Unique Steel Bridge Repair and Strengthening: Two Case Studies

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Presentation Outline

- Lincoln Avenue Bridge
  - Change in span lengths
  - Strengthening
  - Counterweights
  - New pier

- Hawthorn Parkway Bridge
  - Beam crack
  - Repair procedure
  - Bridge raise
Lincoln Ave. Bridge

- Project Location
- Cincinnati, Ohio
- ~3 miles North of Downtown CIN
- Bridge spans over I-71
Lincoln Ave. Bridge

- Part of Design Build Project
- I-71 and Martin Luther King Drive
- Kokosing Construction Company
- HDR Lead Designer
- 12 Bridges total
  - 1 Existing RR Tunnel
  - 2 Bridges Demolished
  - 4 Major Rehabs
  - 4 Minor Rehabs
  - 1 Pedestrian Bridge
Lincoln Ave. Bridge

- Existing Structure
  - 3-span Steel Girder Bridge => 59.0' - 91.25' - 88.5'
  - All supports skewed at 13.5°
  - 7 girders at 9'-2"
  - Non-composite superstructure
Lincoln Ave. Bridge

- **Scope of Work**
  - Change span arrangement to 49.25' – 101' – 88.5' (from 59.0' - 91.25' - 88’.5’)
  - Relocate Pier 1 to accommodate traffic underneath Span 1
  - Raise superstructure: 7.625" at Forward Abutment
  - Maintain traffic on bridge => Phased construction
Lincoln Ave. Bridge

- Careful Consideration of unloading and loading sequence
  - Staged Construction Analysis

- Adjusting Spans resulted in:
  - New Pier
    » 4 column multi-column pier
    » Spread footing on rock
    » Conflict with existing
Lincoln Ave. Bridge

- Strengthening center and end spans
- Shift in bending moment diagram

Span 1 Repair (all girders)

Span 2 Repair (all girders)
Lincoln Ave. Bridge

- Strengthening center and end spans
  - Partial Deck Removal and Replacement

- Span 1 Repair (all girders)
- Span 2 Repair (all girders)
- New Pier 1
- Existing Pier 1

Diagram showing the bridge layout with labeled sections for repair.
Lincoln Ave. Bridge

- Strengthening center span
  - Partial Deck Removal & Replacement
Lincoln Ave. Bridge

- Strengthening center span
  - Partial Deck Removal & Replacement
Lincoln Ave. Bridge

- Strengthening center span
  - Partial Deck Removal & Replacement
Lincoln Ave. Bridge

- Strengthening end span
Lincoln Ave. Bridge

- Strengthening center and end spans
  - Allow flexibility
  - Provide details around stiffeners
  - Exact stiffener locations unknown during design
  - Field scan/survey used by detailer to locate stiffeners
Lincoln Ave. Bridge

- Bridge Raise
  - Non uniform at each support
  - 7.625” at Forward Abutment
  - 0” at Rear Abutment
  - Consideration of Skew and Deck Profile

Rotate about centerline of bearing
Raise at this end
Lincoln Ave. Bridge

- Counterweights in Span 1

Utility Duct
Presentation Outline

- Lincoln Avenue Bridge
  - Change in span lengths
  - Strengthening
  - Counterweights
  - New pier

- Hawthorn Parkway Bridge
  - Beam crack
  - Repair procedure
  - Bridge raise
Hawthorn Parkway Bridge

- Solon, Ohio
- Cuyahoga County
- ~20 miles Southeast of Downtown Cleveland
- Bridge spans over U.S. 422
Hawthorn Parkway Bridge

- Emergency repair due to beam hit
- Full depth crack
- Bridge was closed
- ODOT temporarily plated over crack
Hawthorn Parkway Bridge

- Existing Layout
  - 4-span Steel Beam Bridge
    - 64.0' - 91.0' - 84.0' - 59.0'
  - All supports skewed 39°±
  - Length of 304'±
  - Horizontally curved alignment
Hawthorn Parkway Bridge

- Existing Superstructure
  - 6 Rolled Beams (W36)
  - Dog-legged framing plan
  - 42'-10" out/out deck
  - Two 14' lanes and 8' wide bridle path
  - Safety curbs, parapets, tubular railing and fence
Hawthorn Parkway Bridge

- Replacement options considered
  - Fascia beam with shallower depth section
    - Partial length (Haunched beam section with unique splices)
    - Full length (Replace entire beam, crossframes and deck)
  - Portion of fascia beam of the same depth
    - Additional field splice (reduce vertical clearance)
    - Existing field splice to existing field splice (selected option)
Hawthorn Parkway Bridge

- Beam Hit Mitigation Improvements
  - Raise Hawthorn Parkway
  - Lower U.S. 422
Hawthorn Parkway Bridge

- Selected Solution
  - Replace beam field splice to field splice
  - Partial deck removal
  - Raise Hawthorn Parkway 4" using steel shims
  - U.S. 422 will be lowered with next major road construction project

- Additional Work
  - Backwall and expansion joint modification
  - Patch and seal concrete
  - Salvage railing
  - Replace fence
  - Replace top 2.5" of bridle path
  - Approach slab and pavement
Hawthorn Parkway Bridge

- Design and Analysis
  - 3D Finite Element Modeling
  - Construction sequencing
  - Beam deflections, camber and screed elevations
  - Stress and code checks
Hawthorn Parkway Bridge

- Accurately model construction sequencing using 3D FEM
  - Partial deck removal
  - Partial beam removal
  - Crossframe removal
  - Temporary support location and reactions
Hawthorn Parkway Bridge

- Portion of fascia beam and crossframes removed
Hawthorn Parkway Bridge

- New beam installed
Hawthorn Parkway Bridge

- New crossframes installed
Hawthorn Parkway Bridge

- Steel Details
  - Replaced field splices
    - Field verify bolt hole locations
  - Uses stiffener plates with slotted holes to connect new crossframes
  - 2" steel shim plates under existing bearings to raise superstructure
Screed Elevations
- Account for existing conditions
  - Profile and cross slope
- Contractor determined screed and final deck elevations
- Provided screed points, blank tables and sample calculations
- Ensure positive drainage

Sample Calculations and Table

Screed Lines
Hawthorn Parkway Bridge

- Construction Photos

Existing Cracked Beam
Hawthorn Parkway Bridge

- Construction Photos

- Deck Removal

- Crack and Repair Plate

- Temporary Support
Hawthorn Parkway Bridge

- Construction Photos

- New Beam
- New Splice
- Crossframe Connection Plates
Hawthorn Parkway Bridge

- Completed Project
Hawthorn Parkway Bridge

- Completed Project
Summary

- **Lincoln Avenue Bridge**
  - Revised Span Arrangement
    - Consider loading sequence
    - New Pier
    - Strengthening for moment shift
    - Counterweights

- **Hawthorn Parkway Bridge**
  - Replaced Crack Beam
    - Consider construction sequencing
    - Temporary support reactions
    - Maintain stability of beam during deck placement

- **Flexibility of Steel Bridges**
  - Ability to change span arrangement
  - Ability to replace a single field piece
Acknowledgements

- Lincoln Avenue Bridge
  - Kokosing Construction Company
  - ODOT District 8

- Hawthorn Parkway Bridge
  - Union Industrial Contractors
  - ODOT District 12
QUESTIONS......