Successful Implementation of Steel Coating and Bridge Rehab Projects

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Director of Maintenance
Texas Department of Transportation

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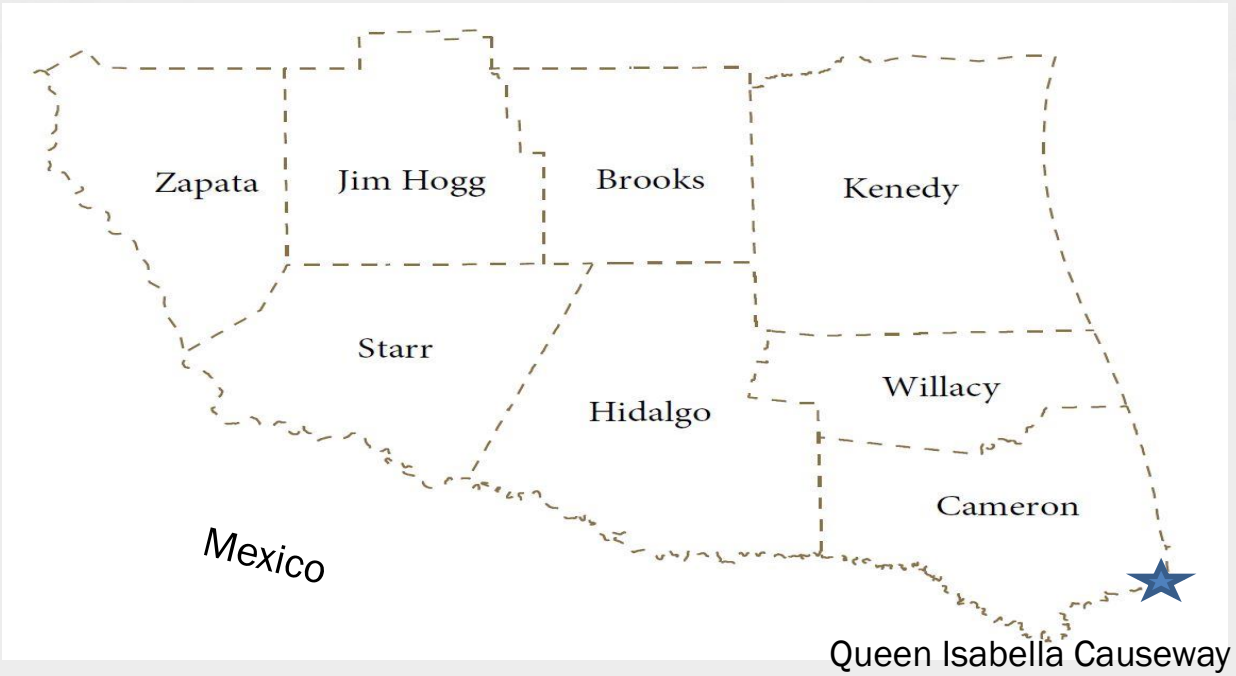
Pharr District Facts

Pharr is a Coastal District with 14 International crossings and serves as a NAFTA corridor. Currently, none of the Pharr District bridges are load rated. Thanks to ongoing maintenance efforts of our structures.

FY 2017	
Population	1,385,195
Square Miles Area	8,812
Lane Miles	6,510 (+102)
Centerline Miles	2,378
Daily Vehicle Miles	19,283,619



Queen Isabella Causeway

Pharr District Facts

On-System Bridges	
State Bridge Total	35,489
State Sufficiency Rating	88%
Pharr District Total	728
Sufficiency Rating	92%

On-System inspections occur every two years. These inspections ensure all bridges open to traffic are safe. Reports are developed along with Follow-up Action reports to correct any significant issues to maintain bridge integrity.


Heights
E Ocean Blvd
48
00
Port Isabel
Queen Isabella Causeway
South Padre Island
Long Island
Clark Island
Image © 2018 TerraMetrics
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

QIC Facts

- Connects Port Isabel to South Padre Island
- Constructed between 1973 and 1974
- 2.36 miles long and 67.75’ wide (2 – 12’ lanes with inside and outside shoulders)
- 150 Pre-stressed Type 54 Concrete Beam Unit Spans (80’)
- 1 – 750’ Variable Depth Plate Girder three span continuous unit (220’ – 310’ – 220’)
- 78’ Vertical clearance and 200’ horizontal clearance over Inter Coastal Waterway
- September 15, 2001 Vessel Impact – 320’ of Bridge removed and replaced
- Steel coating operations – 1982, 1997, and 2010

QIC Maintenance History Costs

FY	PROJECT DESCRIPTION	PROJECT COST
1997	CATHODIC PROTECTION (BENT 19-24)	$478,000.00
1997	REHAB/PAINT MAIN SPAN	$618,601.71
2001	EMERGENCY REPAIRS (SPAN 29-33)	$5,918,012.88
2003	CATHODIC PROTECTION	$3,117,394.00
		$445,000.00
2003	EARLY WARNING DETECTION	$842,861.00
2003	PIER PROTECTION & FENDER SYSTEM	$3,262,255.00
		$2,602,800.00
2003	PIER PROTECTION & FENDER SYSTEM	$6,589,207.38
2004	CATHODIC PROTECTION	$1,296,103.06
2007	DOLPHIN & FENDER REPAIRS	$1,084,750.00
2009	REPAIRS TO DECK SPAN #3	$55,482.80
2010	REHAB/PAINT MAIN SPAN/CATH PROTECTION	$3,940,365.06
2010	REPLACE ILLUMINATION POLES/FIXT	$410,856.68
2010	DOLPHIN & FENDER REPAIRS	$13,336.27
2011	DOLPHIN & FENDER REPAIRS	$17,001.25
2012	DOLPHIN & FENDER REPAIRS	$263,909.00
2013	STRUCTURE REPAIRS, RAIL RETROFIT, SILANE TREATMENT, BEAM END REPAIR	$2,811,843.96
	PROJECTED TOTAL	**$33,767,780.05**

Bridge Elements

Roadway Approach Port Isabel Side

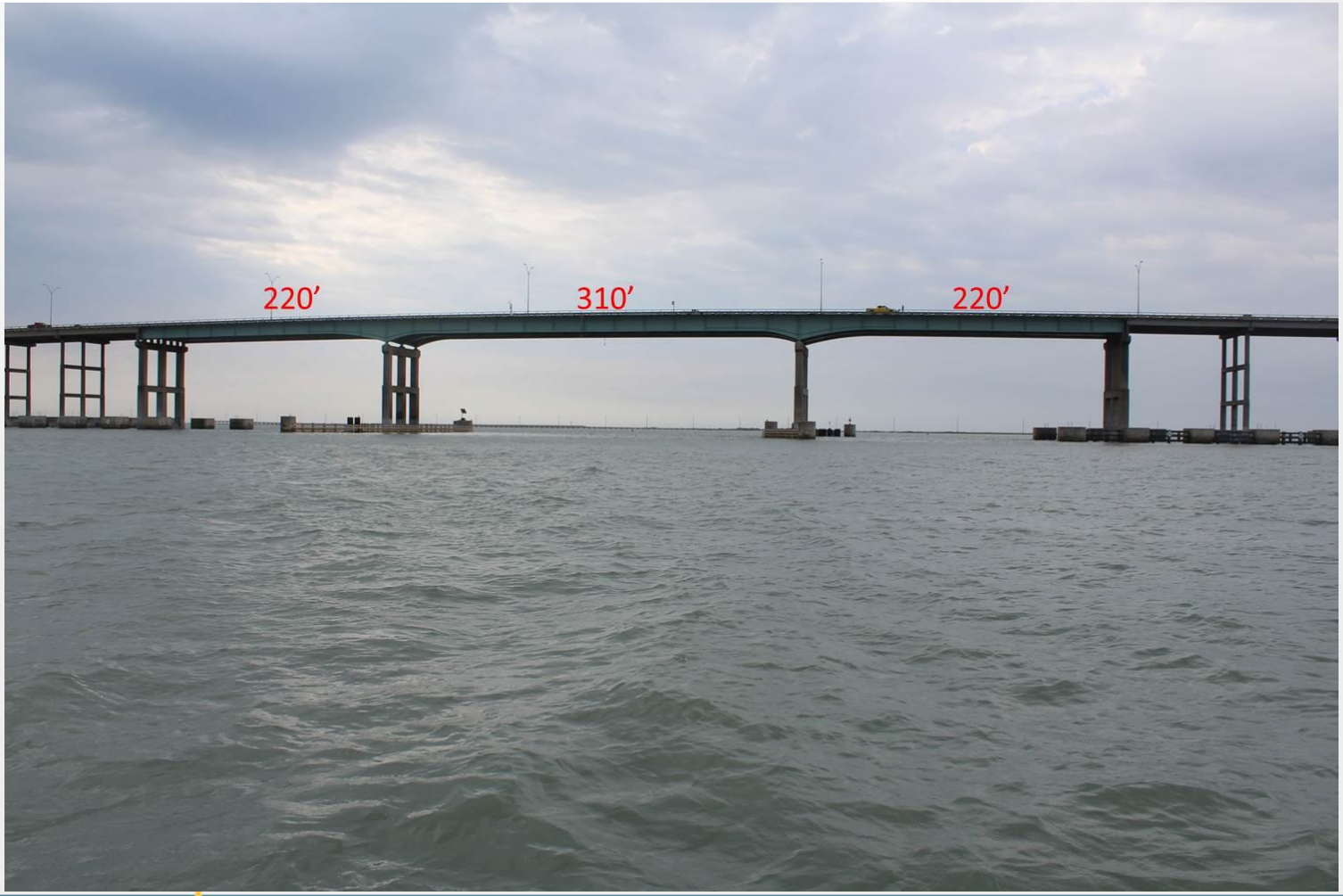
Roadway Approach South Padre Island Side

Side View

Type 54 Girders with Internal Concrete Diaphragm

Multi-Column Bent
Mid and Lower Tie Beams Resting on Pile Cap Footing

750’ Variable Depth Steel Girder Unit – 3 Girders



Steel Girder with Internal Diaphragms

Existing Conditions

Existing Conditions

Existing Conditions

Existing Conditions

Existing Conditions

Maintenance Improvement

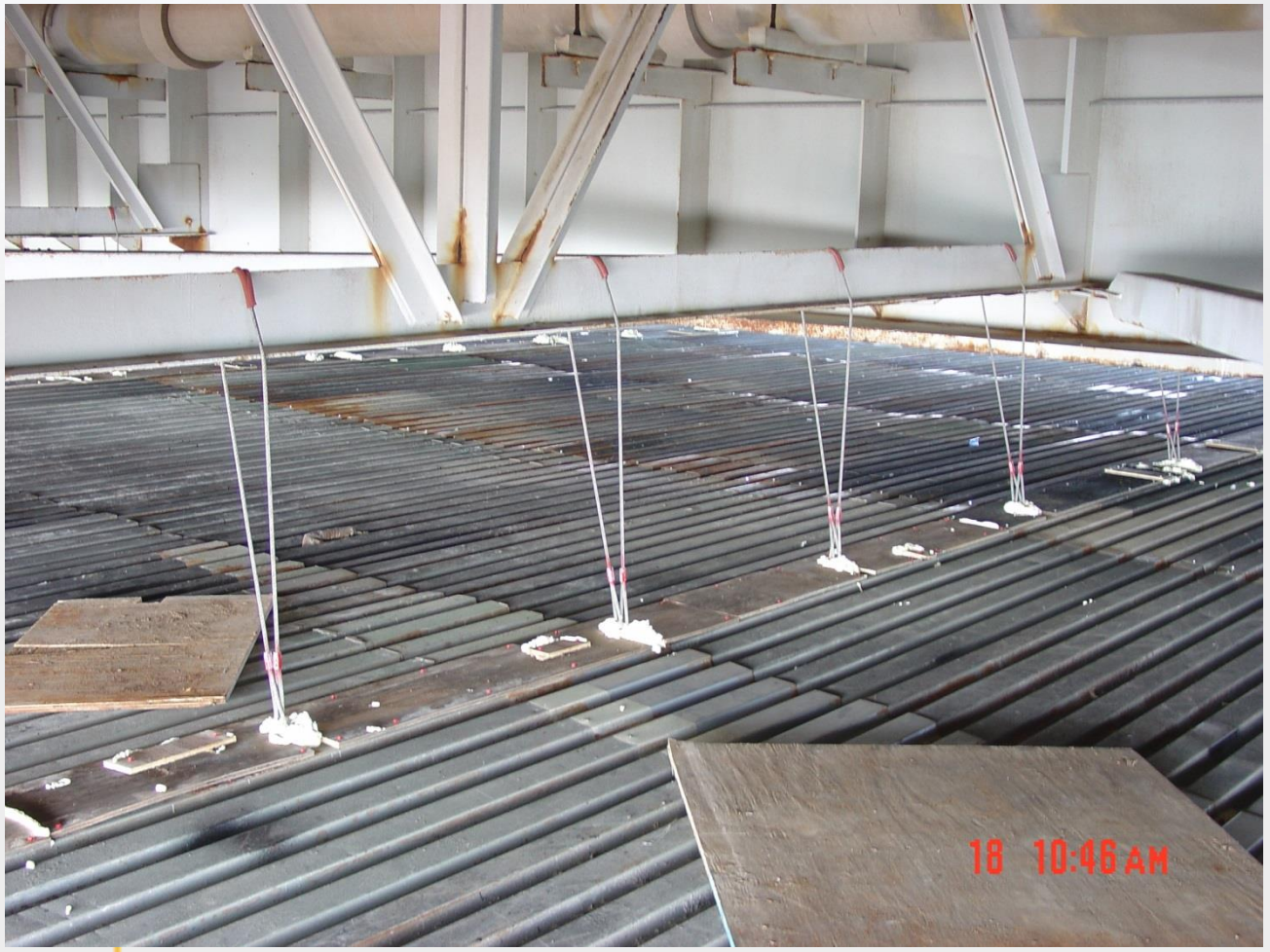
- Blast cleaning with steel grit
- All deteriorated steel areas repaired or replaced with new structural steel
- System III Zinc Clad Marine Paint System (Three Steel Coating Operations)
  - Priming
  - Intermediate Epoxy Coating
  - Appearance Coating

Contractor Operations

- Requires one lane closure – stationary
- Equipment includes: dehumidifier, dust collector, recycle unit, air compressor, job trailer, barrels of steel grit, plastic tarps and rigging

Rigging and Containment

Rigging and Containment



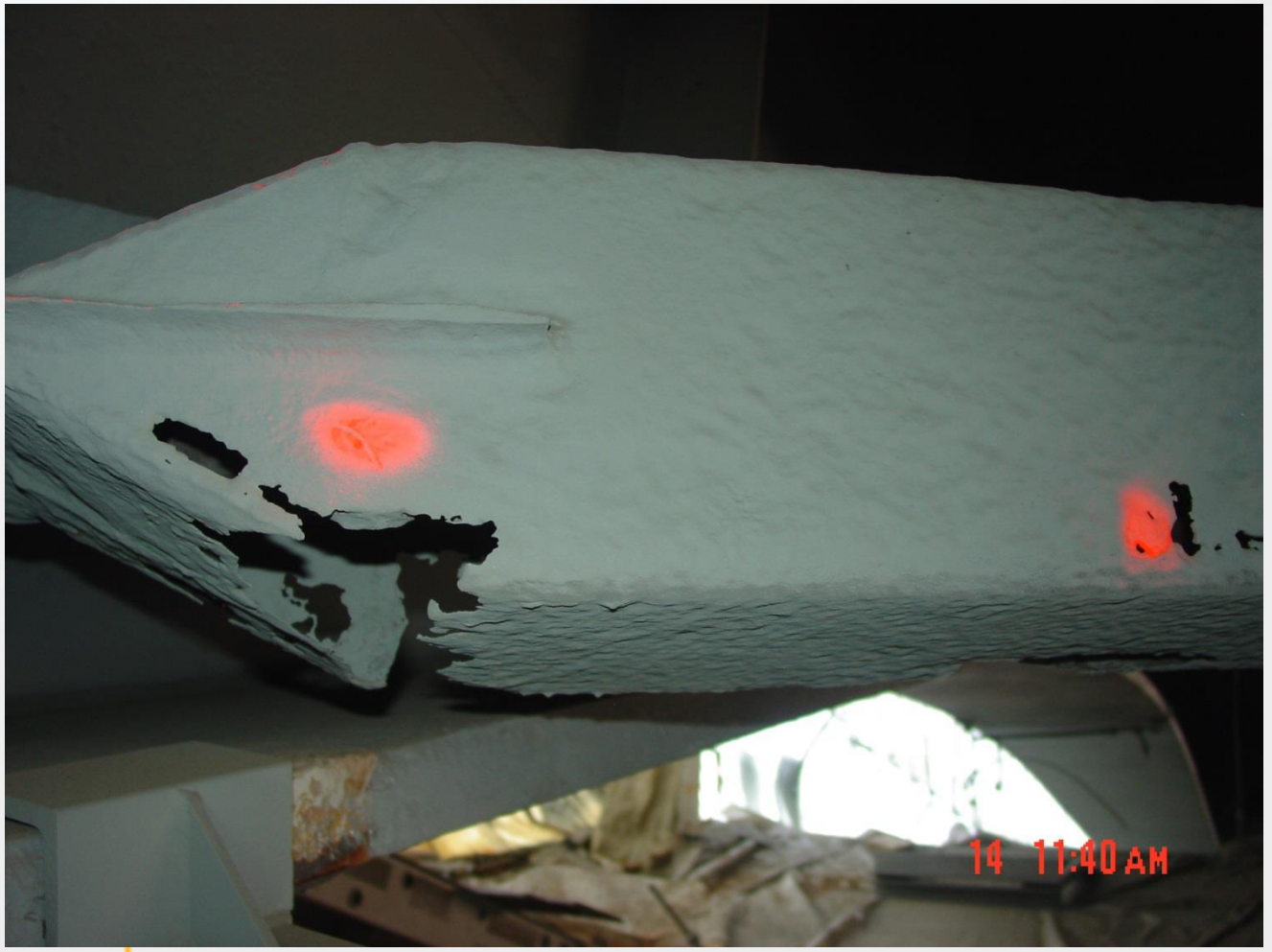
Rigging and Containment

Paint Removal (Removing Pack Rust)

Paint Removal (Blasting)

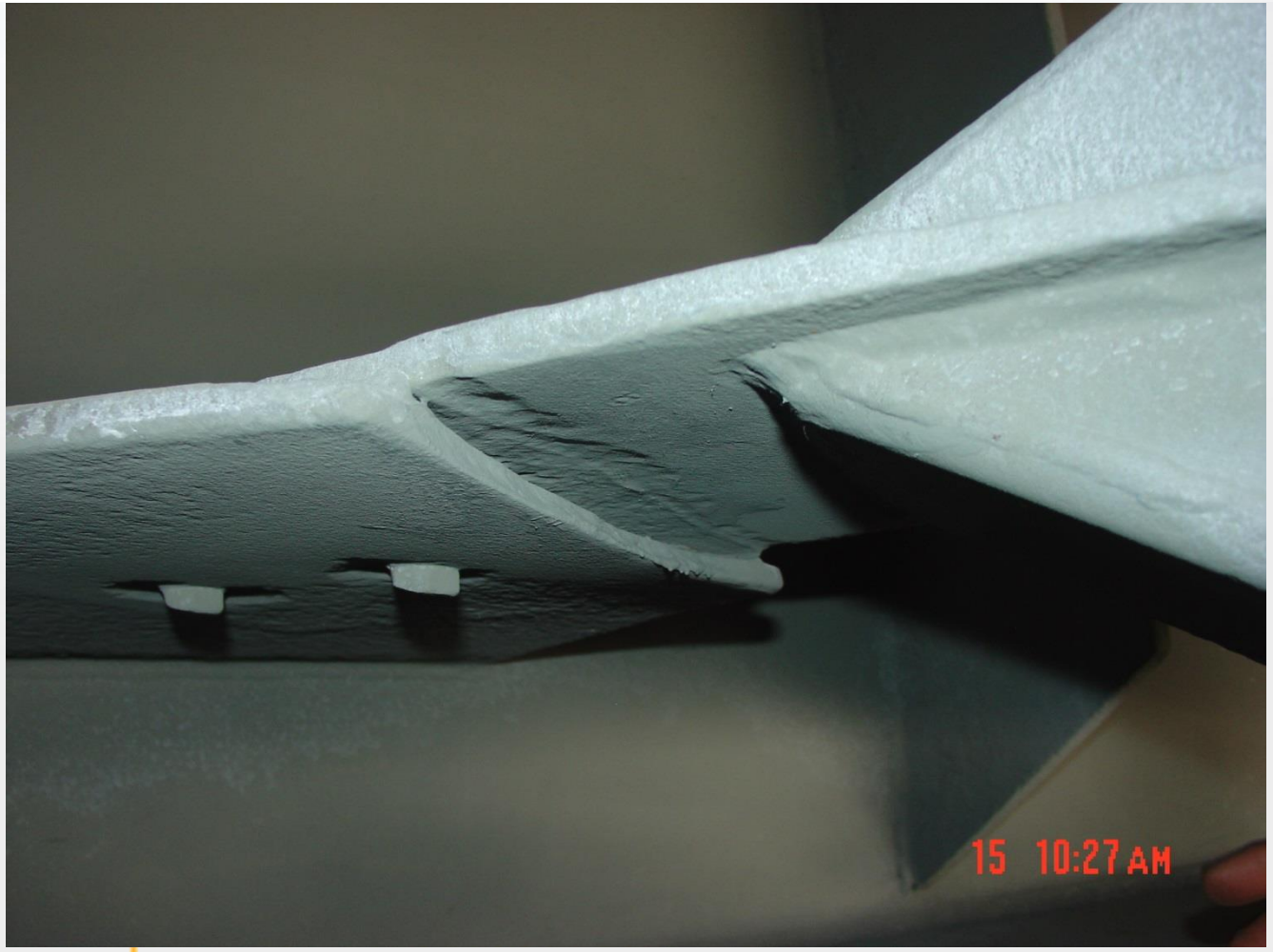
Paint Removal (Blasting)

Paint Removal (Blasting)

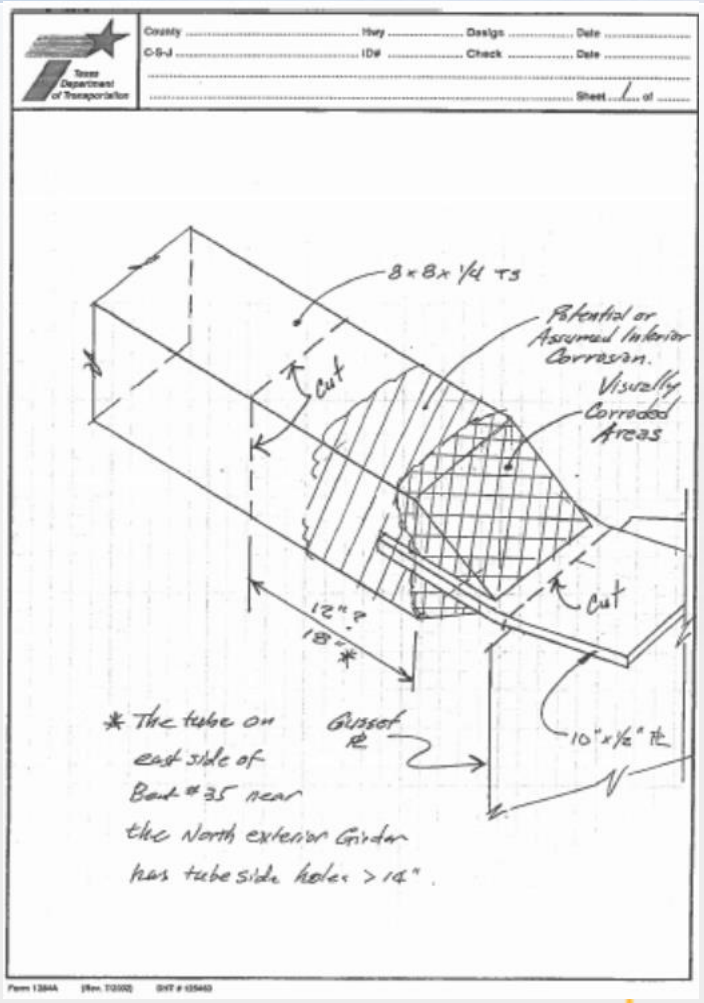


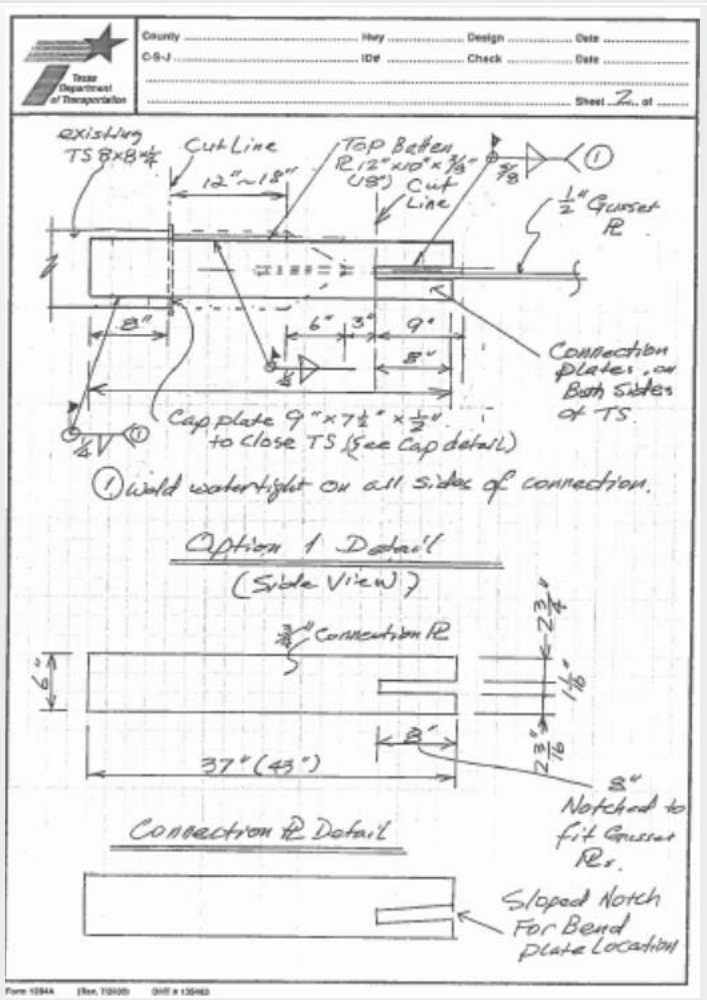
Paint Removal (Blasting)

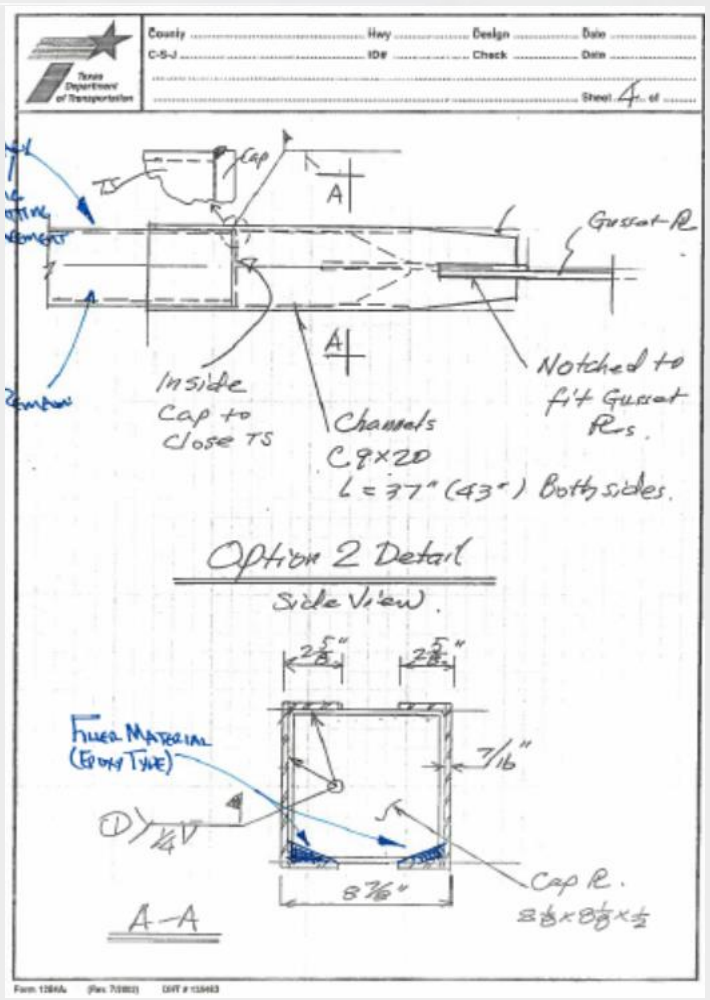
Paint Removal (Blasting)



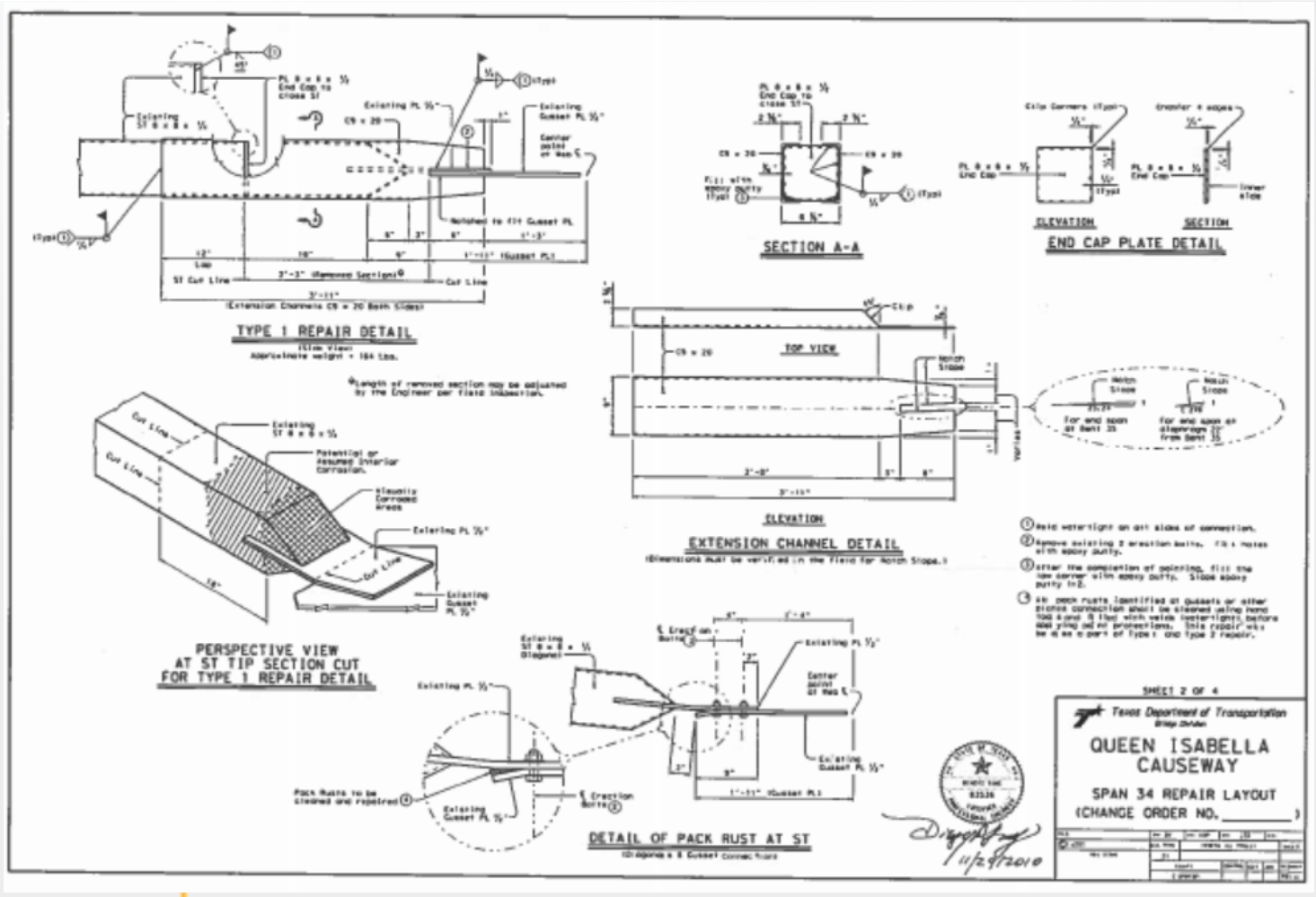
Repairs


8×8×½ TS
Potential or Assumed Interior Corrosion. Visually Corroded Areas
Cut
Cut
12" ~ 18" *
* The tube on east side of Bent #35 near the North exterior Girder has tube side holes > 14".
Gusset PL
10"×½" PL

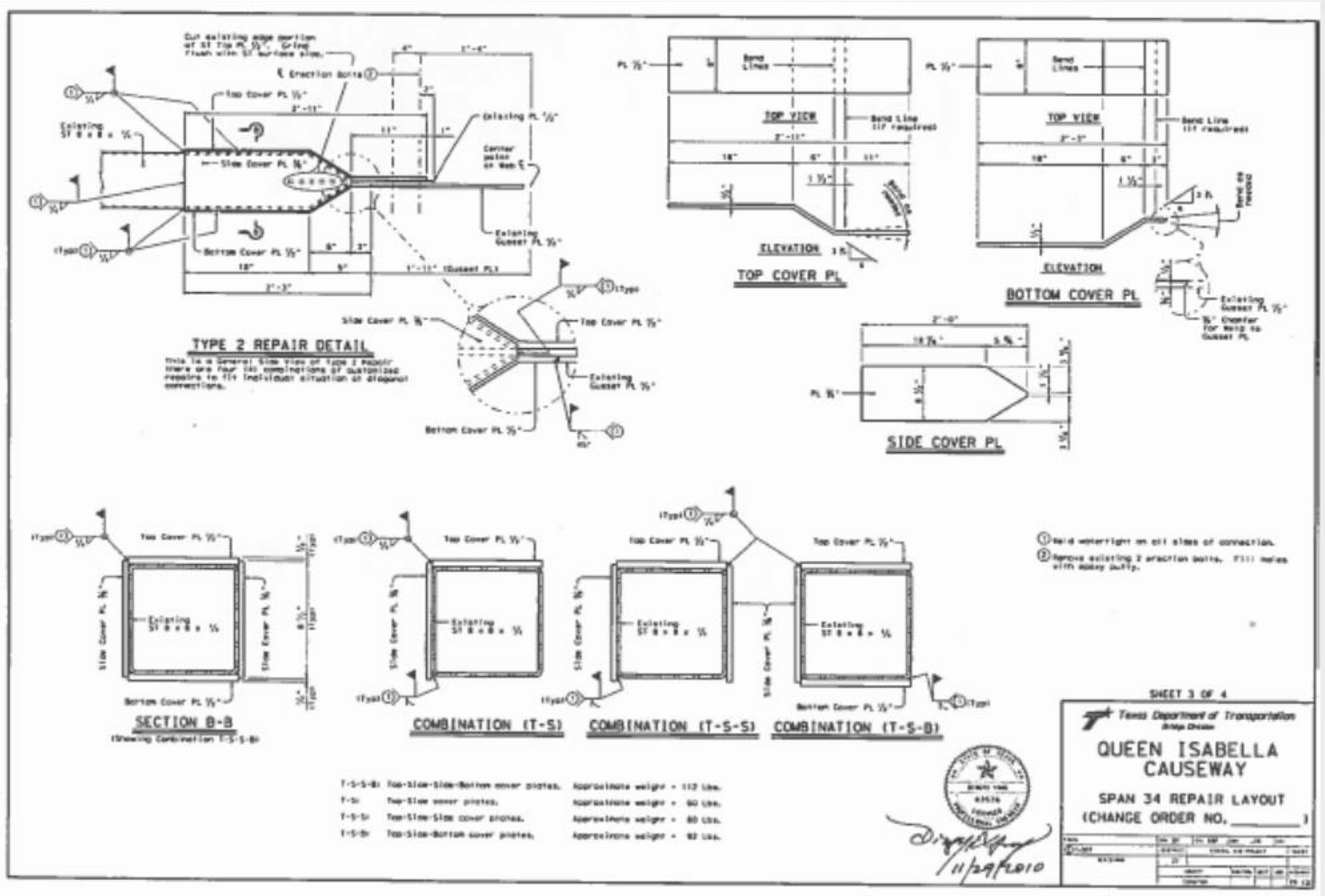

existing TS 8×8×½
Cut Line
12" ~ 18"
Top Batten PL 12"×10"×⅜" (18")
Cut Line
½" Gusset PL
Connection plates on Both Sides of TS
Cap plate 9"×7½"×½" to close TS (See Cap detail)
① Weld watertight on all sides of connection.
Option 1 Detail
(Side View)
Connection PL
37" (43")
8" Notched to fit Gusset PLs.
Connection PL Detail
Sloped Notch For Bend plate Location


Cap
Gusset PL
Inside Cap to Close TS
Channels C8×20 L = 37" (43") Both sides.
Notched to fit Gusset PLs.
Option 2 Detail
Side View
Filler Material (Epoxy Type)
7/16"
Cap PL.
A-A

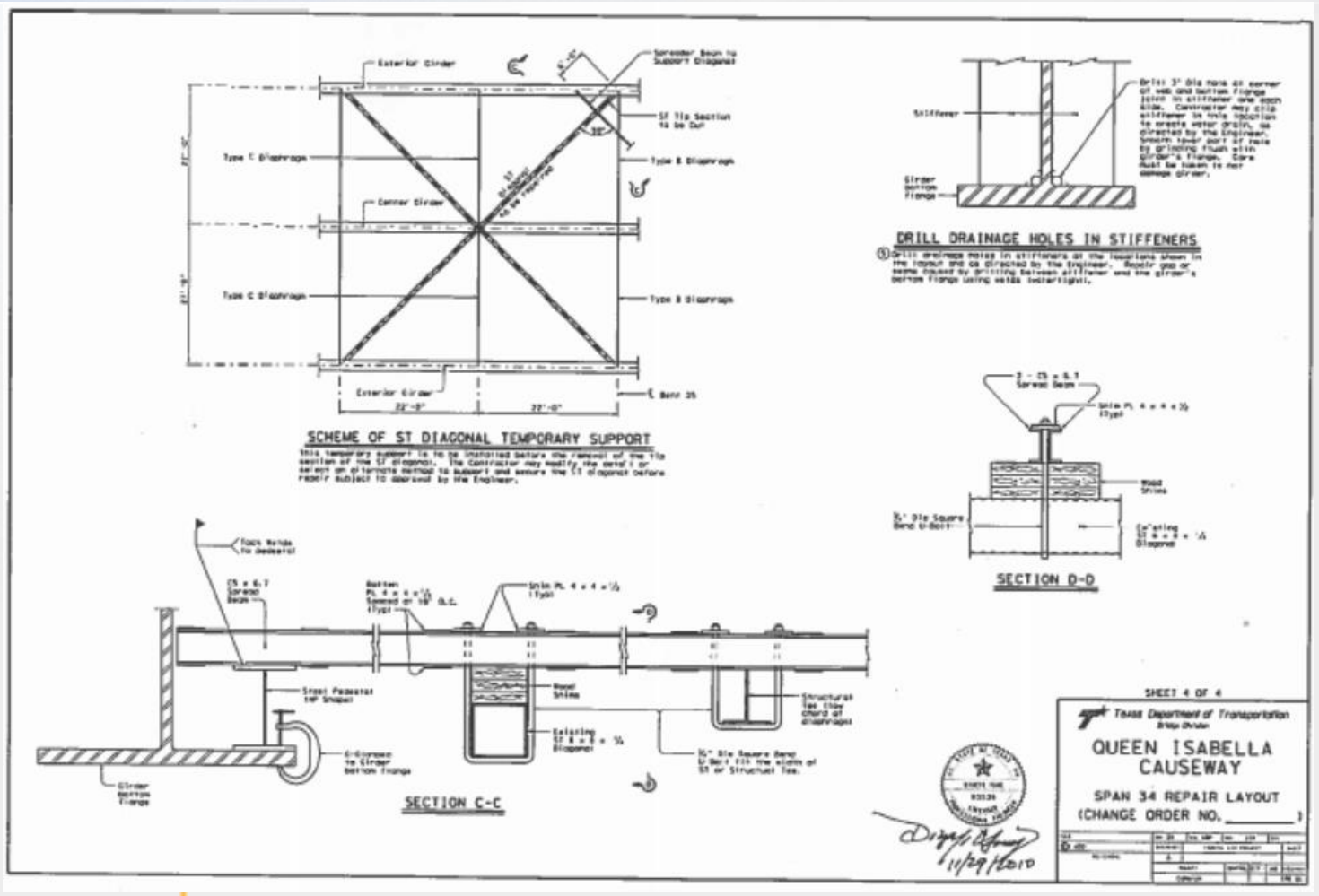
Repairs


TYPE 1 REPAIR DETAIL
SECTION A-A
END CAP PLATE DETAIL
ELEVATION
SECTION
TOP VIEW
ELEVATION
EXTENSION CHANNEL DETAIL
PERSPECTIVE VIEW AT ST TIP SECTION CUT FOR TYPE 1 REPAIR DETAIL
DETAIL OF PACK RUST AT ST
SHEET 2 OF 4
Texas Department of Transportation
QUEEN ISABELLA CAUSEWAY
SPAN 34 REPAIR LAYOUT
(CHANGE ORDER NO. _____)

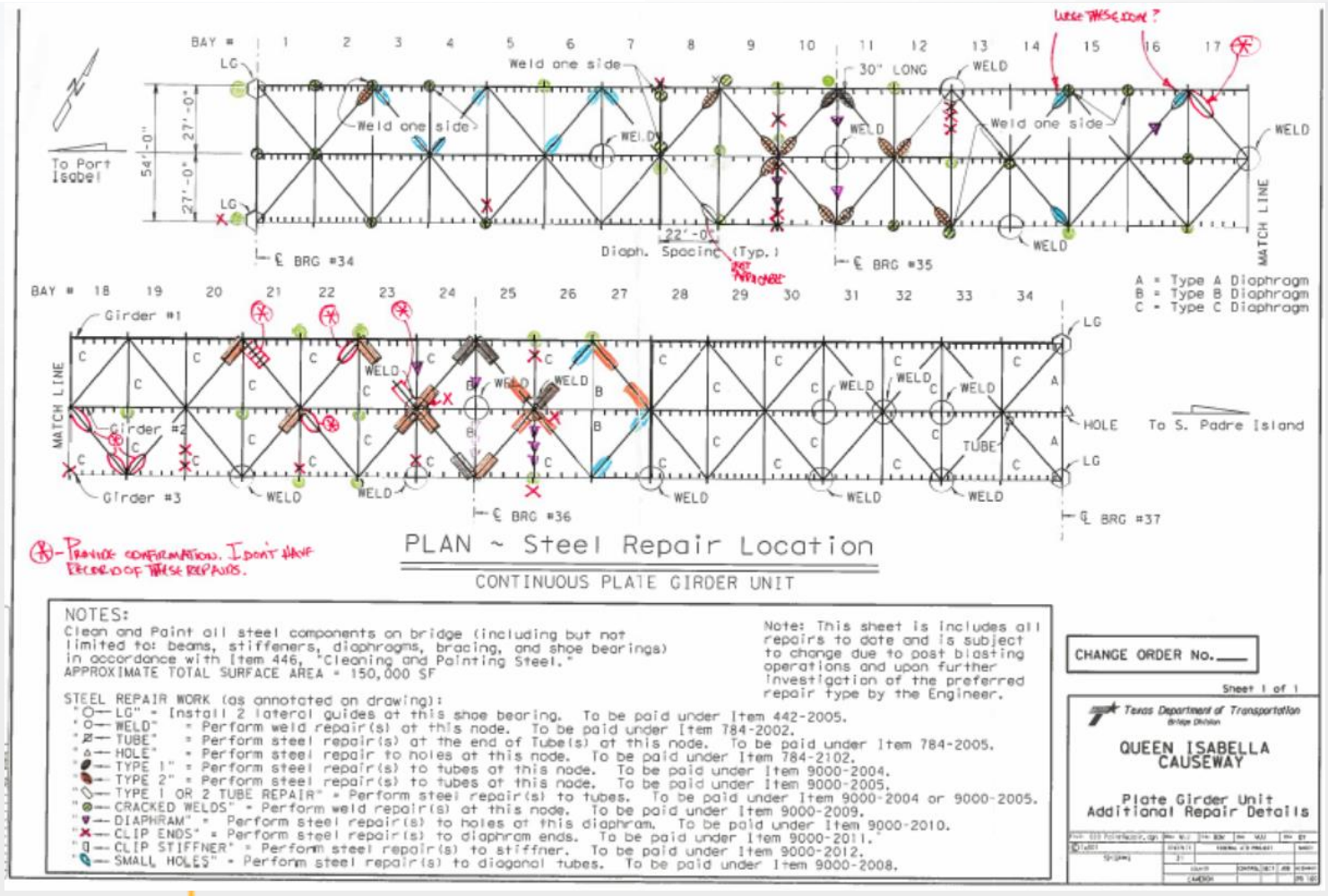
Repairs


TYPE 2 REPAIR DETAIL
TOP COVER PL
BOTTOM COVER PL
SIDE COVER PL
SECTION B-B
COMBINATION (T-S)
COMBINATION (T-S-S)
COMBINATION (T-S-B)
SHEET 3 OF 4
Texas Department of Transportation
QUEEN ISABELLA CAUSEWAY
SPAN 34 REPAIR LAYOUT
(CHANGE ORDER NO. _____)

Repairs

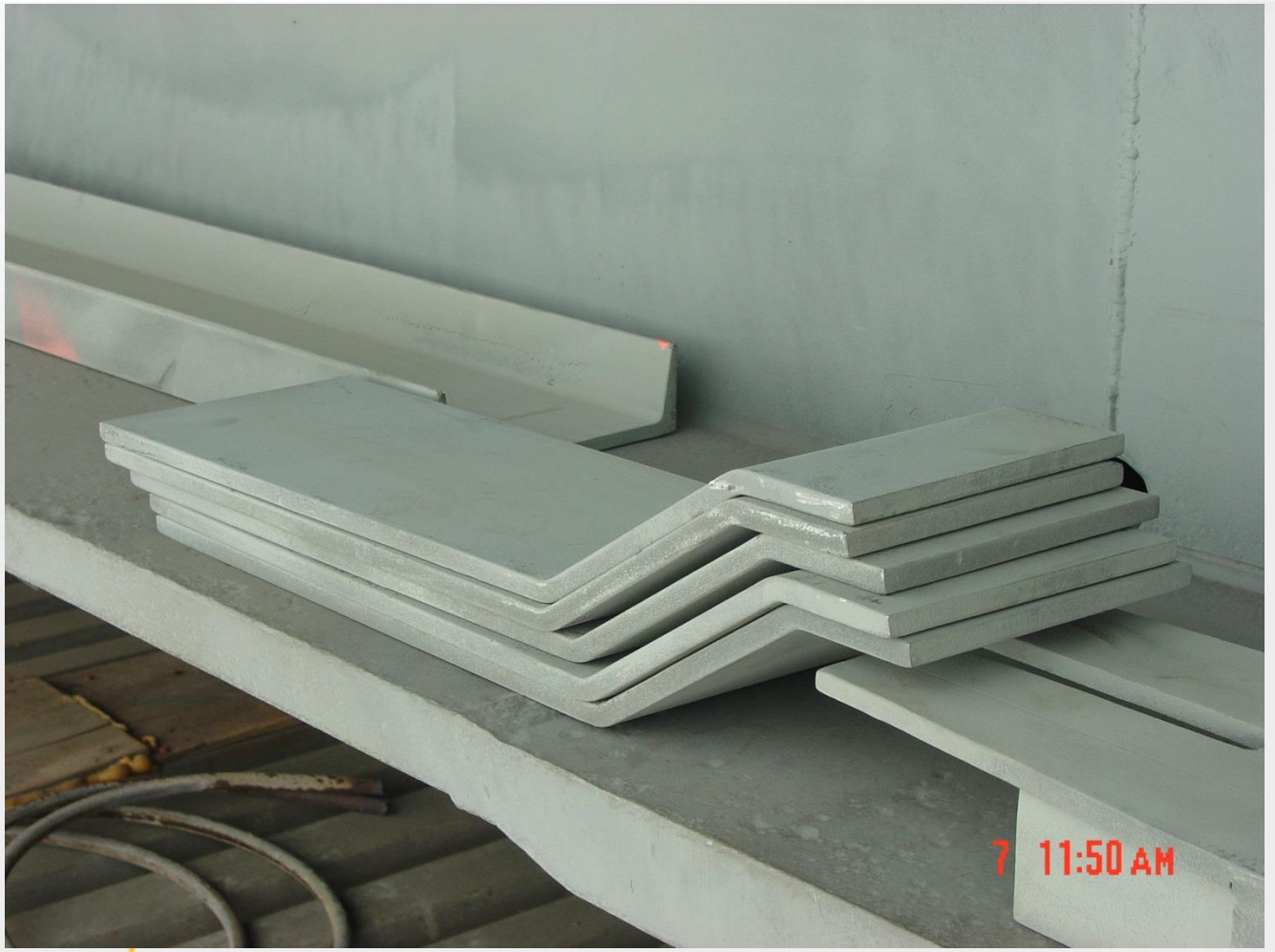

SCHEME OF ST DIAGONAL TEMPORARY SUPPORT
DRILL DRAINAGE HOLES IN STIFFENERS
SECTION D-D
SECTION C-C
SHEET 4 OF 4
Texas Department of Transportation
QUEEN ISABELLA CAUSEWAY
SPAN 34 REPAIR LAYOUT
(CHANGE ORDER NO. _____)

Repairs


BAY #
LG
Weld one side
30" LONG
WELD
To Port Isabel
54'-0"
27'-0"
22'-0"
Diaph. Spacing (Typ.)
℄ BRG #34
℄ BRG #35
MATCH LINE
A = Type A Diaphragm
B = Type B Diaphragm
C = Type C Diaphragm
Girder #1
Girder #2
Girder #3
HOLE
TUBE
To S. Padre Island
℄ BRG #36
℄ BRG #37
PLAN ~ Steel Repair Location
CONTINUOUS PLATE GIRDER UNIT
NOTES:
Clean and Paint all steel components on bridge (including but not limited to: beams, stiffeners, diaphragms, bracing, and shoe bearings) in accordance with Item 446, "Cleaning and Painting Steel."
APPROXIMATE TOTAL SURFACE AREA = 150,000 SF
Note: This sheet is includes all repairs to date and is subject to change due to post blasting operations and upon further investigation of the preferred repair type by the Engineer.
CHANGE ORDER No.____
STEEL REPAIR WORK (as annotated on drawing):
"LG" = Install 2 lateral guides at this shoe bearing. To be paid under Item 442-2005.
"WELD" = Perform weld repair(s) at this node. To be paid under Item 784-2002.
"TUBE" = Perform steel repair(s) at the end of Tube(s) at this node. To be paid under Item 784-2005.
"HOLE" = Perform steel repair to holes at this node. To be paid under Item 784-2102.
"TYPE 1" = Perform steel repair(s) to tubes at this node. To be paid under Item 9000-2004.
"TYPE 2" = Perform steel repair(s) to tubes at this node. To be paid under Item 9000-2005.
"TYPE 1 OR 2 TUBE REPAIR" = Perform steel repair(s) to tubes. To be paid under Item 9000-2004 or 9000-2005.
"CRACKED WELDS" = Perform weld repair(s) at this node. To be paid under Item 9000-2009.
"DIAPHRAM" = Perform steel repair(s) to holes at this diaphram. To be paid under Item 9000-2010.
"CLIP ENDS" = Perform steel repair(s) to diaphram ends. To be paid under Item 9000-2011.
"CLIP STIFFNER" = Perform steel repair(s) to stiffner. To be paid under Item 9000-2012.
"SMALL HOLES" = Perform steel repair(s) to diagonal tubes. To be paid under Item 9000-2008.
Sheet 1 of 1
Texas Department of Transportation
QUEEN ISABELLA CAUSEWAY
Plate Girder Unit
Additional Repair Details

Repairs

Repairs



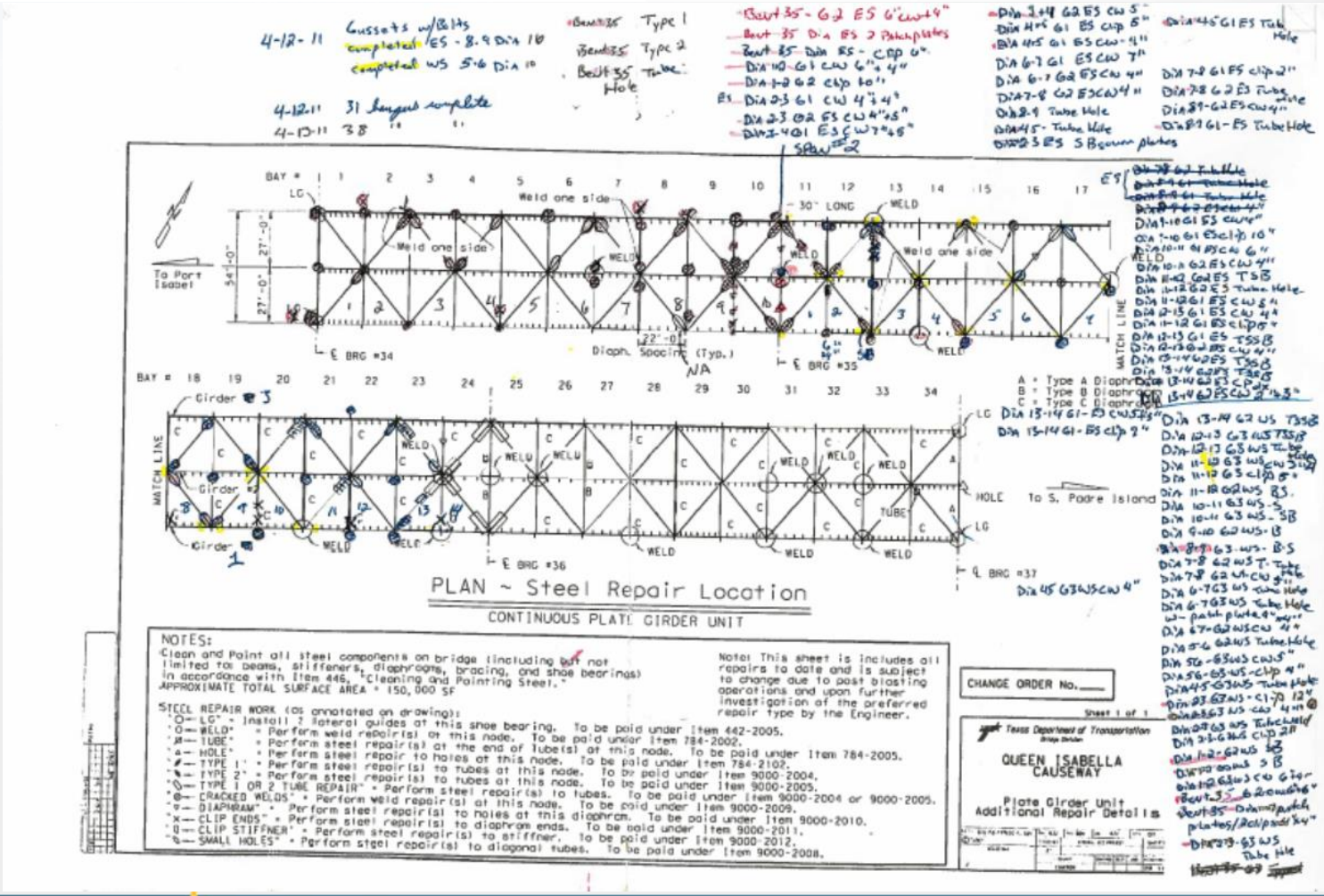
Repairs

Repairs

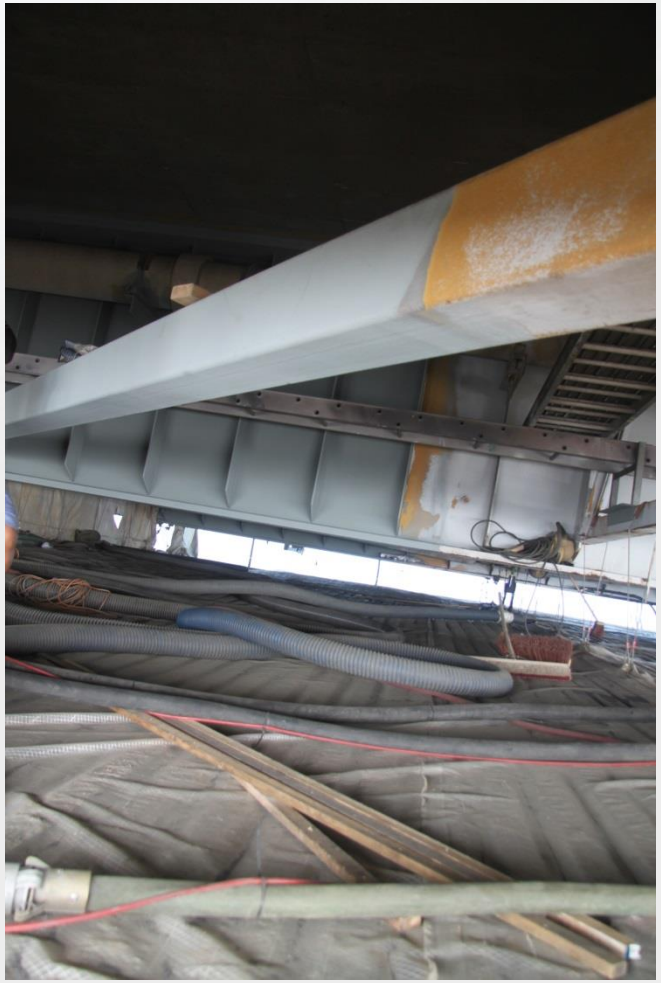
Repairs

Repairs

Repairs


PLAN ~ Steel Repair Location
CONTINUOUS PLATE GIRDER UNIT
NOTES:
Clean and Paint all steel components on bridge (including but not limited to: beams, stiffeners, diaphragms, bracing, and shoe bearings) in accordance with Item 446, "Cleaning and Painting Steel."
APPROXIMATE TOTAL SURFACE AREA = 150,000 SF
STEEL REPAIR WORK (as annotated on drawing):
"O" - LC" - Install 2 lateral guides at this shoe bearing. To be paid under Item 442-2005.
"O" - WELD" - Perform weld repair(s) at this node. To be paid under Item 784-2002.
"TUBE" - Perform steel repair(s) at the end of tube(s) at this node. To be paid under Item 784-2005.
"HOLE" - Perform steel repair to holes at this node. To be paid under Item 784-2102.
"TYPE 1" - Perform steel repair(s) to tubes at this node. To be paid under Item 9000-2004.
"TYPE 2" - Perform steel repair(s) to tubes at this node. To be paid under Item 9000-2005.
"TYPE 1 OR 2 TUBE REPAIR" - Perform steel repair(s) to tubes. To be paid under Item 9000-2004 or 9000-2005.
"CRACKED WELDS" - Perform weld repair(s) at this node. To be paid under Item 9000-2009.
"DIAPHRAM" - Perform steel repair(s) to holes at this diaphram. To be paid under Item 9000-2010.
"CLIP ENDS" - Perform steel repair(s) to diaphram ends. To be paid under Item 9000-2011.
"CLIP STIFFNER" - Perform steel repair(s) to stiffner. To be paid under Item 9000-2012.
"SMALL HOLES" - Perform steel repair(s) to diagonal tubes. To be paid under Item 9000-2008.
Note: This sheet is includes all repairs to date and is subject to change due to post blasting operations and upon further investigation of the preferred repair type by the Engineer.
CHANGE ORDER No.
Texas Department of Transportation
QUEEN ISABELLA CAUSEWAY
Plate Girder Unit
Additional Repair Details
To Port Isabel
To S. Padre Island
Weld one side
30" LONG
WELD
HOLE
TUBE
MATCH LINE
Girder #1
Girder #2
Girder #3
℄ BRG #34
℄ BRG #35
℄ BRG #36
℄ BRG #37
Diaph. Spacing (Typ.)
N/A

Steel Coating Operations



Steel Coating Operations

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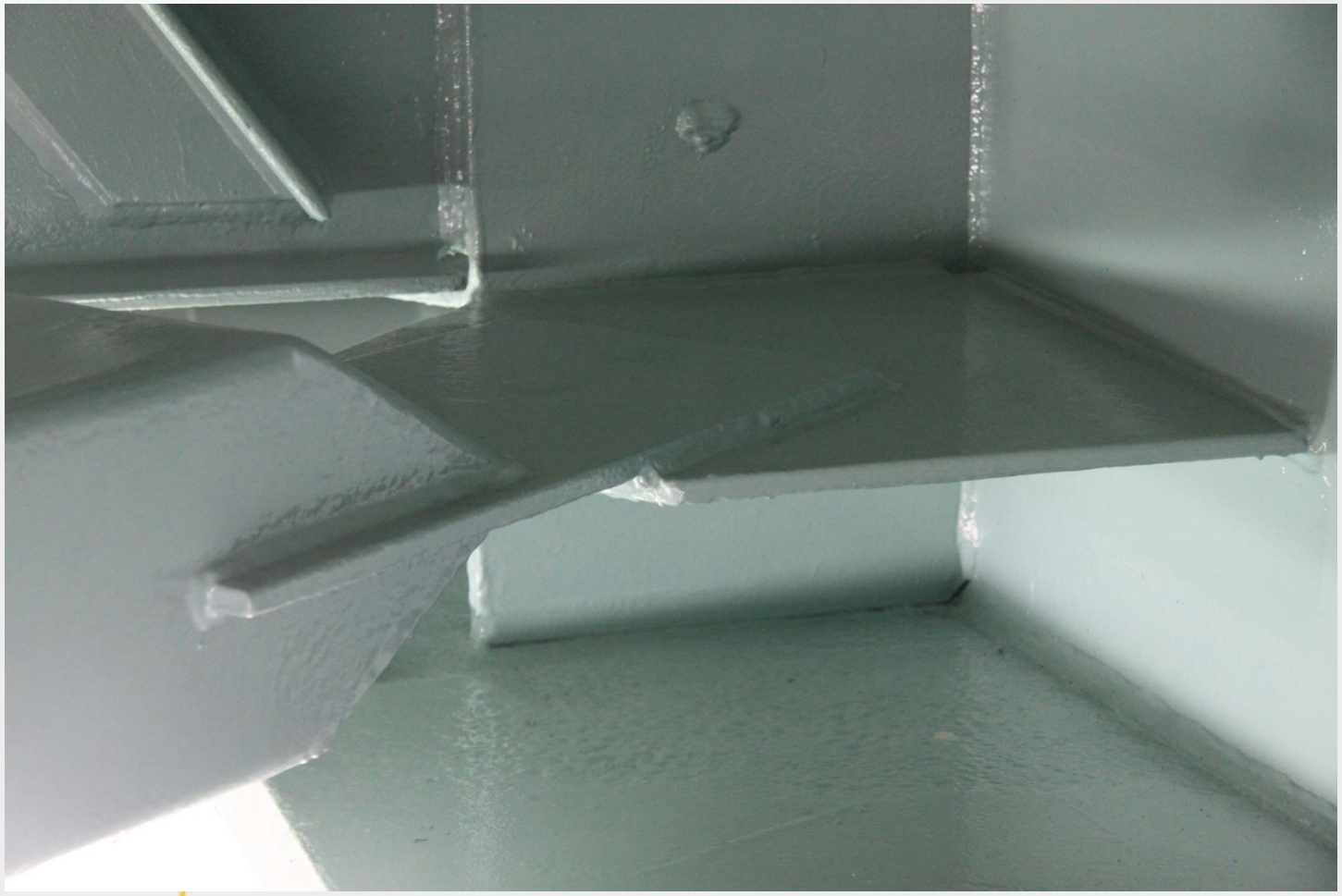

Steel Coating Operations

Steel Coating Operations

Steel Coating Successes

- Good Third Party NACE III Inspectors
- Good painting contractor
- Good structural steel repair contractor
- Excellent structural steel inspector
- Excellent Bridge Division support with respect to structural detailing, RFI's, shop drawing reviews, etc.
- Continued support from District management team allowing overruns for unforeseen conditions due to post blasting operations

Steel Coating Successes

Lessons Learned

- Strengthen notes with respect to no lane closures allowed during Texas Spring Break and Heavy Holidays
- Strengthen notes with respect to projecting compromised conditions due to post blasting operations
- Avoid metal to metal contact with respect to rigging
- Include provisions on rounding sharp edges to prevent localized paint failure and cracking
- Knowledge transfer for next generation

QIC Service Life Assessment

Condition and Service Life Assessment
August 2009

- Based on the assessment findings, the Causeway is in good condition considering its age and service environment


WJE

QUEEN ISABELLA MEMORIAL CAUSEWAY
Condition and Service Life Assessment

South Padre Island, Texas

Final Report
August 25, 2009
WJE No. 2008.5102.1

Prepared for:
Mr. Rex Costley
Pharr District Bridge Engineer
Texas Department of Transportation
600 W US Expressway 83
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Prepared by:
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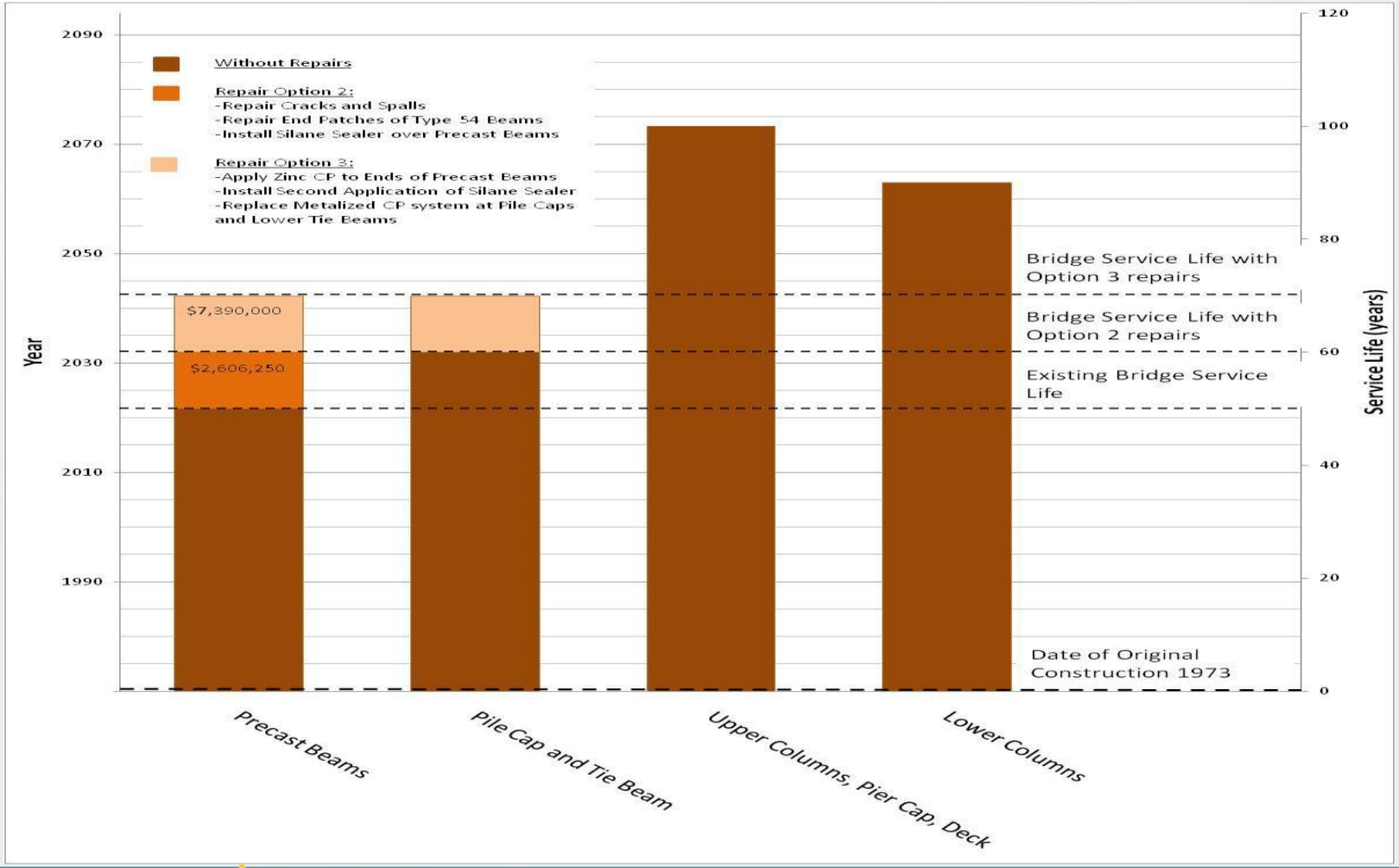
QIC Service Life Assessment

Strategies For Extending the Life of the Structure

1. Not employing any significant remediation efforts and only continuing with “routine” maintenance
2. Employing both remediation and routine maintenance efforts to optimize the service life relative to cost
3. Employing comprehensive remediation efforts to extend the service life of the beams and lower substructure elements to approximately that of the other elements
    - Present estimated cost for QIC Replacement is ~ $ 125 M. (2009)
    - Service Life – bridge able to satisfy state legal load of 80,000 pounds. TxDOT’s goal is to avoid load posting of bridge (baseline).
    - No significant maintenance remedies performed for the first 20 years (1974 to 1995) other than steel coatings

QIC Service Life Assessment



Option 1

- Repair and paint steel girders ($4,500,000)
- Replace deteriorated anchor bolts and guard rails with a T-4 three-bolt railing system ($627,500)
- Remove and replace deteriorated light standards ($680,000)
- Repair and paint exposed end connections for lateral tie roads ($117,000)
- Miscellaneous work (structural and Cathodic Protection ($75,000)
- COMPLETED via BPM 6207-63-001 and CSJ 0331-04-065 (2010 to 2013)

Option 2

- Includes all items captured in Option 1 and extends the service life an additional 10 to 15 years (2033). Again, the pre-stressed beams are the controlling element. This includes the repair and repainting of the steel unit. This will be the fourth repainting effort (1983, 1995, 2010, 2020+ TBD). Total cost for this work is estimated at $14M.
- Perform all items in Option 1 ($6,946,600) COMPLETED
- Repair all existing spalls and major crack elements utilizing conventional repair techniques ($1,203,750)
- Repair end patches at all Type 54 beams ($600,000)
- Apply a single application of a penetrating silane sealer to all exposed surfaces of the Type 54 beams and diaphragms ($802,500)
- COMPLETED above work VIA CSJ 0331-04-065 (2010-2013)

Option 3

- Includes all items captured in Option 1 and 2 with additional remediation efforts for the beams and the existing cathodic protection system on the lower substructure to yield a service life up to 40 years (2043). Again the pre-stressed beams are the controlling element. Total cost for this work is estimated at $ 21.5 M.
- Perform all items in Option 1 and 2, except as noted below, within a one or two year time period ($14,079,850) - COMPLETED
- Apply CP system (zinc alloy thermal spray) to all Type 54 beams at ends, sides, and soffits (bottoms) for a distance of 3 feet from each end in approximately six to eight years following the first silane application ($2,000,000) (PLANNED)
- Apply second application of a penetrating silane sealer to beam and diaphragm surfaces without CP at same time CP system is applied ($802,500) (PLANNED)
- Replace zinc and aluminum alloy CP systems at lower substructure elements with new zinc alloy CP system at the same time CP system is applied to beams and pile caps ($4,587,500) (PLANNED)

Life Assessment Summary and Rehabilitation Successes

- The three options presented provides TxDOT a pathway for the QIC to systematically achieve an estimated service life of an additional 70 years (1973 to 2043)
- Controlling bridge elements are the pre-stressed beam and substructure elements
- The QIC is in good condition considering its age and service environment

Things to Consider

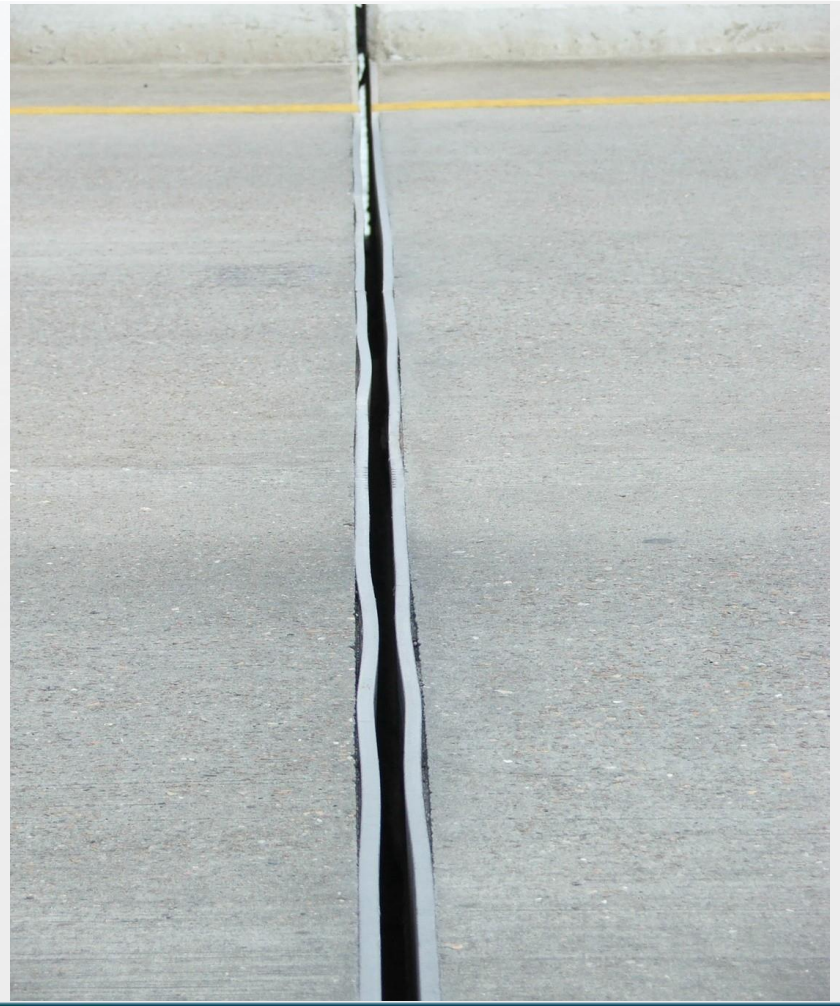
- TxDOT has committed to Option 3 to sustain serviceability to year 2043 and beyond
- Steel unit will receive its fourth paint system and a closer investigation with respect to nominal thicknesses need to be evaluated beyond further painting systems
- Re-application of the cathodic protection will need to be done but further investigation needs to be considered for the concrete beams
- A Life Cycle Cost will need to be performed beyond 2043 to evaluate a replacement benefit cost ratio. For now, it makes financial sense to maintain the QIC.
- Routine Maintenance efforts are still required to sustain predicted service life estimate. Routine Maintenance efforts planned in FY 19 ~ $ 1 M.
- Pharr District understands the need for routine maintenance efforts and to address the right treatment at the right time before the treatment scope turns into replacement efforts. TxDOT's maintenance efforts are reflective in the Service Life Assessment performed in 2009. The report serves as a guide for the QIC to reach and possibly exceed the estimated service life beyond in 2043.

QIC 2013 Repairs Rehabilitation Efforts

Exposed Pre-Stressed Strand – Corrosion Propagating

Completed Concrete Structure Repairs (Beam)

Armor Joint Plate – Deformation

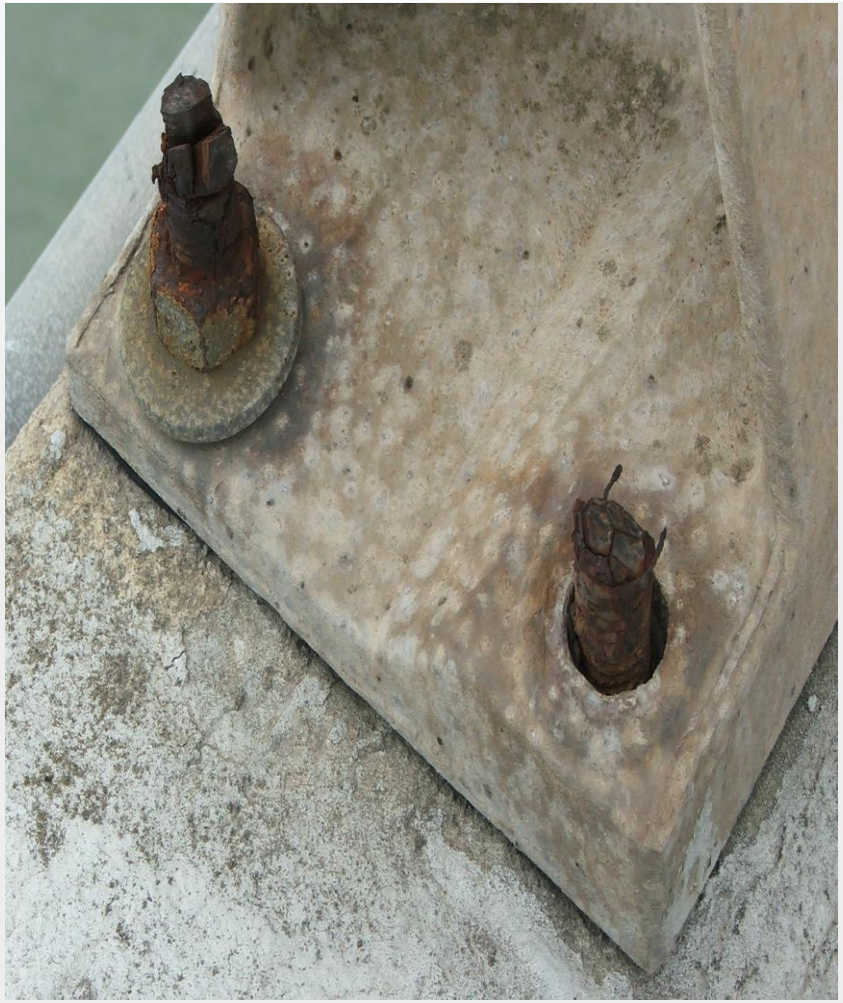


Armor Joint Repair
Removal and Replacement of Armor Joint

Beam End at Various Locations Deteriorated Epoxy Coating and Exposed/Corroded Strands

Beam Ends with Epoxy Coating

Existing Rail Connection – Typical Existing Anchor Bolts and Hardware Severely Corroded



Completed Bridge Rail Retrofit with SAP Seal Covers

Successful Implementation of Steel Coating and Bridge Rehabilitation

Tribute to our past engineers for having the foresight not to push design limits in a corrosive environment. Such simple implements include the following:

- 80’ Simple Spans – this is the practical and economical limit for a Type 54 Beam use. The ultimate design limit could reach up to 110’ thus placing more stress and strain on the beams and pre-stressing strands.

- Concrete Diaphragms – no longer used in TxDOT bridge design, the internal diaphragms help distribute live and dead loads acting on the beams. Without placement at the quarter points, would place additional stress and strain on the beams.

- Pre-stressed Pre-Cast Concrete Panels – a new concept of TxDOT bridge design at that time. The 4” deep concrete panels act as a forming mechanism with the remaining 4” of batch concrete placed to make the 8” deep slab. Little to no chance of corrosive sulfate penetrating into the steel which would lead to deck repair.

Reasons for QIC in Good Condition

- Multi-column Bents w/Tie Beams – the use of tie beams at mid height of the column and at the top of the pile footing caps help with load distribution, slenderness, and limiting cracks along the columns

- Cathodic Protection – the implementation of cathodic protection has prevented the substructure elements (steel reinforcement) from being compromised in a corrosive environment. Re-application of the sacrificial layer is needed to sustain the primary function of the bridge element.

TxDOT's Plan Moving Forward

- The steel girder will be stripped and painted a fifth time ~ 2020+. Concerns with reducing nominal thicknesses and tears in the welds.
- Cathodic protection could be applied to the substructures and girders
- Life cycle cost needs to be investigated for continual maintenance remedies beyond 2043
- TxDOT plans to keep the QIC in good condition with strategic and time based maintenance efforts to prevent load posting and continue to serve as a life line to the traveling public and adjacent stakeholders

QUESTIONS?

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Director of Maintenance

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