Maintaining Traffic on Edmonton Bridge During Replacement Using Gantry Cranes

CEA Transportation Connects Alberta

Edmonton, AB

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With Thanks to:
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COWI GRAHAM

Contents

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Project Background & Design

Project Background

Full Superstructure Replacement Needed

Seven-span, four lane bridge spanning ~1,000 feet across the North Saskatchewan River.

Critical transportation link. ~36,000 vehicles per day + pedestrian thoroughfare.

Built in 1950's. Major rehab required to extend service life by another 50+ years.

Full superstructure replacement + select substructure retrofit & rehab work.

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Existing Structure Prior to Rehabilitation

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Existing Structure Prior to Rehabilitation

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Existing Structure Prior to Rehabilitation

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Existing Structure Prior to Rehabilitation

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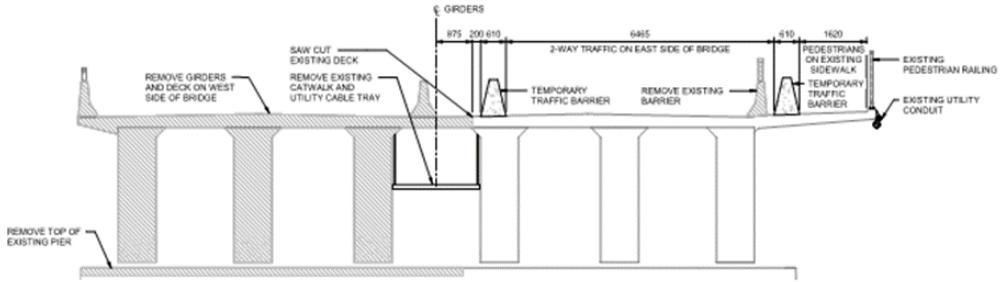
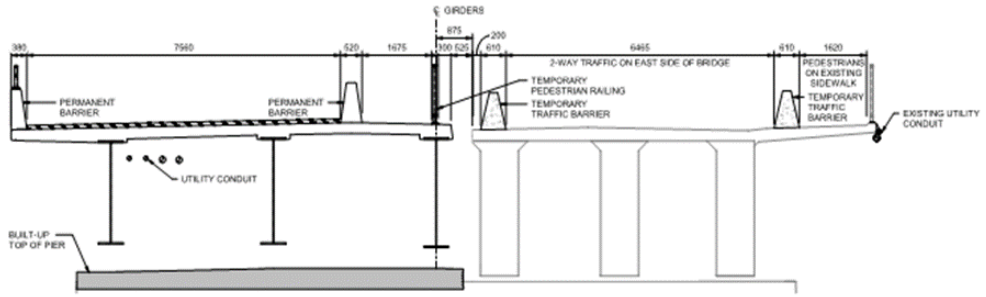
Permanent Works Design



SECTION - PHASE 1 DEMOLITION
ON WEST HALF - STAGES 1 AND 2
A 010 A 009 LOOKING NORTH 1 : 50



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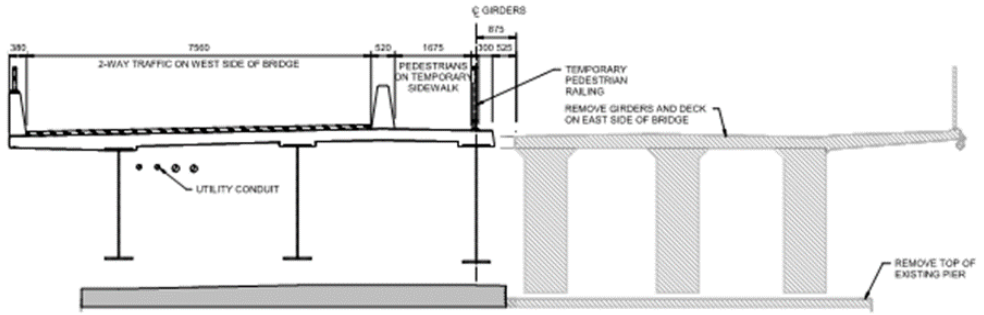
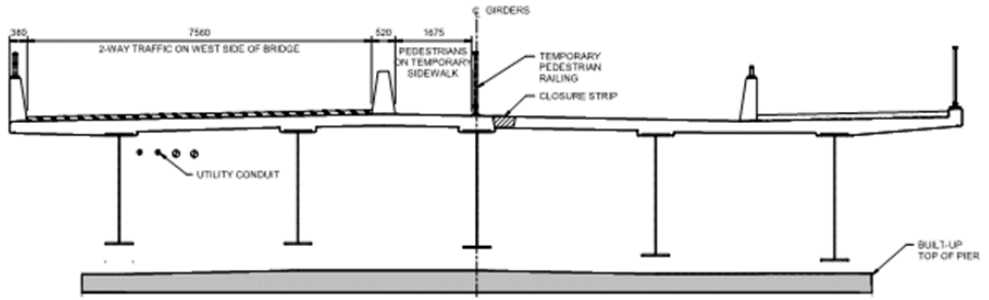
ON WEST HALF - STAGES 1 AND 2
B 010 B 009 LOOKING NORTH 1 : 50



SECTION - PHASE 2 DEMOLITION
ON EAST HALF - STAGES 1 AND 2
A 012 A 011 LOOKING NORTH 1 : 50



SECTION - PHASE 2 CONSTRUCTION
ON EAST HALF - STAGES 1 AND 2
B 012 B 011 LOOKING NORTH 1 : 50

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Execution Strategy and Temporary Works Concept

Execution Strategy

Key Constraints

Maintain two way vehicular and pedestrian traffic at all times.

Mitigate schedule risk associated with in-stream restrictions imposed by environmental regulators.

Minimize environmental impact by completing demolition and reconstruction from above instead of from a berm.

Phased approach required – simplify from four phases to two phases.

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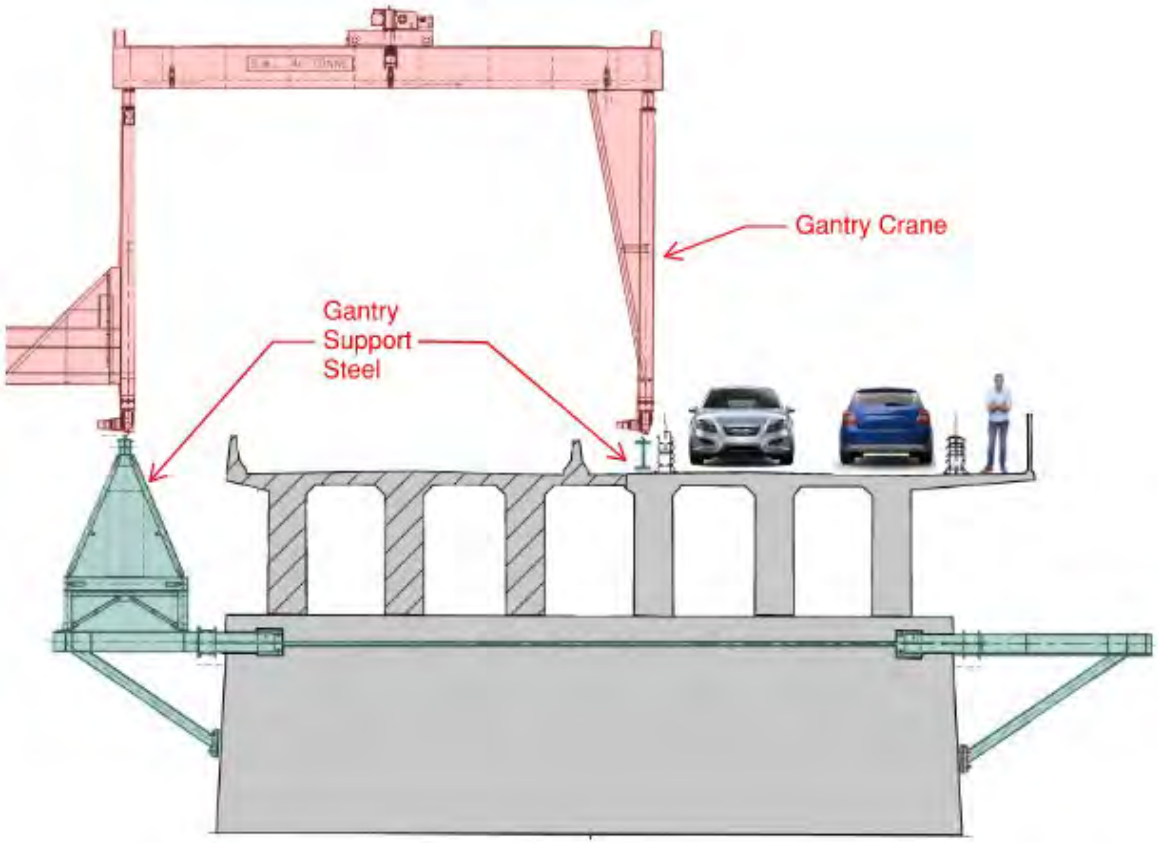
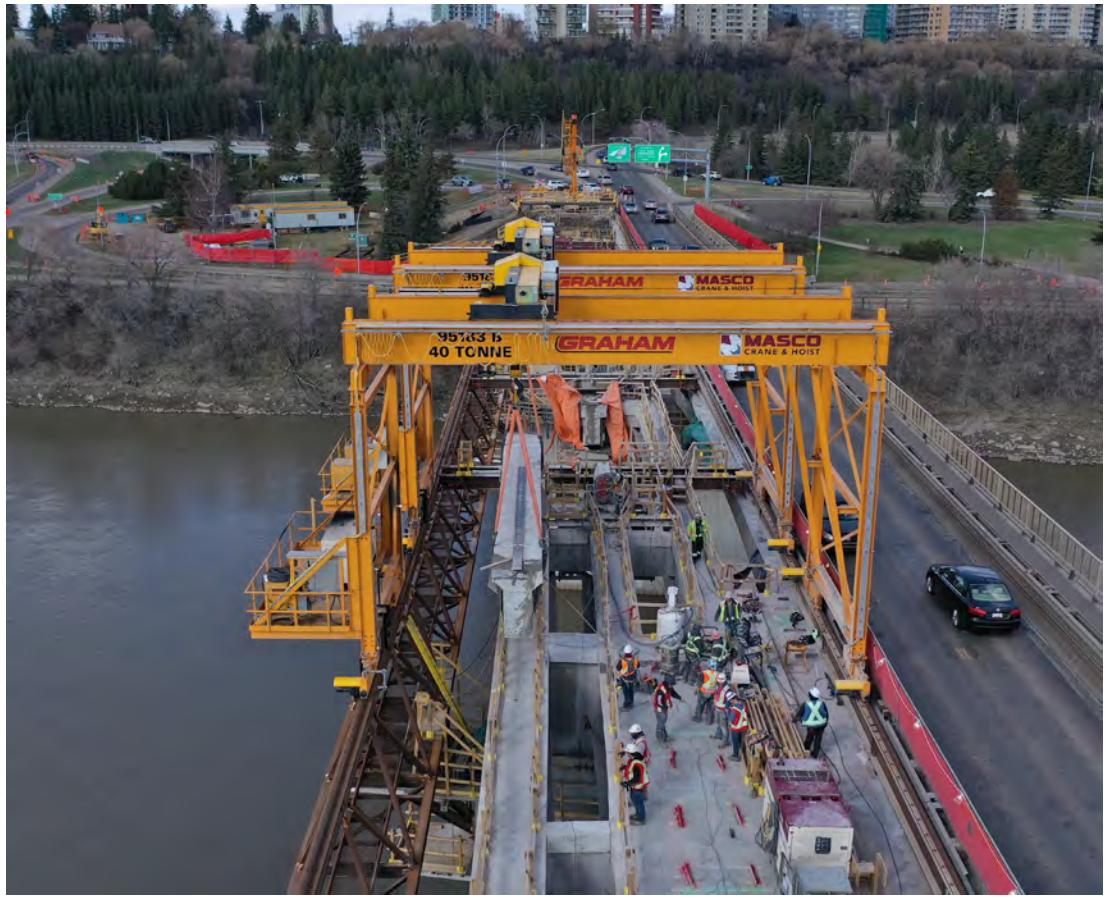
Alternative Approach Selected





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Temporary Works Concept

Gantry System Summary

Design of System (Specifically Fit for Purpose)
Installation of System
Demolition of Phase 1
Reconstruction of Phase 1
Phase Transition – Phase 1 to Phase 2
Demolition of Phase 2
Reconstruction of Phase 2
Removal of System

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Gantry Cranes & Support System

Gantry Cranes

The Centerpiece

Twin 44-ton capacity custom gantry cranes.

Ability to move both independently & synchronously through remote operation.

Construction loads spread over larger footprint on support system.

Operable at temperatures down to -30°C.

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Gantry Support System Constraints

Key Constraints

Outboard support system entirely clear of construction envelope and suspended above the river.

Inboard support system supported by existing CIP girders & directly adjacent to active traffic.

Need to “mirror” entire system between longitudinal halves of the bridge, from Phase 1 to Phase 2 demolition/erection.

Span of work zone differed between Phases, gantries built with two span configurations.

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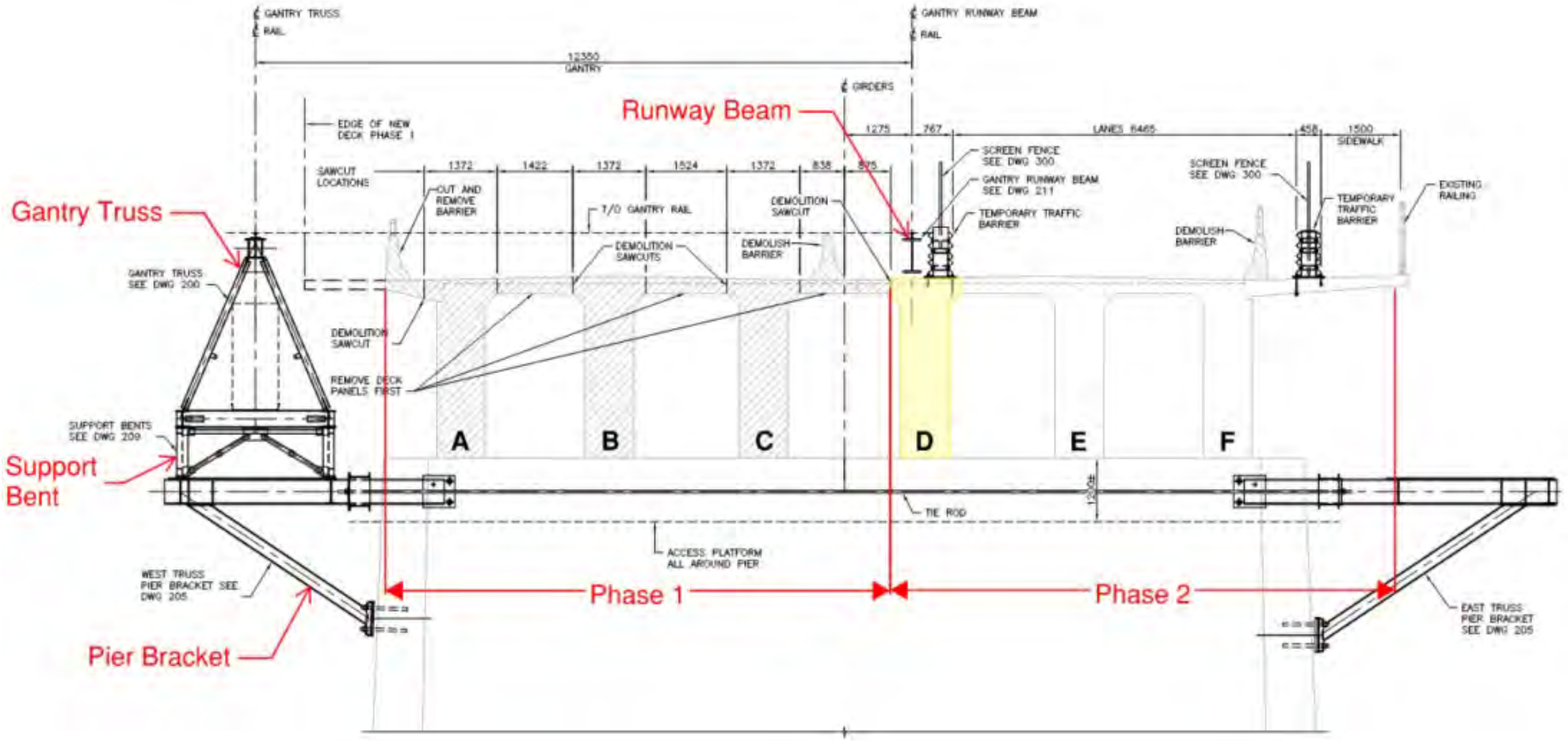
Gantry Support System – Details



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Gantry Support System – Challenges

Installation Challenges

Retaining/adjusting operability criteria for gantry cranes with non-standard runway installation.

Vertical alignment – deflections, clearances.

Horizontal alignment – governed by working envelope, existing bridge geometry and clearances.

Retention of capacity of existing structure – runway beam & reinforcing steel in CIP girder line.

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Gantry Support System – Challenges

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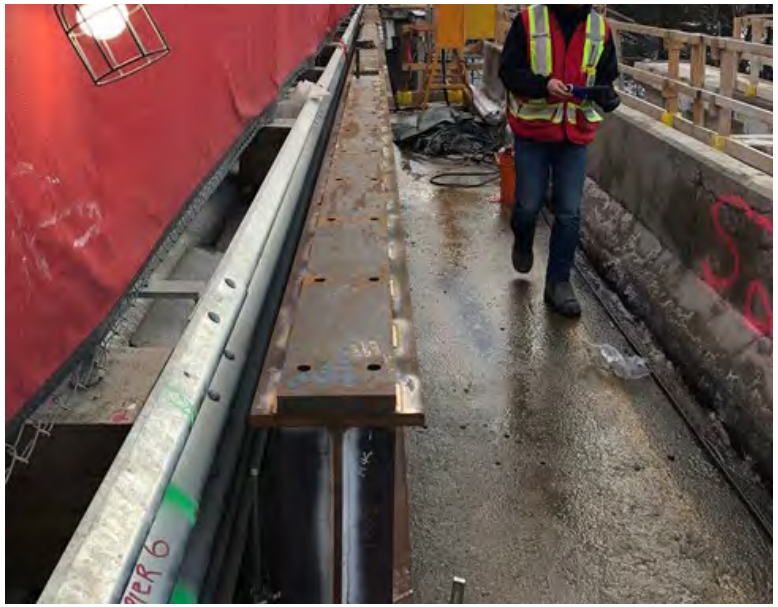
Gantry Support System Installation



Left: Pier brackets – hoisted over deck, anchored to existing piers, tensioned into place.

Centre: Gantry truss – consistent spans, vertical alignment controlled with support bents.

Right: Runway beam – anchored into existing CIP girders through deck; reinforcing steel retained.

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Gantry Support System Installation

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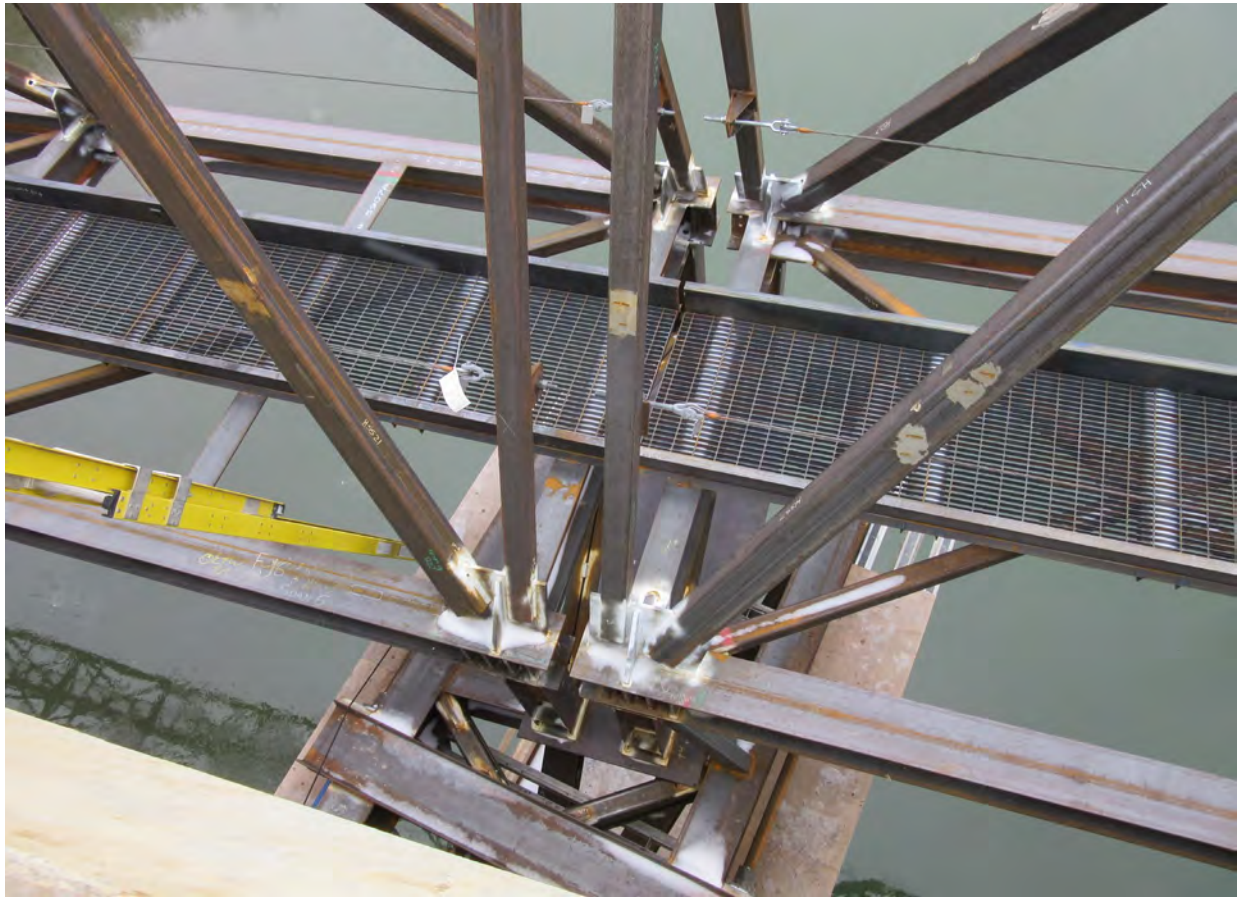

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Gantry Support System Installation

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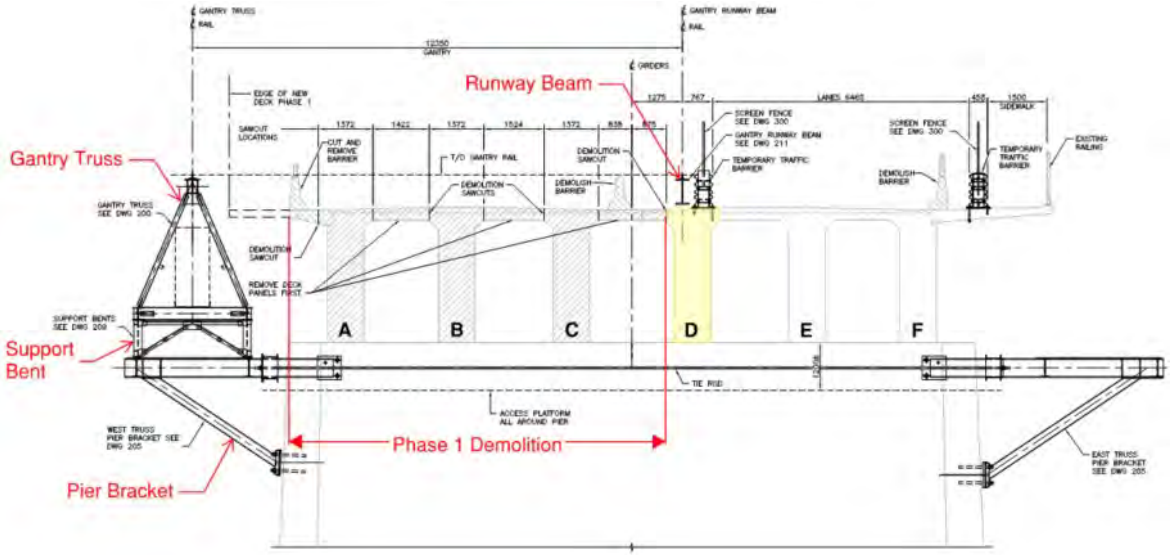
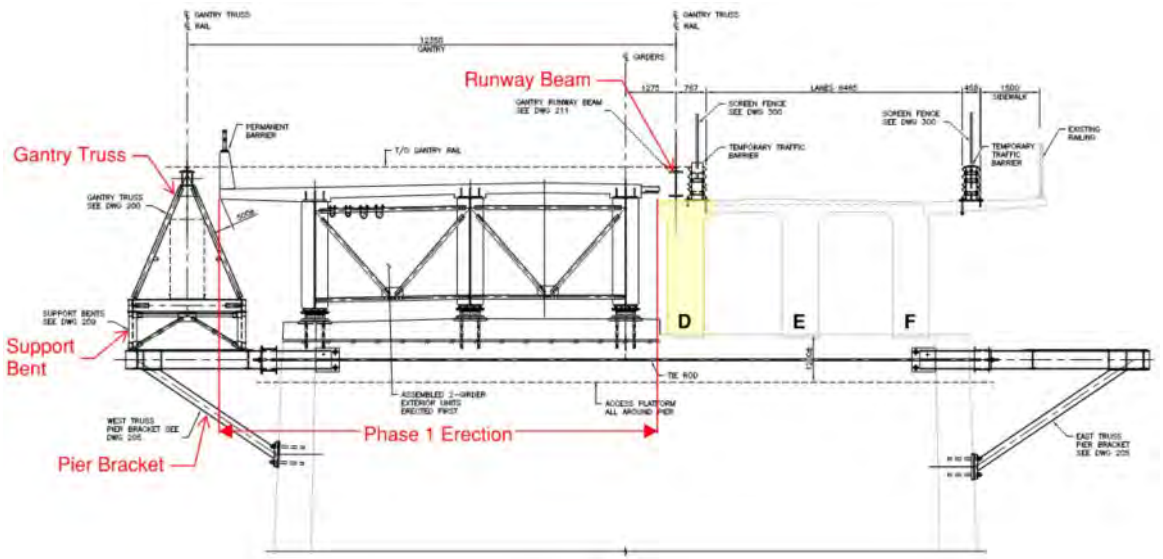
Demolition & Reconstruction Scheme

Phase 1 Demolition & Erection





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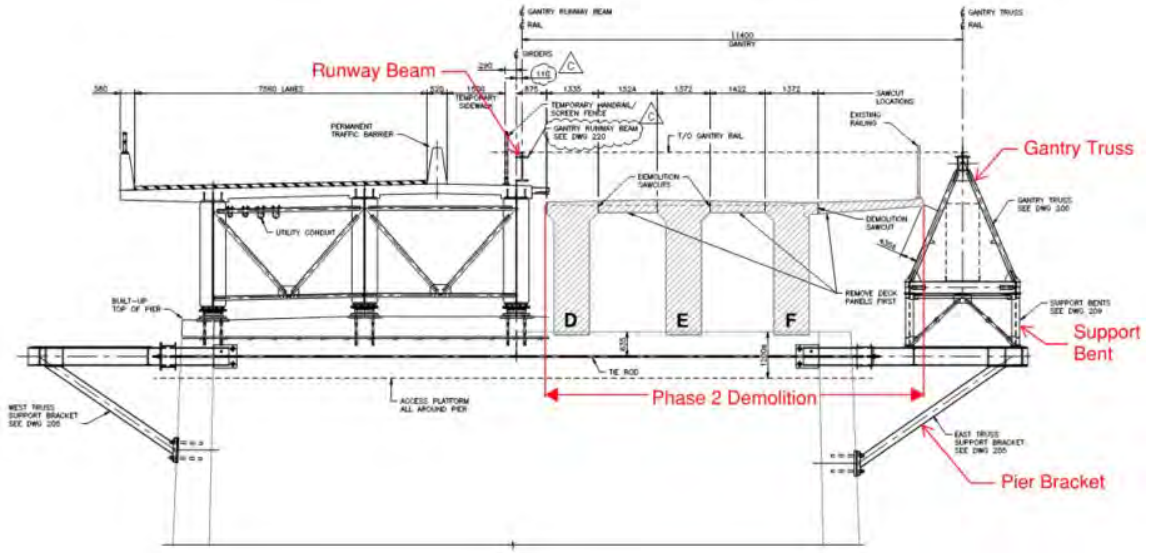
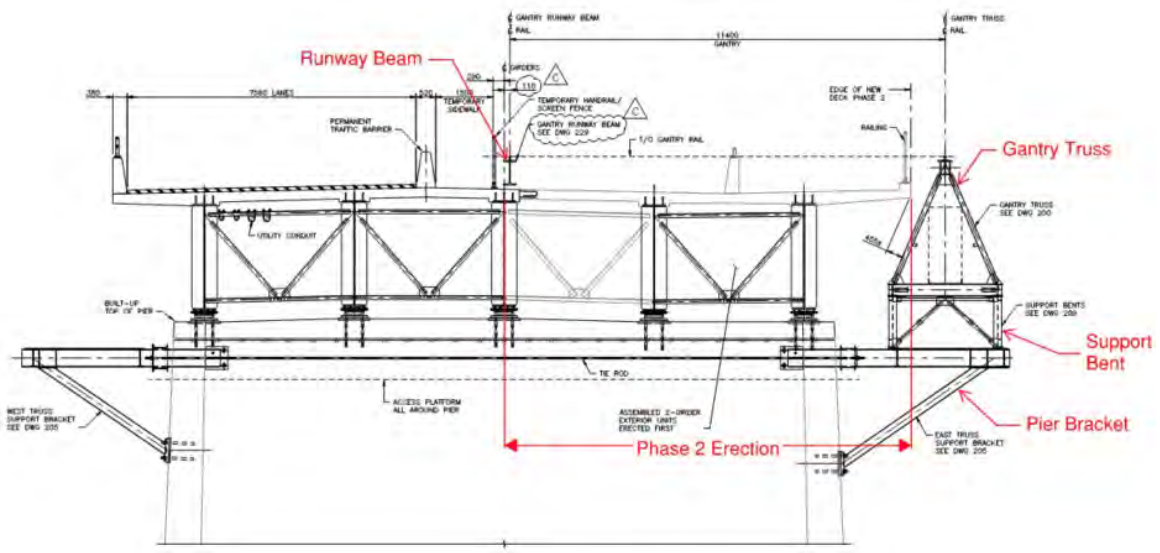
Phase 2 Demolition & Erection





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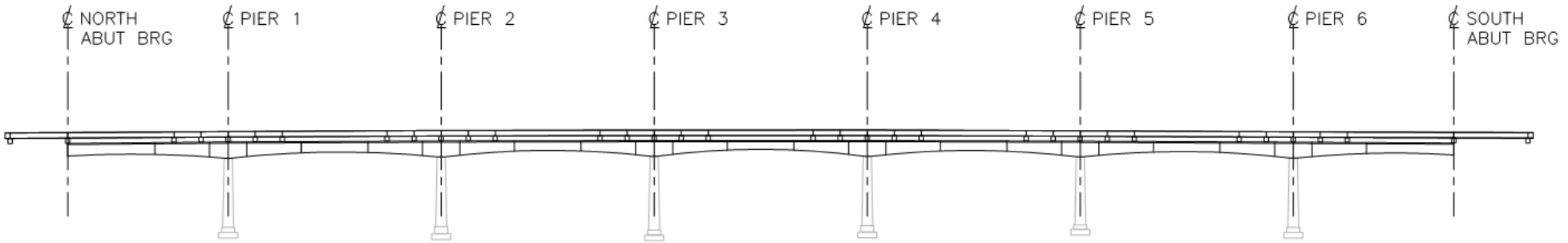
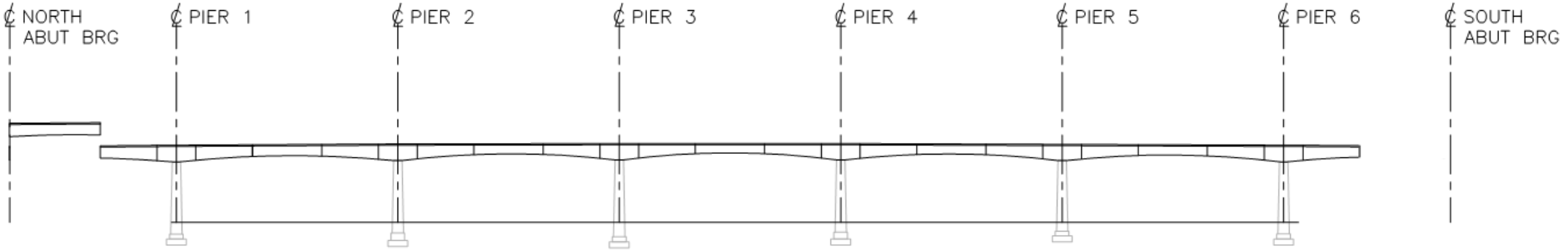
Demolition Scheme – Illustration [1/9]



ELEVATION ALONG GIRDER D



ELEVATION ALONG GIRDER A, B, OR C

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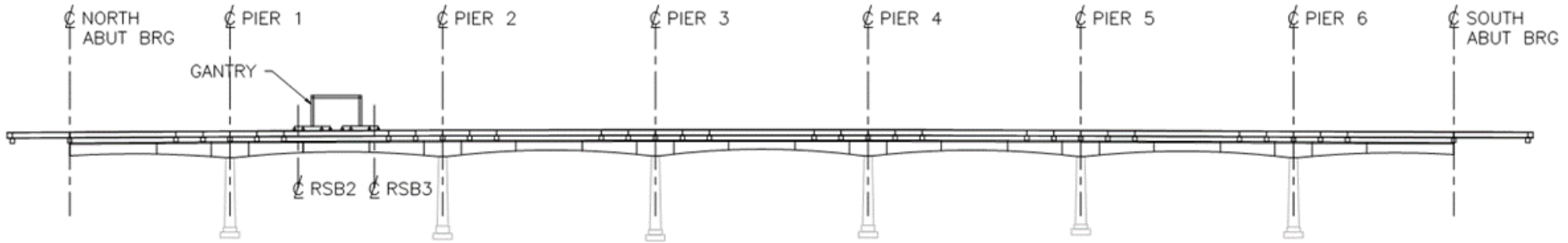
Demolition Scheme – Illustration [2/9]



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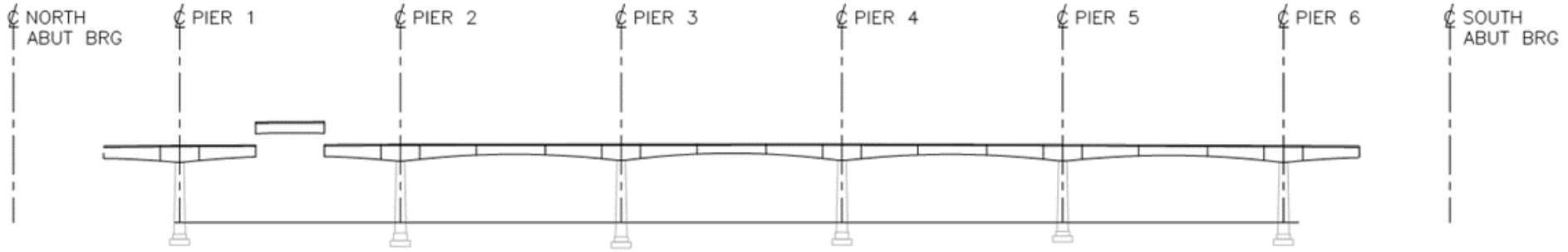

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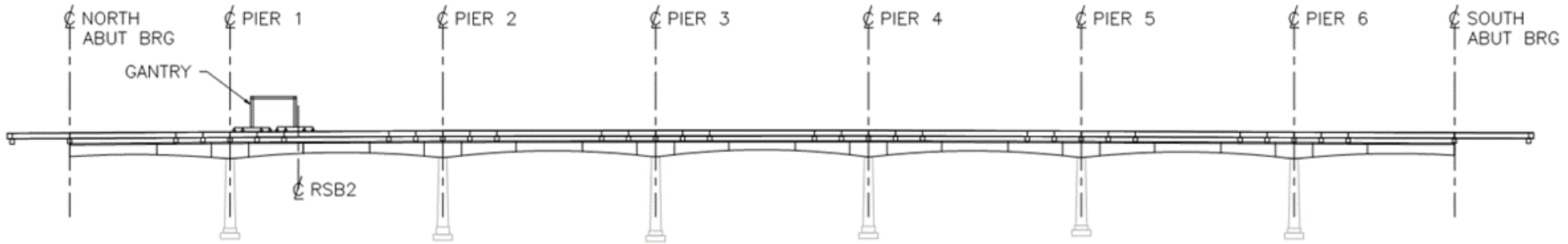
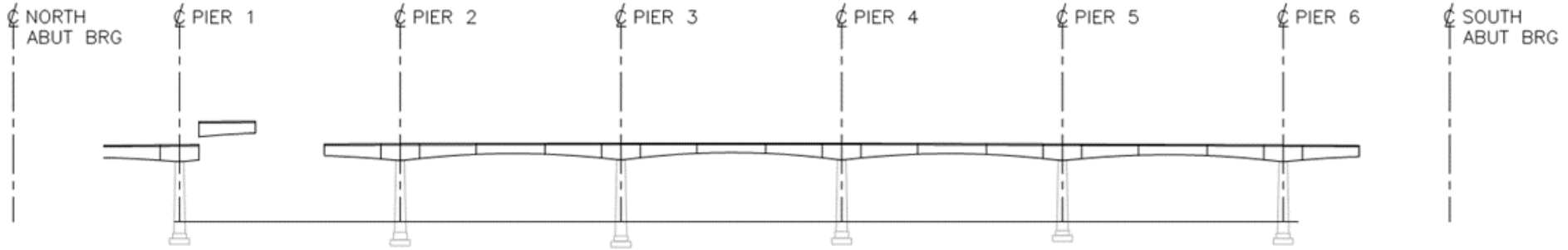
Demolition Scheme – Illustration [3/9]



ELEVATION ALONG GIRDER D



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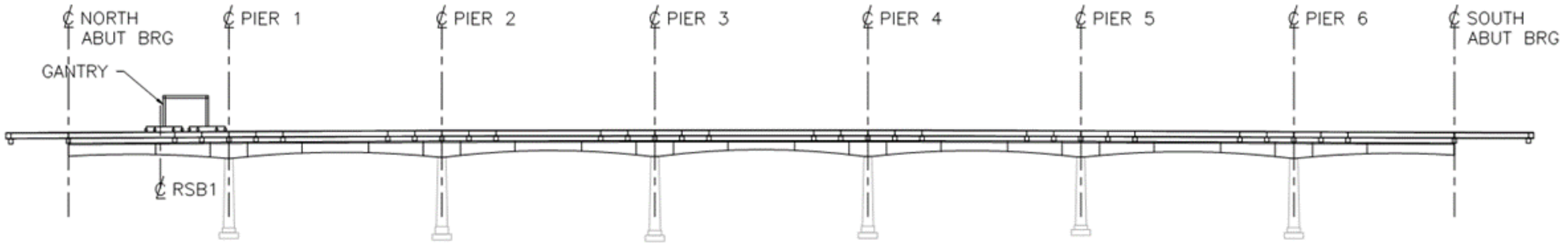
Demolition Scheme – Illustration [4/9]



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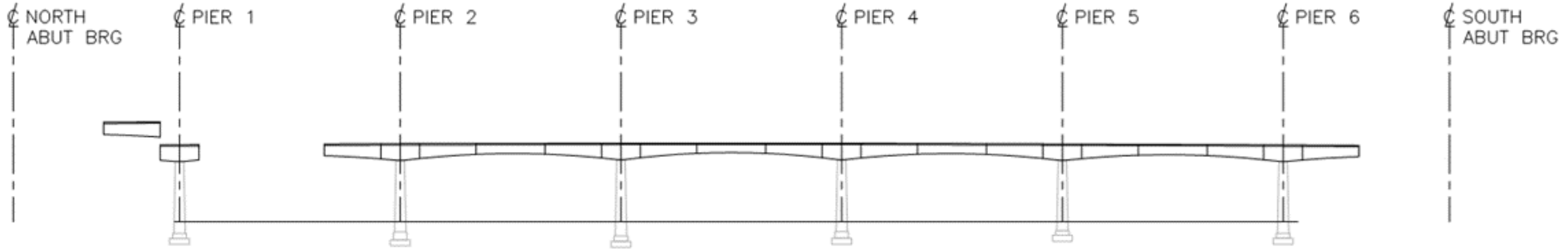

ELEVATION ALONG GIRDER A, B, OR C

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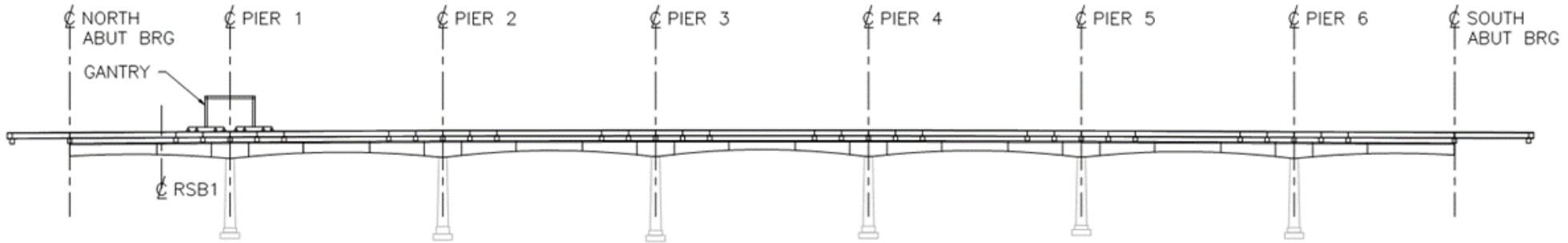
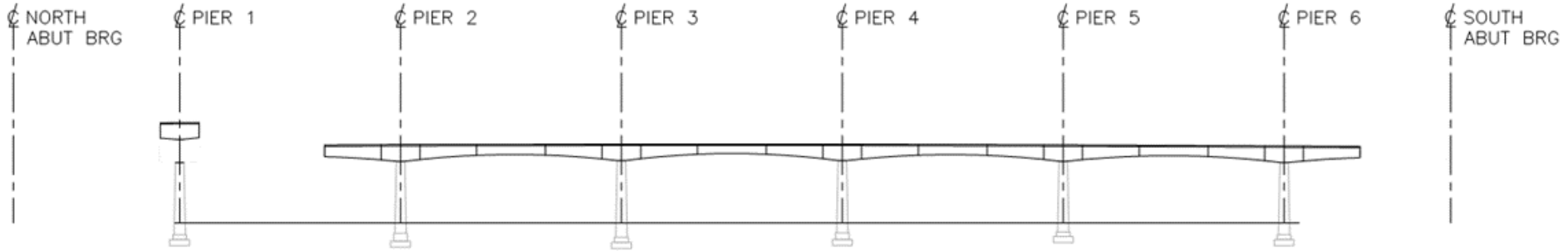
Demolition Scheme – Illustration [5/9]



ELEVATION ALONG GIRDER D



ELEVATION ALONG GIRDER A, B, OR C

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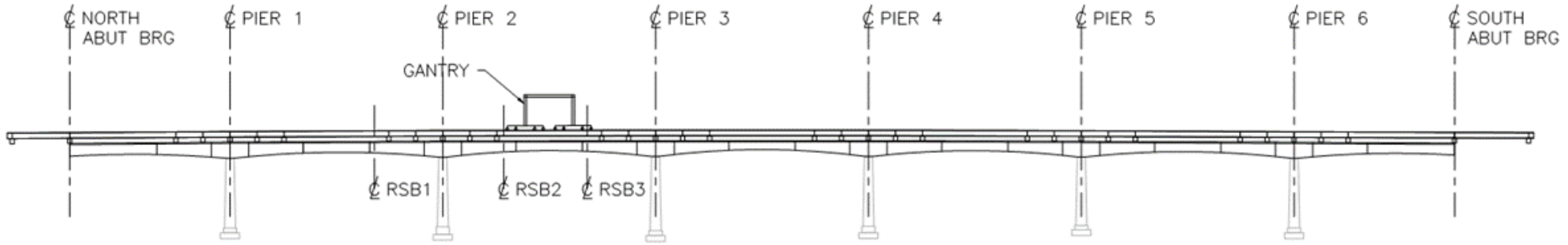
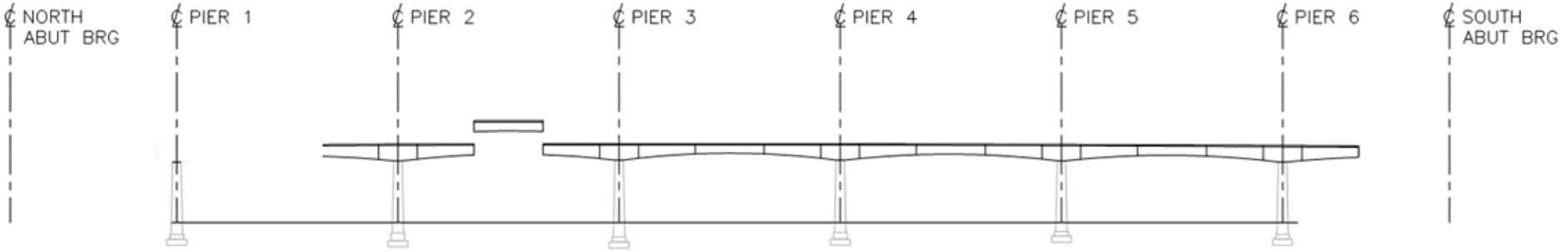
Demolition Scheme – Illustration [6/9]



ELEVATION ALONG GIRDER D



ELEVATION ALONG GIRDER A, B, OR C

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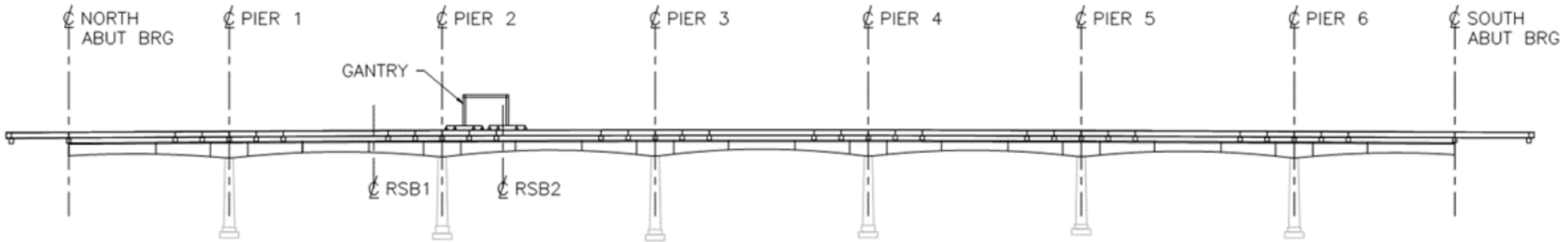
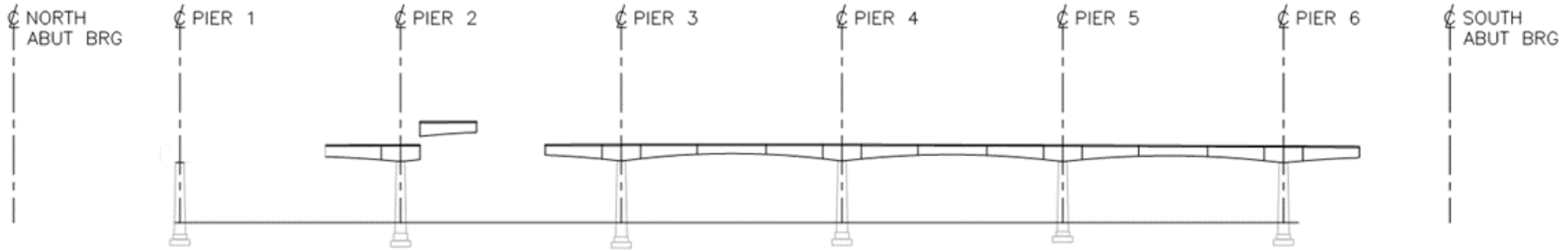
Demolition Scheme – Illustration [7/9]



ELEVATION ALONG GIRDER D



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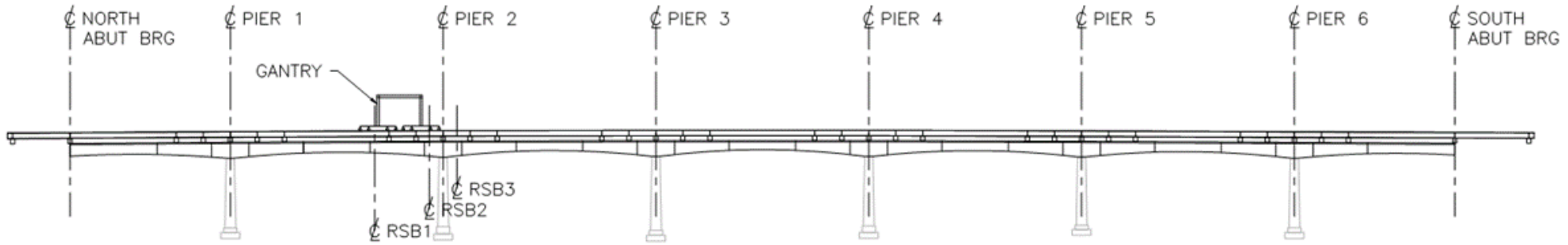
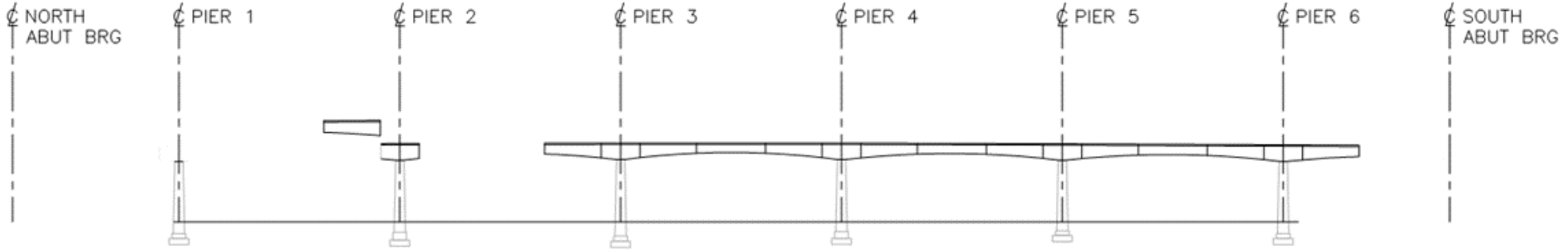
Demolition Scheme – Illustration [8/9]



ELEVATION ALONG GIRDER D



ELEVATION ALONG GIRDER A, B, OR C

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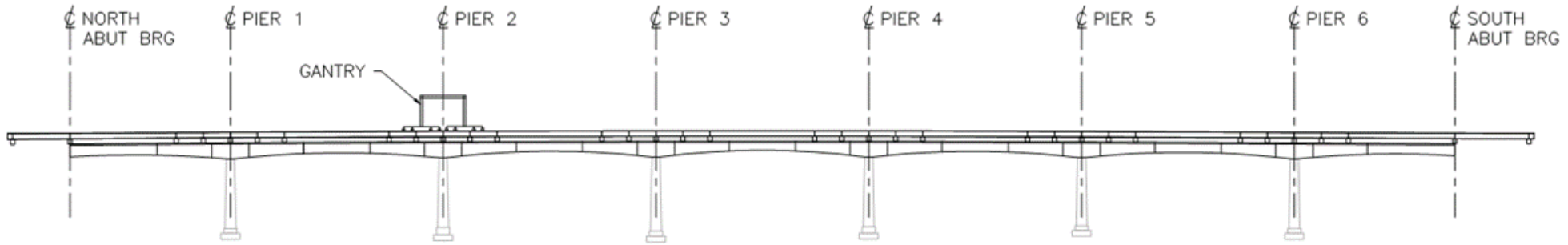
Demolition Scheme – Illustration [9/9]



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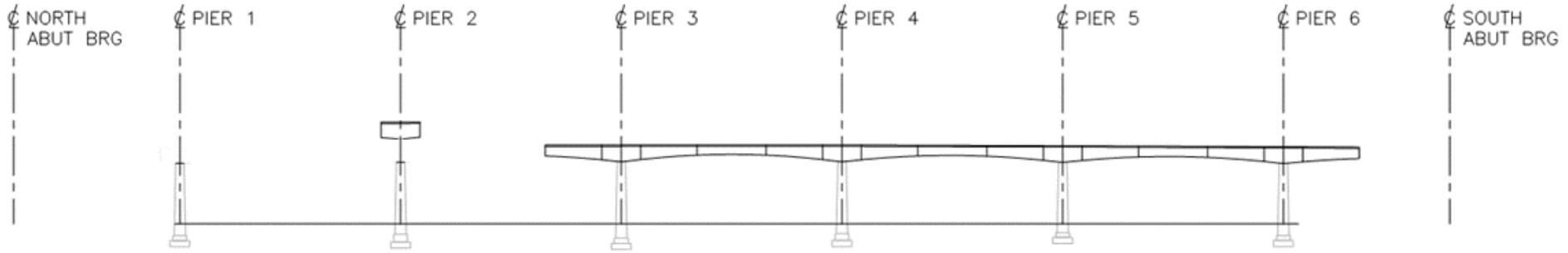

ELEVATION ALONG GIRDER A, B, OR C

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Demolition + Reconstruction

The Fun Never Stops

Supporting unbalanced cantilevers during demolition – the rolling strongback.

Worker and equipment access challenges & solutions.

Installation of new structural steel girders.

Accelerating reconstruction activities with the help of a sky hook – every erector's dream...

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Demolition: Deck

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Demolition: Deck

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Demolition: Deck

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Demolition: Deck

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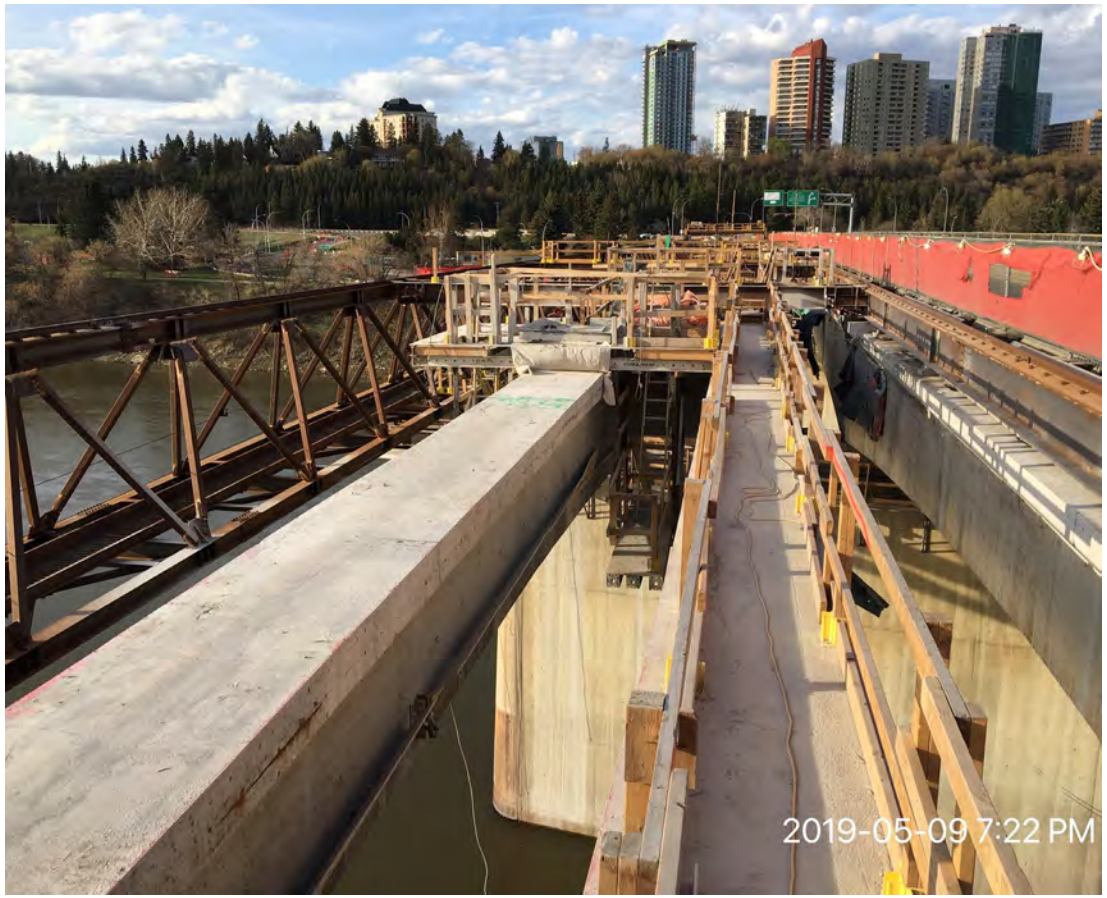
Demolition: Girders



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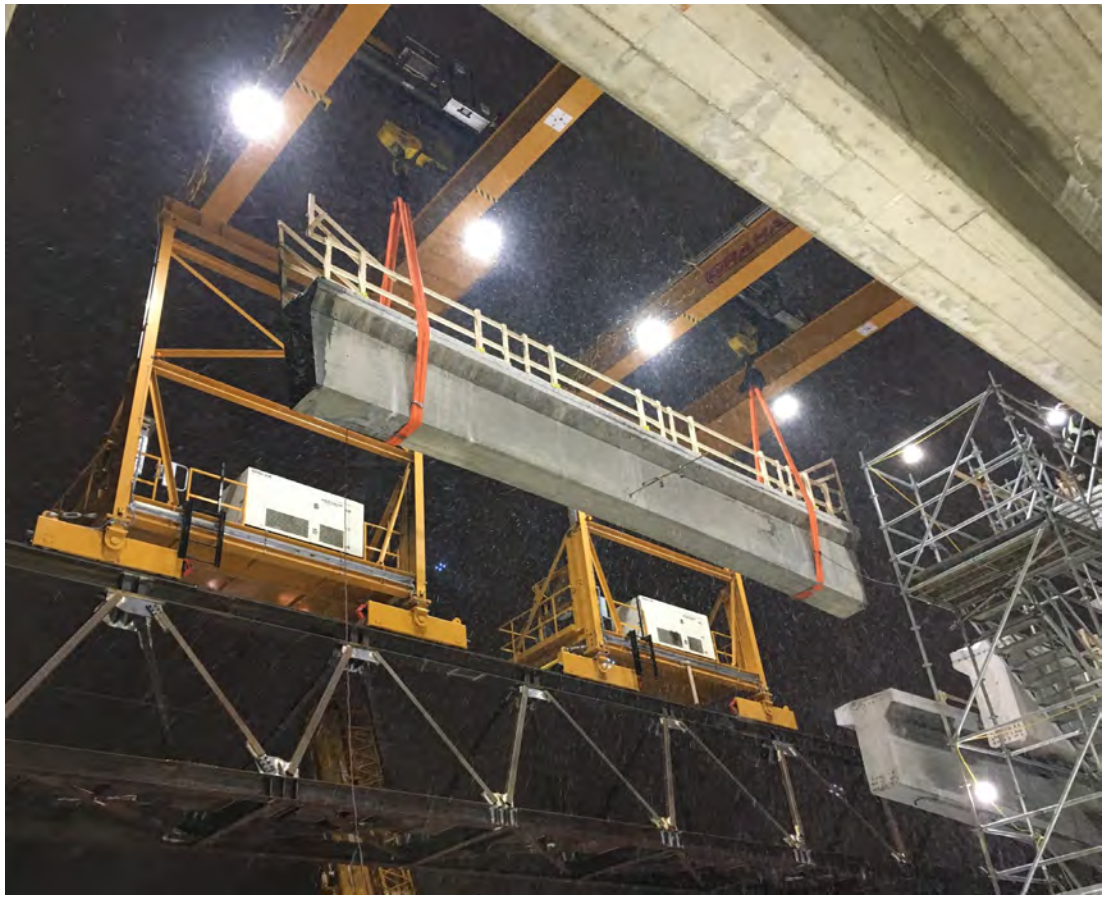
Demolition: Girders



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Demolition: Rolling Strongbacks

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Demolition: Rolling Strongbacks

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Demolition: Process Yard

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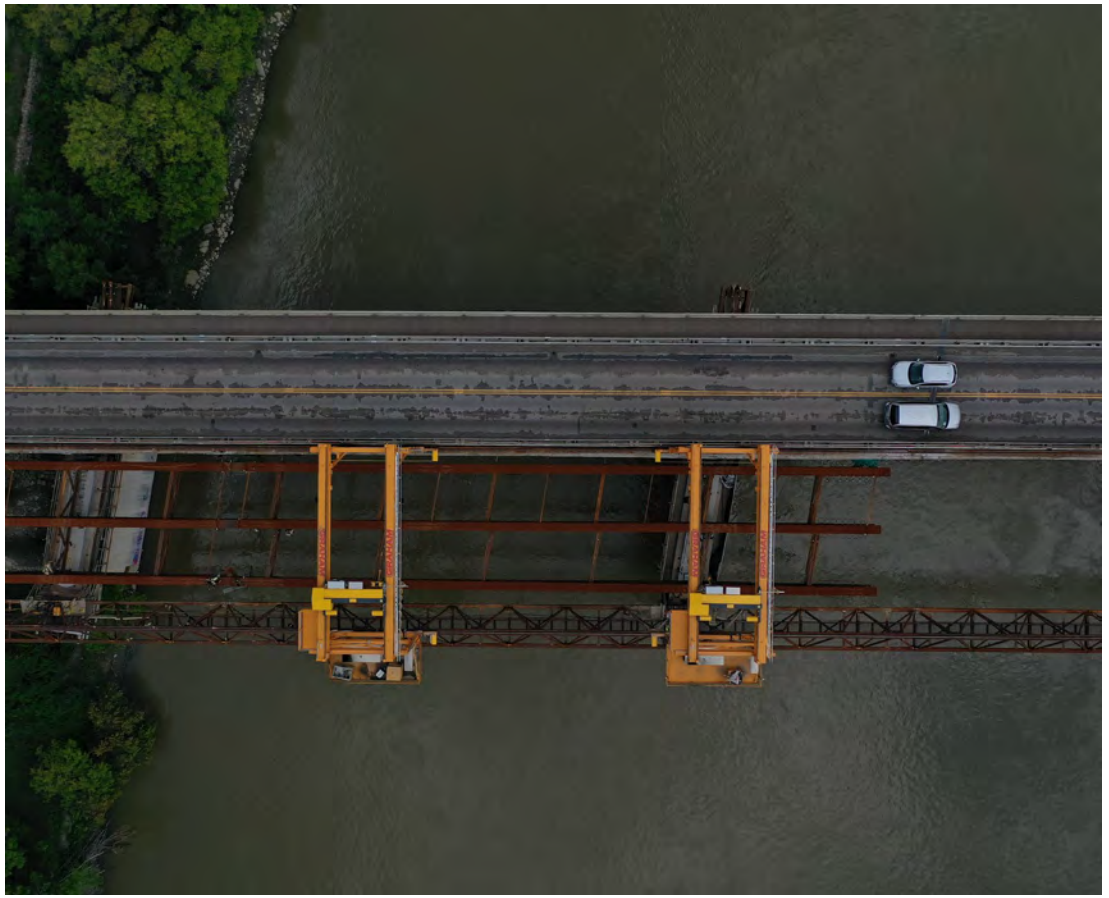
Reconstruction: Steel Erection



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Reconstruction: Steel Erection

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Reconstruction: Steel Erection

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Reconstruction: Deck

Reconstruction: Phase 2

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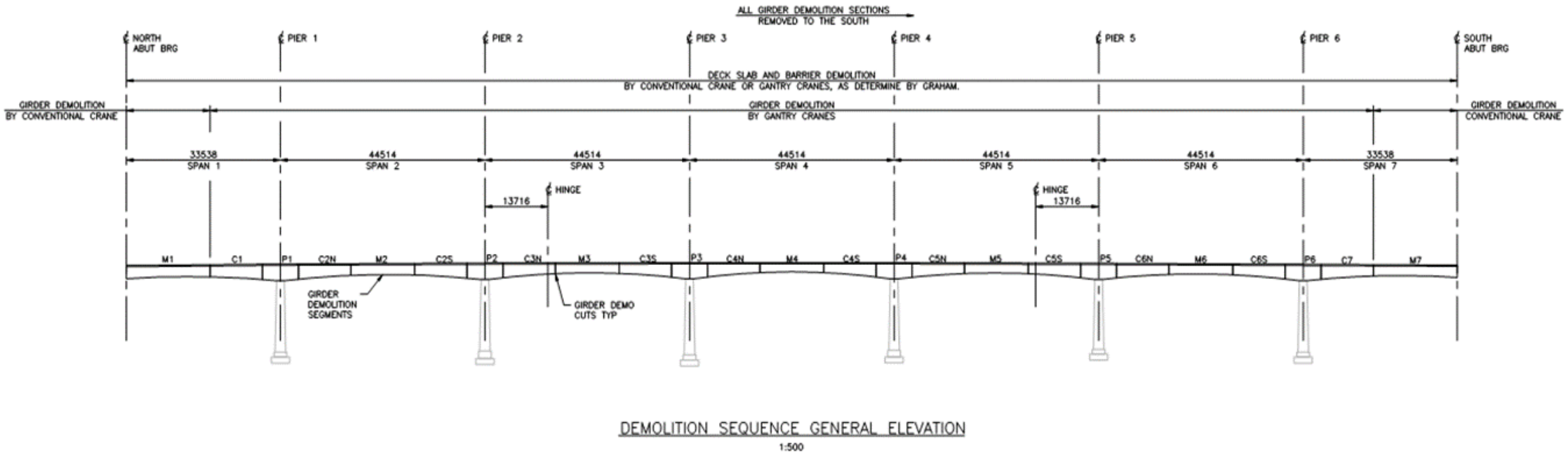
Construction Loads & Structural Challenges

Construction Loads



DEMOLITION SEQUENCE GENERAL ELEVATION

1:500

Construction loads analyzed for all lifting operations in order to design system appropriately.

Demolition – Loads ranged from 60 tonnes (mid-spans) to 80 tonnes (pier sections).

Reconstruction - Loads generally in the range of 65 tonnes (for preassembled twin girder lines).

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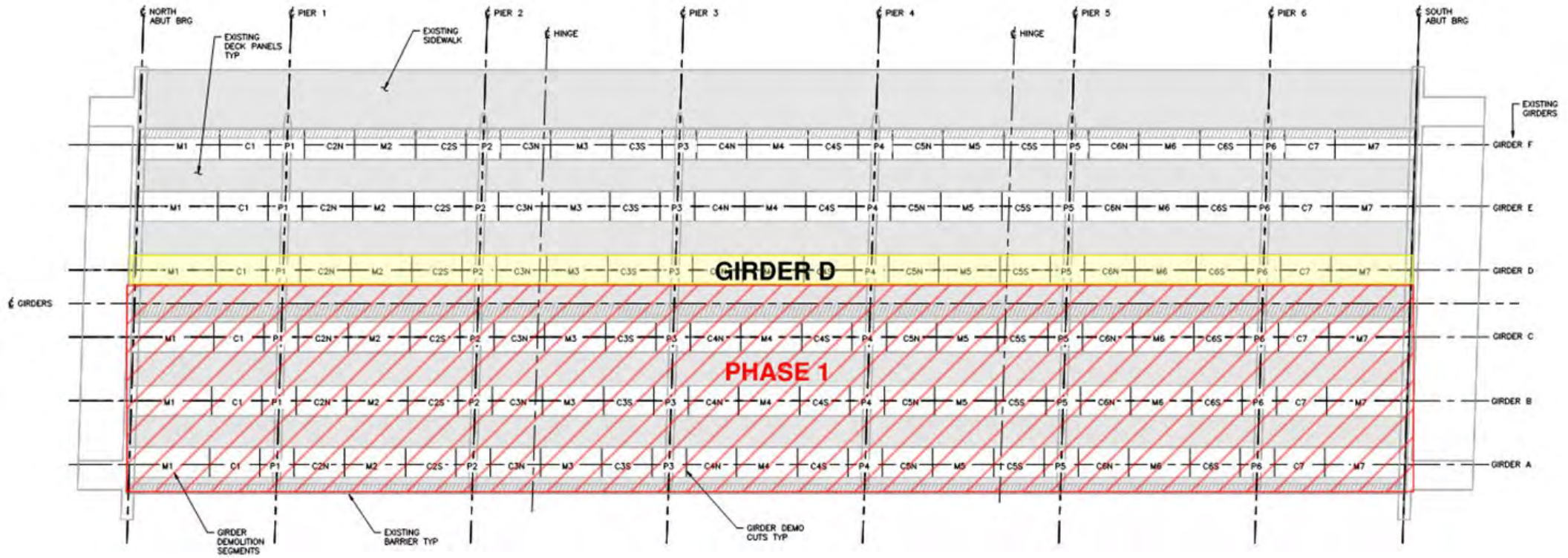
Structural Challenges



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Structural Challenges

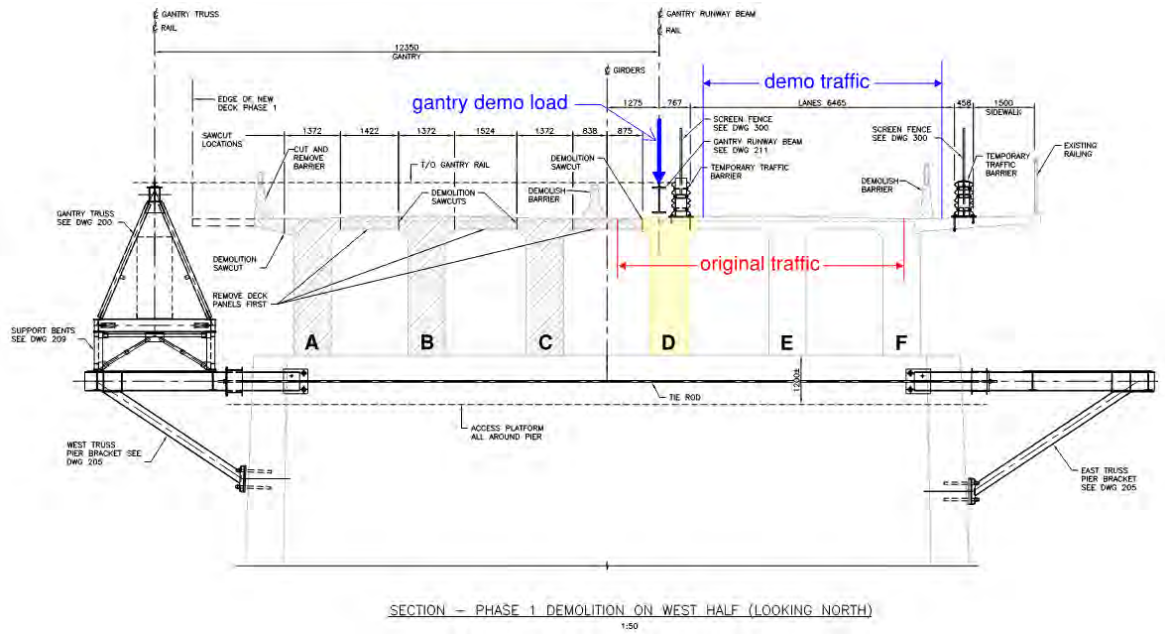
Key Structural Challenges

Runway Beam supported on existing structure (Girder D), designed to old standards.

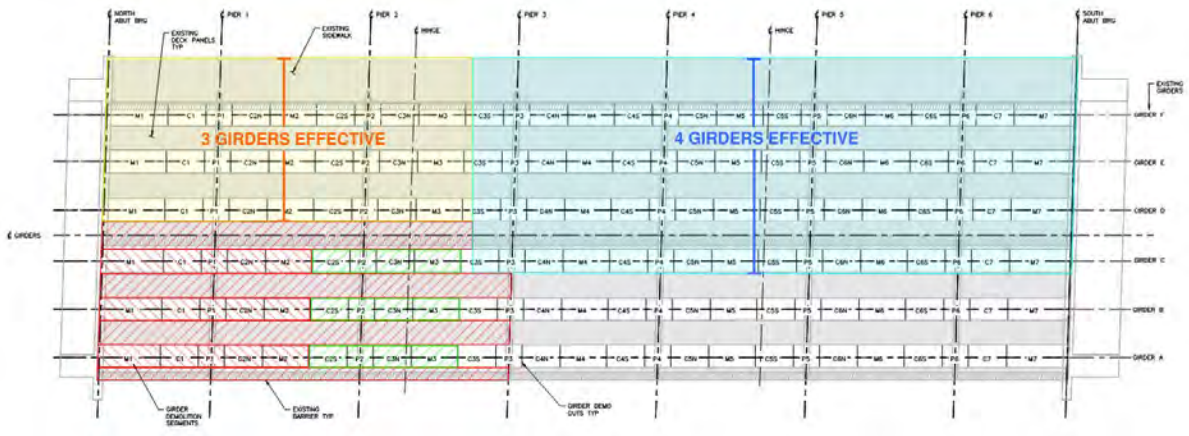
Minimum shear steel requirements differ greatly today, and engineering judgement required.

Demolition traffic shifted off of Girder D, which supports the Gantry demolition loads.

Balancing act of girder segment removal.



Structural Challenges



Key Structural Challenges

3-D analysis model required considering staged demolition of girders.
3 or 4 existing girders considered effective depending on demolition stage.
Deck panels removed from any given span by gantry crane before girder segment removal.
Deviations from current code ≠ unsafe.

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Outcome and Lessons Learned

Project Outcome

Project Delivered Successfully

Completed on time and on budget.
Minimal environmental impact.
Accommodation of traffic throughout construction.
City's ambitious schedule achieved – risk of external environmental constraints mitigated!

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Lessons Learned

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Lessons Learned for Continuous Improvement

Construction tolerances for installation.
Conservatism re: existing condition of structure.
Importance of a formal temporary works program.
Communication of plans for field execution.
Access for workers, materials, and equipment.
Management of cutting fluids and debris.
Logistical challenges with material offtake.
Importance of innovation in industry.

Contact Details

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