIGNER	ARHES
DESCRIPTION	BOTTOM ANCHORAGE BARRING GUIDE BEHAVIOR	DATE	11/11/03
REVISION	DOUBLE INTERNAL HYDRAULIC DAMPER ARRANGEMENT	SCALE	1:1
DATE	11/11/03	BY	ARHES

Lateral Supports

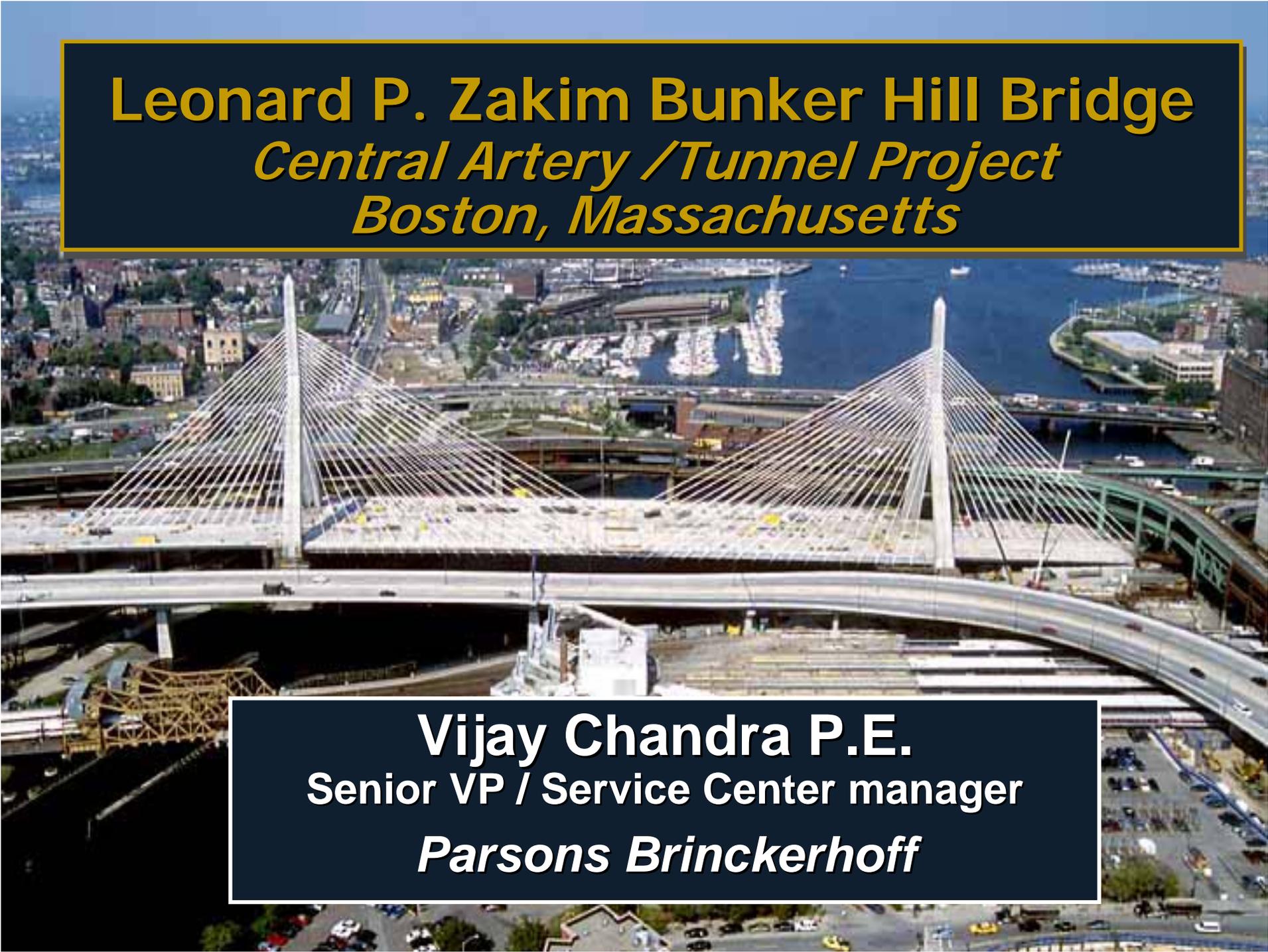




**Concrete
Blocks for
Stiffness**

Cooper River Bridges

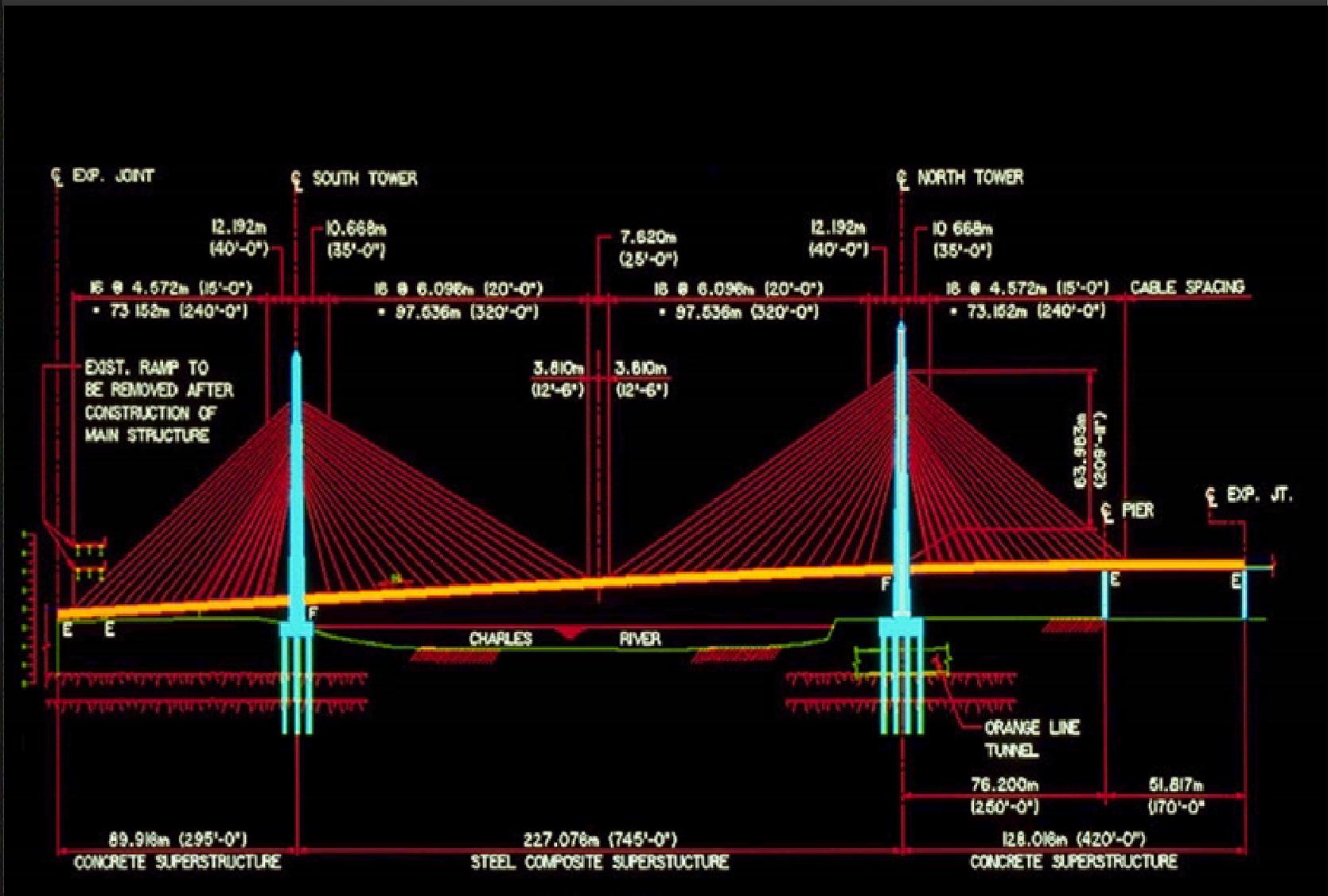




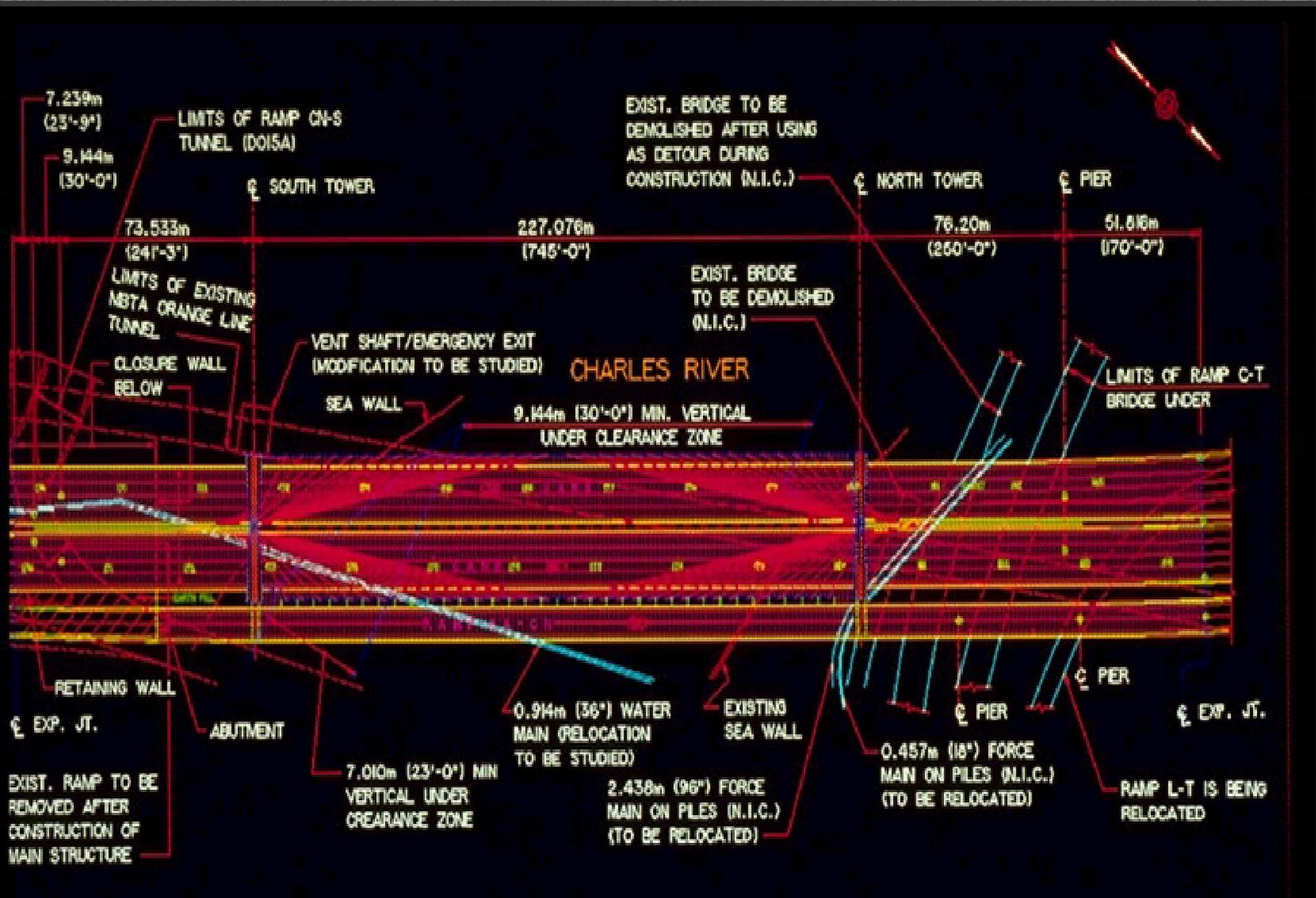
Leonard P. Zakim Bunker Hill Bridge
Central Artery / Tunnel Project
Boston, Massachusetts

Vijay Chandra P.E.
Senior VP / Service Center manager
Parsons Brinckerhoff

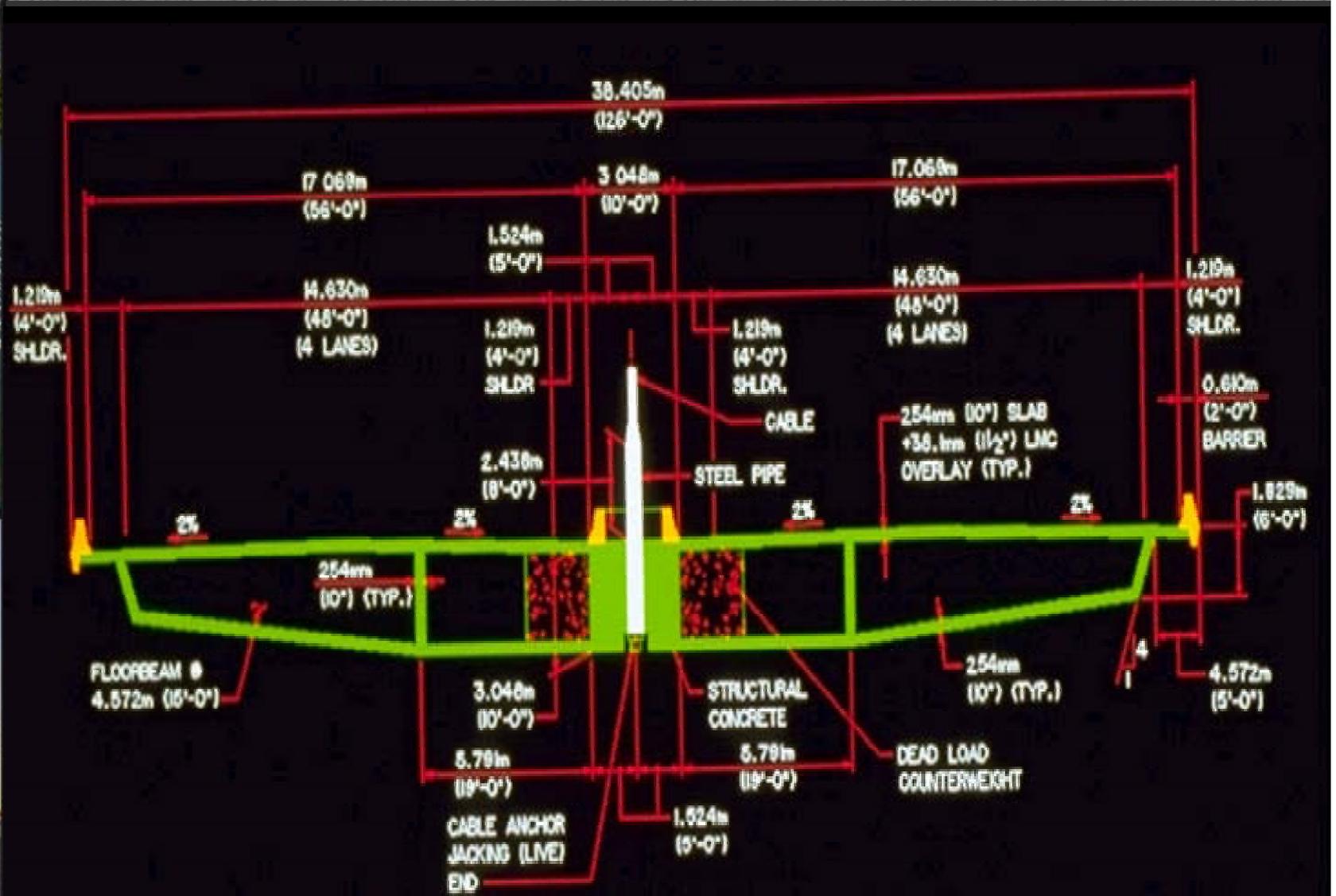
Bridge Elevation



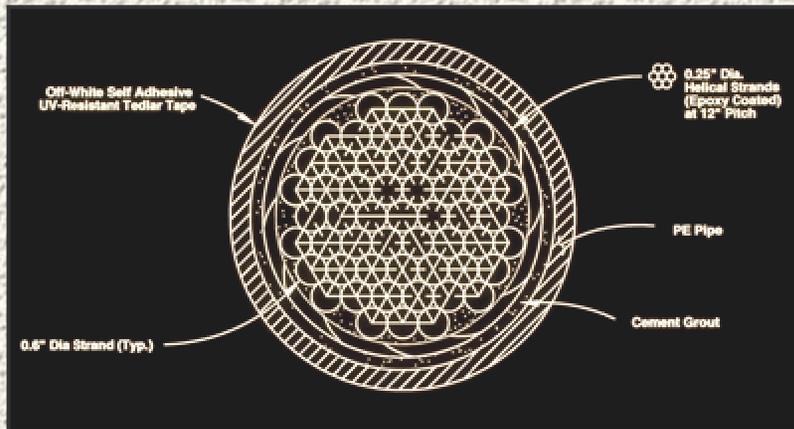
Bridge Plan



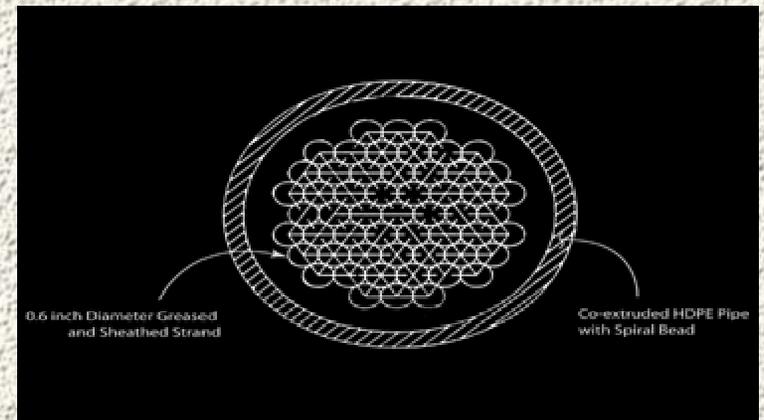
Back Span Superstructure



Stay Cable



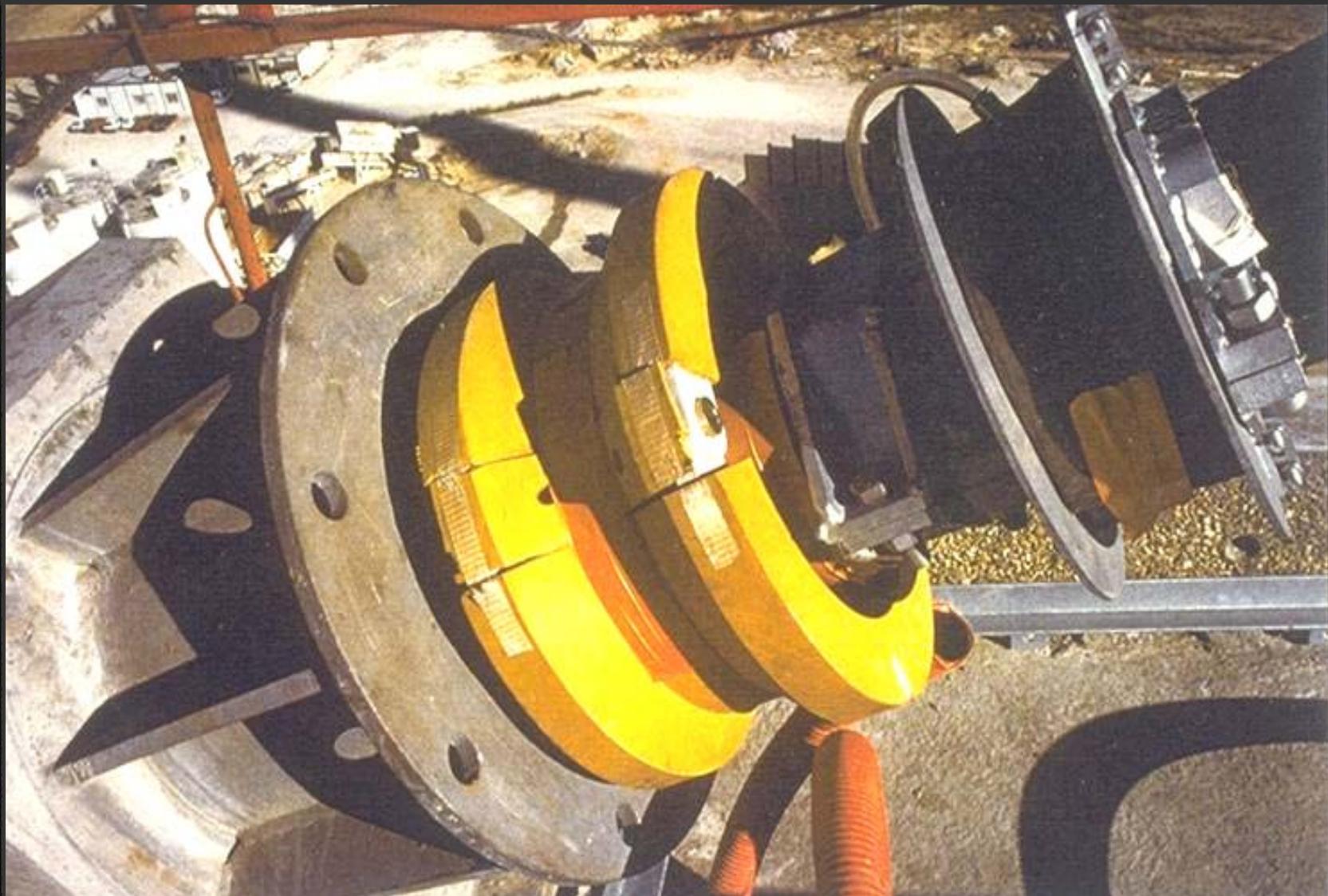
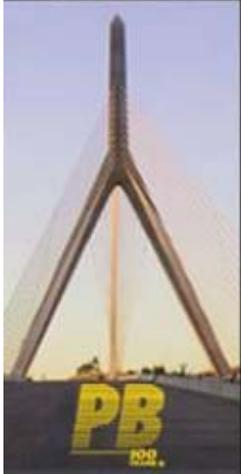
Old Concept



New Concept



Internal Damper

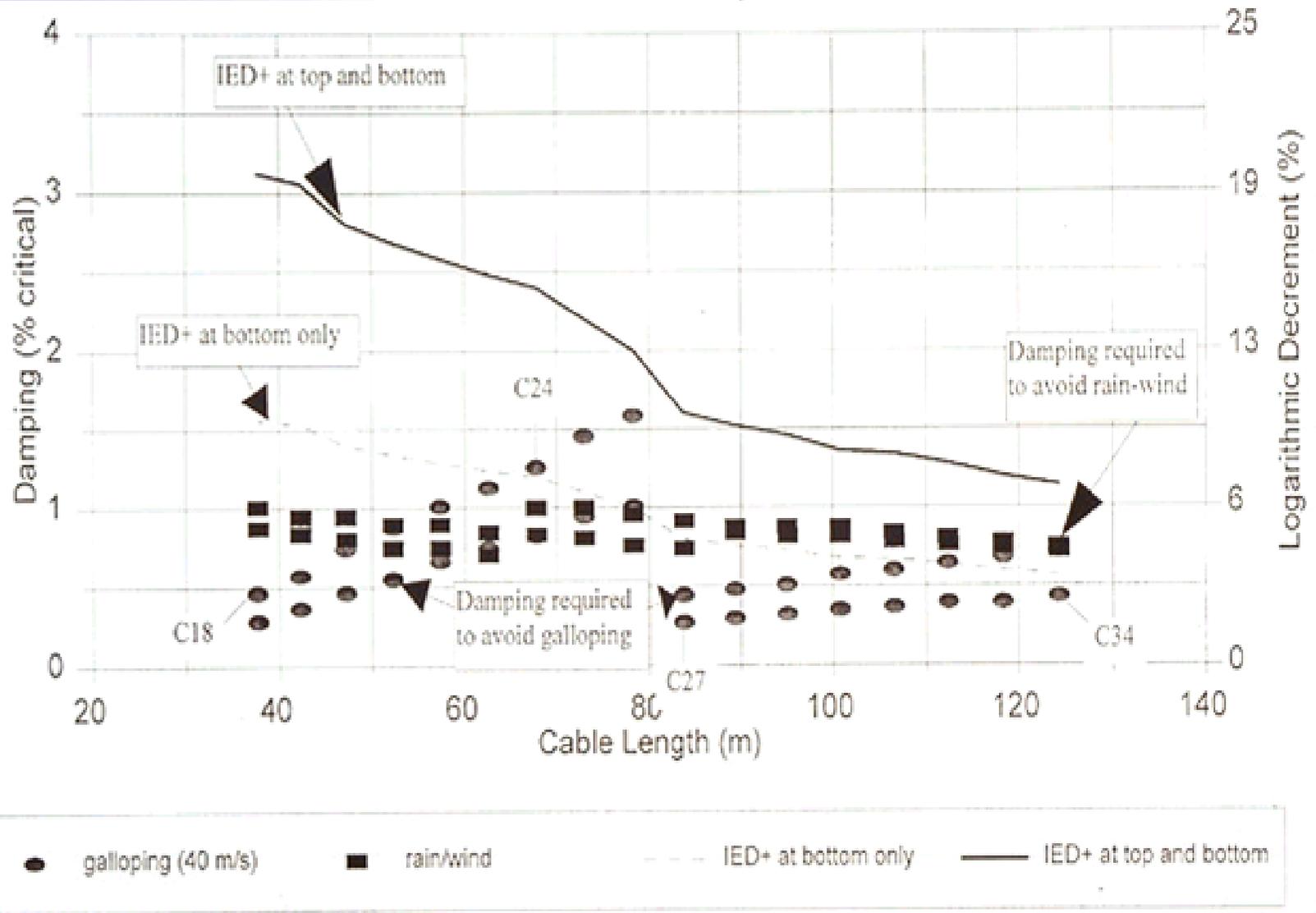


Wind Tie

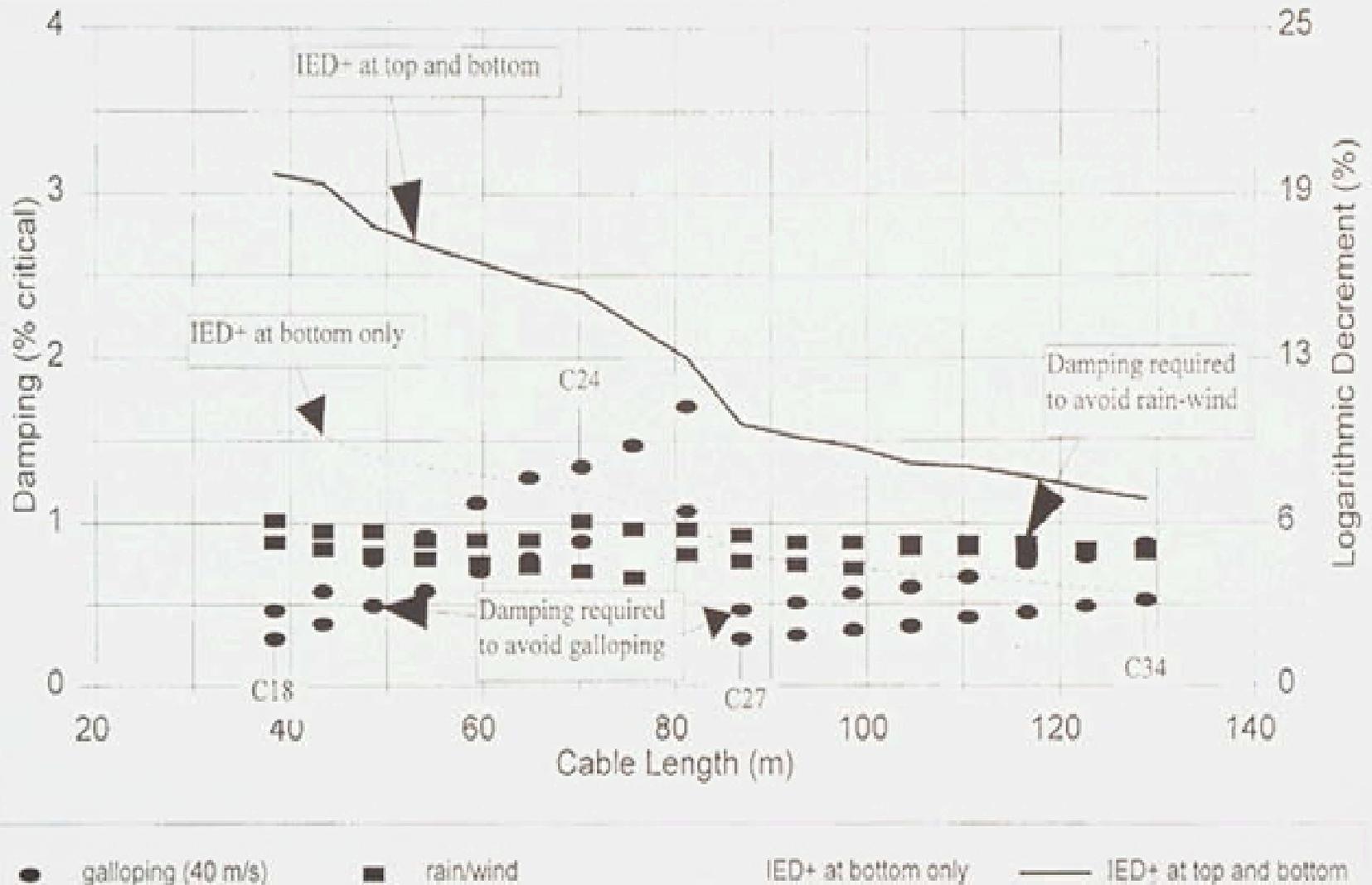


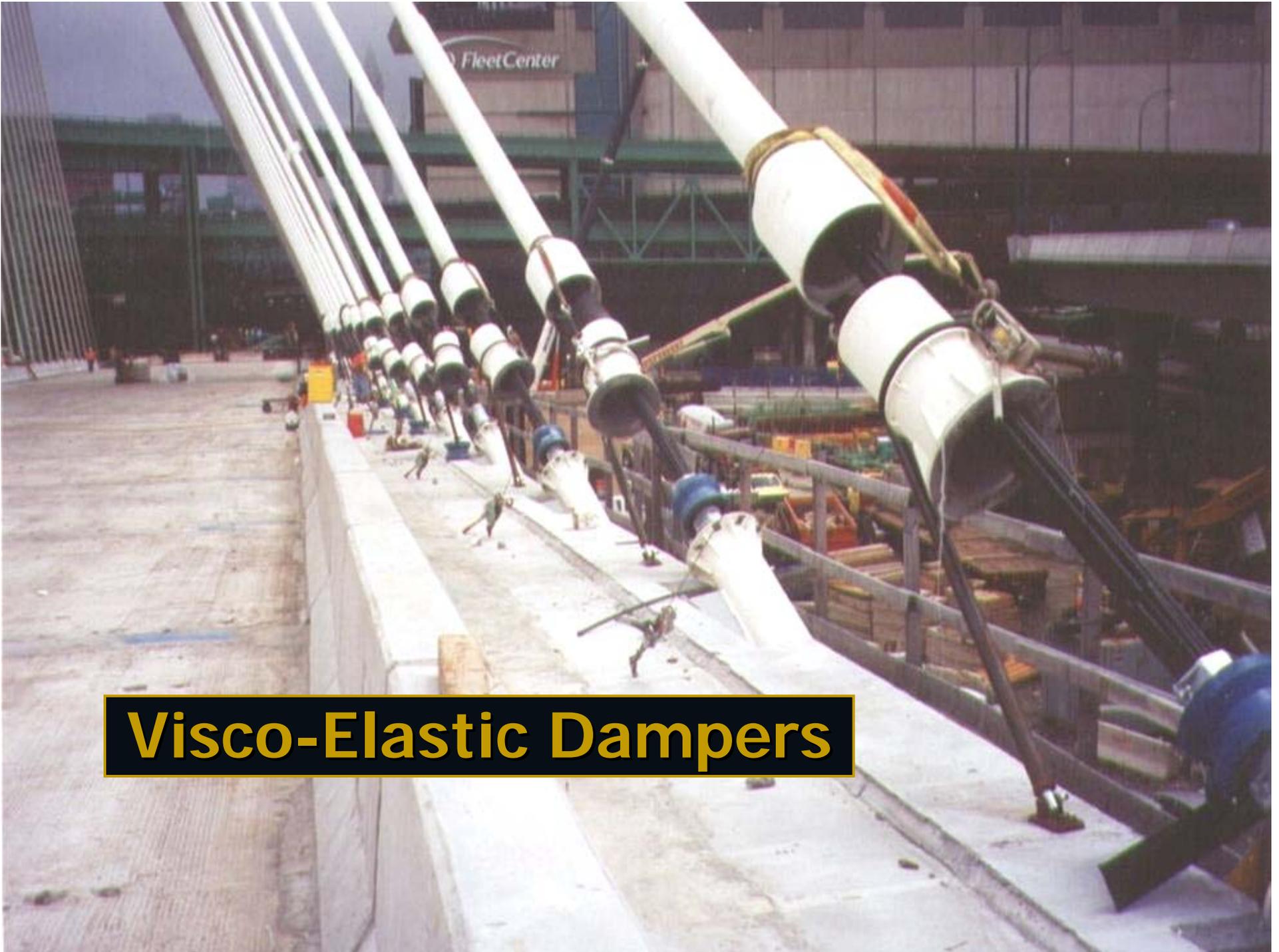


Required Damping (with Cross-ties) South Tower Main Stays



Required Damping (with Cross-ties) North Tower Main Stays



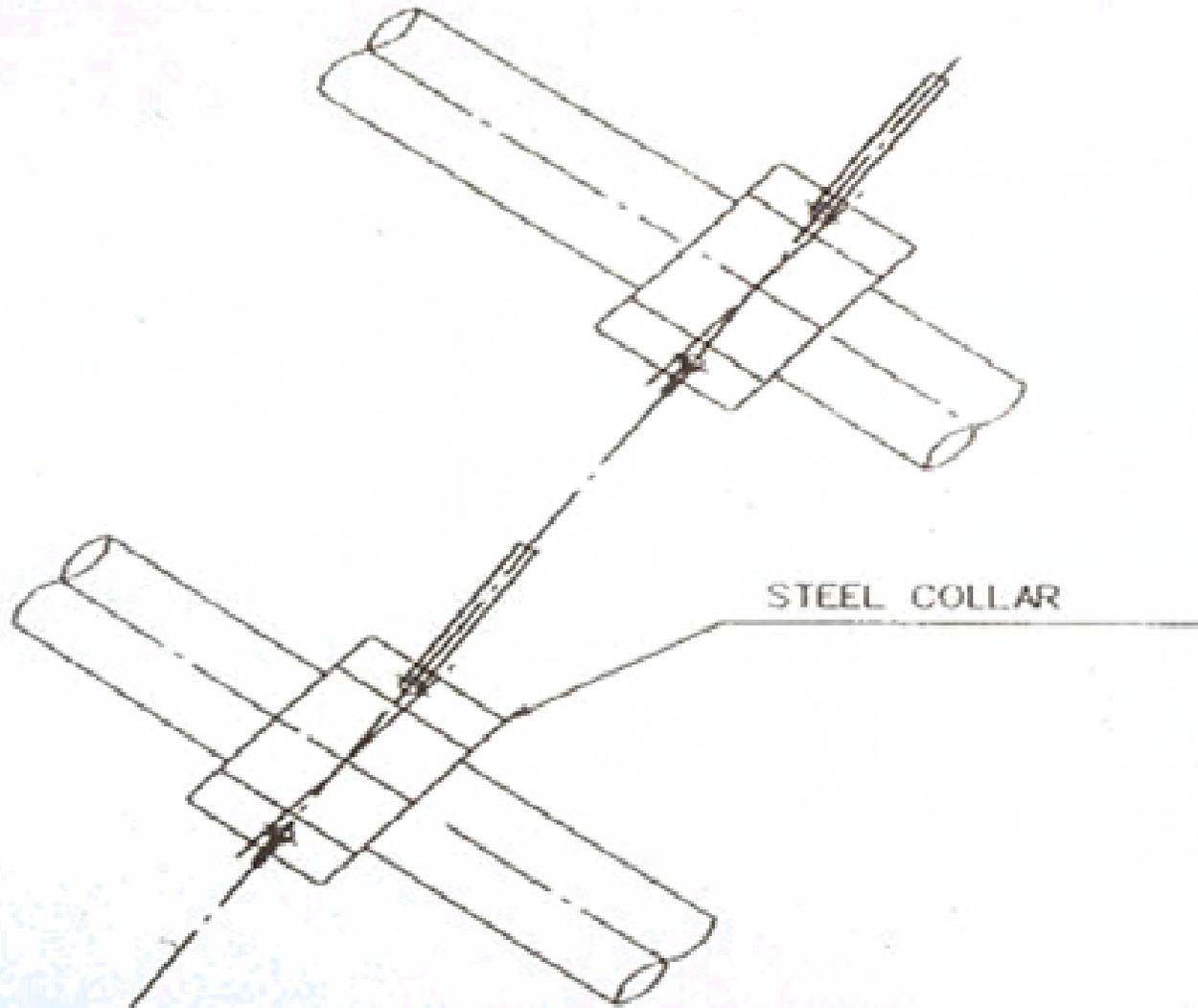


Visco-Elastic Dampers

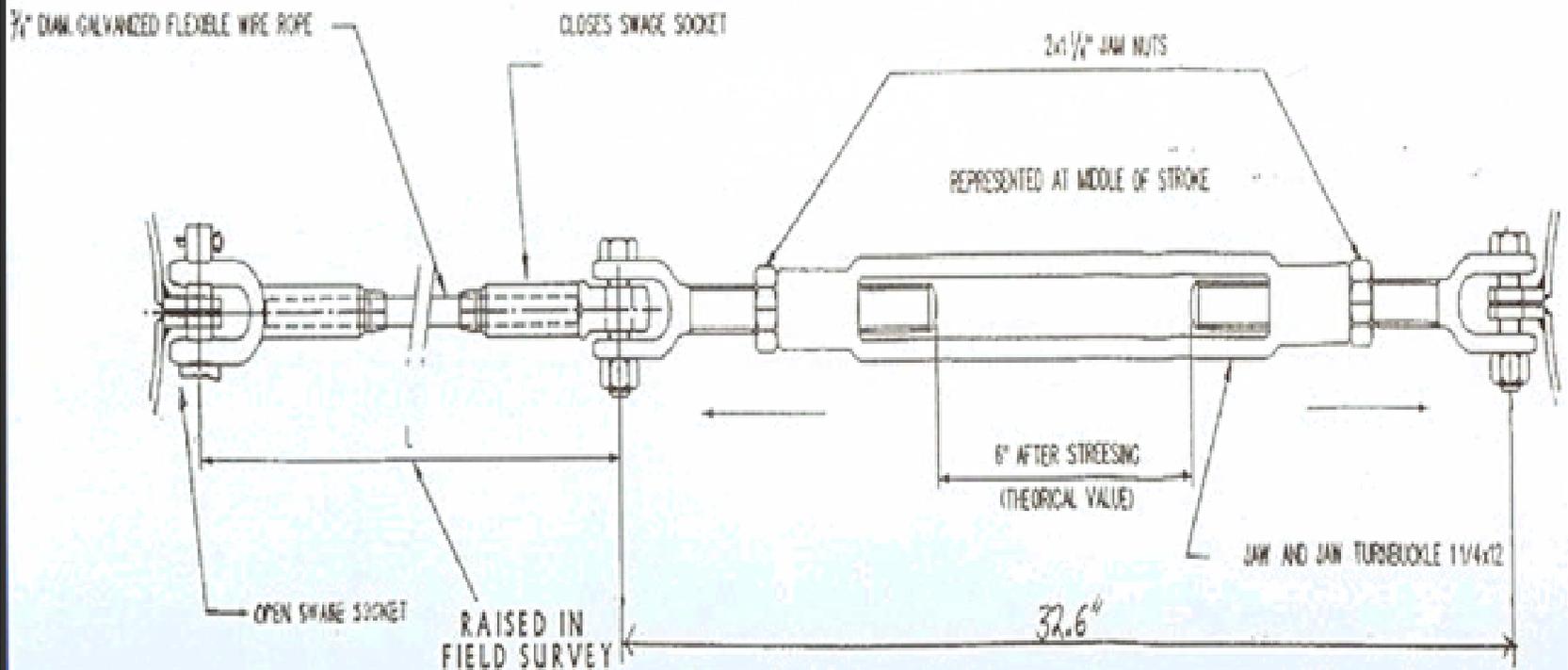




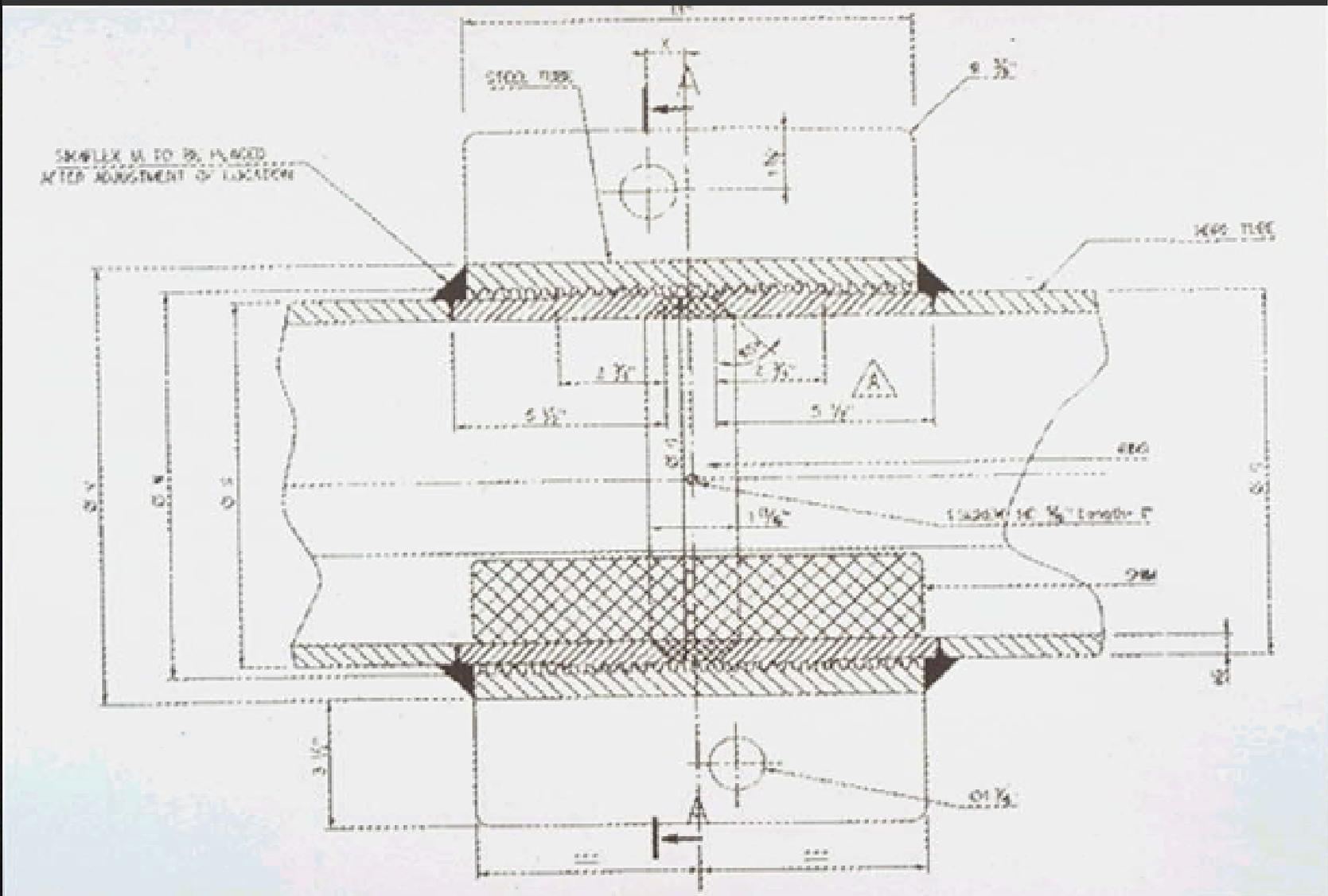
Cross Tie Connection Overview



Cross Tie Detail



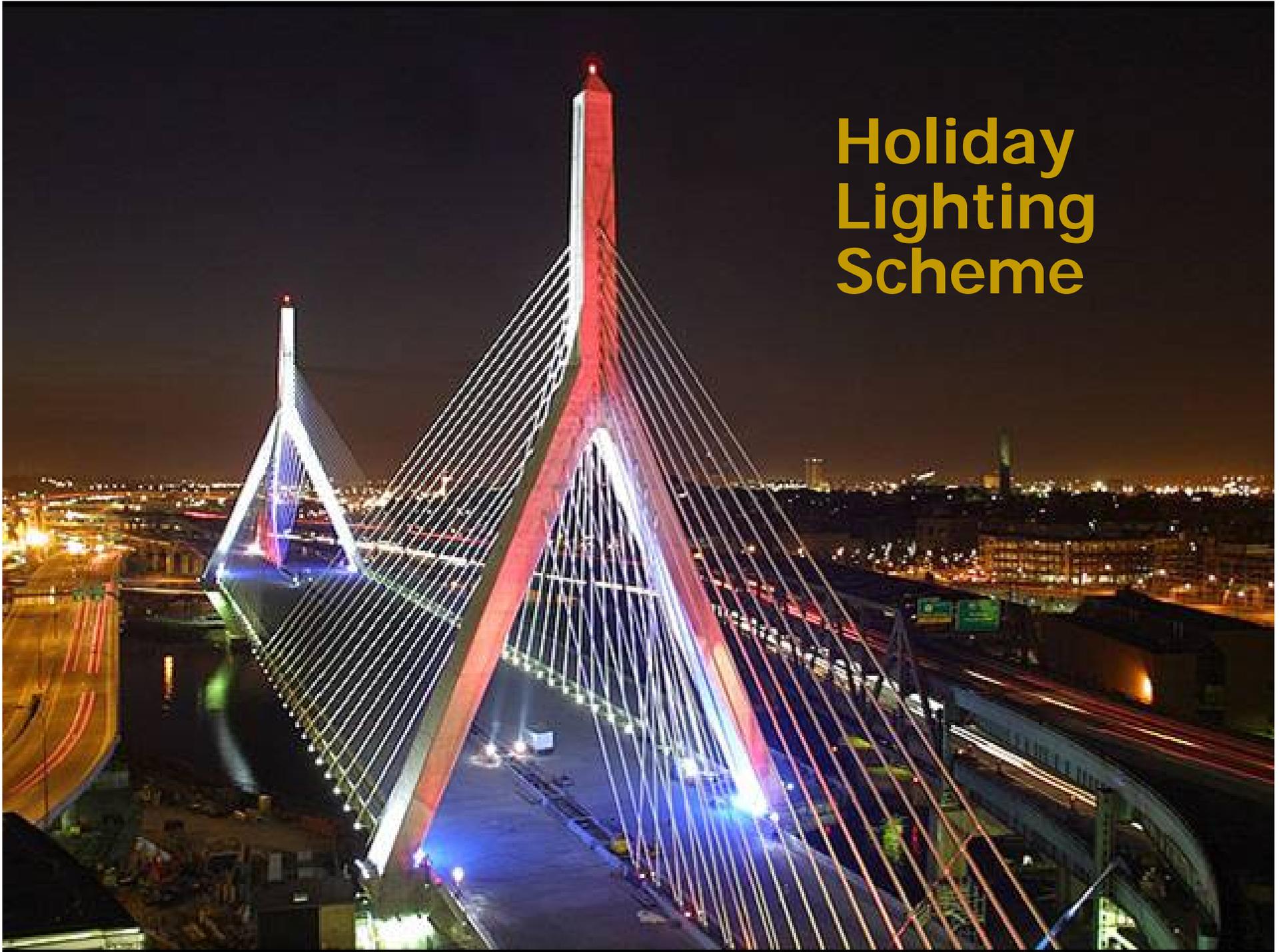
Cross Tie Connection Detail



Load Testing



Holiday Lighting Scheme





William H. Natcher Bridge Owensboro, KY

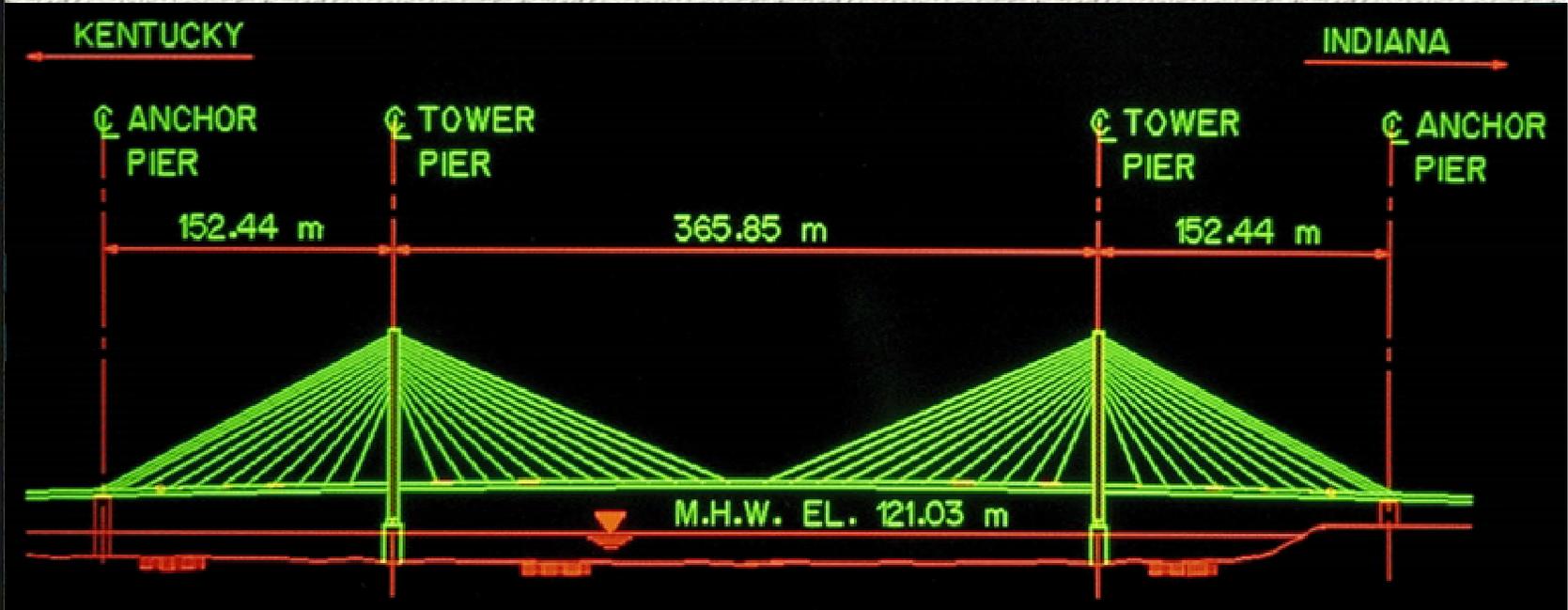
**Ruchu Hsu, P.E.
Project Engineer**

Parsons Brinckerhoff (PB)

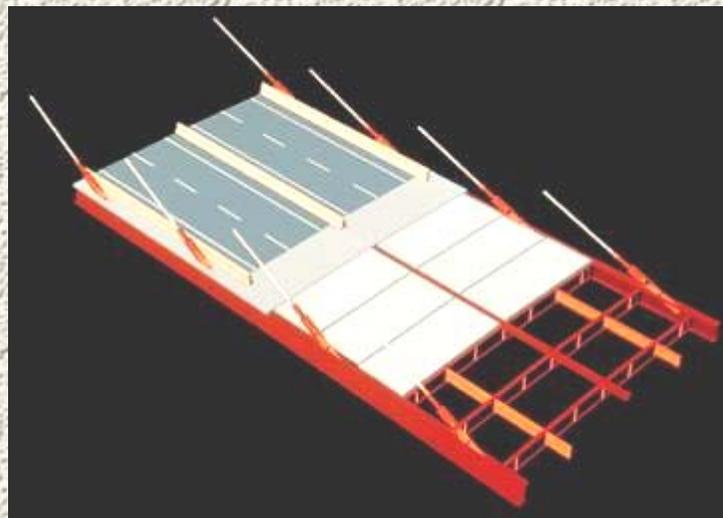
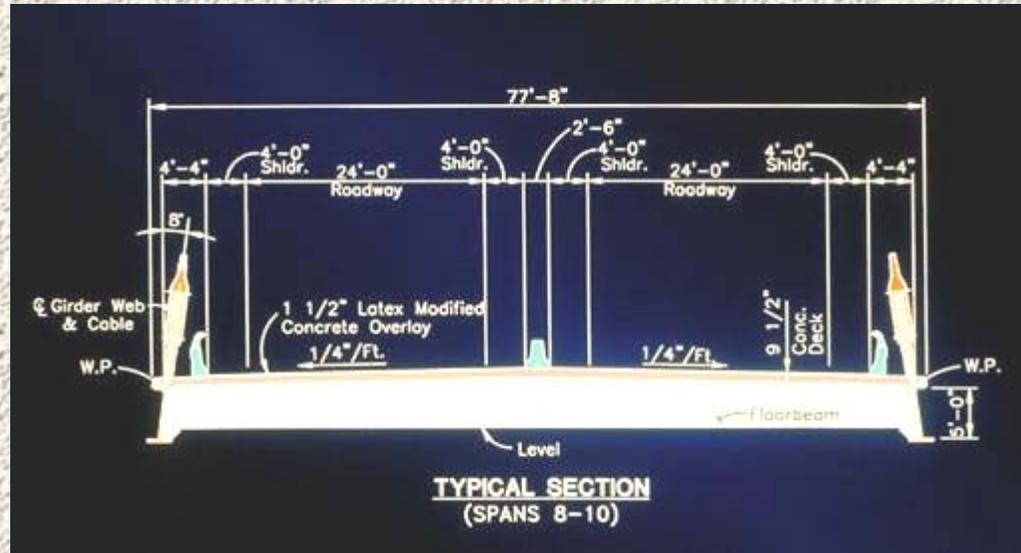


Bridge Site

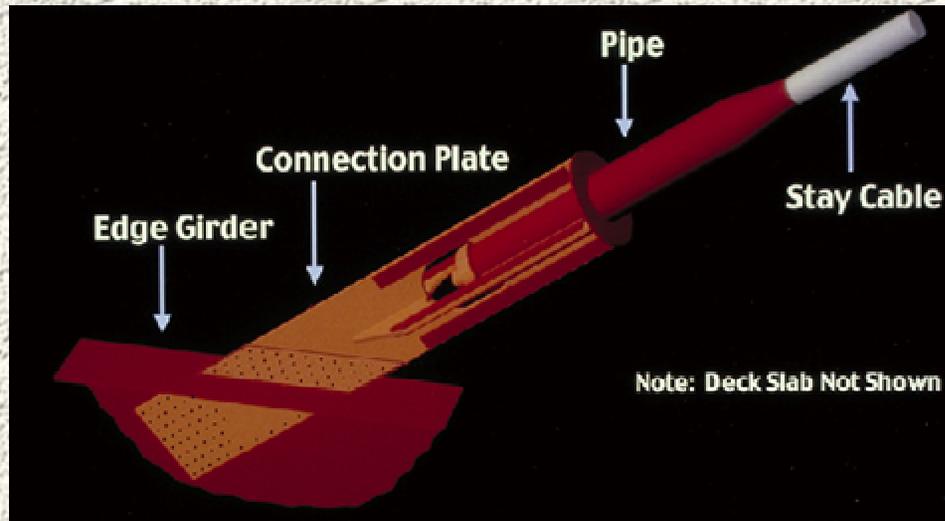
Elevation of Cable-Stayed Spans



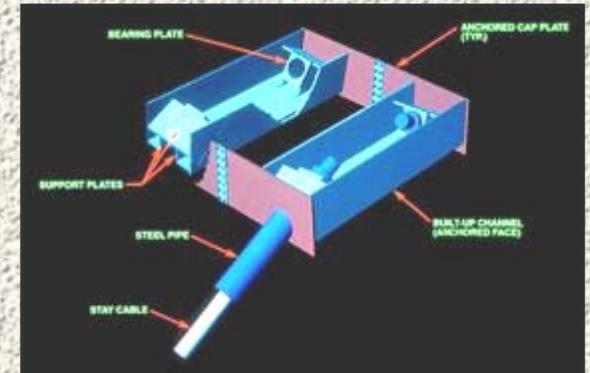
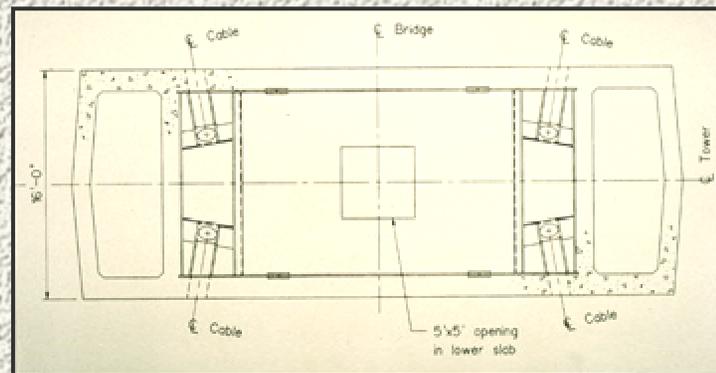
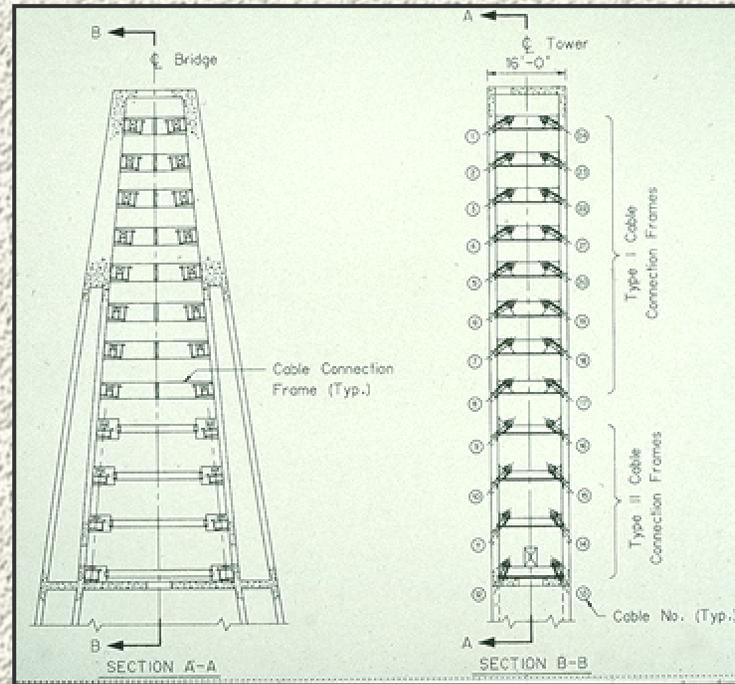
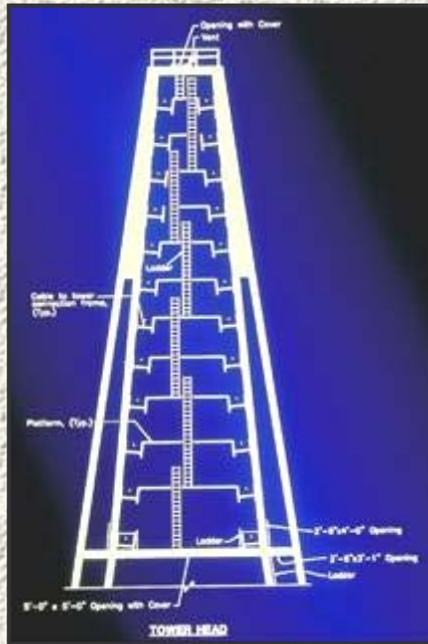
Steel Composite Superstructure



Cable Connection

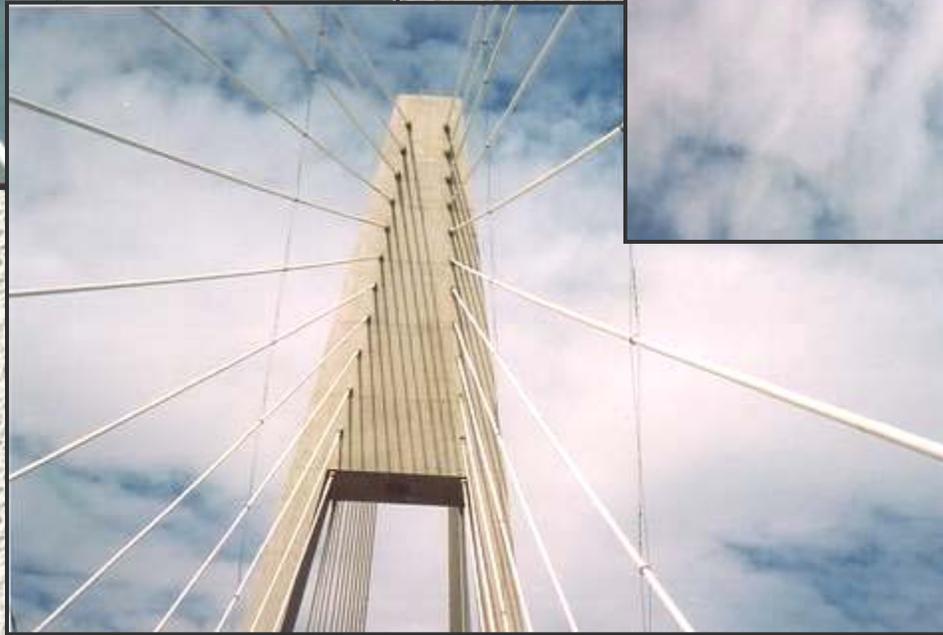
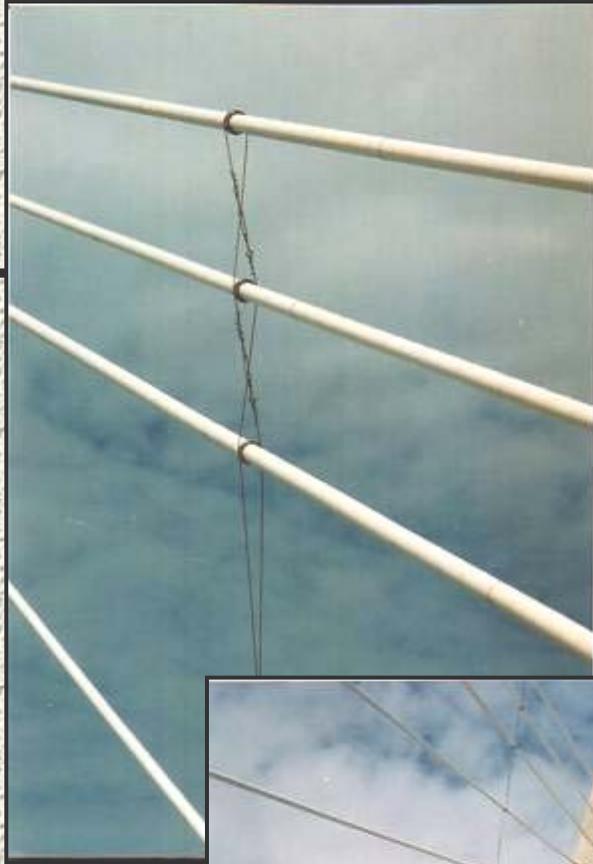
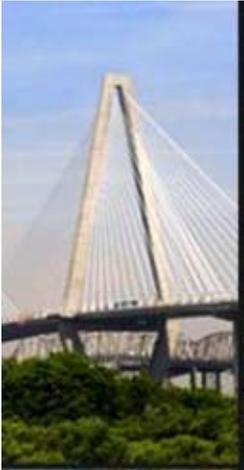


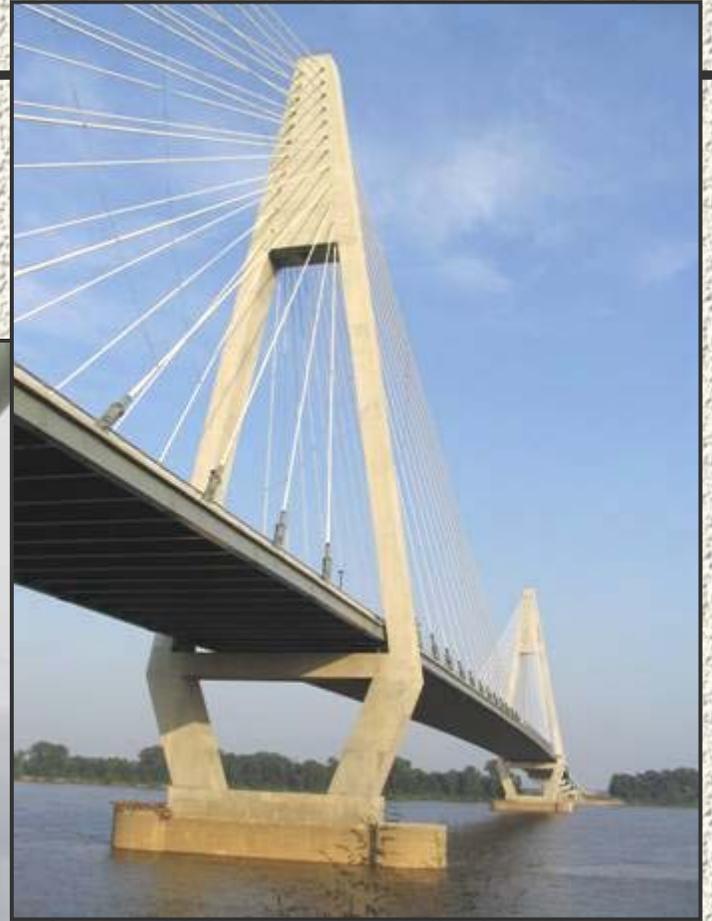
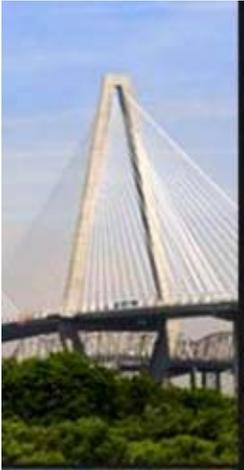
Tower Head and Cable Connections



Access Inside Tower Head



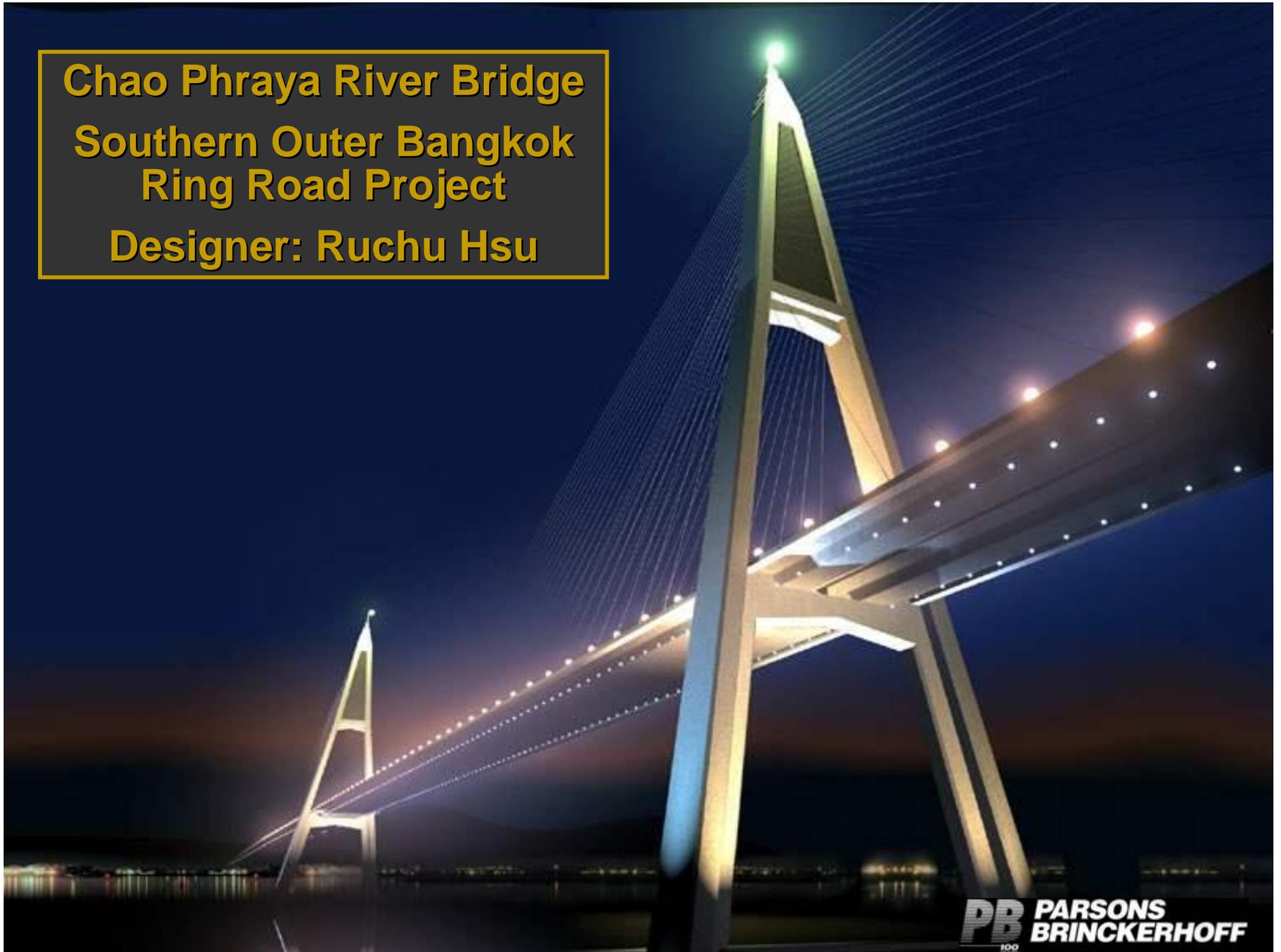


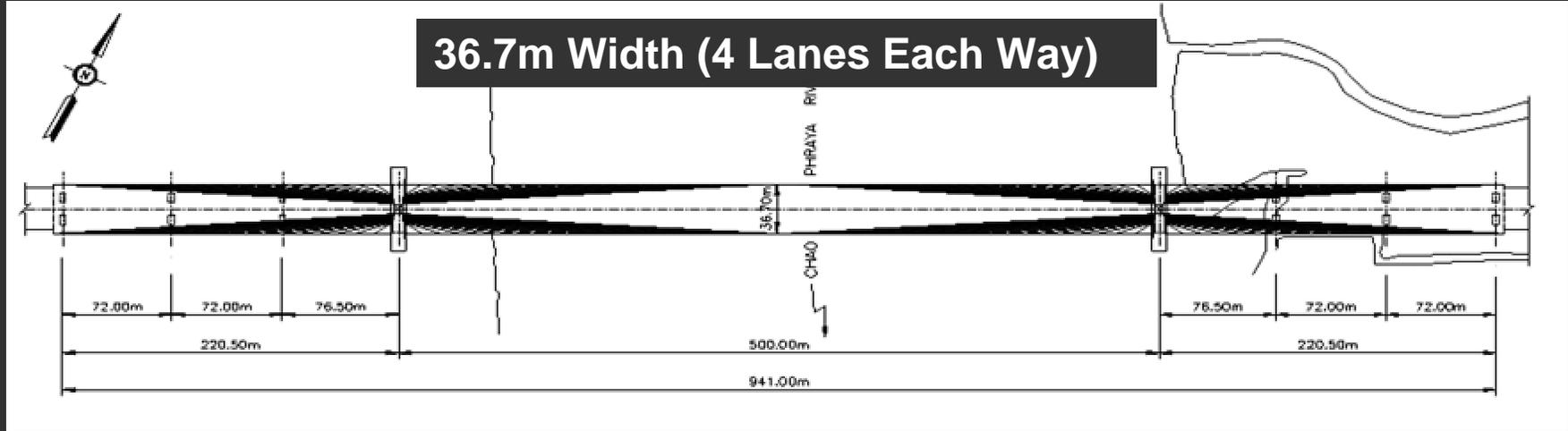


**The Goal of Longevity and
Minimum Maintenance Have
Been Achieved In Design.**

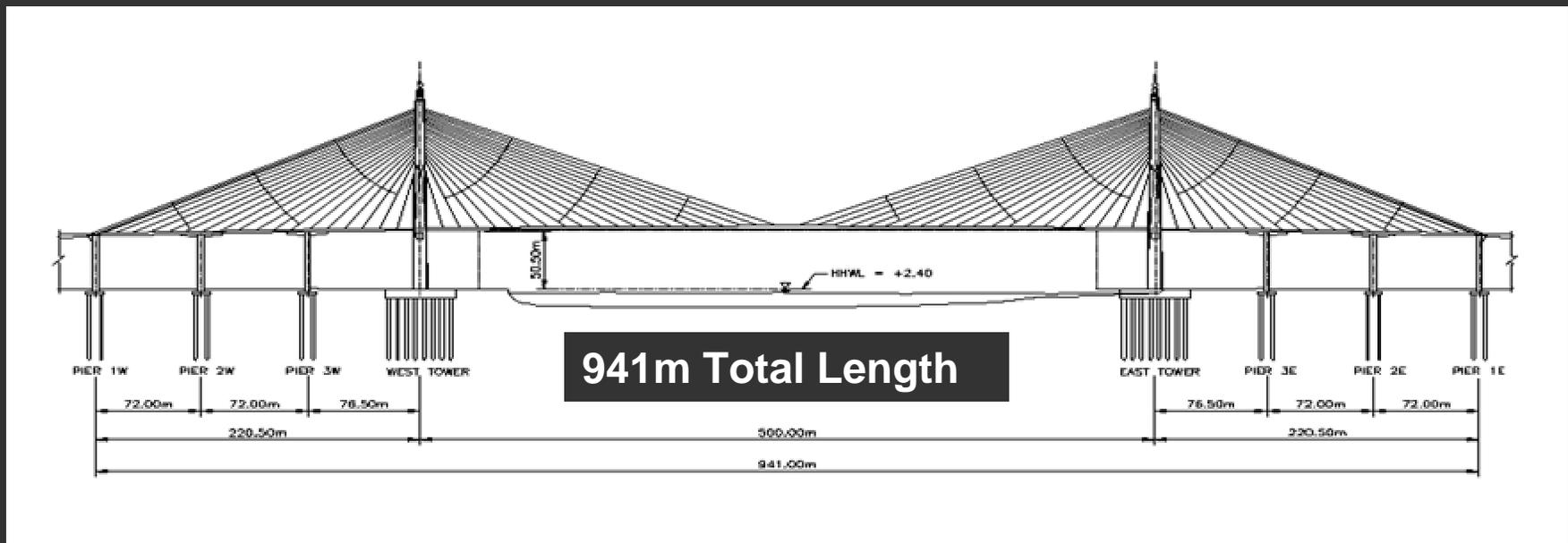


**Chao Phraya River Bridge
Southern Outer Bangkok
Ring Road Project
Designer: Ruchu Hsu**



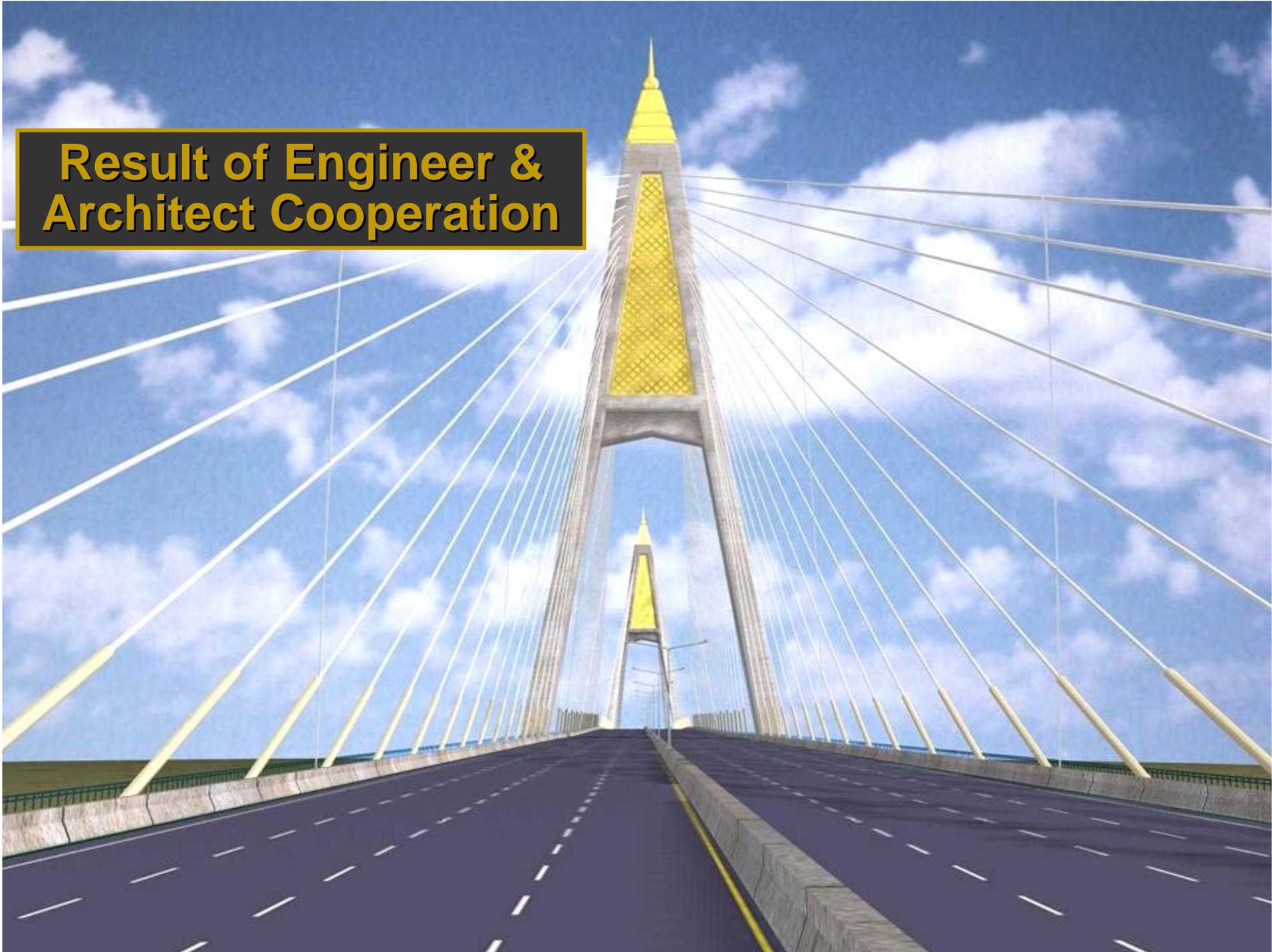


PLAN



ELEVATION

Result of Engineer & Architect Cooperation

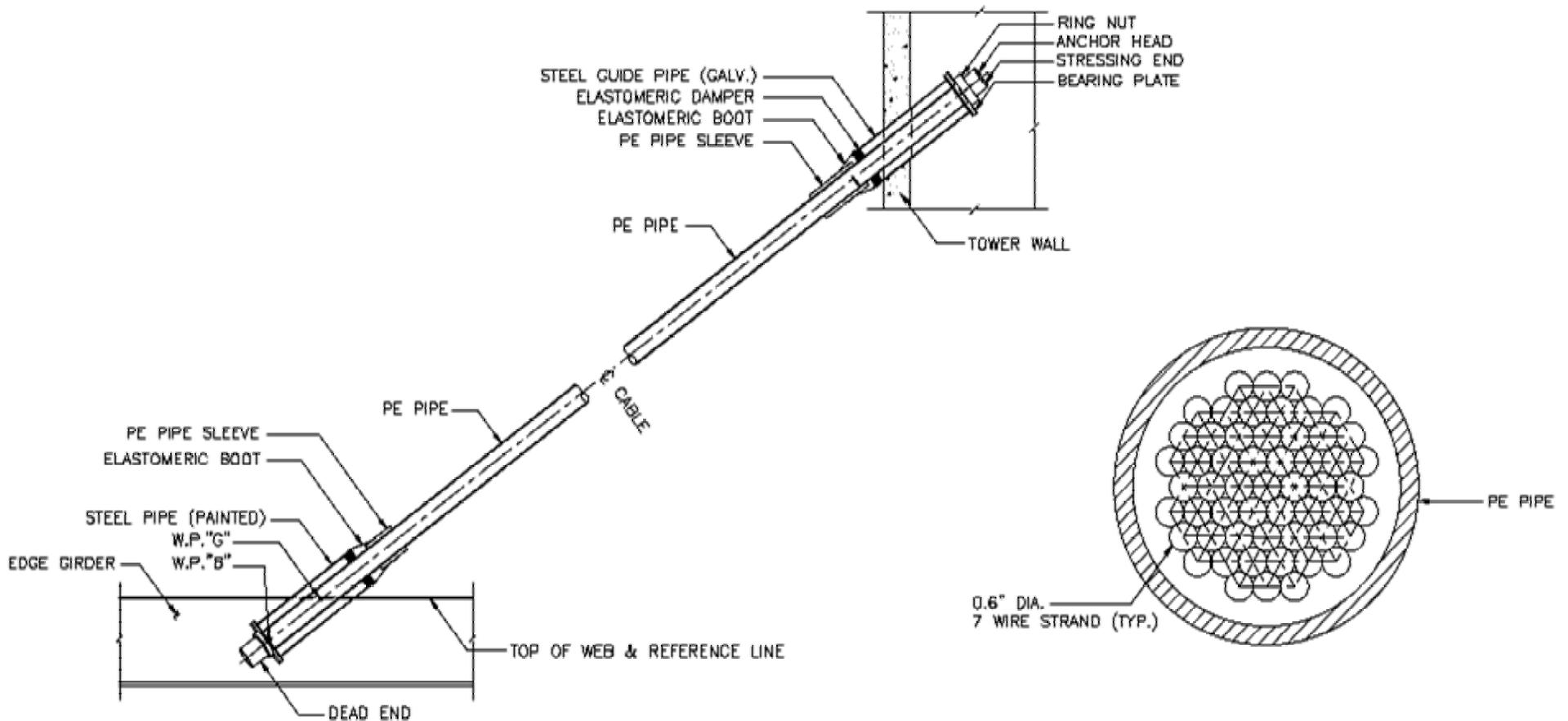


Tower & Anchor Pier Construction





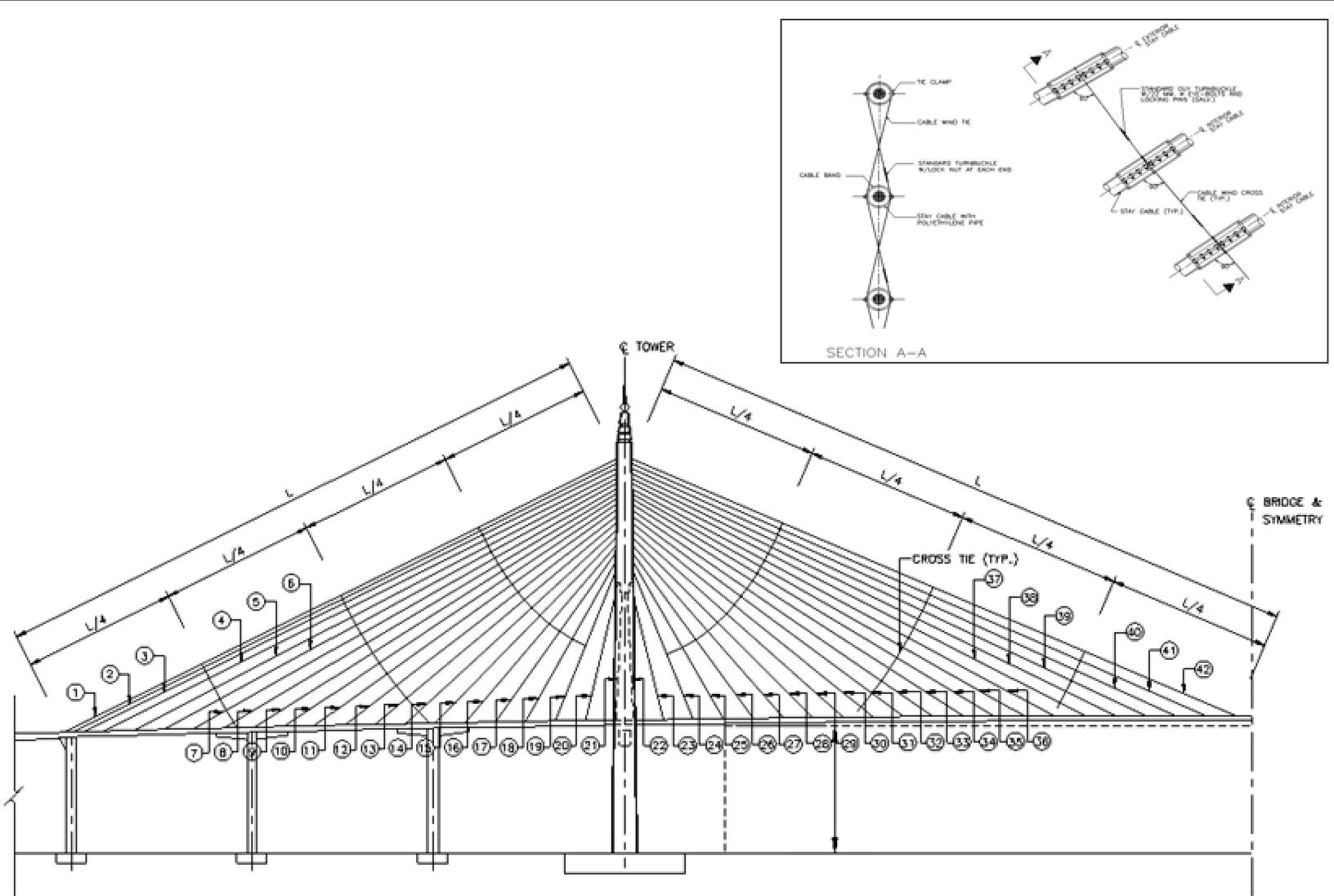
Stay Cable



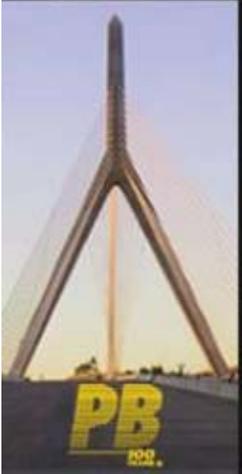
TYPICAL CABLE ASSEMBLY LAYOUT

TYPICAL CABLE CROSS SECTION

Wind Tie Layout and Details



Human Engineering



A User Friendly Bridge for Thailand

