Lecture 3
Structural Issues During Construction

Alan D. Fisher, PE
Construction Structures Group Leader

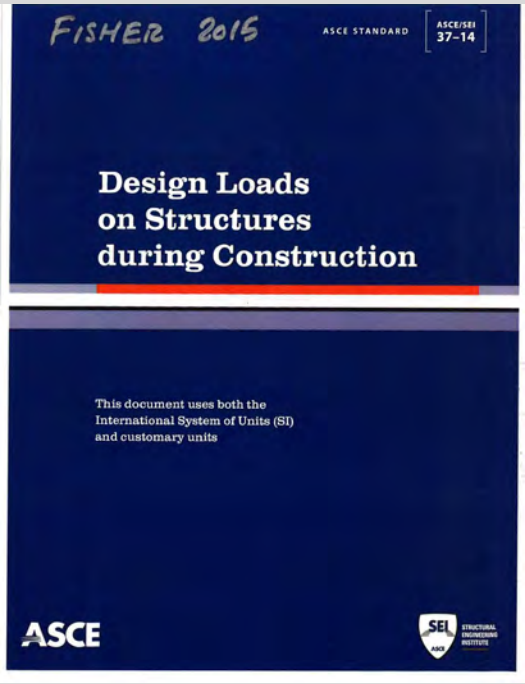
To do the impossible, you must see the invisible

Line from a Tetley Tea Tag

Structural Issues During Construction

Part 1

- General Resources
- Casco Bay Bridge Cofferdam Issue
- North Bound Gold Star Bridge Emergency Repairs
- Mystic River Bridge Construction Design Engineering



General Resources

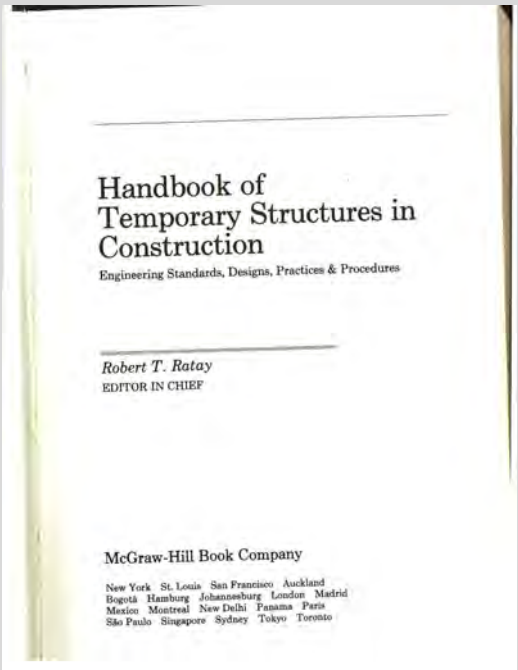
ASCE/SEI 37-14

- Multiple Topics
- LRFD and ASD
- Dead Loads
- Live Loads
- Construction Loads
- Environmental Loads
- Ties to ASCE 7-10

General Resources

Department of Labor 29 CFR 1926 OSHA Construction Industry Regulations

- Multiple Topics
- Some Loads
- Some tabulated solutions
- Guidelines for excavations that do not require a PE
- Coming close to recognizing that design affects site safety
- Has a vague connection to design engineers.

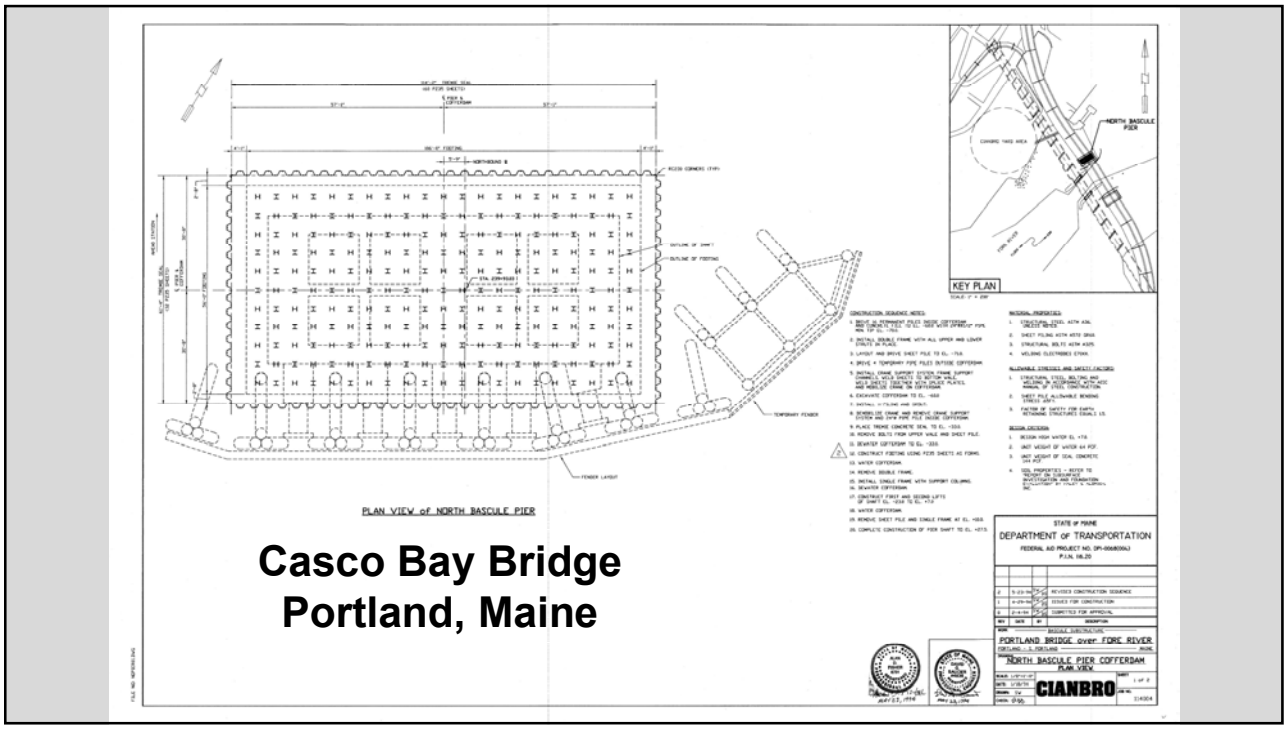


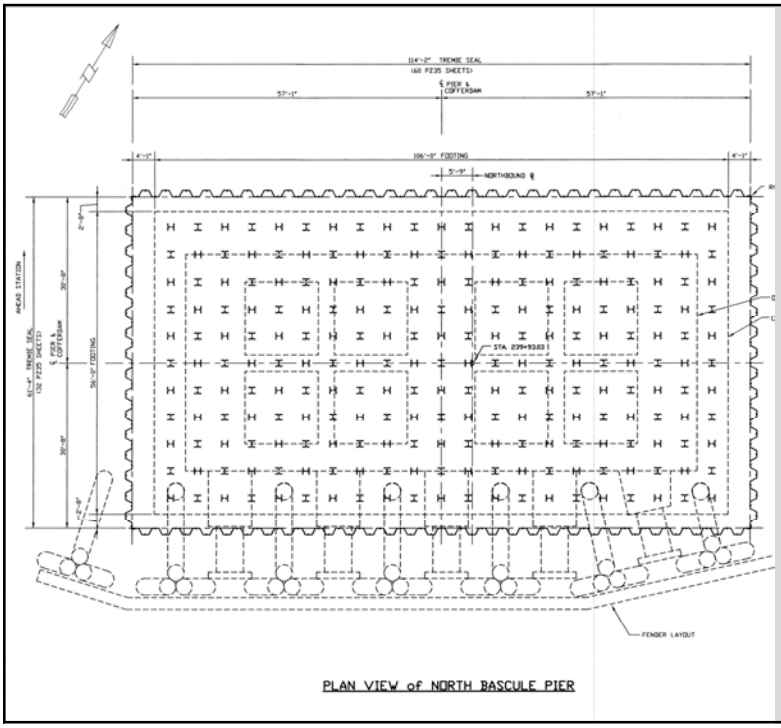
General Resources

Handbook of Temporary Structures in Construction

Robert T. Ratay, Editor in Chief

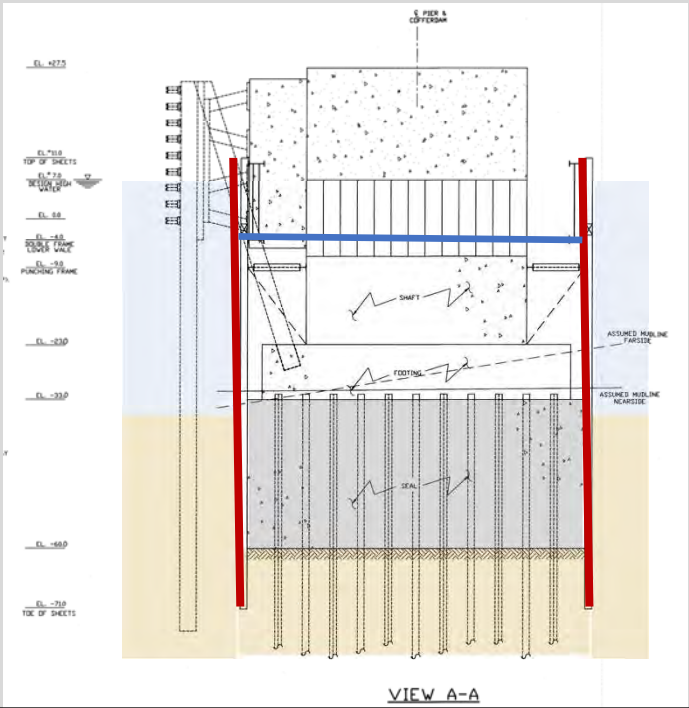
- Origin of ASCE 37 Committee and Standard
- Handbook of Construction Structures
- Comprehensive coverage of topic
- First reference for Construction Structures


KEY PLAN
NORTH BASCULE PIER
PLAN VIEW of NORTH BASCULE PIER
Casco Bay Bridge
Portland, Maine
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
PORTLAND BRIDGE over FORE RIVER
NORTH BASCULE PIER COFFERDAM
PLAN VIEW
CIANBRO



Casco Bay Bridge Bascule Pier Cofferdam

- Plan area 61 ft x 114 ft
- 231 HP 14 x 117 piles
- Pile tip (pre-drilled) el -132
- Pile tip (not drilled) el -121
- Design capacity 200 tons
- Test load 600 tons



Casco Bay Bridge Bascule Pier Cofferdam

- Design high water el +7
- Existing bottom el -30
- Top of tremie el -33
- Bottom of tremie el -60

- Top frame el +10
- Lower frame el -4

- Dewatered depth 40 ft
- Max pressure 2800 psf
- Force on lower wale 23 klf

CIANBRO — ENGINEERING BACKUP SHEET

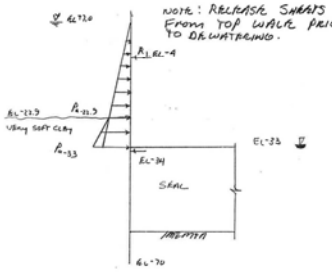
Project PORTLAND - S.PORTLAND Date 2-3-94 Sheet 49 78

Subject BASCULE PIER COFFERDAMS Job No. 118004 Initials SDS

CASE III DEWATER STAGE I FORM FOOTING & SHAFT TO EL -7

FRAME DESIGN DESIGN HIGH WATER EL 77.0

NOTE: RELEASE SHEARS FROM TOP WALK PRISM TO DK WATERLINE.



$P_{-22.9} = 64(69) = 1314$ psf

$P_{-33} = 64(41) + 50(1)(10.1) = 3123$ psf

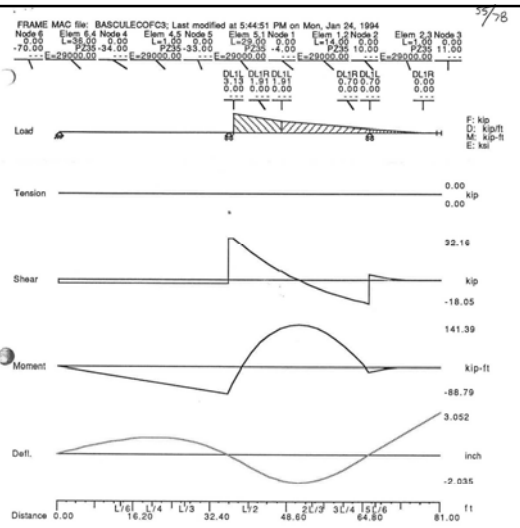
REFER TO COMPUTER OUTPUT

$R_1 = 21.9$ K/ft (compression).

Rev. 12/20/83 ED 313

55/78

FRAME MAC file: BASCULECOFC3; Last modified at 5:44:51 PM on Mon, Jan 24, 1994

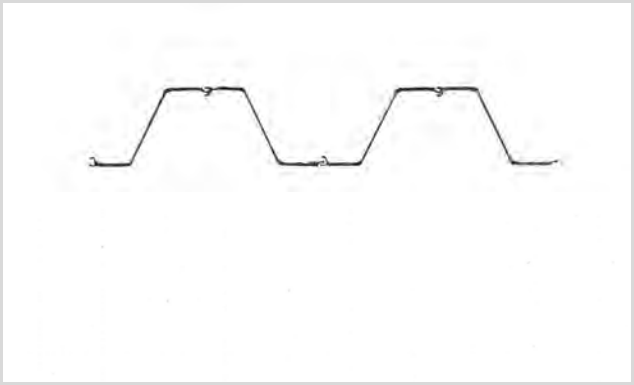


Casco Bay Bridge Bascule Pier Cofferdam

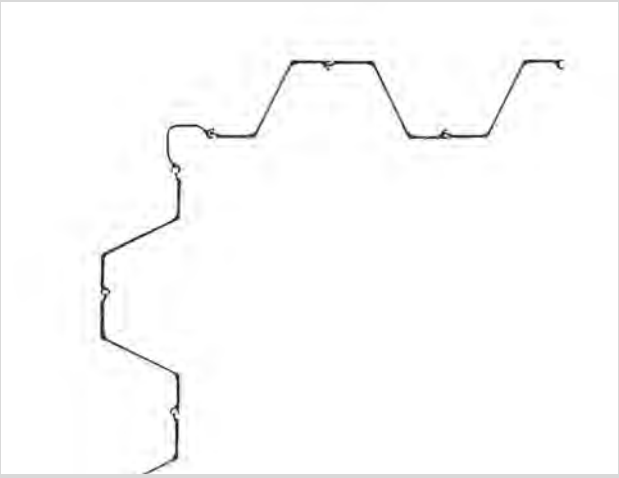
- Design high water el +7
- Top of tremie el -33

- Top of tremie to lower wale 29 ft
- Lower wale to DHW 11 ft

- Dewatered depth 40 ft
- Max pressure 2800 psf
- Force on lower wale 23 klf

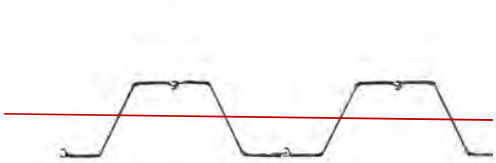


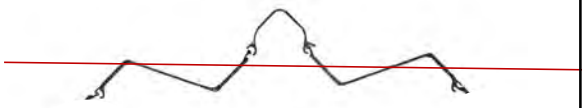
- PZ35 Sheet Pile
- Grade 60
- Moment capacity 158 ft kips / ft
- Actual Moment 142 ft kps / ft
- Anticipated **Δ** = -3” at top wale
- Anticipated **Δ** = +2” at mid height



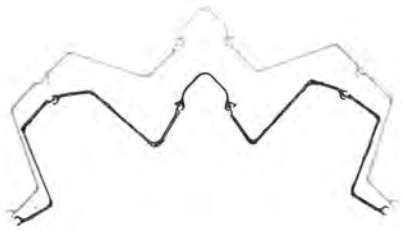
- Expected to see a corner like this

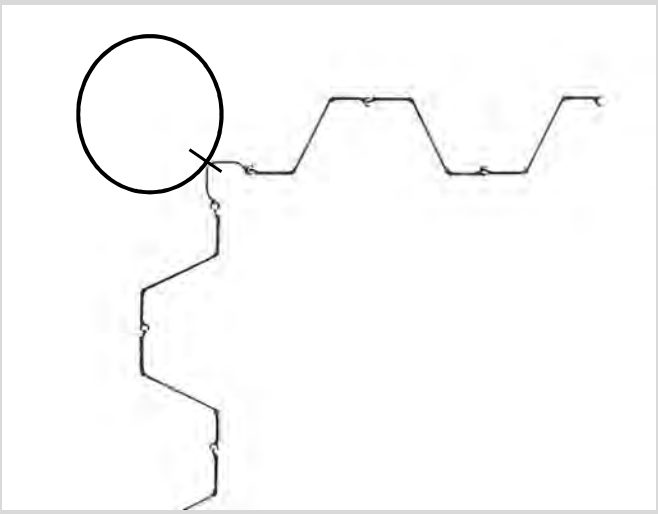
- Found a corner like this





- 8 inches deflection vs
- 2 inches expected
- Corner had about ¼ the moment of inertia of the straight run of sheets





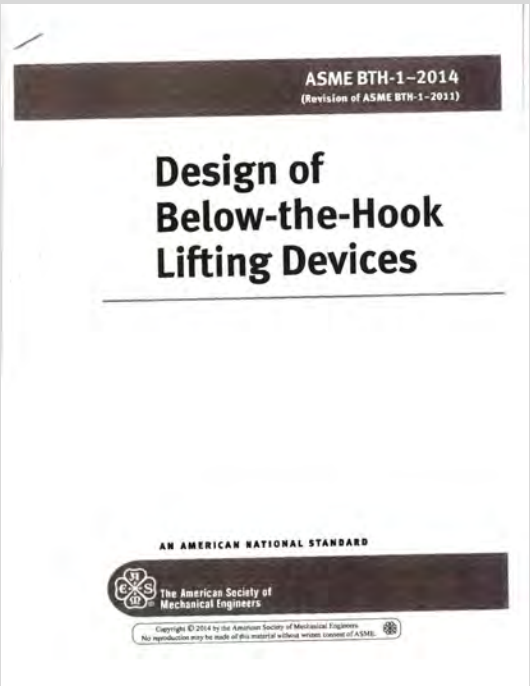
- Solution for next Cofferdam:
  - Reinforce the corners
  - 30” diameter, ½” wall steel pipe
- Solution for this Cofferdam:
  - Quietly weld in supplemental steel braces
- Interesting fact:
  - When pulled, corners and adjacent sheet pile were not permanently distorted

'An inch to the left'

Staff photo by Gordon Chibroski

Workers supervise the lowering of an 82-foot sheet piling for the south side bascule pier of the new Portland-South Portland bridge Thursday. The piling and others will be sunk 50 feet below the river bottom. The pier eventually will serve as the base for one hinge of the drawbridge.

North Bound Gold Star Bridge
Emergency Bearing Replacements
New London, Connecticut
Rigging Engineering



Steel Erection and Rigging Engineering

ASME BTH-1-2014

- Design guide following ASME B30.20
- Design of “spreader” beams
- Design of “pad eyes”

Rigging Engineering ASME B30 Series

B30.1	Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries
B30.2	Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
B30.3	Tower Cranes
B30.4	Portal and Pedestal Cranes
B30.5	Mobile and Locomotive Cranes
B30.6	Derricks
B30.7	Winches
B30.8	Floating Cranes and Floating Derricks
B30.9	Slings
B30.10	Hooks
B30.11	Monorails and Underhung Cranes
B30.12	Handling Loads Suspended From Rotorcraft
B30.13	Storage/Retrieval (S/R) Machines and Associated Equipment
B30.14	Side Boom Tractors
B30.15	Mobile Hydraulic Cranes (withdrawn 1982 — requirements found in latest revision of B30.5)
B30.16	Overhead Hoists (Underhung)
B30.17	Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
B30.18	Stacker Cranes (Top or Under Running Bridge, Multiple Girder With Top or Under Running Trolley Hoist)
B30.19	Cableways
B30.20	Below-the-Hook Lifting Devices
B30.21	Manually Lever-Operated Hoists
B30.22	Articulating Boom Cranes
B30.23	Personnel Lifting Systems
B30.24	Container Cranes
B30.25	Scrap and Material Handlers
B30.26	Rigging Hardware
B30.27	Material Placement Systems
B30.28	Balance Lifting Units
B30.29	Self-Erect Tower Cranes[1]

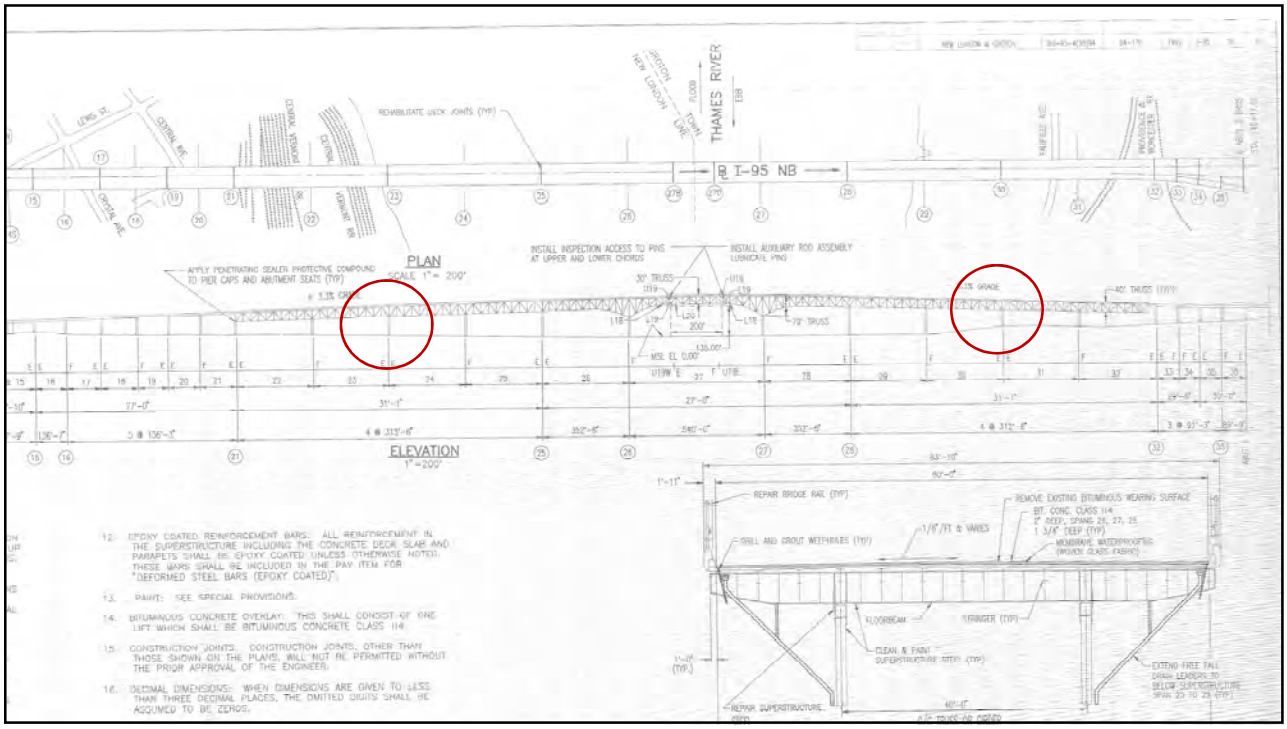
North Bound Gold Star Bridge Team

CTDOT
Robert Obey
Mark Elliott
Eileen Ego

Close, Jenson and Miller
John Miller, Jr.
Tom Ryan
Behrooz Adnani

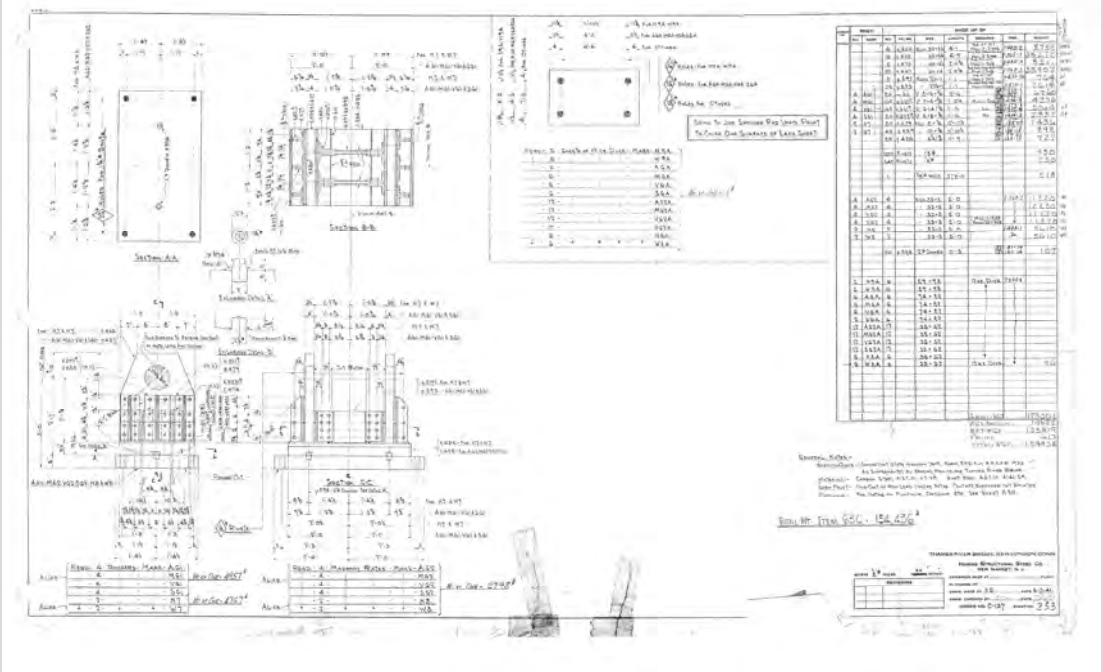
HAKS
Charles Ghosio

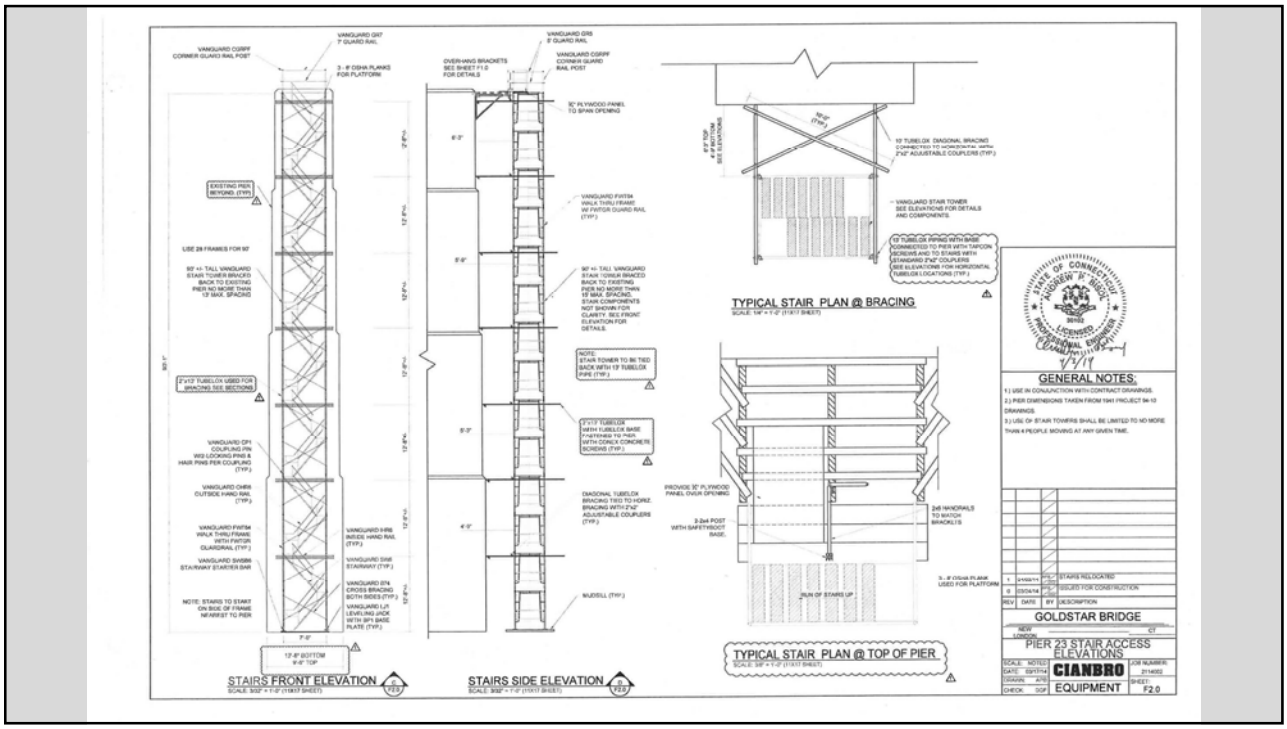
Cianbro
Gary Nash
David Schill
Alan Fisher

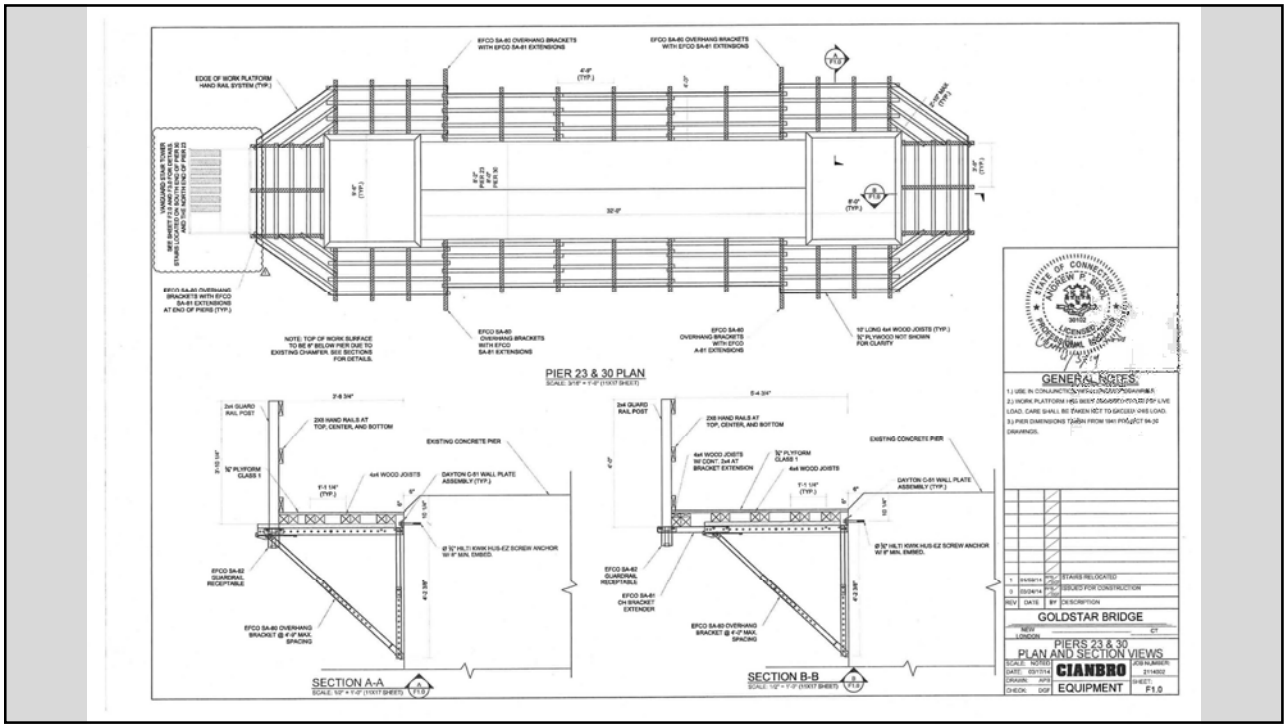


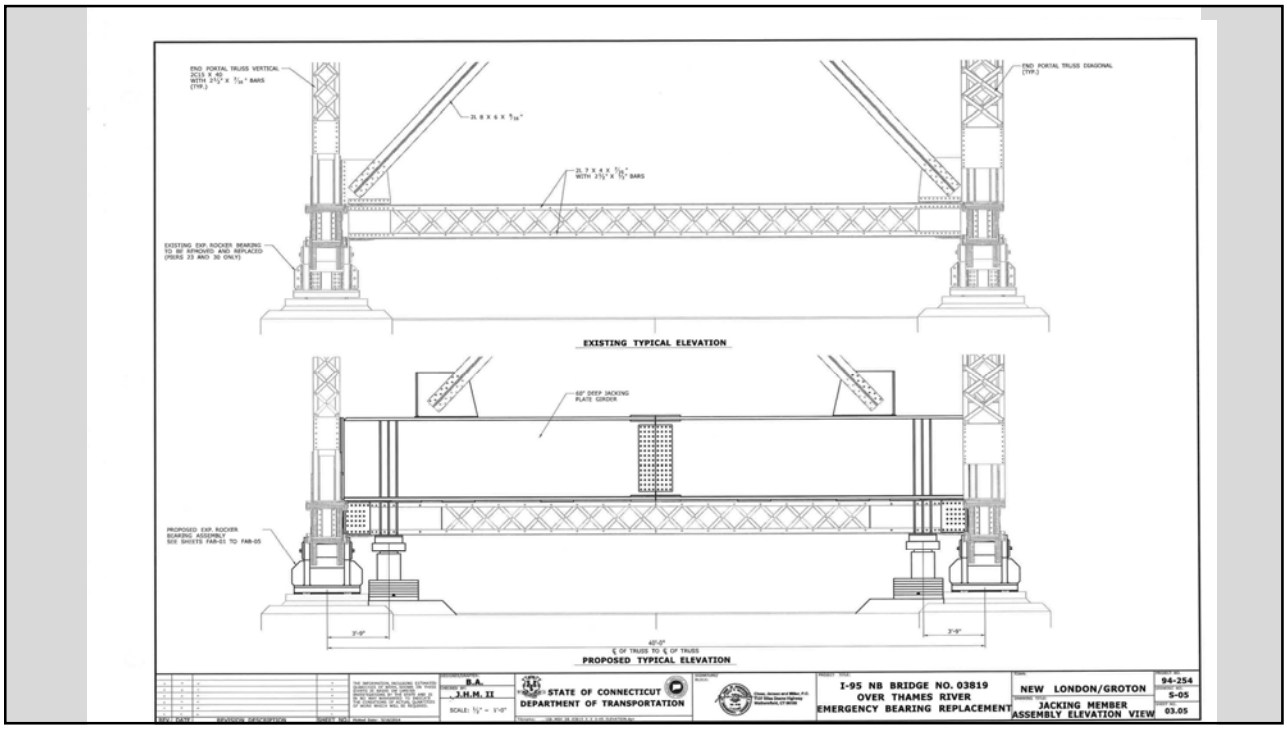
Construction Design Challenges:

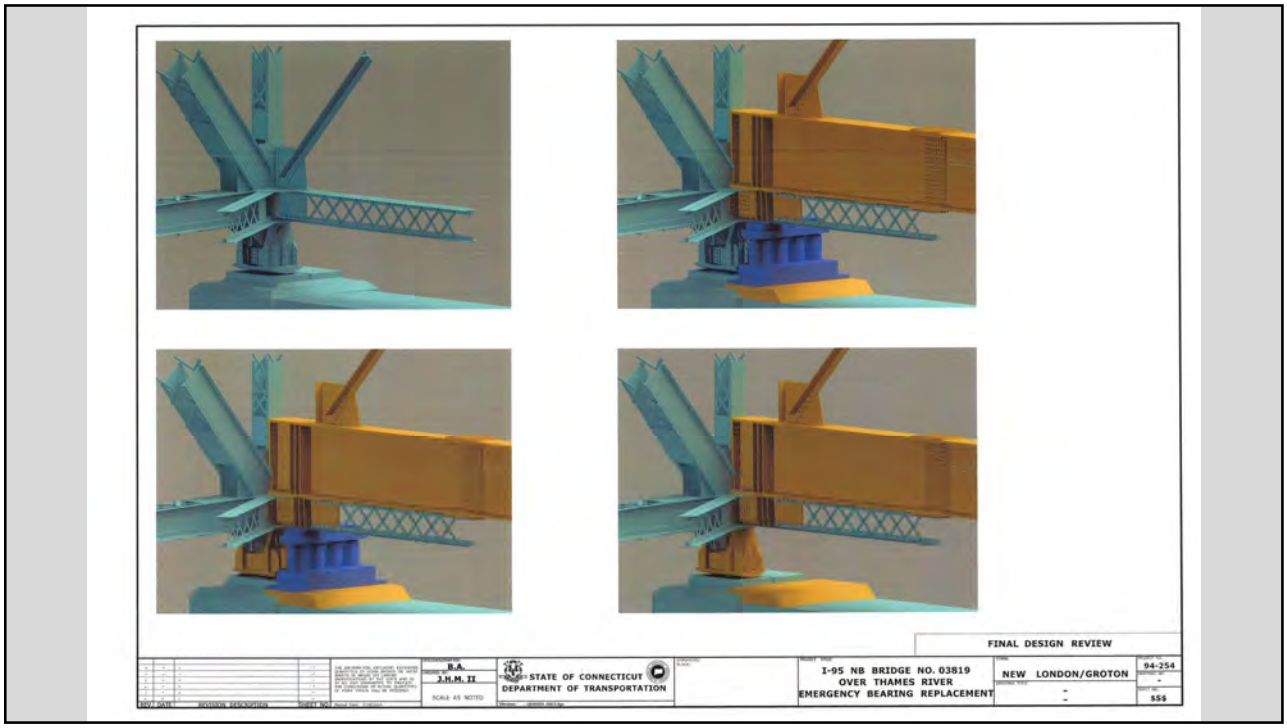
- Access
  - People
  - Materials
- How to get hold of the bridge
- Temp removal of wind braces
- Bearing removal / replacement

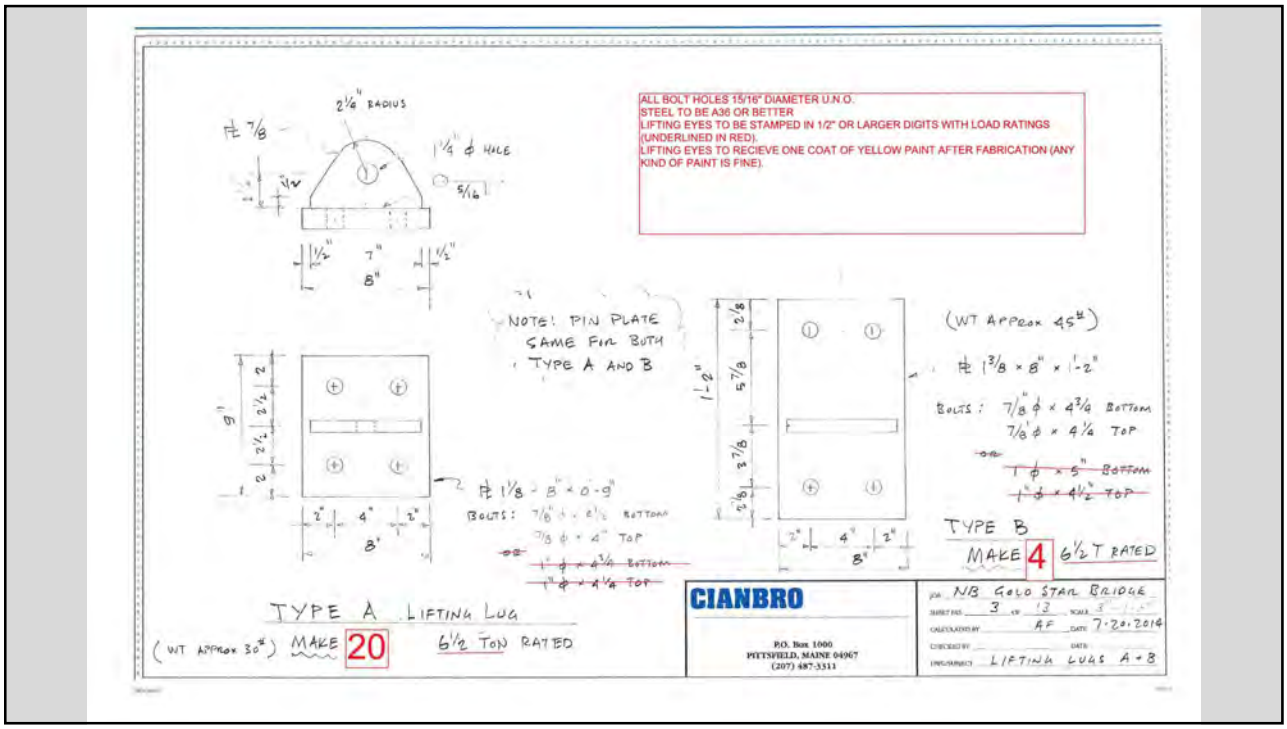


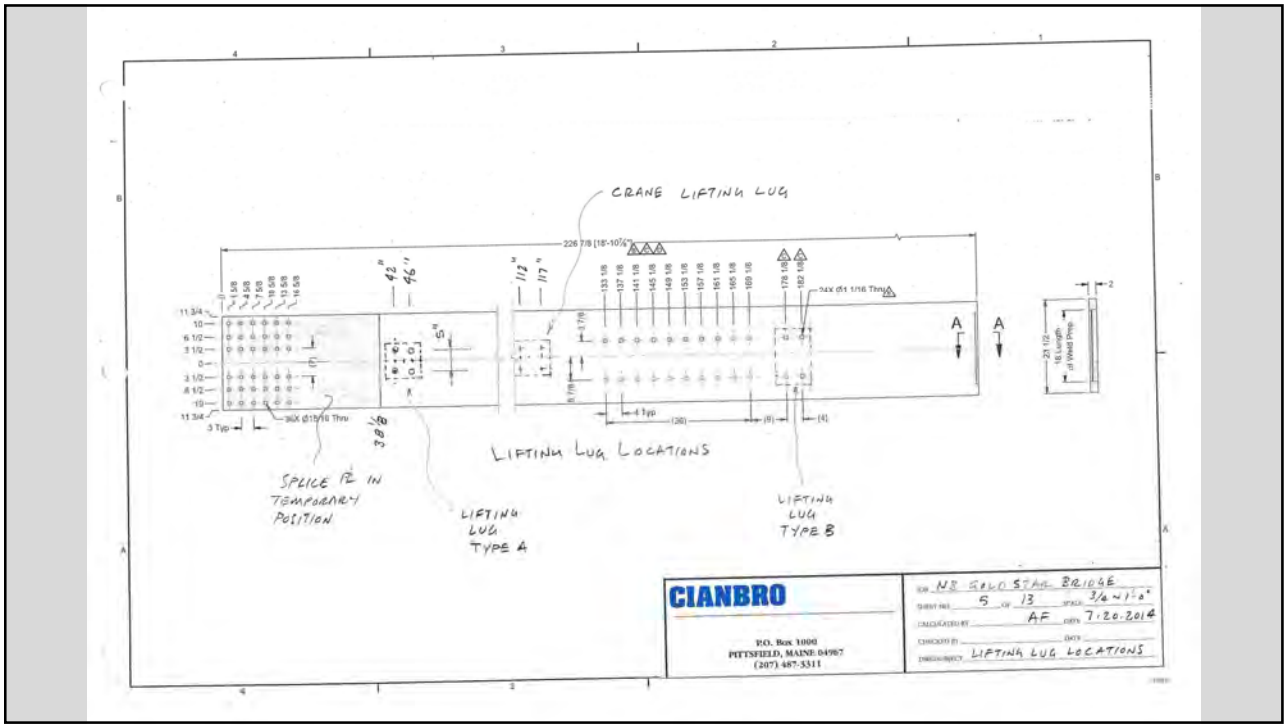

STAIRS FRONT ELEVATION
STAIRS SIDE ELEVATION
TYPICAL STAIR PLAN @ BRACING
TYPICAL STAIR PLAN @ TOP OF PIER
GENERAL NOTES:
1.) USE IN CONJUNCTION WITH CONTRACT DRAWINGS.
2.) PIER DIMENSIONS TAKEN FROM 1941 PROJECT 94-10 DRAWINGS.
3.) USE OF STAIR TOWERS SHALL BE LIMITED TO NO MORE THAN 4 PEOPLE MOVING AT ANY GIVEN TIME.
GOLDSTAR BRIDGE
PIER 23 STAIR ACCESS ELEVATIONS
CIANBRO
EQUIPMENT
F2.0

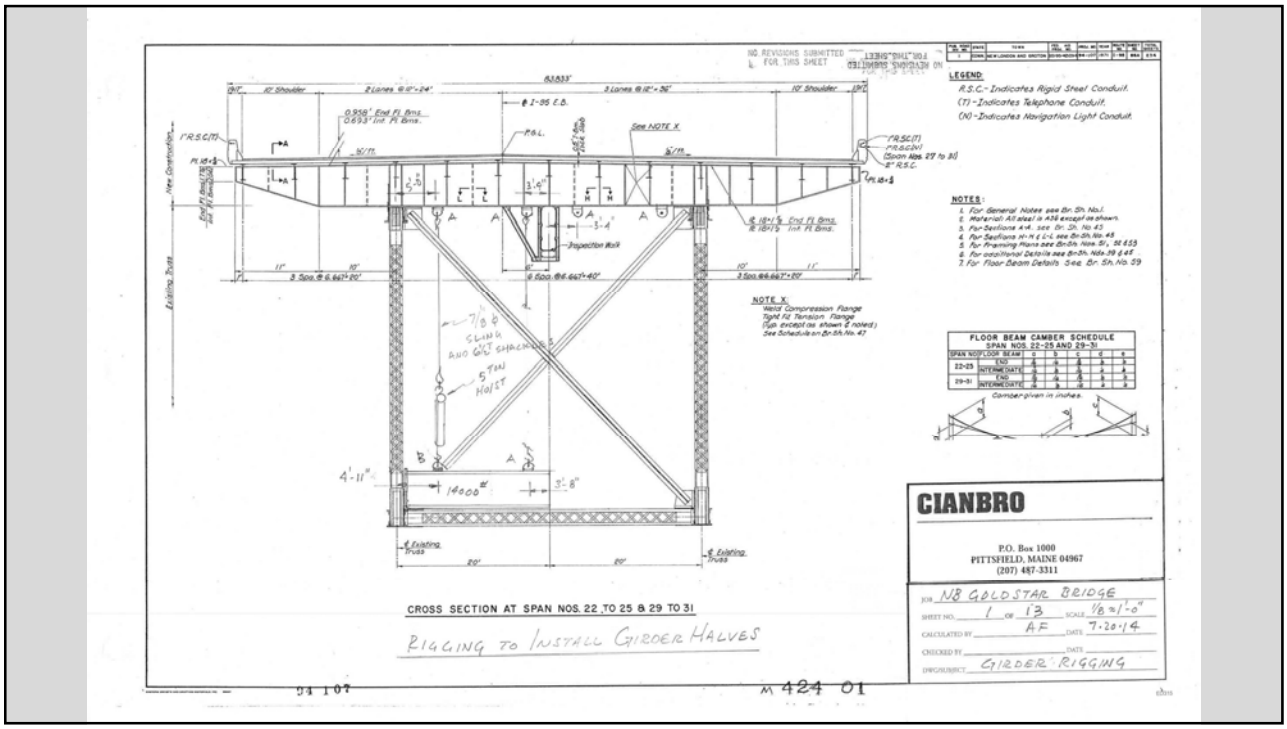

PIER 23 & 30 PLAN
SECTION A-A
SECTION B-B
GENERAL NOTES:
GOLDSTAR BRIDGE
PIERS 23 & 30 PLAN AND SECTION VIEWS
CIANBRO
EQUIPMENT
F1.0

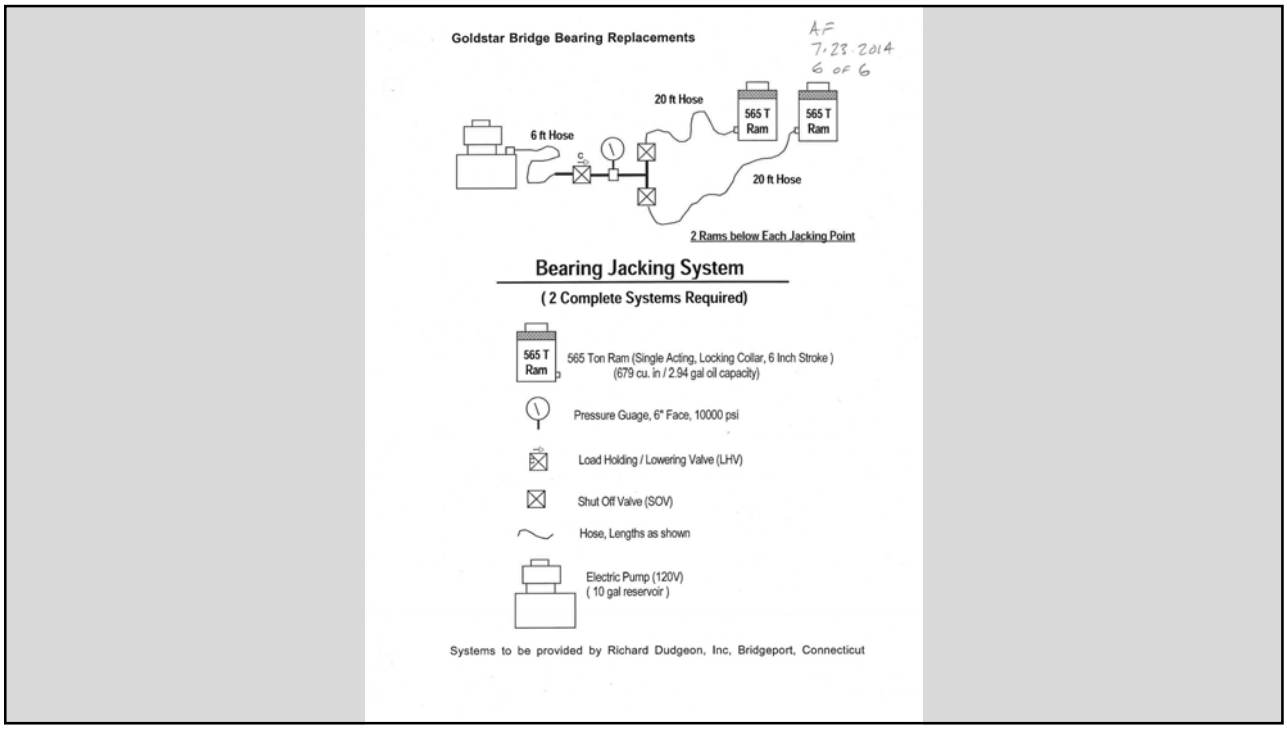

END PORTAL TRUSS VERTICAL
END PORTAL TRUSS DIAGONAL (TYP.)
EXISTING EXP. ROCKER BEARING TO BE REMOVED AND REPLACED (PIERS 25 AND 30 ONLY)
EXISTING TYPICAL ELEVATION
60" DEEP JACKING PLATE GIRDER
PROPOSED EXP. ROCKER BEARING ASSEMBLY SEE SHEETS FAB-01 TO FAB-05
PROPOSED TYPICAL ELEVATION
B.A.
J.H.M. II
STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
I-95 NB BRIDGE NO. 03819
OVER THAMES RIVER
EMERGENCY BEARING REPLACEMENT
NEW LONDON/GROTON
JACKING MEMBER
ASSEMBLY ELEVATION VIEW
94-254
S-05
03.05

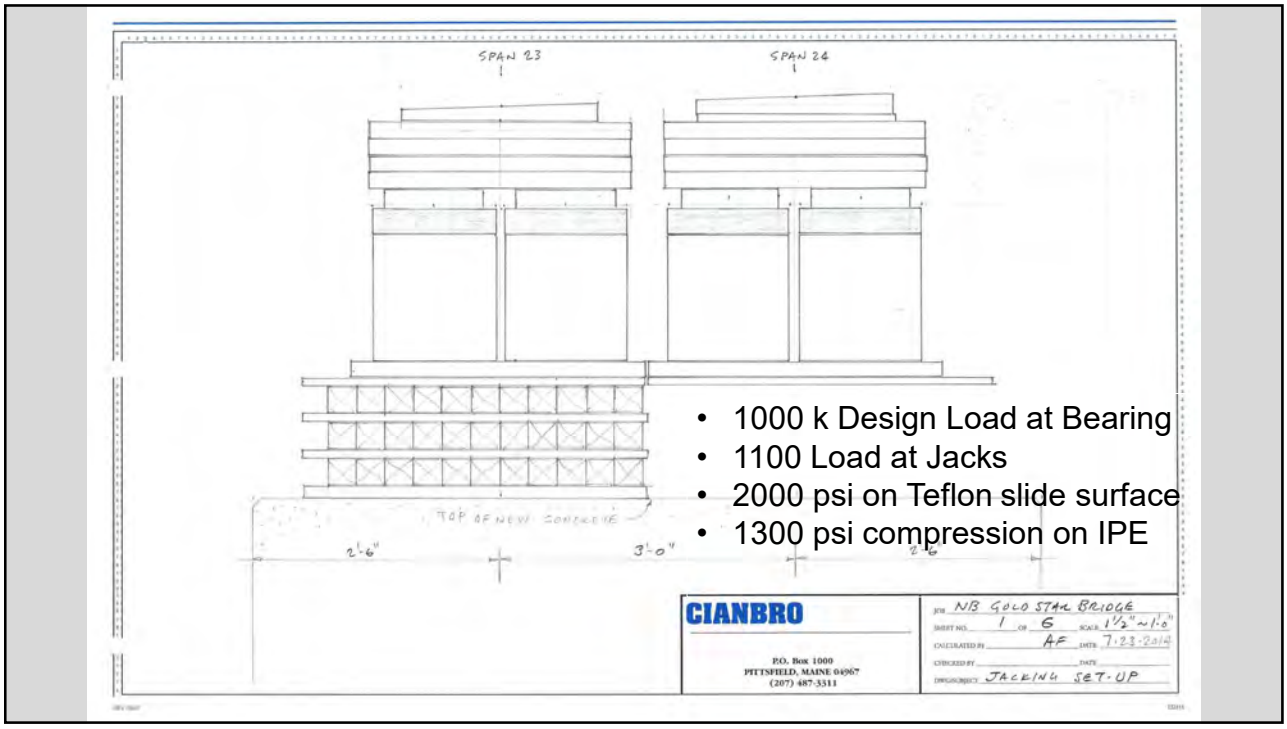

FINAL DESIGN REVIEW
B.A.
J.H.M. II
STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
I-95 NB BRIDGE NO. 03819
OVER THAMES RIVER
EMERGENCY BEARING REPLACEMENT
NEW LONDON/GROTON
94-254
55


ALL BOLT HOLES 15/16" DIAMETER U.N.O.
STEEL TO BE A36 OR BETTER
LIFTING EYES TO BE STAMPED IN 1/2" OR LARGER DIGITS WITH LOAD RATINGS (UNDERLINED IN RED).
LIFTING EYES TO RECIEVE ONE COAT OF YELLOW PAINT AFTER FABRICATION (ANY KIND OF PAINT IS FINE).
NOTE! PIN PLATE SAME FOR BOTH TYPE A AND B
(WT APPROX 45#)
PL 1 3/8 x 8" x 1'-2"
BOLTS: 7/8" ϕ x 4 3/4 BOTTOM
7/8" ϕ x 4 1/4 TOP
1" ϕ x 5" BOTTOM
1" ϕ x 4 1/2" TOP
TYPE B
MAKE 4
6 1/2 T RATED
PL 1 1/8 - 8" x 0'-9"
BOLTS: 7/8" ϕ x 4 1/2 BOTTOM
7/8 ϕ x 4" TOP
1" ϕ x 4 3/4 BOTTOM
1" ϕ x 4 1/4 TOP
TYPE A LIFTING LUG
(WT APPROX 30#) MAKE 20
6 1/2 TON RATED
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
NB GOLD STAR BRIDGE
SHEET NO. 3 OF 13
CALCULATED BY AF DATE 7.20.2014
LIFTING LUGS A+B


CRANE LIFTING LUG
LIFTING LUG LOCATIONS
SPLICE PL IN TEMPORARY POSITION
LIFTING LUG TYPE A
LIFTING LUG TYPE B
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
NB GOLD STAR BRIDGE
SHEET NO. 5 OF 13
SCALE 3/4"=1'-0"
CALCULATED BY AF DATE 7.20.2014
LIFTING LUG LOCATIONS

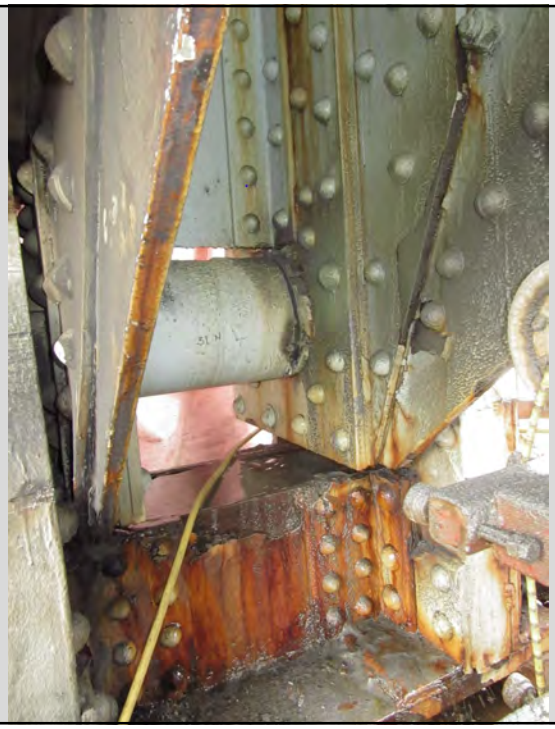

LEGEND:
R.S.C.- Indicates Rigid Steel Conduit.
(T)- Indicates Telephone Conduit.
(N)- Indicates Navigation Light Conduit.
NOTES:
NOTE X:
FLOOR BEAM CAMBER SCHEDULE
SPAN NOS. 22-25 AND 29-31
CROSS SECTION AT SPAN NOS. 22 TO 25 & 29 TO 31
RIGGING TO INSTALL GIRDER HALVES
GIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
JOB N8 GOLDSTAR BRIDGE
SHEET NO. 1 OF 13
SCALE 1/8"=1'-0"
CALCULATED BY AF
DATE 7-20-14
CHECKED BY
DATE
DWG/SUBJECT GIRDER RIGGING

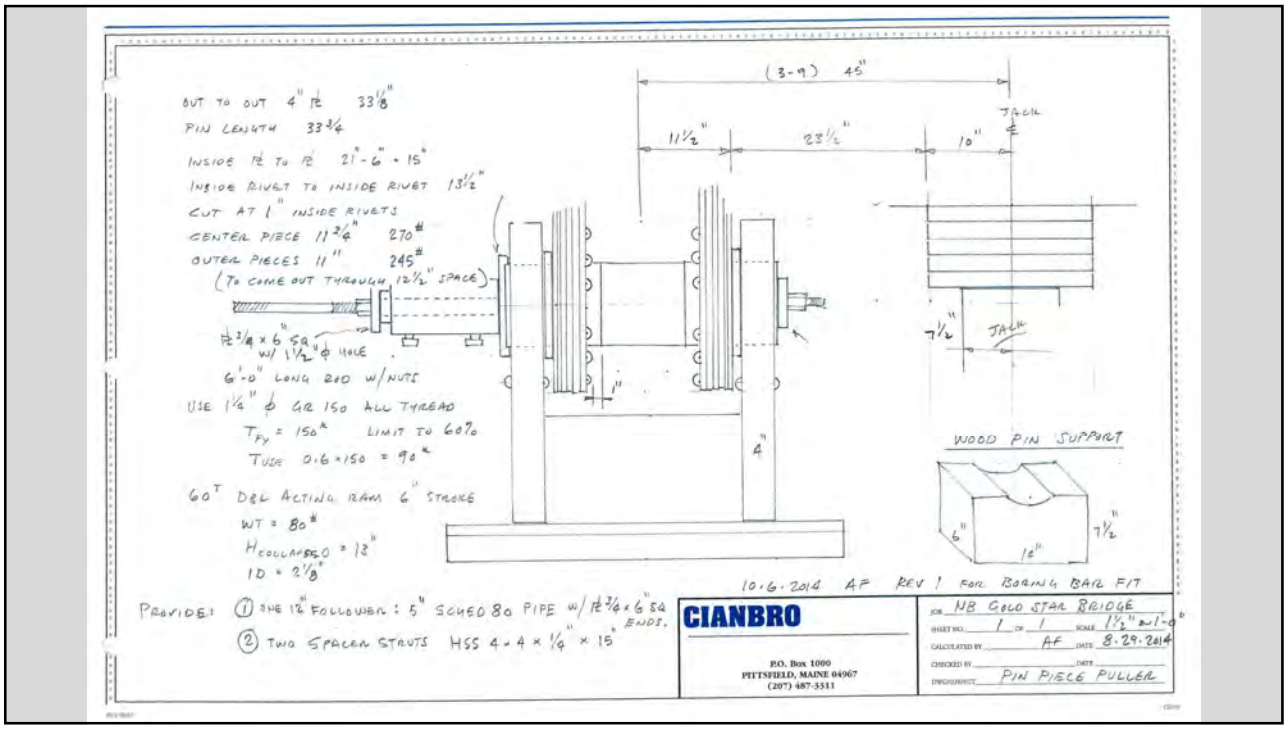


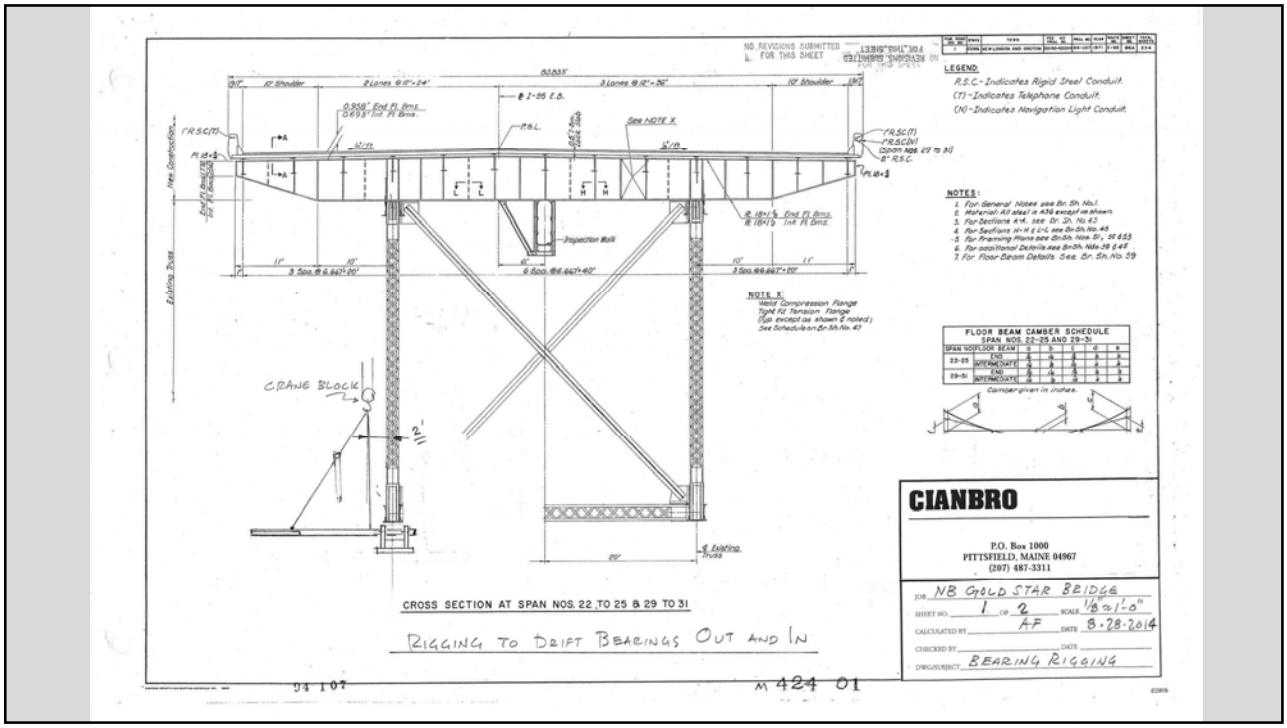


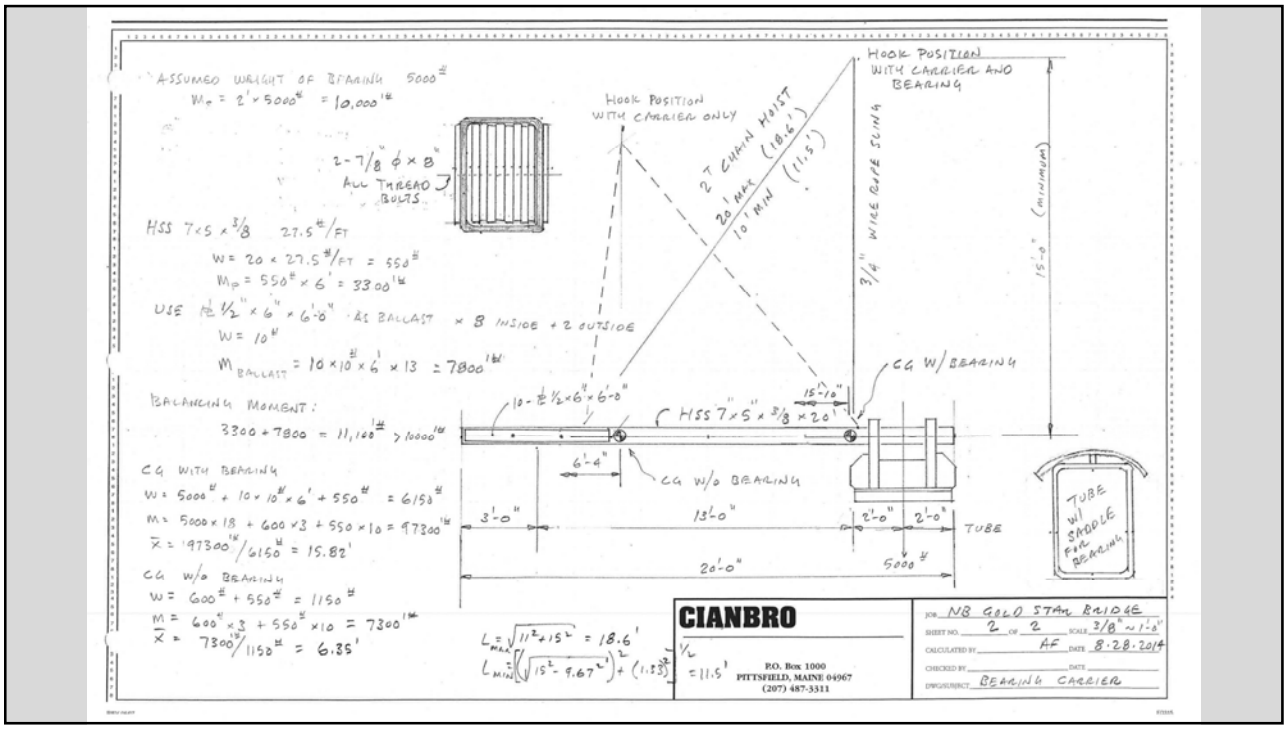
- 1000 k Design Load at Bearing
- 1100 Load at Jacks
- 2000 psi on Teflon slide surface
- 1300 psi compression on IPE

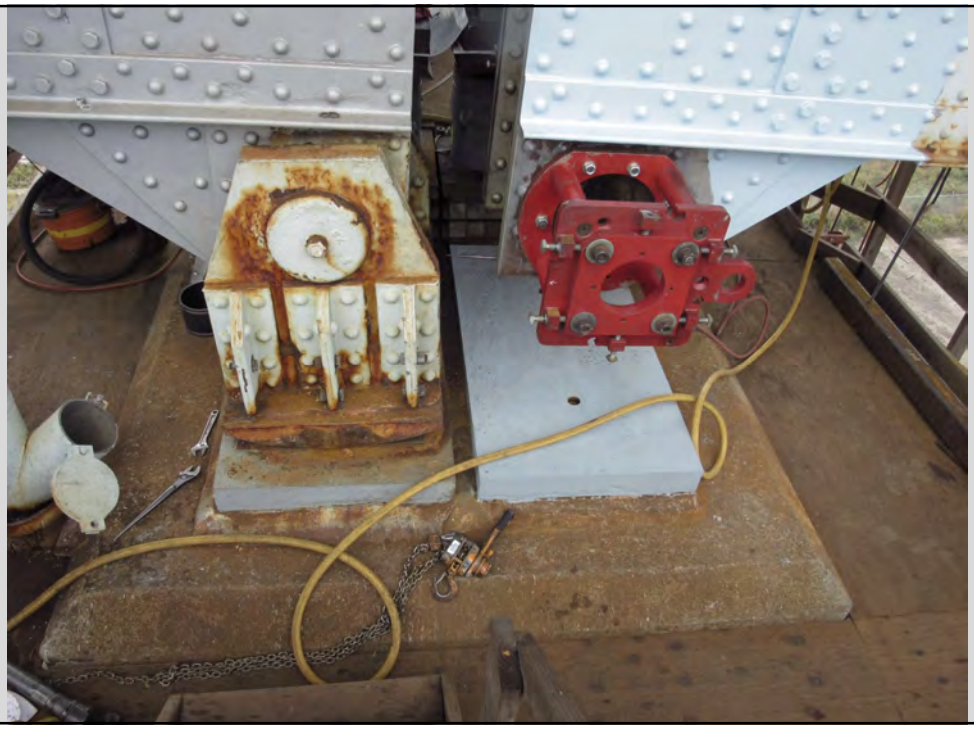
1-888-DUDGEON



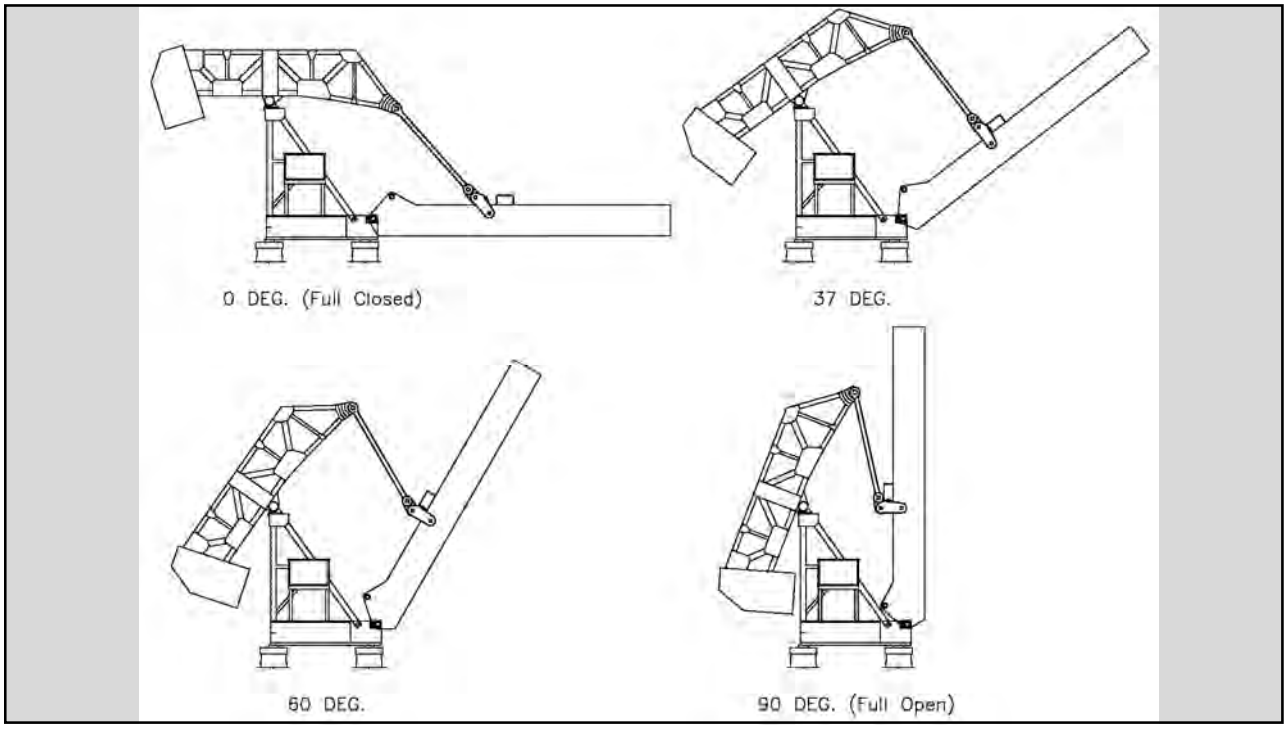

OUT TO OUT 4" PL 33 1/8"
PIN LENGTH 33 3/4
INSIDE PL TO PL 21'-6" - 15"
INSIDE RIVET TO INSIDE RIVET 13 1/2"
CUT AT 1" INSIDE RIVETS
CENTER PIECE 11 3/4" 270#
OUTER PIECES 11" 245#
(TO COME OUT THROUGH 12 1/2" SPACE)
PL 3/4 x 6" SQ w/ 1 1/2" ϕ HOLE
6'-0" LONG ROD w/NUTS
USE 1 1/4" ϕ GR 150 ALL THREAD
T_FY = 150^k LIMIT TO 60%
T_USE 0.6 x 150 = 90^k
60^T DBL ACTING RAM 6" STROKE
WT = 80#
H_COLLAPSED = 13"
ID = 2 1/8"
PROVIDE: ① ONE 12" FOLLOWER : 5" SCHED 80 PIPE w/ PL 3/4 x 6" SQ ENDS.
② TWO SPACER STRUTS HSS 4 x 4 x 1/4" x 15"
(3-9) 45"
11 1/2"
23 1/2"
10"
JACK
7 1/2"
JACK
1"
4"
WOOD PIN SUPPORT
6"
14"
7 1/2"
10.6.2014 AF REV 1 FOR BORING BAR FIT
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
JOB NB GOLD STAR BRIDGE
SHEET NO. 1 OF 1 SCALE 1 1/2" = 1'-0"
CALCULATED BY AF DATE 8.29.2014
CHECKED BY DATE
DWG/SUBJECT PIN PIECE PULLER

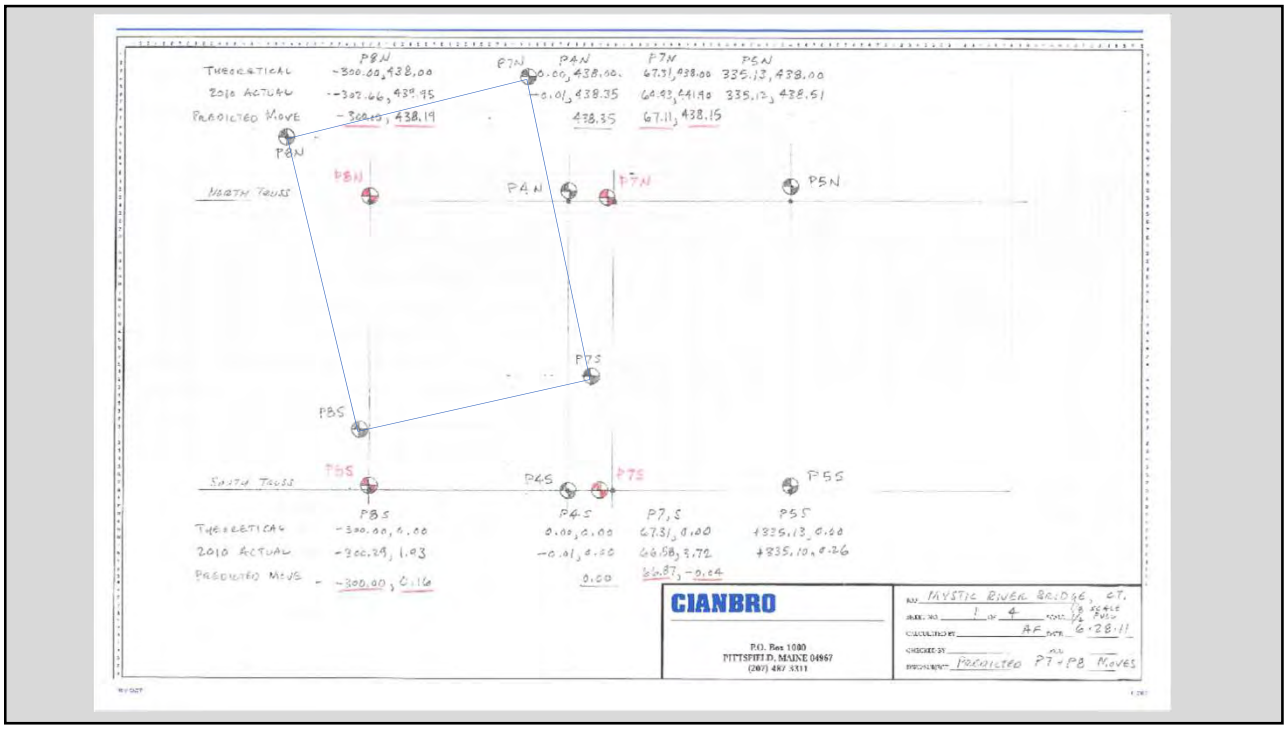

NO REVISIONS SUBMITTED FOR THIS SHEET
LEGEND
R.S.C.- Indicates Rigid Steel Conduit.
(T)-Indicates Telephone Conduit.
(N)-Indicates Navigation Light Conduit.
NOTES:
1. For General Notes see Br. Sh. No.1.
2. Material: All steel is A36 except as shown.
3. For Sections A-A, see Br. Sh. No. 43
4. For Sections H-H & L-L see Br.Sh.No. 45
5. For Framing Plans see Br.Sh. Nos. 51, 52 & 53
6. For additional Details see Br.Sh. Nos. 59 & 45
7. For Floor Beam Details See Br. Sh. No. 59
NOTE X:
Weld Compression Flange
Tight Fit Tension Flange
(Typ except as shown & noted)
See Schedule on Br.Sh.No. 47
FLOOR BEAM CAMBER SCHEDULE
SPAN NOS. 22-25 AND 29-31
Camber given in inches.
CRANE BLOCK
CROSS SECTION AT SPAN NOS. 22 TO 25 & 29 TO 31
RIGGING TO DRIFT BEARINGS OUT AND IN
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
JOB NB GOLD STAR BRIDGE
SHEET NO. 1 OF 2 SCALE 1/8" = 1'-0"
CALCULATED BY AF DATE 8.28.2014
CHECKED BY DATE
DWG/SUBJECT BEARING RIGGING
M 424 01

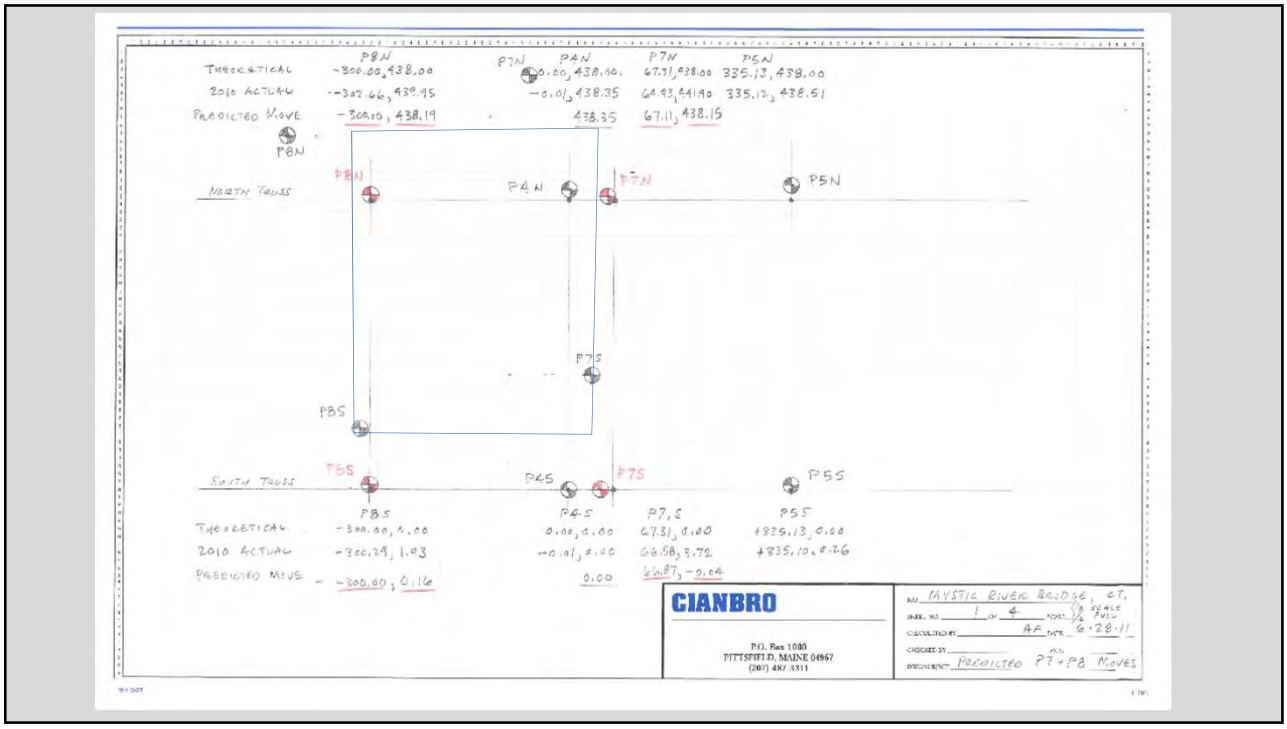

ASSUMED WEIGHT OF BEARING 5000#
Mp = 2' x 5000# = 10,000'#
2-7/8" ϕ x 8" ALL THREAD BOLTS
HSS 7x5x3/8 27.5#/FT
W = 20 x 27.5#/FT = 550#
Mp = 550# x 6' = 3300'#
USE PL 1/2" x 6" x 6'-0" AS BALLAST x 8 INSIDE + 2 OUTSIDE
W = 10#
M BALLAST = 10 x 10# x 6' x 13 = 7800'#
BALANCING MOMENT:
3300 + 7800 = 11,100'# > 10000'#
CG WITH BEARING
W = 5000# + 10 x 10# x 6' + 550# = 6150#
M = 5000 x 18 + 600 x 3 + 550 x 10 = 97300'#
X = 97300'#/6150# = 15.82'
CG W/O BEARING
W = 600# + 550# = 1150#
M = 600# x 3 + 550# x 10 = 7300'#
X = 7300'#/1150# = 6.35'
HOOK POSITION WITH CARRIER ONLY
HOOK POSITION WITH CARRIER AND BEARING
2 T CHAIN HOIST
20' MAX (18.6')
10' MIN (11.5')
3/4" WIRE ROPE SLING
15'-0" (MINIMUM)
CG W/ BEARING
10-PL 1/2x6"x6'-0"
HSS 7"x5"x3/8"x20'
15'-10"
6'-6"
CG W/O BEARING
3'-0"
13'-0"
2'-0"
2'-0"
TUBE
TUBE W/ SADDLE FOR BEARING
20'-0"
5000#
L MAX = √(11²+15²) = 18.6'
L MIN = [√(15²-9.67²)]² + (1.33)²
1/2 = 11.5'
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
JOB NB GOLD STAR BRIDGE
SHEET NO. 2 OF 2 SCALE 3/8" = 1'-0"
CALCULATED BY AF DATE 8.28.2014
CHECKED BY DATE
DWG/SUBJECT BEARING CARRIER

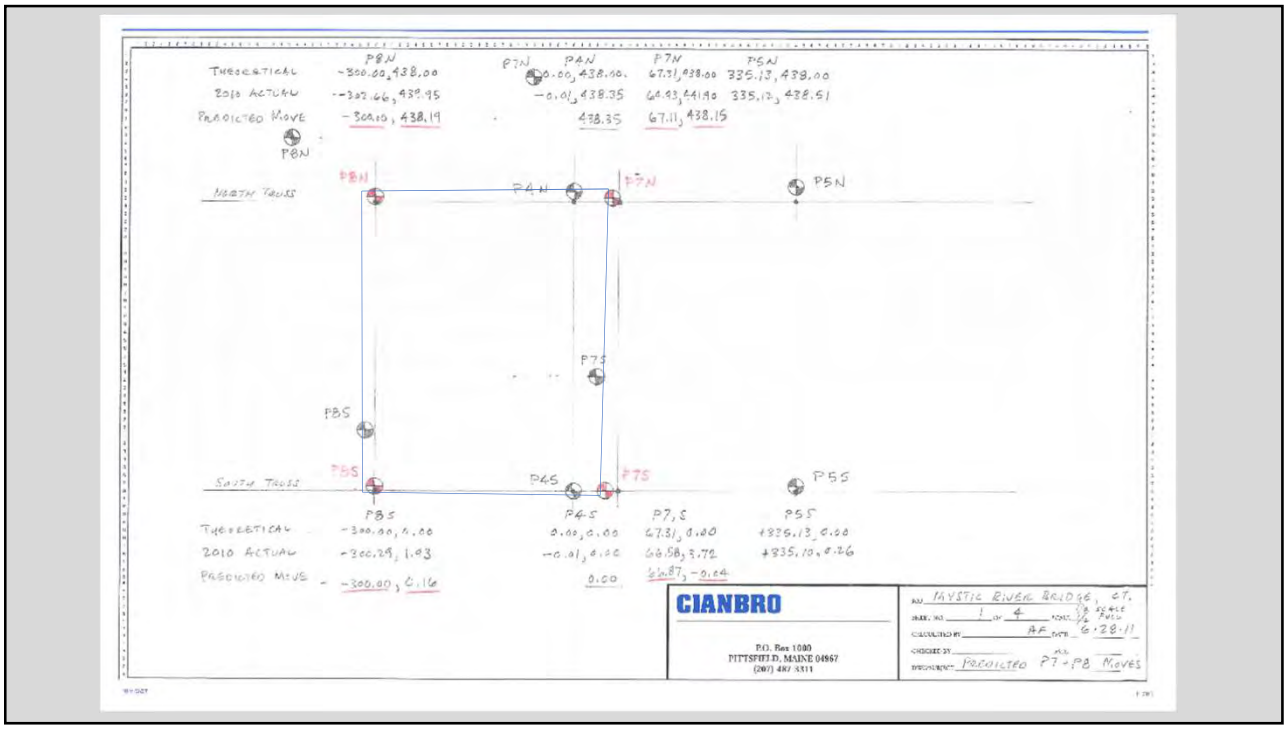


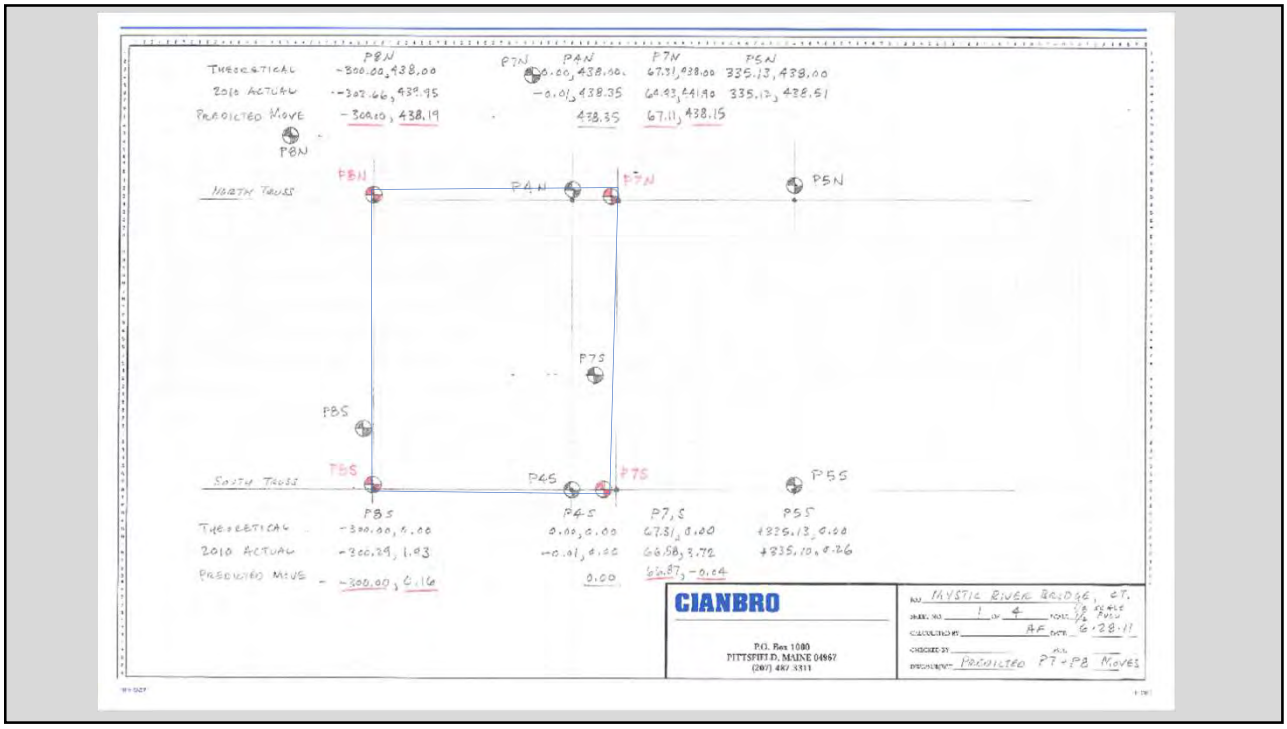
Mystic River Bridge
Mystic, Connecticut
Construction Design Engineering

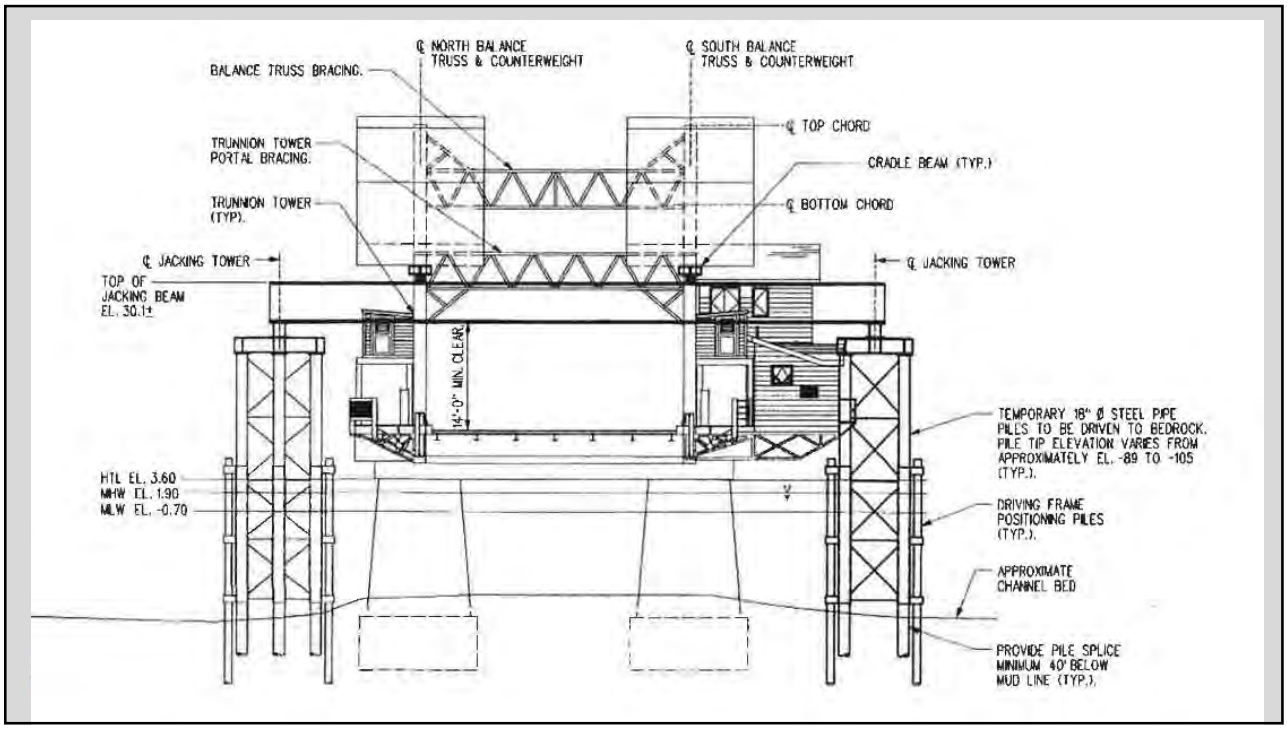

0 DEG. (Full Closed)
37 DEG.
60 DEG.
90 DEG. (Full Open)


P8N
P7N
P4N
P7N
P5N
THEORETICAL -300.00, 438.00 0.00, 438.00 67.31, 438.00 335.13, 438.00
2010 ACTUAL --302.66, 439.95 -0.01, 438.35 66.93, 441.90 335.12, 438.61
PREDICTED MOVE -300.00, 438.19 438.35 67.11, 438.15
P8N
P8N
NORTH TRUSS
P4N
P7N
P5N
P7S
P8S
P8S
SOUTH TRUSS
P4S
P7S
P5S
P8S
P4S
P7, S
P5S
THEORETICAL -300.00, 0.00 0.00, 0.00 67.31, 0.00 335.13, 0.00
2010 ACTUAL -300.29, 1.03 -0.01, 0.00 66.58, 3.72 335.10, 0.26
PREDICTED MOVE -300.00, 0.16 0.00 66.87, -0.04
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
JOB MYSTIC RIVER BRIDGE, CT.
SHEET NO 1 OF 4 SCALE 1/8 FULL
CALCULATED BY AF DATE 6-28-11
CHECKED BY DATE
DESCRIPTION PREDICTED P7+P8 MOVES

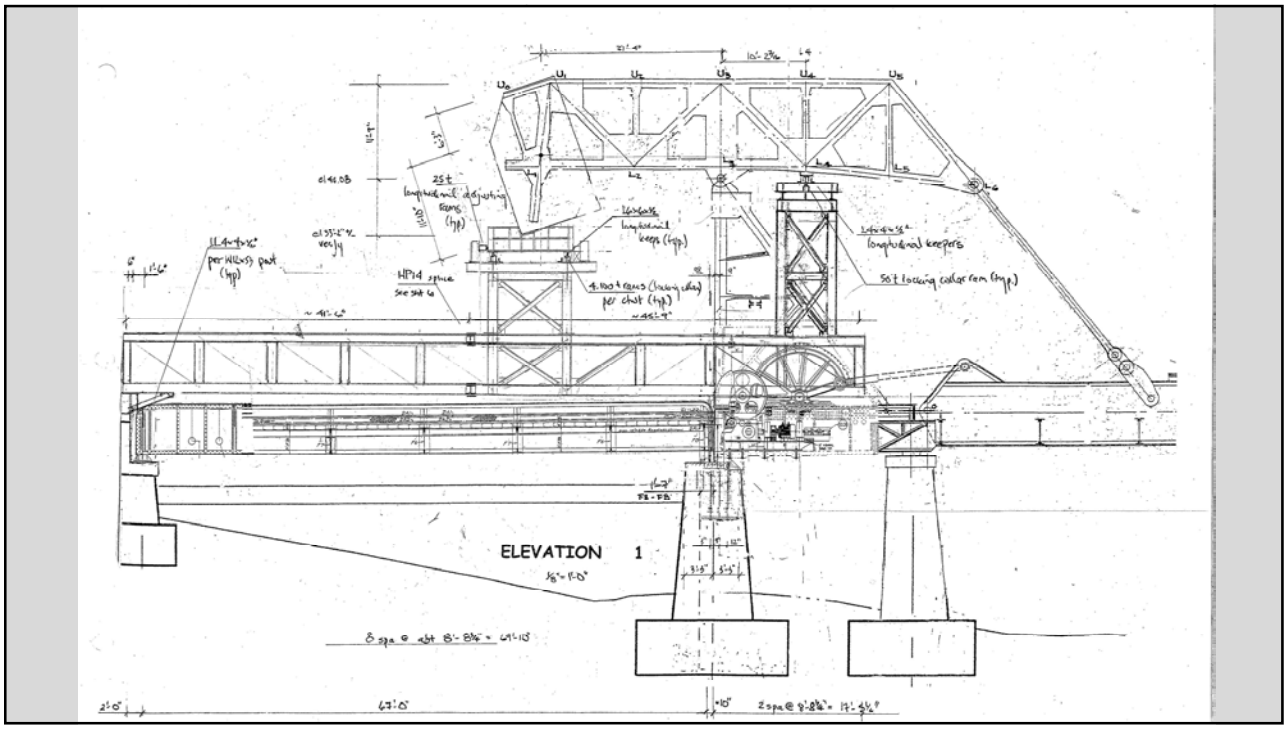

P8N
P7N
P4N
P7N
P5N
THEORETICAL -300.00, 438.00 0.00, 438.00 67.31, 438.00 335.13, 438.00
2010 ACTUAL --302.66, 439.95 -0.01, 438.35 66.93, 441.90 335.12, 438.61
PREDICTED MOVE -300.00, 438.19 438.35 67.11, 438.15
P8N
P8N
NORTH TRUSS
P4N
P7N
P5N
P7S
P8S
P8S
SOUTH TRUSS
P4S
P7S
P5S
P8S
P4S
P7, S
P5S
THEORETICAL -300.00, 0.00 0.00, 0.00 67.31, 0.00 335.13, 0.00
2010 ACTUAL -300.29, 1.03 -0.01, 0.00 66.58, 3.72 335.10, 0.26
PREDICTED MOVE -300.00, 0.16 0.00 66.87, -0.04
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
JOB MYSTIC RIVER BRIDGE, CT.
SHEET NO 1 OF 4 SCALE 1/8 FULL
CALCULATED BY AF DATE 6-28-11
CHECKED BY DATE
DESCRIPTION PREDICTED P7+P8 MOVES

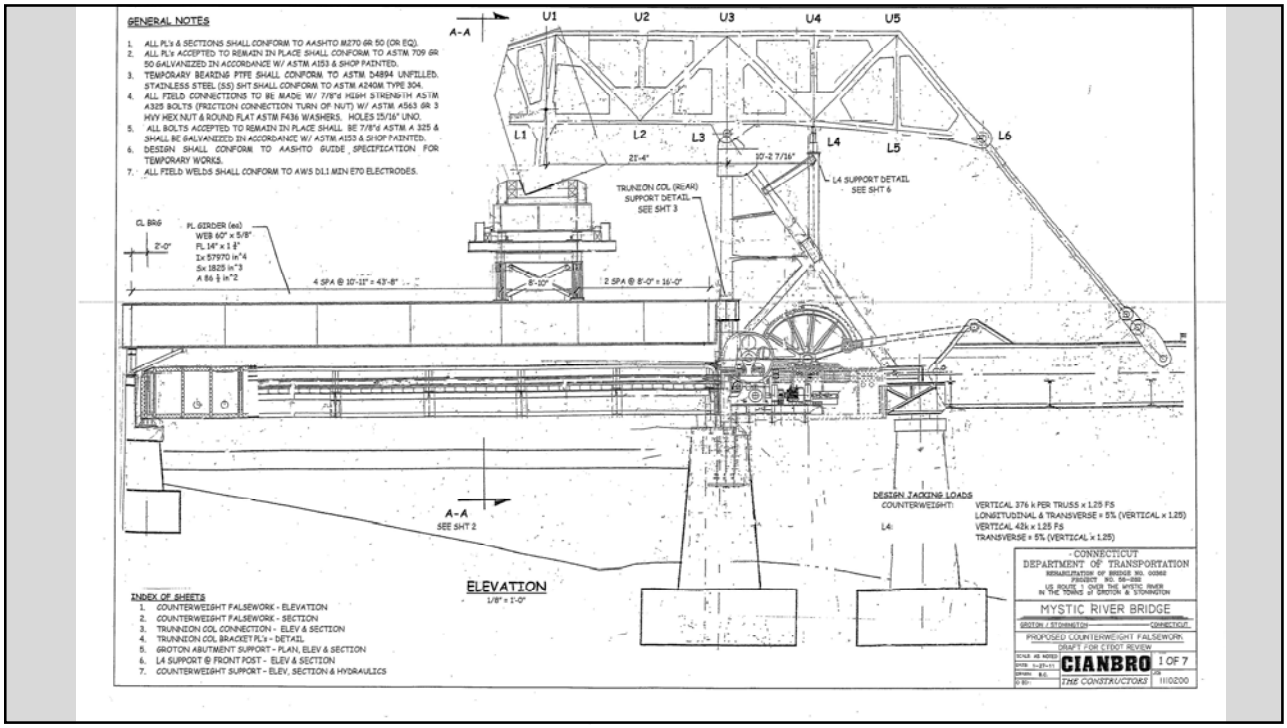

P8N
P7N
P4N
P5N
NORTH TRUSS
P7S
P8S
P4S
P5S
SOUTH TRUSS
THEORETICAL
2010 ACTUAL
PROJECTED MOVE
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
MYSTIC RIVER BRIDGE, CT.
PROJECTED P7 - P8 MOVES

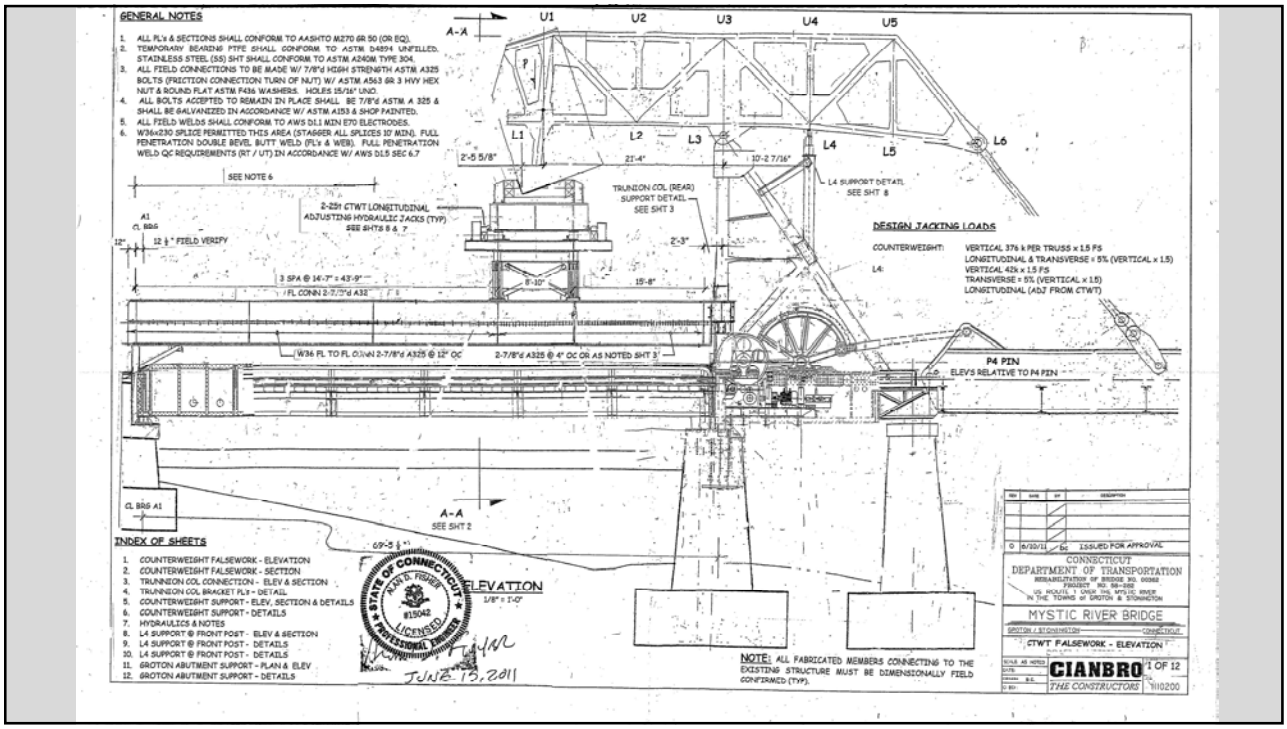

P8N
P7N
P4N
P5N
NORTH TRUSS
P7S
P8S
P4S
P5S
SOUTH TRUSS
THEORETICAL
2010 ACTUAL
PROJECTED MOVE
CIANBRO
P.O. Box 1000
PITTSFIELD, MAINE 04967
(207) 487-3311
MYSTIC RIVER BRIDGE, CT.
PROJECTED P7 - P8 MOVES


℄ NORTH BALANCE TRUSS & COUNTERWEIGHT
℄ SOUTH BALANCE TRUSS & COUNTERWEIGHT
BALANCE TRUSS BRACING.
℄ TOP CHORD
TRUNNION TOWER PORTAL BRACING.
CRADLE BEAM (TYP.)
TRUNNION TOWER (TYP).
℄ BOTTOM CHORD
℄ JACKING TOWER
℄ JACKING TOWER
TOP OF JACKING BEAM EL. 30.1±
14'-0" MIN. CLEAR
TEMPORARY 18" Ø STEEL PIPE PILES TO BE DRIVEN TO BEDROCK. PILE TIP ELEVATION VARIES FROM APPROXIMATELY EL. -89 TO -105 (TYP.).
HTL EL. 3.60
MHW EL. 1.90
MLW EL. -0.70
DRIVING FRAME POSITIONING PILES (TYP.).
APPROXIMATE CHANNEL BED
PROVIDE PILE SPLICE MINIMUM 40' BELOW MUD LINE (TYP.).

THE MYSTIC DRAWBRIDGE ICE CREAM SHOPPE


ELEVATION 1
1/8" = 1'-0"
67'-0"
8 spa @ abt 8'-8¾" = 69'-10"
2 spa @ 8'-8¾" = 17'-5½"
U0
U1
U2
U3
U4
U5
L1
L2
L3
L4
L5
L6
25t longitudinal adjusting rams (typ)
longitudinal keeps (typ)
longitudinal keepers
50t locking collar ram (typ)
4.100t rams (locking collar) per chut (typ)
HP14 splice see sht 6
per W12x53 post (typ)
FB - FB


GENERAL NOTES
1. ALL PL's & SECTIONS SHALL CONFORM TO AASHTO M270 GR 50 (OR EQ).
2. ALL PL's ACCEPTED TO REMAIN IN PLACE SHALL CONFORM TO ASTM 709 GR 50 GALVANIZED IN ACCORDANCE W/ ASTM A153 & SHOP PAINTED.
3. TEMPORARY BEARING PTFE SHALL CONFORM TO ASTM D4894 UNFILLED. STAINLESS STEEL (SS) SHT SHALL CONFORM TO ASTM A240M TYPE 304.
4. ALL FIELD CONNECTIONS TO BE MADE W/ 7/8"d HIGH STRENGTH ASTM A325 BOLTS (FRICTION CONNECTION TURN OF NUT) W/ ASTM A563 GR 3 HVY HEX NUT & ROUND FLAT ASTM F436 WASHERS. HOLES 15/16" UNO.
5. ALL BOLTS ACCEPTED TO REMAIN IN PLACE SHALL BE 7/8"d ASTM A 325 & SHALL BE GALVANIZED IN ACCORDANCE W/ ASTM A153 & SHOP PAINTED.
6. DESIGN SHALL CONFORM TO AASHTO GUIDE SPECIFICATION FOR TEMPORARY WORKS.
7. ALL FIELD WELDS SHALL CONFORM TO AWS D1.1 MIN E70 ELECTRODES.
A-A
U1
U2
U3
U4
U5
L1
L2
L3
L4
L5
L6
21'-4"
10'-2 7/16"
L4 SUPPORT DETAIL SEE SHT 6
TRUNION COL (REAR) SUPPORT DETAIL SEE SHT 3
CL BRG
2'-0"
PL GIRDER (ea)
WEB 60" x 5/8"
FL 14" x 1 ½"
Ix 57970 in^4
Sx 1825 in^3
A 86 ½ in^2
4 SPA @ 10'-11" = 43'-8"
8'-10"
2 SPA @ 8'-0" = 16'-0"
A-A
SEE SHT 2
ELEVATION
1/8" = 1'-0"
DESIGN JACKING LOADS
COUNTERWEIGHT: VERTICAL 376 k PER TRUSS x 1.25 FS
LONGITUDINAL & TRANSVERSE = 5% (VERTICAL x 1.25)
L4: VERTICAL 42k x 1.25 FS
TRANSVERSE = 5% (VERTICAL x 1.25)
INDEX OF SHEETS
1. COUNTERWEIGHT FALSEWORK - ELEVATION
2. COUNTERWEIGHT FALSEWORK - SECTION
3. TRUNNION COL CONNECTION - ELEV & SECTION
4. TRUNNION COL BRACKET PL's - DETAIL
5. GROTON ABUTMENT SUPPORT - PLAN, ELEV & SECTION
6. L4 SUPPORT @ FRONT POST - ELEV & SECTION
7. COUNTERWEIGHT SUPPORT - ELEV, SECTION & HYDRAULICS
CONNECTICUT
DEPARTMENT OF TRANSPORTATION
REHABILITATION OF BRIDGE NO. 00362
PROJECT NO. 56-282
US ROUTE 1 OVER THE MYSTIC RIVER
IN THE TOWNS of GROTON & STONINGTON
MYSTIC RIVER BRIDGE
GROTON / STONINGTON
CONNECTICUT
PROPOSED COUNTERWEIGHT FALSEWORK
DRAFT FOR CTDOT REVIEW
SCALE AS NOTED
DATE 1-27-11
DRAWN B.C.
CHKD BY:
CIANBRO
THE CONSTRUCTORS
1 OF 7
JOB 1110200


GENERAL NOTES
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2. TEMPORARY BEARING PTFE SHALL CONFORM TO ASTM D4894 UNFILLED. STAINLESS STEEL (SS) SHT SHALL CONFORM TO ASTM A240M TYPE 304.
3. ALL FIELD CONNECTIONS TO BE MADE W/ 7/8"d HIGH STRENGTH ASTM A325 BOLTS (FRICTION CONNECTION TURN OF NUT) W/ ASTM A563 GR 3 HVY HEX NUT & ROUND FLAT ASTM F436 WASHERS. HOLES 15/16" UNO.
4. ALL BOLTS ACCEPTED TO REMAIN IN PLACE SHALL BE 7/8"d ASTM A 325 & SHALL BE GALVANIZED IN ACCORDANCE W/ ASTM A153 & SHOP PAINTED.
5. ALL FIELD WELDS SHALL CONFORM TO AWS D1.1 MIN E70 ELECTRODES.
6. W36x230 SPLICE PERMITTED THIS AREA (STAGGER ALL SPLICES 10' MIN). FULL PENETRATION DOUBLE BEVEL BUTT WELD (FL's & WEB). FULL PENETRATION WELD QC REQUIREMENTS (RT / UT) IN ACCORDANCE W/ AWS D1.5 SEC 6.7
A-A
U1
U2
U3
U4
U5
L1
L2
L3
L4
L5
L6
2'-5 5/8"
21'-4"
10'-2 7/16"
SEE NOTE 6
2-25t CTWT LONGITUDINAL ADJUSTING HYDRAULIC JACKS (TYP) SEE SHTS 8 & 7
TRUNION COL (REAR) SUPPORT DETAIL SEE SHT 3
L4 SUPPORT DETAIL SEE SHT 8
A1 CL BRG
12"
12 ½" FIELD VERIFY
2'-3"
3 SPA @ 14'-7" = 43'-9"
FL CONN 2-7/8"d A32
8'-10"
15'-8"
W36 FL TO FL CONN 2-7/8"d A325 @ 12" OC
2-7/8"d A325 @ 4" OC OR AS NOTED SHT 3
DESIGN JACKING LOADS
COUNTERWEIGHT: VERTICAL 376 k PER TRUSS x 1.5 FS
LONGITUDINAL & TRANSVERSE = 5% (VERTICAL x 1.5)
L4: VERTICAL 42k x 1.5 FS
TRANSVERSE = 5% (VERTICAL x 1.5)
LONGITUDINAL (ADJ FROM CTWT)
P4 PIN
ELEVS RELATIVE TO P4 PIN
CL BRG A1
A-A
SEE SHT 2
INDEX OF SHEETS
1. COUNTERWEIGHT FALSEWORK - ELEVATION
2. COUNTERWEIGHT FALSEWORK - SECTION
3. TRUNNION COL CONNECTION - ELEV & SECTION
4. TRUNNION COL BRACKET PL's - DETAIL
5. COUNTERWEIGHT SUPPORT - ELEV, SECTION & DETAILS
6. COUNTERWEIGHT SUPPORT - DETAILS
7. HYDRAULICS & NOTES
8. L4 SUPPORT @ FRONT POST - ELEV & SECTION
9. L4 SUPPORT @ FRONT POST - DETAILS
10. L4 SUPPORT @ FRONT POST - DETAILS
11. GROTON ABUTMENT SUPPORT - PLAN & ELEV
12. GROTON ABUTMENT SUPPORT - DETAILS
STATE OF CONNECTICUT
ALAN D. FISHER
#15042
LICENSED
PROFESSIONAL ENGINEER
ELEVATION
1/8" = 1'-0"
JUNE 15, 2011
NOTE: ALL FABRICATED MEMBERS CONNECTING TO THE EXISTING STRUCTURE MUST BE DIMENSIONALLY FIELD CONFIRMED (TYP).
0 6/30/11 bc ISSUED FOR APPROVAL
CONNECTICUT
DEPARTMENT OF TRANSPORTATION
REHABILITATION OF BRIDGE NO. 00362
PROJECT NO. 58-262
US ROUTE 1 OVER THE MYSTIC RIVER
IN THE TOWNS of GROTON & STONINGTON
MYSTIC RIVER BRIDGE
GROTON / STONINGTON CONNECTICUT
CTWT FALSEWORK - ELEVATION
CIANBRO
THE CONSTRUCTORS
1 OF 12
1110200

DEWALK
LOSED
ETOUR

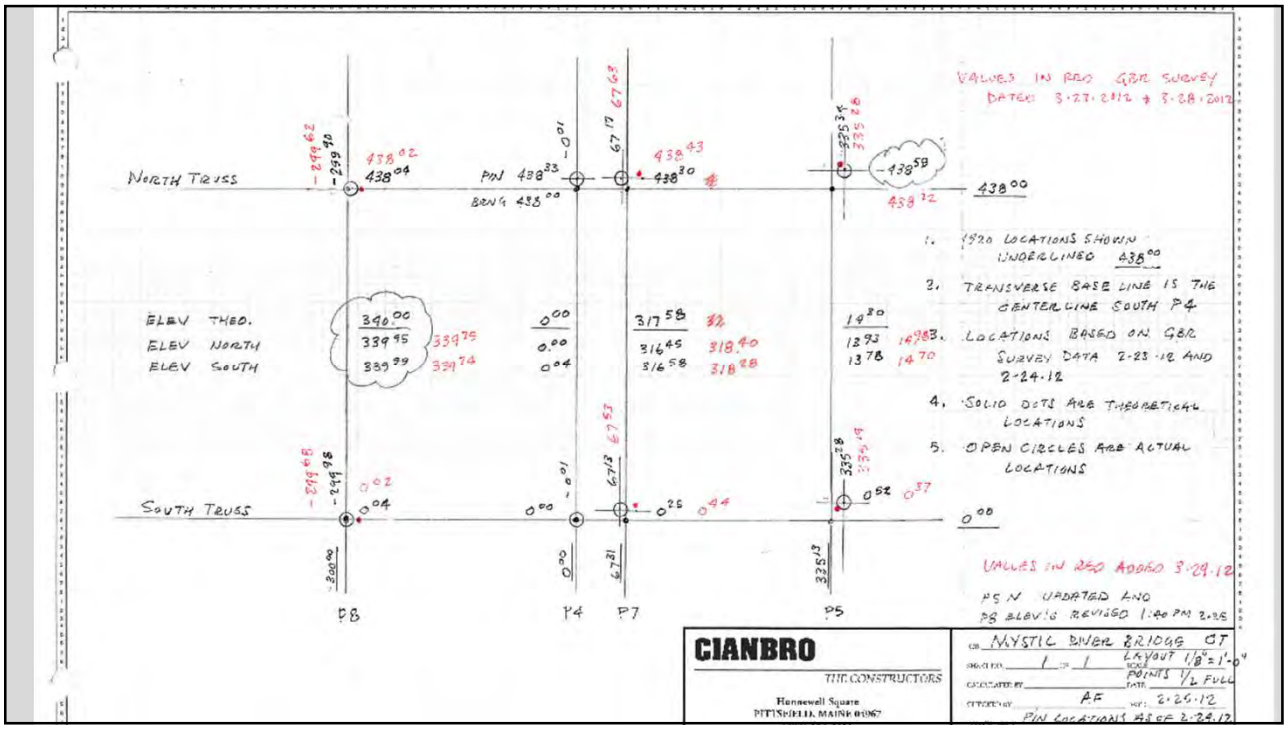
14-0
NES Rentals
450AJ

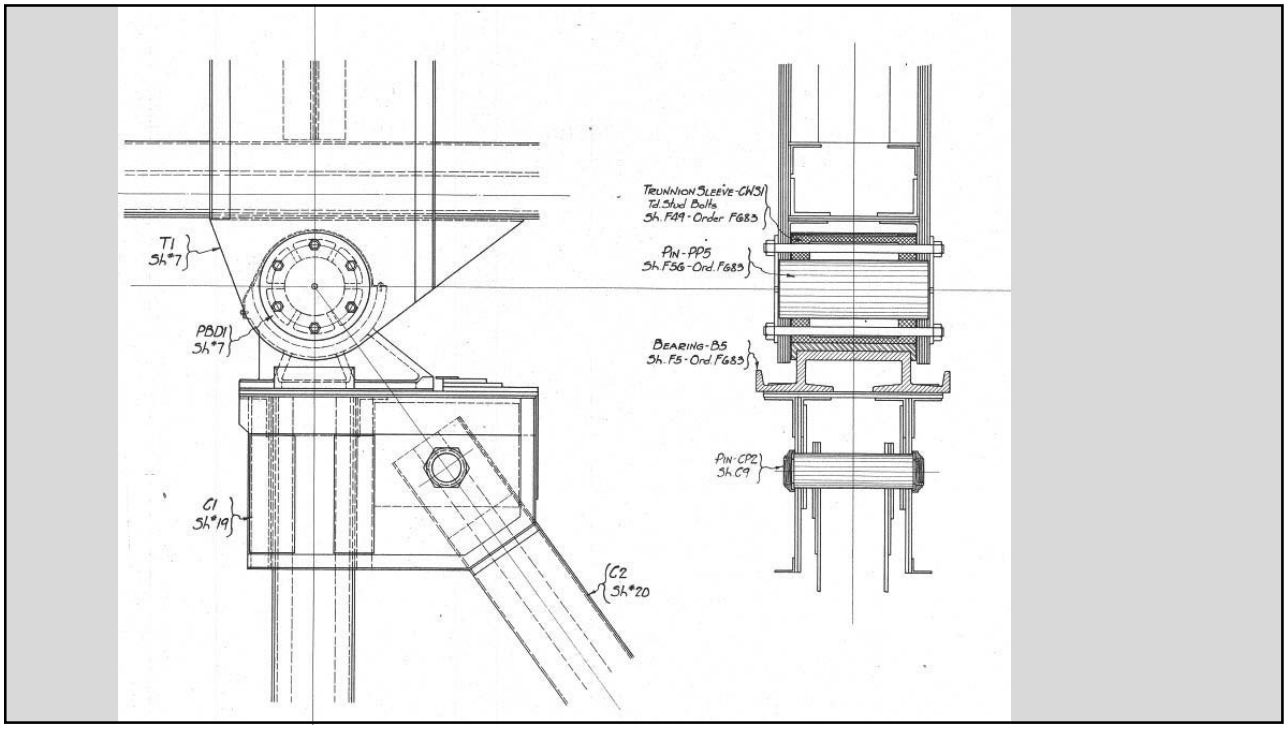
MYSTIC RIVER
HIGHWAY BRIDGE

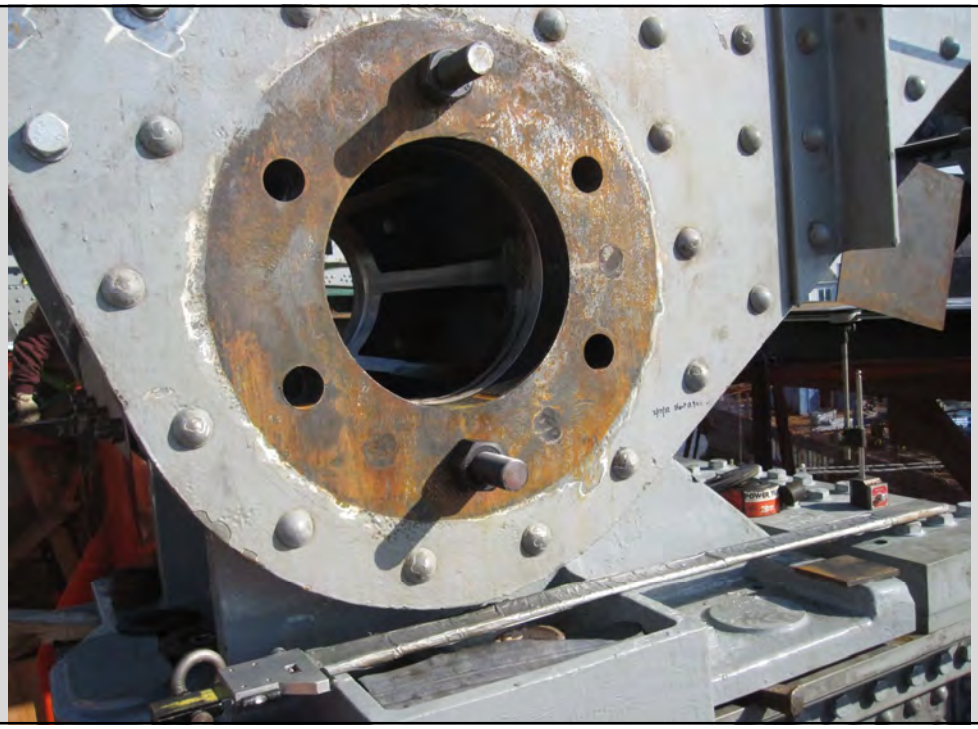
MYSTIC RIVER
HIGHWAY BRIDGE

MYSTIC RIVER
HIGHWAY BRIDGE

CLEARANCE 40'
N


NORTH TRUSS
SOUTH TRUSS
P8
P4
P7
P5
ELEV THEO.
ELEV NORTH
ELEV SOUTH
VALUES IN RED GBR SURVEY DATED 3-27-2012 & 3-28-2012
1. 1920 LOCATIONS SHOWN UNDERLINED 438.00
2. TRANSVERSE BASE LINE IS THE CENTERLINE SOUTH P4
3. LOCATIONS BASED ON GBR SURVEY DATA 2-23-12 AND 2-24-12
4. SOLID DOTS ARE THEORETICAL LOCATIONS
5. OPEN CIRCLES ARE ACTUAL LOCATIONS
VALUES IN RED ADDED 3-29-12
PSN UPDATED AND PB ELEVS REVISED 1:40 PM 3-26
CIANBRO
THE CONSTRUCTORS
Hannewell Square
PITTSFIELD, MAINE 04967
JOB MYSTIC RIVER BRIDGE CT
LAYOUT 1/8"=1'-0"
POINTS 1/2 FULL
CALCULATED BY AE
DATE 2-26-12
P/N LOCATIONS AS OF 2-24-12


T1 Sh*7
PBD1 Sh*7
C1 Sh*19
C2 Sh*20
TRUNNION SLEEVE-CW31 Td Stud Bolts Sh. F49 - Order F683
PIN-PP5 Sh. F56 - Ord. F683
BEARING-B5 Sh. F5 - Ord. F683
PIN-CP2 Sh. C9



2012.02.08 12:03

Lecture 3
Structural Issues During Construction

Alan D. Fisher, PE
Construction Structures Group Leader

Lecture 3
Structural Issues During Construction

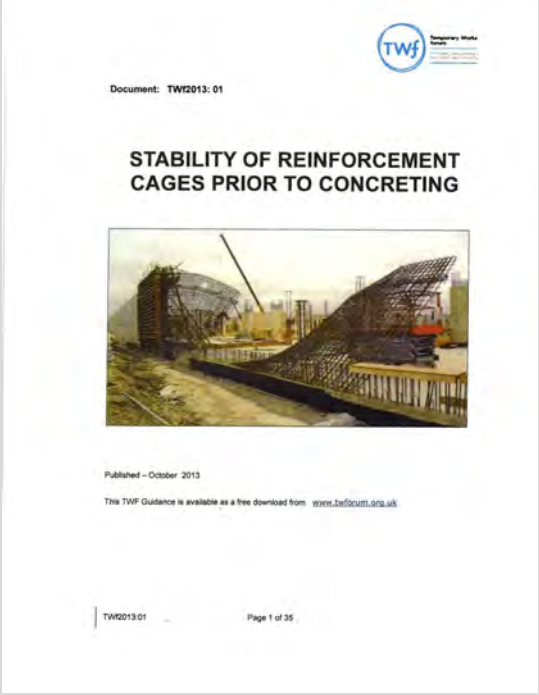
Alan D. Fisher, PE
Construction Structures Group Leader

No one of us is smarter than all of together

Structural Issues During Construction

Part 2

- Odds and Ends
- Thames River Railroad Bridge Counterweight Issue
- Issues with Skewed and Curved Steel Girder Bridges
- Waldo Hancock Suspension Bridge Emergency Repair


Document: TWf2013: 01

STABILITY OF REINFORCEMENT CAGES PRIOR TO CONCRETING

Published – October 2013

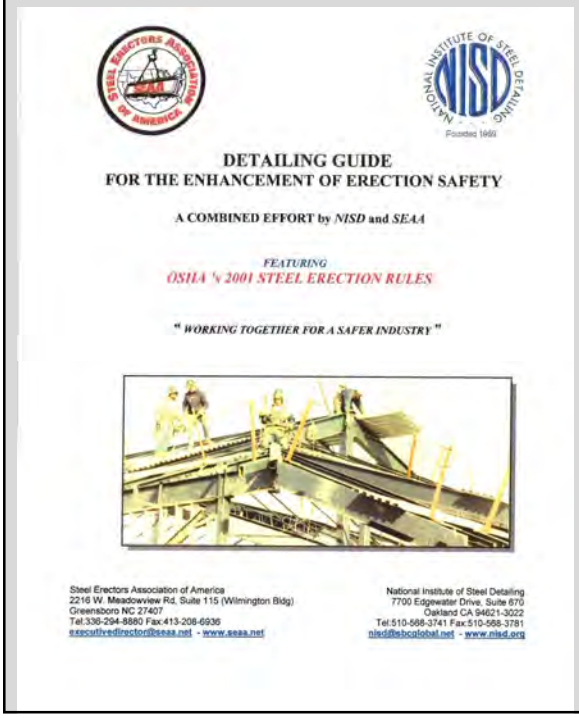
This TWF Guidance is available as a free download from www.twforum.org.uk

TWf2013:01 Page 1 of 35

Odds and Ends

Stability of Reinforcement Cages Prior to Concreting

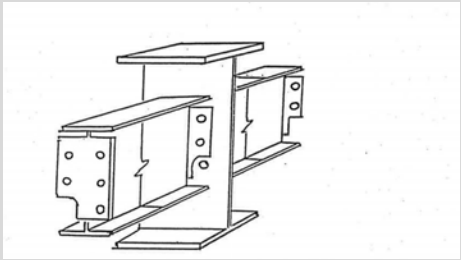
- Free download from www.twforum.org.uk
- Subject of session at ASCE Construction Institute Track during Texas ASCE Centennial 2013

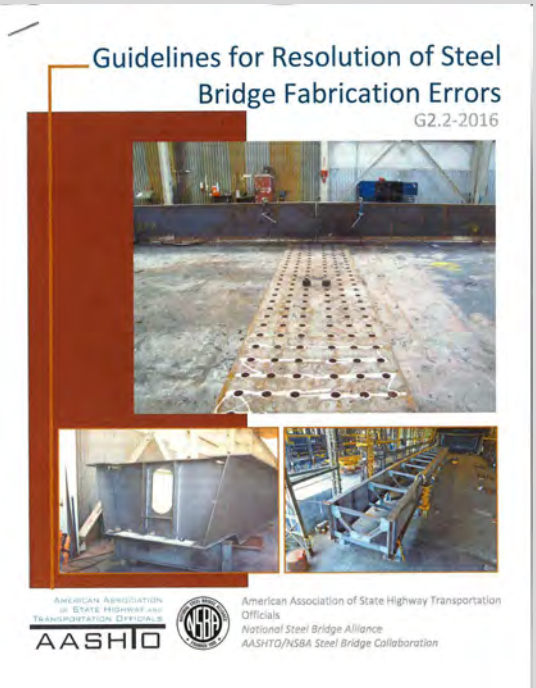


Odds and Ends

Detailing Guide for the Enhancement of Erection Safety

- National Institute of Steel Detailing
- Follows OSHA Sub Part R 2001

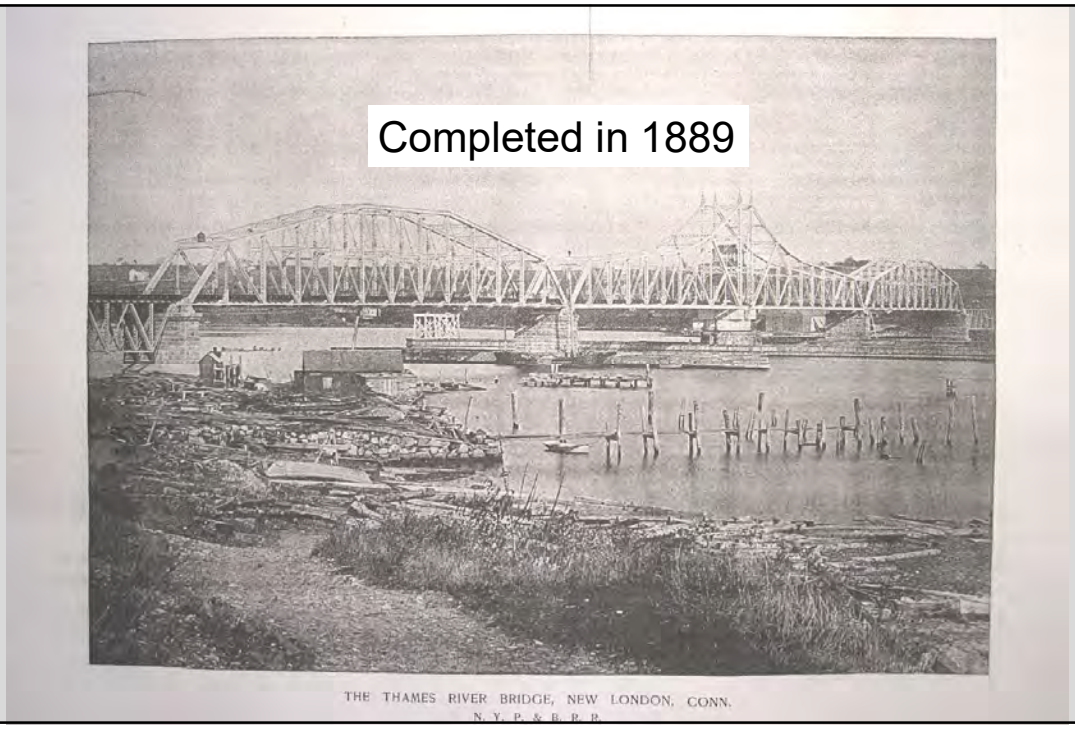




Odds and Ends

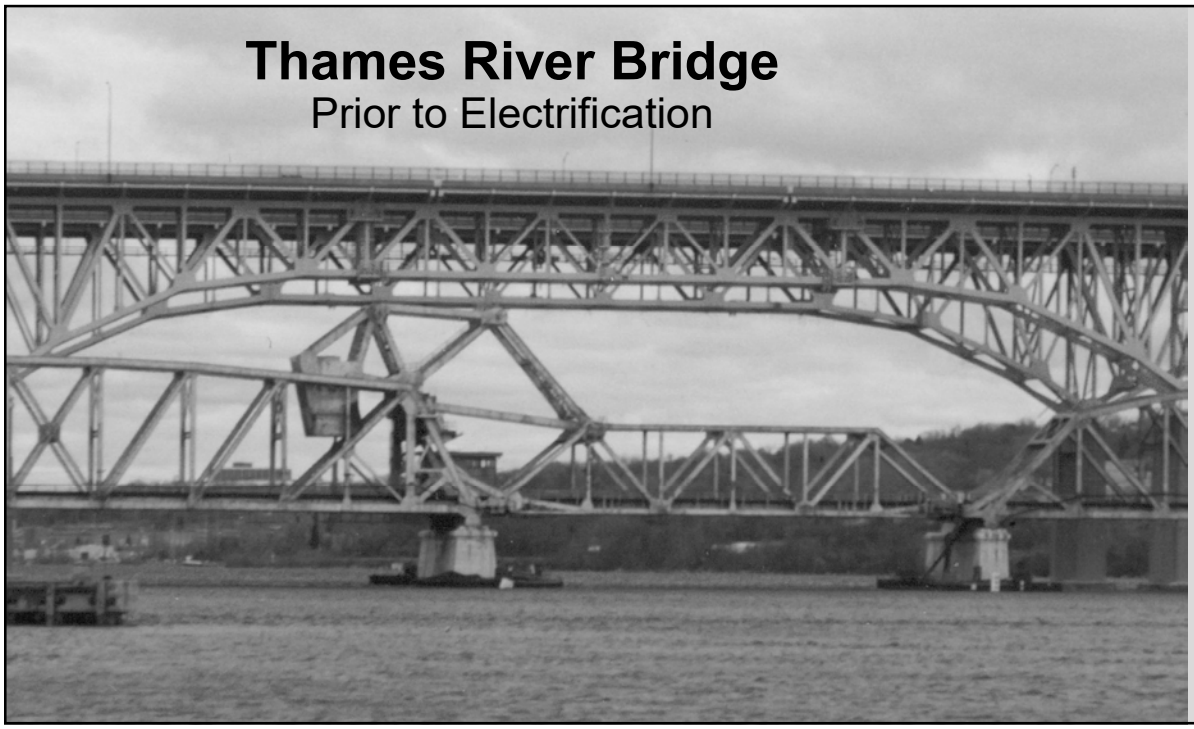
Guidelines for Resolution of Steel Bridge Fabrication Errors G2.2-2016

- AASHTO / NSBA Publication
- Free download from the AASHTO Bookstore for E-Affiliates https://bookstore.transportation.org


Completed in 1889
THE THAMES RIVER BRIDGE, NEW LONDON, CONN.
N. Y. P. & B. R. R.

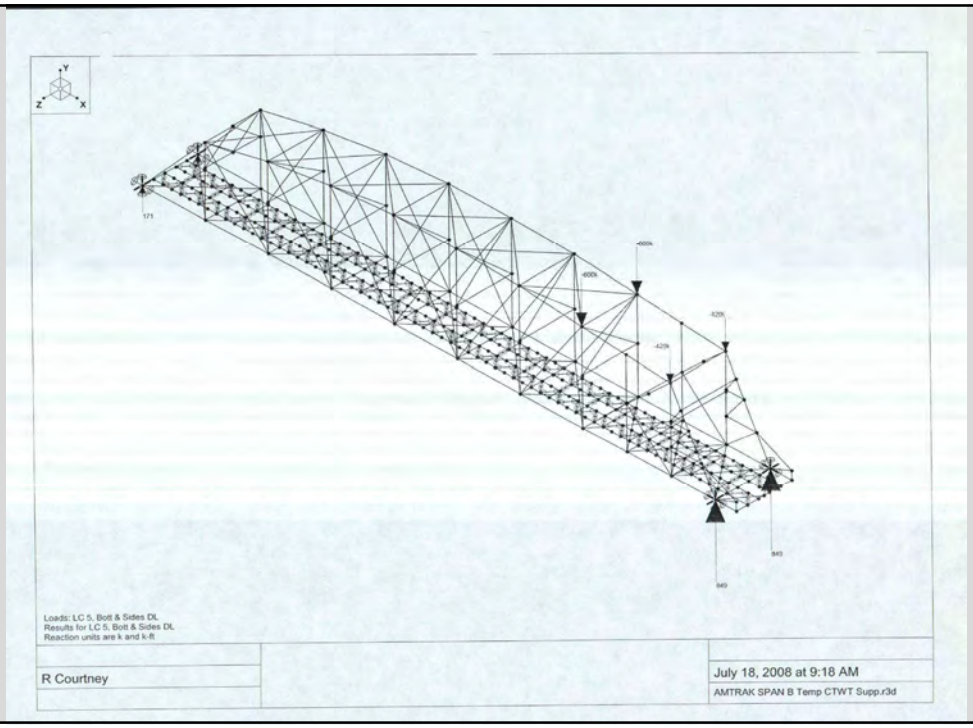
Thames River Bridge

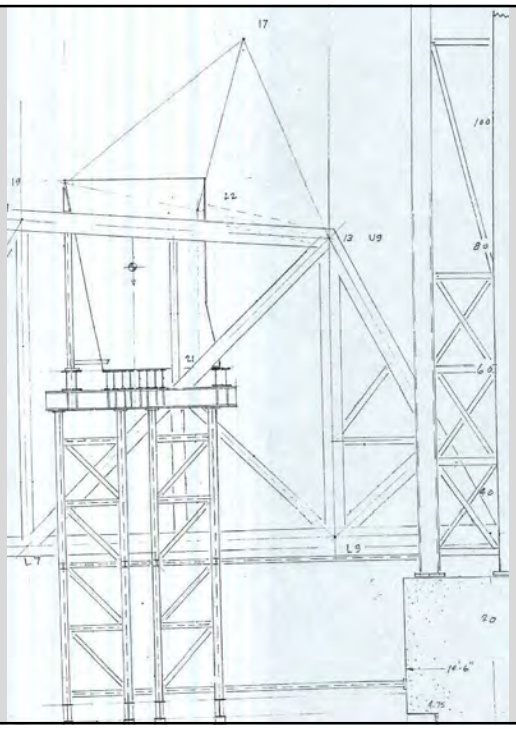
Prior to Electrification



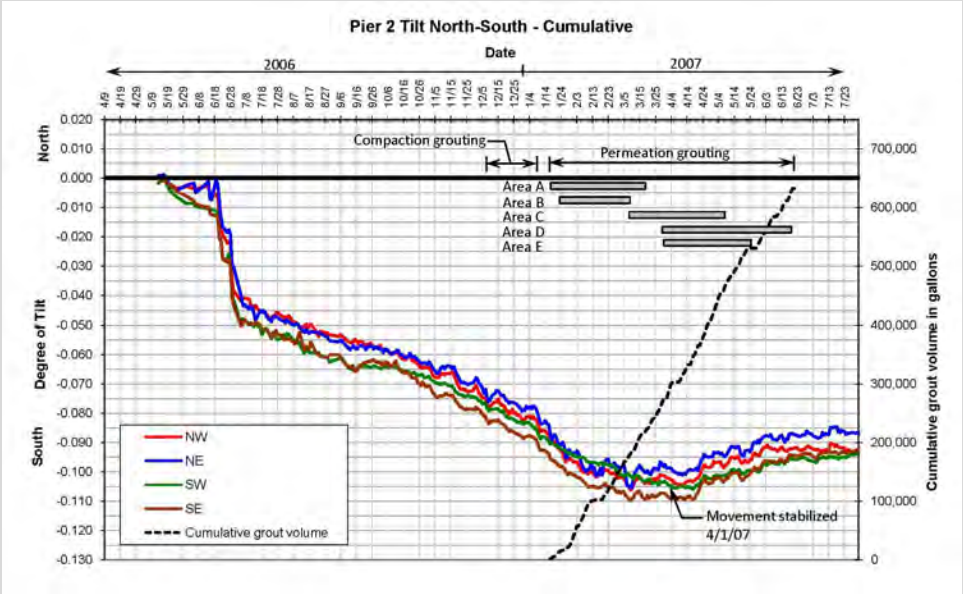
Plan A – Bid Time Method - Independent Support

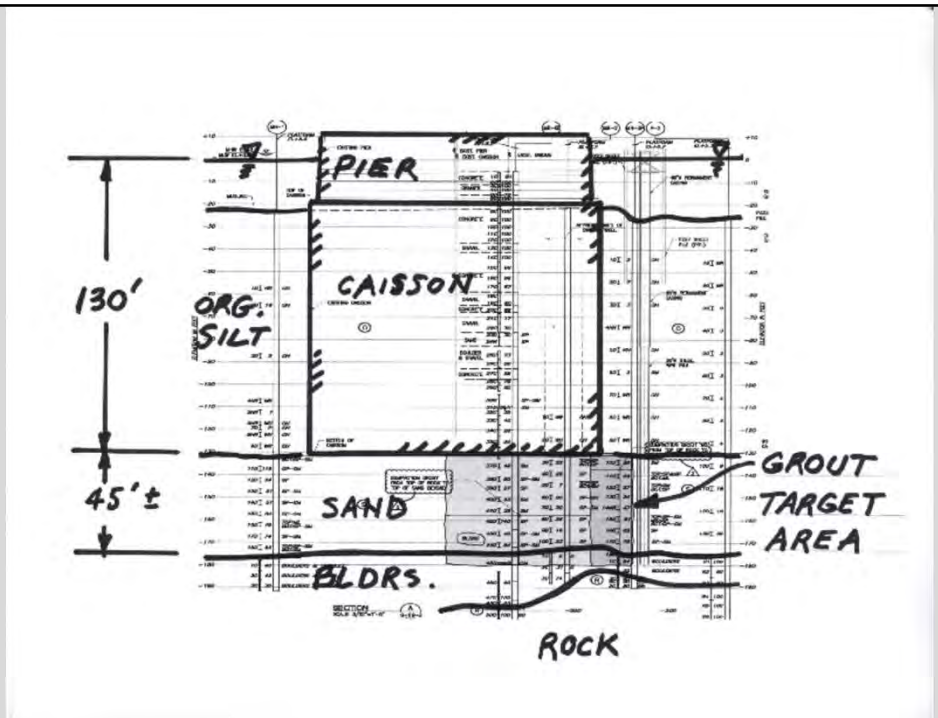
- Install piles and support towers
- Jack counterweight load onto supports
- Cut free from span
- Wire-saw into 20 -100 ton pieces



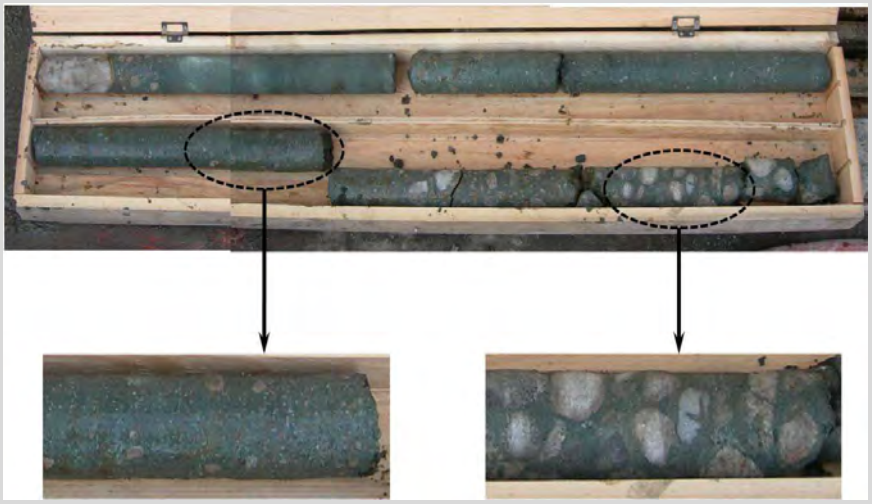


Pier 2


Pier 2 Tilt North-South - Cumulative
Date
2006
2007
North
South
Degree of Tilt
Cumulative grout volume in gallons
Compaction grouting
Permeation grouting
Area A
Area B
Area C
Area D
Area E
NW
NE
SW
SE
Cumulative grout volume
Movement stabilized
4/1/07


PIER
CAISSON
130'
ORG. SILT
45'±
SAND
BLDRS.
ROCK
GROUT
TARGET
AREA

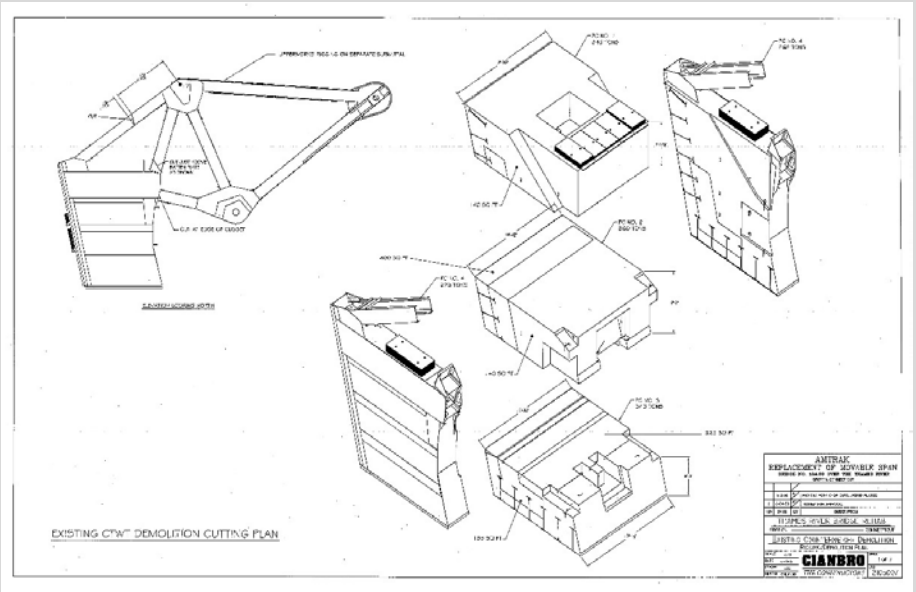
Core Samples of Grouted Sands

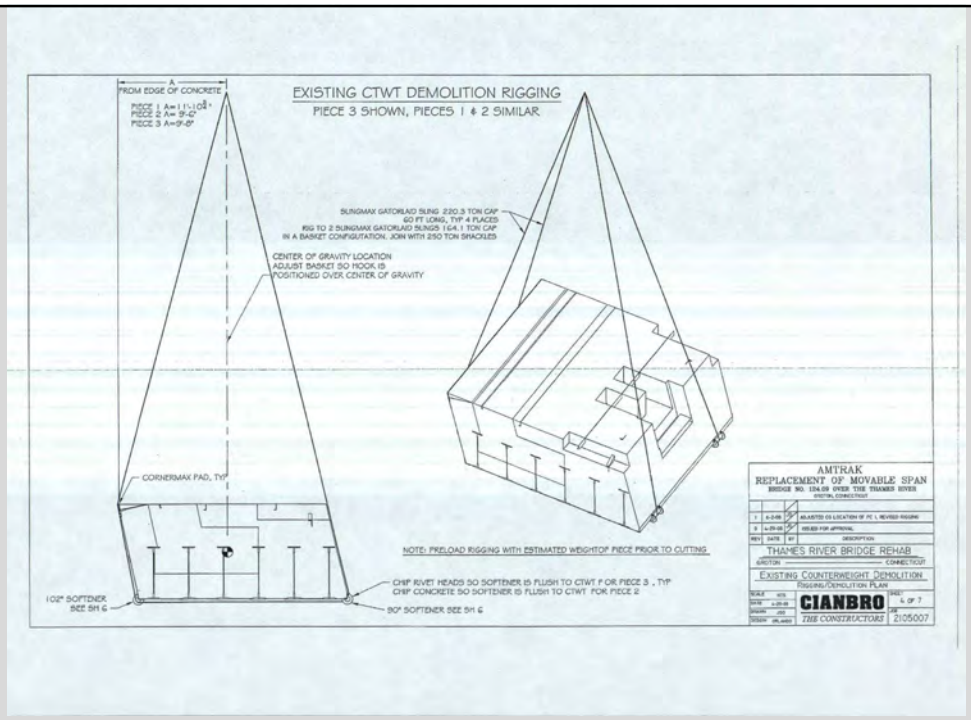


Change Plan A to Plan B

- Probable inability to drive 250 ton piles to rock
- Avoid risk of further movement of pier
- Need to move Span B and Span D to re-align tracks

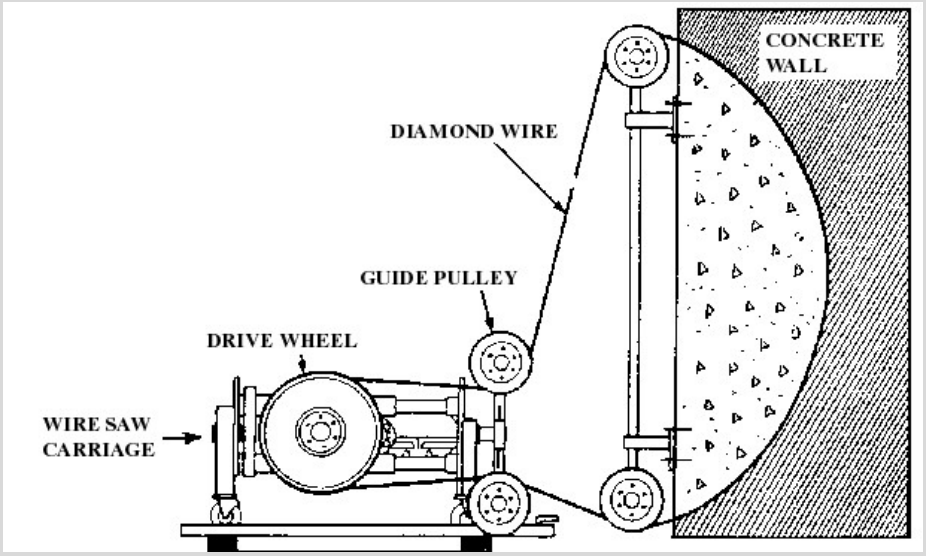
Plan B - De-Construct in Place




EXISTING CTWT DEMOLITION RIGGING
PIECE 3 SHOWN, PIECES 1 & 2 SIMILAR
A
FROM EDGE OF CONCRETE
PIECE 1 A= 11'-10 1/2"
PIECE 2 A= 9'-0"
PIECE 3 A=9'-0"
SLINGMAX GATORLAID SLING 220.3 TON CAP
60 FT LONG, TYP 4 PLACES
RIG TO 2 SLINGMAX GATORLAID SLINGS 164.1 TON CAP
IN A BASKET CONFIGUTATION. JOIN WITH 250 TON SHACKLES
CENTER OF GRAVITY LOCATION
ADJUST BASKET SO HOOK IS
POSITIONED OVER CENTER OF GRAVITY
CORNERMAX PAD, TYP
NOTE: PRELOAD RIGGING WITH ESTIMATED WEIGHTOF PIECE PRIOR TO CUTTING
CHIP RIVET HEADS SO SOFTENER IS FLUSH TO CTWT FOR PIECE 3 , TYP
CHIP CONCRETE SO SOFTENER IS FLUSH TO CTWT FOR PIECE 2
102" SOFTENER
SEE SH 6
90" SOFTENER SEE SH 6
AMTRAK
REPLACEMENT OF MOVABLE SPAN
BRIDGE NO. 124.09 OVER THE THAMES RIVER
GROTON — CONNECTICUT
THAMES RIVER BRIDGE REHAB
GROTON — CONNECTICUT
EXISTING COUNTERWEIGHT DEMOLITION
RIGGING/DEMOLITION PLAN
CIANBRO
THE CONSTRUCTORS
SHEET 6 OF 7
DR 2105007

OPENS IN
MIN

Wire Sawing Technology

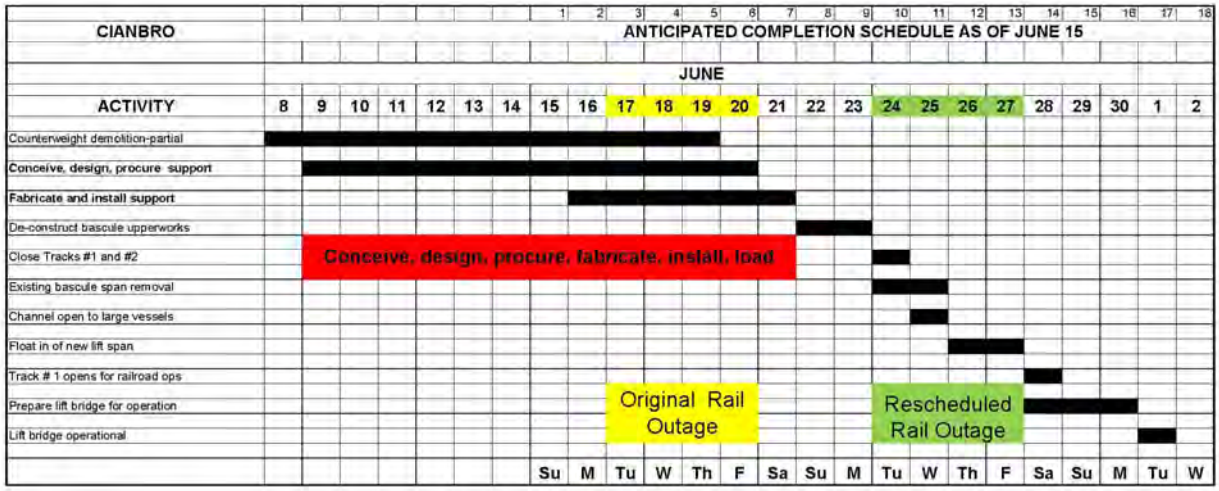


Concrete Containing Steel Punchings

Change Plan B to Plan C

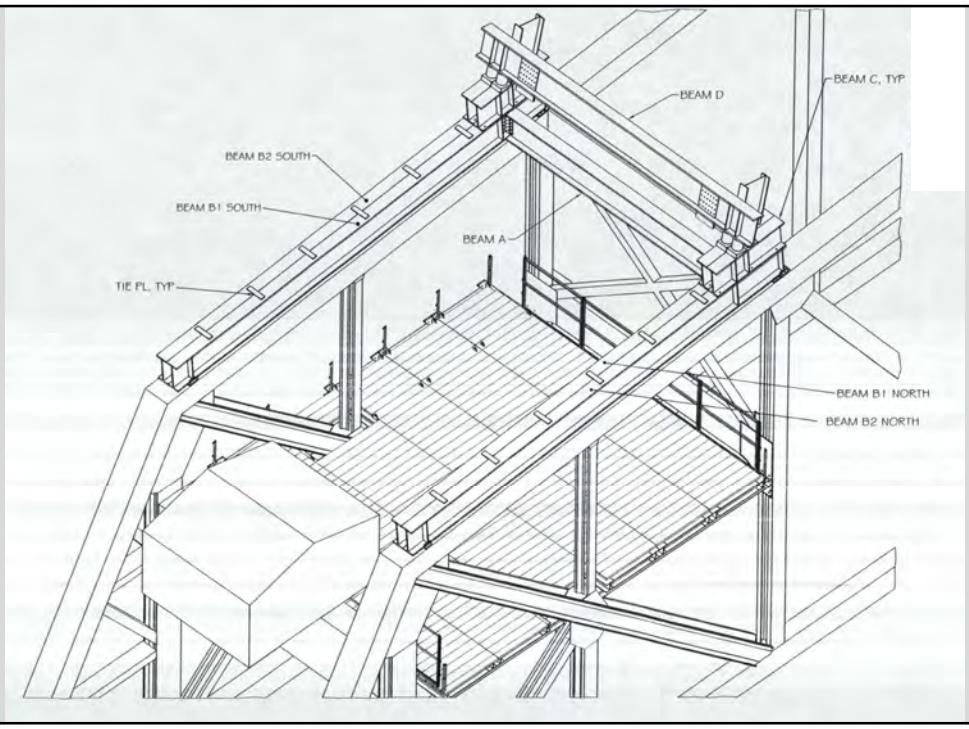
- Failure to cut counterweight into sections in time available
- Unexpected voids in counterweight
- Integrity of matrix around steel punchings less than anticipated

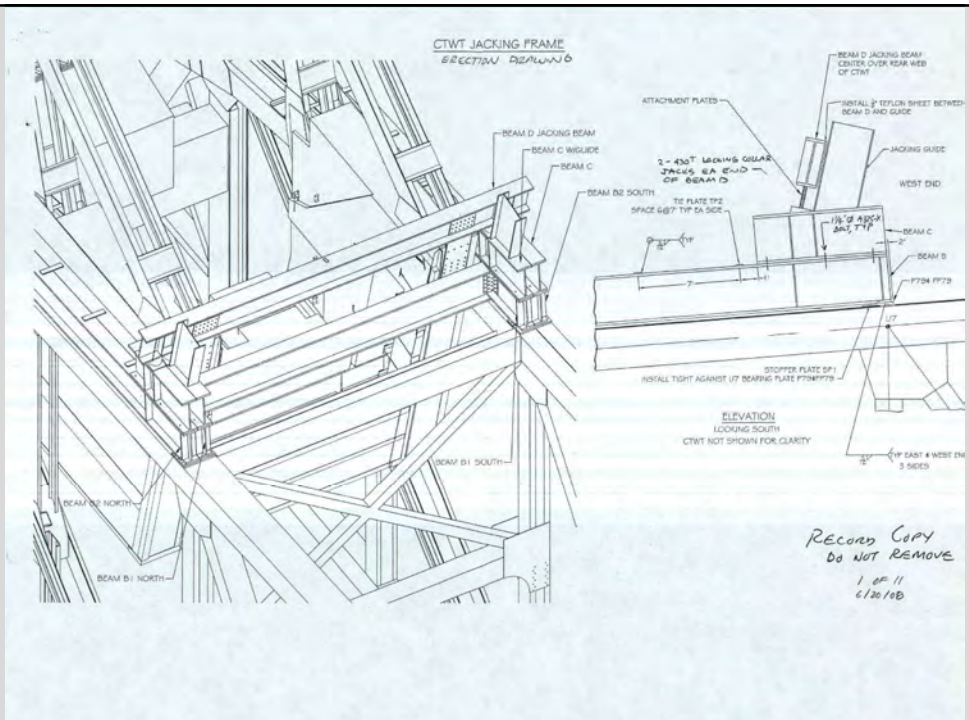
Plan C - Partial Demo and Support



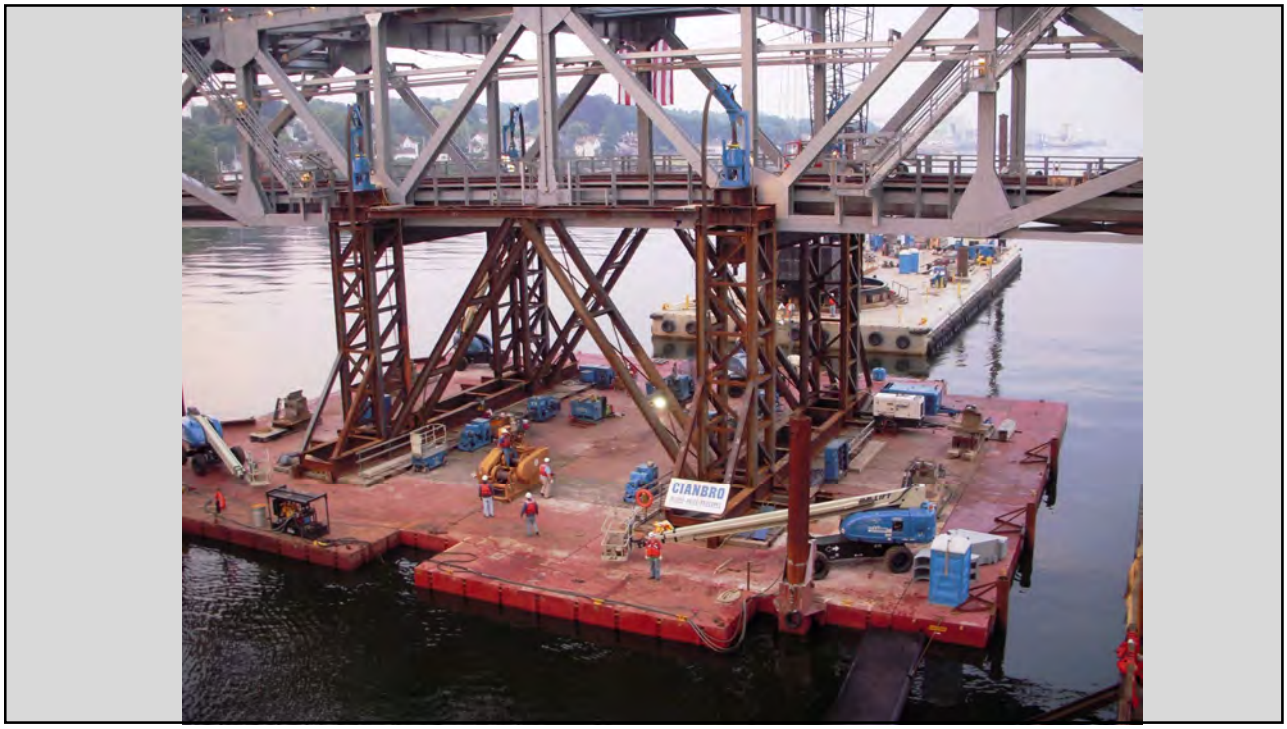
June 17, 2008

June 19, 2008


BEAM D
BEAM C, TYP
BEAM B2 SOUTH
BEAM B1 SOUTH
BEAM A
TIE PL, TYP
BEAM B1 NORTH
BEAM B2 NORTH


CTWT JACKING FRAME
ERECTION DRAWING
BEAM D JACKING BEAM
BEAM C WIGLIDE
BEAM C
BEAM B2 SOUTH
BEAM B1 SOUTH
BEAM B2 NORTH
BEAM B1 NORTH
ATTACHMENT PLATES
2 - 450T LOCKING COLLAR JACKS EA END OF BEAM D
TIE PLATE TP2
SPACE 6@7" TYP EA SIDE
JACKING GUIDE
WEST END
BEAM C
BEAM B
F734 FP79
U7
STOPPER PLATE SP1
INSTALL TIGHT AGAINST U7 BEARING PLATE FP734/FP79
ELEVATION
LOOKING SOUTH
CTWT NOT SHOWN FOR CLARITY
Record Copy
Do Not Remove
1 of 11
6/20/08

OPENS IN
MIN.


CIANBRO

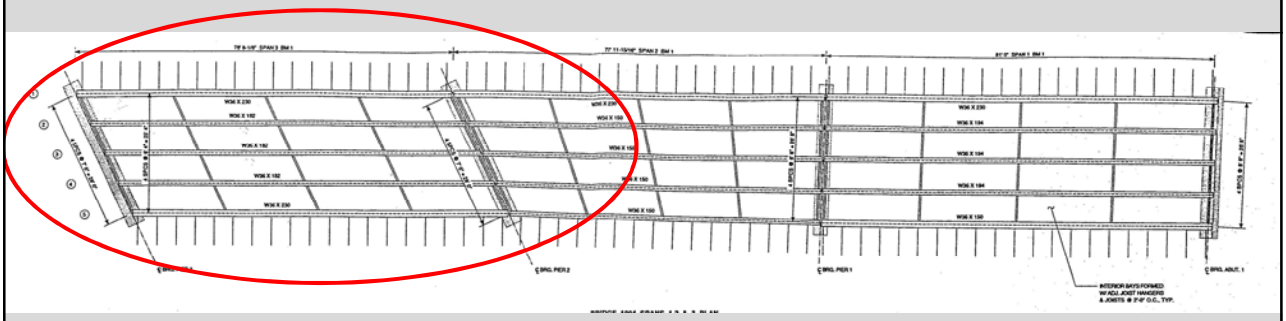
08/07/2008

August 7, 2008

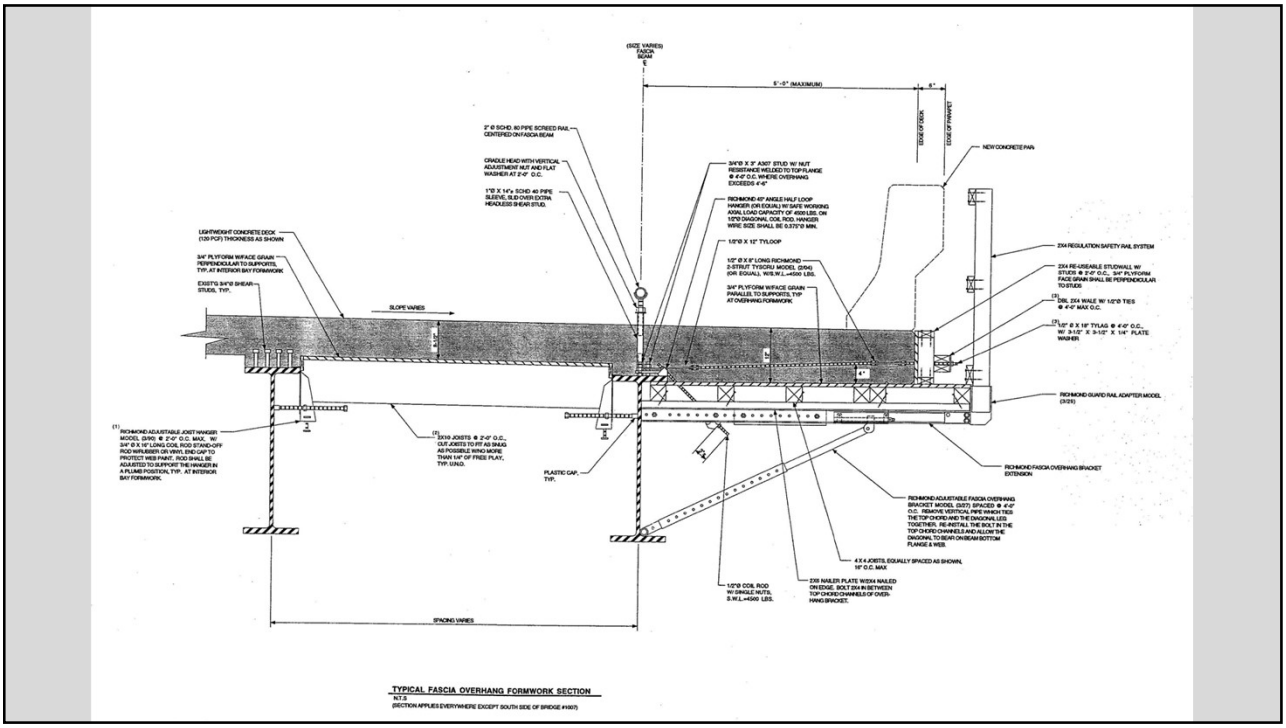
September 18, 2008

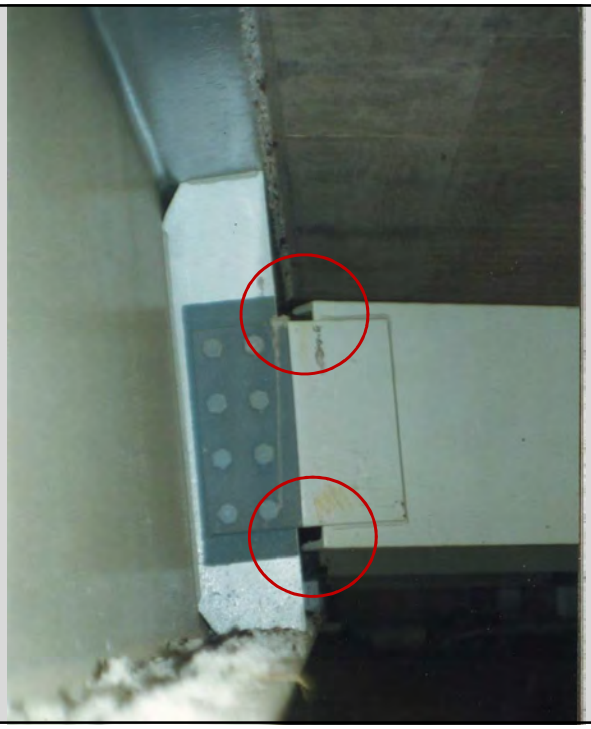
October 1, 2008

Issues with Skewed and Curved Steel Girder Bridges
Rotation of Stringers and Formwork
1998



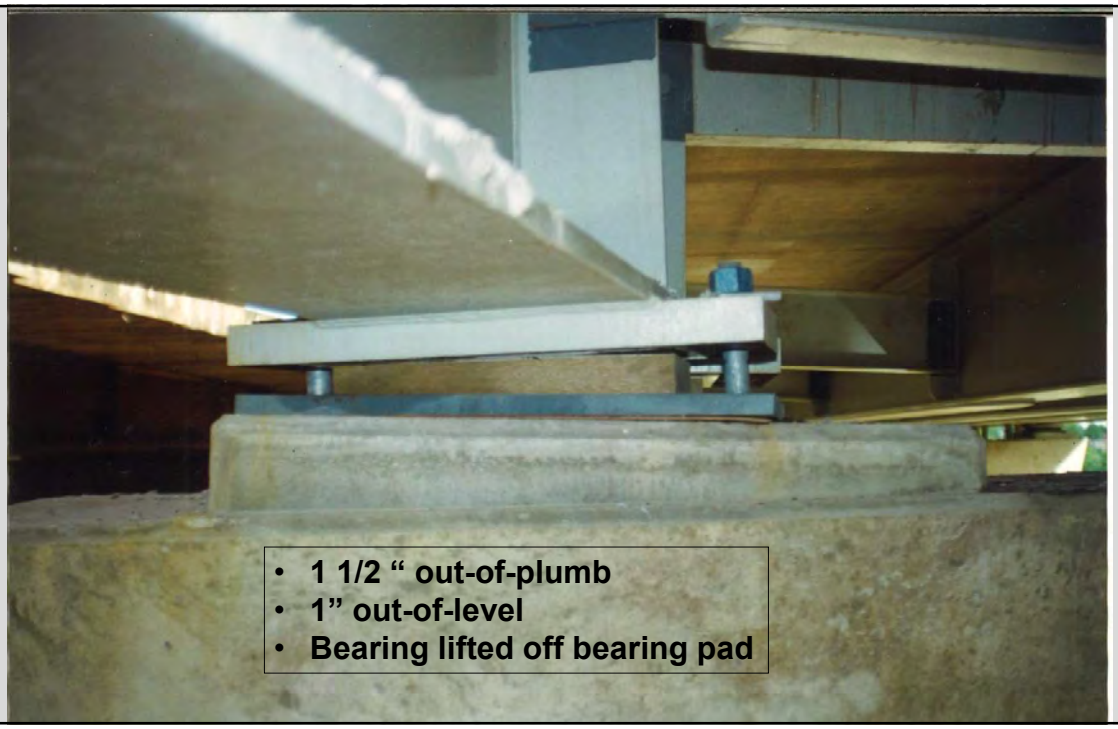
80 ft spans, 30° skew, W36, 5 ft overhang

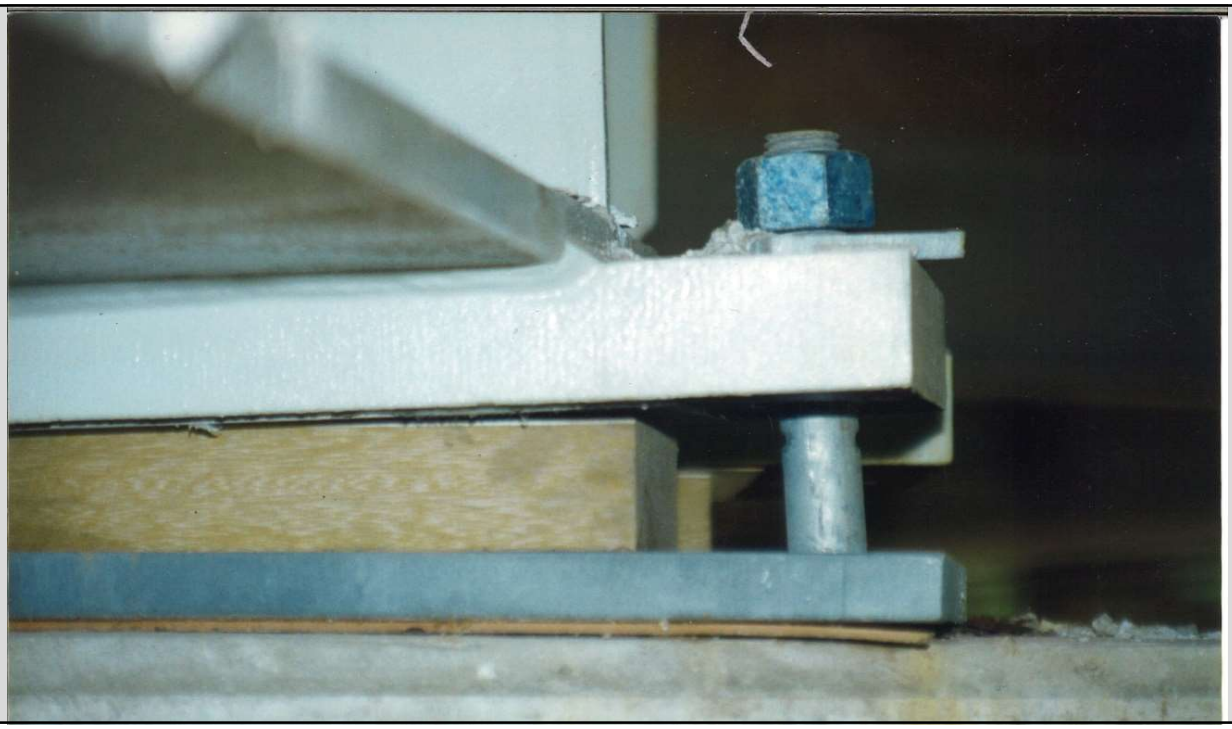


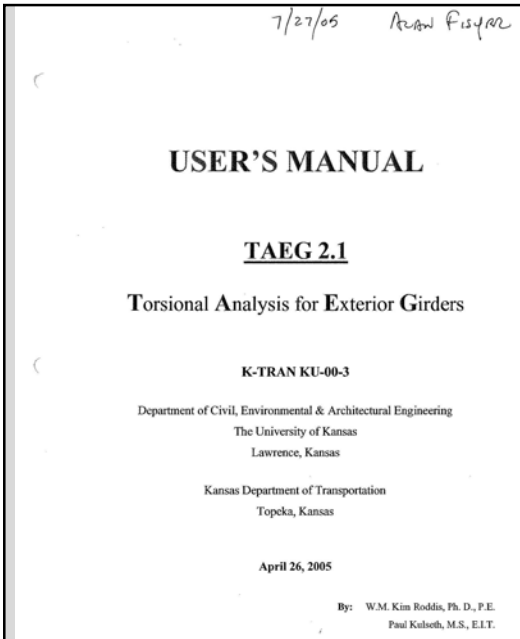


Gaps were equal

- Girder rotated
- Diaphragm connection not stiff enough


• 1 1/2 “ out-of-plumb
• 1” out-of-level
• Bearing lifted off bearing pad




7/27/05 Brian Fisher

USER'S MANUAL

TAEG 2.1

Torsional Analysis for Exterior Girders

K-TRAN KU-00-3

Department of Civil, Environmental & Architectural Engineering
The University of Kansas
Lawrence, Kansas

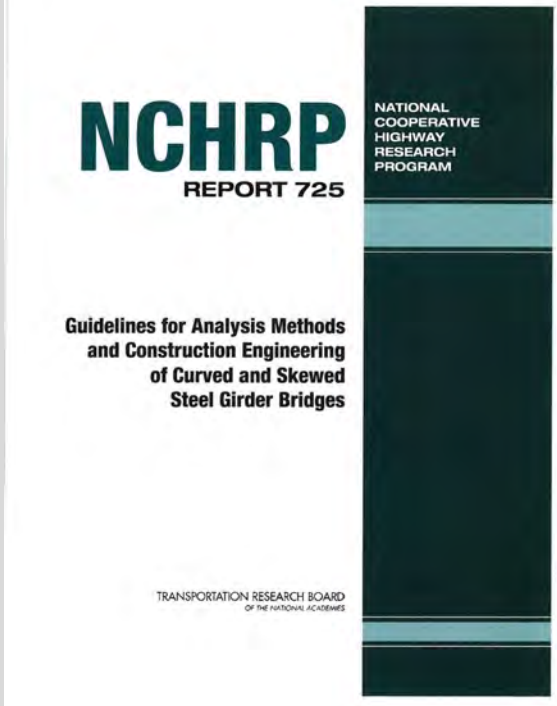
Kansas Department of Transportation
Topeka, Kansas

April 26, 2005

By: W.M. Kim Roddis, Ph. D., P.E.
Paul Kulseth, M.S., E.I.T.

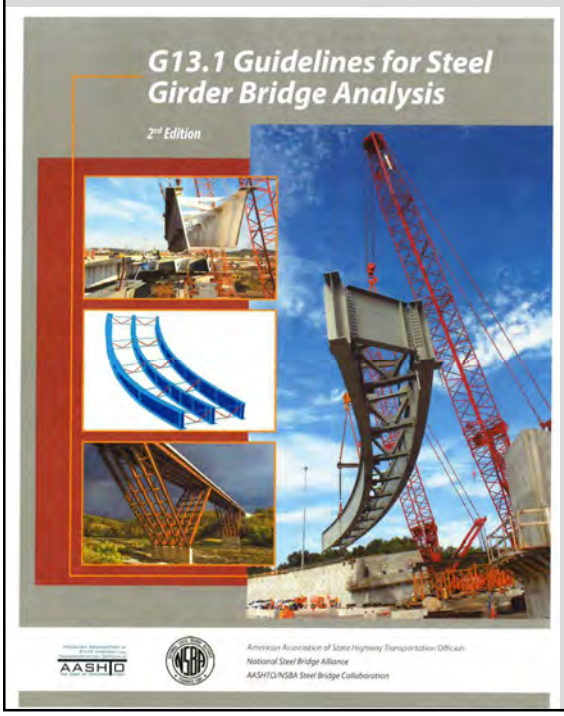
Torsional Analysis for Exterior Girders - 2005

- Turns out we were not the only constructors who had encountered this problem
- One issue is that big overhangs are an issue, addressed by this publication.
- Second issue is that curved and skewed bridges have their own problems, now being addressed.



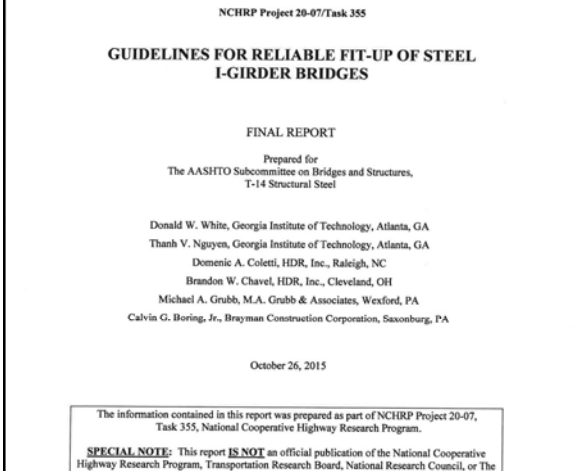
Guidelines for Analysis Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges

- NCHRP Report 725
- Published in 2012
- Report, Appendix A and Appendix B - 199 pages
- Appendix C – 387 pages
- 586 pages total



Guidelines for Steel Girder Bridge Analysis G13.1-2014

- Free download from the AASHTO Bookstore for E-Affiliates https://bookstore.transportation.org
- 184 Pages – Readable document



NCHRP Project 20-07/Task 355

GUIDELINES FOR RELIABLE FIT-UP OF STEEL I-GIRDER BRIDGES

FINAL REPORT

Prepared for
The AASHTO Subcommittee on Bridges and Structures,
T-14 Structural Steel

Donald W. White, Georgia Institute of Technology, Atlanta, GA
Thanh V. Nguyen, Georgia Institute of Technology, Atlanta, GA
Domenic A. Coletti, HDR, Inc., Raleigh, NC
Brandon W. Chavel, HDR, Inc., Cleveland, OH
Michael A. Grubb, M.A. Grubb & Associates, Wexford, PA
Calvin G. Boring, Jr., Brayman Construction Corporation, Saxonburg, PA

October 26, 2015

The information contained in this report was prepared as part of NCHRP Project 20-07, Task 355, National Cooperative Highway Research Program.

SPECIAL NOTE: This report IS NOT an official publication of the National Cooperative Highway Research Program, Transportation Research Board, National Research Council, or The National Academies.

Guidelines for Reliable Fit-Up of Steel I-Girder Bridges

- 4687 pages total
- 523 pages in main report
- 4080 pages of bridge results
- 60 pages Chapter 4: Conclusions and Recommendations
- Detailed revisions and additions for AASHTO Bridge Design Spec 8th Ed.

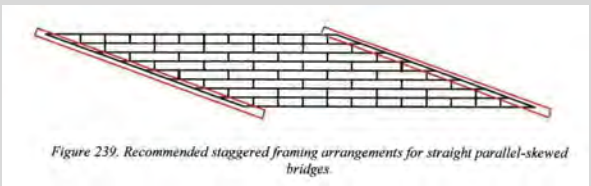
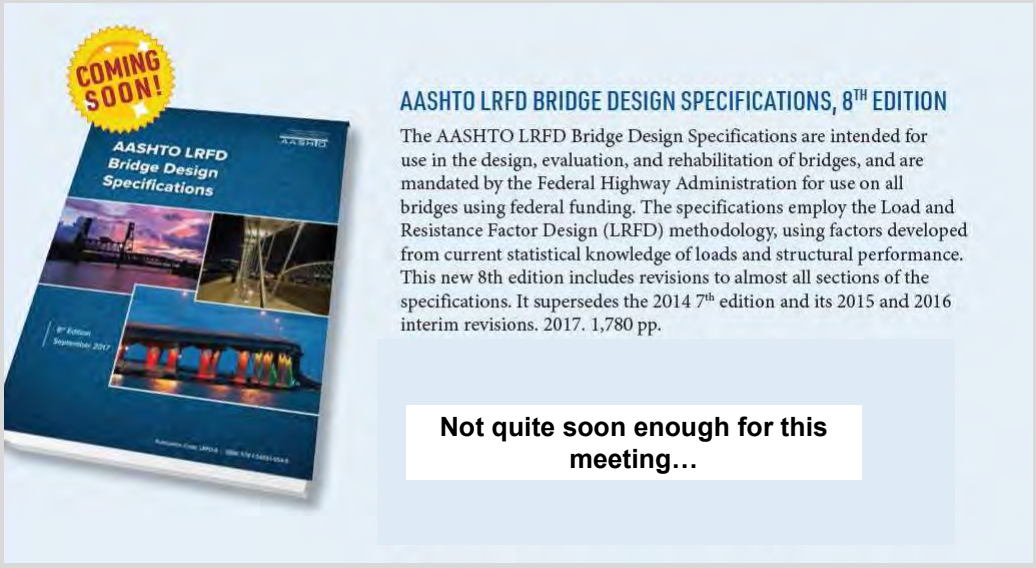
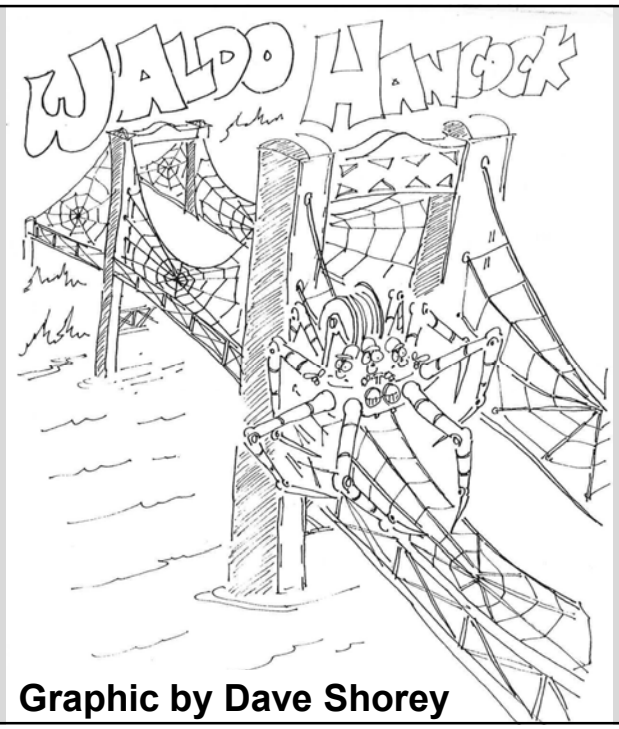


Figure 239. Recommended staggered framing arrangements for straight parallel-skewed bridges.

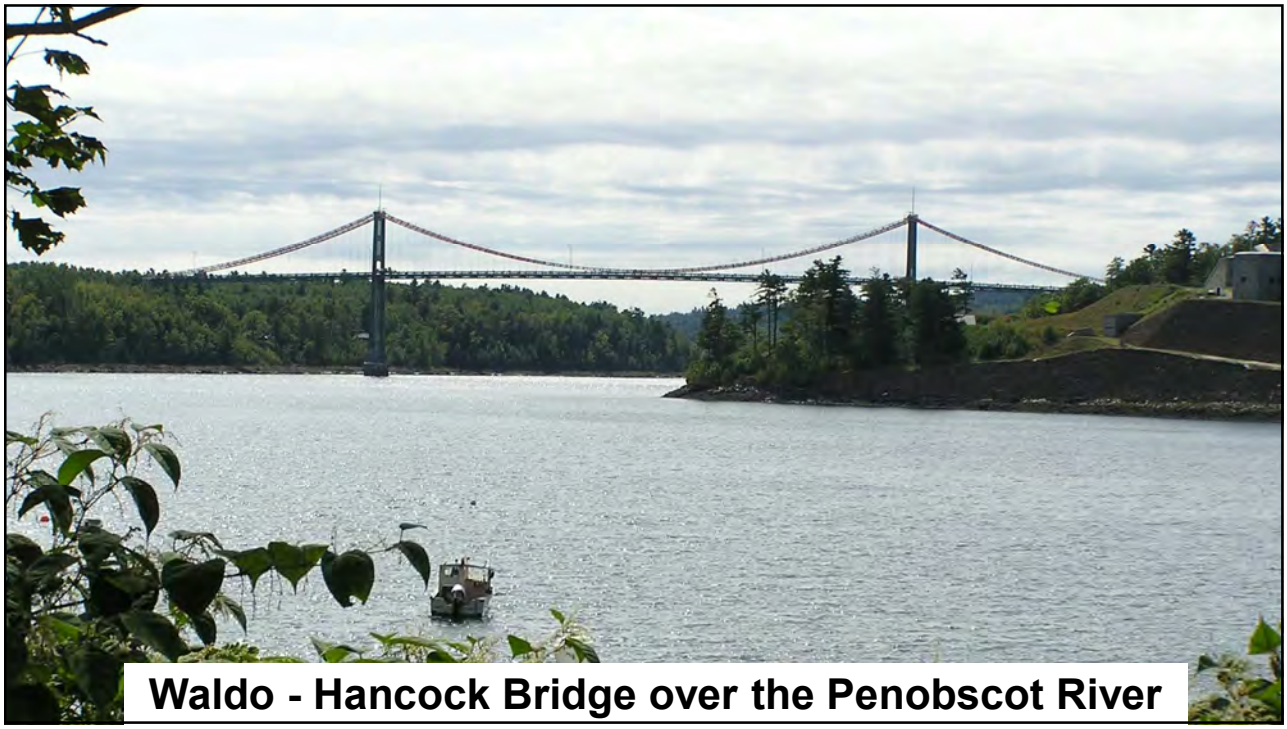
Guidelines for Reliable Fit-Up of Steel I-Girder Bridges

- Proposed definitions to be added to the AASHTO Bridge Design Spec 8th Ed.
  - Fit Condition
    - **NLF** No-Load Fit Detailing
    - **SDLF** Steel Dead Load Fit Detailing
    - **TDLF** Total Dead Load Fit Detailing
  - Phased Construction
  - Staged Deck Placement
  - Locked-in Forces
  - Contiguous Cross Frames
  - Discontiguous Cross Frames



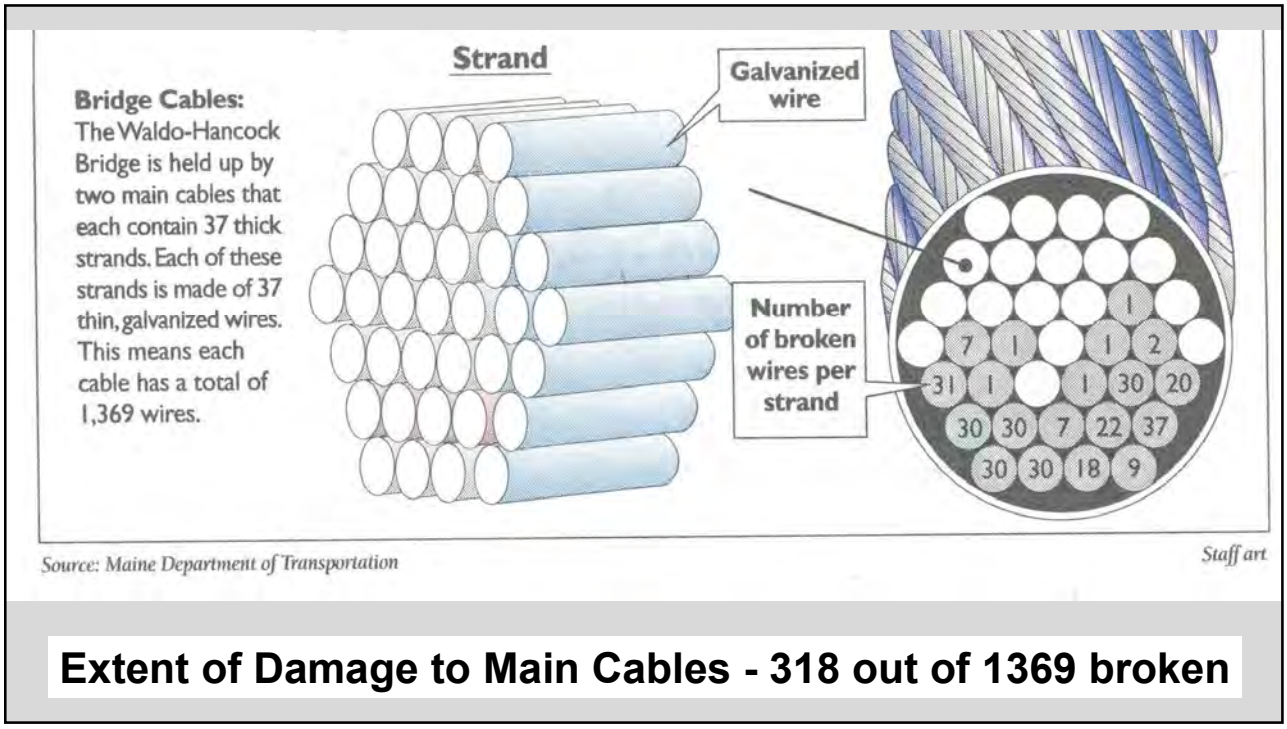


Graphic by Dave Shorey

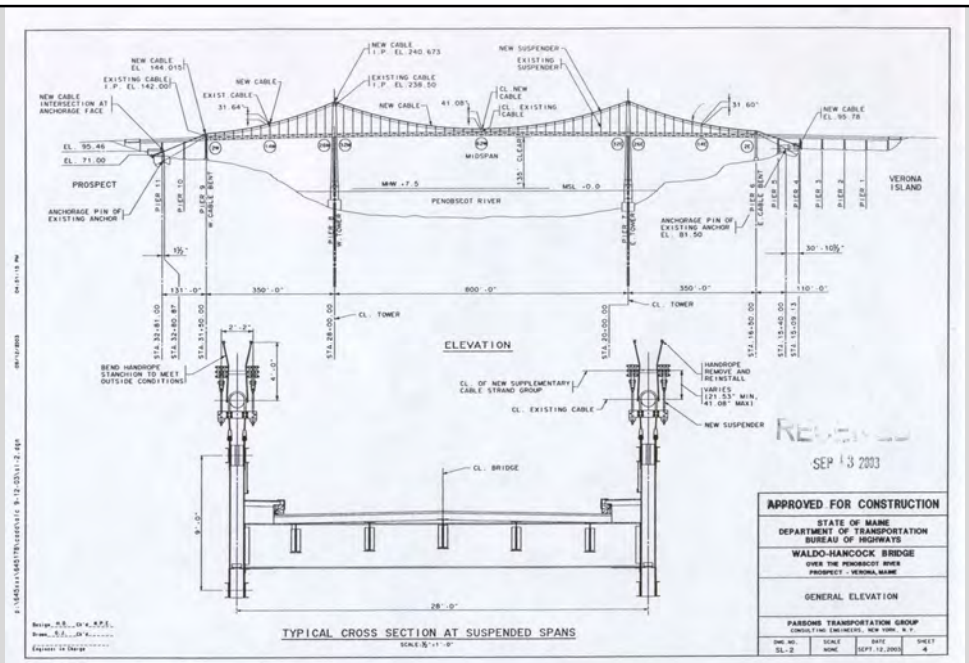


Waldo - Hancock Bridge over the Penobscot River

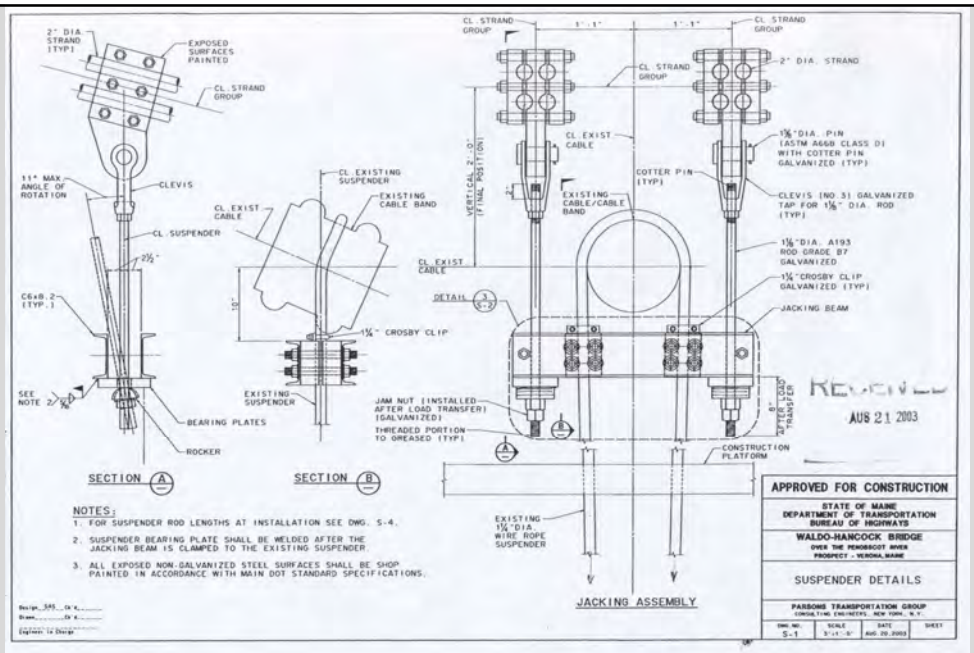
Main Cable with Wire Wrap Removed



Extent of Damage to Main Cables - 318 out of 1369 broken



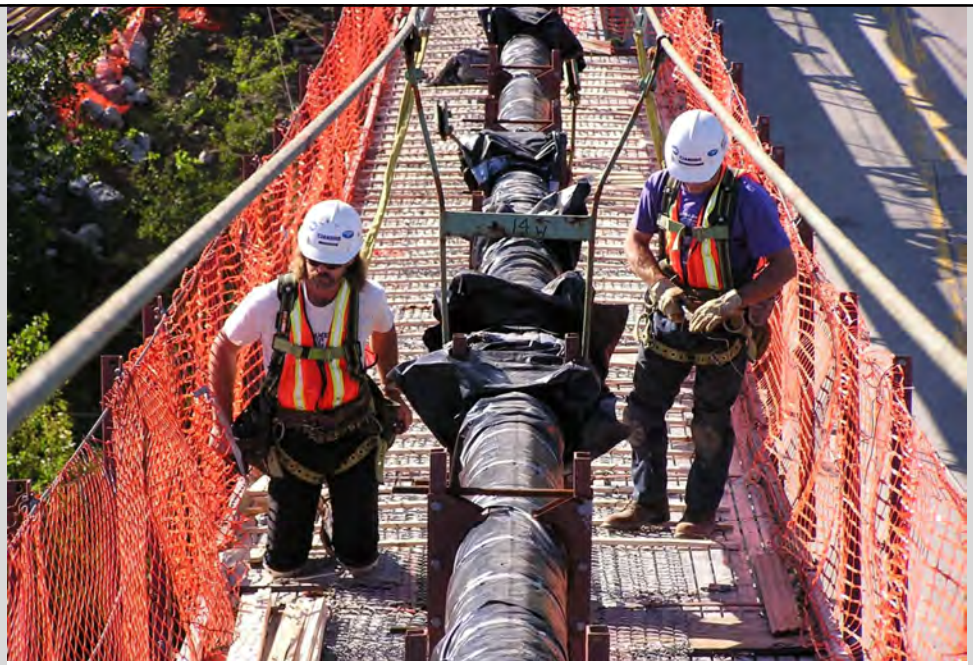
Main Cable and Supplemental Cable Geometry



Supplemental Cable to Main Cable Load Transfer

First Meeting August 11, 2008

Cianbro promises to complete within 12 weeks



First Job Make It Safe

Concrete Placement at Tops of Towers, Support for Main Saddles

Main Saddle with Strand Guide & Gantry to Move Strand onto Saddle

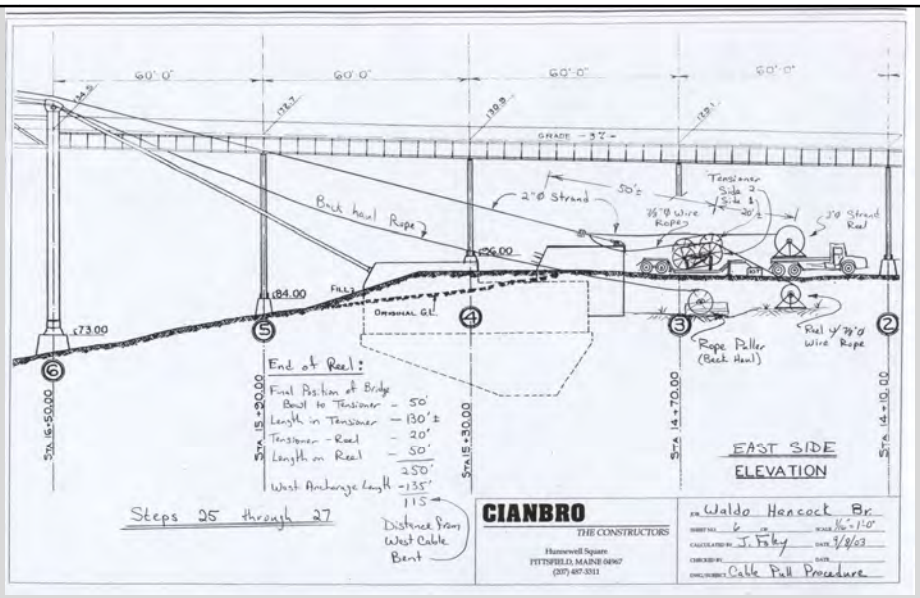


Diagram of Cable Pulling Procedure - Tensioner End

Hydraulic Winch for Pulling Strand

Tensioner for Maintaining Load on Strand During Pulling

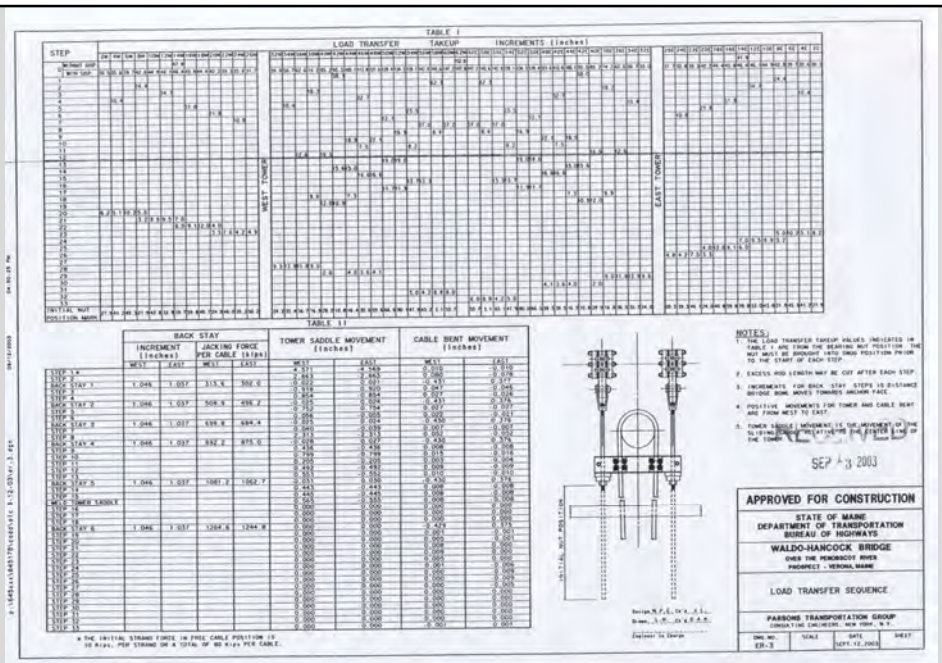
Tensioner Maintained 10-15 Thousand Pounds of Tension During Strand Pulling

“Mouse” Approaching the “Toboggan Ride” Over Tower Saddle

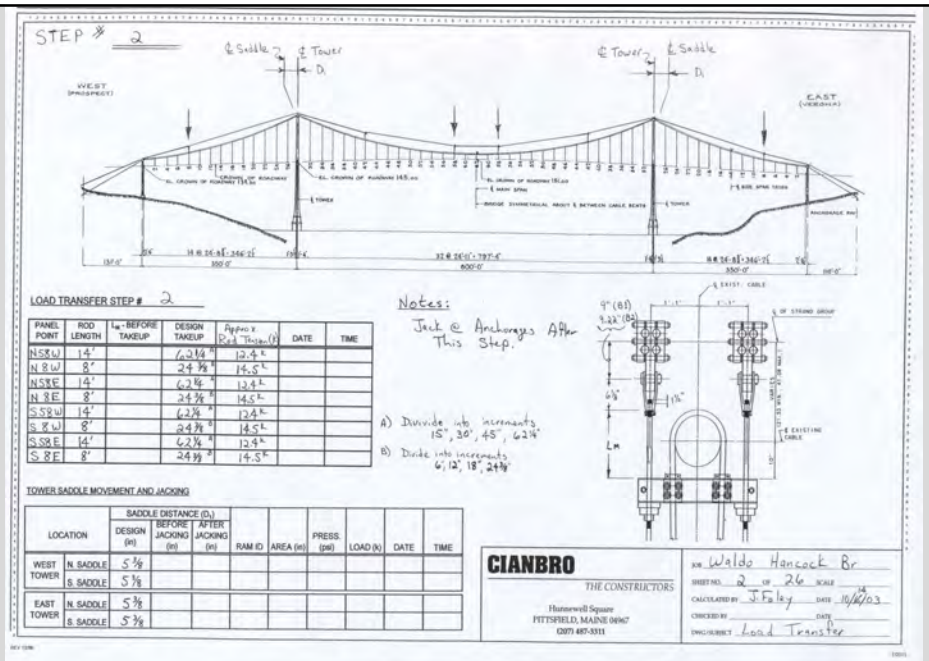
Overview of Entire Strand Tensioning Equipment Set-Up

Installing Cable Clamps

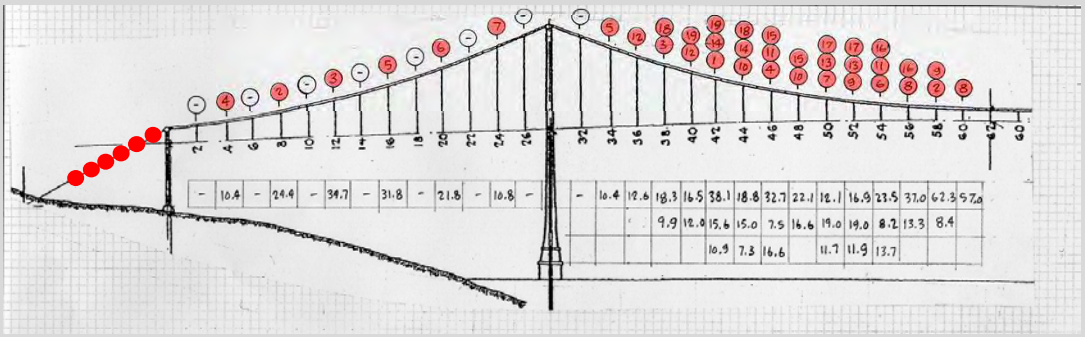
Installing New Suspender Hanger Blocks



Load Transfer Sequence



Typical Load Transfer Specifics Sheet



Load Transfer Sequence - First Stage

First Stage of Load Transfer - 19 LT Steps and 6 BS Steps

Step 2 of Load Transfer

Switch Suspender Loading Method

Improved Suspender Loading Method

Load Transfer Operation - Jacking at 8 Locations at Once

Typical Load Transfer Step - Suspender Loading Method B

Back Stay Tensioning at Abutment - 32 Jacks per Abutment

Nearing the End of the Load Transfer Process

Complete

CONSTRUCTION TIMELINE

Aug 11	First meeting Cianbro-MDOT
Aug 25	Cianbro mobilization on site
Sept 2	Cianbro start on-site work
Sept 12	Placed first saddle concrete
Sept 23	Pulled first south side strand
Oct 10	Pulled last north side strand
Oct 17	Completed steps 1 & 2 of load transfer
Oct 26	Completed steps 24, 25 & 26 of load transfer

Complete - 11 weeks after first meeting

Lecture 3
Structural Issues During Construction

Alan D. Fisher, PE
Construction Structures Group Leader