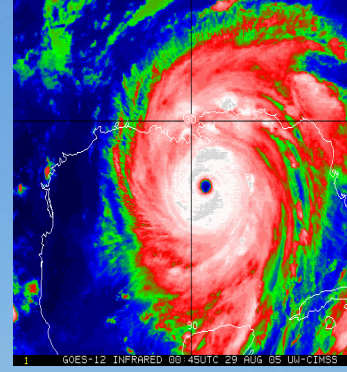
I -10 TWIN SPAN REBUILDING PROJECT



Paul B. Fossier, Jr., P.E., M. ASCE

Tulane Engineering Forum
May 11, 2007

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
DOTD

BRIDGE DESIGN

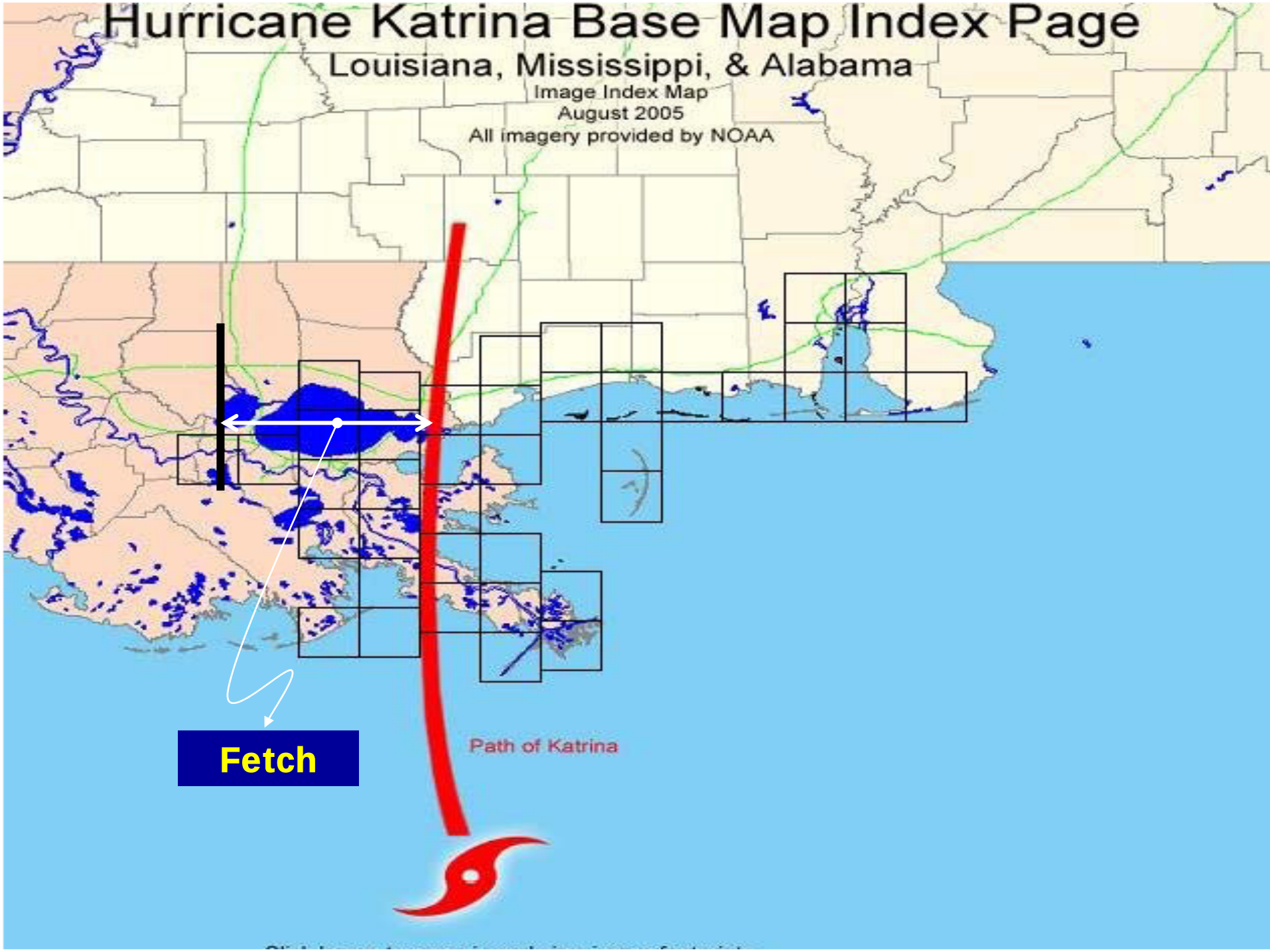

1. EMERGENCY BRIDGE REPAIRS
2. LONG TERM BRIDGE REPLACEMENT
Pontchartrain Causeway (20')
US 11 (11')
I-10 (15')
US 90 (17')
Rigolet's Pass
Chef Menteur Pass

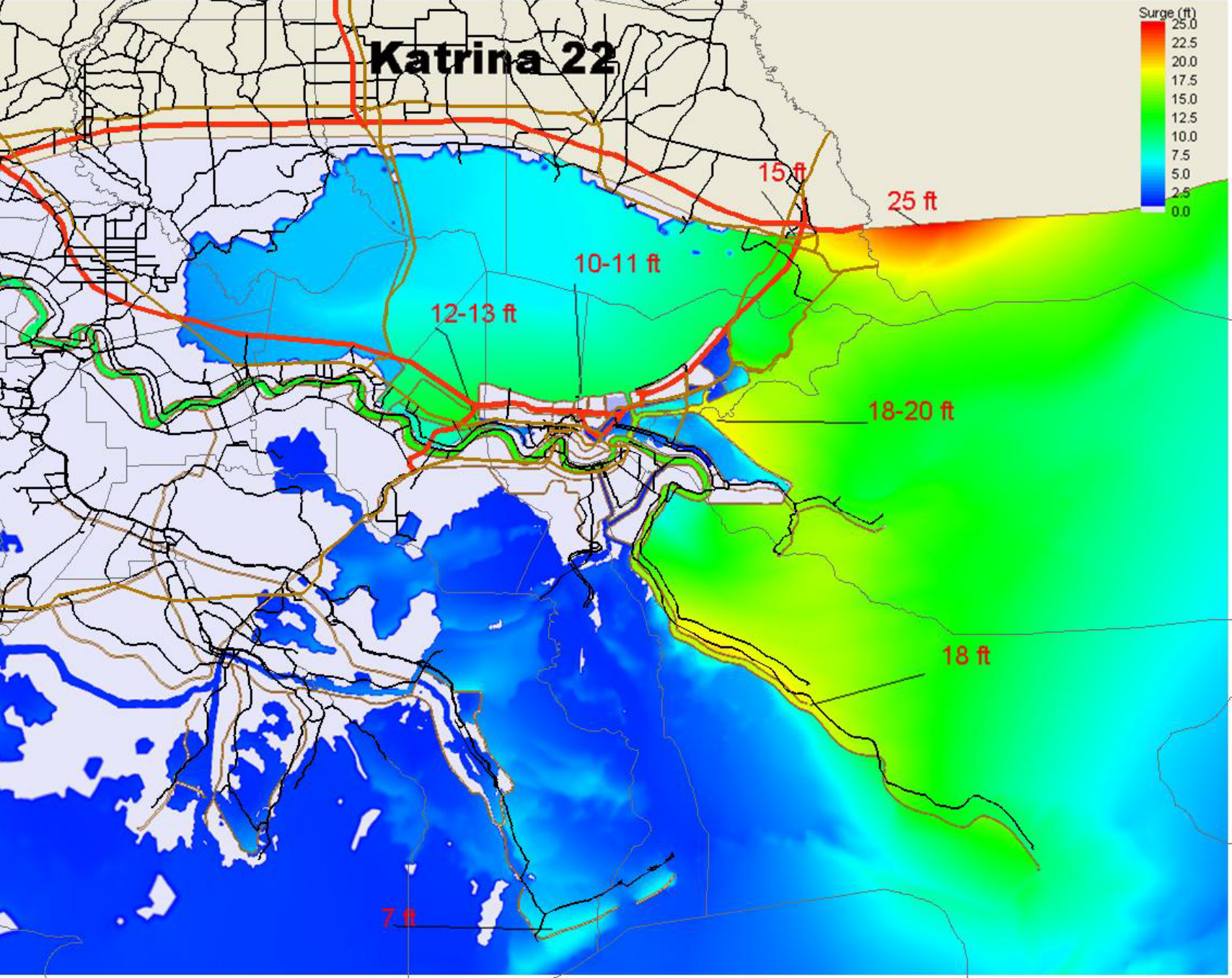
- EACH PARALLEL BRIDGE – 5.4 MILES, YR. COMPLETED = 1963
- LOW LEVEL 65’ L x 43’ W MONOLITHIC PRESTRESSED PRECAST GIRDER SPANS
- 54” PRECAST PRESTRESSED CYLINDER PILE
- EACH 65’ SPAN DEAD LOAD APPROX. 300 TONS
- 250 FT. HIGH LEVEL STEEL NAVIGATIONAL SPAN

Hurricane Katrina Base Map Index Page

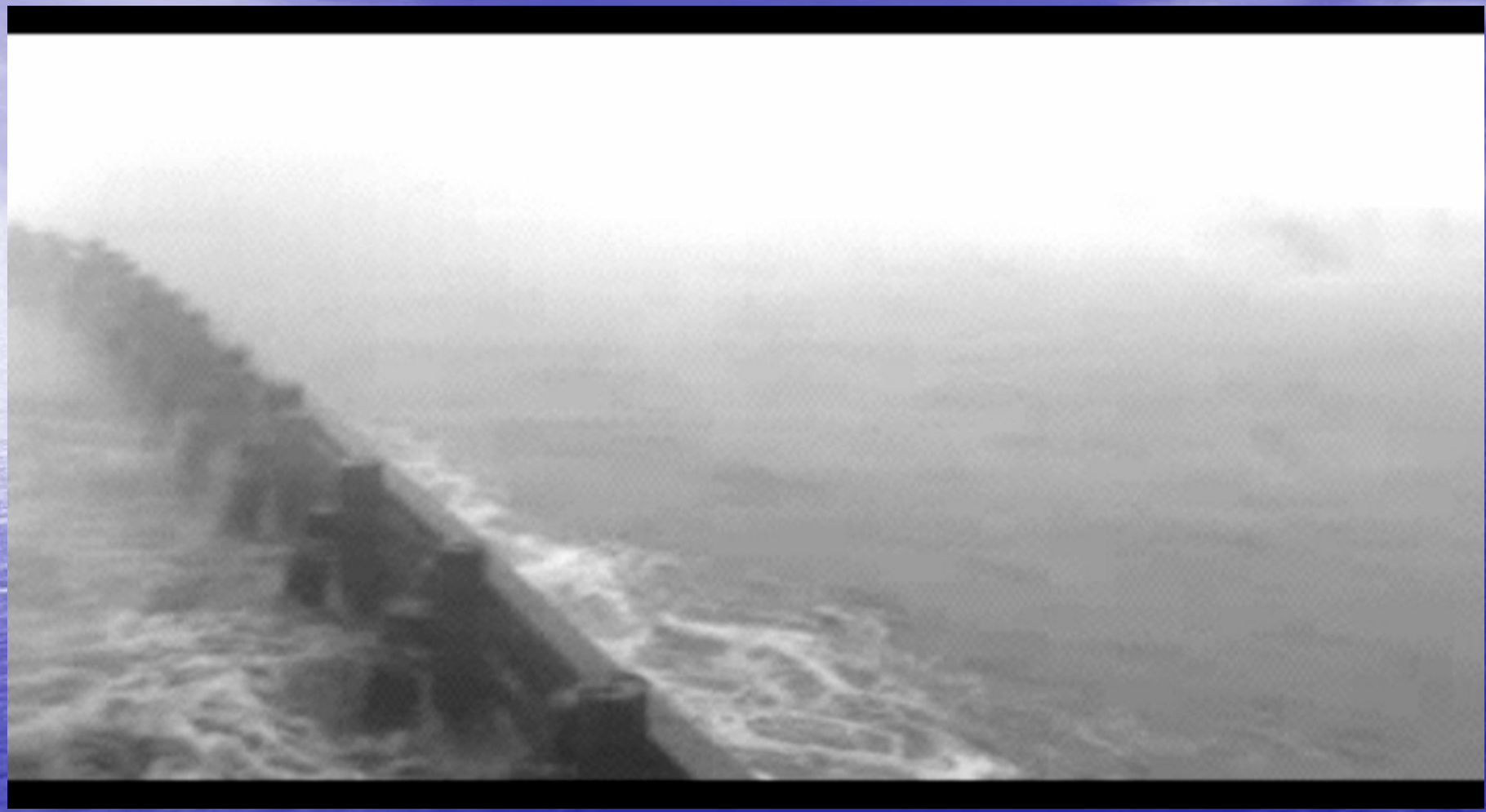
Louisiana, Mississippi, & Alabama

Image Index Map
August 2005
All imagery provided by NOAA





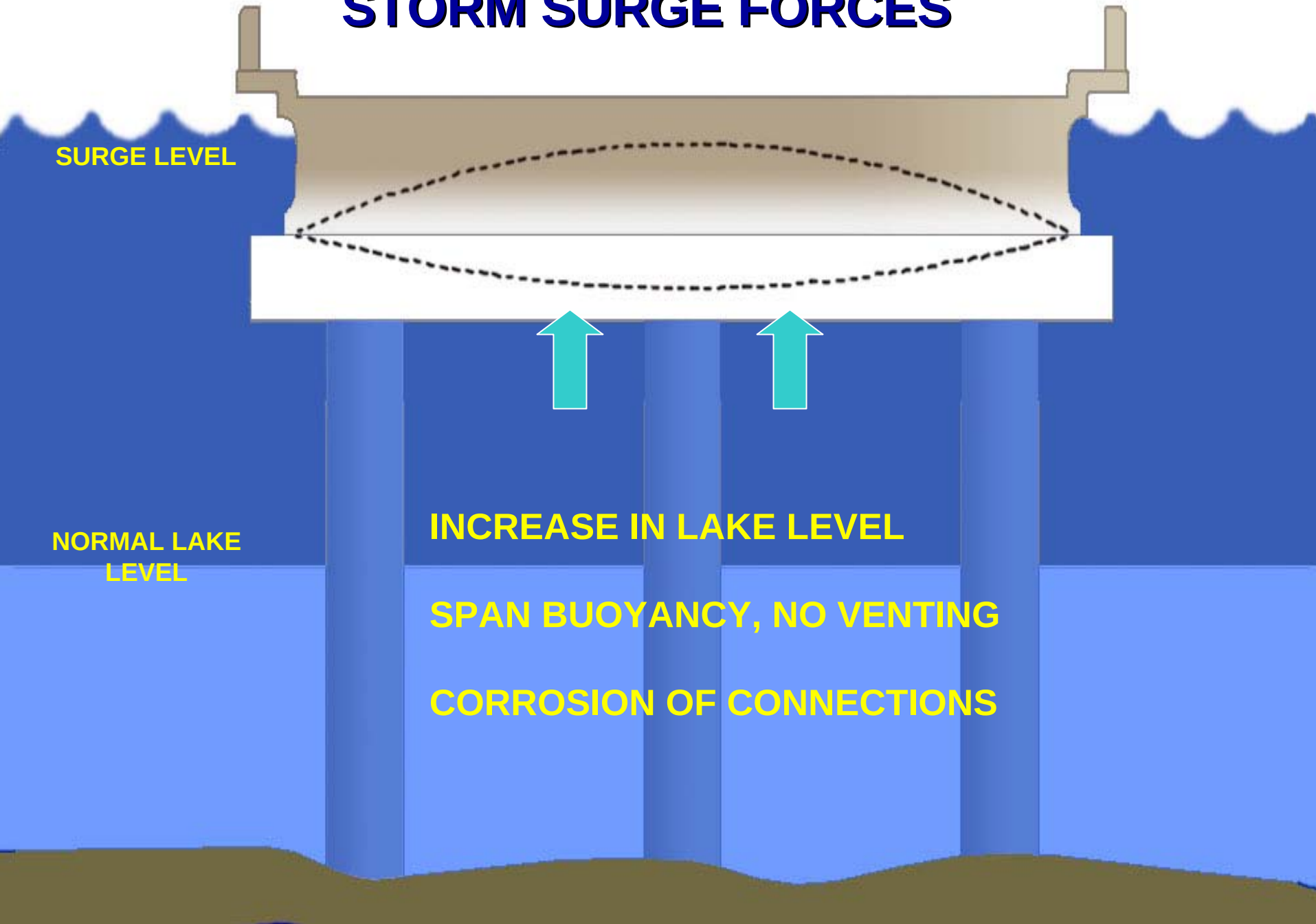
http://hurricane.lsu.edu/floodprediction/katrina22/

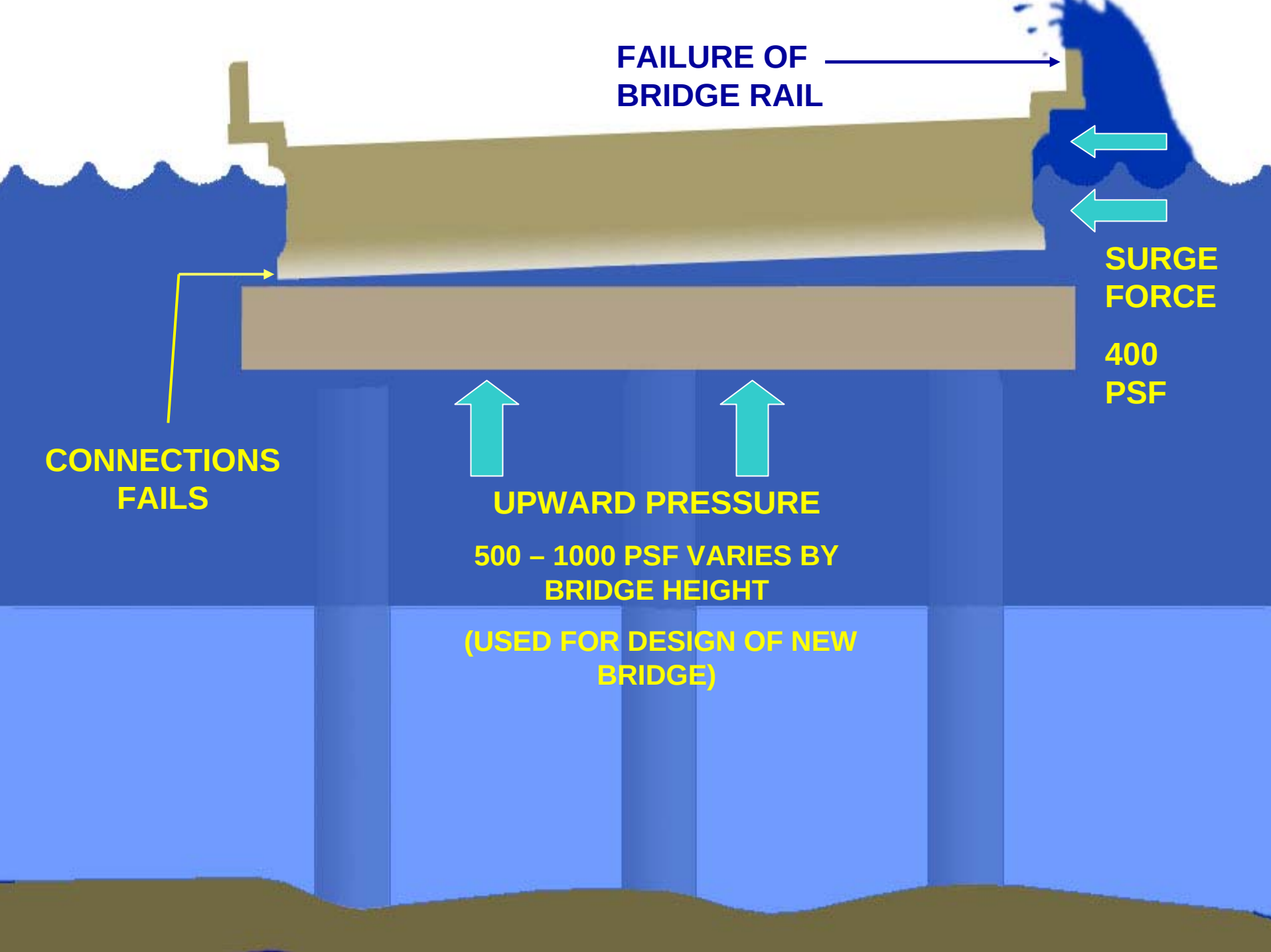


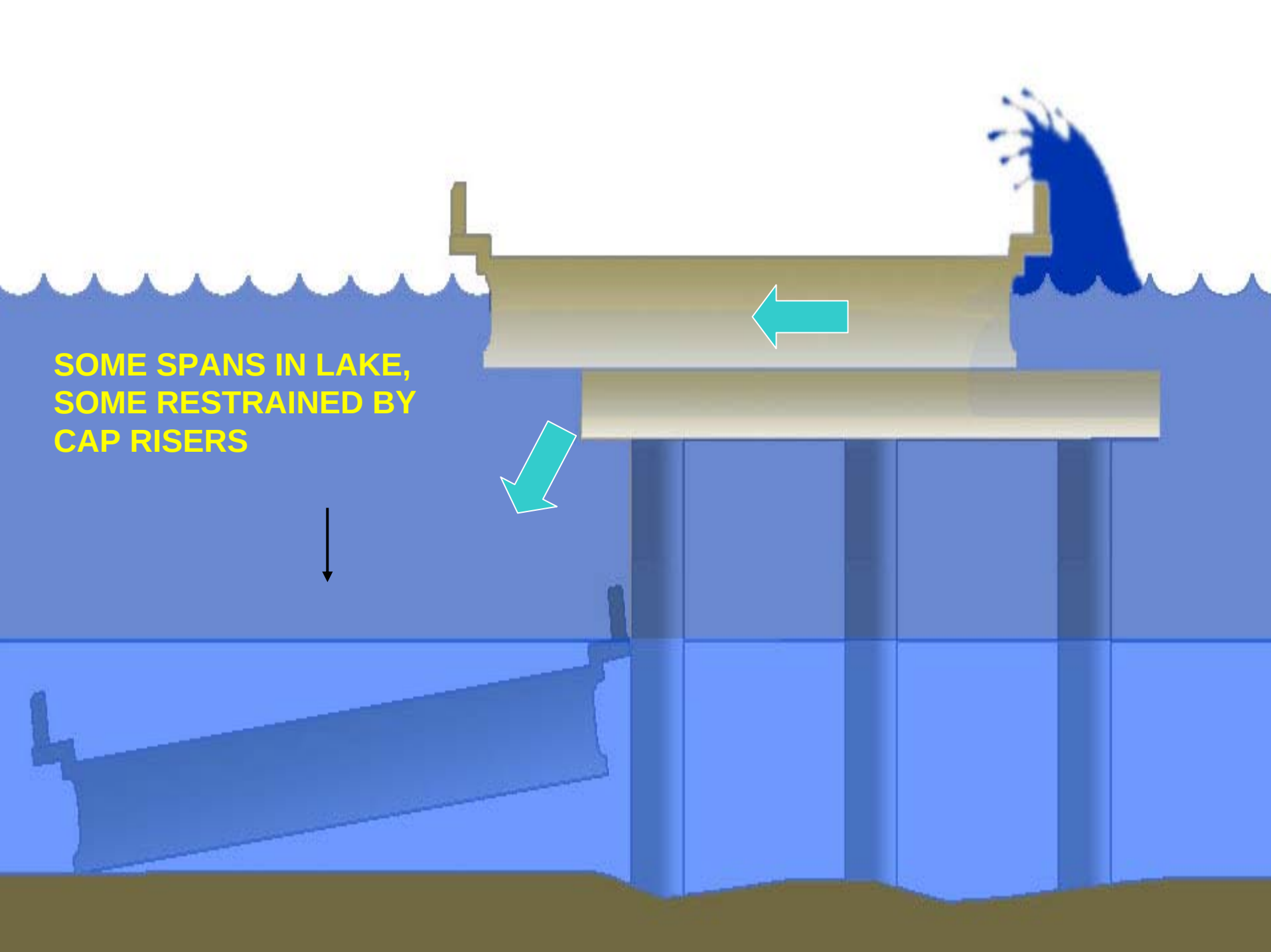
Surge Force

Fender System Pontchartrain Causeway Bridge

STORM SURGE FORCES

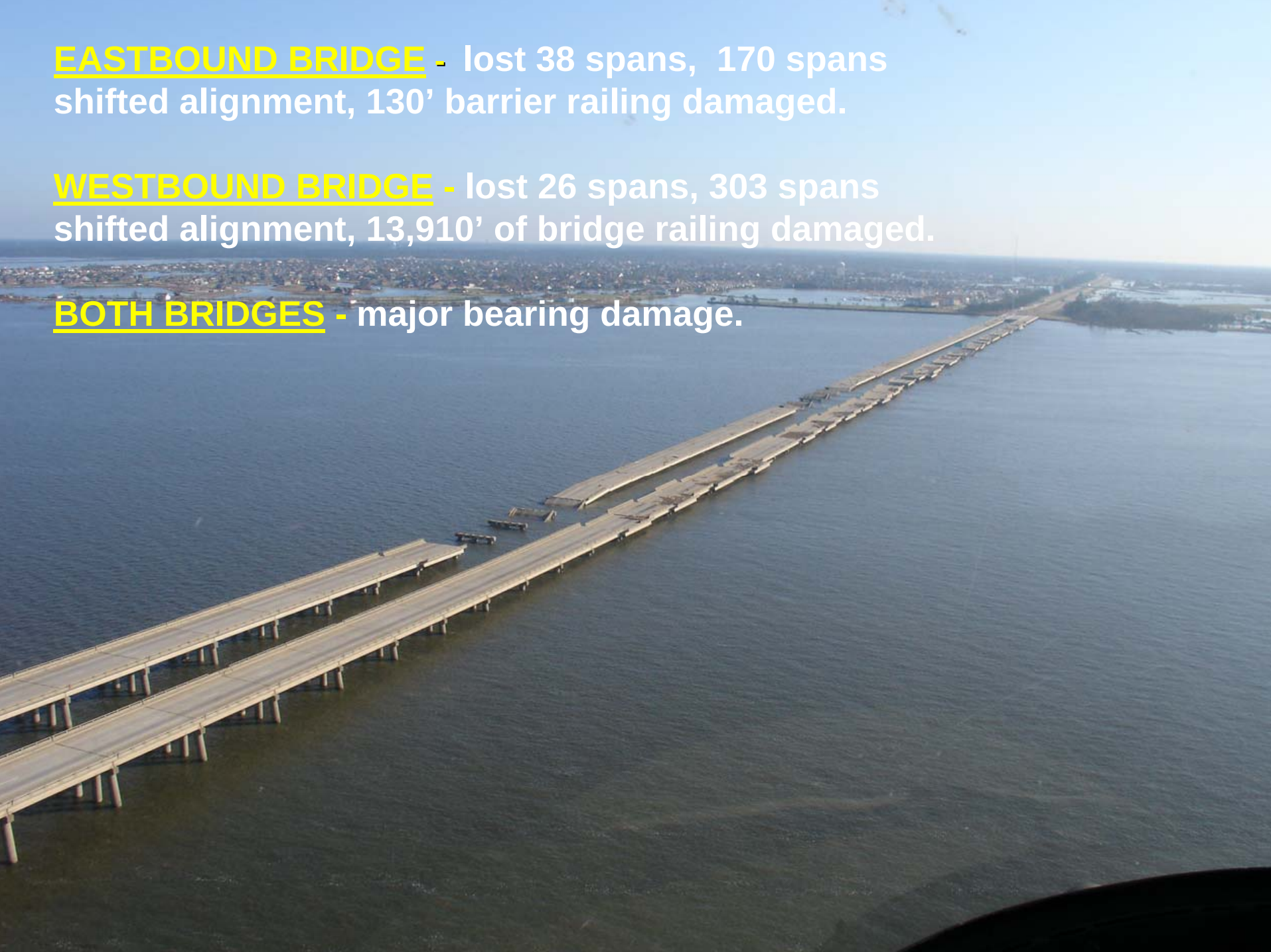



FAILURE OF
BRIDGE RAIL
SURGE
FORCE
400
PSF
CONNECTIONS
FAILS
UPWARD PRESSURE
500 – 1000 PSF VARIES BY
BRIDGE HEIGHT
(USED FOR DESIGN OF NEW
BRIDGE)


SOME SPANS IN LAKE,
SOME RESTRAINED BY
CAP RISERS

US 11 DAMAGE

NORFOLK SOUTHERN RAILROAD DAMAGE


EASTBOUND BRIDGE - lost 38 spans, 170 spans shifted alignment, 130’ barrier railing damaged.
WESTBOUND BRIDGE - lost 26 spans, 303 spans shifted alignment, 13,910’ of bridge railing damaged.
BOTH BRIDGES - major bearing damage.

SPANS SHIFTED
OFF CAPS

MOVEMENT STOPPED BY
RISERS, BUT CAUSED
GIRDER AND CAP DAMAGE

SPAN DISPLACMENT BY ONE RISER SPACING

TYPICAL BARRIER DAMAGE FROM BACKSIDE SURGE FORCE

TYPICAL BEARING DAMAGE AT GIRDER ENDS OF TWO SPANS

REPAIRS

- REESTABLISH MAJOR ROUTE INTO NEW ORLEANS FOR RECOVERY.
- ACCELERATED COMPLETION FOR BRIDGE INSPECTION, BID PACKAGE AND REPAIRS AS PER GOVENOR.
- MEET WITH FLA. DOT TO DISCUSS I-10 ESCAMBIA BRIDGE – HURRICANE IVAN.

REPAIR SCHEDULE

- Hurricane Katrina hit Monday, August 29, 2005.
- Bridge Inspections started immediately.
- Proposal developed and pre-bid mtg. held by DOTD, low bidder announced on Wednesday, September 7.
- Contractor NTP on Monday, September 12, Fourteen days after the hurricane made landfall.
- Three Phases – East bound, West Bound and Long term Maintenance

BID RESULTS

BOH BROTHERS - $30.9 M, ESTIMATE $53M

2nd bidder, $40 M

3rd bidder, $90 M

TWO OTHER CONTRACTORS DROPPED OUT.

CONTRACTOR RISKS

LABOR, EQUIPMENT & HOUSING AFTER STORM

DESIGN FOR REPAIRS DURING CONSTRUCTION

REMOVAL OF SPANS IN WATER

LEARNING CURVE FOR SPMT
INSPECTION REPORTS GIVEN

Immediately Start planning and design for new bridge

PHASE 1: REPAIR EASTBOUND ROADWAY

- Move spans from WB to fill gaps on EB
- Realign and repair missing spans on EB
- 45 days, completed in 34 days (Opened October 14, 2005)
- Construct road crossovers & Open EB two way traffic

Span Realignment & Replacement

SPMT – SELF PROPELLED MODULAR TRANSPORTERS - Mammoet

LIFTING SPANS

SPAN SWAPS FROM WESTBOUND TO EASTBOUND BRIDGE

REALIGNMENT OF SPANS BY SPMT

REALIGNMENT BY JACK AND SLIDE METHOD


MASSMAN

PHASE 2: REPAIR WESTBOUND ROADWAY

- Replace WB spans with ACROW 700 Series bridging & realign spans.
- Open WB lanes to one way traffic (Date opened January 6, 2006)
- Convert EB lanes to one way traffic




BENT SADDLES

HELPER BENTS

PHASE 3 MAINTENANCE CONTRACT

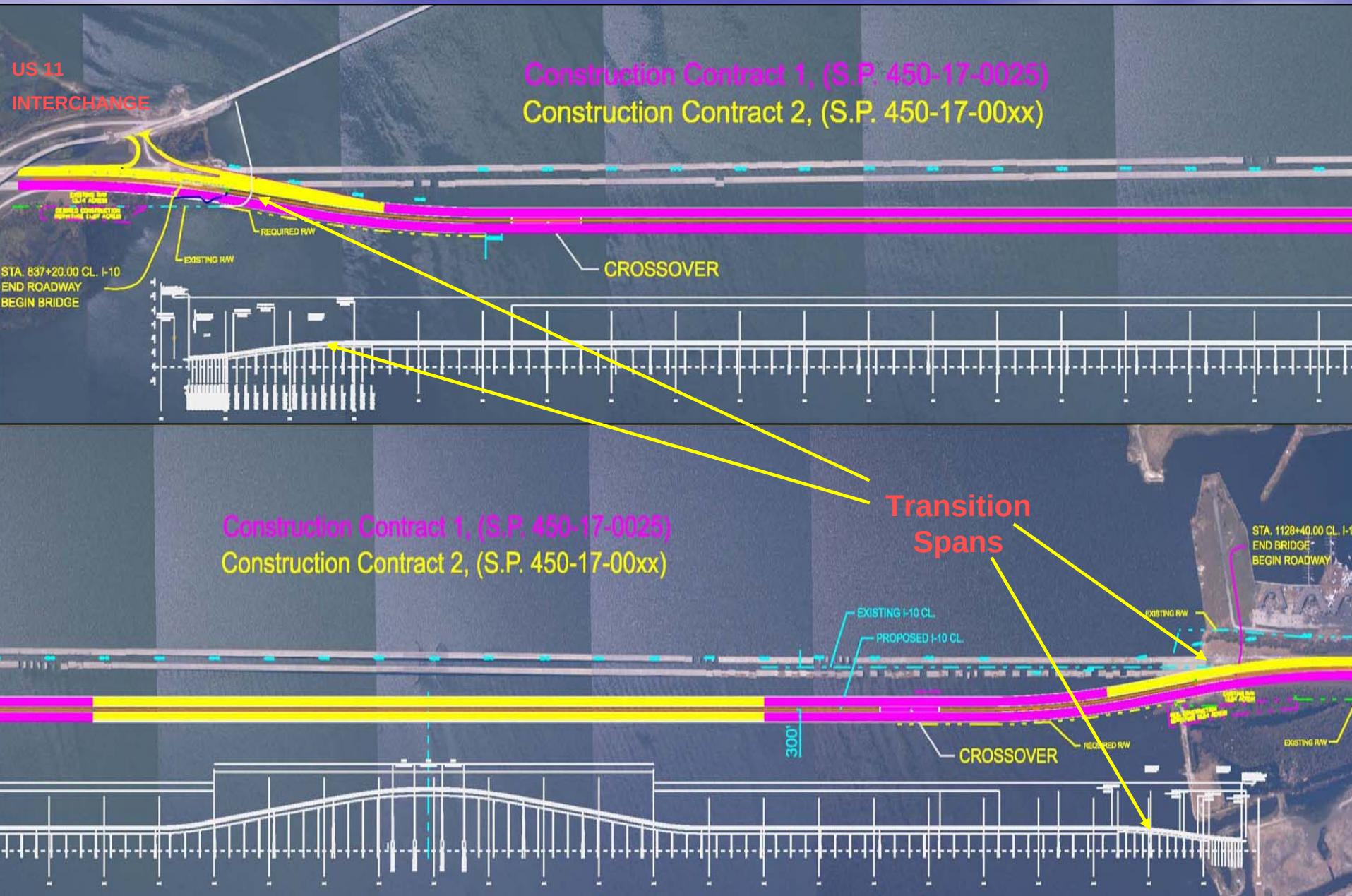
UNTIL NEW BRIDGE IS OPEN

- Periodic repairs to the Acrow Spans due to truck overloads.
- Construction of a weigh in motion station north of the westbound bridge.
- Better anchorage of the existing spans to resist future storms.
- Existing bridge was load posted for 20 T – 35 T.

NEW BRIDGE CRITERIA

- FAST TRACK DESIGN AND LETTING DUE TO BRIDGE CONDITION
- OFFSET ALIGNMENT TO KEEP EXISTING TRAFFIC MAINTAINED
- STORM SURGE PROTECTION BY INCREASED ELEVATION ON BRIDGE
- LOWER TRANSITION SPANS DESIGNED FOR SURGE FORCE
- INCREASE CAPACITY, 3 - 12 FT. LANES AND 2 - 12 FT. SHLDRS.
- ITS SYSTEM
- 100 YEAR DESIGN LIFE – ADVANCED MATERIALS - HPC
- HIGH STRENGTH CONCRETE SPANS
- OPEN BRIDGE RAIL TEST LEVEL 4 SYSTEM
- VESSEL IMPACT COLLISION
- REDUCE R/W AND ENVIRONMENTAL IMPACTS
- BAYOU SAUVAGE WILDLIFE RESERVE & US 11 INTERCHANGE
- AASHTO LRFD DESIGN CODE & PERMIT VEHICLE

CONSTRUCTION PHASING



BID ALTERNATES CONTRACT 1
NEW LOW LEVEL BRIDGE

Alternate A

Precast 135 ft. 78” BT HPC Prestressed Girders with pile bents and 36” Precast Piles.

Alternate B

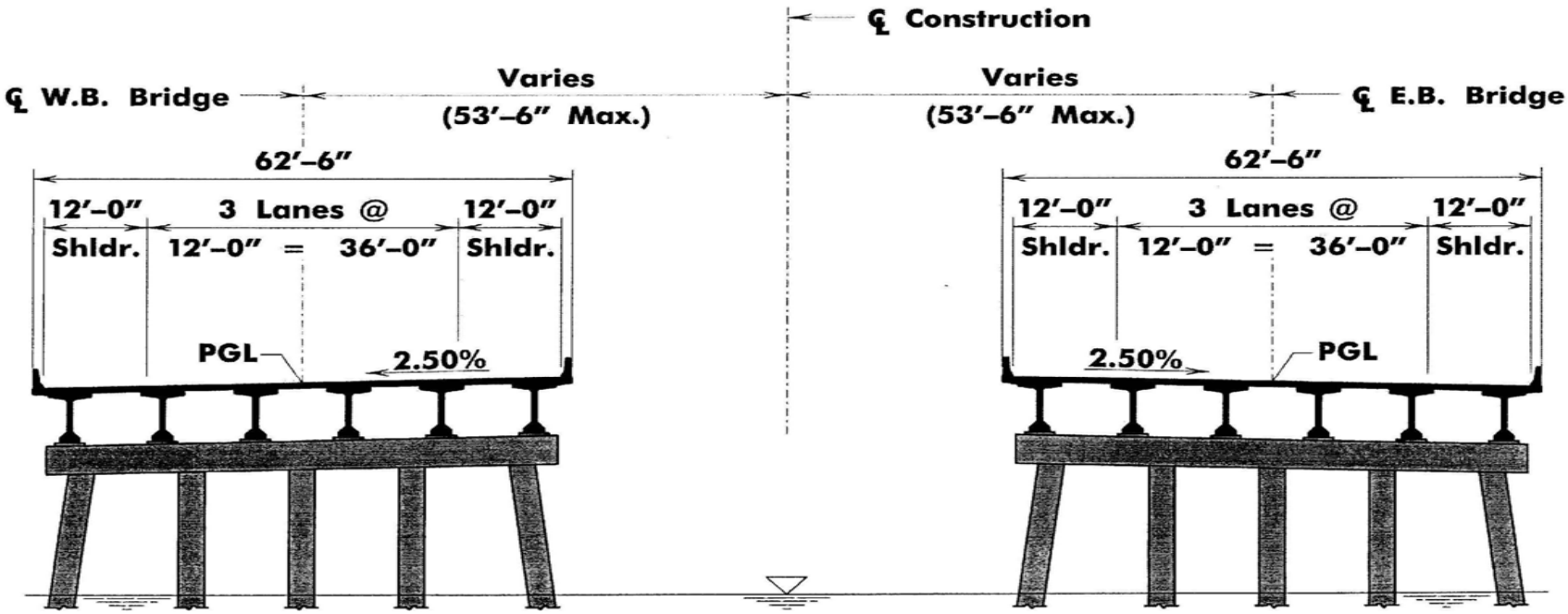
154 ft. Segmental Concrete Box Girder using span by span erection on pile bents and 36” Precast Piles.

Low level transition

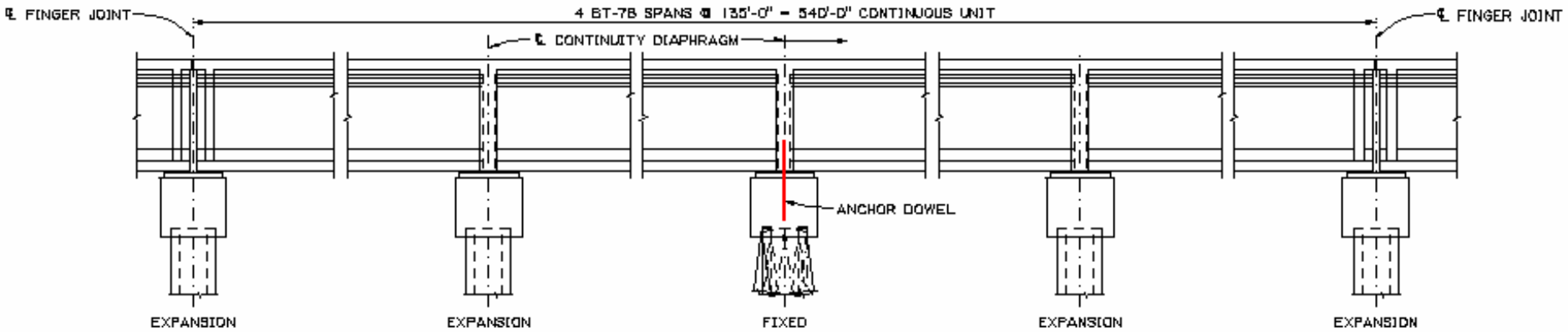
Flat Slabs and Type III beams, no alternate.

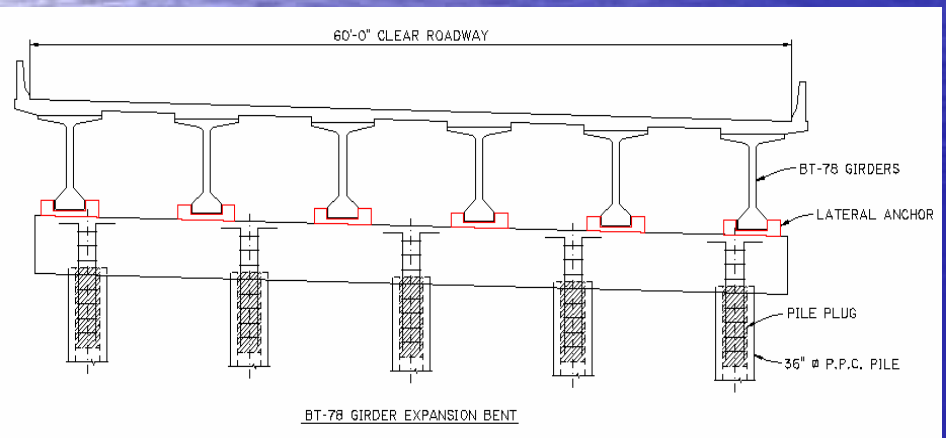
BT Alternate with 36” Precast Piles

Typical Section

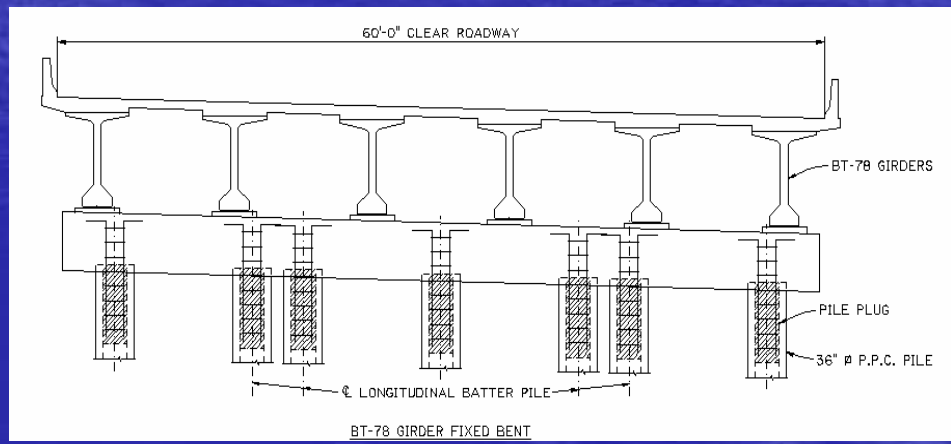


BT 78 Span Anchorage Details



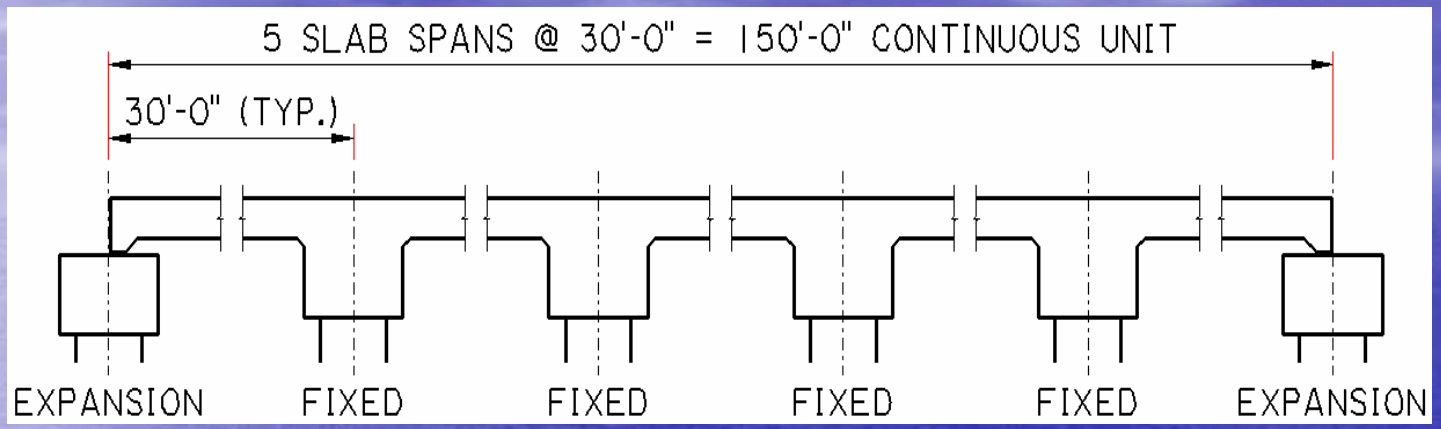


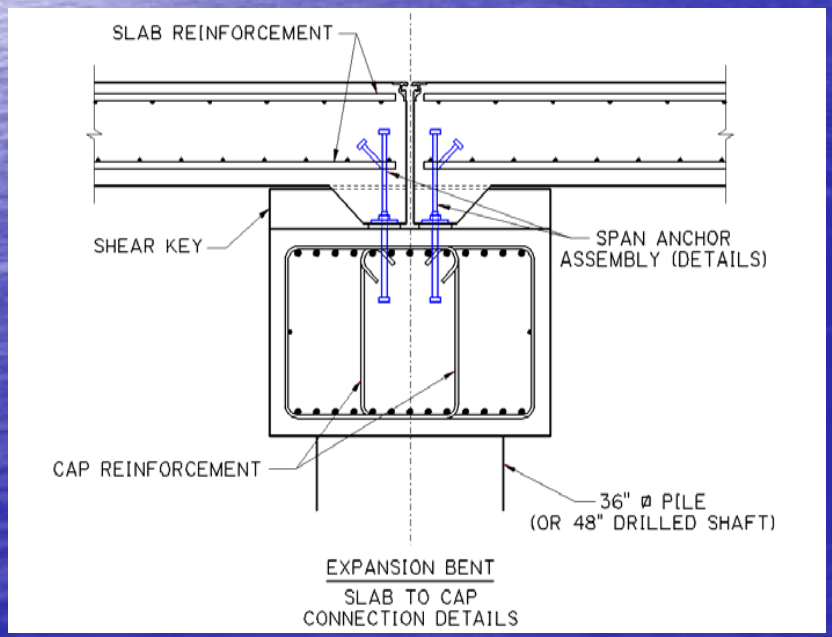
BT-78 GIRDER EXPANSION BENT

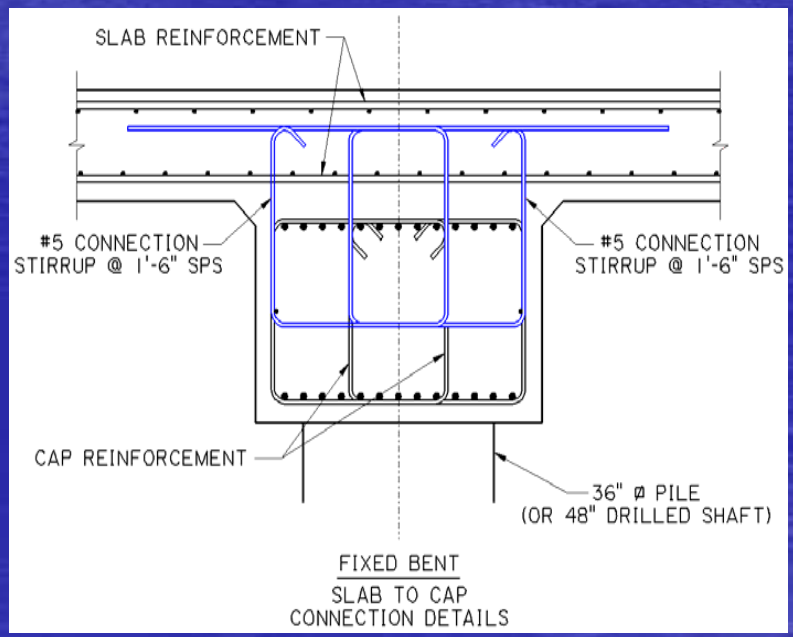


BT-78 GIRDER FIXED BENT

Slab Span
Transition Anchorage Details

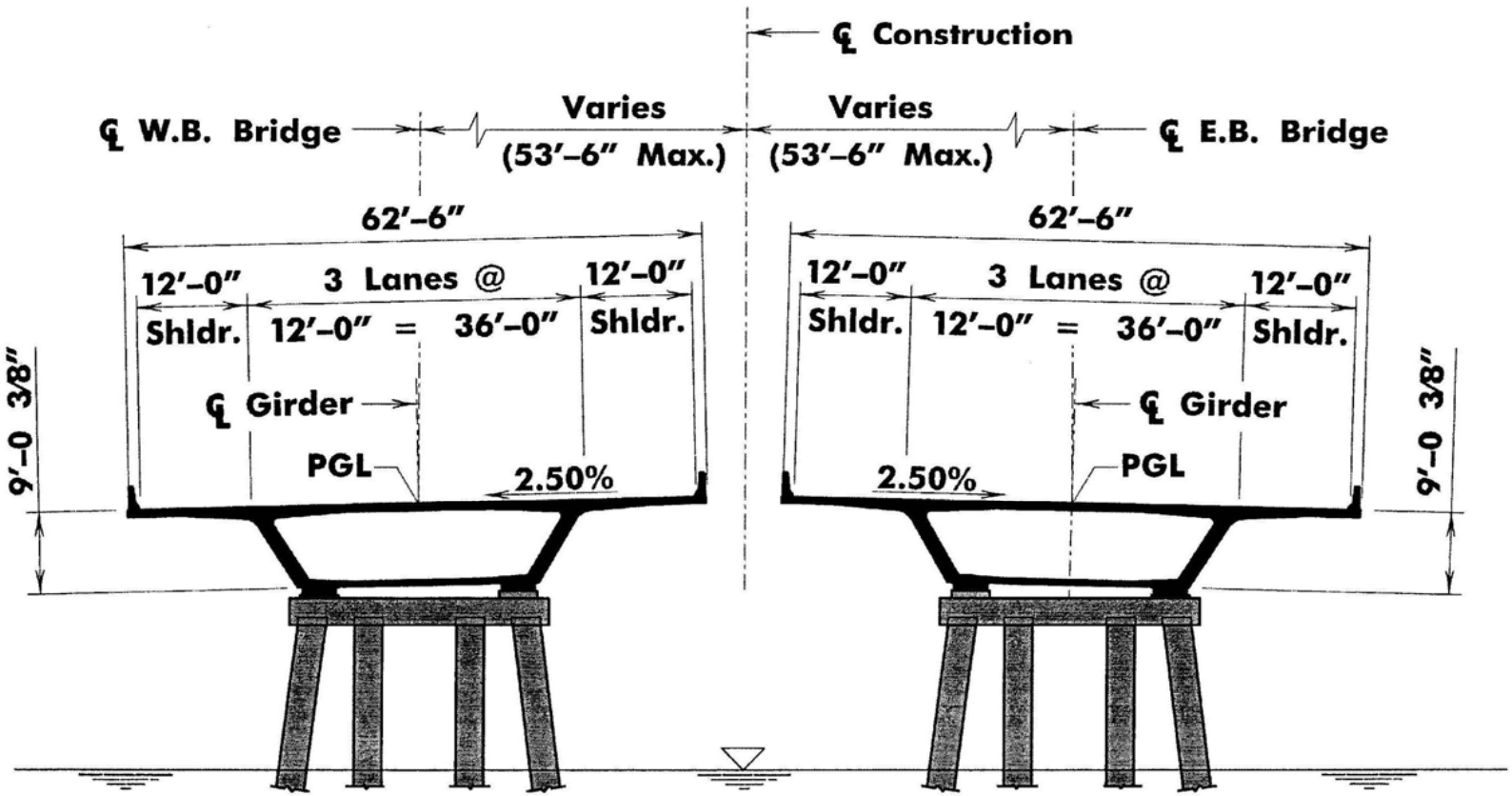




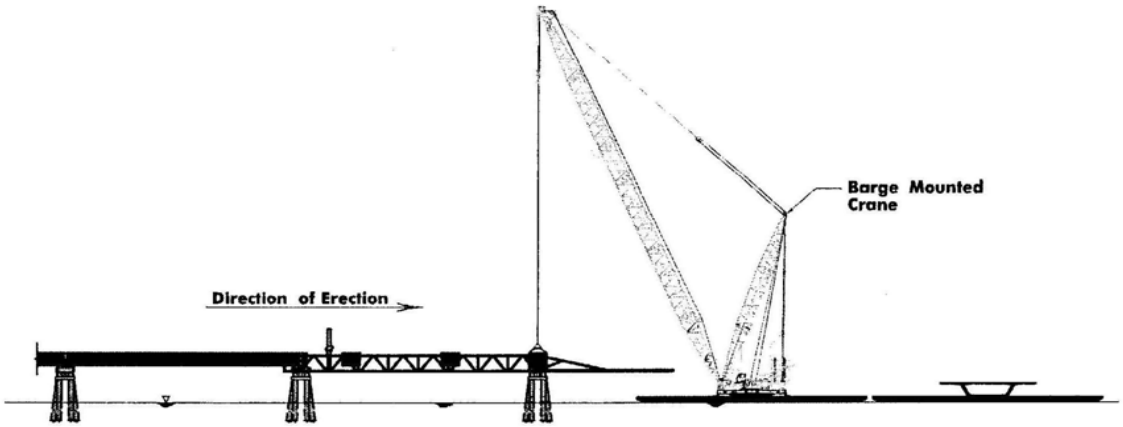


154.5 FT. SEGMENTAL LOW LEVEL ALTERNATE

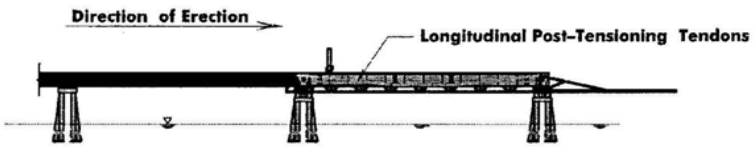
Typical Section



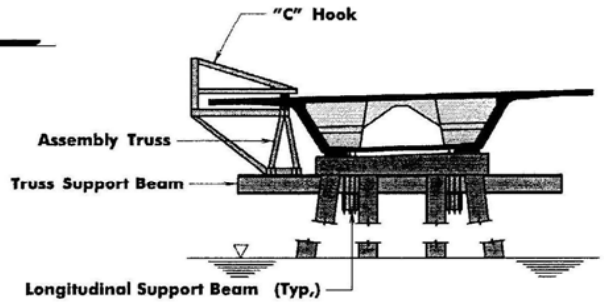
LOW LEVEL SEGMENTAL
Superstructure Erection Scheme



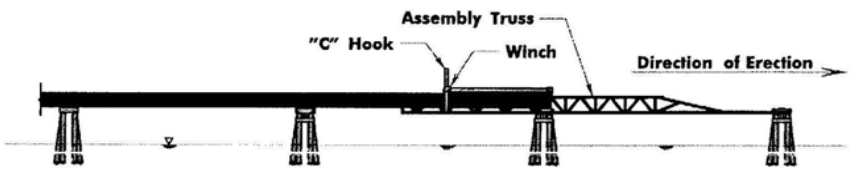
PHASE I – SEGMENT PLACEMENT



PHASE II – STRESSING LONGITUDINAL TENDONS



ELEVATION AT BENT



PHASE III – TRUSS ADVANCEMENT

CONTRACT NO. 2 - 1.1 MILE HIGH SPAN PORTION

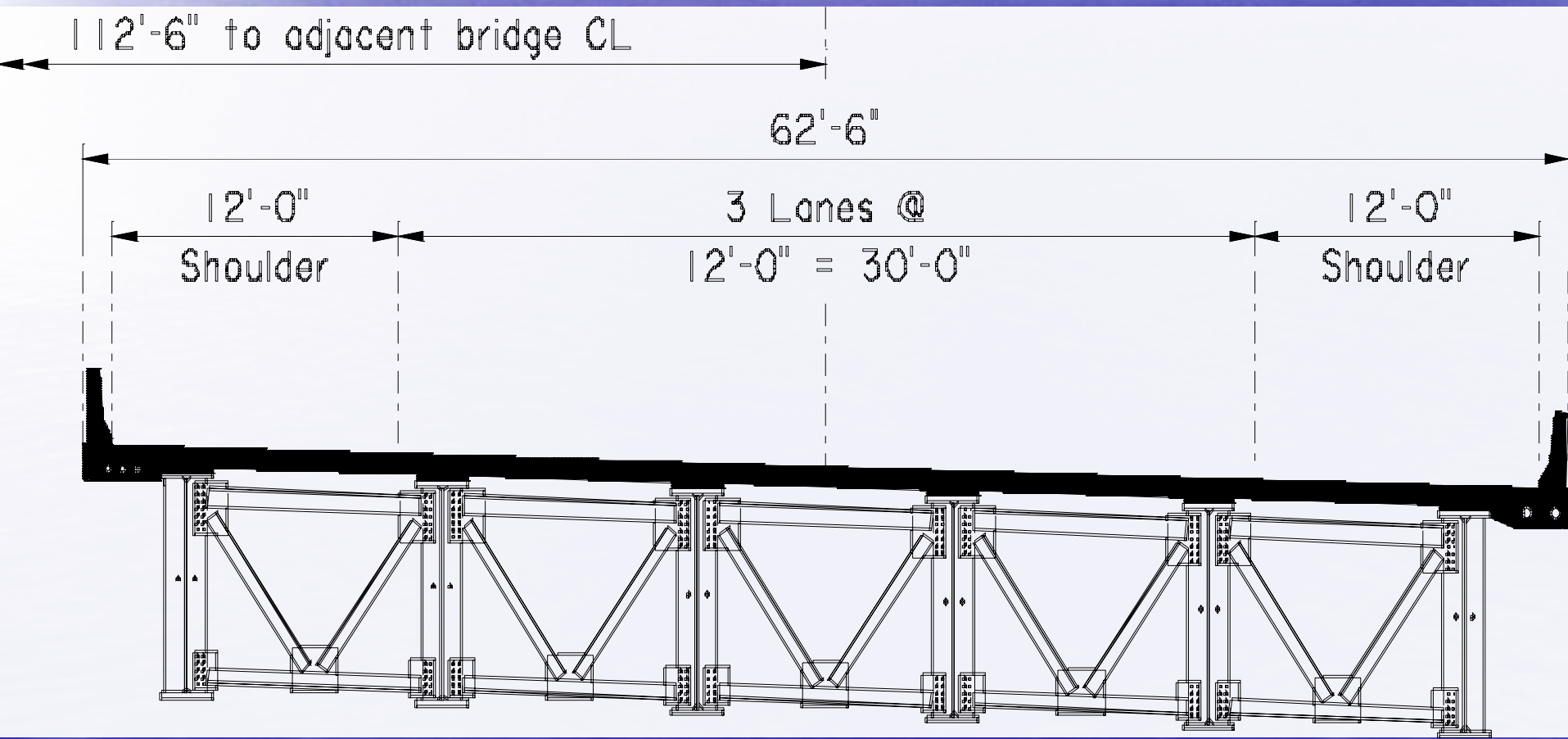
- **ALTERNATE A1**
  BT78 & Steel Plate Girders with CIP Columns

- **ALTERNATE A2**
  Segmental Box Girders with CIP Columns

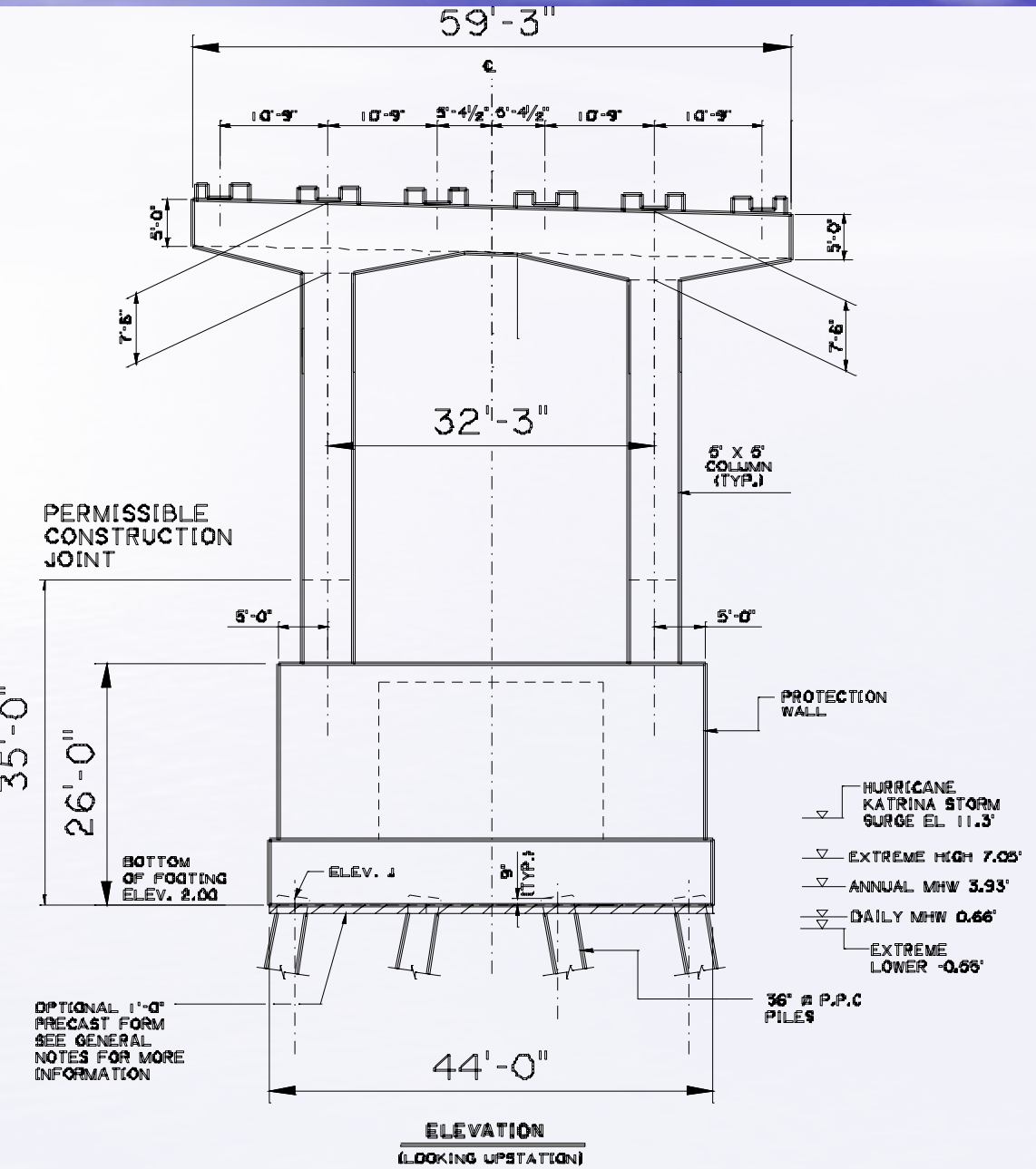
- **ALTERNATE A3**
  Segmental Box Girders with Precast Columns

Steel Span Typical Section

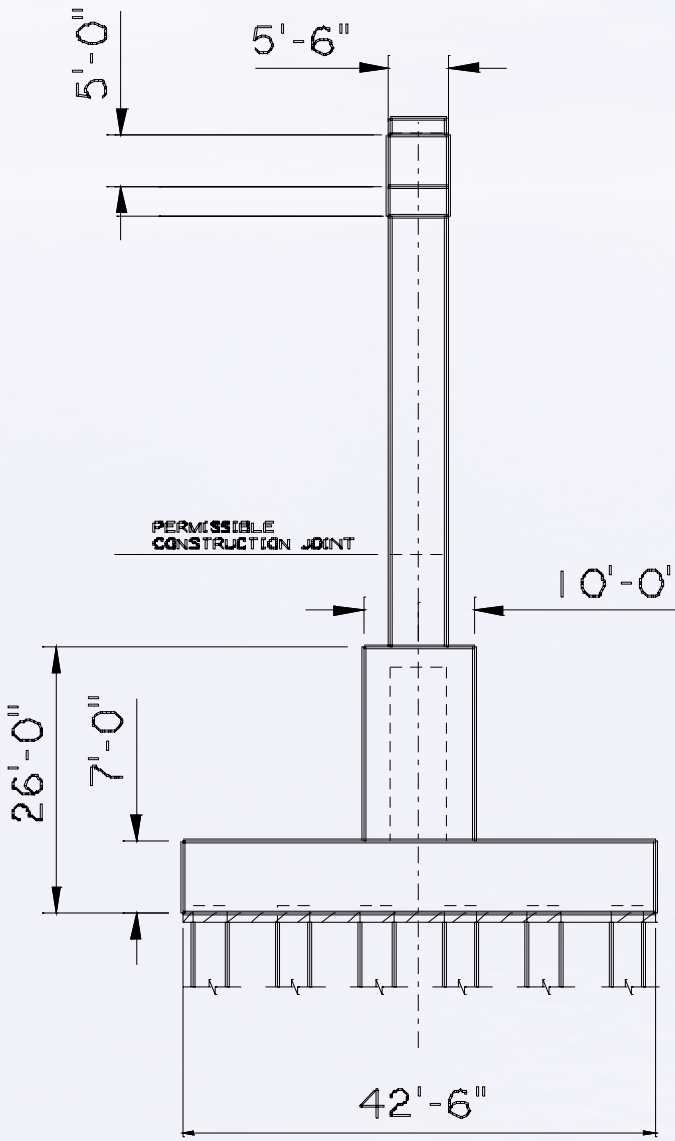
ASTM Grade 50W steel 90” Web



Typical Column Bent – BT Span

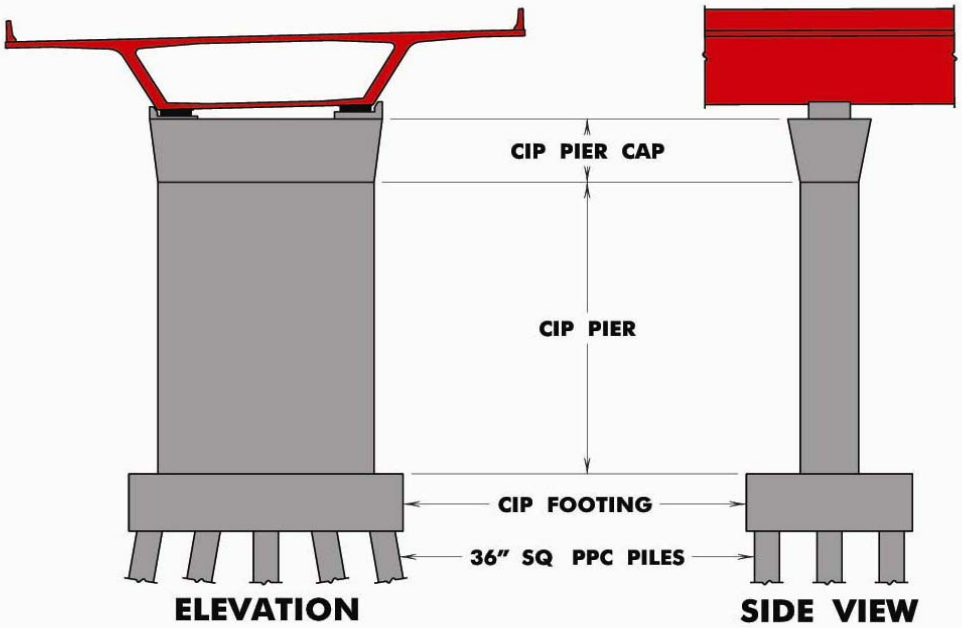


ELEVATION
(LOOKING UPSTATION)



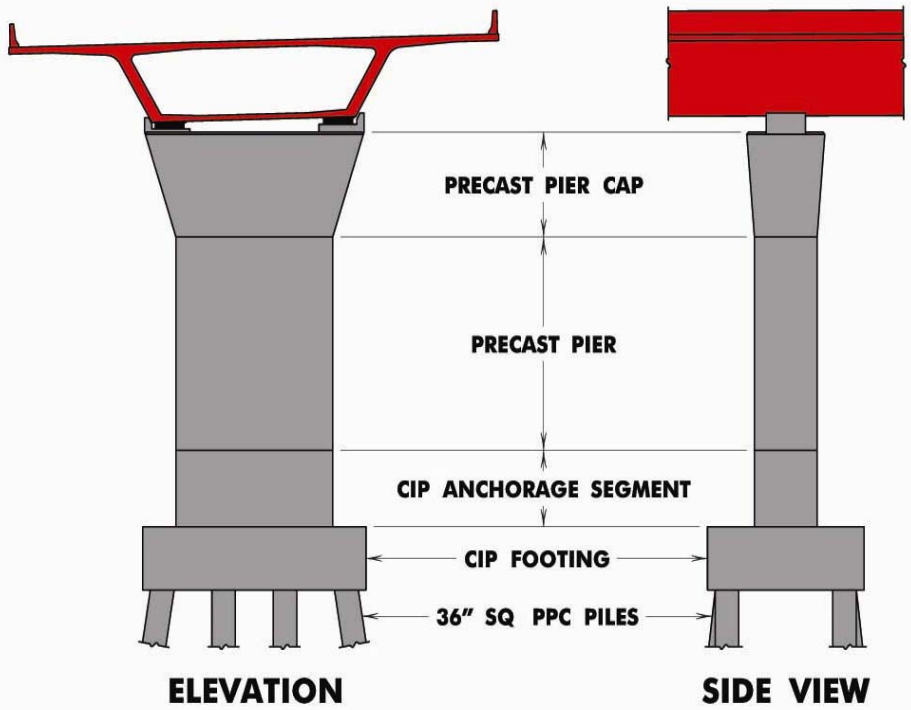
SIDE VIEW

(BENT M17, M18WB & M24)

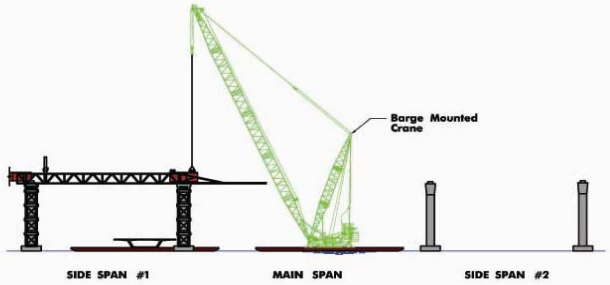


Alternate A2 – Cast-in-Place Piers

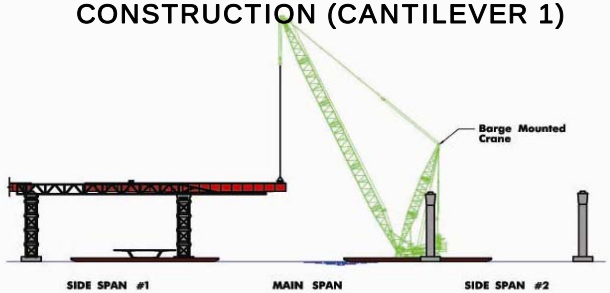
Alternate A3 – Precast Piers

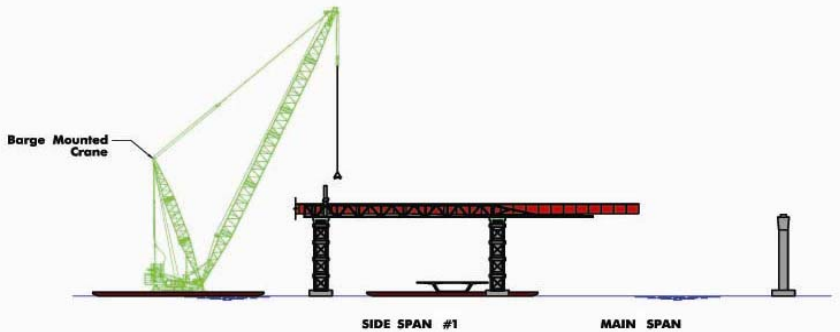


Main Span Erection Scheme

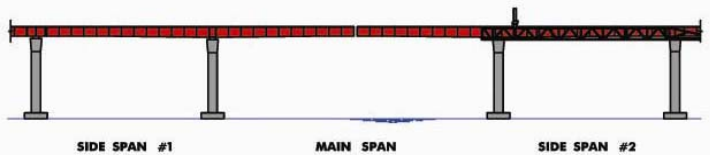


PHASE I – MODIFIED BALANCED CANTILEVER CONSTRUCTION (CANTILEVER 1)





PHASE I – MODIFIED BALANCED CANTILEVER CONSTRUCTION (CANTILEVER 1) COMPLETE SIDE SPAN #1



PHASE II – MODIFIED BALANCED CANTILEVER CONSTRUCTION (CANTILEVER 2)

PHASE III – MAIN SPAN CONTINUITY (COMPLETED MAIN SPAN UNIT)

SURGE Modeling Data Tools

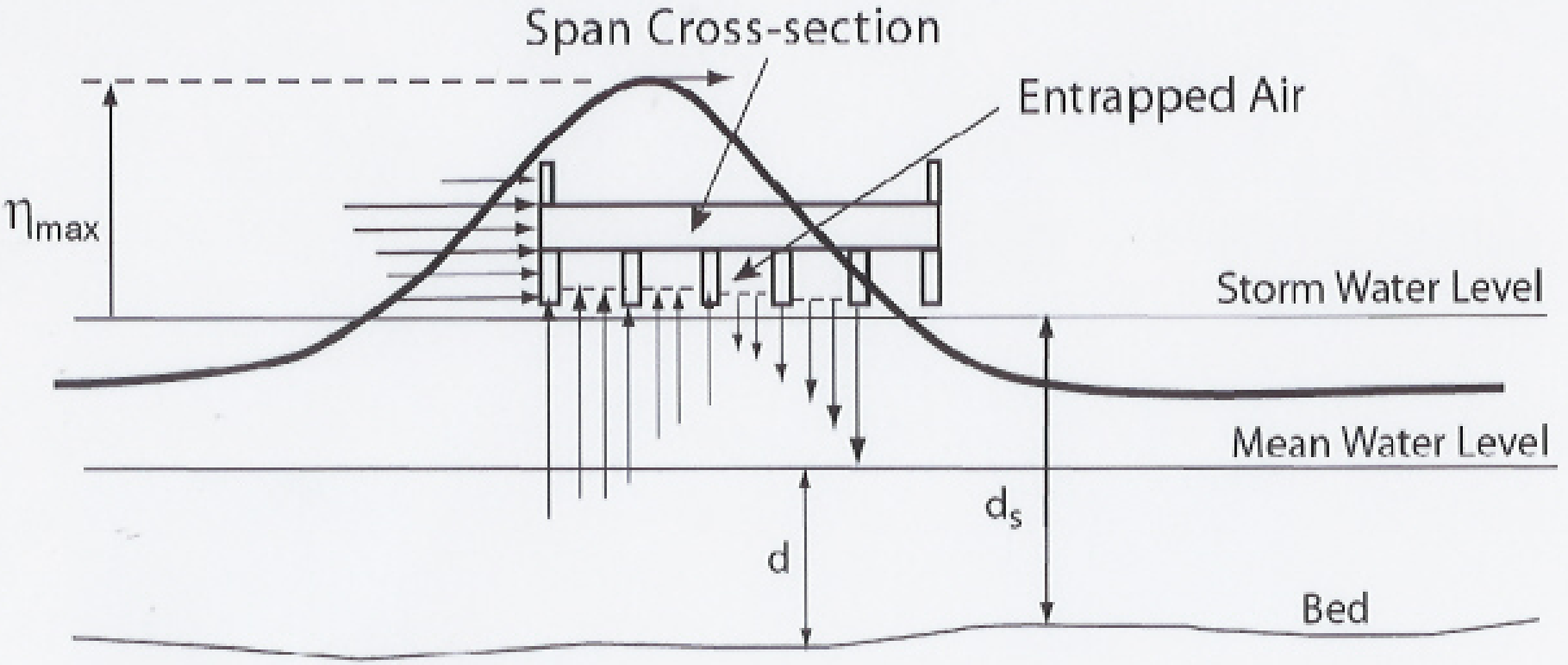
DELFT 3D SWAN (Delft Hydraulics, Netherlands) to develop the numerical model

Boussinesq Wave Model (Danish Hydraulic Institute) for potential wave set up at the bridge

Statistical analysis of wind speed and direction of 324 hurricanes and tropical storms

ADCIRC (Finite Element Hydrodynamic Model, LSU & USACE) to perform storm modeling of Hurricane Katrina and hypothetical stronger storms

Instantaneous Wave Forces on Bridge Span



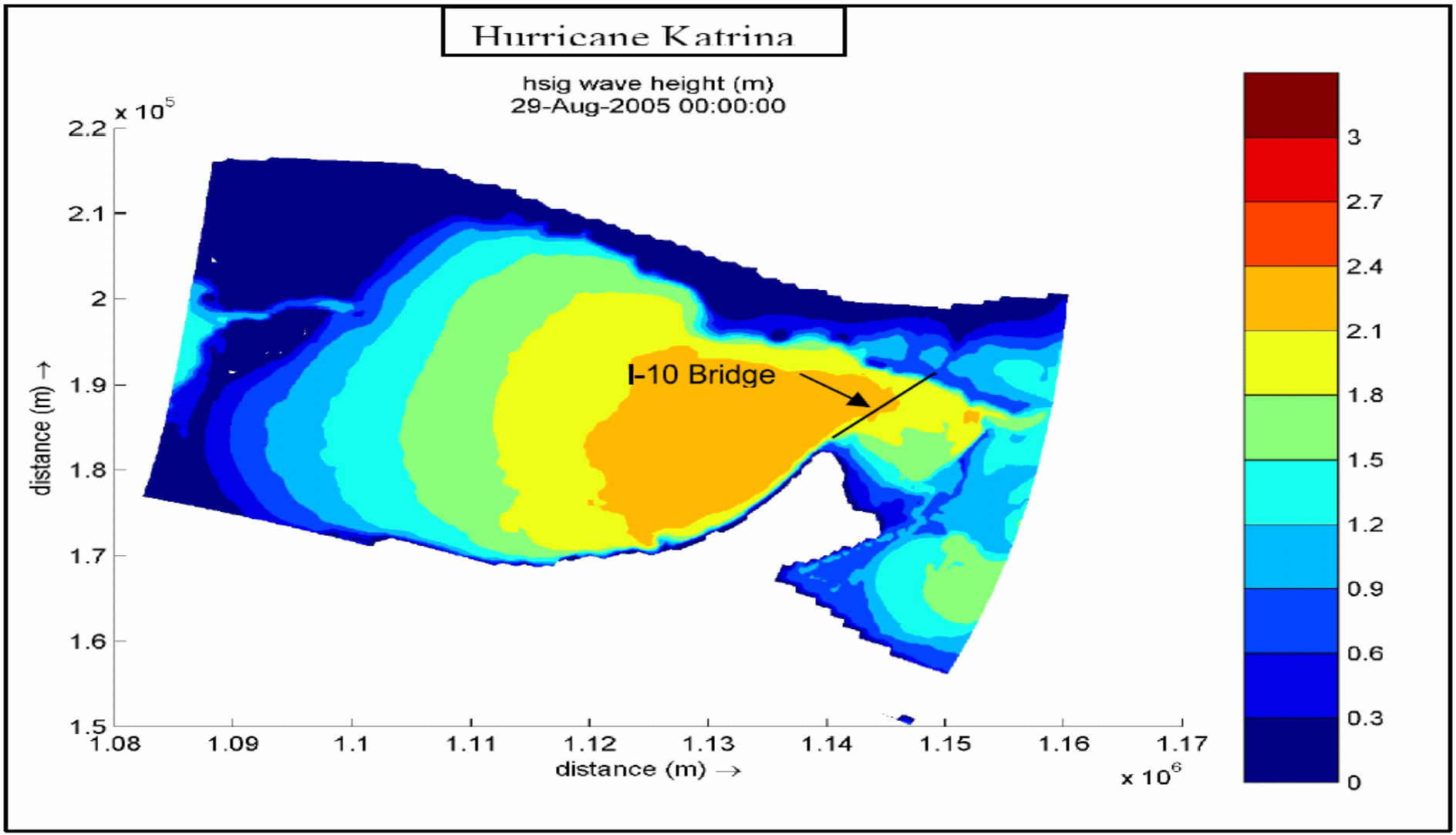
Horizontal Forces

F_{drag} = Drag Force
$F_{inertia}$ = Inertia Force
F_{cam} = Change in Added Mass Force

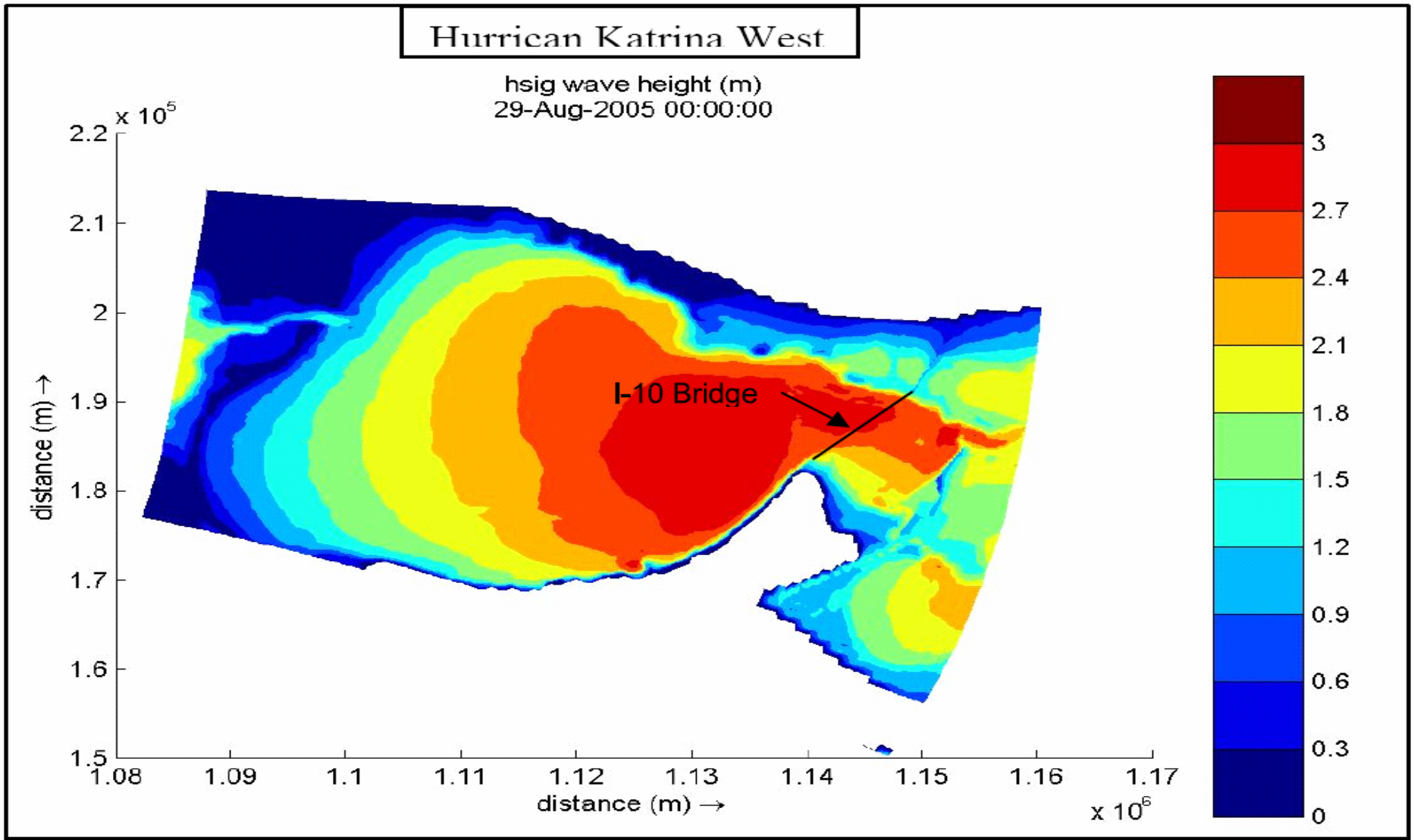
Vertical Forces

F_{drag} = Drag Force
$F_{inertia}$ = Inertia Force
F_{cam} = Change in Added Mass Force
F_b = Buoyancy Force

Hurricane Katrina
~ 100-year Event
Max. Wave Crest Elevation= 22.8’



Hurricane Katrina West
~ 500-year Event
Max. Wave Crest Elevation = 30.6'(NAVD88)



STORM PROTECTION CONCLUSIONS

- Where possible, the bridge finished grade will be elevated beyond the 500 year event (30.6 ft. for low concrete & 38.17 ft. for FG low level bridges)

- For transition spans close to the shore, spans will be designed for the 100 year event and anchored accordingly.

LRFD Load Combinations

- **The AASHTO LRFD specifications do not directly address the wave surge load condition.**

- **The long duration load caused by the surge could be applied as a Strength III case and the short impact load could be treated as an extreme event** load.

DESIGN SPECIFICATIONS
I-10 Bridge Over Lake Pontchartrain
S.P. 450-17-0025
Rev. 8 ??

Load Combinations and Load Factors
(Per AASHTO LRFD Bridge Design Specifications Table 3.4.1-1 unless noted otherwise)

Limit States	Load Factors																
	DC		DW		LL	IM	WA	S[1]	S[2]	WS	WL	FR	TU CR SH	TG	SE	CV	SC[3]
	Max	Min	Max	Min													
Strength I	1.25	0.9	1.5	0.65	1.75	1.75	1.0	-	-	-	-	1.0	0.5/1.2	-	1.0	-	-
Strength II	1.25	0.9	1.5	0.65	1.35	1.35	1.0	-	-			1.0	0.5/1.2	-	1.0	-	-
Strength III	1.25	0.9	1.5	0.65	-	-	1.0	-	-	1.4	-	1.0	0.5/1.2	-	1.0	-	-
Strength V	1.25	0.9	1.5	0.65	1.35	1.35	1.0	-	-	0.4	1.0	1.0	0.5/1.2	-	1.0	-	-
Extreme II[5]	1.25	0.9	1.5	0.65	0.25	0.25	1.0	-	-	0.3	-	1.0	-	-	-	1.0	-
Extreme III[5]	1.25	0.9	1.5	0.65	1.75	1.0	1.0	-	-	-	-	1.0	-	-	-	-	1.8[4]
Extreme IV[5]	1.25	0.9	1.5	0.65	-	-	1.0	-	-	1.4	-	1.0	-	-	-	-	0.7
Extreme V[5]	1.25	0.9	1.5	0.65	-	-	1.0	-	-	-	-	1.0	-	-	-	1.0	0.6[6]
Service I	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	0.3	1.0	1.0	1.0/1.2	0.5	1.0	-	-
VService II	1.0	1.0	1.0	1.0	1.3	1.3	1.0	-	-	-	-	1.0	1.0/1.2	-	-	-	-
Service III	1.0	1.0	1.0	1.0	0.8	0.8	1.0	-	-	-	-	1.0	1.0/1.2	0.5	1.0	-	-
Service IV	1.0	1.0	1.0	1.0	-	-	1.0	-	-	0.7	-	1.0	1.0/1.2	1.0	1.0	-	-
Fatigue	-	-	-	-	0.75	0.75	1.0	-	-	-	-	-	-	-	-	-	-
Storm Surge 1	1.25	0.9	-	-	-	-		1.4	-	1.4[7]	-	1.0	0.5/1.2	-	-	-	-
Storm Surge 2	1.25	0.9	-	-	-	-		-	1.0	0.3[7]	-	1.0	-	-	-	-	-

[1] Quasi-Static Storm Surge Forces
[2] Dynamic or Impact Storm Surge Forces
[3] Scour Depth
[4] 180% of the Scour Depth
[5] Per NCHRP Report 489 “Design of Highway Bridges for Extreme Events”.
[6] 60% of the Scour Depth
[7] Apply wind load on structure (WS) to surfaces where storm surge forces (S) are absent.

VESSEL IMPACT RESISTANCE

- Model all Span Units and Substructure Using the Florida Multi-Pier Program.
- Design Loads Obtained by Vessel Collision Report and Surge Model.

Vessel Impact Loads

Bent	Distance to Center of Channel (ft)	Design Vessel	Impact Force Parallel to Bent (kips)		Impact Force Perpendicular to Bent (kips)	
			Loaded	Unloaded	Loaded	Unloaded
175 and 176	125	Oversize Tanker	2642	2182	1321	1091
174 and 177	325	Oversize Tanker	2505	2145	1252	1073
173 and 178	460	Oversize Tanker	2419	2124	1209	1062
172 and 179	595	Oversize Tanker	2338	2104	1169	1052
171 and 180	730	Oversize Tanker	2264	1837	1132	918
170 and 181	865	Oversize Tanker	2198	1438 (Note 1)	1099	719
169 and 182	1000	Oversize Tanker	2142	1438 (Note 1)	1071	719
168 and 183	1135	Oversize Tanker	2097	1438 (Note 1)	1049	719
Other Bents	>1140 (3 x LOA)	Empty Barge	96	96	48	48

Vessel Impact Speed, V:

1) Use 2 feet per second for the locations beyond 3xLOA from the center of the channel.
2) Use 7.3 feet per second in the navigation channel.
3) The speed beyond the navigation channel shall be linearly reduced from 7.3 fps to 2 fps as a function of the distance from the center of the channel.

Notes:

1) For bents located within 3xLOA, the minimum impact force shall be 1438 kips which is the empty standard hopper barge impact force at vessel impact speed of 12 feet per second per storm surge analysis report (Appendix A).
2) The vessel impact forces shall be applied to the locations specified in AASHTO LRFD Bridge Design Specification Section 3.14.14.

Provide Minimum 100 Years of Service

- Combination of High Performance Concrete (1000 coulombs) and additional concrete cover are used to improve the durability of the bridge.
- Previously used HPC mix designs, including the Cooper River and Confederation bridges, are studied.
- Life-365 software used as a tool for service life.


BENT 16E
03/01/99


DRIVING
4856

Low-Level Approach Superstructure Design Life: (Uncoated Reinforcement)

Project Mix	Cementitious Content (LB/CY)	Water/ Cement Ratio	Silica Fume Percentage of Total C.M.	Class F Fly Ash Percentage of Total C.M.	B.F. Slag Percentage of Total C.M.	Reinf. Type	Min. Comp. Strength at 28/56 days (psi)	Required Chloride Permeability at 56 days (ASTM C1202) (coulombs)	Required Diffusion Coefficient at 28 days (x 10-12 m/s2) (ASTM C1556)	**Design Life (See Note) (years)**	Minimum Cover (inches)
LaDOTD Girders	987	0.25	0.0%	30%	0%	Uncoated	10000	2000	n/a	**51.7**	1.5
Virginia Girders	827	0.28	9.0%	0%	0%	Uncoated	10000	n/a	n/a	**51.3**	1.5
Wash. Girders	1000	0.27	5.0%	22%	0%	Uncoated	10000	n/a	n/a	**73.4**	1.5
Nebraska Deck	825	0.31	0.0%	9%	0%	Uncoated	8000	1800	n/a	**21.2**	1.5
New Hamp. Deck	660	0.38	8.0%	0%	0%	Uncoated	6000	1000	n/a	**29.5**	1.5
Texas Deck	530	0.43	0.0%	28%	0%	Uncoated	4000	n/a	n/a	**22.0**	1.5
Confeder. Mix	801	0.30	7.5%	9.5%	0%	Uncoated	8700 @ 91 d	1000	.48 @ 6 mo.	**54.4**	1.5
Cooper River Sub.	700	0.38	0.0%	43%	0%	Uncoated	5000	500	n/a	**44.2**	1.5
Cooper River Sup.	650	0.40	0.0%	20%	0%	Uncoated	4000	n/a	n/a	**20.4**	1.5
BR 1	705	0.39	7.0%	15%	0%	Uncoated	7477	1563	n/a	**40.4**	1.5
BR 2	600	0.39	4.0%	0%	25%	Uncoated	6797	1257	n/a	**30.1**	1.5
BR 3	600	0.39	0.0%	0%	50%	Uncoated	8974	1126	n/a	**31.9**	1.5
BR 4	610	0.36	3.0%	3%	25%	Uncoated	7176	1244	n/a	**33.1**	1.5
Victory Mix	800	0.33	0.0%	0%	50%	Uncoated	8000	1000	n/a	**42.9**	1.5
Four Bears Mix	750	0.39	0.0%	15%	0%	Uncoated	6000	n/a	n/a	**19.1**	1.5
Our Spec (FA1)	750	0.35	As req'd.	15%	0%	Uncoated	6000	1500	0.85	**106.6**	1.5
Our Spec (FA2)	750	0.35	As req'd.	20%	0%	Uncoated	6000	1500	1.1	**103.3**	1.5
Our Spec (FA3)	750	0.35	As req'd.	25%	0%	Uncoated	6000	1500	1.4	**101.9**	1.5
Our Spec (FA4)	750	0.35	As req'd.	30%	0%	Uncoated	6000	1500	1.65	**102.4**	1.5
Our Spec (Slag1)	750	0.35	As req'd.	0%	25%	Uncoated	6000	1500	0.85	**106.6**	1.5
Our Spec (Slag2)	750	0.35	As req'd.	0%	30%	Uncoated	6000	1500	1.1	**103.3**	1.5
Our Spec (Slag3)	750	0.35	As req'd.	0%	35%	Uncoated	6000	1500	1.4	**101.9**	1.5
Our Spec (Slag4)	750	0.35	As req'd.	0%	40%	Uncoated	6000	1500	1.65	**102.4**	1.5

CONTRACT #1 – LOW LEVEL SPANS AND ROADWAY

- Letting Date: April 2006 (6 month design schedule)
- 44,547'of bridge – low level trestle
- Boh Brothers, NTP on June, 2006, $355 M
- BT alternate chosen
- Change Order issued for Transition spans near each end.

CONTRACT #2 - NAVIGATION MAIN SPAN

- Letting Date: November 2006
- 11,560' of main navigational span bridge
- Traylor/Kiewit/Massman JV, NTP on Jan. 2007, $167M
- BT and Steel Girder Alternate Chosen

Contract Number 1

- All the advanced foundation testing have been completed and pile lengths have been defined for both new bridges.
- Most dredging operations and construction staging areas have been constructed.
- All road way detours have been built including provisions for a third lane during hurricane evacuation.
- Low permeability concrete mixes have been agreed upon.
- Shop drawings have been reviewed for piles, caps, formwork, girders, joints, bearing pads, electrical and ITS equipment.

Contract Number 2

- Pile order lengths have been determined.
- Construction yard is being established.
- Shop drawings for steel girders are under review.

NORTH SHORE CONSTRUCTION

Completion of first WB bridge is planned for March 2009.

Completion of entire project is planned for March 2011.

PROJECT TEAM – EMERGENCY REPAIRS

- **BID PACKAGE & SPECIFICATIONS – LA DOTD**
- **BRIDGE INSPECTION – LA DOTD , VOLKERT & ASSOCIATES**
- **CONTRACTOR – BOH BROTHERS**
- **SPMT - MAMMOET**
- **TEMPORARY BRIDGING – ACROW**
- **CONSTRUCTION QA FOR DOTD – VOLKERT AND ASSOCIATES**

PROJECT TEAM – BRIDGE REPLACEMENT

- **DESIGN** – LA DOTD
- **DESIGN ALTERNATE** - FIGG ENGINEERING, BURK KLEINPETER, TRC
- **SURGE ANALYSIS** – MOFFATT AND NICHOL, LSU
- **GEOTECHNICAL** – FUGRO
- **GEOTECHNICAL TEST PILE PROGRAM** – FUGRO & AFT
- **CONTRACTOR CONTRACT 1** – BOH BROTHERS
- **CONTRACTOR CONTRACT 2** – TRAYLOR KIEWIT MASSMAN JV
- **CONSTRUCTION QA FOR DOTD** – VOLKERT AND ASSOCIATES

QUESTIONS?

RENDERING OF HIGH LEVEL SPAN