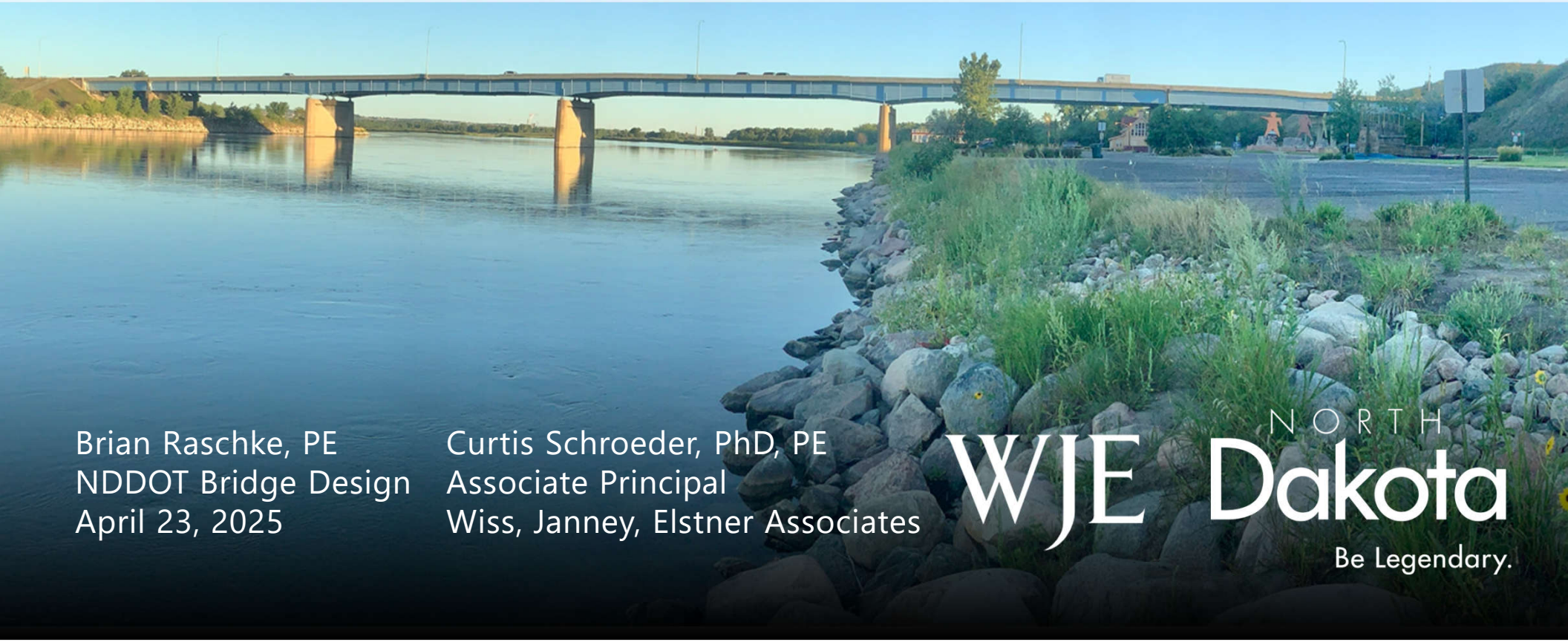
GRANT MARSH BRIDGE REHABILITATION

North Dakota Department of Transportation



Brian Raschke, PE
NDDOT Bridge Design
April 23, 2025

Curtis Schroeder, PhD, PE
Associate Principal
Wiss, Janney, Elstner Associates

WJE

NORTH Dakota

Be Legendary.

GRANT MARSH BRIDGE REHABILITATION

- NBI Data / Span Layout / Superstructure Configuration
- Deficiencies
- RFP on In-depth Inspection / Urgent Repairs
- Rehabilitation Design Project
  - In-Depth Inspection Findings
  - Urgent Mitigation and Repairs
  - Design, Load Rating, and Plan Preparation
- Rehabilitation Construction

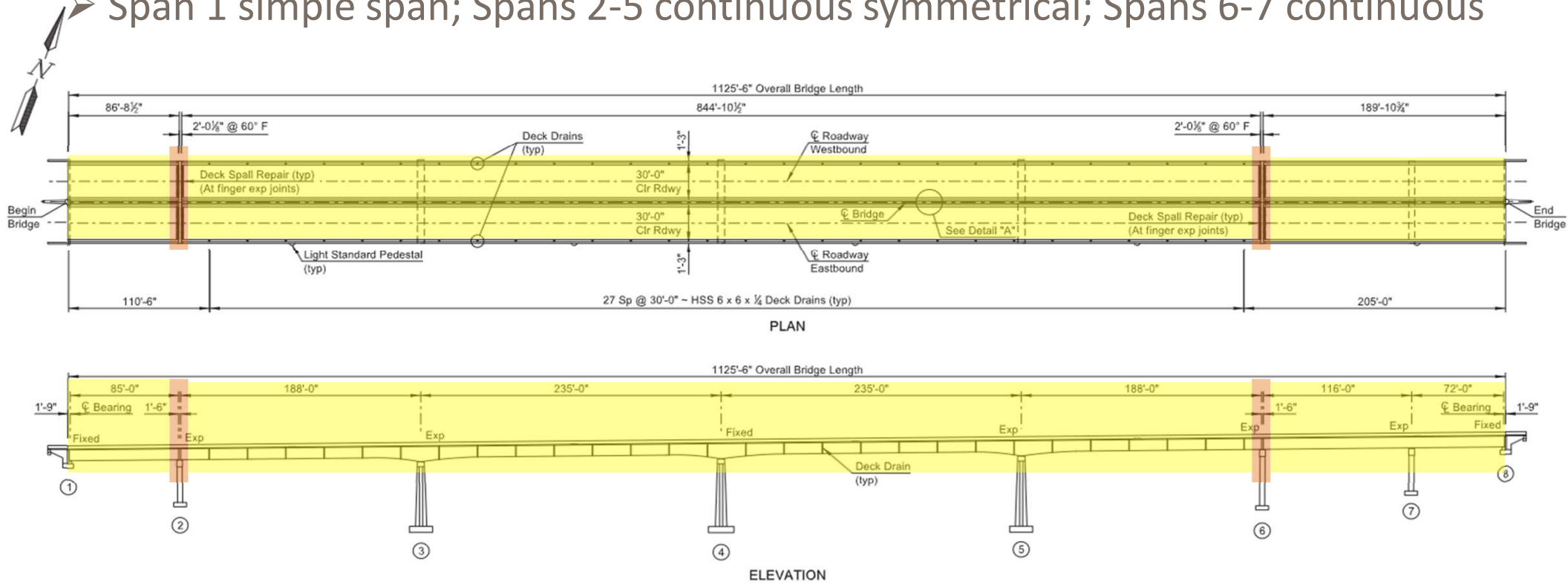
GRANT MARSH BRIDGE LOCATION

GRANT MARSH BRIDGE INVENTORY DATA (NBI) 0094-156.609

- Built in 1965
- Condition rating (current)
  - Deck = 7
  - Superstructure = 6
  - Substructure = 6
- ADT 37,630; ADTT 2,466 (both bounds)
- Inventory = 25.1 tons (0.70) - flexure
- Operating = 41.9 tons (1.17) - flexure
- Permit (ND 2) = 59.4 tons (1.00) - bearing
- Permit (ND 2) = 71.9 tons (1.21) - flexure (rehab)

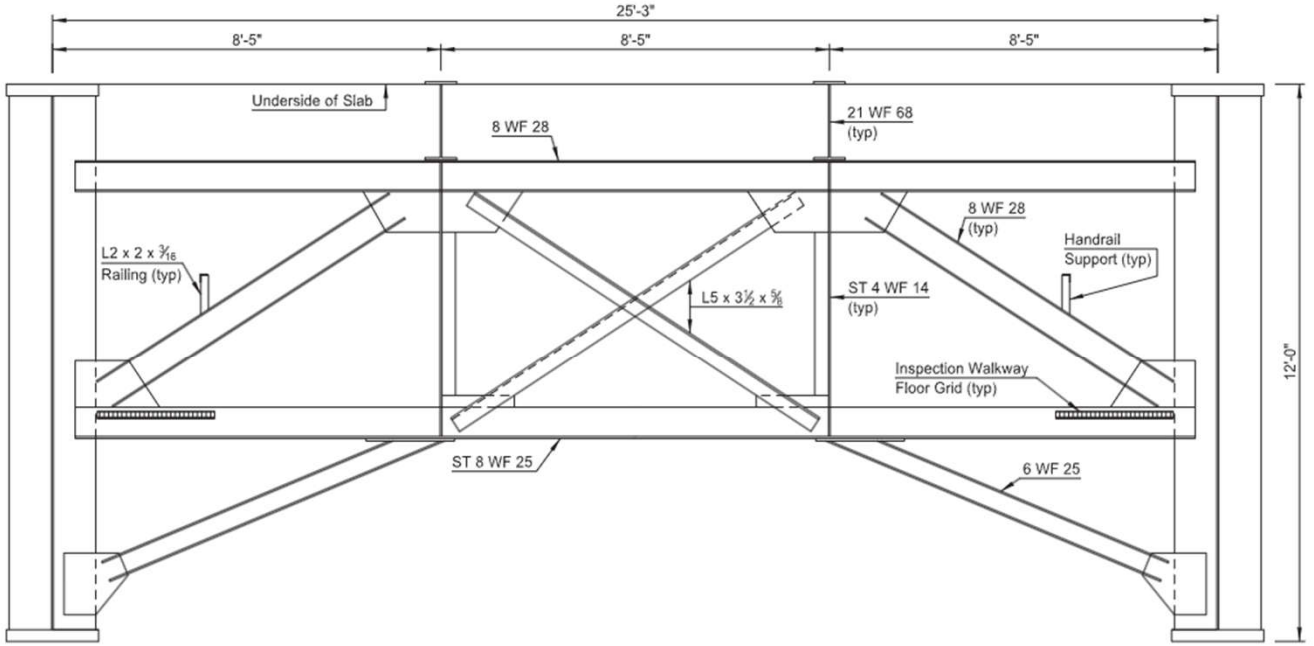
GRANT MARSH BRIDGE SPAN LAYOUT
3 UNIT BRIDGE

- 7-span steel welded plate girder (overall length = 1125.5', longest span 235')
- Span 1 simple span; Spans 2-5 continuous symmetrical; Spans 6-7 continuous



GRANT MARSH BRIDGE SUPERSTRUCTURE

- 2-main girder/2-interior stringer/floor truss system (one bound shown)
- Floor trusses spaced at 23’-6”
- 12’-0“ haunched main girder depth (Piers 3, 4 & 5); 21” rolled beam interior stringer

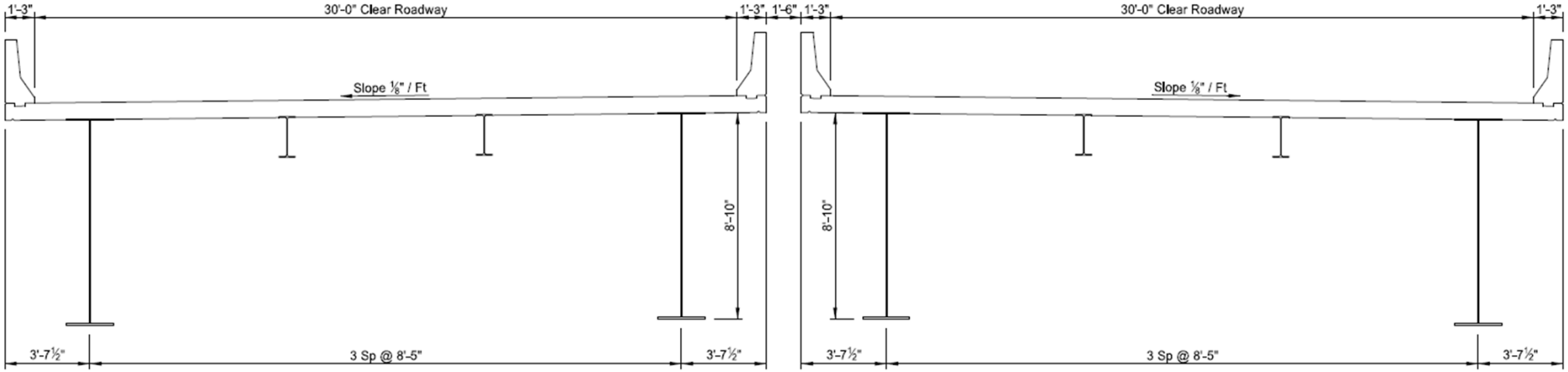


(SHOWING SECTION AT PIERS 3, 4 & 5)

FLOOR TRUSS ELEVATION

GRANT MARSH BRIDGE SUPERSTRUCTURE

- Deck section separated by 1’-6”
- Two lanes each direction 30’-0” clear roadway
- 8’-10“ main girder depth



SUPERSTRUCTURE SECTION

GRANT MARSH BRIDGE SUPERSTRUCTURE / SUBSTRUCTURE

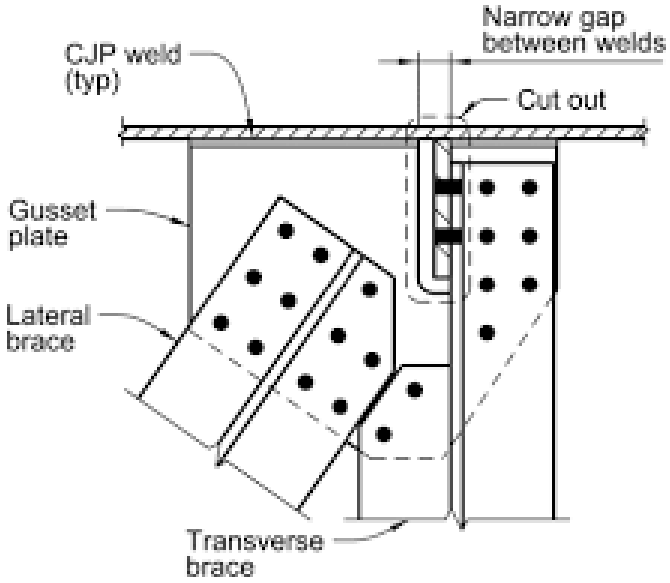
- Separate superstructures on common substructure
- Lateral “X” bracing (main unit) - bolted to gusset plates welded to web
  - Potential CIF detail?

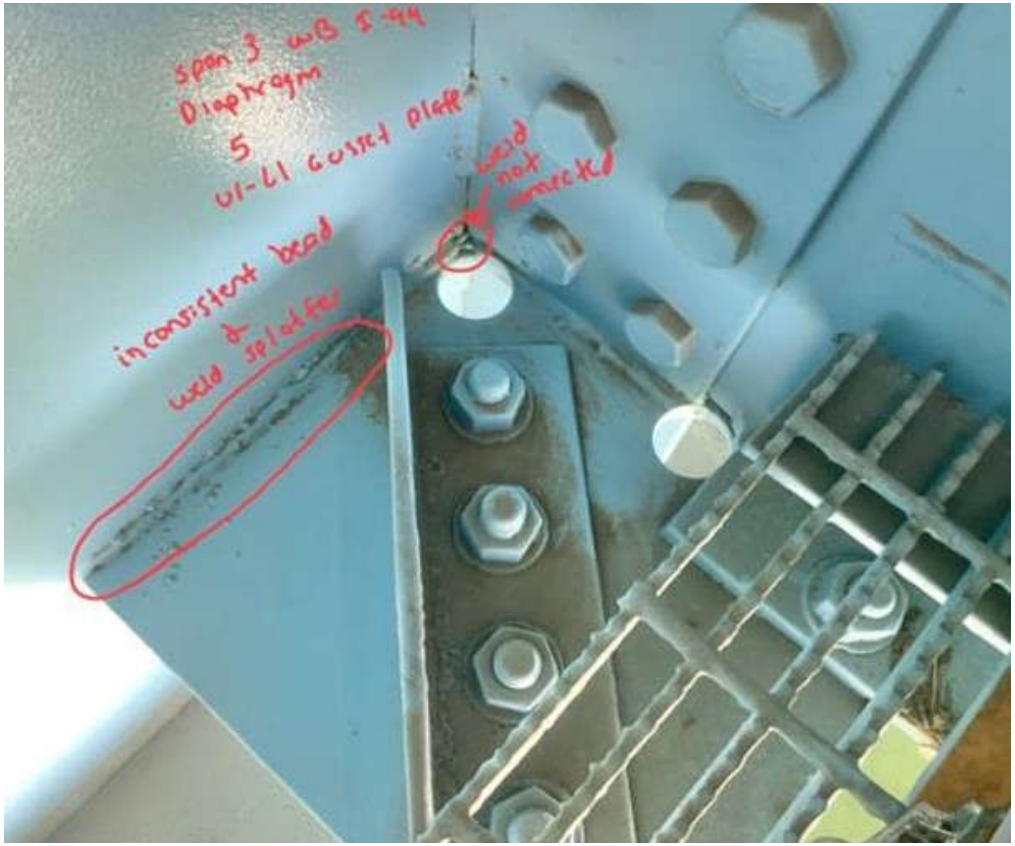
GRANT MARSH BRIDGE DEFICIENCIES

- Nonredundant Steel Tension Members (NSTM) - Two main girders
- No structural redundancy - Span 1 (simple span)
- Fatigue-prone details
- Constraint-Induced Fracture (CIF) details
- Bridge geometry
  - Narrow shoulders
  - No recovery area
  - Limited emergency access during traffic incidents
  - No pedestrian accommodations
- Poor highway geometry
  - Two tangential lefts on back-to-back interchanges
- Feasibility study to improve traffic operations / bridge replacement

GRANT MARSH BRIDGE NEED FOR IN-DEPTH INSPECTION

- Constraint-Induced Fracture (CIF details)
- Existing drilled holes in tension region





GRANT MARSH BRIDGE NEED FOR IN-DEPTH INSPECTION

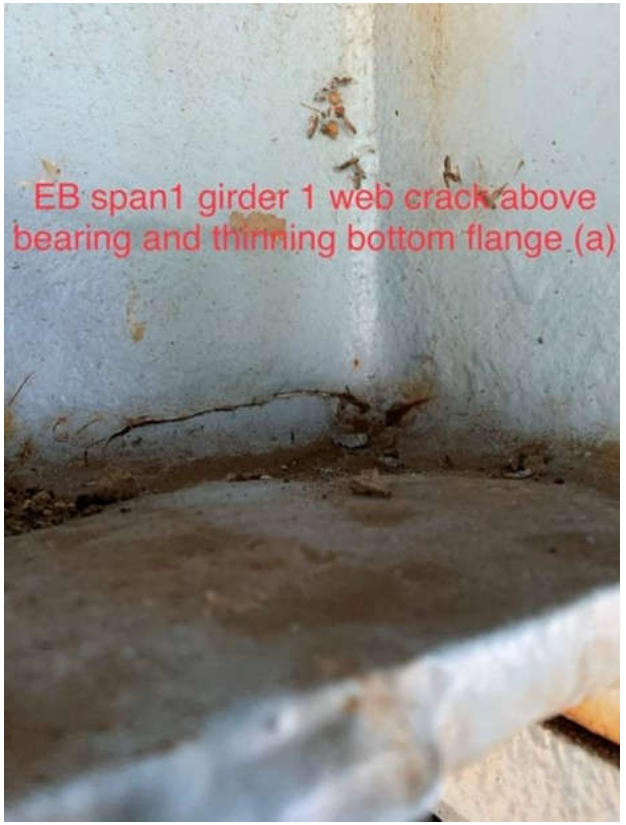
- Fatigue prone details
  - Potential distress observed at lateral gusset plate terminations

- Issues with thermal expansion
  - Rocker bearings misaligned
  - Deformation of main girder bottom flange

GRANT MARSH BRIDGE NEED FOR IN-DEPTH INSPECTION

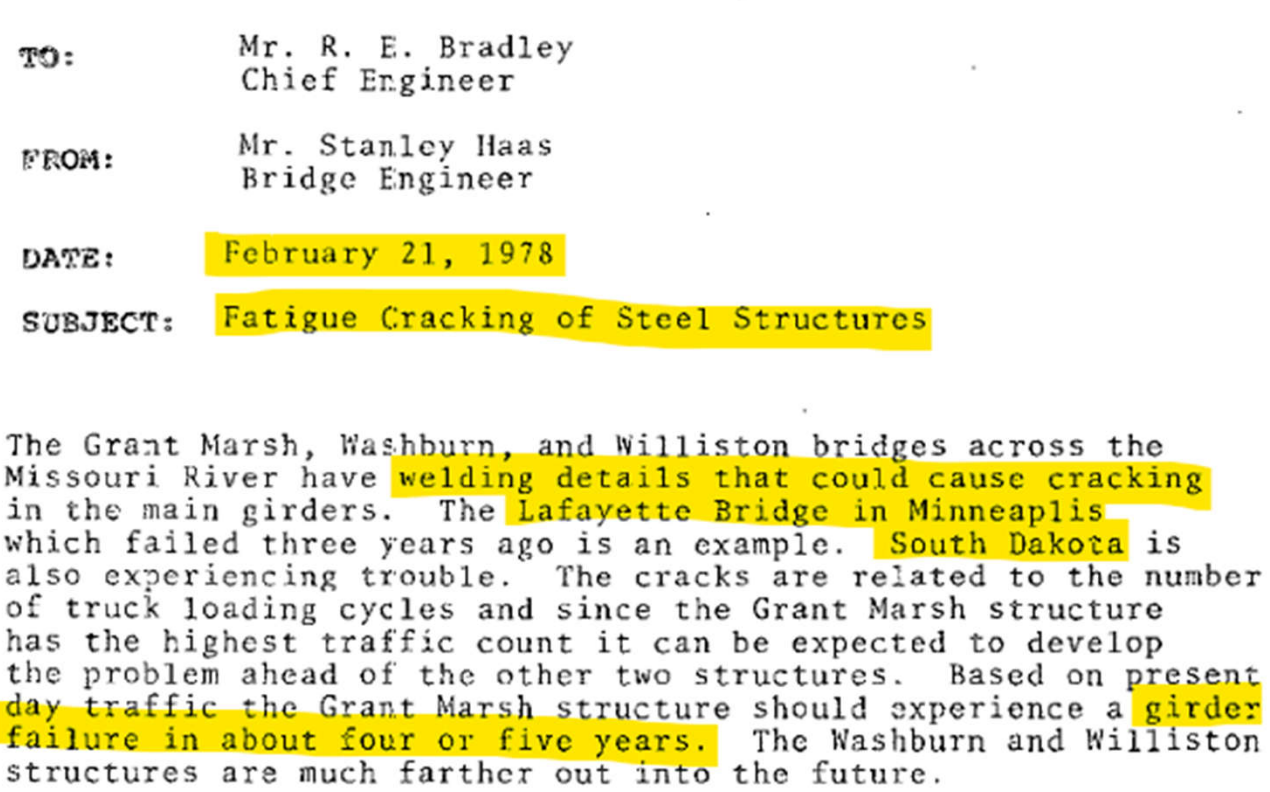
- Corrosion of NSTM members

  Located at expansion joints primarily on girder webs and stringers



GRANT MARSH BRIDGE NEED FOR IN-DEPTH INSPECTION

- Bridge Division aware of weld details prone to fatigue cracking - 1978
- Lafayette Bridge St. Paul, MN (near collapse - 1975)
- Previously drilled holes present but lacking information - adequate repair?
- No record to what extent repairs were completed
- Wiss, Janney, Elstner Associates, Inc. (WJE) hired to do in-depth inspection / repairs - May 2022



TO: Mr. R. E. Bradley
Chief Engineer

FROM: Mr. Stanley Haas
Bridge Engineer

DATE: February 21, 1978

SUBJECT: Fatigue Cracking of Steel Structures

The Grant Marsh, Washburn, and Williston bridges across the Missouri River have welding details that could cause cracking in the main girders. The Lafayette Bridge in Minneaplis which failed three years ago is an example. South Dakota is also experiencing trouble. The cracks are related to the number of truck loading cycles and since the Grant Marsh structure has the highest traffic count it can be expected to develop the problem ahead of the other two structures. Based on present day traffic the Grant Marsh structure should experience a girder failure in about four or five years. The Washburn and Williston structures are much farther out into the future.

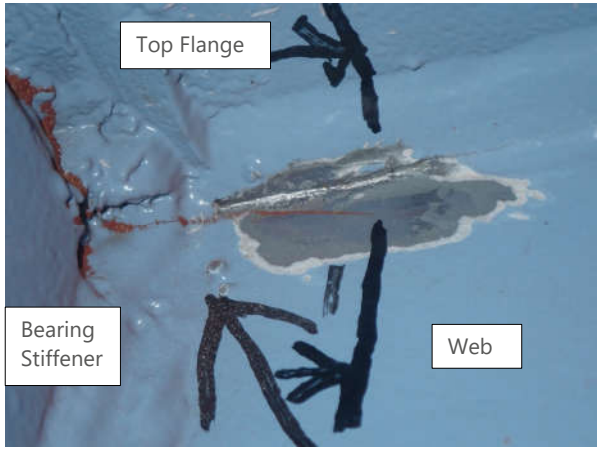
REHABILITATION DESIGN PROJECT SCOPE

- Phased Approach
  - Phase 1: In-Depth Inspection and Load Rating
    - Initial Load Rating
    - In-Depth Inspection
    - Evaluation of Inspection Findings
    - Development of Urgent Repairs
  - Phase 2: Urgent Mitigation and Repairs
    - Design Repairs
    - Install Repairs
  - Phase 3: Design, Load Rating, and Plan Preparation
    - Develop Scope of Repairs
    - Final Load Rating
    - Construction Design Package

IN-DEPTH INSPECTION FINDINGS

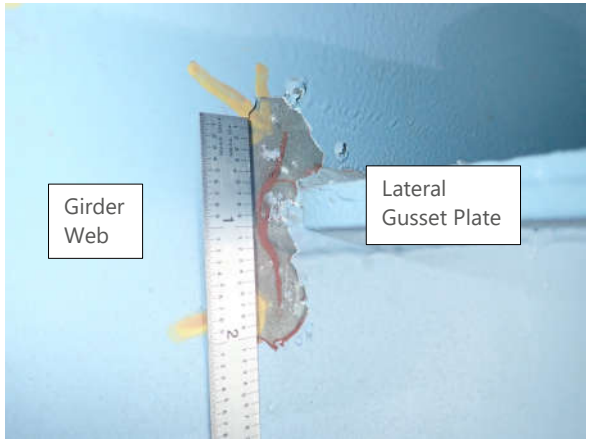
- Deterioration of girder ends near expansion joints
  - Corrosion holes
  - Misaligned rocker bearings
  - Inadequate gap for thermal expansion
  - Cracking along web-to-flange welds
  - Localized pitting and section loss

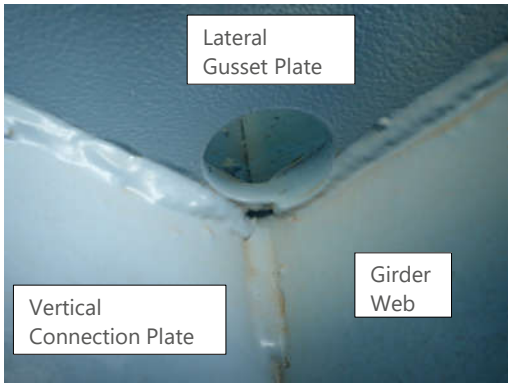
- Out-of-plane distortion girder web cracks
  - Confirmed with MT
  - Occurred at the intermediate pier of the two-span approach unit



IN-DEPTH INSPECTION FINDINGS

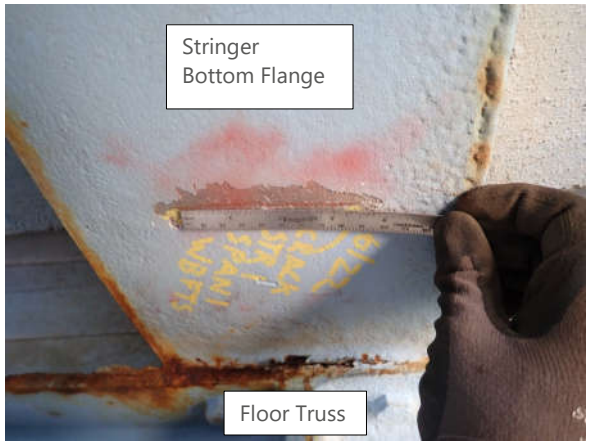
- Corrosion and pack rust at bolted field splices in Span 6
- Fatigue crack initiation at lateral gusset plate terminations
  - Paint cracking observed typically
  - Confirmed cracking at multiple locations with MT
- Inadequate CIF retrofits
  - Remnant lateral gusset plate and weld metal material was not removed when CIF retrofit holes were previously installed





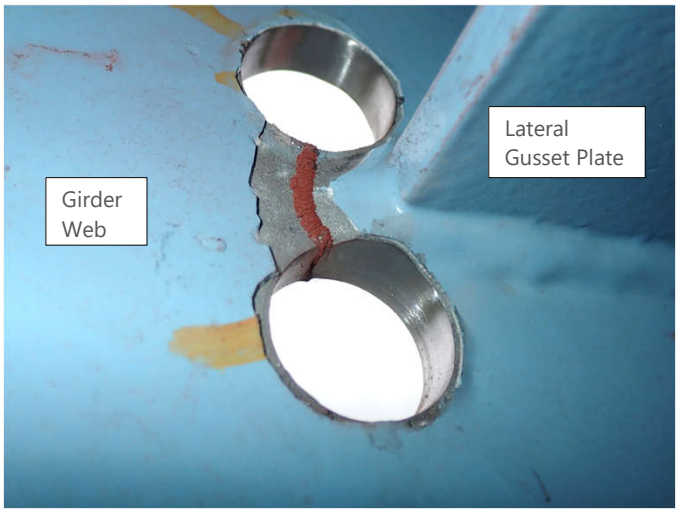
IN-DEPTH INSPECTION FINDINGS

- Section loss in end floor truss members at expansion joints
  - Corrosion holes
  - Widespread debris and moisture accumulation
- Stringer cracking at web and bottom flange near expansion joints
  - Two locations had previously installed reinforcement plates which were only welded to web on three sides



IMMEDIATE REPAIRS (PRE-PHASE 2)

- WJE immediately arrested multiple cracks by coring holes at the crack tips
  - 4 cracks at the lateral gusset plate terminations
  - 3 cracks in the stringers



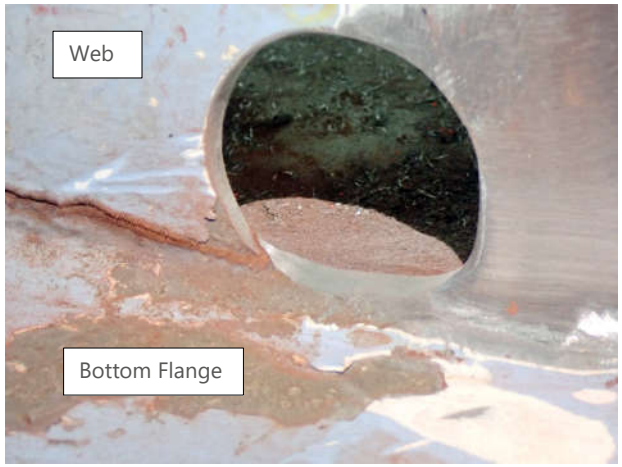
PHASE 2: URGENT MITIGATION AND REPAIRS

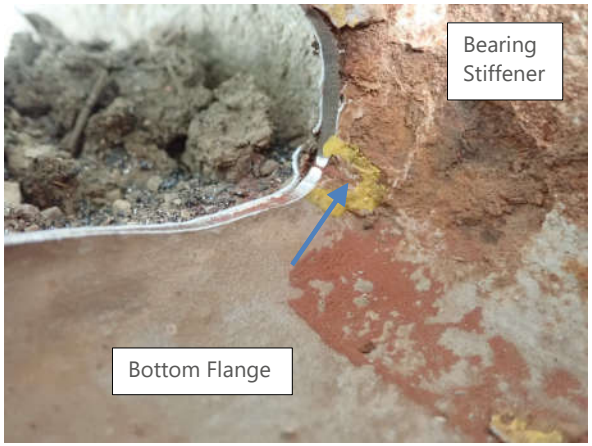
WJE designed and installed urgent mitigation and repairs of most critical items identified during Phase 1 inspection

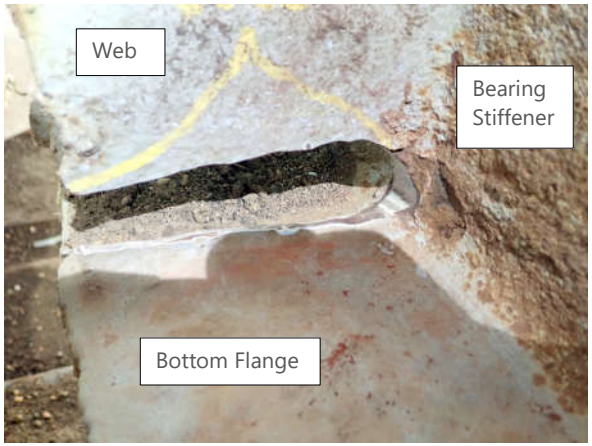
- Bolted retrofits at 3 stringer ends
- Removal of 11 MT indications at the terminations of longitudinal stiffeners by grinding

PHASE 2: URGENT MITIGATION AND REPAIRS

- Modification of the corrosion holes and removal of cracks at bottom of web at 9 girder ends
- Drilled hole retrofits at the top of 4 girder webs at Pier 7 bearing stiffener

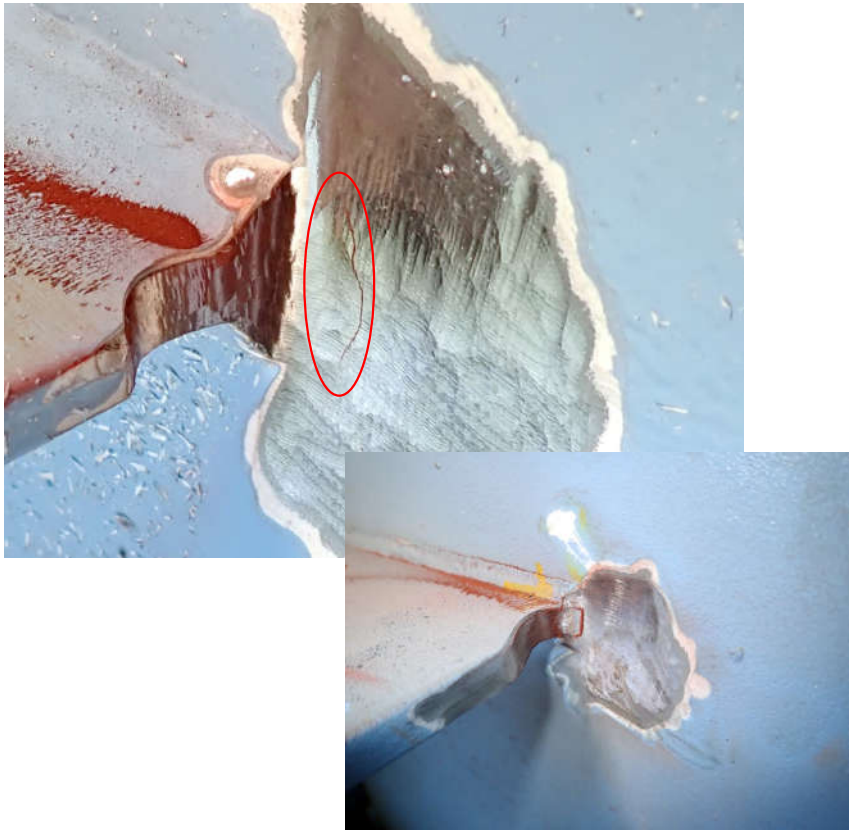






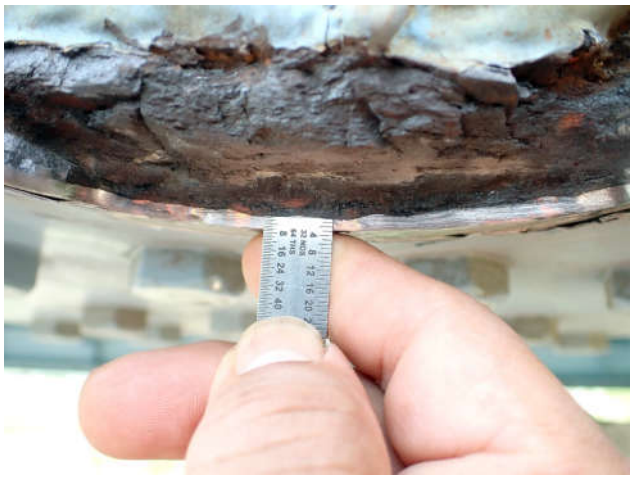
PHASE 2: URGENT MITIGATION AND REPAIRS

- Modification of 212 lateral gusset plate terminations in the positive moment regions of the girder
- Removal of remnant lateral gusset plate and web material at 186 existing CIF repair holes



PHASE 2: URGENT MITIGATION AND REPAIRS

- Additional grinding repair was performed at a bolted field splice later to remove cracks observed by NDDOT during a subsequent NSTM inspection

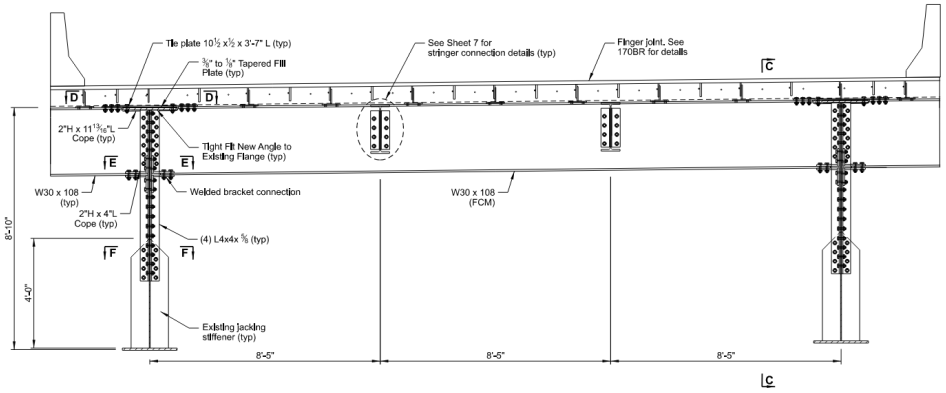


PHASE 3: DESIGN, LOAD RATING, AND PLAN PREPARATION

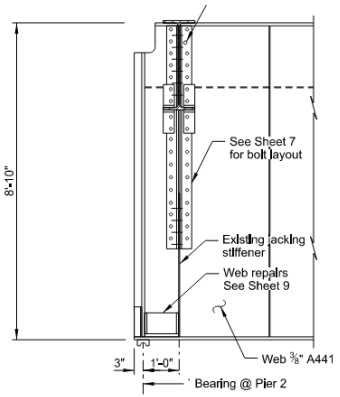
- Primary objectives for superstructure rehabilitation
  - Permanent repair for the stringer ends and floor trusses adjacent to the expansion joints
    - Incorporate modification to allow for support of replacement finger joint by NDDOT
    - Increase distance between approach and main span floor trusses to provide for adequate drainage
  - Repair deteriorated girder webs adjacent to the expansion joints
    - Incorporate trimming of girder ends to provide for additional thermal expansion
    - Incorporate reset of rocker bearings which may shift the location of the bearing force on the girder end
  - Heat straighten the distorted flange and web from previous lack of thermal expansion
  - Design a repair for deteriorated girder bolted field splices in Span 6 to replace splice plates
  - Repair, replace, splice, or strengthen other deteriorated items
    - Lateral bracing members, lateral gusset plates, hanger rods, anchor rods, bolts, longitudinal stiffeners, and walkway panels

REPAIR OF FLOOR SYSTEM NEAR EXPANSION JOINTS

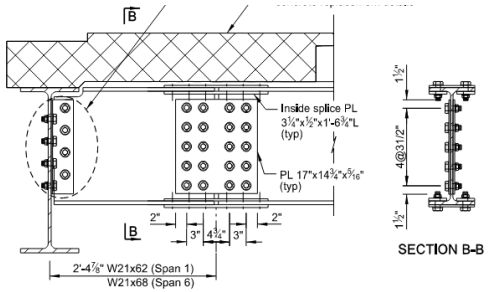
- Replace floor trusses adjacent to expansion joint with floor beam
  - Avoids patching individual areas of section loss
  - Lower fabrication cost than a replacement floor truss
- Extend jacking stiffener as new floor beam connection using back-to-back angles
  - Moves floor beam further from expansion joint to allow support of finger joint and provide for drainage
  - Removes deterioration at ends of stringer
- Floor beam elevation shifted to deck level to directly support finger joint
  - Avoids concrete end beam under finger joint



(SPAN 2 AND SPAN 5)
SECTION B-B (SEE SHEET 4)
EASTBOUND OPPOSITE HAND



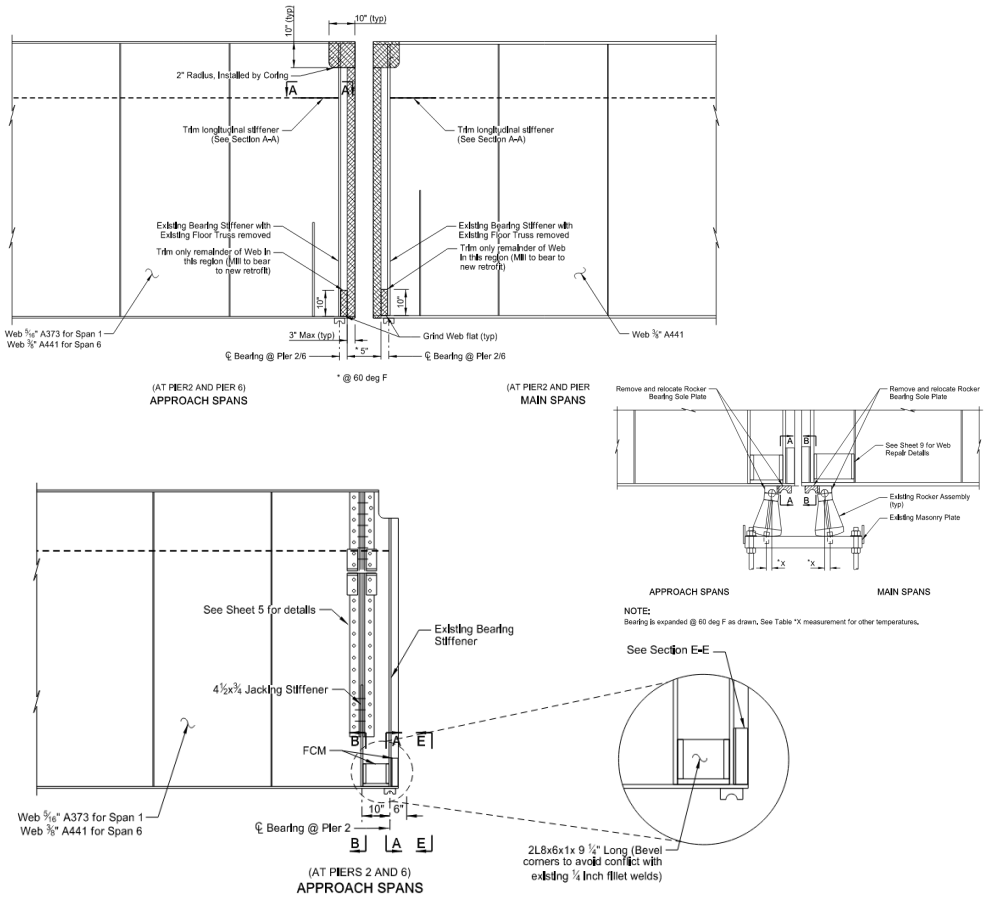
SECTION C-C
(BOLTS NOT SHOWN FOR CLARITY)



SECTION B-B

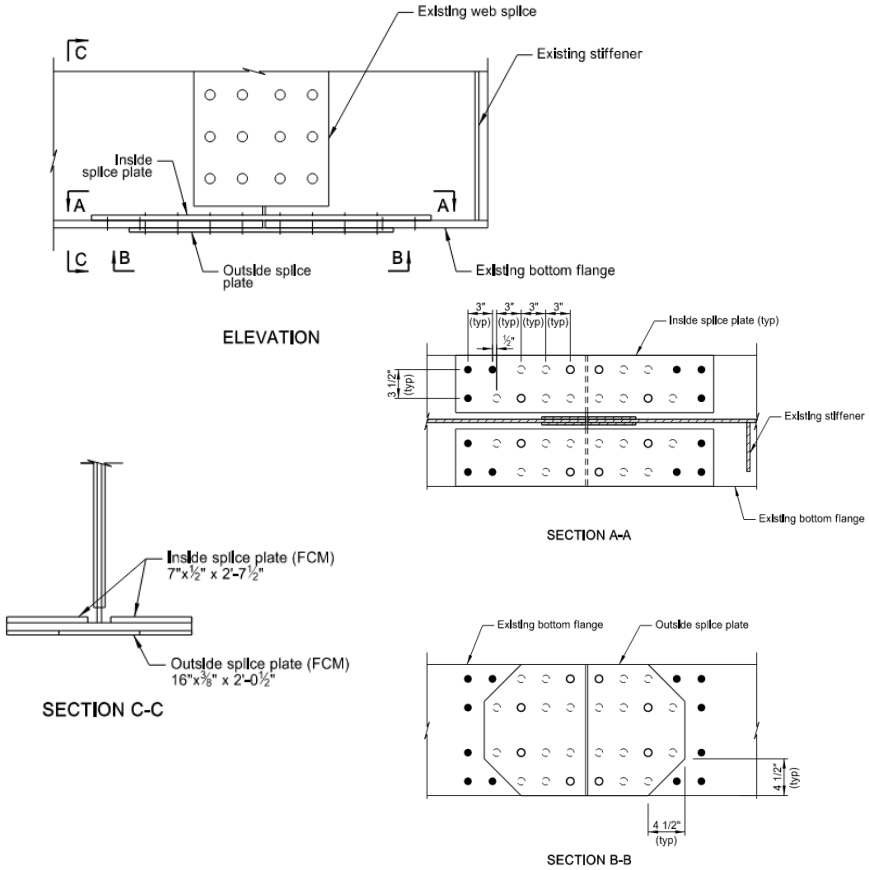
REPAIR OF GIRDER ENDS

- Trim girder ends to provide for additional thermal expansion
  - Allow for continuous finger joint from out-to-out of deck
- Reinforce girder web with field welded bracket
  - Reinforces and reattaches web to flange
  - Connects tight between bearing stiffener and jacking stiffener
  - Allows for rocker bearing reset by moving sole plate
  - Acts as a short beam to spread bearing force to bearing stiffener and jacking stiffener
- Jack bridge and reset rocker bearings
  - Rocker bearings have combined masonry plate for approach and main spans
  - Sole plate was removed, components cleaned, and reset



REPAIR OF GIRDER BOLTED FIELD SPLICES

- Removal and replacement of bottom flange splice plates
  - Staged to avoid release of locked-in dead load
- Construction sequence
  - Remove one inside splice plate by one-by-one replacing bolts with drift pins installed in bolt holes to bear on outside splice plate
  - Clean and install a new, longer inside splice plate with 3 bolts fully pretensioned to bottom flange only on each end
  - Flip drift pins to bear on inside splice plate
  - Repeat on other inside splice plate
  - Remove outside splice plate, install new outside splice plate, remove drift pins one-by-one and install pretensioned bolts



GRANT MARSH BRIDGE REHABILITATION PROJECT

- Awarded contract to Industrial Builders, Inc., Fargo - December 2023
- Fabricator - Egger Steel Co., Sioux Falls
- WJE provided structural steel rehabilitation plans
- NDDOT provided MOT, deck, barrier, and substructure rehabilitation plans
- NDDOT provided plans for new drainage system at the expansion joints

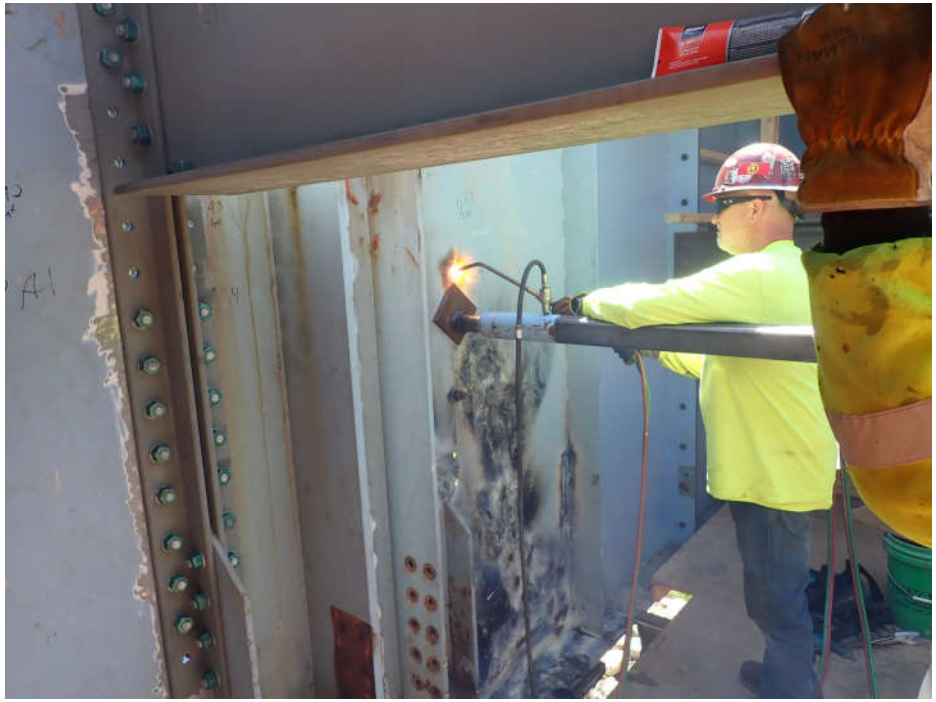
REPAIR NEAR EXPANSION JOINTS

- Temporary support of stringers
- Removal of floor trusses adjacent to expansion joints
- Trimming of stringer ends to allow support by floor beam shifted away from the expansion joint
  - Extended removal at areas of deterioration with new bolted stringer stubs

REPAIR NEAR EXPANSION JOINTS

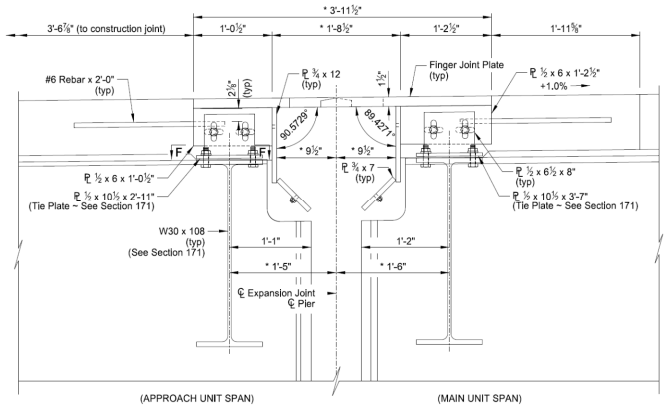
- Trimming of girder ends
- Installation of floor beam connection angles at jacking stiffener
- Field welding of repair brackets at bottom of girder web

HEAT STRAIGHTENING OF DISTORTED GIRDER



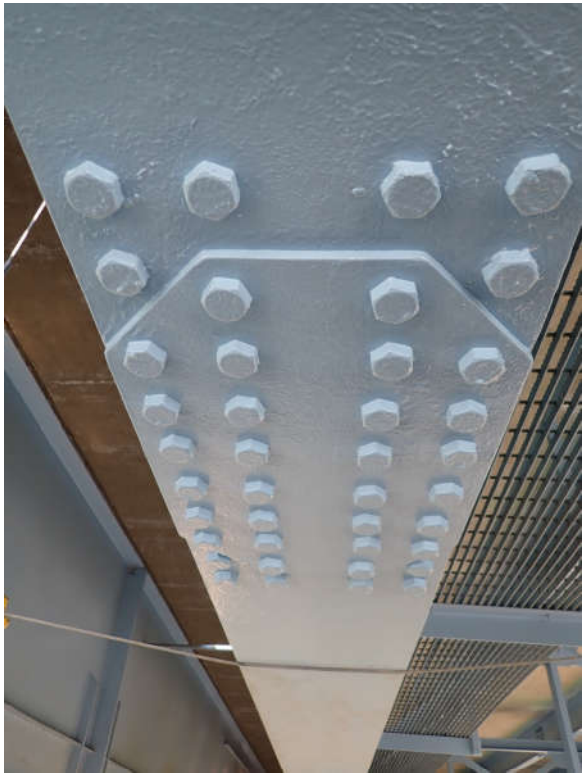
REHABILITATE EXPANSION JOINT

- Jack bridge girders from substructure
- Clean, lubricate, and reset rocker bearings
- Install finger joint
- Provide adequate gap for thermal expansion from deck to bearings



REHABILITATE EXPANSION JOINT

BOLTED FIELD SPLICE REPAIRS



COMPLETED REPAIRS

THANK YOU

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