I-64 Sherman Minton Bridge

Inspection, Closure, & Structure Retrofit

Background

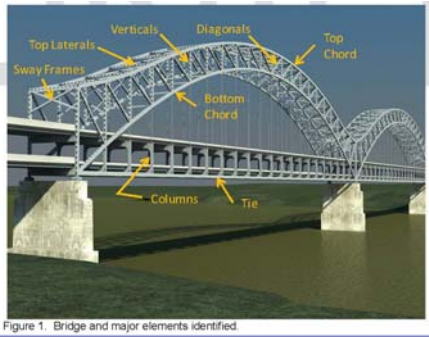
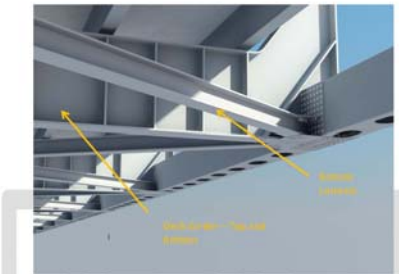


Figure 1. Bridge and major elements identified.

Background

- The bridge carries approximately 70,000 vehicles per day on I-64 over the Ohio River.
- Consists of two 800 foot simple span tied arches.
- There are two decks. The lower deck carries traffic into Kentucky while the upper deck carries traffic to Indiana.

Background



Background

- Designed in 1959
- First Deck opened in 1961
- Second deck opened in 1962
- 100 ksi

Why was there concern?

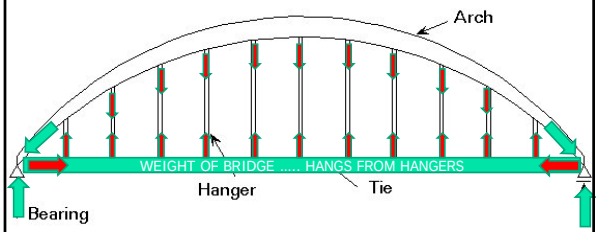
Type of Construction

- Tied arches are FRACTURE CRITICAL bridges.
- Failure of the tie = likely collapse of the entire span

Material Properties

- Type of Material
  - "T1" Steel
    - VERY high strength steel
    - Susceptible to FRACTURE at cold temperatures and with small cracks
    - Fractures are cracks that propagate through the steel at rates faster than the speed of sound
    - Hydrogen induced cracks may form during welding

Type of Construction



- Think of a bow (like in a bow and arrow....)
  - Stand it on a table like shown
  - Push down on the bow
  - What would happen if we cut the string?

Slide courtesy of Baker

Sensitive Details

- Sensitive Details
  - Tie girder welds
  - Diaphragm plates
  - Lateral bracing details
  - Some longitudinal fillet welds

Type of Construction

Source: 1978 FHWA Technical Advisory

- *...the serious consequences of weld cracking associated with the tie girder of a tied arch structure should not be overlooked.*
- *...it is one of the most nonredundant structures, relying entirely on the capability of two tie girders to accommodate the total thrust imposed by the arch ribs*

Slide courtesy of Baker

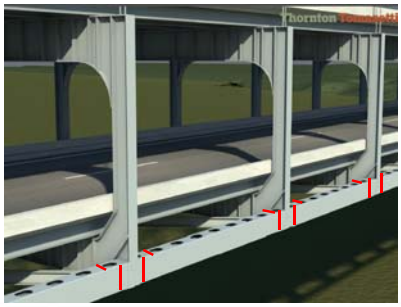
Sensitive Details

Tie Girder Welds

Slide courtesy of Baker

Sensitive Details

Tie Girder Welds



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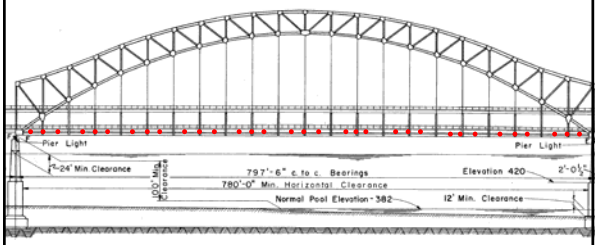
Sensitive Details



Diaphragm Lugs

33 diaphragms per tie x 2 ties x 2 spans x 8 lugs per diaphragm x 2 legs = 2112 welds

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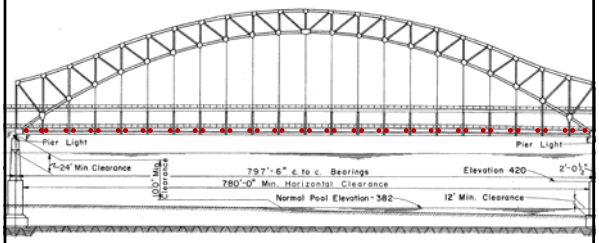
Sensitive Details



Tie Girder Welds

176 Individual welds per tie x 2 ties x 2 spans = 704 potential fracture sites

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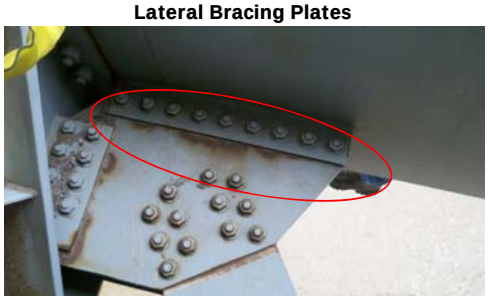
Sensitive Details

Lateral Bracing Plates



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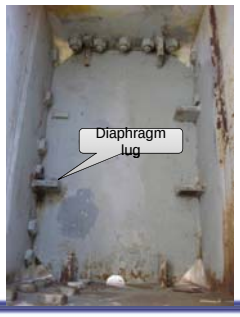
Sensitive Details

Diaphragm Lugs



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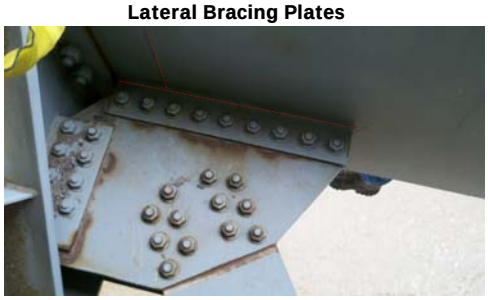
Sensitive Details

Lateral Bracing Plates



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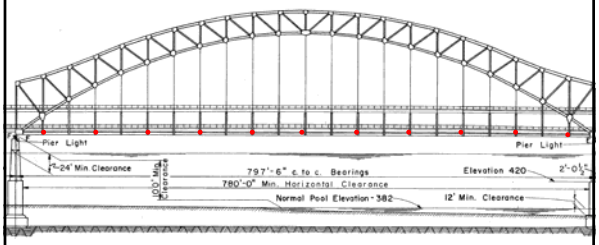


Lateral Bracing Plates

11 panels x 2 plates per panel x 2 ties x 2 spans = 88 connection plates

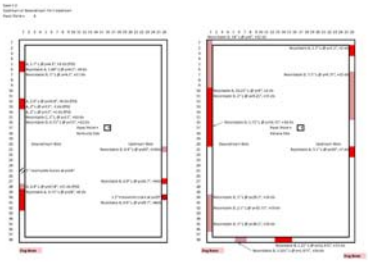
Slide courtesy of Baker

Inspection

- Material samples
- Fracture Mechanics analysis
- Inspectors were proof tested
  - NDT
  - Vision

Inspection

Inspection



Inspection

- Comprehensive Inspection Plan Developed
  - Visual Inspections
  - Instrumentation
  - NDT
    - Magnetic Particle
    - Ultrasound
    - High Intensity X-ray
    - Radiography

FHWA Technical Advisories

- 5140-32
  - Inspection of Fracture Critical Bridges Fabricated from AASHTO M270 Grade 100 (ASTM A514/A517) Steel

Retrofit # 1

Why was the bridge closed?

Retrofit #1

- Remove diaphragm lugs & inspect
- Retrofit lateral bracing connections & inspect
- Core or install dog-bone detail based on results from inspection and fracture mechanics model

Why was the bridge closed?

Slide courtesy of Baker

Sherman Minton Bridge

September 9, 2011

Why was the bridge closed?

Slide courtesy of Baker

Why was the bridge closed?

Retrofit # 2

Metro Area Map

Retrofit #2

Timeline

- Bridge was closed September 9, 2011
- Repair plan announced September 30, 2011
- Contract let October 19, 2011

Traffic Mitigation

- Detour
- Signal retiming
- Add temporary lanes on Interstate ramps
- US 31 bridge: reversible lane
- Extra Hoosier Helper service patrols
- Message boards
- Other

Retrofit #2

Short Listed ideas

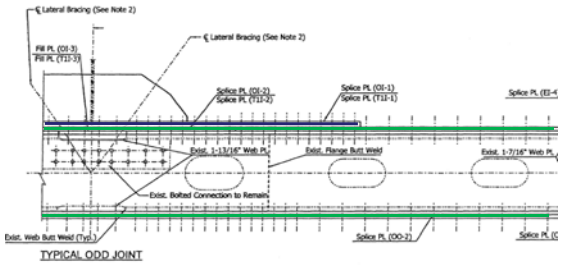
- Local Plating
- Global Plating
- Post-tensioning
- Replacing the Tie

Retrofit #2

Considerations

- Location of indications
- Future Inspection
- Availability of steel
- Length of Construction

Retrofit #2



Global Plating Option – **Odd Joint**

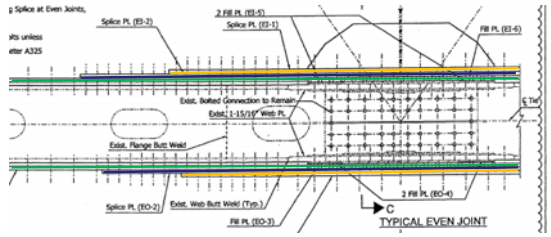
Retrofit #2

- Chosen Solution
  - Global Plating
  - Installation of dog-bones to isolate the welds in the top and bottom plate of the tie-girder

Retrofit #2

Global Plating Option

Retrofit #2



Global Plating Option – **Even Joint**

Retrofit # 2

Top Plate: Dog Bone - Crack Isolation

Retrofit #2: Global Plating

Bidding Results

Contractor	Part A	Closure Days	Total
Hall Contracting	$13.9M	135	$27.4M
Walsh Construction	$17.2M	150	$35.2M
American Bridge	$16.4M	195	$35.9M

A + B Bidding

- **Contract was bid in 2 parts**
  - **Part A** – Includes all pay items in the Schedule of Pay Items
  - **Part B** – Total dollar value of closure days at $100,000 per day

Moving at the Speed of Business

- Bridge Closure – September 9, 2011
- Mandatory Pre-Bid – September 27, 2011
- Contract Letting – October 18, 2011
- Pre-Construction Conference – October 19, 2011
- First Chargeable Closure Day – October 19, 2011

A + B Bidding

- **The Great Motivator**
  - $100,000 per day incentive for beating closure days bid
  - $100,000 per day penalty for not meeting closure days bid

Major Project Quantities

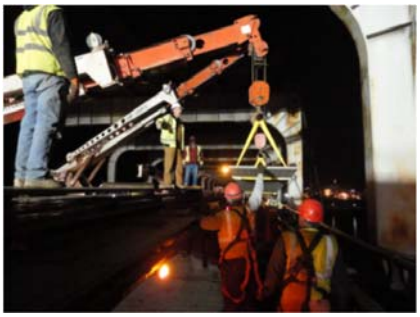
- 2.4 M pounds of structural steel
- Just over 1,000 steel plates
- Plates up to 67’ in length

Major Project Quantities

- 55,000 field drilled holes
- 73,000 bolts

Structural Steel Placement

First Steel Arrived December 19, 2011



Field Drilled Holes for Bolts

Structural Steel Placement

Structural Steel - Bolting

Steel Placement

- **Repeat the process 1,000 times**

Bridge Opening 2/17/2012

Sherman Minton Bridge

September 7, 2011

Thank you to:

- Baker
- FHWA
- KYTC
- Robert Connor and Purdue University
- Phil Fish and Associates
- ATS
- Thornton Thomasetti
- Glenn Washer

Sherman Minton Bridge

- Hall bid 135 closure days (Part “B” of bid)
- Bridge reopened on day 122
- 13 days x $100,000 = $1.3M incentive

Questions?

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