Replacement of Fender System at I-10 Mississippi River Bridge

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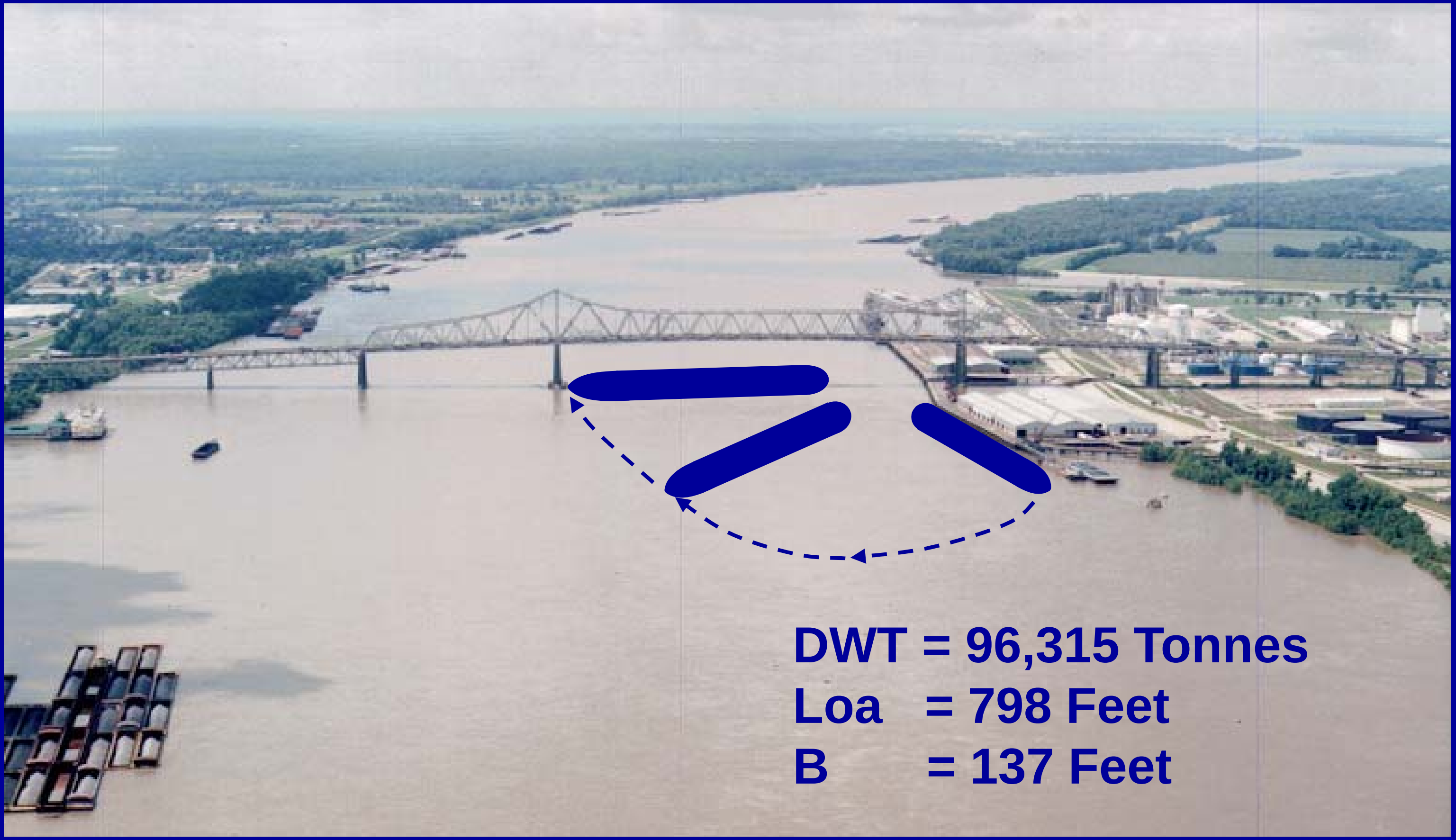
2008 LTRC Seminar Series: Bridge Structures

February 10, 2007 – M/T Kition Allision

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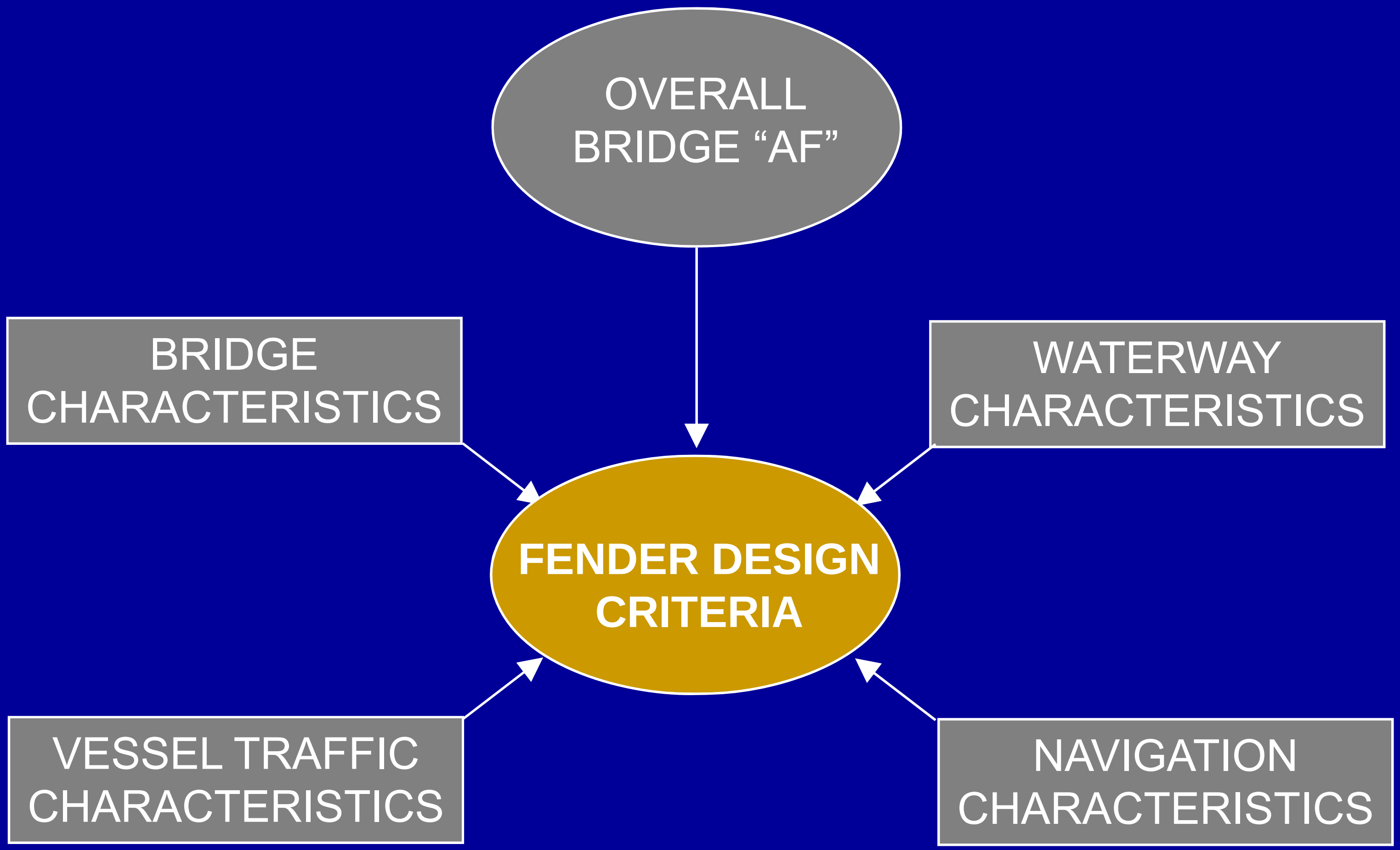
Scope of Work

- Study Alternatives for Fender Repair or Replacement
- Develop Fender Selection and Design Criteria
- Prepare Plans and Specifications for the Selected Fender Alternative

Factors Involved



Overall Risk to the Bridge (“AF”)

Method I (AASHTO Guide)

1. Collect vessel and waterway data
2. Select design vessel and compute collision loads

Method II (AASHTO Guide, AASHTO LRFD)

1. Collect vessel, navigation, waterway and bridge data
2. Perform probability based analysis and select pier capacities

AASHTO Method I

<u>Design Vessel for Critical Bridges</u>

- > 50 passages per year, or
- > 5% of the total number of passages

<u>Design Vessel for Regular Bridges</u>

- > 200 passages per year, or
- > 10% of the total number of passages

AASHTO Method II

$$AF = (N)\ (PA)\ (PG)\ (PC)$$

- AF = Annual Frequency of Collapse
- N = Annual Number of Vessels
- PA = Probability of Vessel Aberrancy
- PG = Geometric Probability
- PC = Probability of Collapse

AF acceptable: < 0.0001 for Critical Bridges
< 0.001 for Regular Bridges

Annual Number of Vessels, N

Number of vessels N, grouped by

- Type
- Size and shape
- Loading condition
- Direction of traffic

Adjusted for the water depth at each pier

Probability of Vessel Aberrancy, PA

$PA = (BR)\,(R_B)\,(R_C)\,(R_{XC})\,(R_D)$

BR = Aberrancy base rate

R_B = Correction factor for bridge location

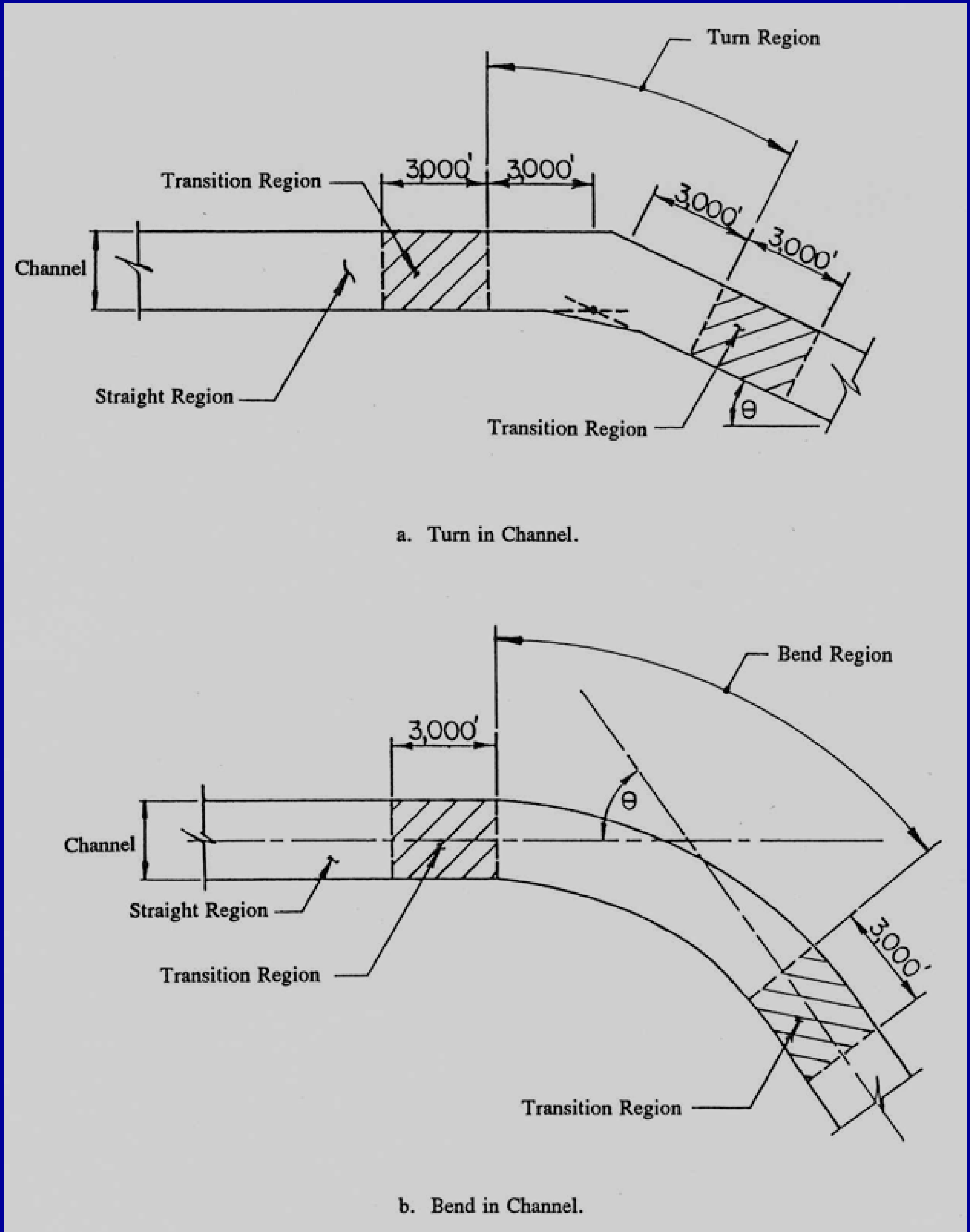
R_C = Correction factor for parallel current

R_{XC} = Correction factor for cross-currents

R_D = Correction factor for vessel density

Correction factor for bridge location, R_B

Waterway Regions for Bridge Location

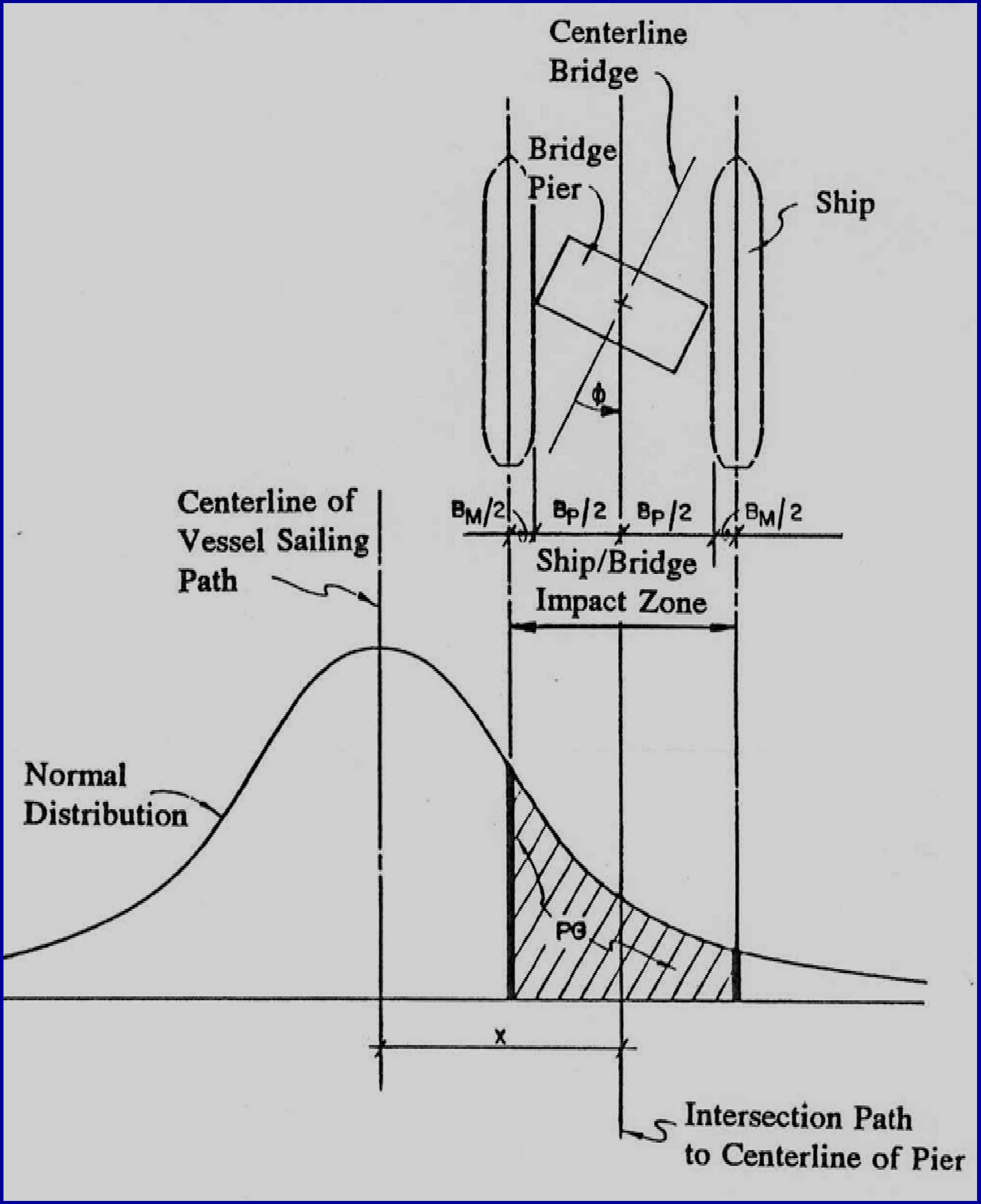


Geometric Probability, PG

- Models the location of an aberrant vessel relative to the channel
- Quantifies the conditional probability that a vessel will hit a pier given that it is aberrant
- Accounts for the lower likelihood of an aberrant vessel being located further away from the channel
- Accounts for Pier Protection

Geometric Probability Model

Normal Distribution with σ = LOA



Geometric Probability of Pier Collision

Probability of Collapse, PC

Reduces AF by a factor that varies from 0 to 1

PC = 0.1+9(0.1-H/P)	if 0.0<= H/P <0.1
PC = (1.0-H/P)/9	if 0.1<= H/P <1.0
PC = 0.0	if H/P >=1.0

where:

H = resistance of bridge component (kips)

P = vessel impact force (kips)

Ship Collision Force on Pier, P_S

$$P_S = 8.15\,(DWT)^{1/2}\,V$$

P_S = Equivalent static impact force (Kips)

DWT = Deadweight tonnage (Tonnes)

V = Vessel collision velocity (Ft/sec)

Ship Impact Force, P_S

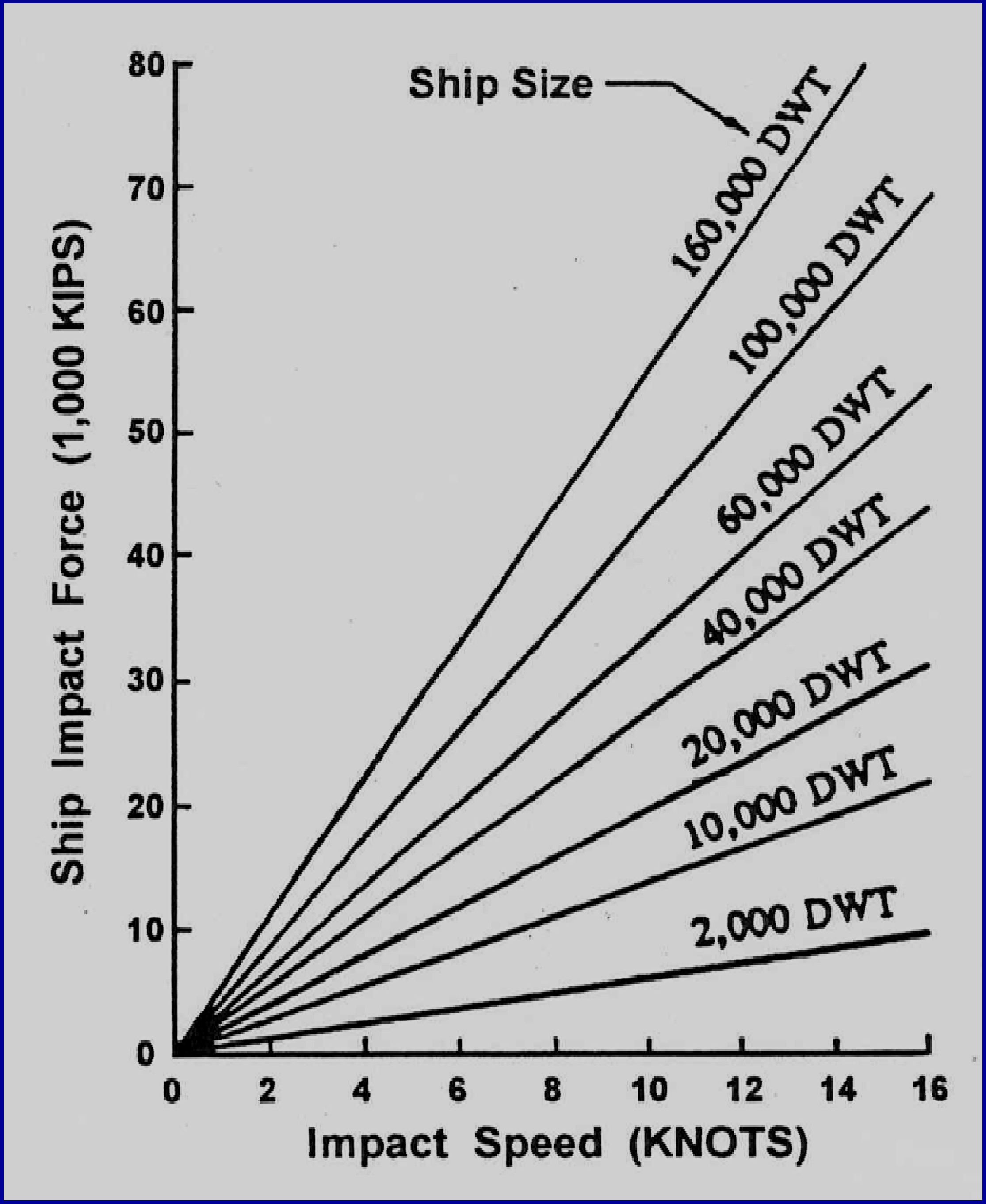
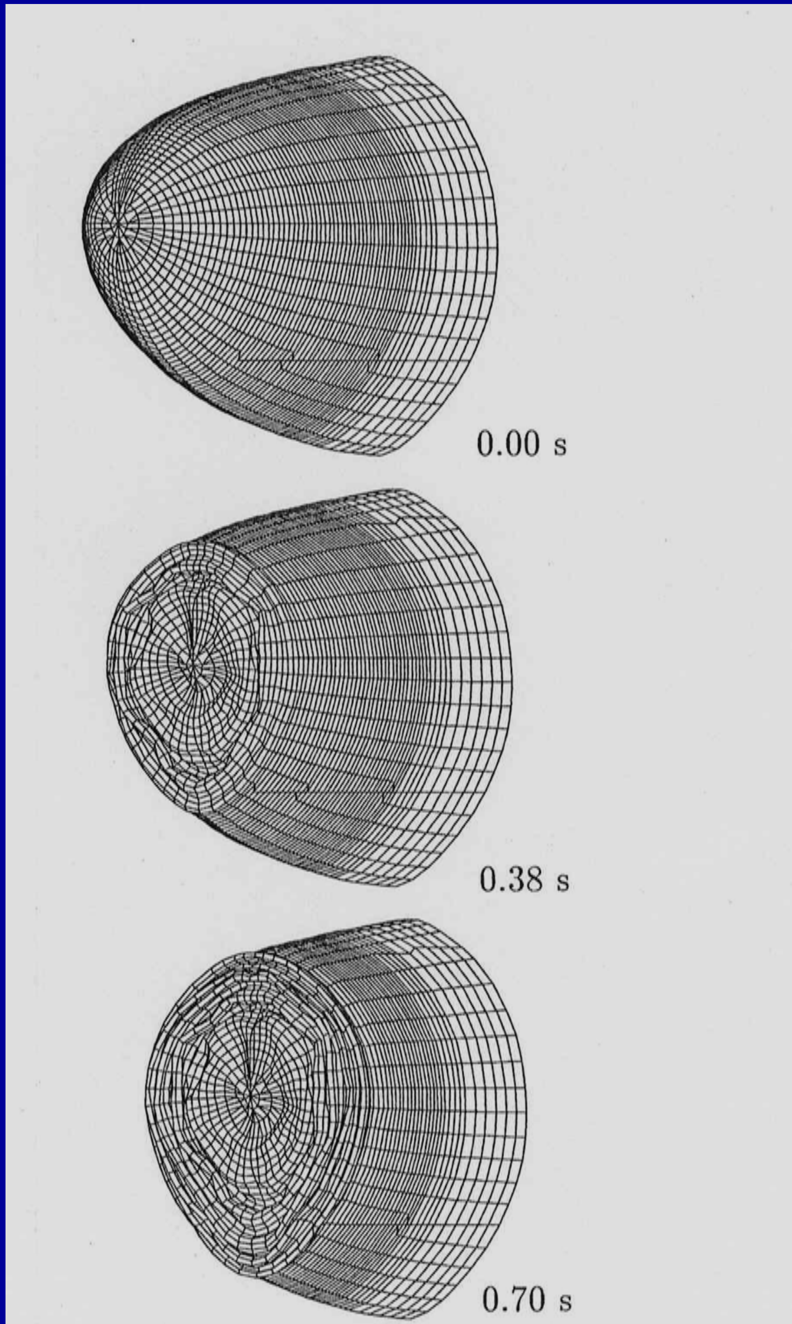
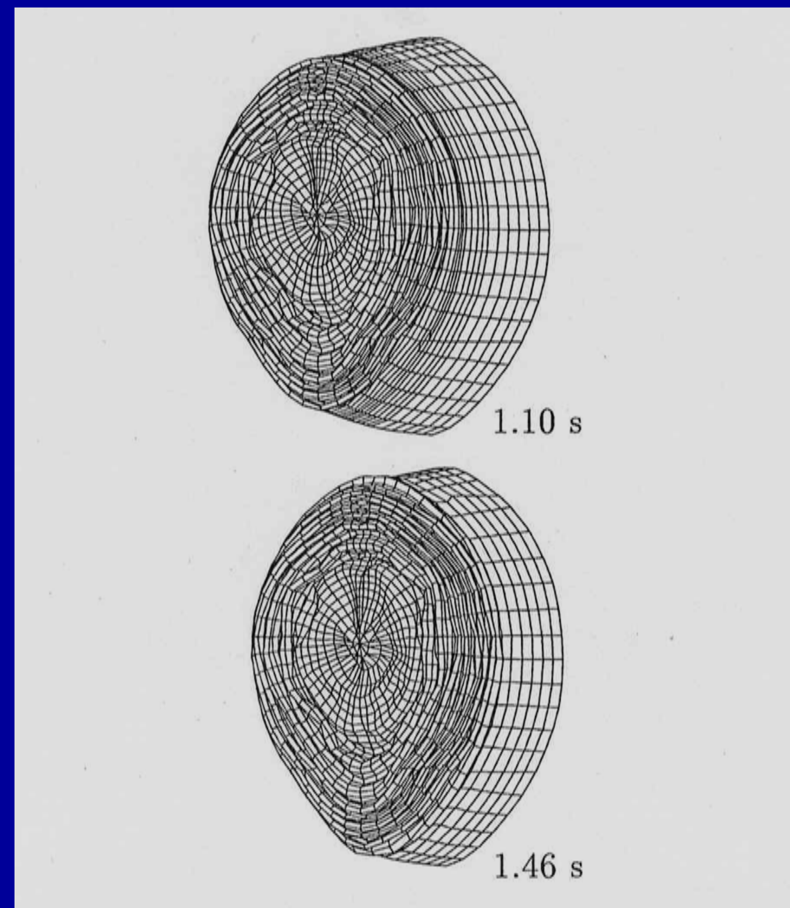


Figure Shows Typical Ship Impact Forces


BRIGHT FIEL


0.00 s
0.38 s
0.70 s


1.10 s
1.46 s

Barge Collision Force on Pier, P_B

$$P_B = 4{,}112(a_B)(R_B) \qquad \text{for } a_B < 0.34$$

$$P_B = (1{,}349+110a_B)(R_B) \qquad \text{for } a_B >= 0.34$$

$$a_B = [(1+KE/5{,}672)^{1/2} - 1](10.2/R_B)$$

P_B = Equivalent static impact force (Kips)

a_B = Barge bow indentation (ft)

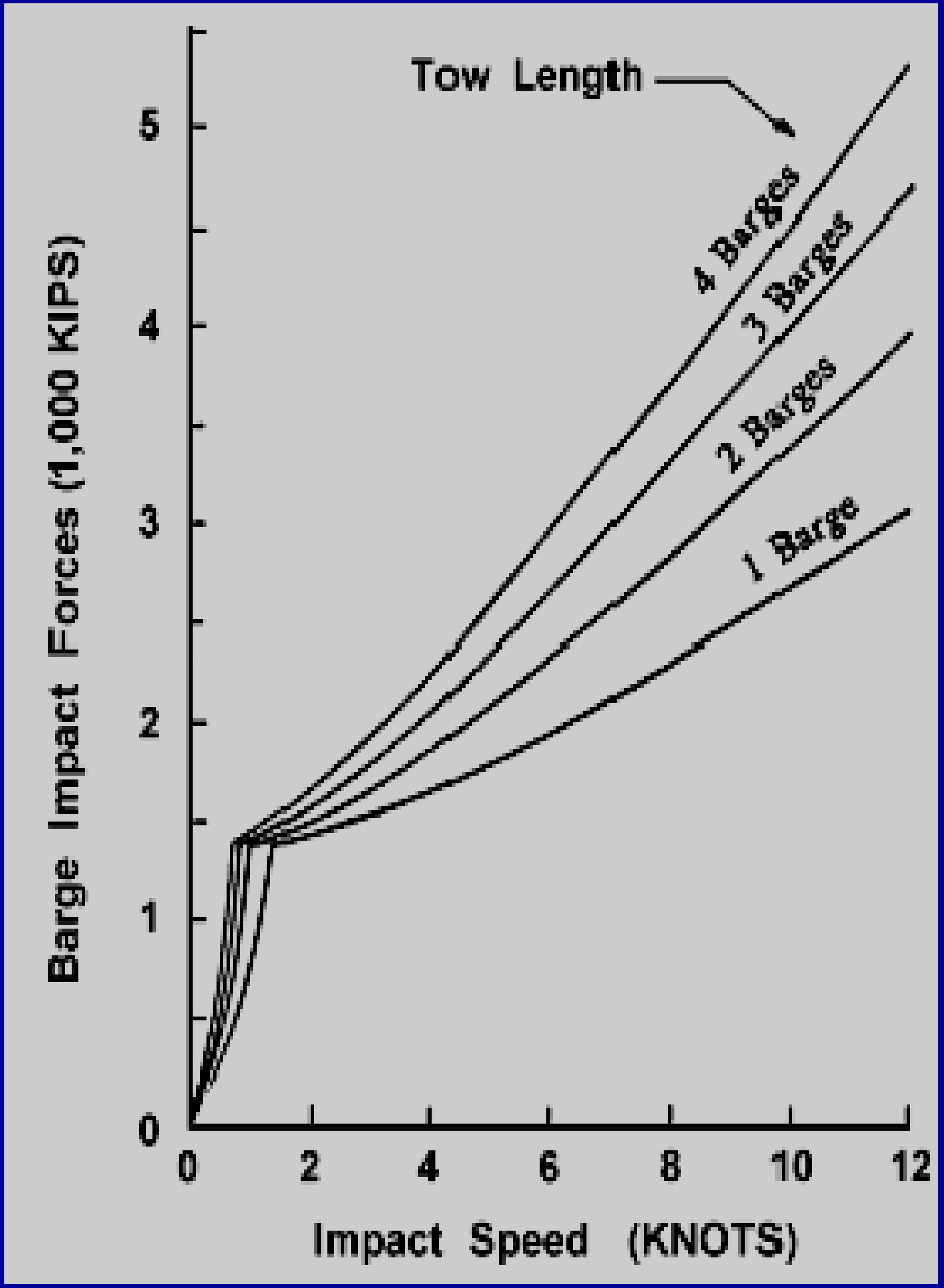
R_B = Ratio of barge width (ft) to 35 ft

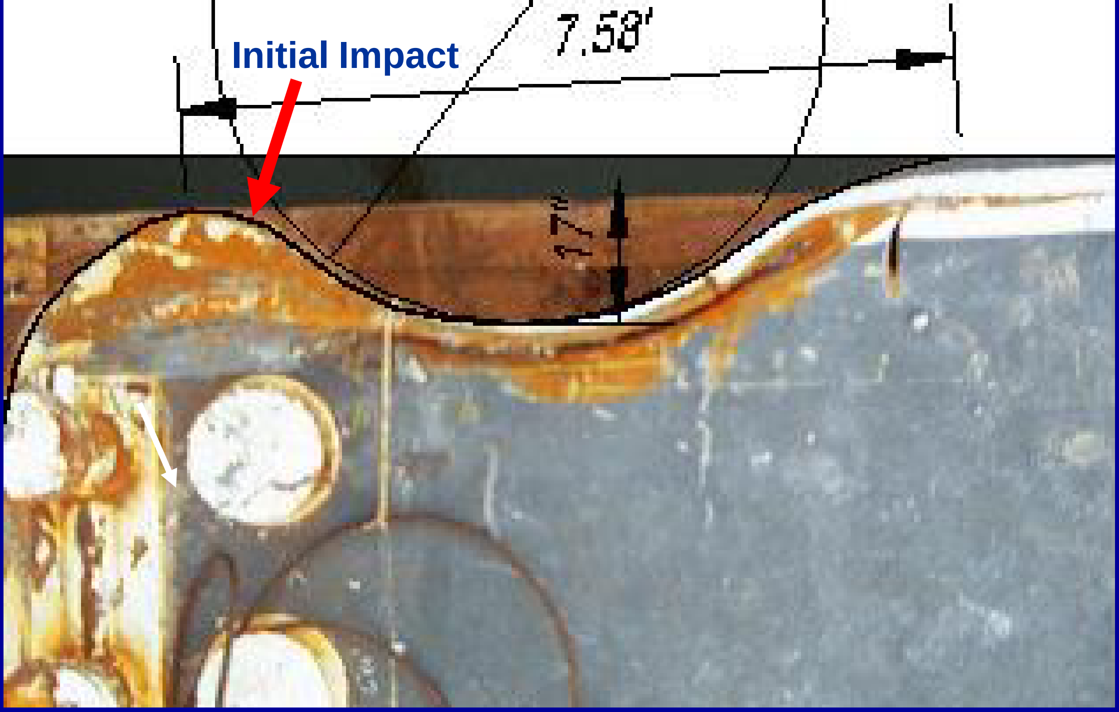
KE = Barge collision energy (K-ft)

Barge Tow Impact Force, P_B

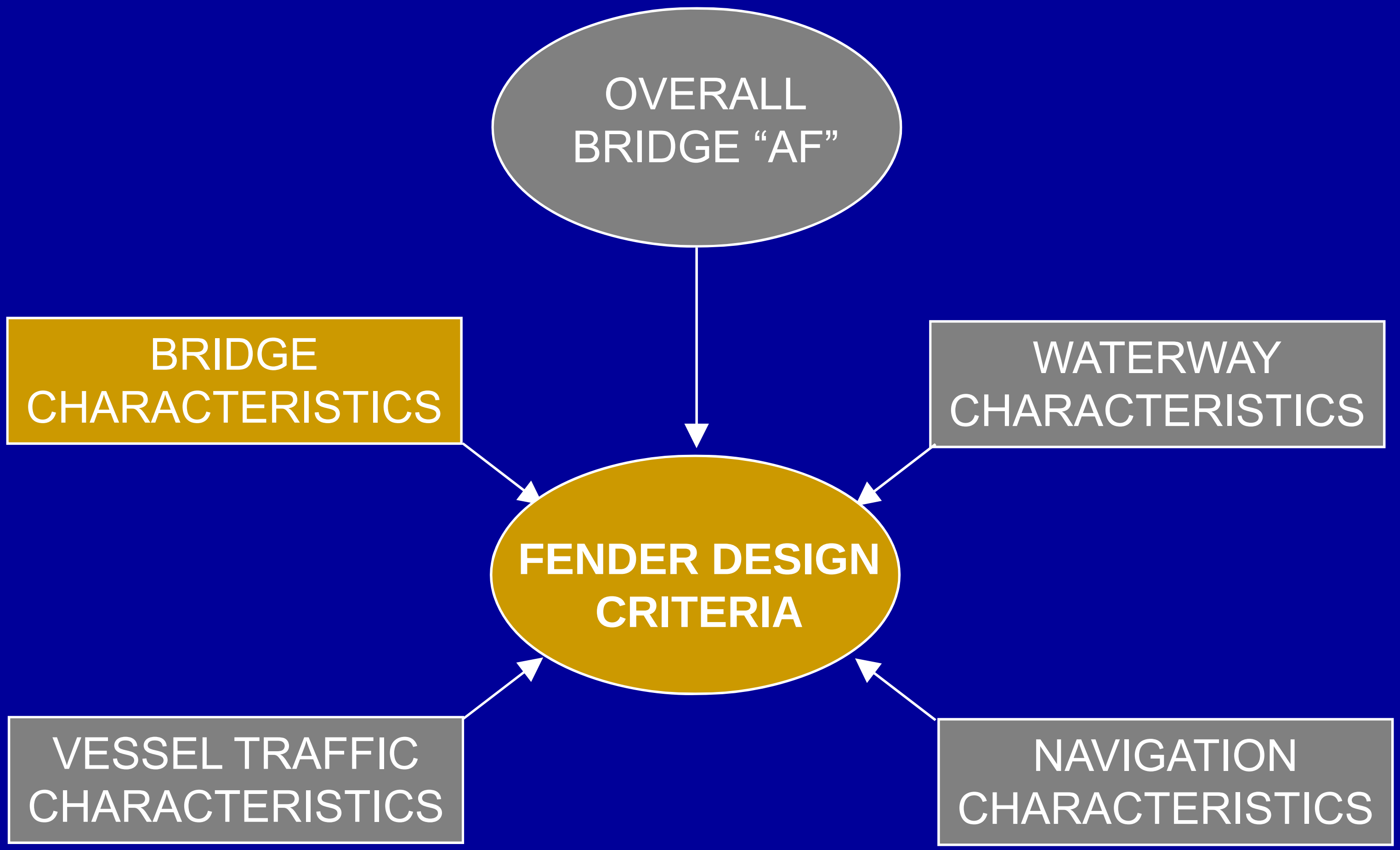
Crushing Load Level:
35 Ft Wide Barge 1,350 k

Figure Shows Typical Hopper Barge (35 ft wide) Impact Forces

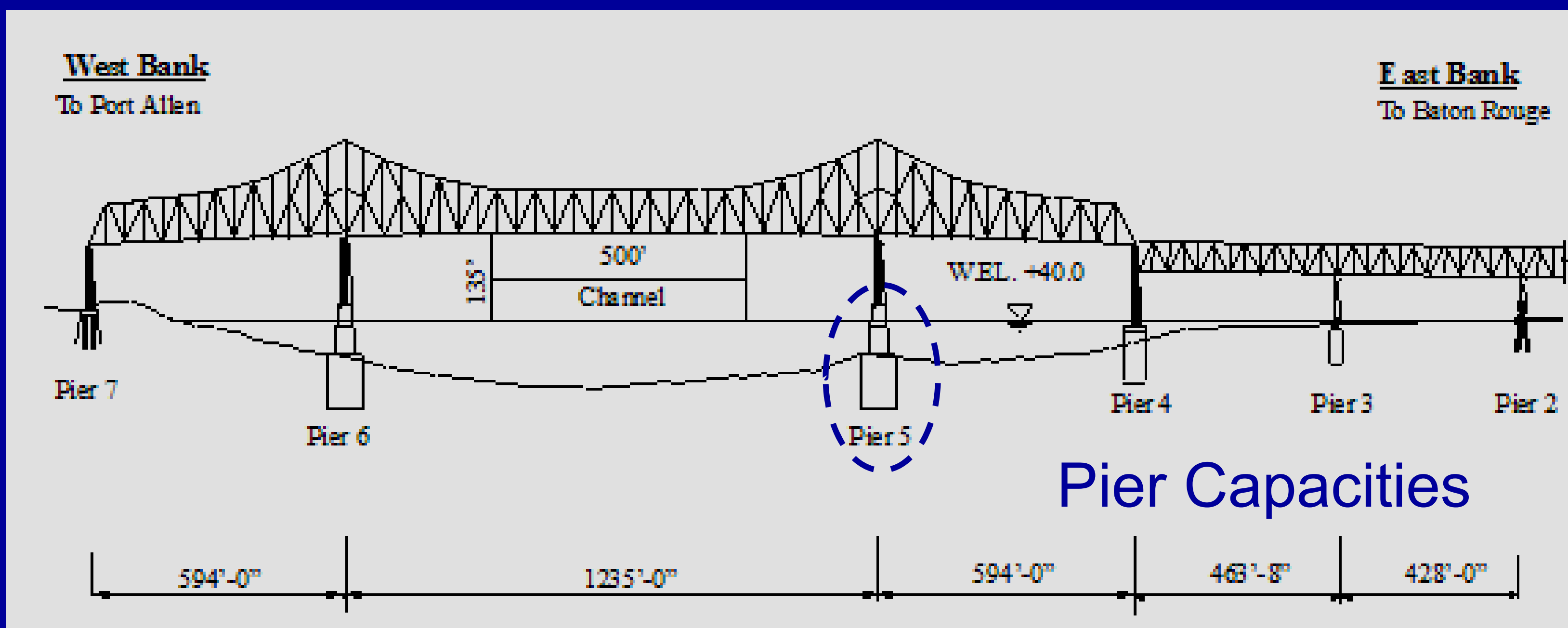


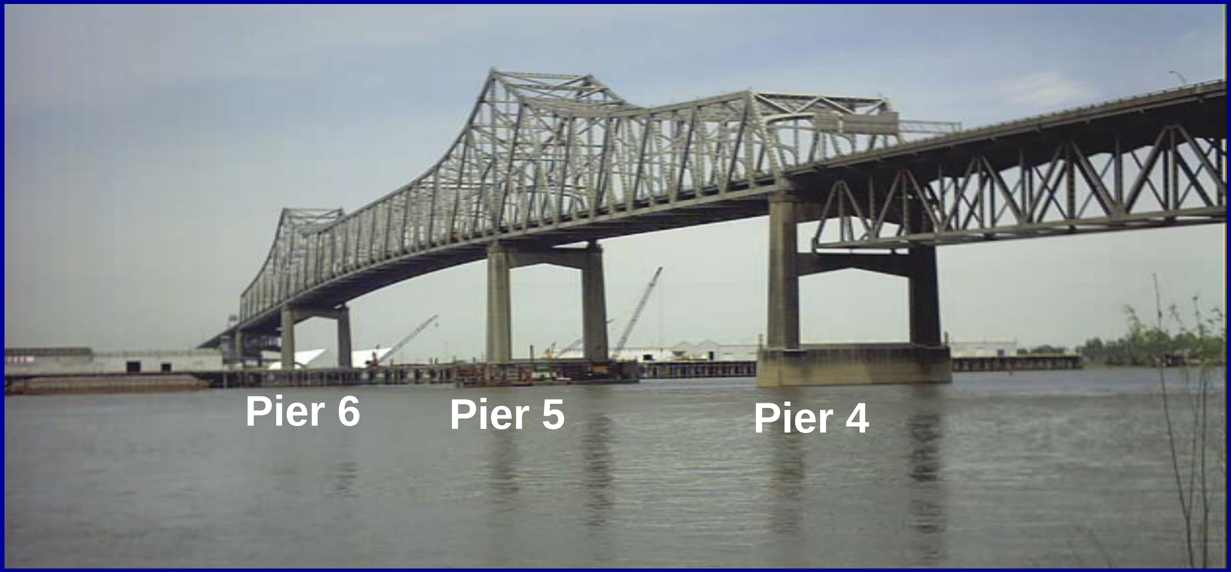

Initial Impact
7.58'

Factors Involved

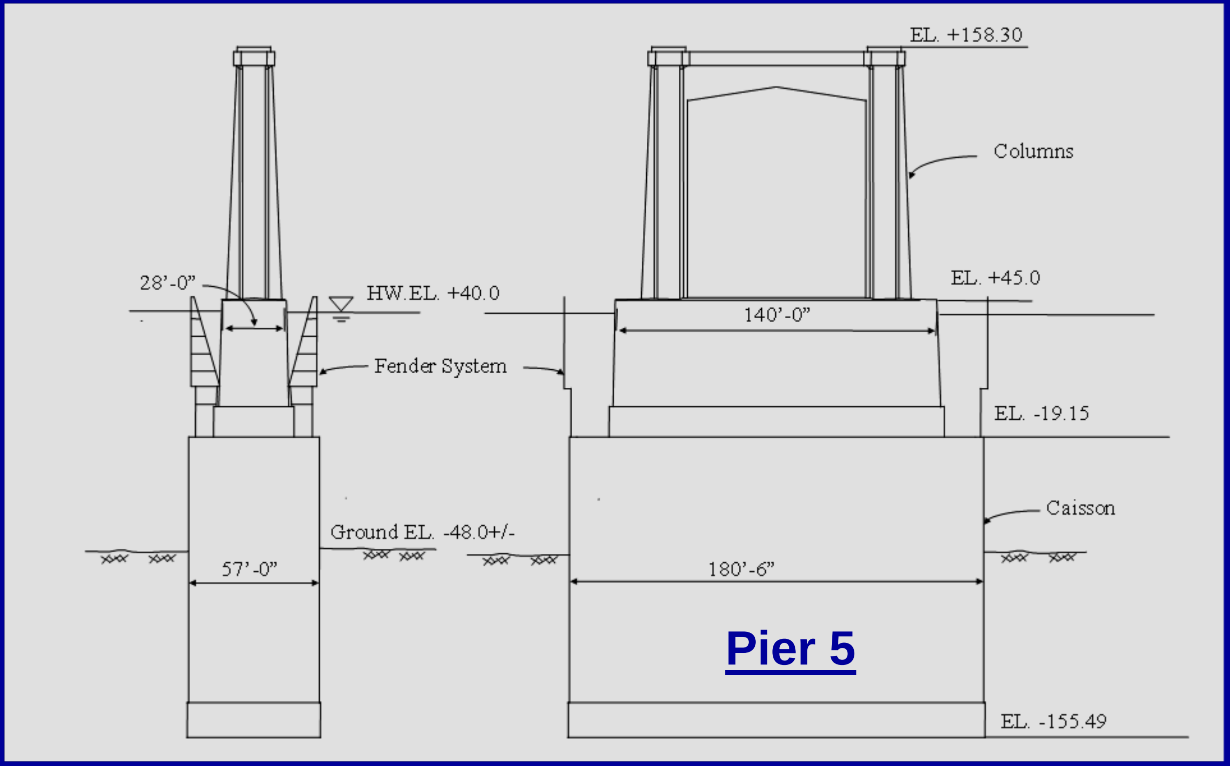


Bridge and Existing Fender Characteristics





Pier 6
Pier 5
Pier 4



EL. +158.30
Columns
28'-0"
HW.EL. +40.0
EL. +45.0
140'-0"
Fender System
EL. -19.15
Caisson
Ground EL. -48.0+/-
57'-0"
180'-6"
Pier 5
EL. -155.49

Pier Geometry Findings:

- The pier columns could be exposed to ship deck contact and the criteria for the new fender should address prevention of access to the columns.
- The top of the distribution block forms an underwater shelf which could damage ship hulls and the criteria for the new fender should address prevention of protruding underwater ledges.

Pier Capacity Findings:

- The capacity of the pier to vessel collision is governed by the local capacity of the pier columns.
- The capacity of the pier shaft to resist collision loads in the longitudinal direction is relatively high and therefore a stronger and more rigid fender structure can be used to minimize repair and maintenance costs and to reduce the likelihood of vessel contact with the pier columns.
- The capacity of the pier to resist collision loads in the transverse direction is limited by the sectional capacity of the pier shaft at its base elevation. A weaker fender could reduce collision load levels but its deformation would have to be minimized to prevent contact with the pier columns.

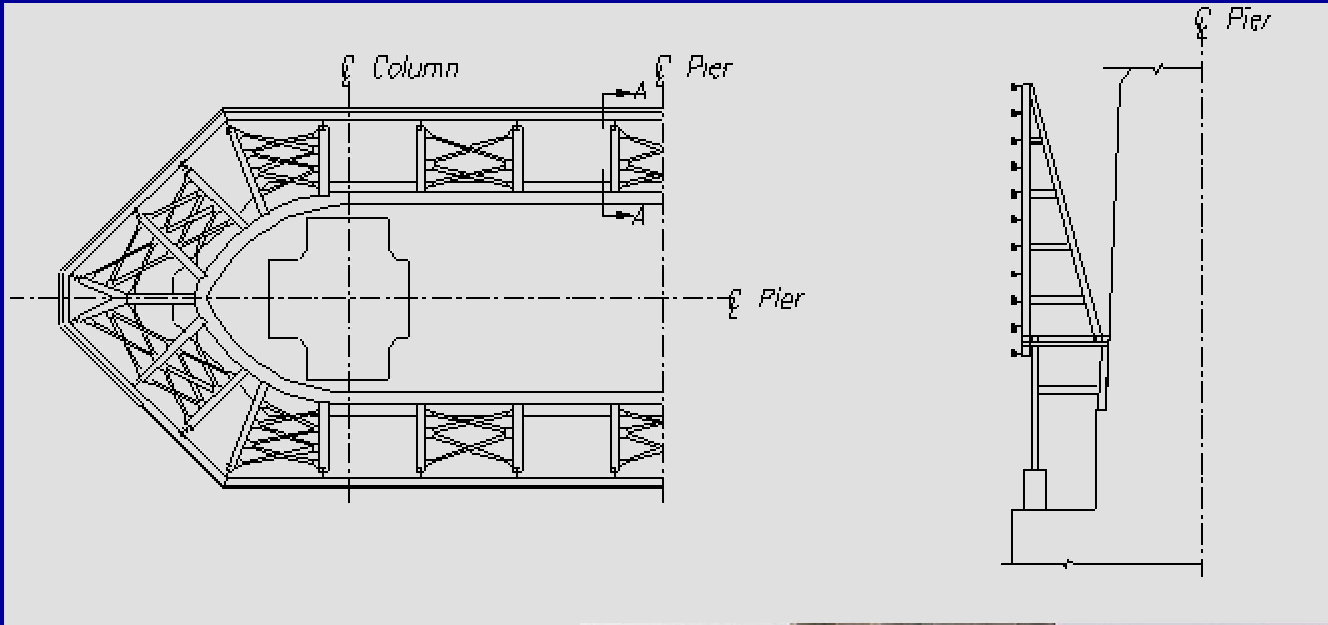
Pier Lateral Capacities (kips)

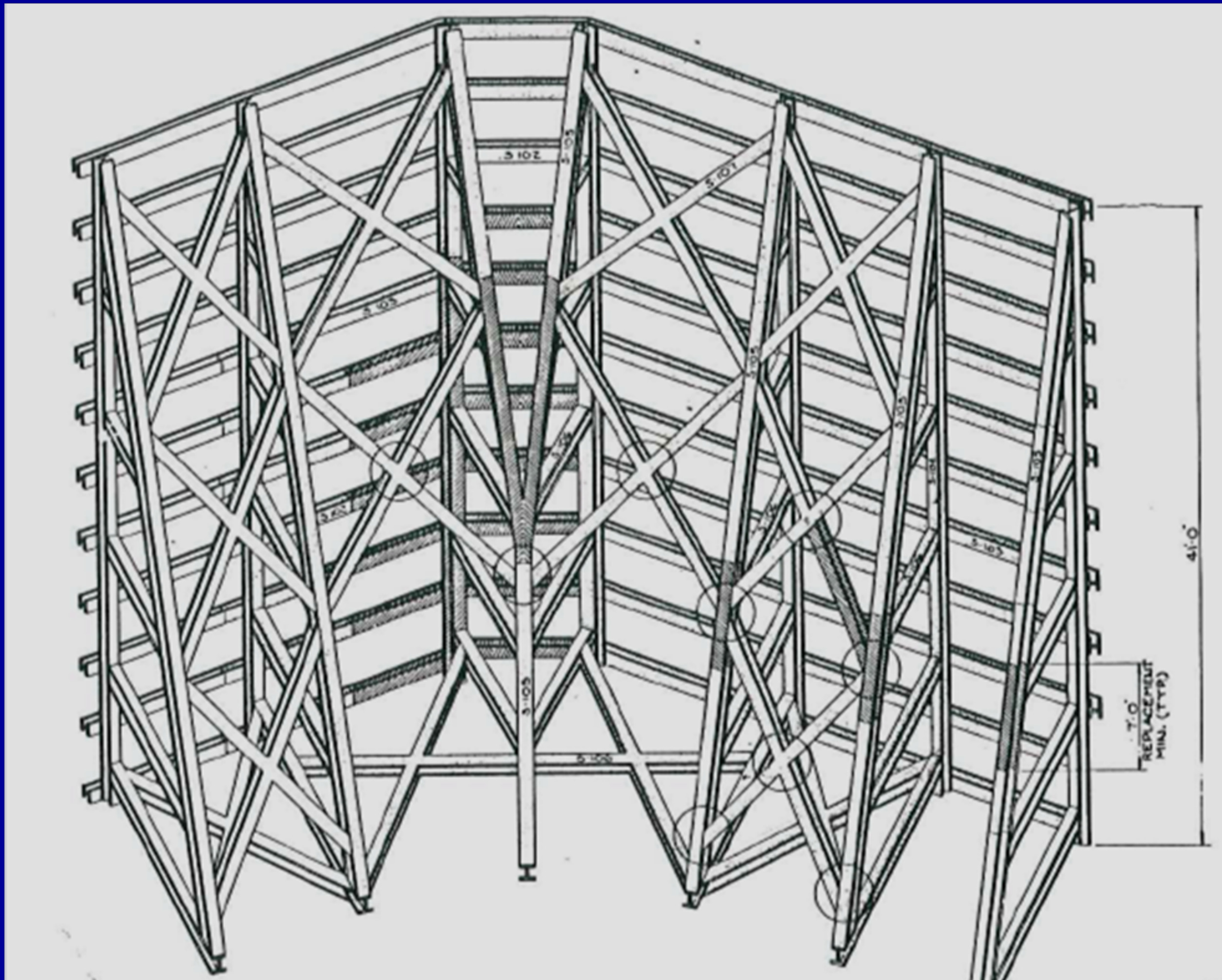
	Loading Direction	
	Longitudinal	Transverse
Foundation		
Caisson		
Sliding	148039	351957
Overturning	78240	76592
Sectional Capacities		
Section EL -19.15		
Moment	80060	19544
Interface Shear	75921	75921
Shear	64062	42708
Controlling Capacity	64062	19544

Localized Capacities

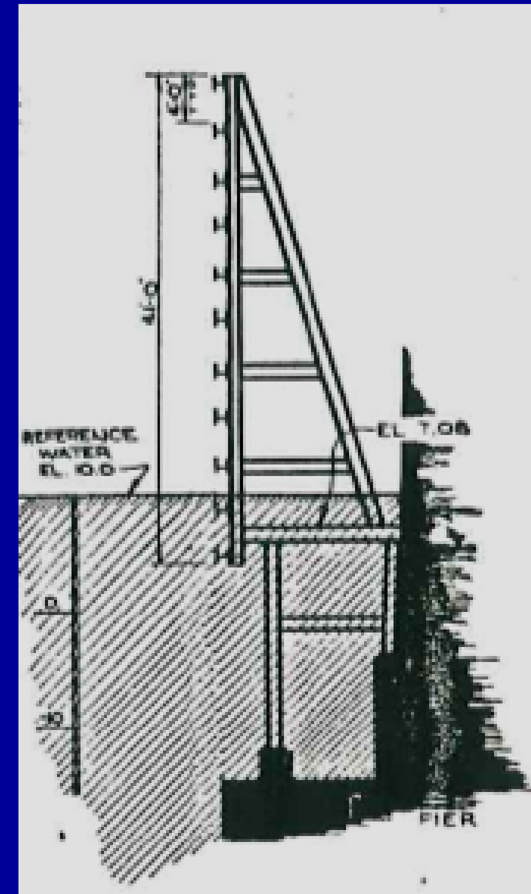
	Loading Direction	
	Longitudinal	Transverse
Pier Columns		
Interface Shear	9734	9734
Shear	5113	5113
Base Shear	5113	5113

Existing Fender System Characteristics





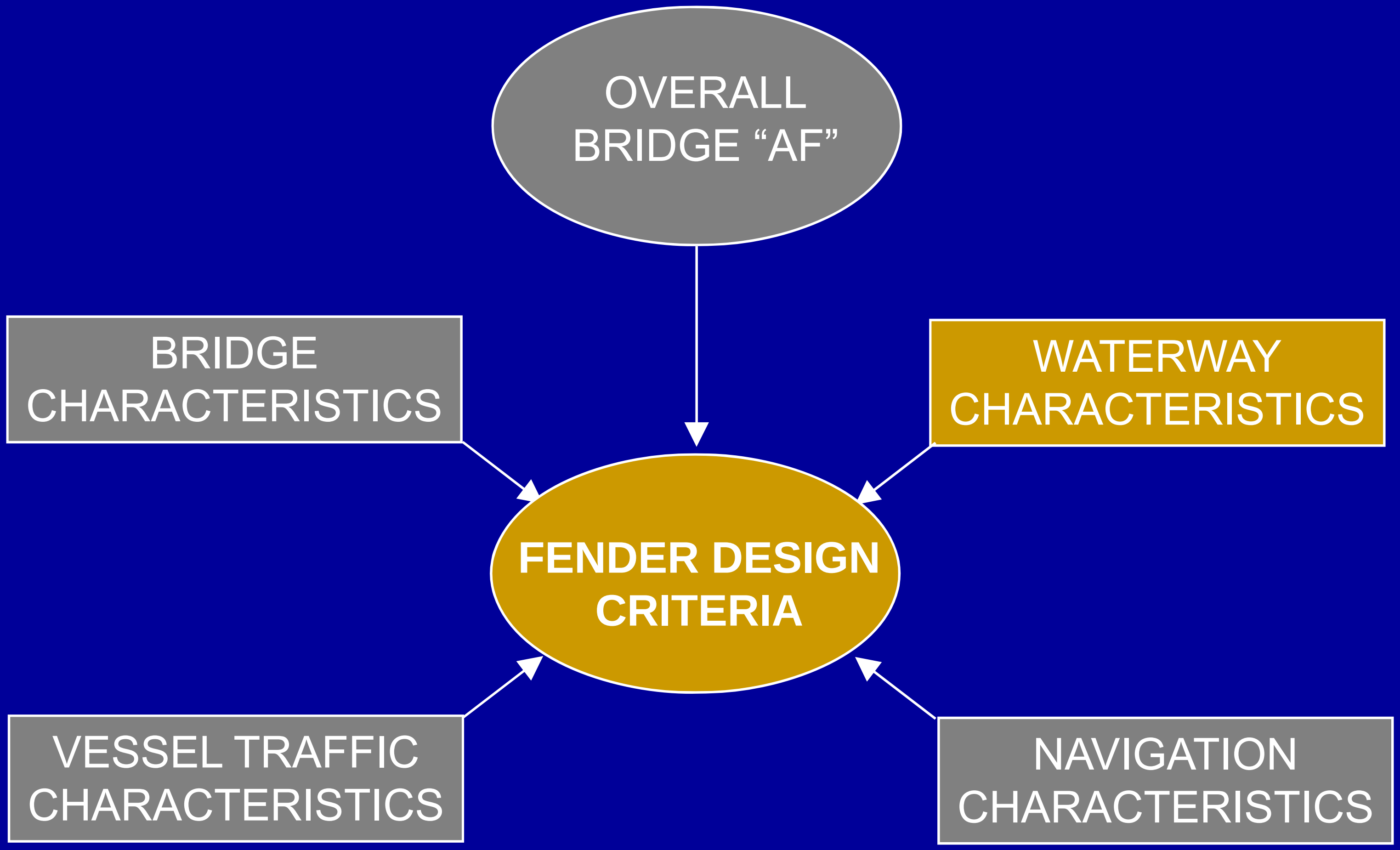
NORTH END ISOMETRIC



Existing Fender System Attributes

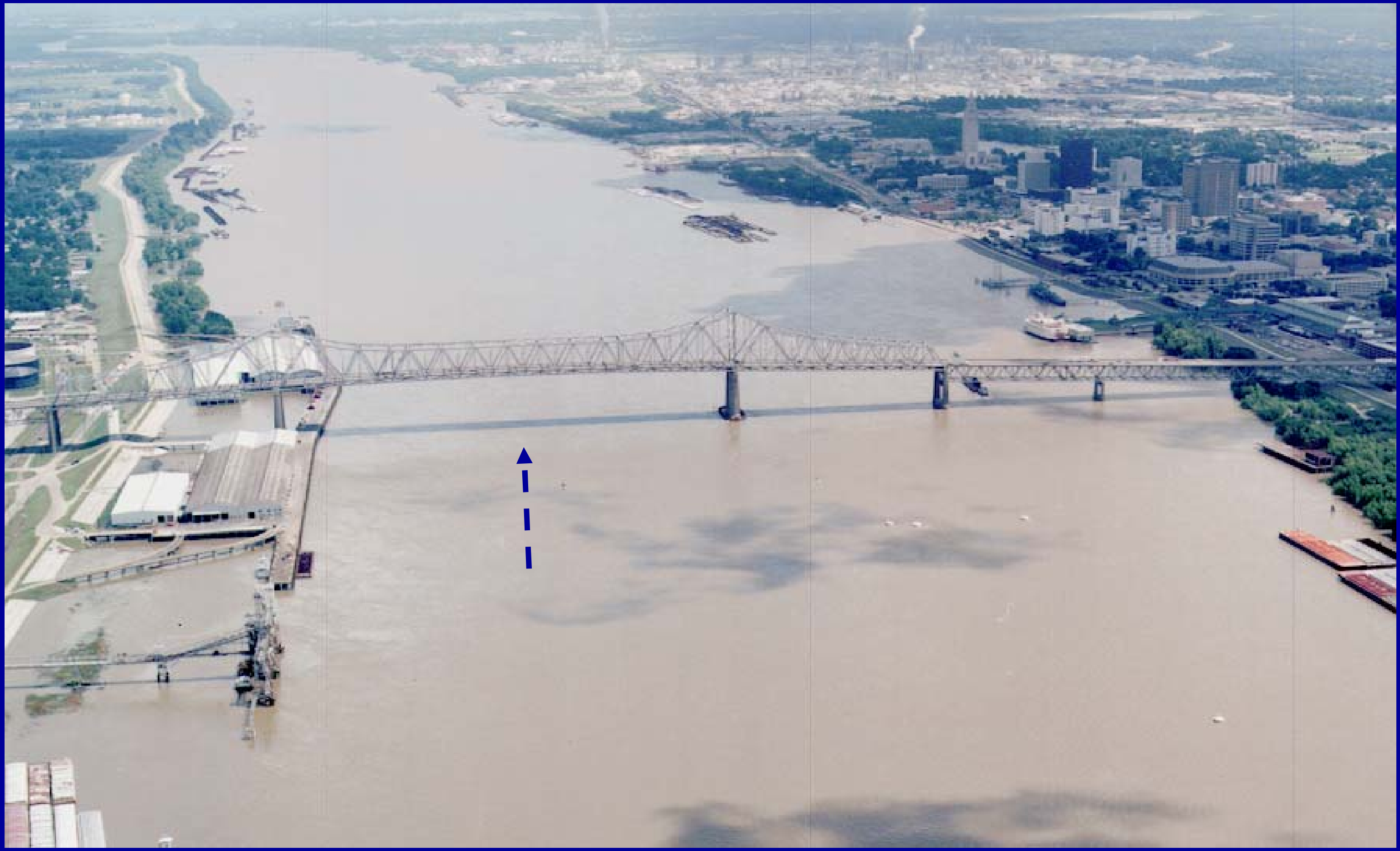
1. Reduction of the impact loads imparted to the vessel and the pier.
2. Prevention of potential sparks during collisions.
3. Ability to redirect, absorb energy and reduce loads on the pier during lower energy collisions and during impacts at an angle with the pier.

Factors Involved

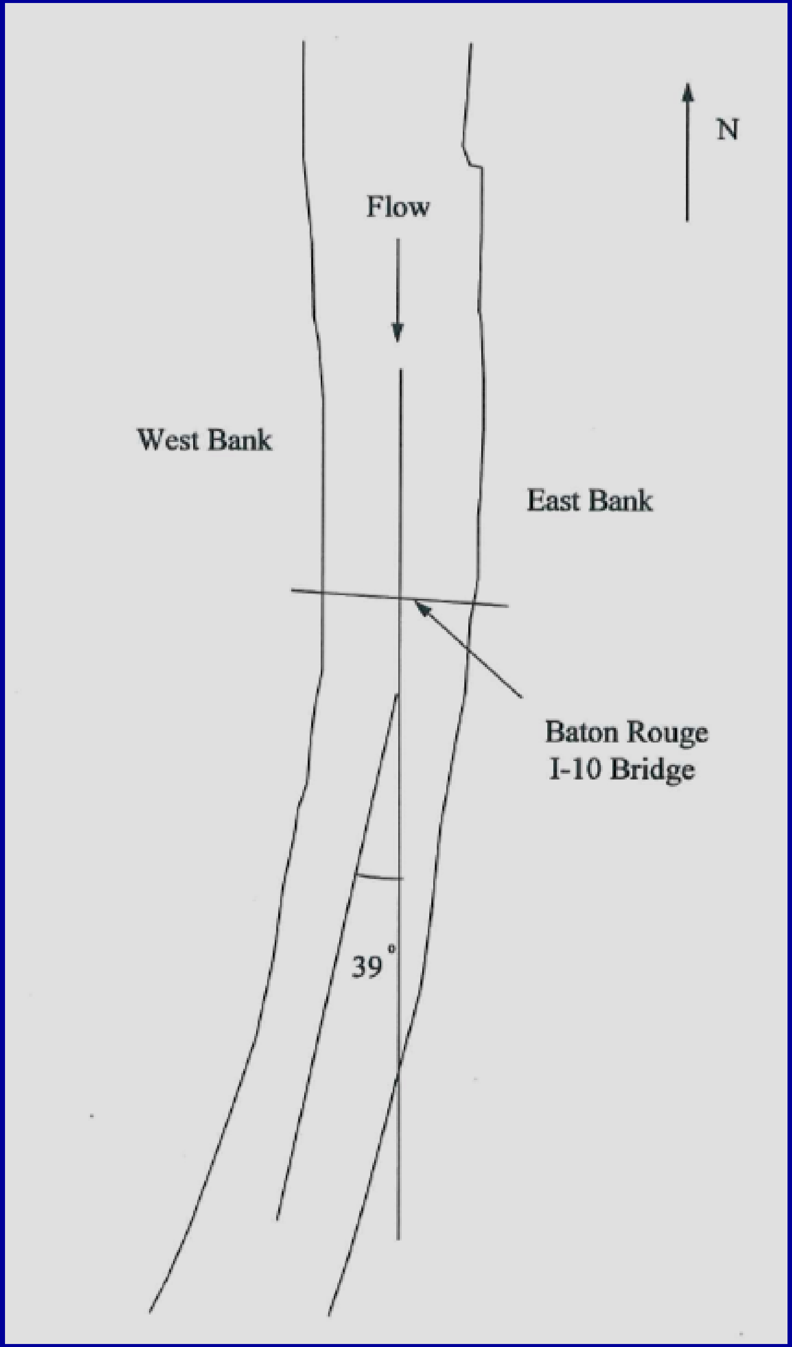


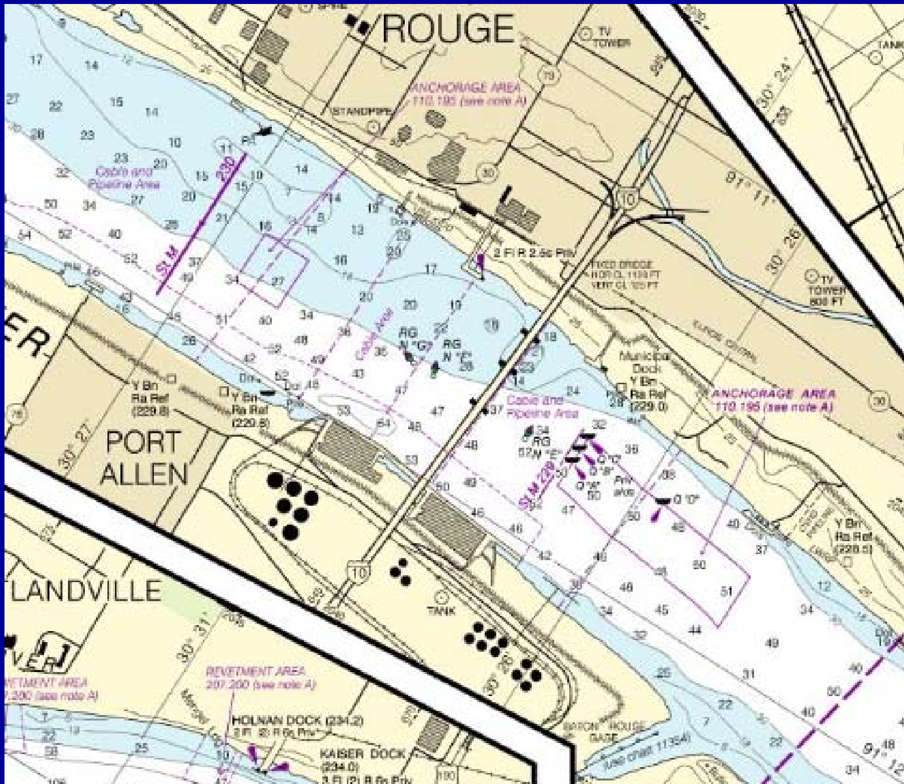
Waterway Characteristics and Docking Facilities

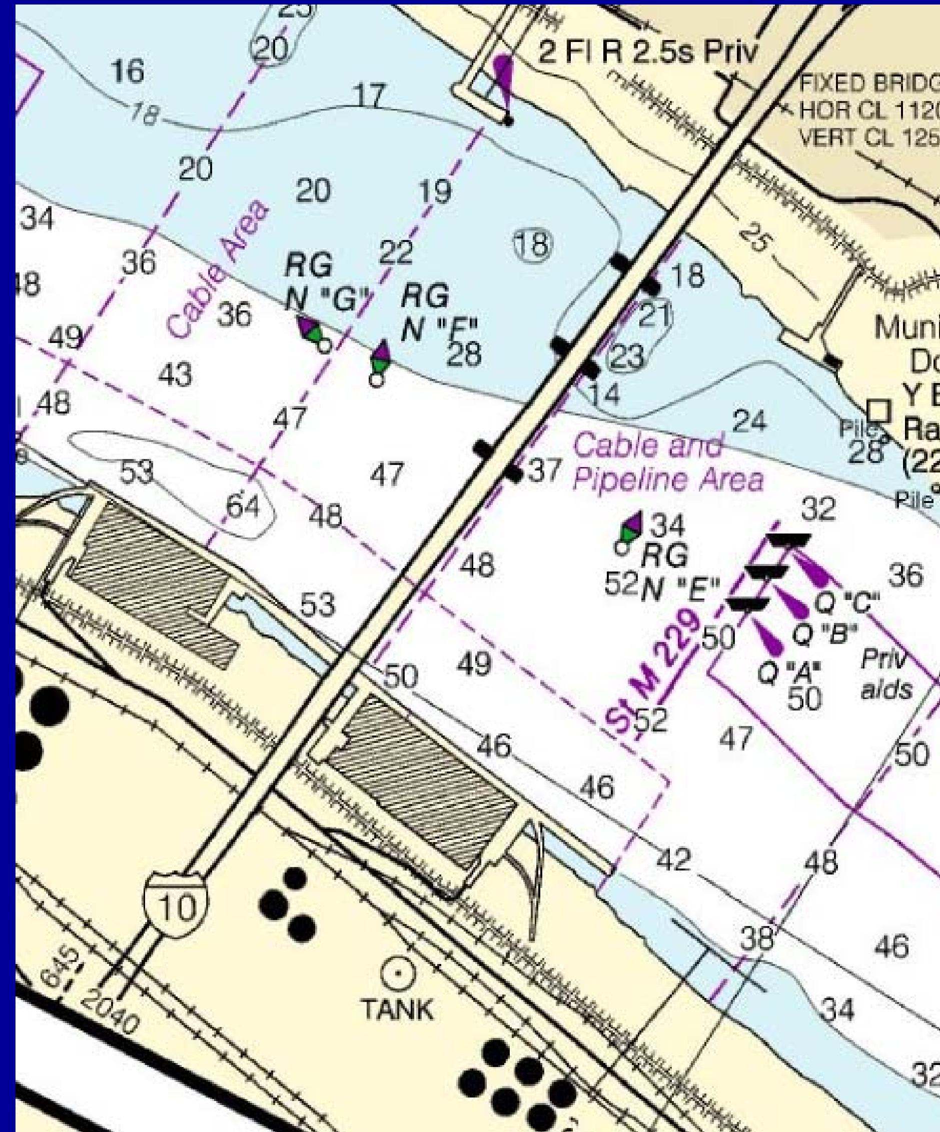
Bridge View Looking Downstream



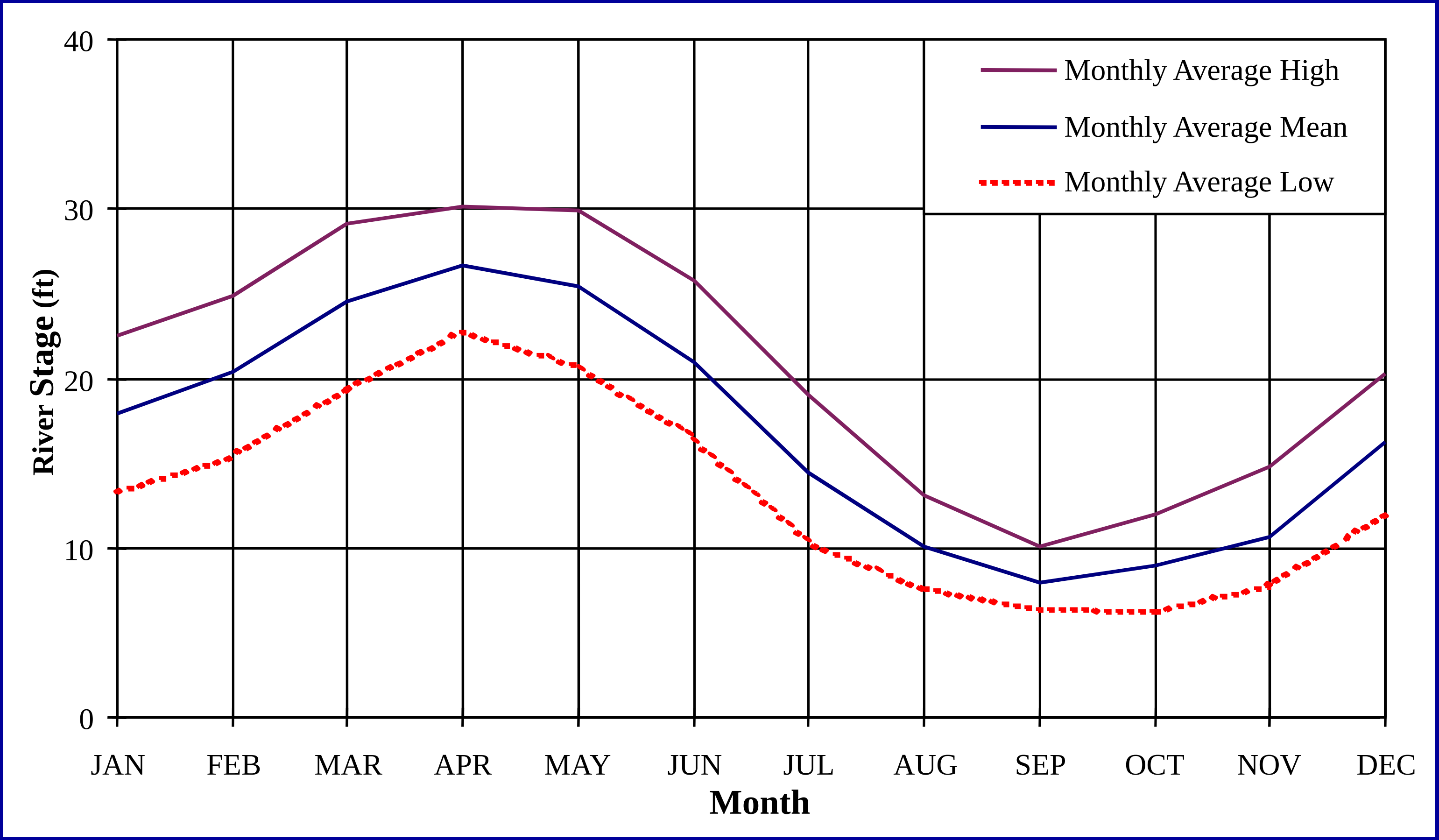
Bridge View Looking Upstream


N
Flow
West Bank
East Bank
Baton Rouge
I-10 Bridge
39°

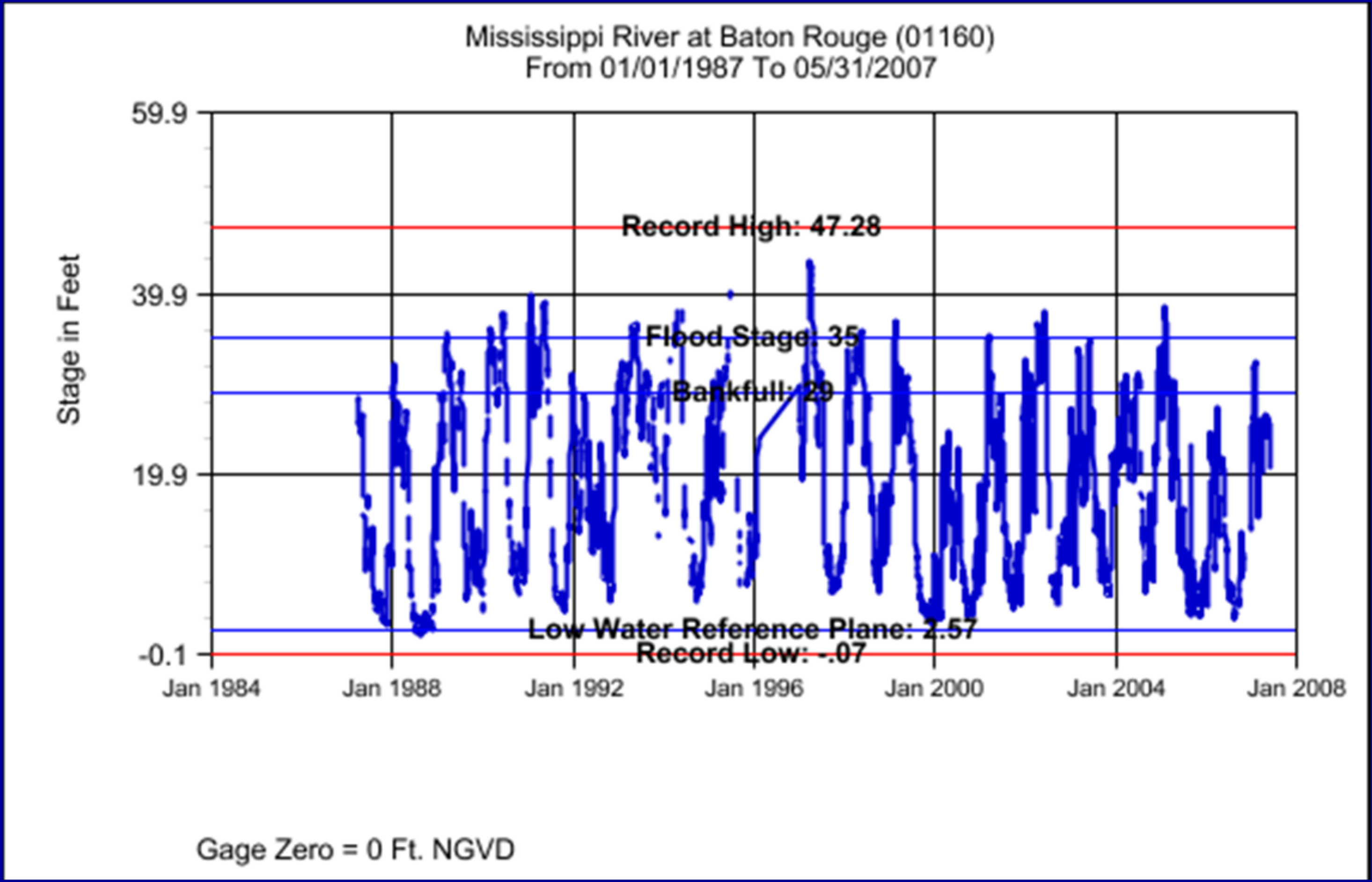

ROUGE
STANDPIPE
ANCHORAGE AREA 110.195 (see note A)
Cable and Pipeline Area
2 Fl R 2.5s Priv
PORT ALLEN
LANDVILLE
TANK
REVETMENT AREA 207.200 (see note A)
HOLNAN DOCK (234.2)
KAISER DOCK (234.0)


2 Fl R 2.5s Priv
FIXED BRIDGE
HOR CL 1120
VERT CL 125
Cable Area
RG N "G"
RG N "F"
Cable and Pipeline Area
RG N "E"
Q "C"
Q "B"
Q "A"
Priv aids
St M 229
Pile
TANK
10

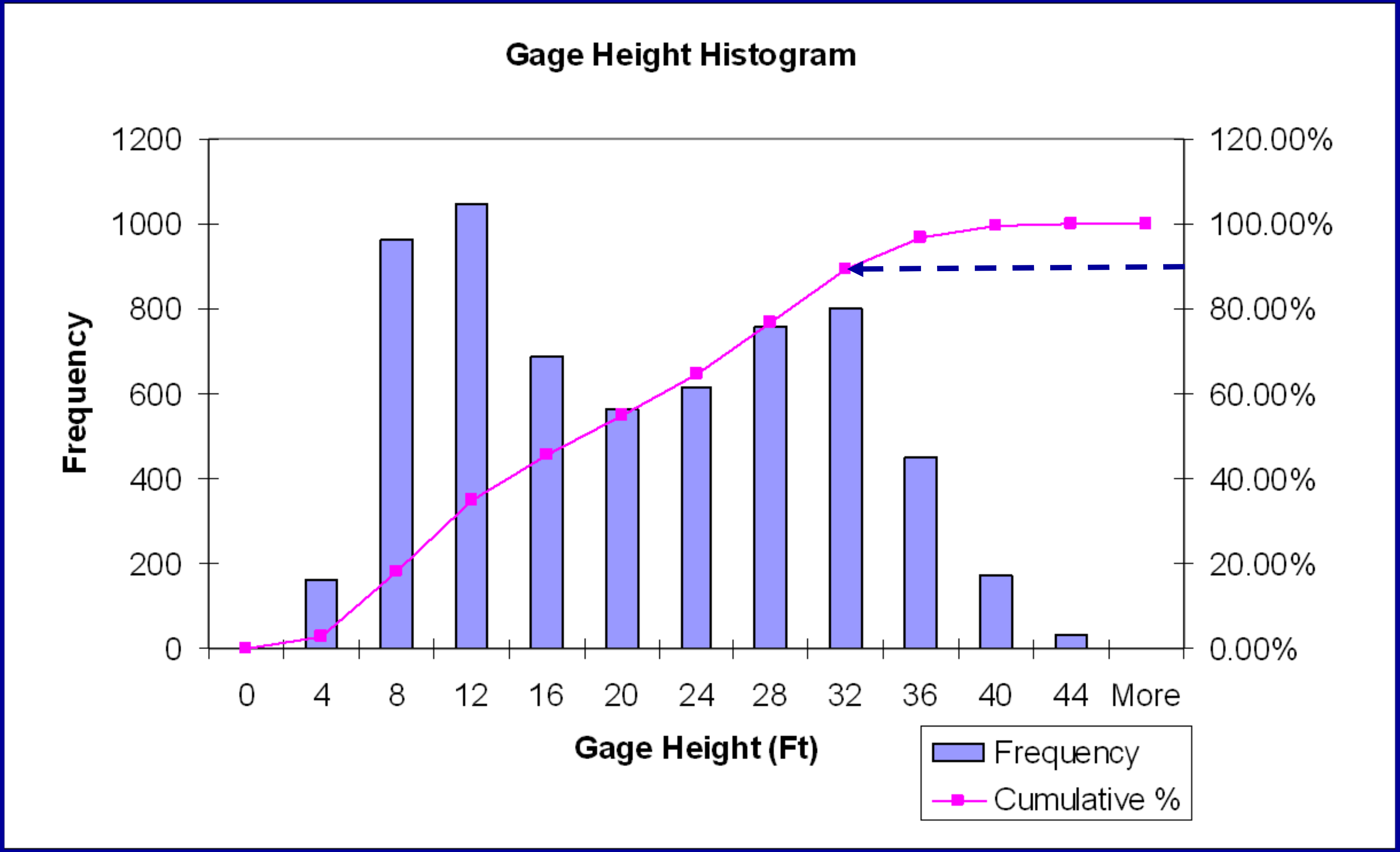
River Stage Monthly Average Variations



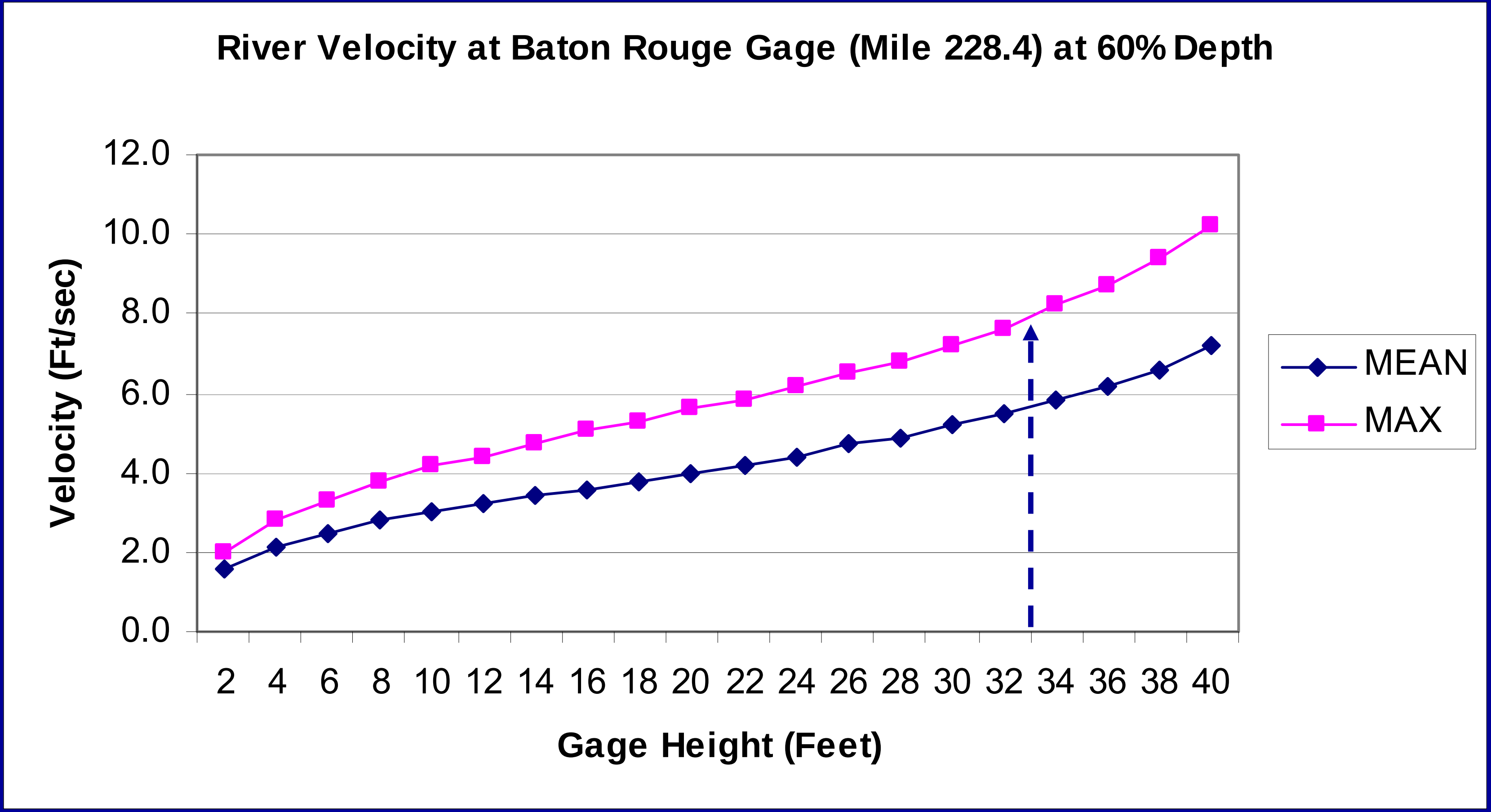
River Stage Daily Variations



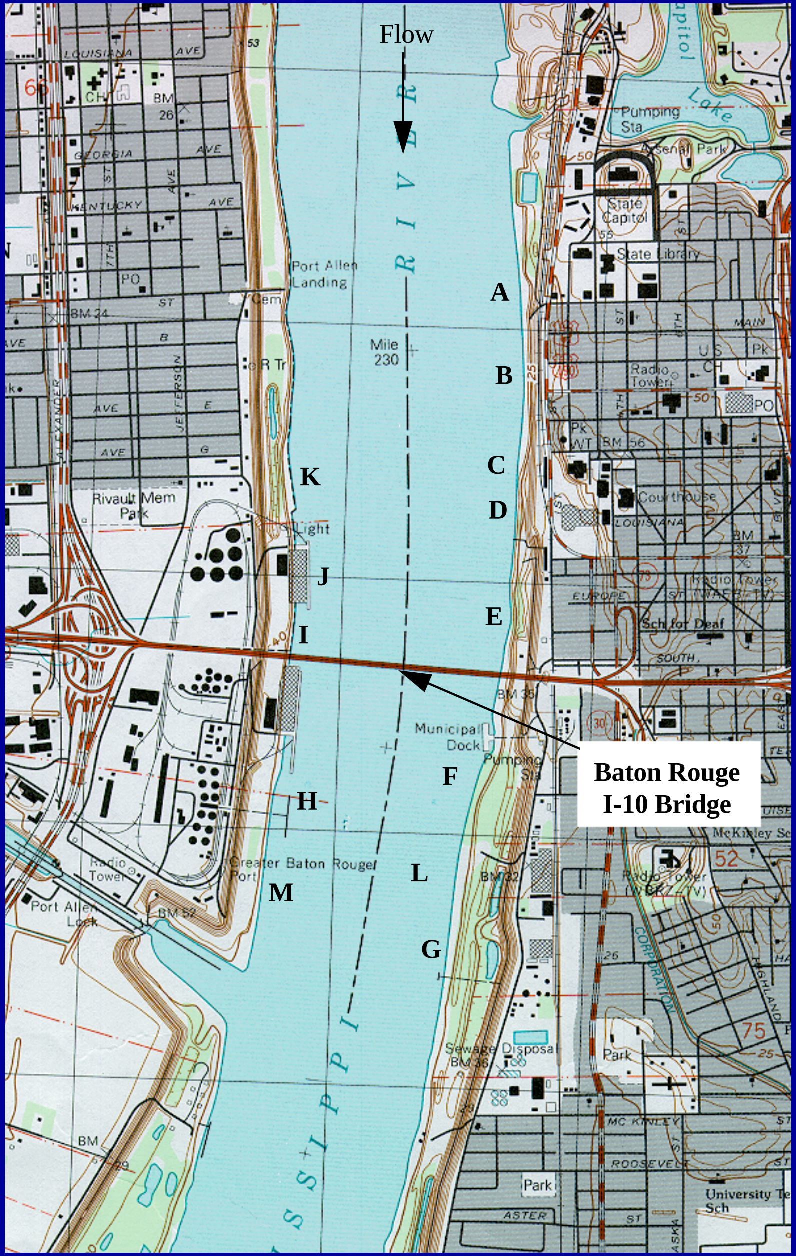
River Stage Statistics



River Velocities at Baton Rouge Gage



Docking Facilities Near the Bridge



East Bank Facilities

A. Casino Rouge

B. Capitol Fleet Landing Area

C. Passenger Dock

D. USS Kidd

E. Belle of Baton Rouge Casino

F. Old Baton Rouge City Wharf (Abandoned)

G. McKinney Fleet and Barge Service Wharf

L. International Marine Terminals, Moorings

West Bank Facilities

H. GBR Port Commission, Dock No. 1 Wharf

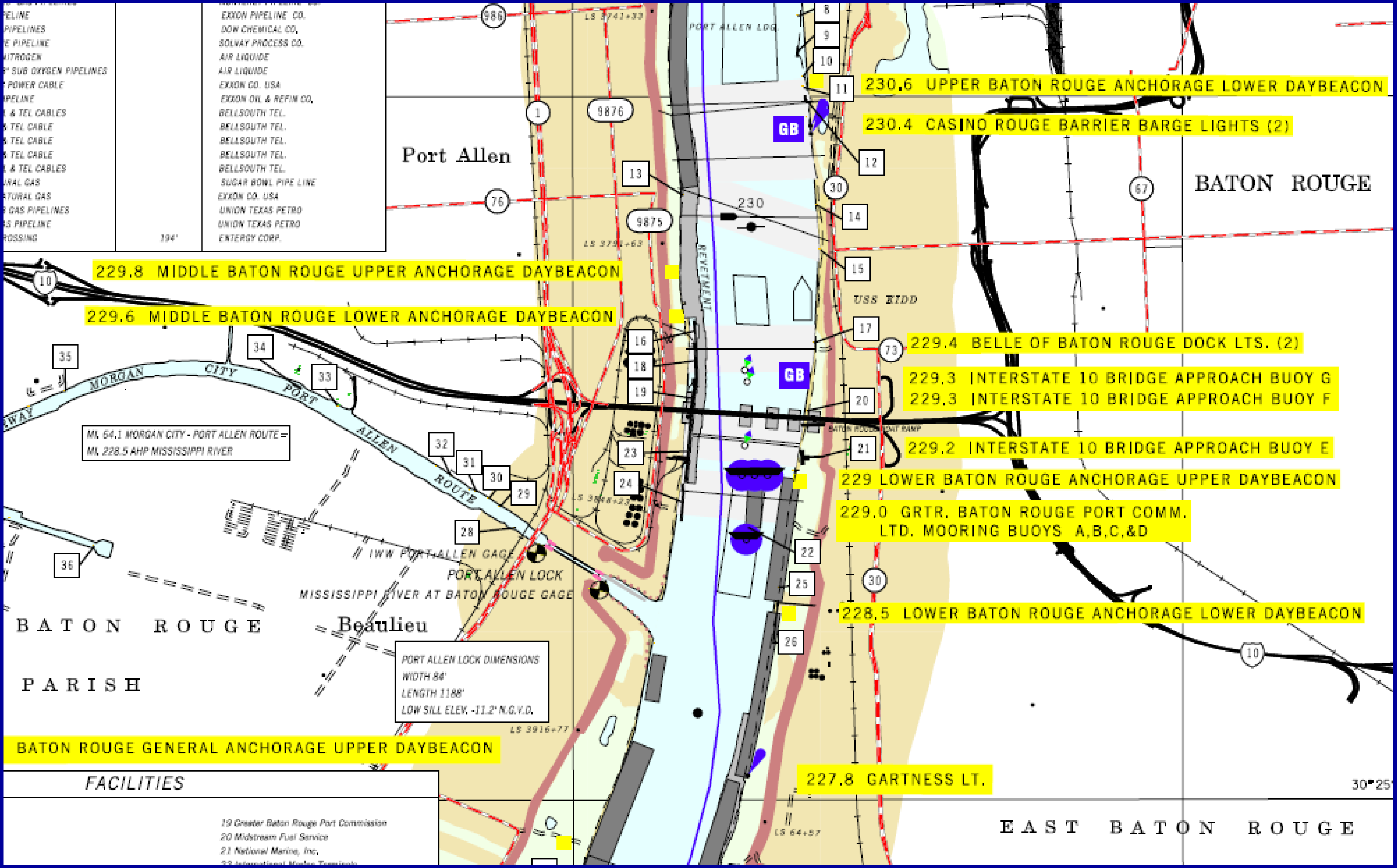
I. GBR Port Commission, Dock Connection

J. GBR Port Commission, Dock No. 2 Wharf

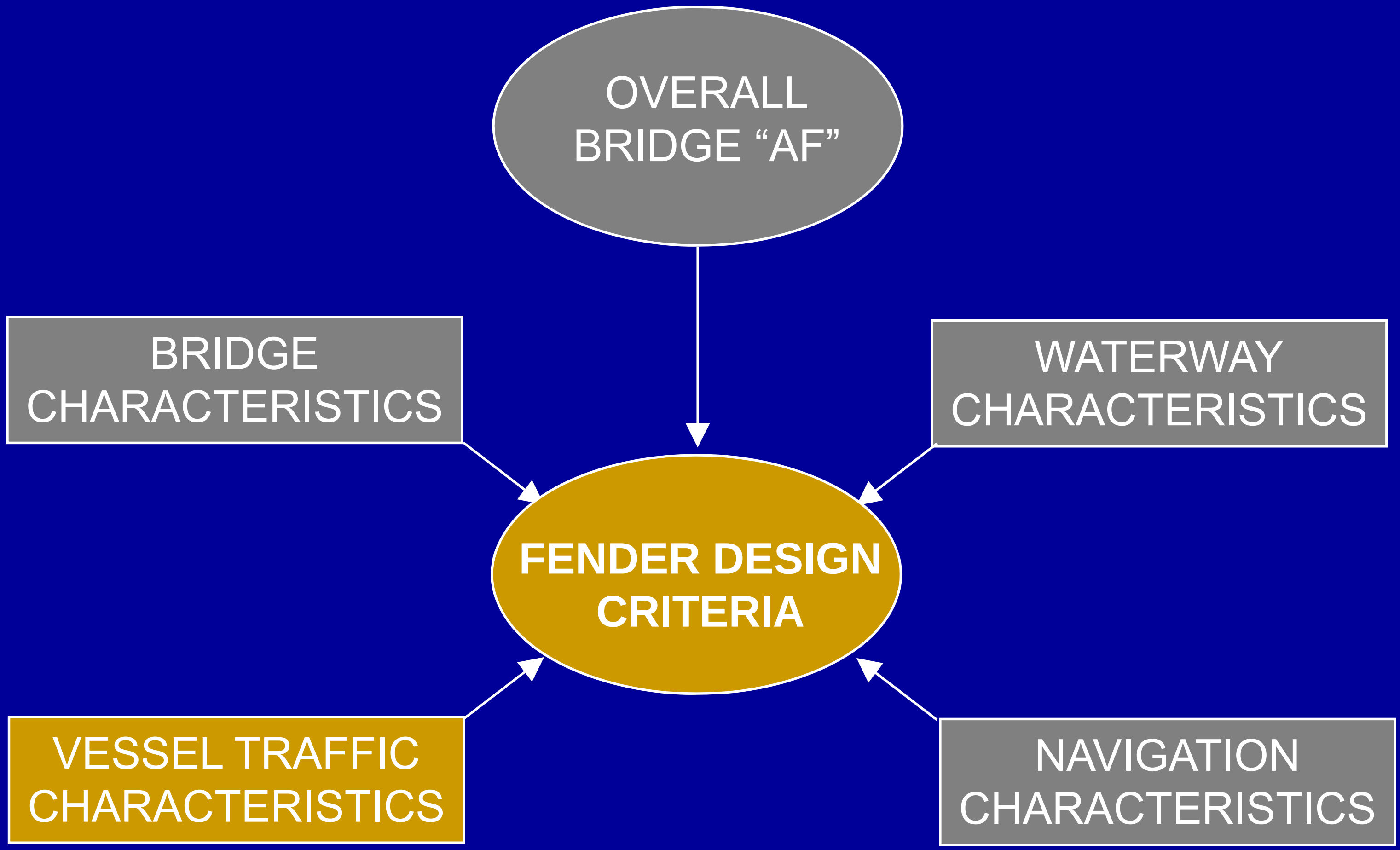
K. GBR Port Commission, Petroleum Terminal

M. GBR Port Commission, Grain Wharf

Vessel Anchorages Near the Bridge



Factors Involved



Vessel Traffic Characteristics

Barge Tow Sizes

Common hopper barge tows:

35 barges in a 7 long x 5 wide configuration headed upstream and a 5 long x 7 wide configuration headed downstream

Largest hopper barge tows:

49 barges, in a 7 x 7 configuration, 1,585 feet long x 245 feet wide

Common tanker barge tows:

6 barges in a 3 long x 2 wide configuration

Largest Ship Sizes at Bridge

Traffic Type	Length (feet)	Breadth (feet)	Light Draft (feet)	Loaded Draft (feet)	Highest Fixed Point (feet)
Domestic	810	110	19	44	161
Foreign	946	144	22	56	170

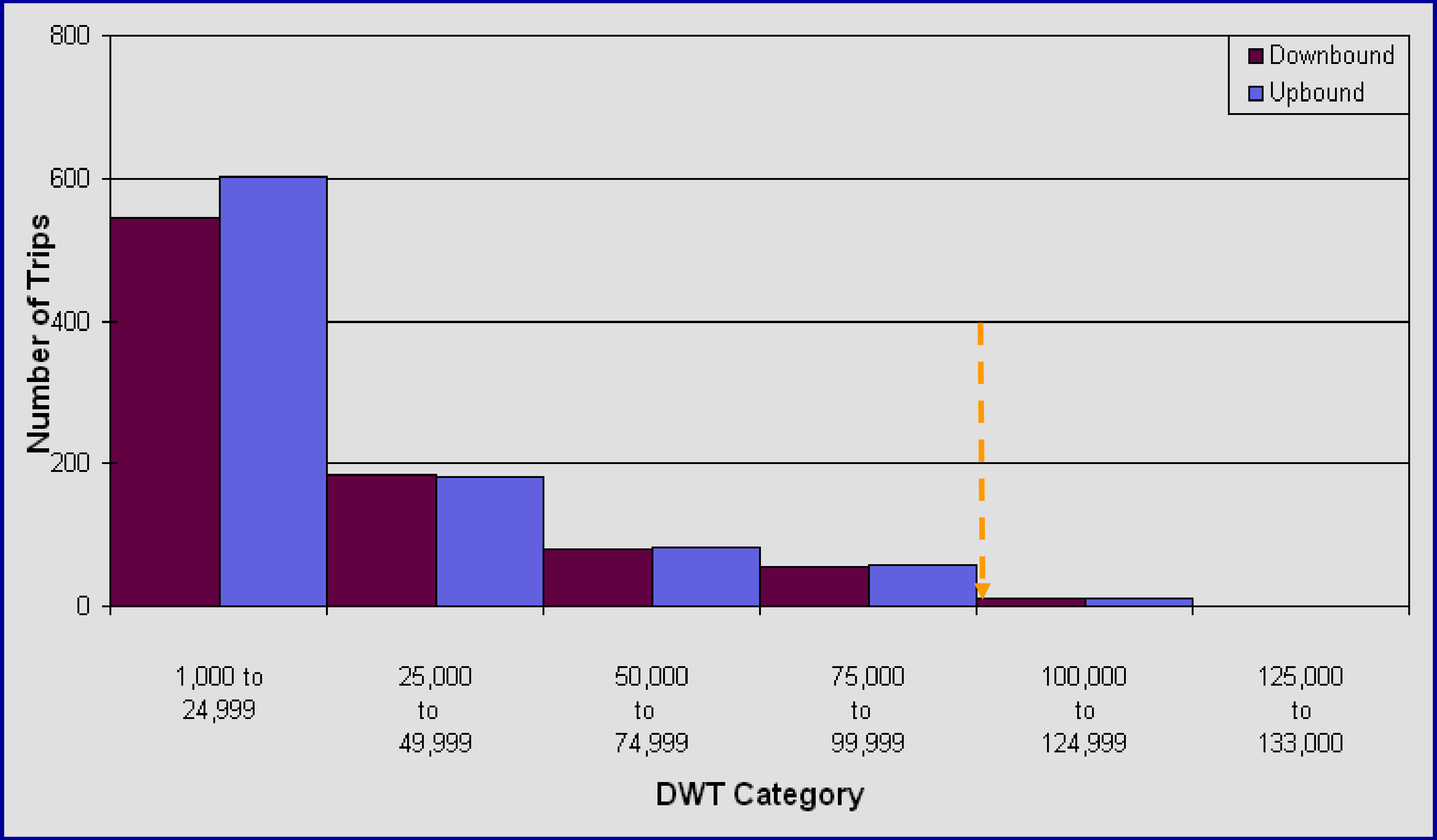
Ship Characteristics by DWT Category

DWT	Length	Breadth	Loaded Draft	Bow Depth
Category	(feet)	(feet)	(feet)	(feet)
1,000 to 24,999	200 to 525	30 to 81	4 to 31	24 to 70
25,000 to 49,999	525 to 664	81 to 103	31 to 39	70 to 79
50,000 to 74,999	664 to 771	103 to 120	39 to 45	79 to 86
75,000 to 99,999	771 to 860	120 to 134	45 to 50	86 to 91
100,000 to 124,999	860 to 939	134 to 146	50 to 54	91 to 96
125,000 to 133,000	939 to 962	147 to 150	54 to 56	96 to 97

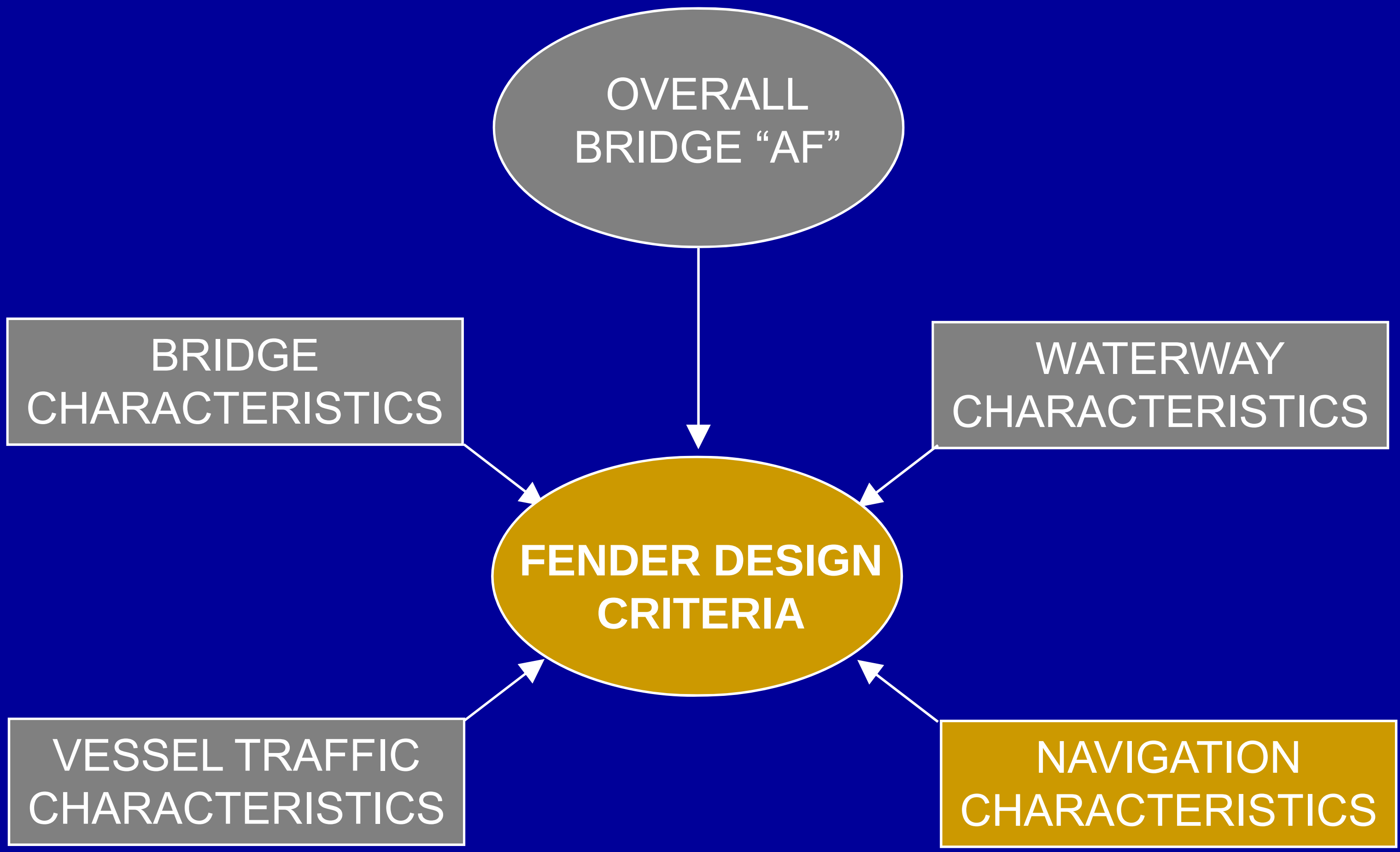
Ship Distribution and Loading Data by DWT Category

	Downbound Trips		Upbound Trips		Total	
DWT Category	No	(%) loaded	No	(%) loaded	No	(%) of total
1,000 to 24,999	545	62.2%	603	64.4%	1,148	63.4
25,000 to 49,999	183	20.9%	182	19.4%	365	20.1
50,000 to 74,999	80	9.1%	83	8.9%	163	9.0
75,000 to 99,999	56	6.4%	57	6.1%	113	6.2
100,000 to 124,999	11	1.3%	11	1.2%	22	1.2
125,000 to 133,000	1	0.1%	1	0.1%	2	0.1
Sum	876	100.0	937	100.0	1,813	100.0

Ship Size Distribution Plot



Factors Involved

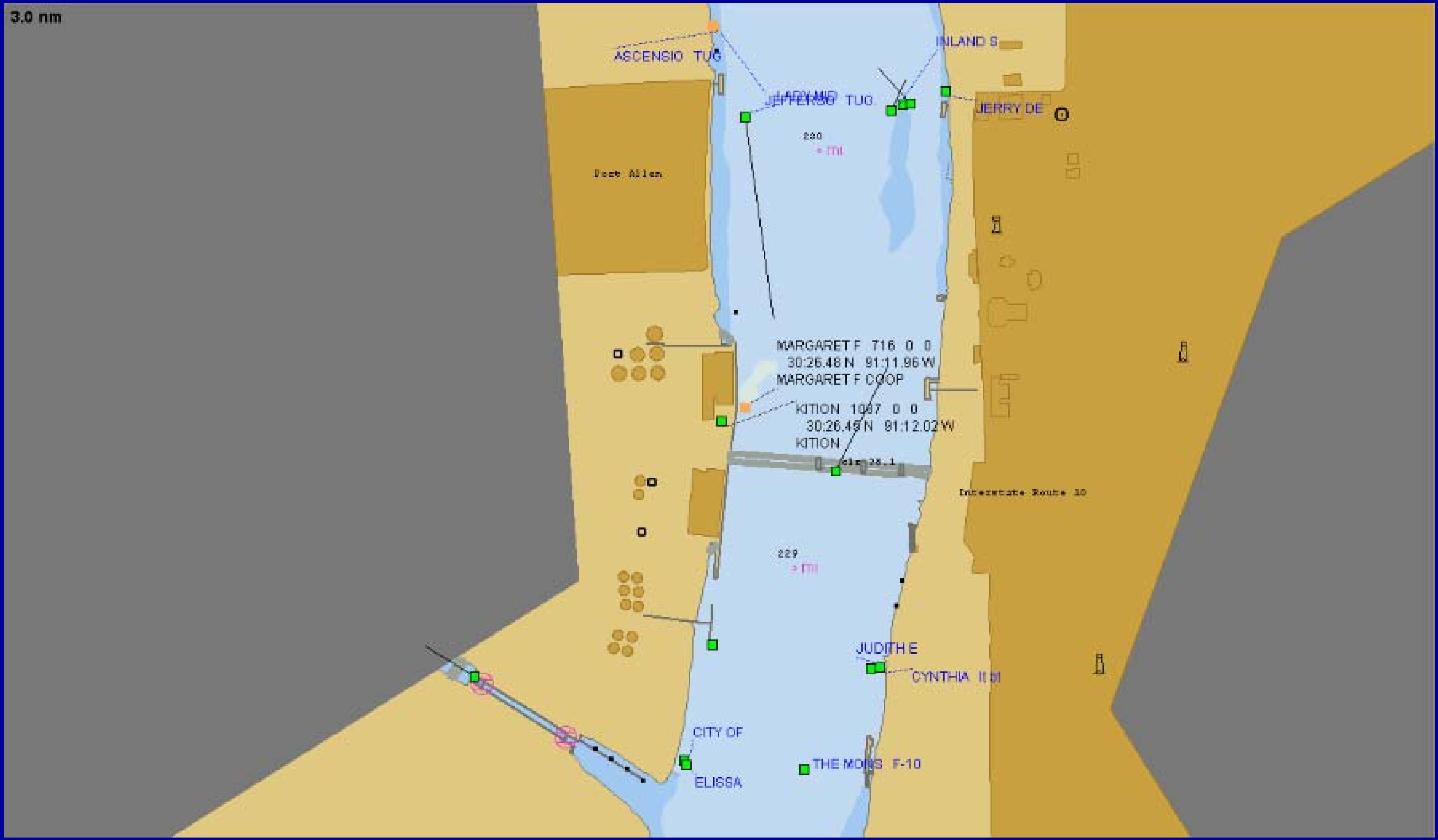


Navigation Conditions and History of Accidents

Main Hazards to Navigation:

- High volume of through traffic combined with local vessel movements at nearby docks and anchorages
- During medium to high water river stages, currents make navigation difficult carrying vessels in the channel span towards Pier 5

Vessel Traffic Identification (AIS) and Monitoring System



AIS provides precise information on ship identification, position, speed and heading to a vessel traffic control center and to other AIS-equipped vessels

United States Coast Pilot 5

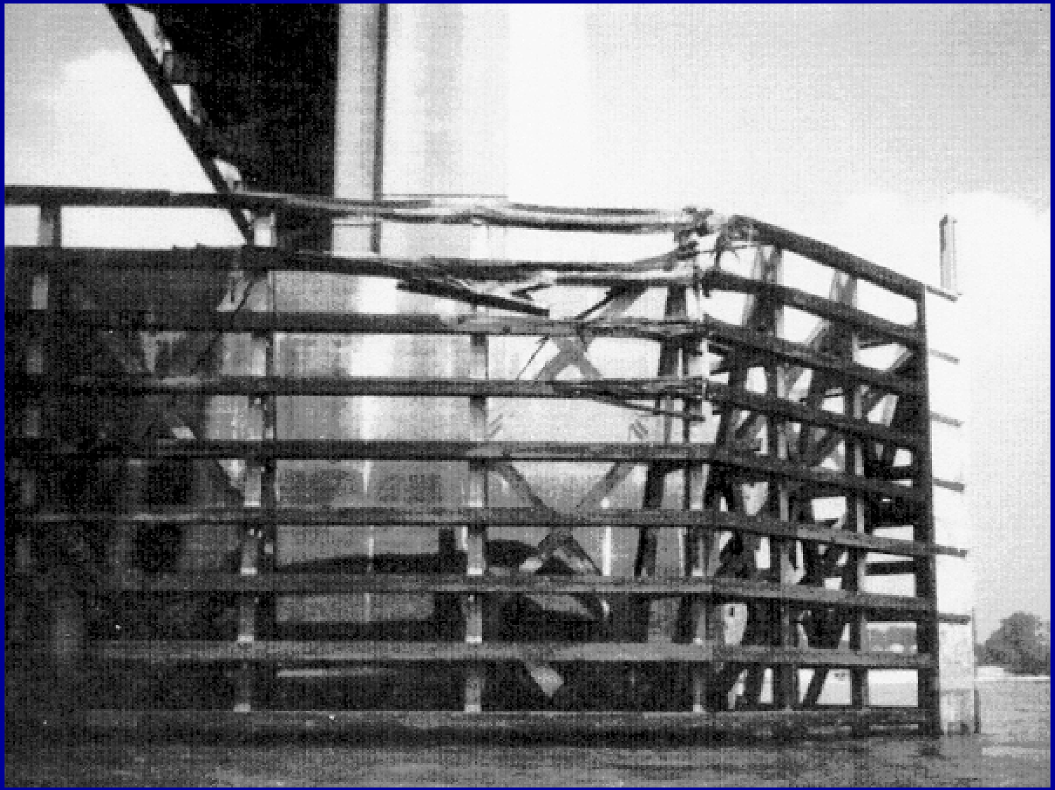
Includes regulations regarding vessel navigation and detailed instructions for mooring of barges and fleeting operations along the river, e.g.:

"*Mariners departing Port Commission Dock No.2 are advised to use extreme caution when turning vessels downstream. Strong currents (over 7 knots) associated with high water have caused vessels departing this facility to be set down upon the fender system of the bridge, causing extensive damage. Moving vessels well above or below the bridge before turning downstream is advised.*"

History of Accidents

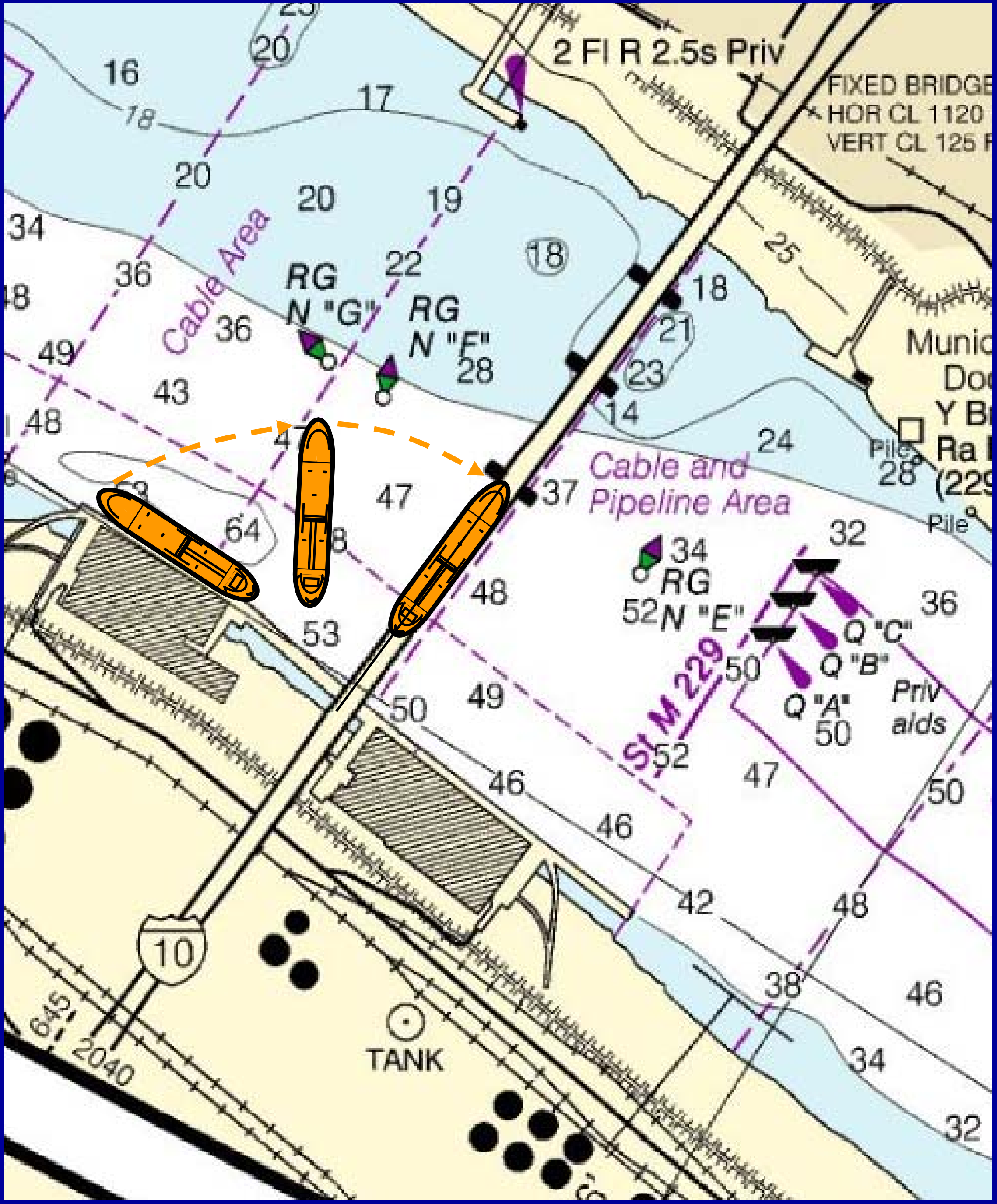
Accident Number	Date	Location of Damage		Baton Rouge Gage
		Substructure	Superstructure	River Stage (feet)
1	3/12/77	South end of the Pier 5 fender system		23.08
2	5/27/77	North end and the east side of the Pier 5 fender system		10.00
3	12/5/77	West side of Pier 5 fender system		22.12
4	3/5/79	North end and east side of the Pier 5 fender system		29.43
5	6/14/82		Green navigation light was torn off	27.37
6	12/21/01	North end of the Pier 5 fender system		31.70
7	2/10/07	West side of the Pier 5 fender system		26.09

May 27, 1977 - M/V Gulf Solar



December 21, 2001 – M/V Ace G


130
140



Feb 10, 2007

- M/T Kition

DWT = 96,315 Tonnes
Loa = 798 Feet
B = 137 Feet

February 10, 2007 – M/T Kition


ITION


Fender Criteria

- Requirements and Attributes
- Evaluation Scenarios
- Performance Requirements
- Design Vessels
- Material Selection Criteria

Requirements and Attributes

1. Prevention of vessel access to the pier columns.
2. Protection of vessels from contacting underwater “shelf”.
3. Adequate strength, stiffness and energy absorption cap.
4. Elimination of sparks upon vessel impact.
5. Abrasion resistance and low coefficient of friction.
6. Low initial cost.
7. Ease of construction.
8. Ease of repair and replacement of damaged parts.
9. Durability and low maintenance costs.

Evaluation Scenarios

- Both barge and ship impacts at various angles and directions
- Both minor (low energy) but frequent collisions and potential for major (high energy) but rare collisions.

Performance Requirements

- Damage due to minor collisions should be limited and easily repairable
- Damage due to major collisions should be repairable at a reasonable cost

Design Vessels

- 6 - Hopper Barge Long Tow at 14.7 ft/sec

  P_head-on = 5,000 kips; P_sideways = 3,200 kips

- 3 - Tanker Barge Long Tow at 14.7 ft/sec

  P_head-on = 5,600 kips; P_sideways = 3,800 kips

- 100,000 DWT Ship at 14.7 ft/sec

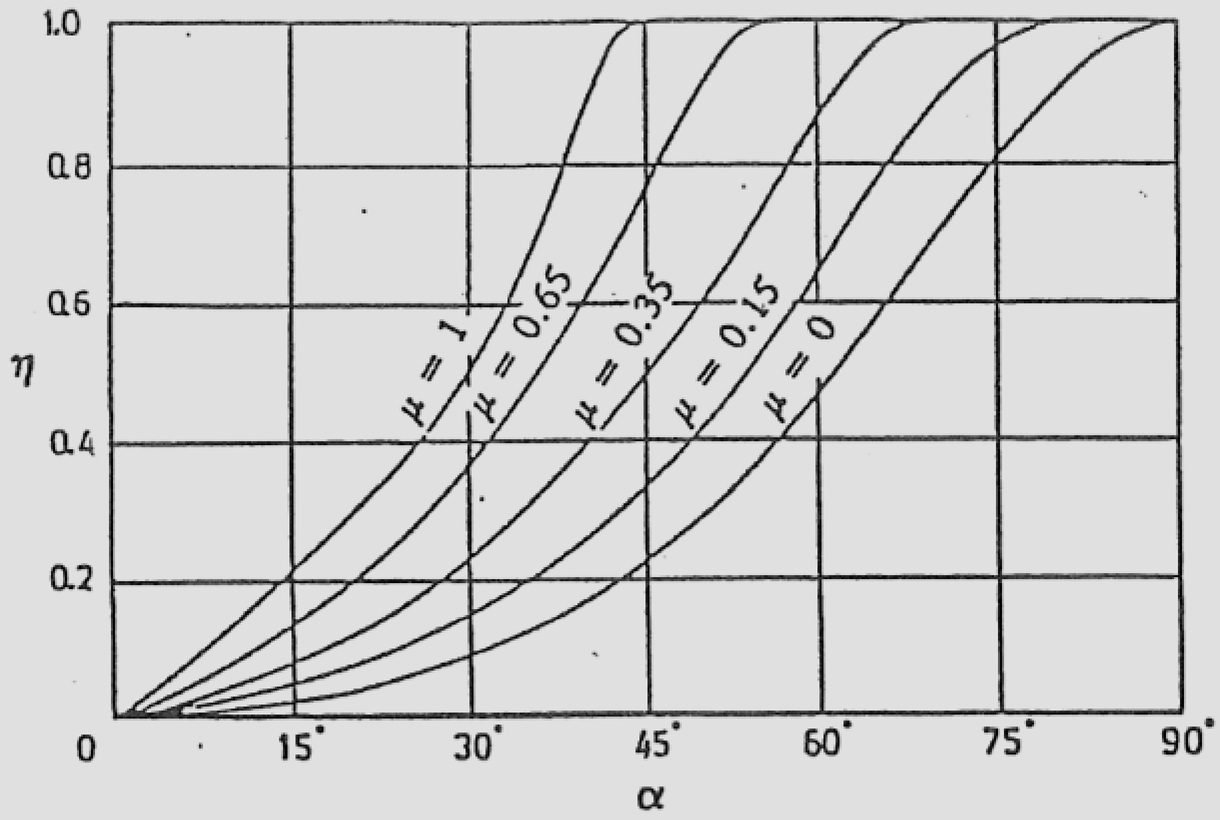
  P_head-on = 37,800 kips; P_sideways = 18,900 kips

Material Selection Criteria

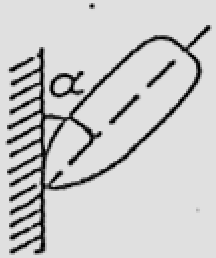
- Requirements for the high energy but rare collision scenarios
- Requirements for the low energy but frequent collision scenarios
- Durability and ease of installation and repair

Composite Marine Timber Wales

- Low coefficient of friction
- High abrasion resistance
- Durable



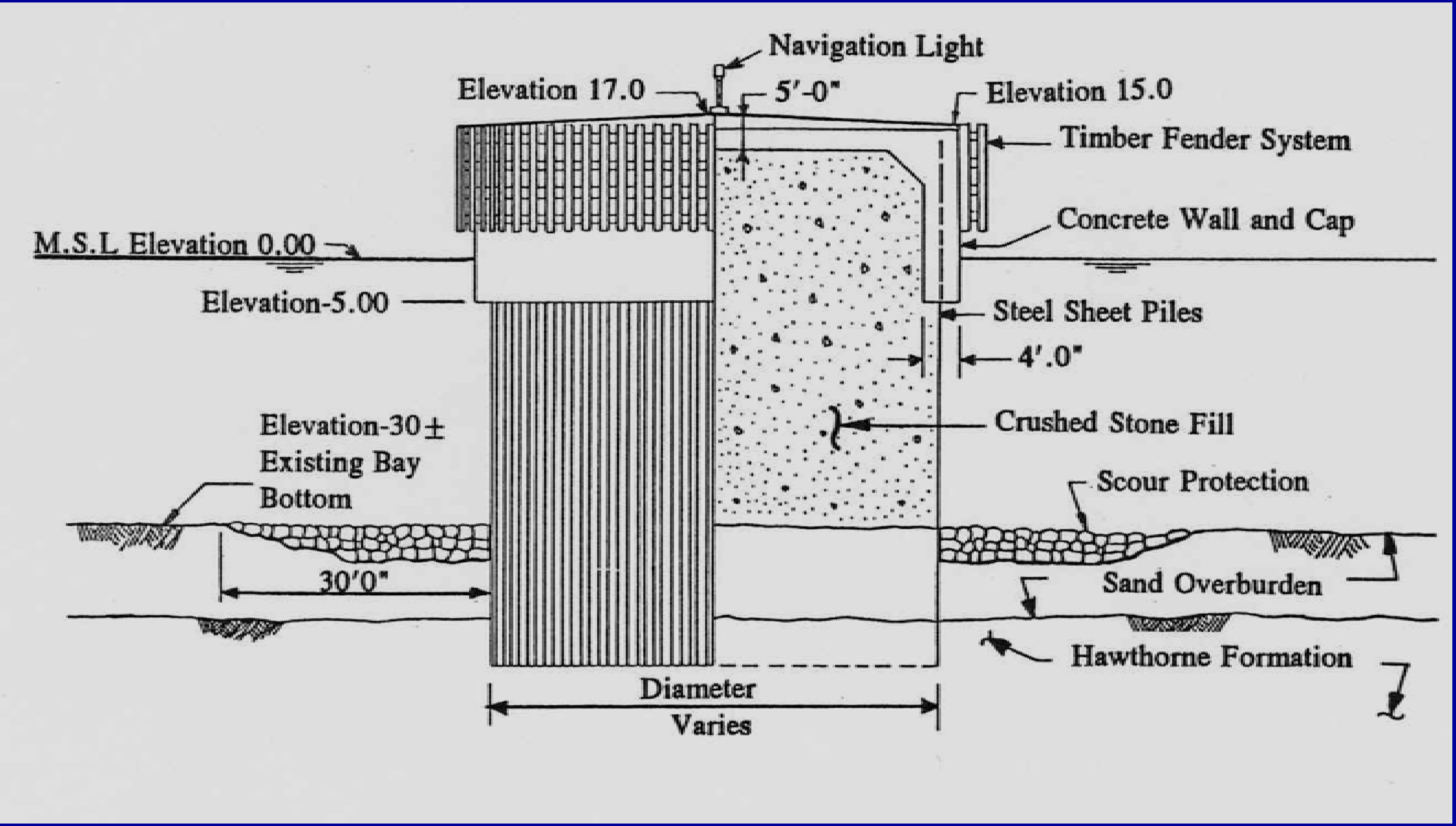
$$\eta = \frac{\text{absorbed collision energy}}{\text{initial ship's energy}}$$

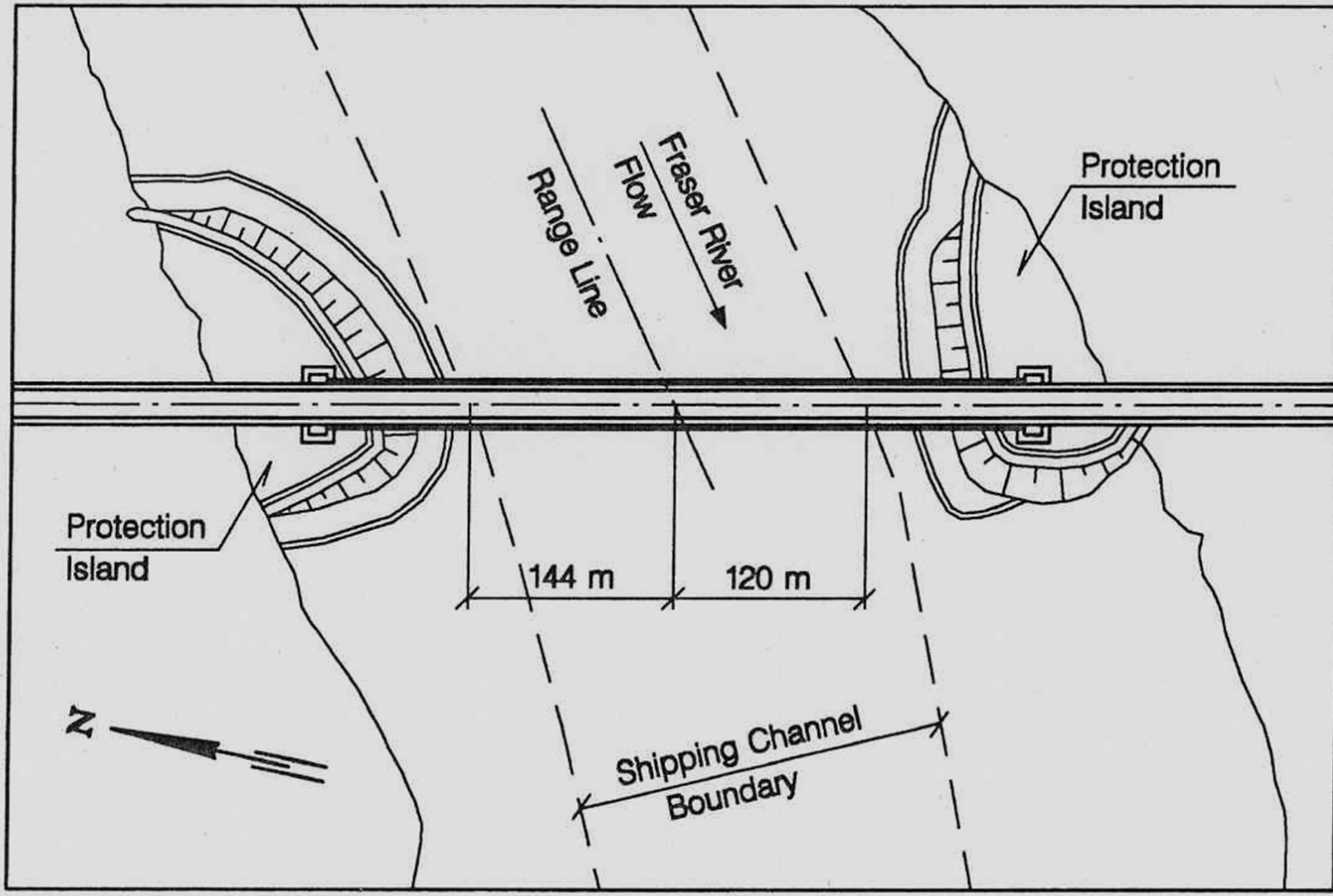


Coefficient of Friction (μ)		
Steel - steel	~	0.15
Steel - concrete	~	0.35
Steel - wood	~	0.65

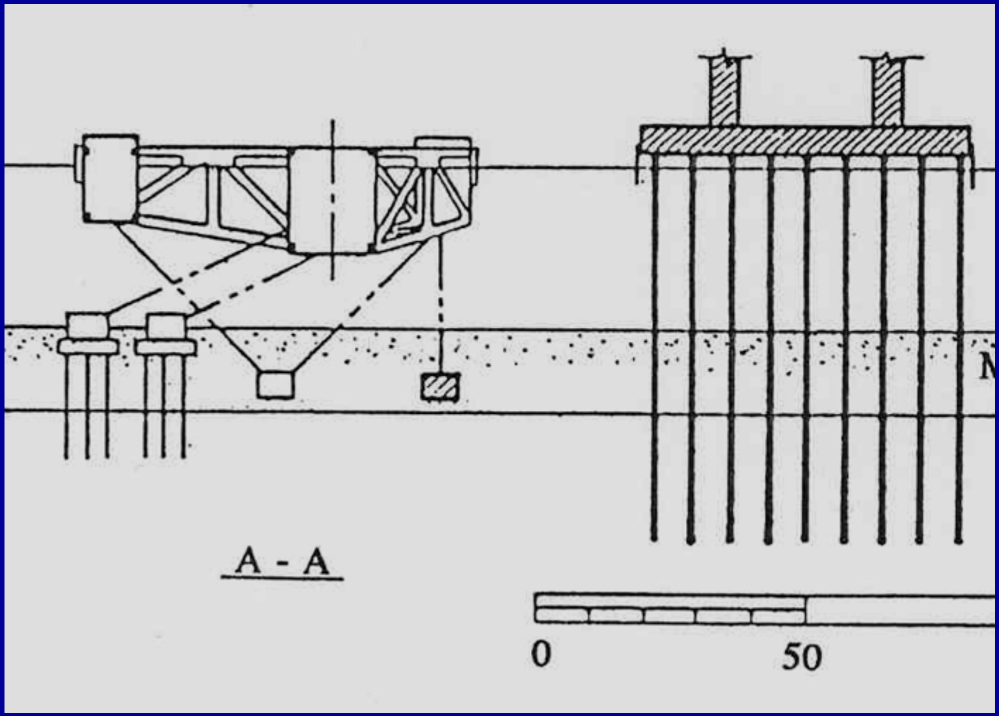
General Categories of Pier Protection

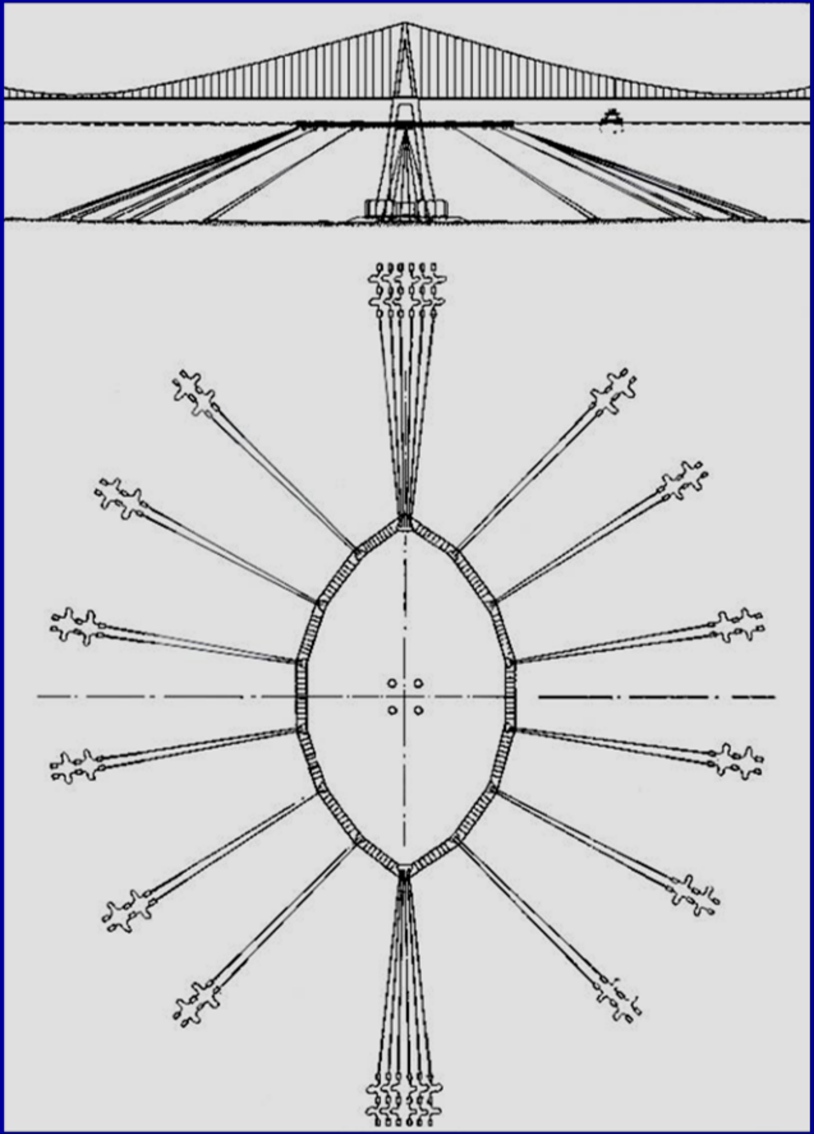
- Independent Systems
  - Sheet Pile Dolphins
  - Artificial Islands
  - Floating Systems
- Semi-Independent Systems
- Pier-Supported Systems
- Guide Fender Systems


Navigation Light
Elevation 17.0
5'-0"
Elevation 15.0
Timber Fender System
Concrete Wall and Cap
M.S.L Elevation 0.00
Elevation-5.00
Steel Sheet Piles
4'.0"
Crushed Stone Fill
Elevation-30±
Existing Bay
Bottom
Scour Protection
30'0"
Sand Overburden
Hawthorne Formation
Diameter
Varies

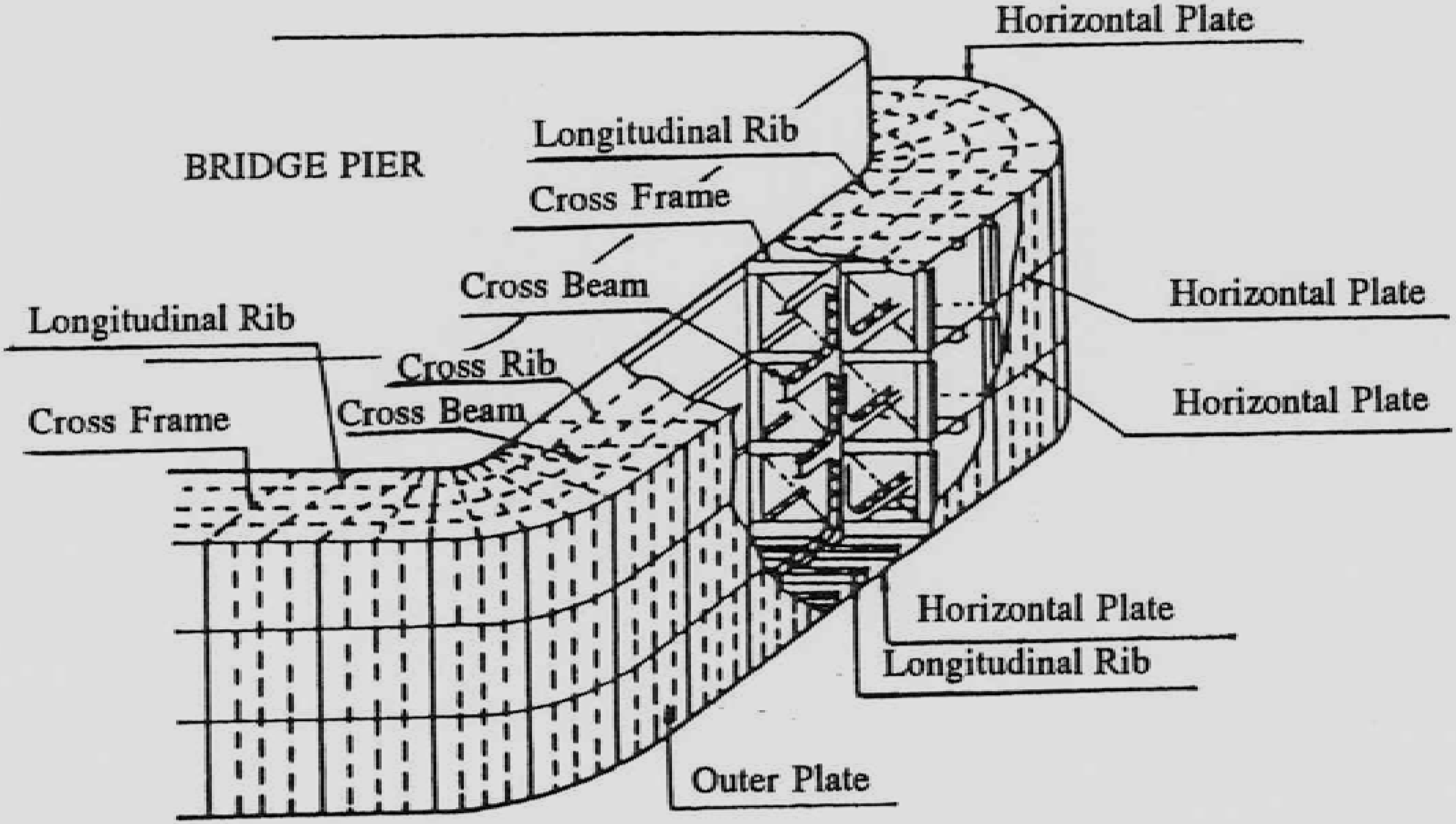

Protection
Island
Fraser River
Flow
Range Line
Protection
Island
144 m
120 m
N
Shipping Channel
Boundary

Fred Hartman Bridge, Houston Ship Channel


A - A
0
50

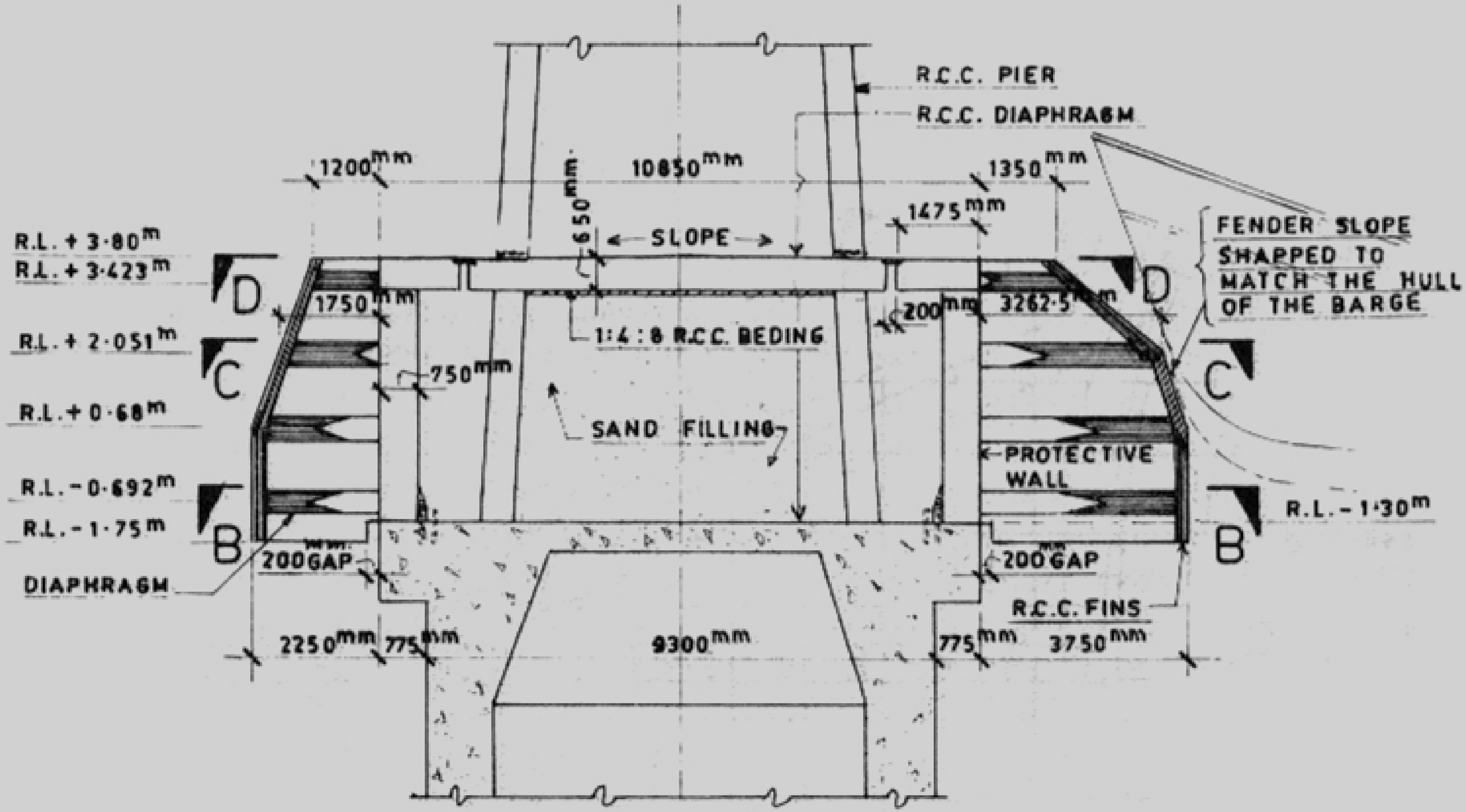


San Mateo Hayward Bridge, CA



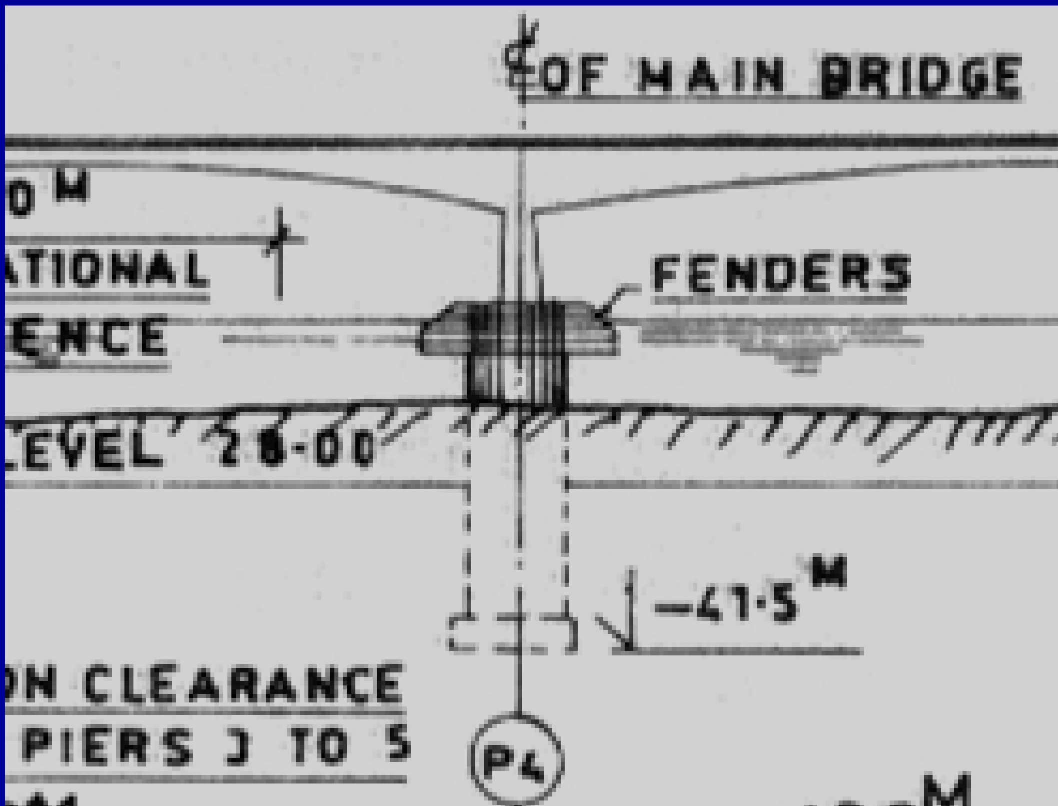
Horizontal Plate
Longitudinal Rib
BRIDGE PIER
Cross Frame
Cross Beam
Longitudinal Rib
Cross Rib
Cross Beam
Cross Frame
Horizontal Plate
Horizontal Plate
Horizontal Plate
Longitudinal Rib
Outer Plate

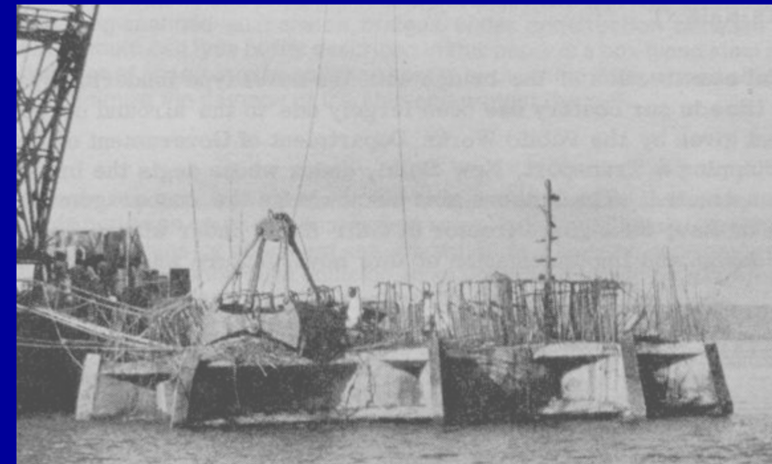
Honshu-Shikoku Bridge, Japan

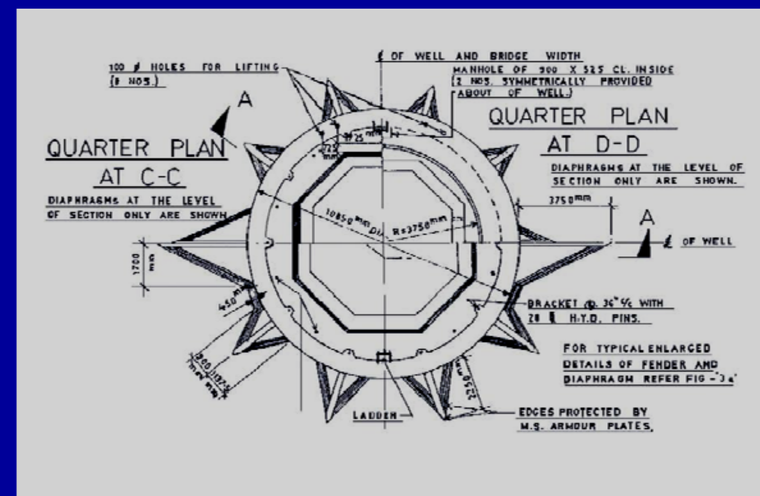


ENLARGED DETAIL AT-X

SECTION AT A-A REFER PLAN IN FIG-'2 b'







Zuari Bridge, India

Alternative Fender Concepts Considered

A. Floating fender tied to the subshaft

B. Fender supported by the top of the subshaft

C. Fender supported on the face of the subshaft above water

D. Fender supported by the “shelf” on top of the distribution block

A. Floating Foam Filled Fenders

Attributes

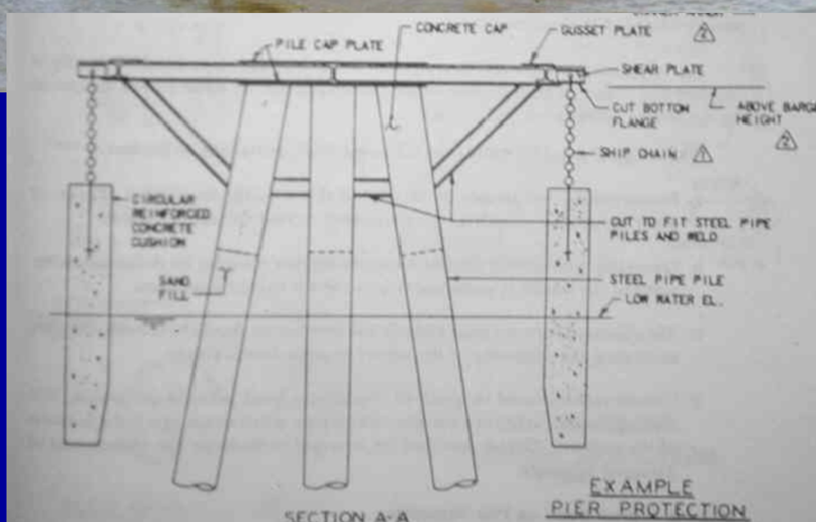
- Effective for frequent low energy sideways berthing scenarios.
- Installation is relatively easy and the initial cost is relatively low.

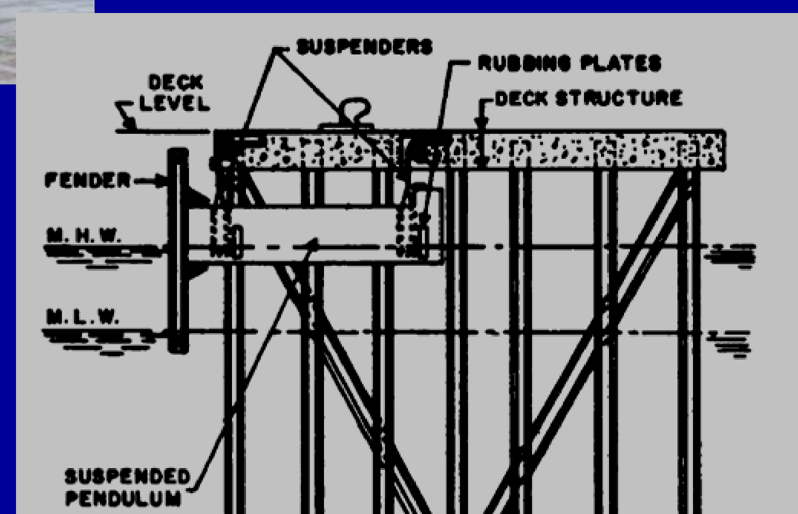
Shortcomings

- Relatively soft with the energy absorption capacity rated at about 60% compression. Not effective in preventing vessel access to the pier columns and the underwater pier “shelf”.
- Little capacity in the longitudinal direction, ineffective and easily damaged after collisions at an angle.
- High maintenance costs of hardware.

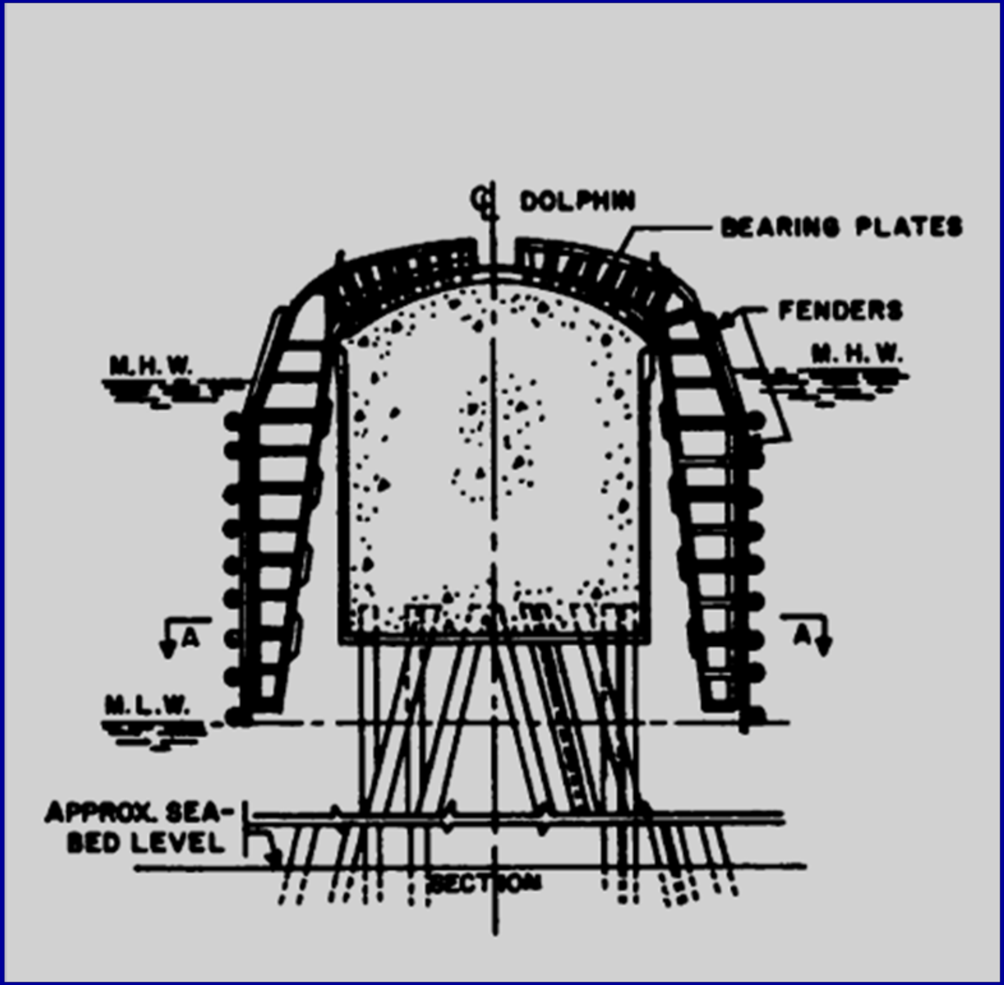
B1. Gravity Type Fenders

Gravity Suspended Fenders





Gravity Bell Fender



B1. Gravity Type Fenders

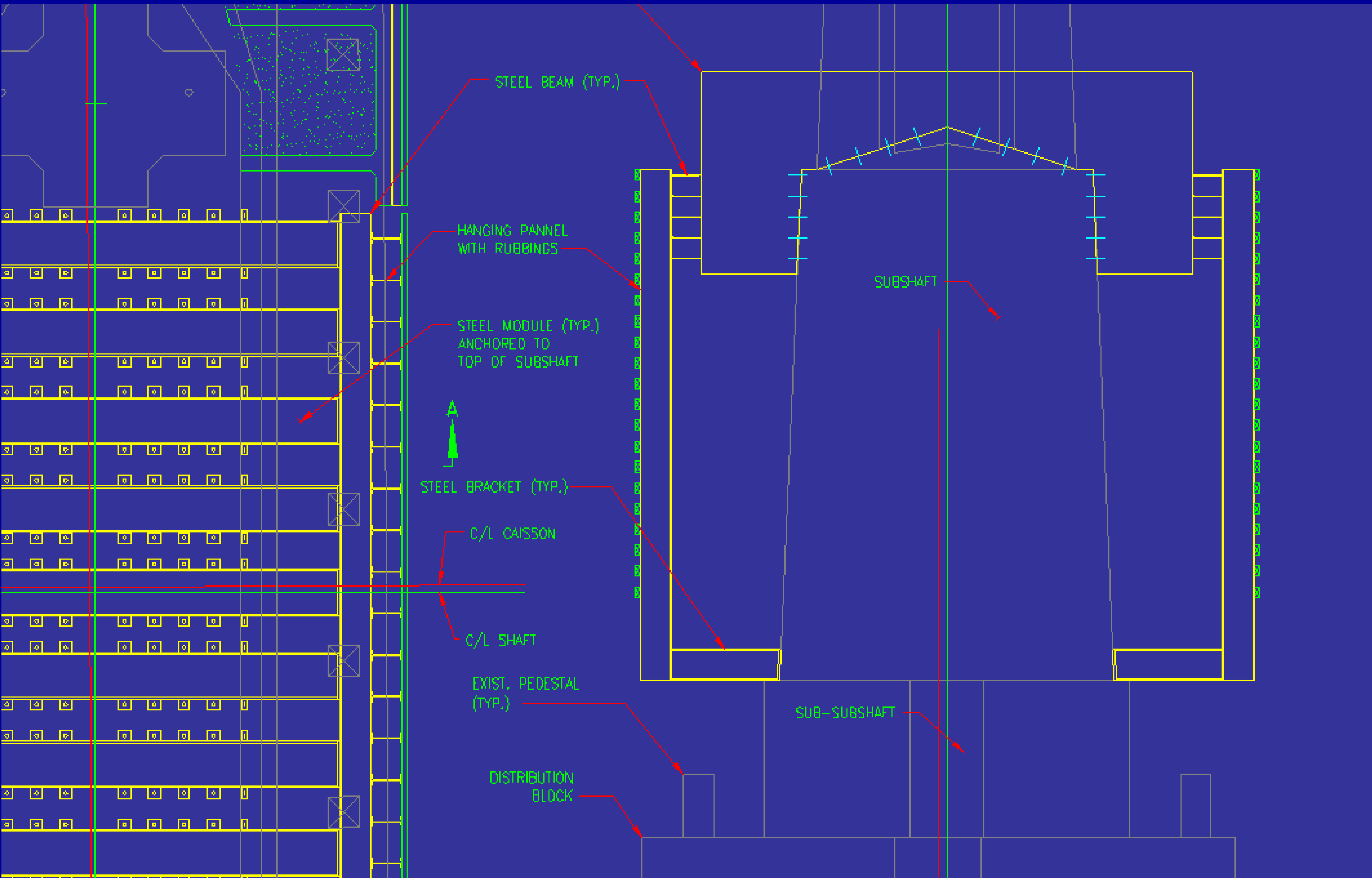
Attributes

- High energy-absorption and large impact load reductions can be achieved over long travel distance.

Shortcomings

- There is a need for large displacement for the fender to be effective.
- A strong supporting structure is required.
- Heavy equipment is necessary for installation and replacement.
- High initial and maintenance costs.
- Supporting structure can be damaged by ship’s overhang.

B2. Fixed Fender Supported on the Top of the Subshaft



B2. Fixed Fender Supported on the Top of the Subshaft

Attributes

- Underwater work is minimized.

Shortcomings

- The main supporting structure at the top of the subshaft is exposed to impact by ship's overhang.
- Difficult fabrication of the many elements involved.
- Can be easily damaged during less severe collisions.
- Relatively high maintenance and repair costs.

Alternative Fender Types Evaluated

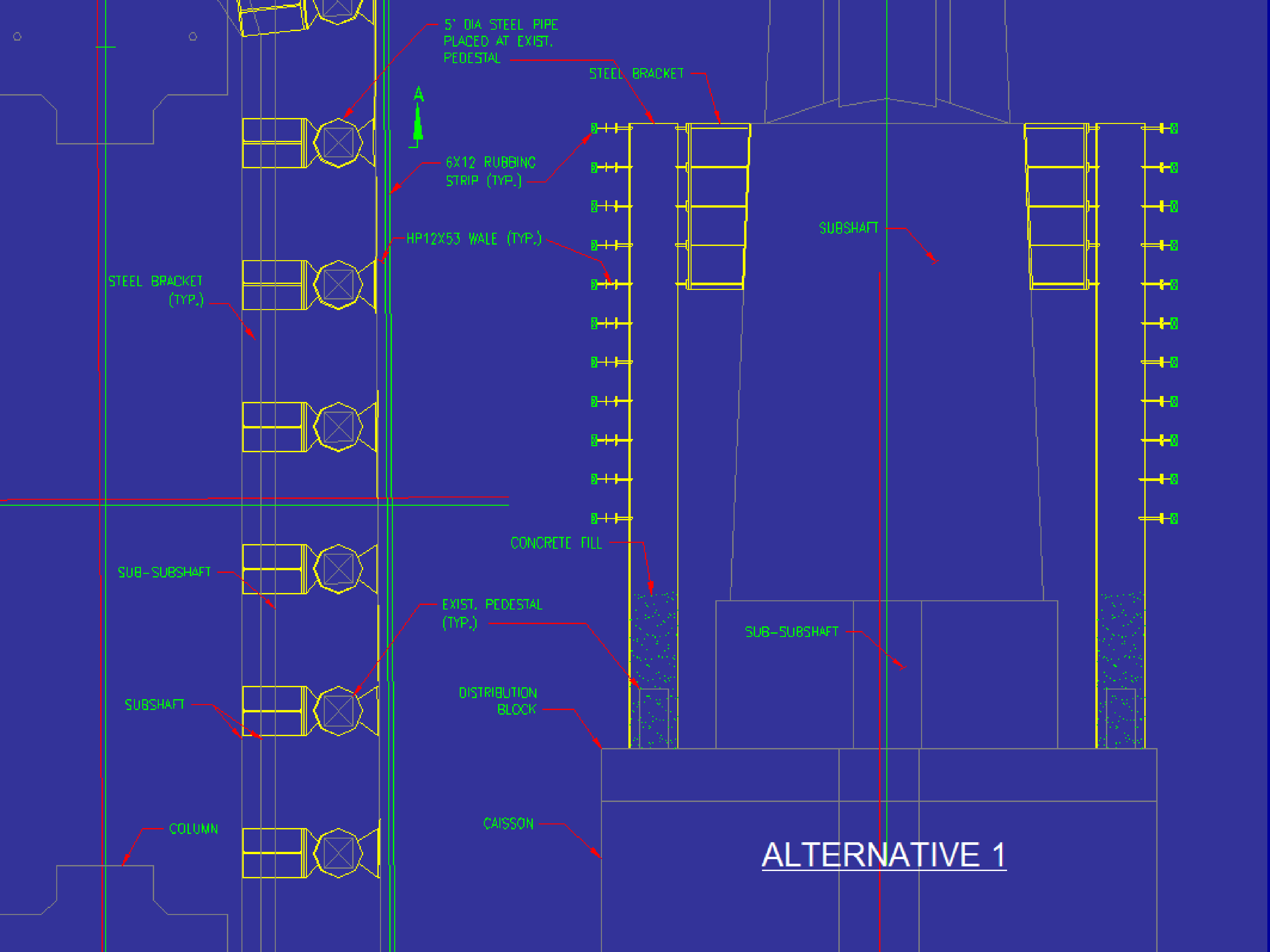
Alternative 1 – Steel Pipe Fender

Alternative 2 – Full Height Precast Concrete Cells

Alternative 3 – Steel Pipes with Brackets and Precast Concrete Modules

Alternative 4 – Steel Pipes with Full Depth Precast Concrete Modules

Alternative 5 – Full Depth Precast Concrete Modules


5' DIA STEEL PIPE PLACED AT EXIST. PEDESTAL
STEEL BRACKET
A
6X12 RUBBING STRIP (TYP.)
HP12X53 WALE (TYP.)
SUBSHAFT
STEEL BRACKET (TYP.)
CONCRETE FILL
SUB-SUBSHAFT
EXIST. PEDESTAL (TYP.)
SUB-SUBSHAFT
DISTRIBUTION BLOCK
SUBSHAFT
CAISSON
COLUMN
ALTERNATIVE 1

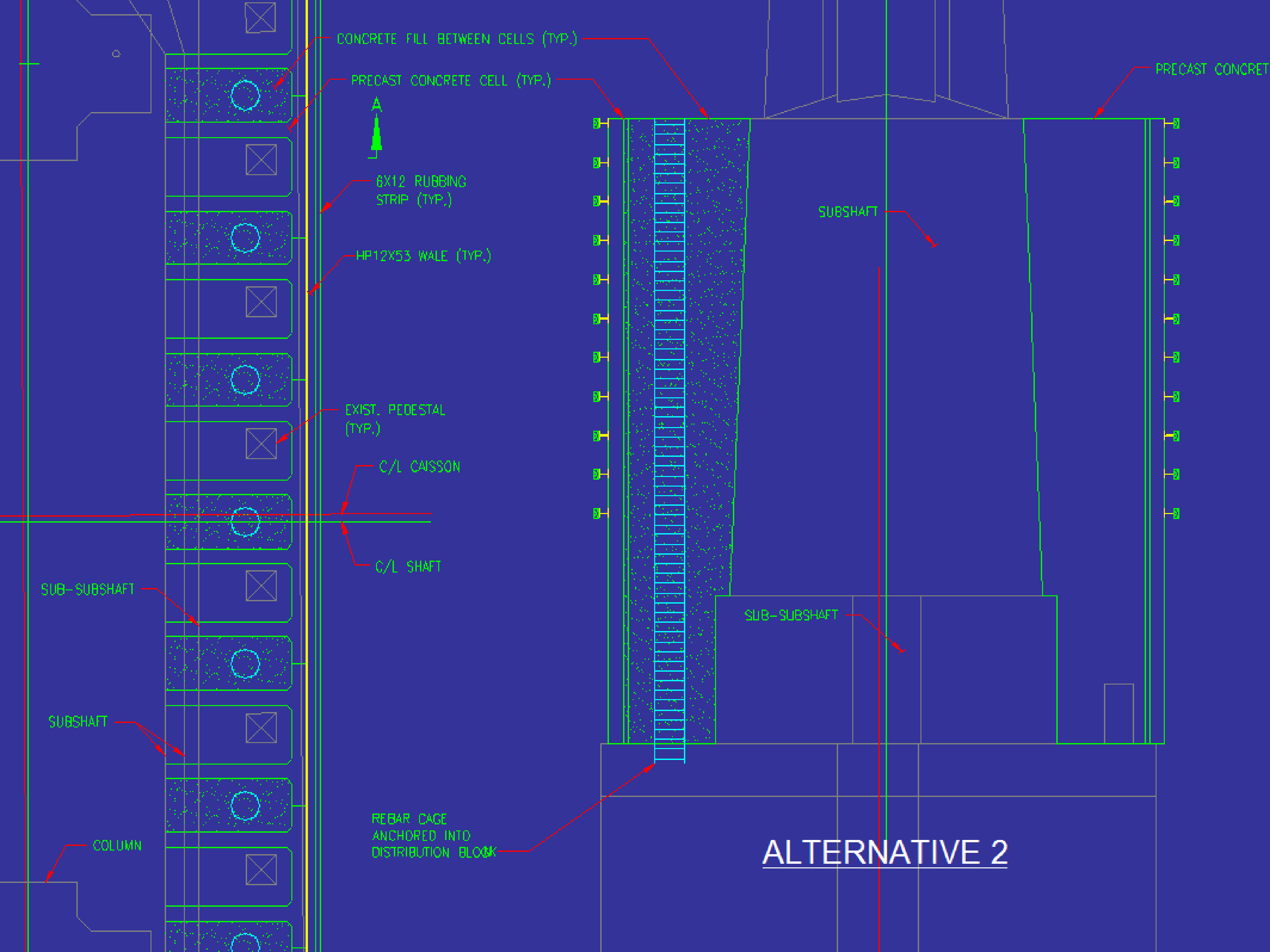
Alternative 1 – Steel Pipe Fender

Attributes

- Relatively simple installation.
- Relatively low initial cost.

Shortcomings

- Low strength in the longitudinal direction.
- Difficult fabrication of the brackets due to varying geometry and need to match existing geometry.
- Can be easily damaged during less severe collisions.
- Relatively high repair costs.



CONCRETE FILL BETWEEN CELLS (TYP.)
PRECAST CONCRETE CELL (TYP.)
A
6X12 RUBBING STRIP (TYP.)
HP12X53 WALE (TYP.)
EXIST. PEDESTAL (TYP.)
C/L CAISSON
C/L SHAFT
SUB-SUBSHAFT
SUBSHAFT
COLUMN
REBAR CAGE ANCHORED INTO DISTRIBUTION BLOCK
PRECAST CONCRET
SUBSHAFT
SUB-SUBSHAFT
ALTERNATIVE 2

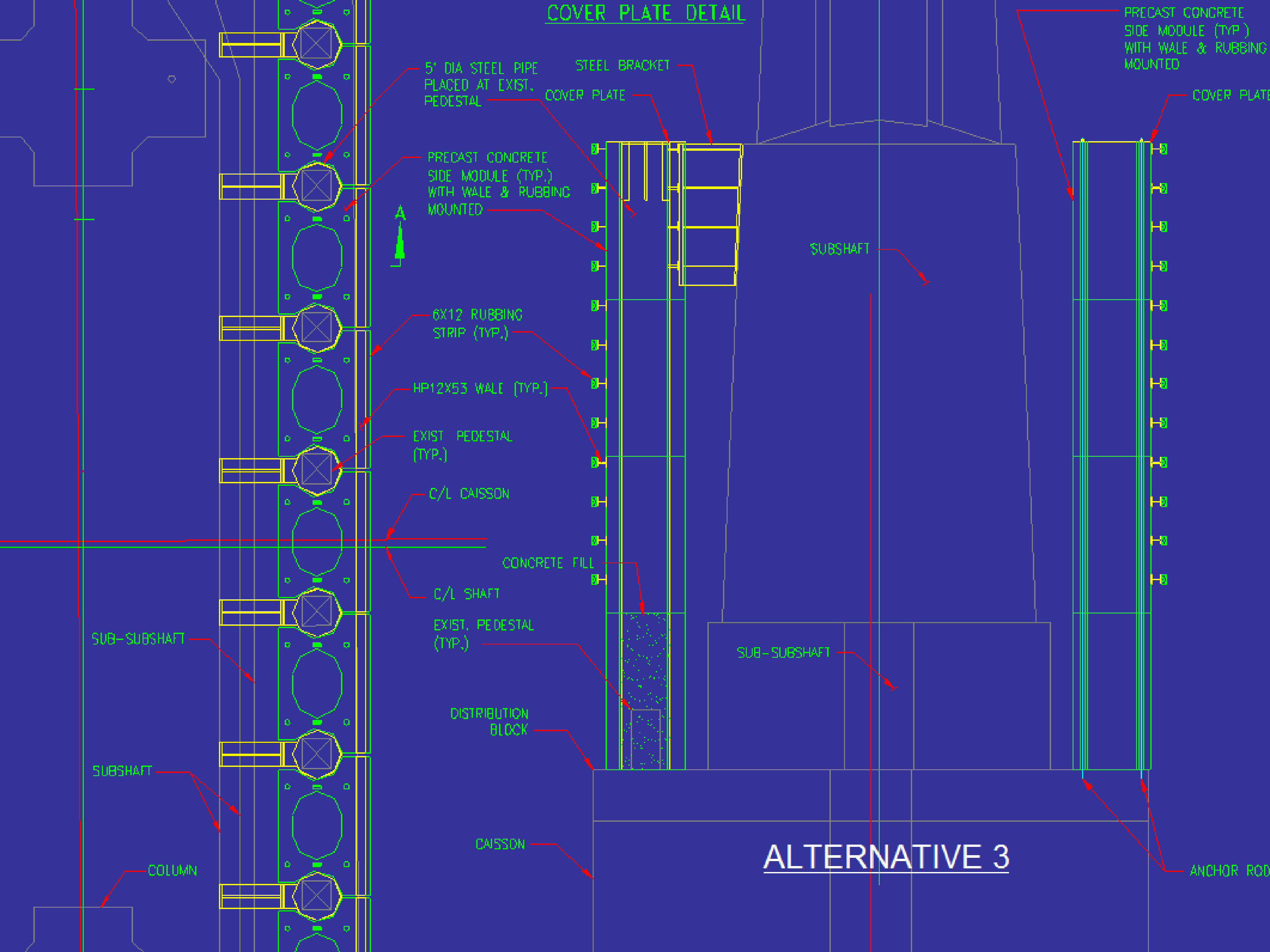
Alternative 2 – Full Height Precast Concrete Cells

Attributes

- Relatively fast installation.
- Not likely to be damaged during collisions.
- Satisfies performance requirements for the nose sections of the fender
- Low maintenance costs.

Shortcomings

- Difficult fabrication of the cells due to varying geometry and need to match existing geometry.
- Requires higher capacity cranes.
- Difficult repairs and relatively high repair costs.



ALTERNATIVE 3

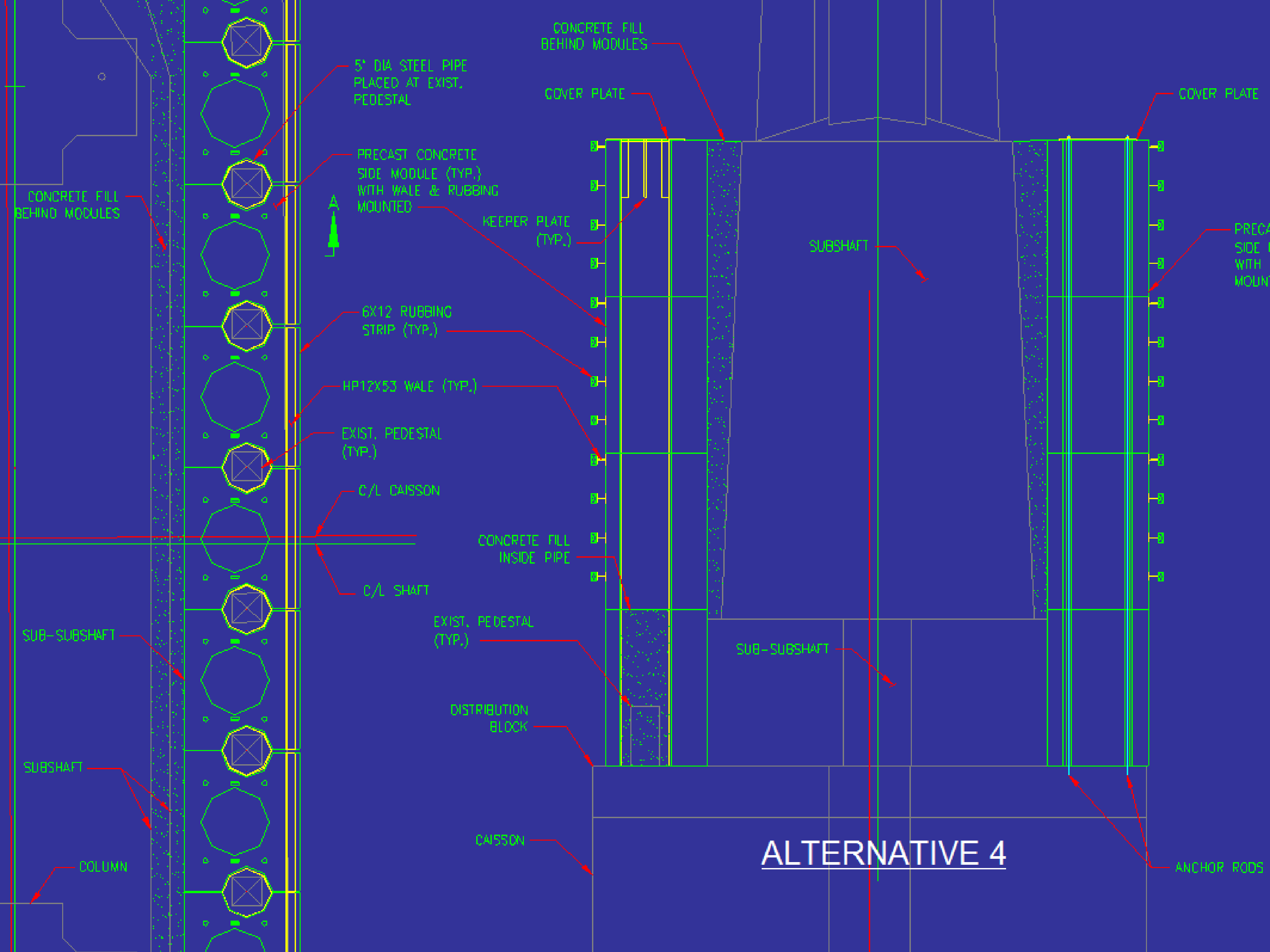
Alternative 3 – Steel Pipes with Brackets and Precast Concrete Modules

Attributes

- Satisfies performance requirements for both the nose and the side sections of the fender.
- Damaged concrete modules can be replaced.

Shortcomings

- Difficult fabrication of the brackets due to varying geometry and need to match existing geometry.
- Difficult repair of the steel pipes and brackets if they too get damaged.


CONCRETE FILL
BEHIND MODULES
5' DIA STEEL PIPE
PLACED AT EXIST.
PEDESTAL
COVER PLATE
COVER PLATE
PRECAST CONCRETE
SIDE MODULE (TYP.)
WITH WALE & RUBBING
MOUNTED
CONCRETE FILL
BEHIND MODULES
A
KEEPER PLATE
(TYP.)
SUBSHAFT
6X12 RUBBING
STRIP (TYP.)
HP12X53 WALE (TYP.)
EXIST. PEDESTAL
(TYP.)
C/L CAISSON
C/L SHAFT
CONCRETE FILL
INSIDE PIPE
EXIST. PEDESTAL
(TYP.)
SUB-SUBSHAFT
SUB-SUBSHAFT
DISTRIBUTION
BLOCK
SUBSHAFT
CAISSON
COLUMN
ANCHOR RODS
ALTERNATIVE 4

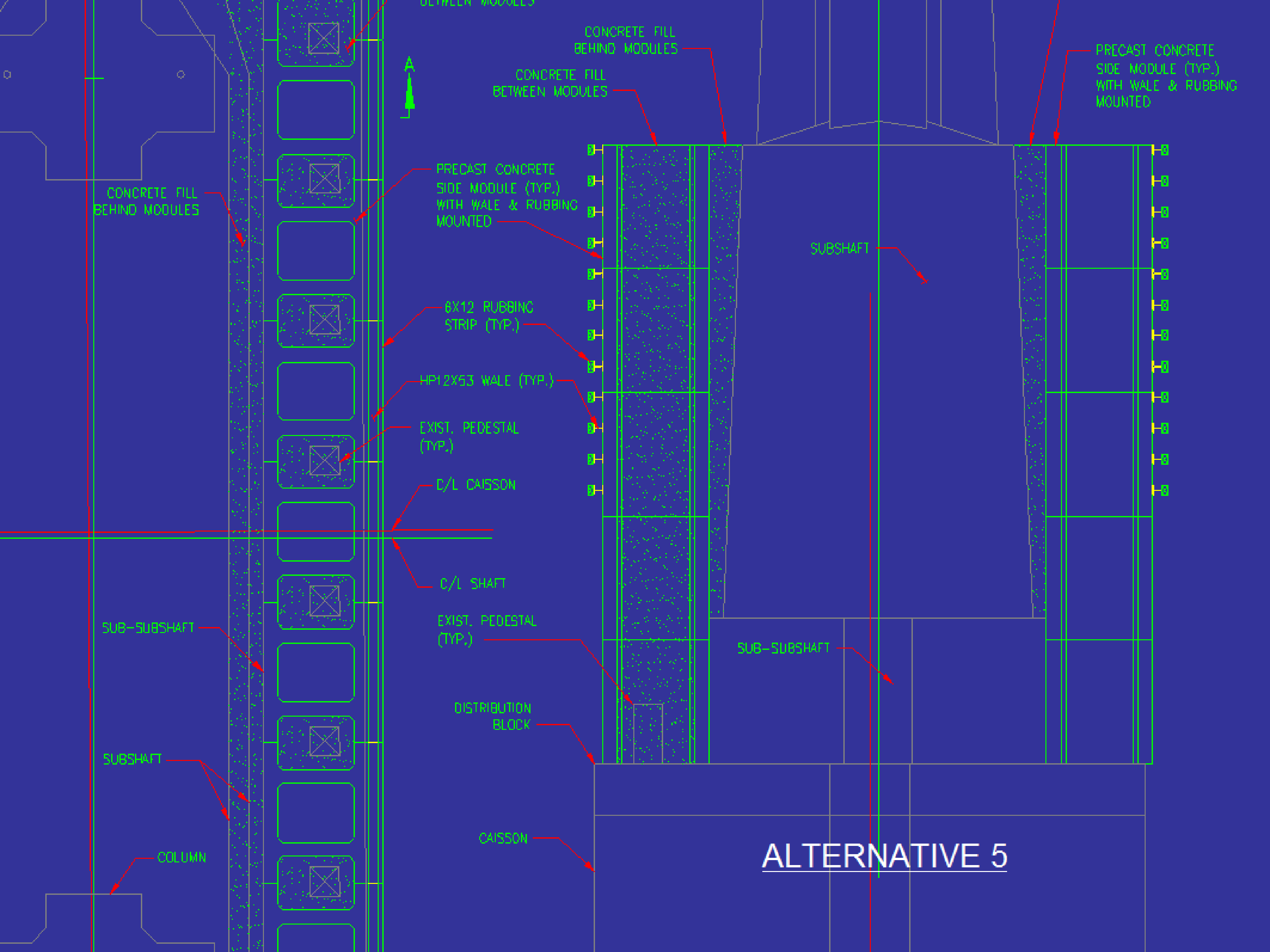
Alternative 4 – Steel Pipes with Full Depth Precast Concrete Modules

Attributes

- Satisfies performance requirements for both the nose and the side sections of the fender.
- Damaged concrete modules can be replaced.

Shortcomings

- Difficult fabrication of the temporary brackets and modules due to varying geometry and need to match existing geometry.
- Difficult repair of the steel pipes if they too get damaged.


CONCRETE FILL BEHIND MODULES
CONCRETE FILL BETWEEN MODULES
PRECAST CONCRETE SIDE MODULE (TYP.) WITH WALE & RUBBING MOUNTED
A
CONCRETE FILL BEHIND MODULES
PRECAST CONCRETE SIDE MODULE (TYP.) WITH WALE & RUBBING MOUNTED
SUBSHAFT
8X12 RUBBING STRIP (TYP.)
HP12X53 WALE (TYP.)
EXIST. PEDESTAL (TYP.)
C/L CAISSON
C/L SHAFT
SUB-SUBSHAFT
EXIST. PEDESTAL (TYP.)
SUB-SUBSHAFT
DISTRIBUTION BLOCK
SUBSHAFT
CAISSON
COLUMN
ALTERNATIVE 5

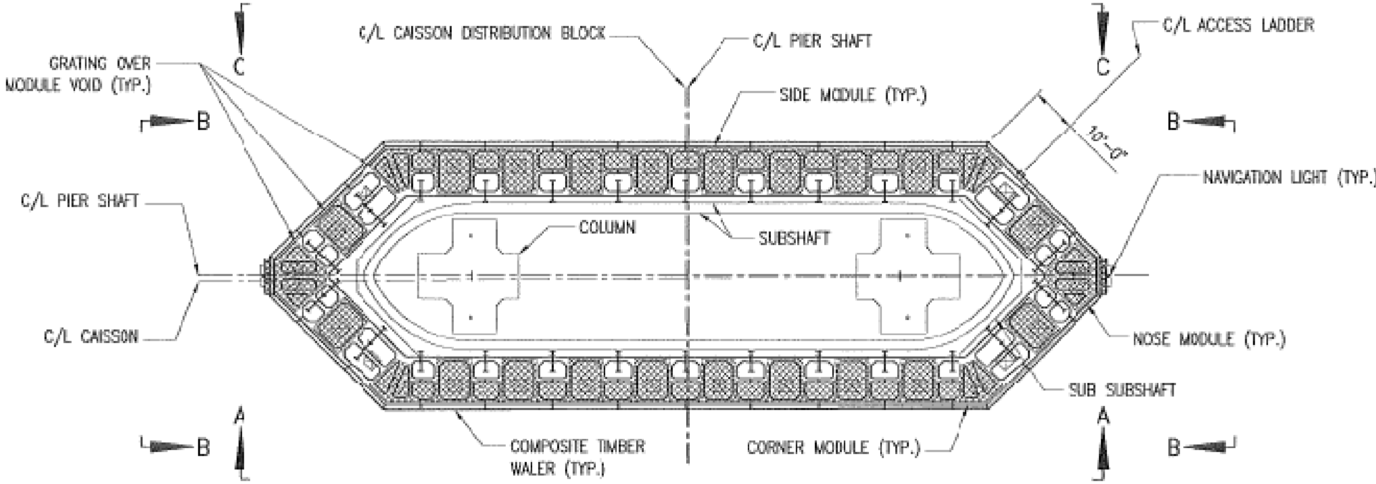
Alternative 5 – Full Depth Precast Concrete Modules

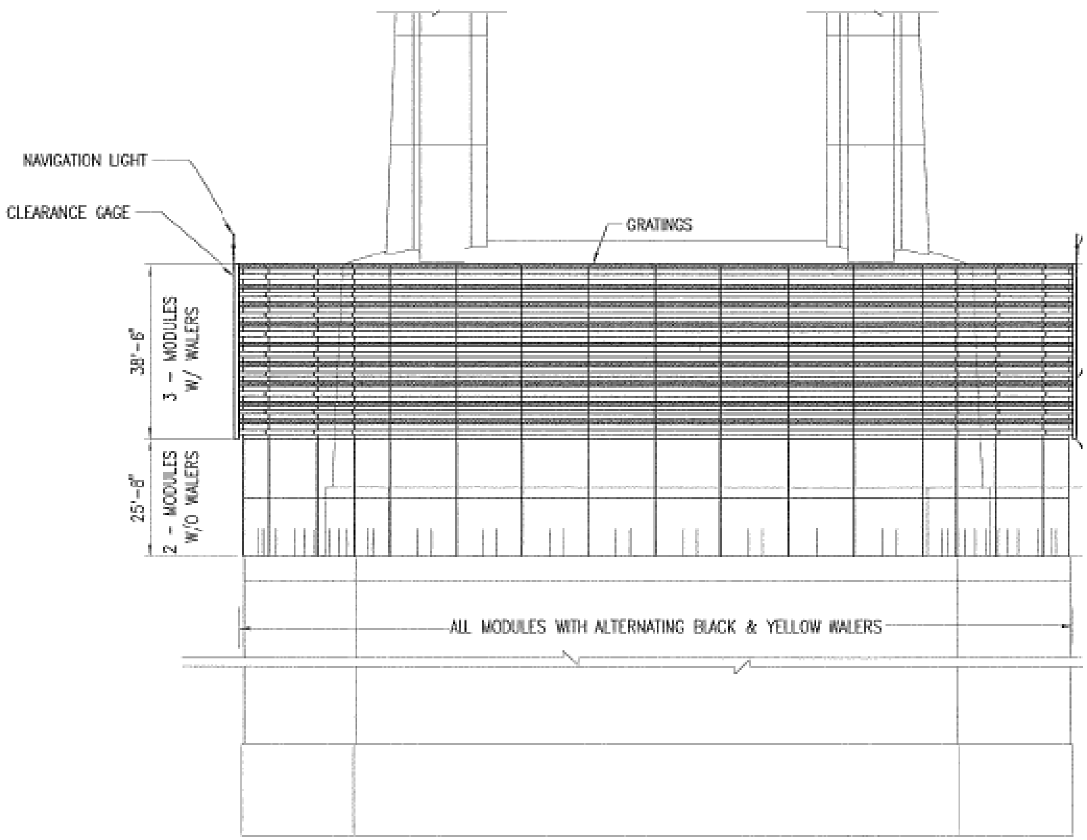
Attributes

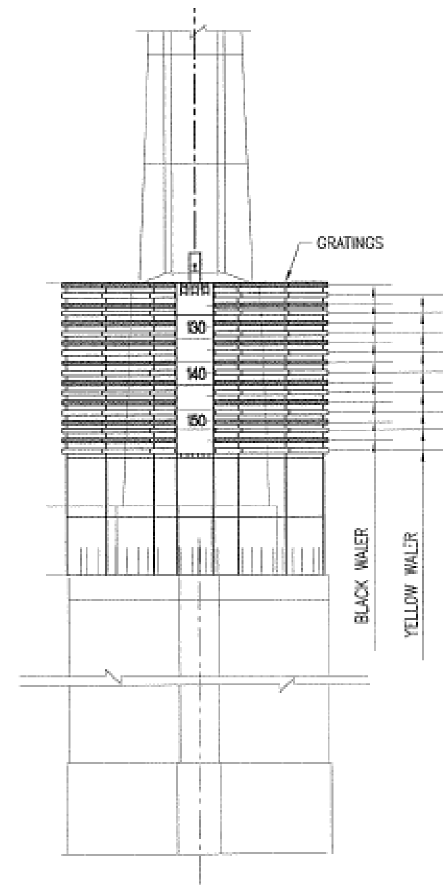
- Satisfies performance requirements for both the nose and the side sections of the fender.
- Damaged concrete modules can be replaced.

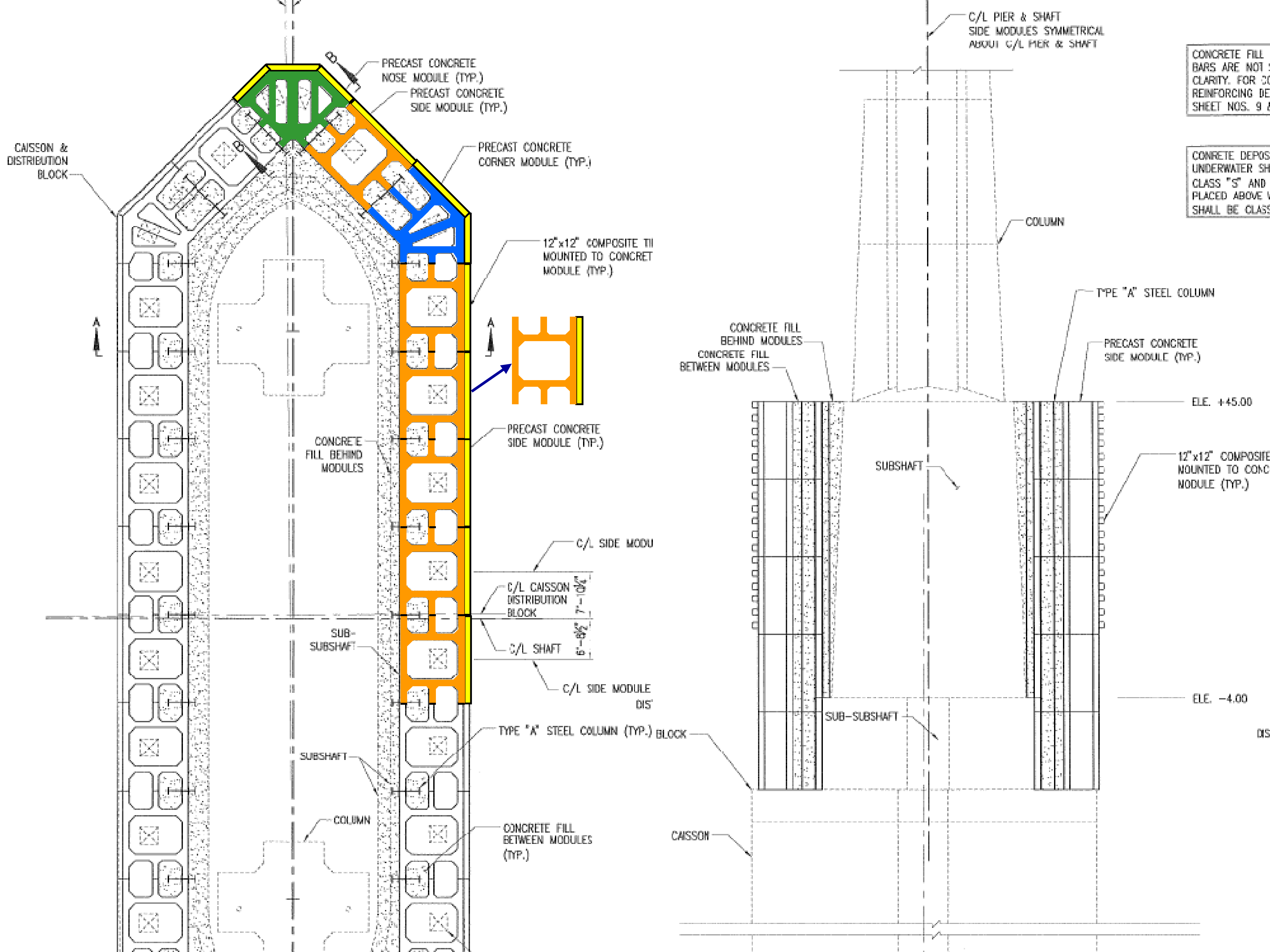
Shortcomings

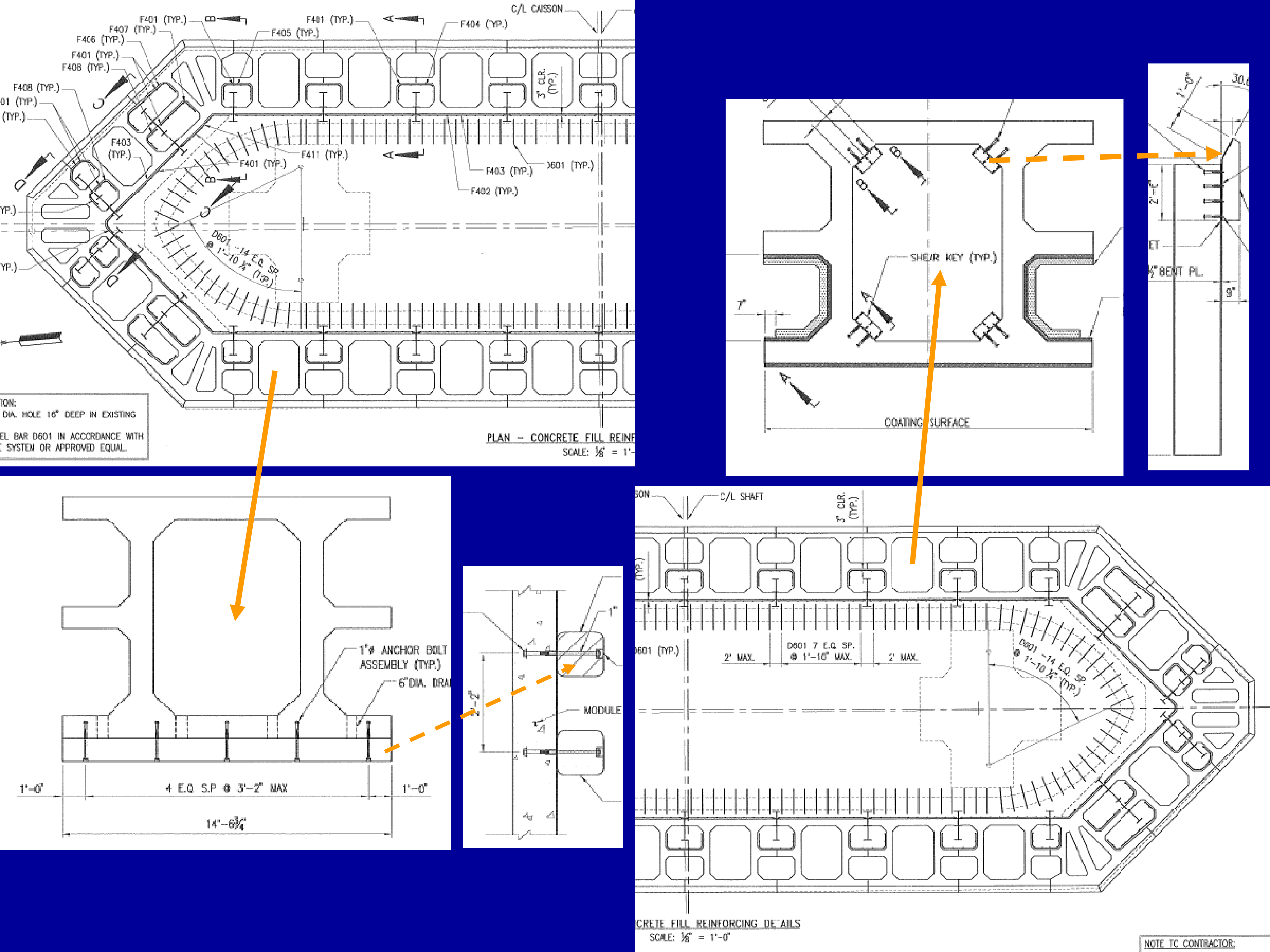
- There is more effort involved in the erection of the bottom concrete modules.

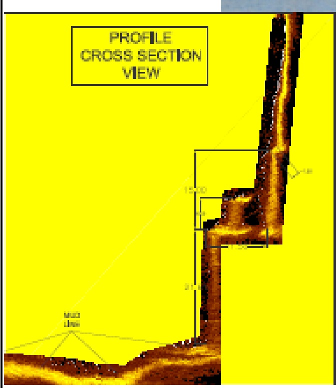

C/L CAISSON DISTRIBUTION BLOCK
C/L PIER SHAFT
C/L ACCESS LADDER
GRATING OVER MODULE VOID (TYP.)
SIDE MODULE (TYP.)
10'-0"
NAVIGATION LIGHT (TYP.)
C/L PIER SHAFT
COLUMN
SUBSHAFT
C/L CAISSON
NOSE MODULE (TYP.)
SUB SUBSHAFT
COMPOSITE TIMBER WALER (TYP.)
CORNER MODULE (TYP.)
A
B
C

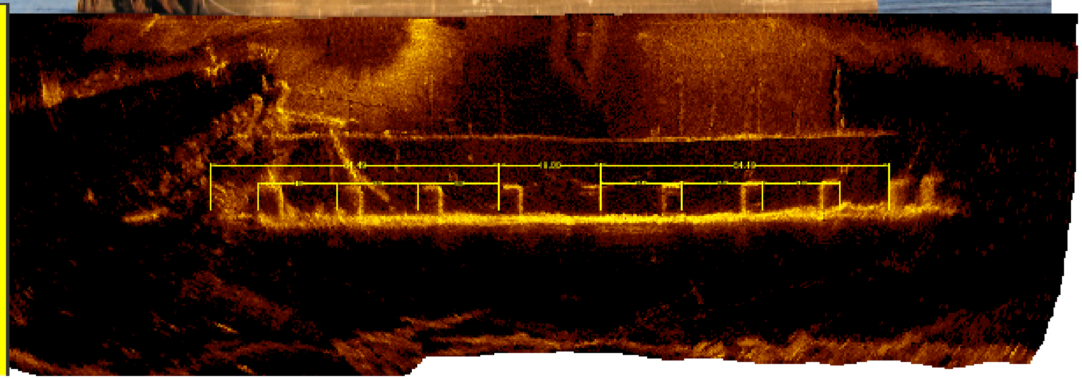

NAVIGATION LIGHT
CLEARANCE GAGE
GRATINGS
38'-6"
3 - MODULES W/ WALERS
25'-8"
2 - MODULES W/O WALERS
ALL MODULES WITH ALTERNATING BLACK & YELLOW WALERS


GRATINGS
130
140
150
BLACK WALER
YELLOW WALER


PRECAST CONCRETE NOSE MODULE (TYP.)
PRECAST CONCRETE SIDE MODULE (TYP.)
CAISSON & DISTRIBUTION BLOCK
PRECAST CONCRETE CORNER MODULE (TYP.)
12"x12" COMPOSITE TI MOUNTED TO CONCRET MODULE (TYP.)
A
A
PRECAST CONCRETE SIDE MODULE (TYP.)
CONCRETE FILL BEHIND MODULES
C/L SIDE MODU
C/L CAISSON DISTRIBUTION BLOCK
C/L SHAFT
SUB-SUBSHAFT
C/L SIDE MODULE DIS'
TYPE "A" STEEL COLUMN (TYP.)
SUBSHAFT
COLUMN
CONCRETE FILL BETWEEN MODULES (TYP.)
C/L PIER & SHAFT SIDE MODULES SYMMETRICAL ABOUT C/L PIER & SHAFT
CONCRETE FILL BARS ARE NOT CLARITY. FOR CO REINFORCING DE SHEET NOS. 9 &
CONRETE DEPOS UNDERWATER SH CLASS "S" AND PLACED ABOVE SHALL BE CLASS
COLUMN
TYPE "A" STEEL COLUMN
CONCRETE FILL BEHIND MODULES
CONCRETE FILL BETWEEN MODULES
PRECAST CONCRETE SIDE MODULE (TYP.)
ELE. +45.00
SUBSHAFT
12"x12" COMPOSITE MOUNTED TO CONC MODULE (TYP.)
ELE. -4.00
SUB-SUBSHAFT
BLOCK
CAISSON
DIS


F401 (TYP.)
F407 (TYP.)
F406 (TYP.)
F408 (TYP.)
F405 (TYP.)
F404 (TYP.)
C/L CAISSON
3" CLR. (TYP.)
F403 (TYP.)
F401 (TYP.)
F411 (TYP.)
F403 (TYP.)
F402 (TYP.)
D601 (TYP.)
D601 -14 E.Q. SP. @ 1'-10 ½" (TYP.)
DIA. HOLE 16" DEEP IN EXISTING
EL BAR D601 IN ACCORDANCE WITH
SYSTEM OR APPROVED EQUAL.
PLAN - CONCRETE FILL REINF
SCALE: ⅛" = 1'-
SHEAR KEY (TYP.)
7"
COATING SURFACE
1'-0"
30.0
2'-6"
½" BENT PL.
9"
1"ø ANCHOR BOLT
ASSEMBLY (TYP.)
6" DIA. DRA
1'-0"
4 E.Q. S.P @ 3'-2" MAX
1'-0"
14'-6¾"
2'-2"
1"
MODULE
C/L SHAFT
3" CLR. (TYP.)
D601 (TYP.)
2' MAX.
D601 7 E.Q. SP. @ 1'-10" MAX.
2' MAX.
D601 -14 E.Q. SP. @ 1'-10 ½" (TYP.)
CRETE FILL REINFORCING DETAILS
SCALE: ⅛" = 1'-0"
NOTE TO CONTRACTOR:





VICINITY MAP

MODJESKI and MASTERS
Consulting Engineers
SINCE 1893

DRAWING LEGEND

SONAR POSITION

SYSTEM DAMAGE REINSPECTION

I-10 BRIDGE PIER #5 FENDER

PIER FACE – WEST SIDE
EAST BATON ROUGE PARISH, LOUISIANA

DETAIL

SHEET 1 OF 2

FENSTERMAKER