CASE STUDY: DECK REPLACEMENT OF THE CHESAPEAKE BAY BRIDGE

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2016 Project Management Symposium

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Case Study

This project involved the repair of a complex structural system on Maryland's Iconic Bay Bridge.

The Deck Replacement of the Westbound Through Cantilever Truss Span (Through Truss) portion of the Chesapeake Bay Bridge Project involved removal of the original cast-in-place concrete decking and replacing it with precast concrete sections, integrally cast with guardrail.

The existing structural steel stringers in the Through Truss were to remain in place and support the new precast concrete decking.

Case Study

A survey performed by the Contractor of the existing structural steel stringers in the Through Truss resulted in the submittal of numerous change orders by the Contractor alleging a differing site condition that would require a significant redesign effort. The damages alleged by the Contractor exceeded the original contract value.

What happened, why and who was responsible…the rest of the story!

- OVERVIEW
- THE PROJECT
- CONTRACT PROCUREMENT
- CONTRACT SPECIAL PROVISIONS
- PERFORMANCE OF CONTRACTOR
- MDTA'S INVESTIGATION

OVERVIEW

Project Overview

- The 3 Components
  - Redeck Suspension Span
  - Redeck Through Cantilever Truss Span (Through Truss)
  - Miscellaneous Structural Repairs

Project Overview

- The 3 Components
  - Redeck Suspension Span
  - Redeck Through Cantilever Truss Span (Through Truss)
  - Miscellaneous Structural Repairs

This Case Study Focuses on Redecking of Through Truss

Project Overview

- Through Truss Deck Replacement
  - Need: to replace failing deck on large bridge over water
  - Problem: can only close bridge for construction overnight.
  - Solution: pre-stressed concrete planks – drop-in at night – open bridge in a.m.


Link-Belt

The Scope

- Leave existing structural steel stringers in-place
- Cut-out cast-in-place concrete deck
- Drop-in precast deck sections
- Open for traffic in a.m.

The Scope

Contractor required to survey existing stringers

Produce shop drawings

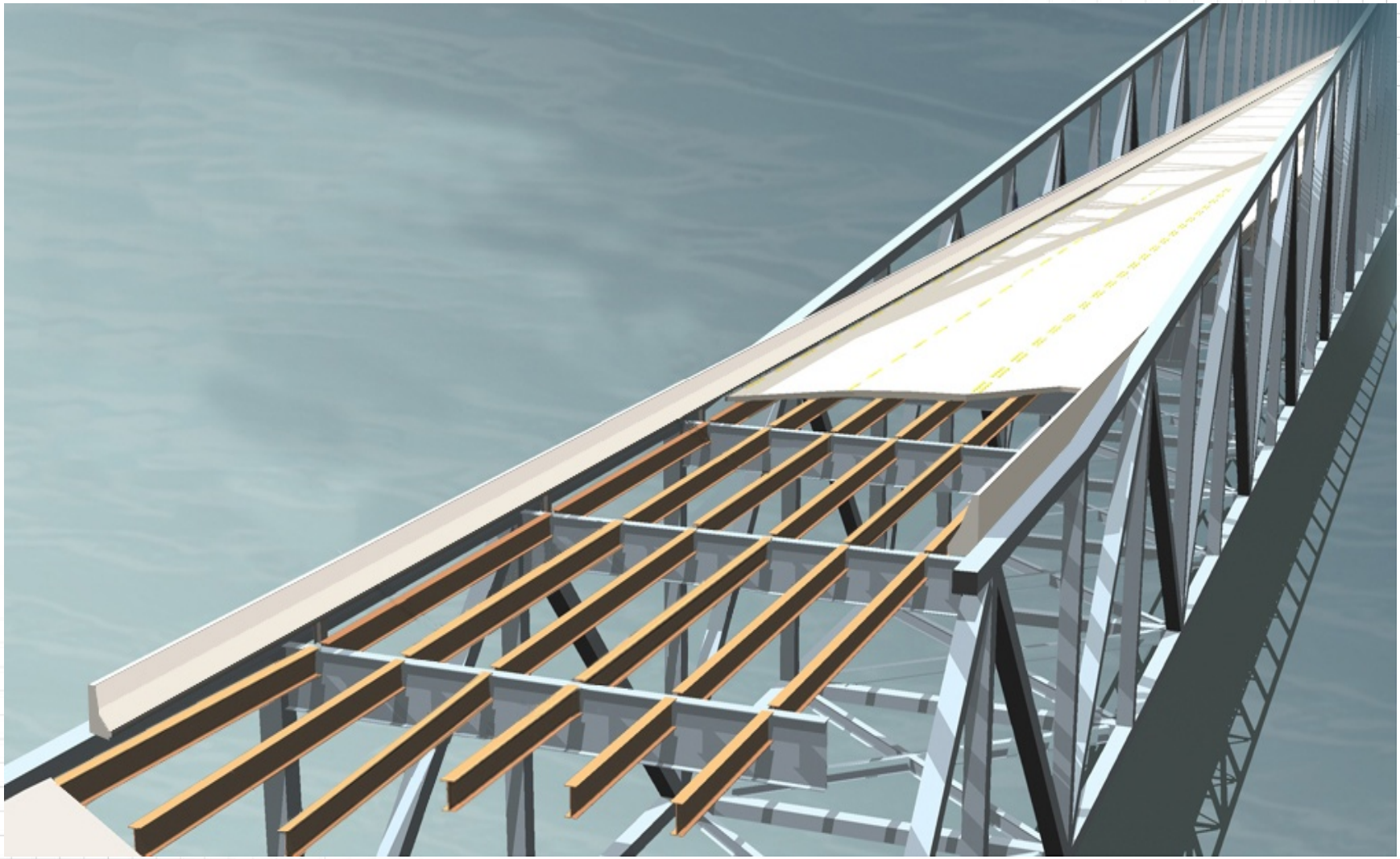
Fabricate panels

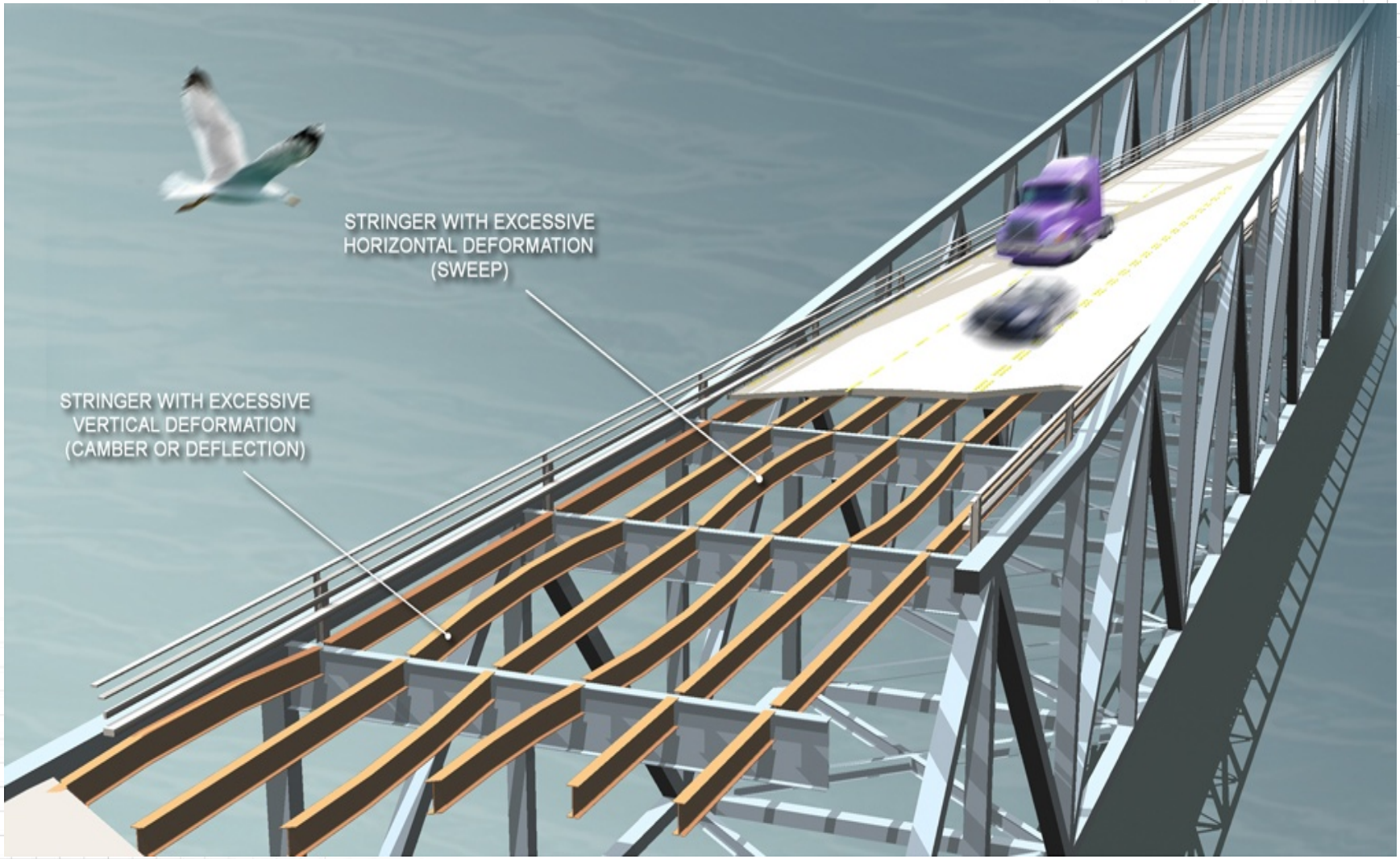
Install

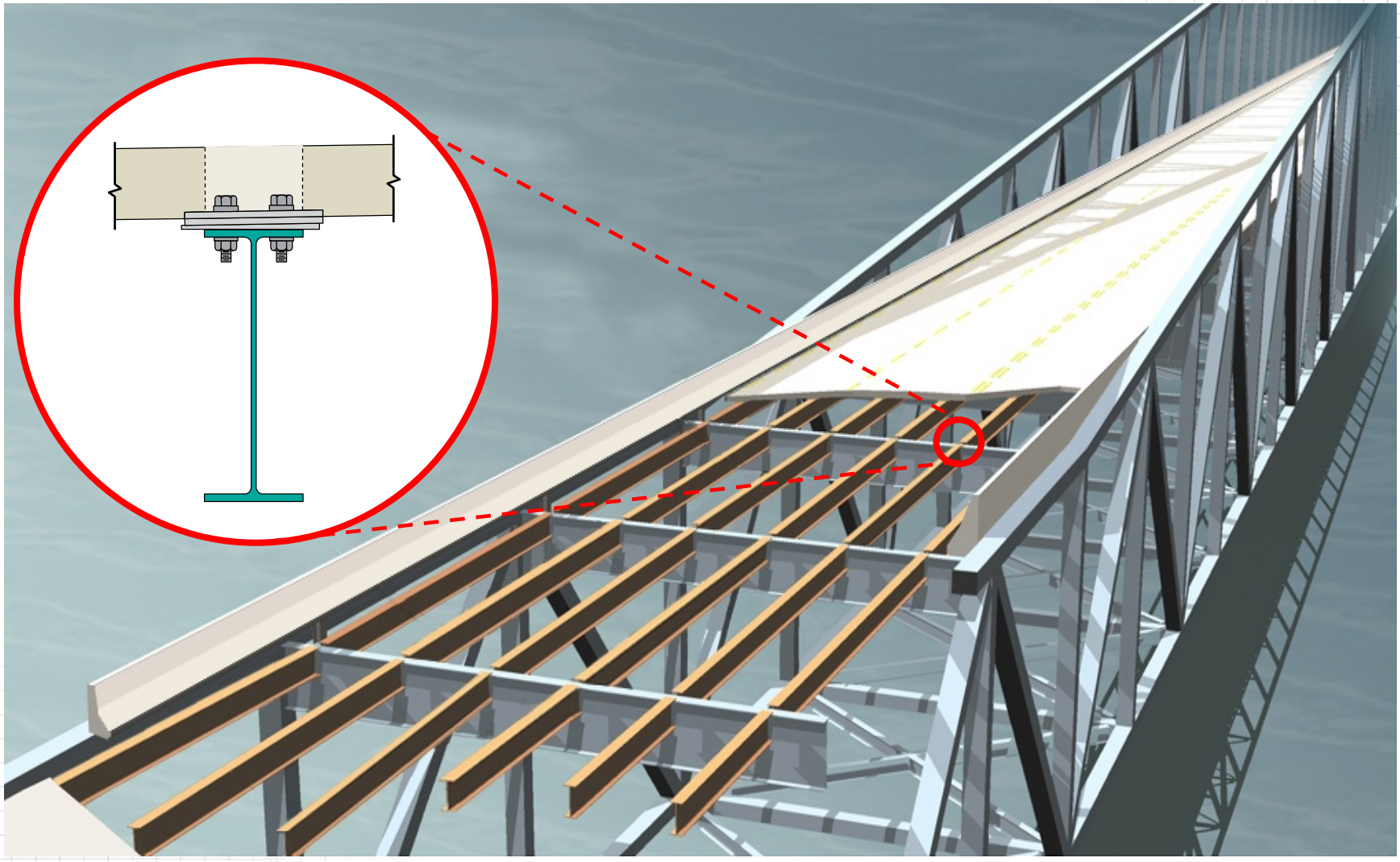
The Problem

- Contractor says stringers are not straight vertically or horizontally

- Contractor alleges Differing Site Condition




STRINGER WITH EXCESSIVE
HORIZONTAL DEFORMATION
(SWEEP)
STRINGER WITH EXCESSIVE
VERTICAL DEFORMATION
(CAMBER OR DEFLECTION)



The Solution

- Work collaboratively to design a fix

The Outcome

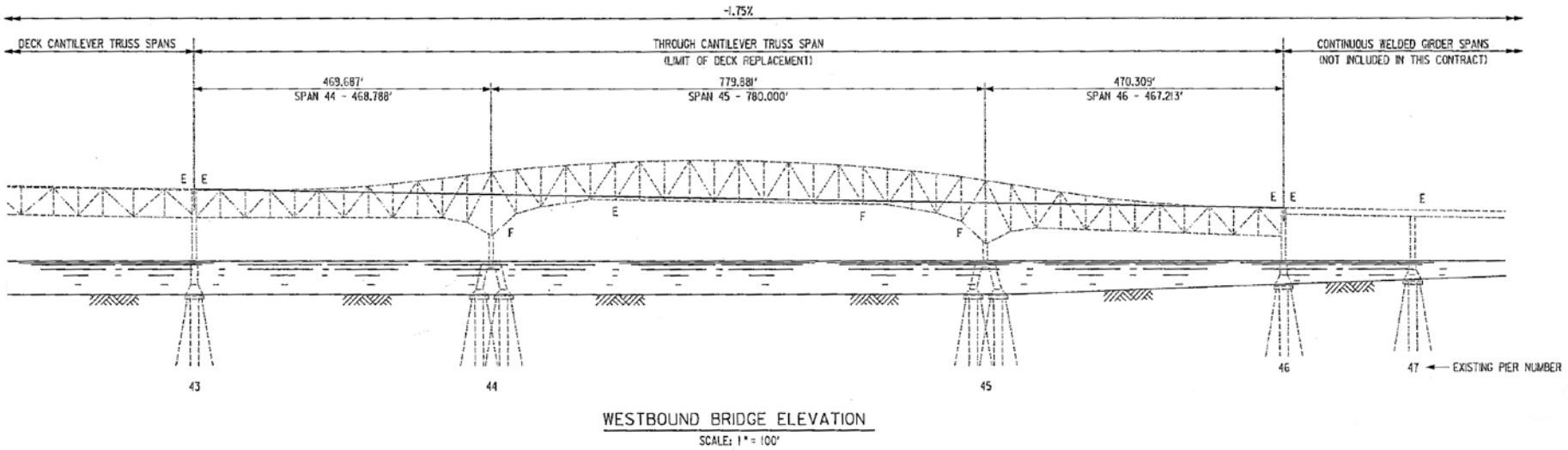
- Owner and Contractor agree to collaborate
- Redesign takes over one year
- Project finishes almost 2 years late
- Contractor submits **$59 million claim**
- Owner hires expert to investigate

THE PROJECT

Major Players

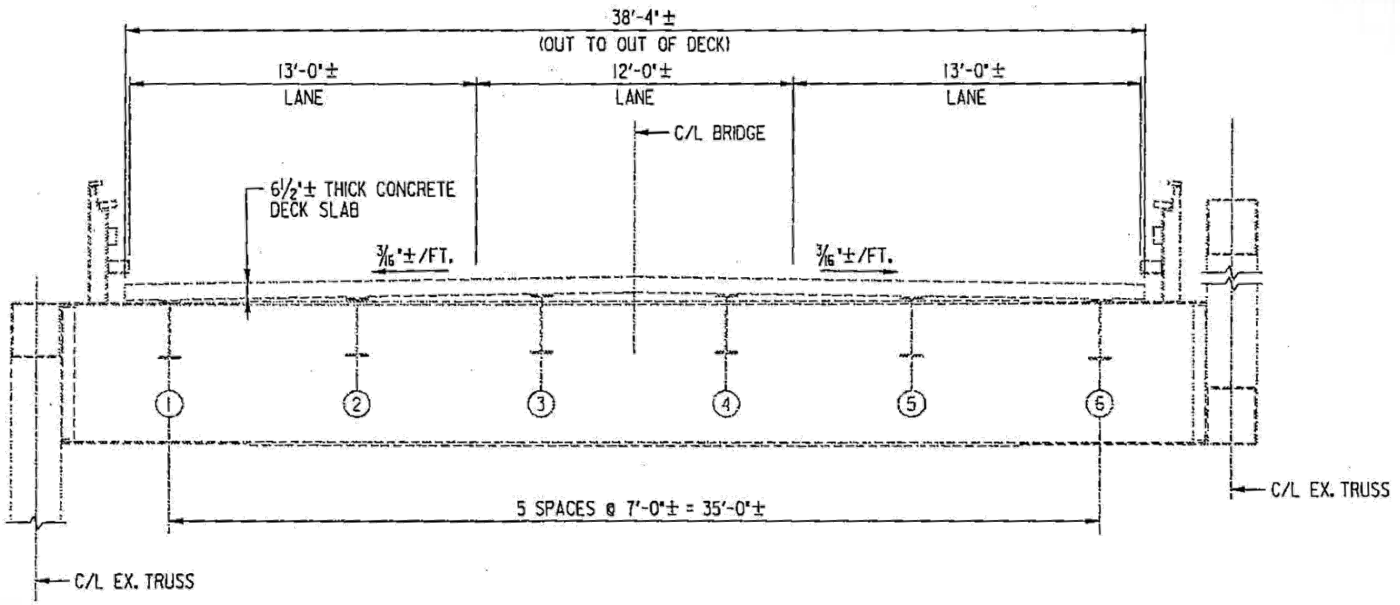
- Owner: Maryland Transportation Authority (MdTA)
- Owner's Design Firm: URS, Inc.
- Contractor: Atlantic Bridge (AB)
- Contractor's First Surveyor: Ali Bi Surveying
- Contractor's Second Surveyor: Reliable Surveying

Elevation of Westbound Bridge



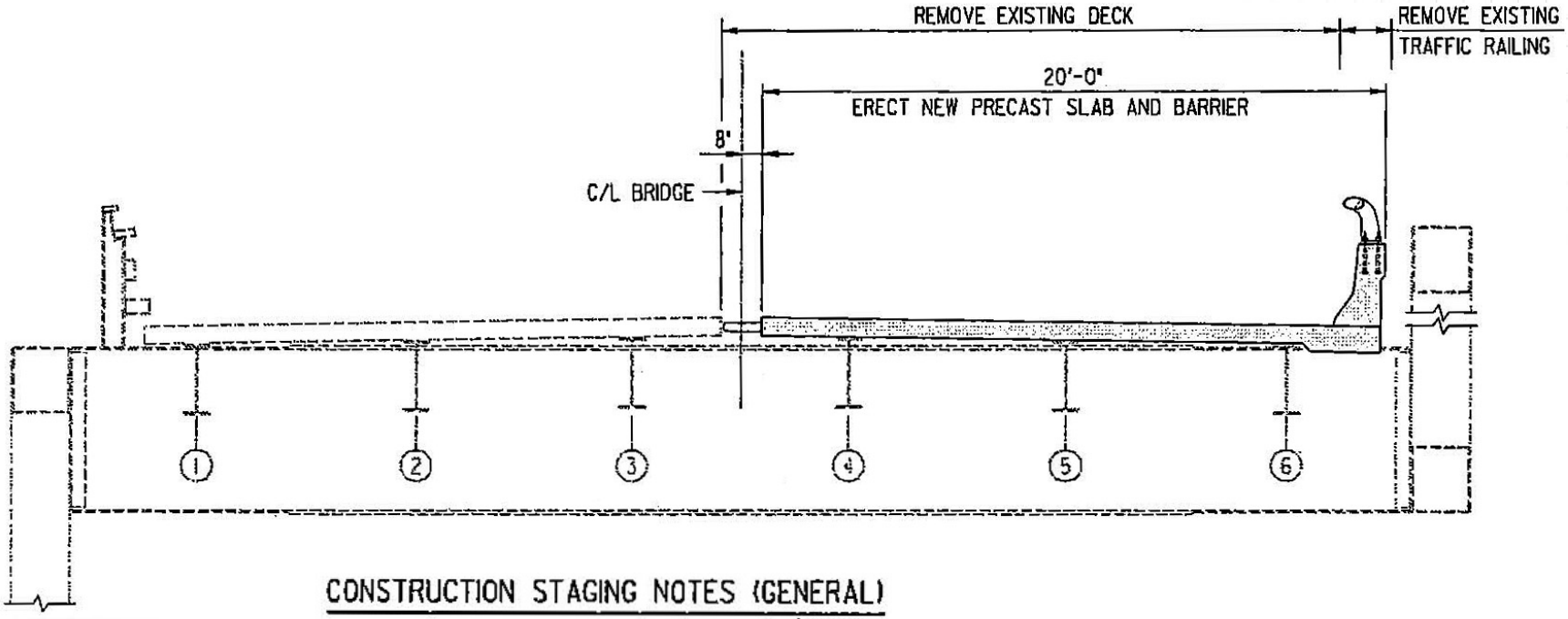
WESTBOUND BRIDGE ELEVATION
SCALE: 1" = 100'

Existing Typical Section



EXISTING TYPICAL SECTION
SCALE: 1/4" = 1'-0"

Phase 1

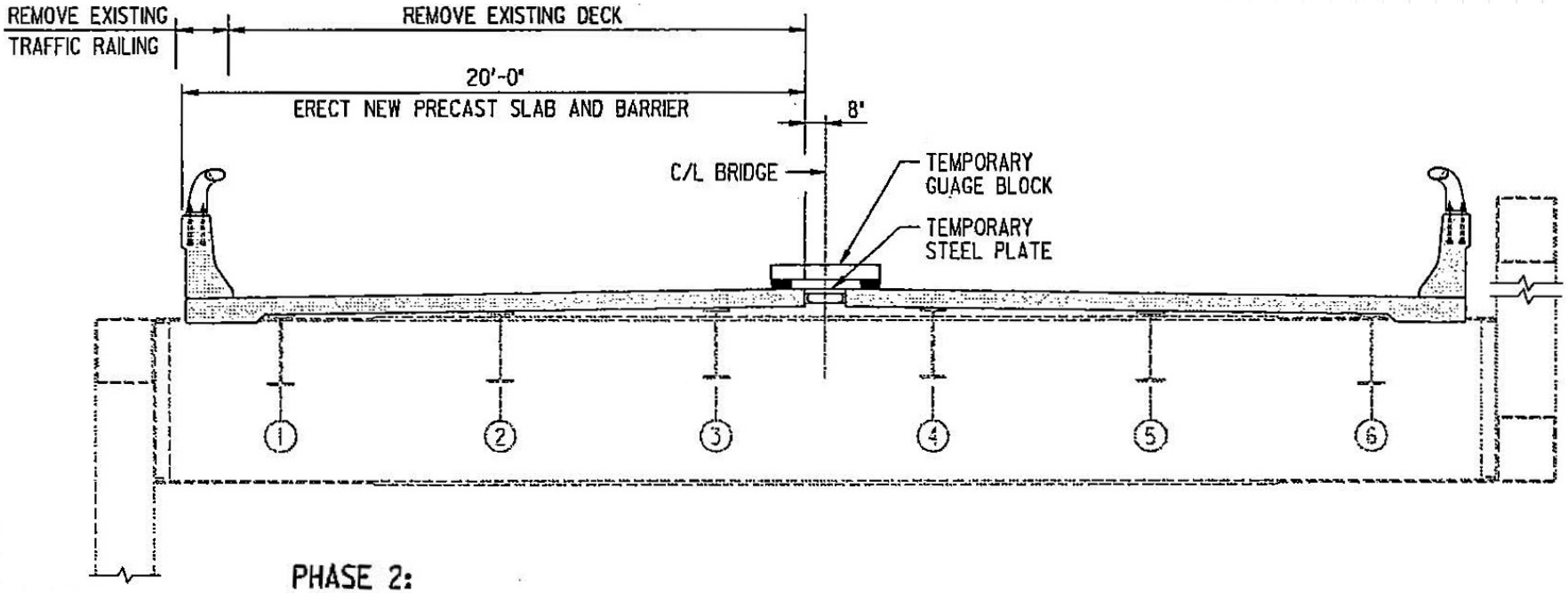


CONSTRUCTION STAGING NOTES (GENERAL)

PHASE I:

REMOVE REQUIRED SOUTH PORTION OF EXISTING DECK AND TRAFFIC RAILING. PLACE SOUTH PRECAST SLAB(S). COUPLE POST-TENSIONING BARS AND STRESS BARS TO REQUIRED LOAD. BOLT PRECAST SLABS TO EXISTING STRINGERS AND FILL BLOCKOUTS AND FLOOR BEAM/ STRINGER HAUNCH.

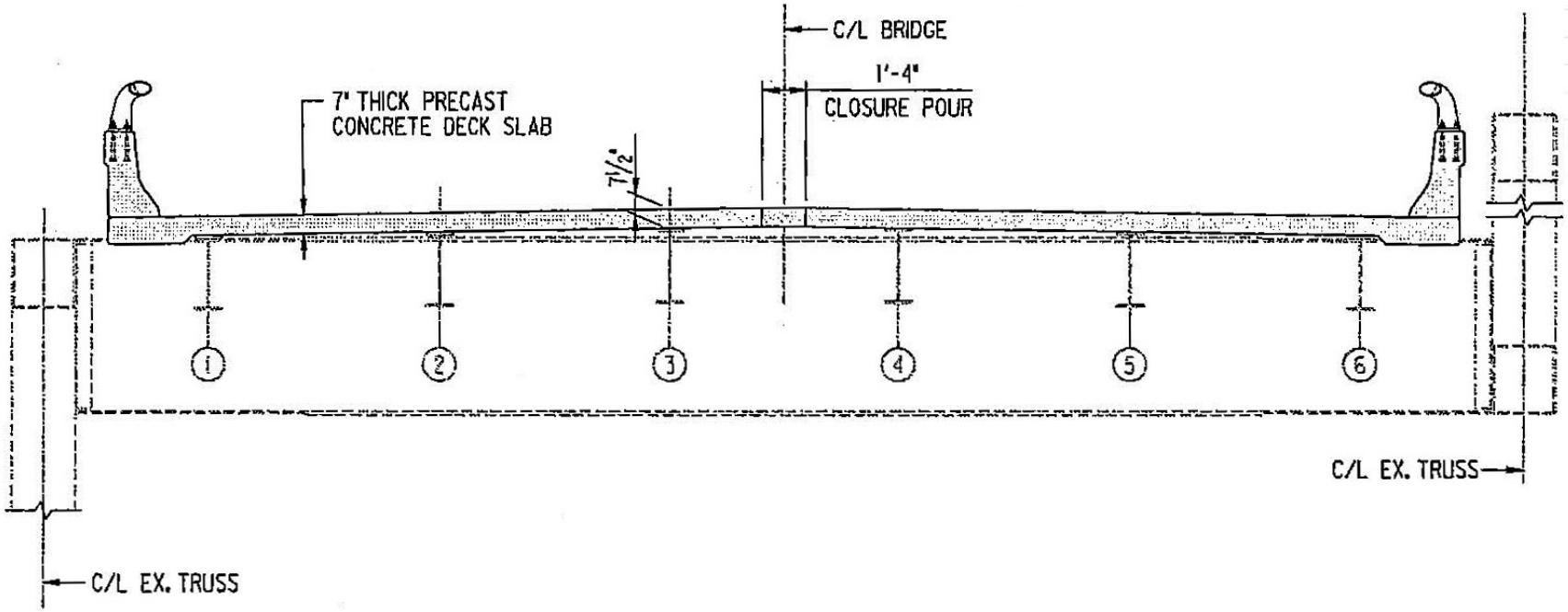
Phase 2



PHASE 2:

REMOVE REQUIRED NORTH PORTION OF EXISTING DECK AND TRAFFIC RAILING. PLACE NORTH PRECAST SLAB(S). COUPLE POST-TENSIONING BARS AND STRESS BARS TO REQUIRED LOAD. BOLT PRECAST SLABS TO EXISTING STRINGERS AND FILL BLOCKOUTS AND FLOOR BEAM/ STRINGER HAUNCH. INSTALL STEEL PLATE IN TRANSVERSE AND LONGITUDINAL OPENINGS. OPEN BRIDGE FOR THREE (3) LANES OF TRAFFIC (FOLLOWING MORNING).

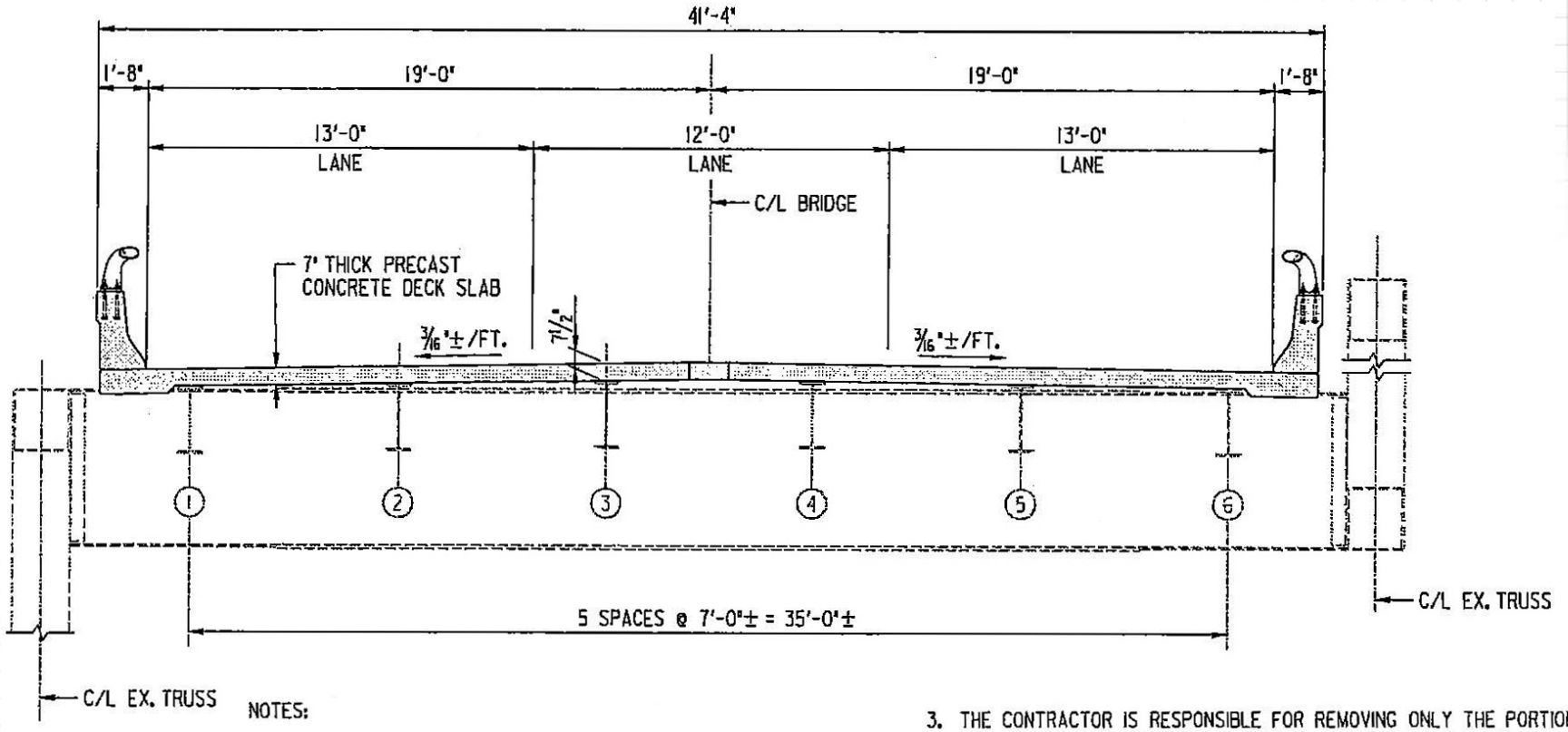
Phase 3



PHASE 3:

INSTALL AND STRESS STRAND TENDONS. GROUT ALL POST-TENSIONING DUCTS. CONSTRUCT CLOSURE POURS. CONTINUE OPERATION UNTIL REPLACEMENT OF PRECAST SLABS FOR THE THROUGH TRUSS SPANS IS COMPLETE.

Proposed Typical Section



NOTES:

1. THE CONTRACTOR HAS THE OPTION OF PLACING THE NORTH PRECAST SLABS PRIOR TO THE SOUTH PRECAST SLABS, RATHER THAN THE ORDER SHOWN.
2. THE PRECAST SLABS SHALL BE MATCH CAST.
3. THE CONTRACTOR IS RESPONSIBLE FOR REMOVING ONLY THE PORTIONS OF THE EXISTING STRUCTURE THAT CAN BE INSTALLED IN THEIR ENTIRETY IN ONE NIGHT.
4. PROVIDE TEMPORARY GAUGE BLOCKS DURING ERECTION OF THE PRECAST SLABS IN ORDER TO MAINTAIN HORIZONTAL ALIGNMENT. EXPOSED GAUGE BLOCKS SHALL BE REMOVED PRIOR TO OPENING THE BRIDGE TO TRAFFIC.

CONTRACT PROCUREMENT

Contract Procurement

- Request for Proposal (RFP) Process
  - Not a Low Bid!

- See Contract Special Provisions

Contract Special Provisions

- Key Provision
  - GP 2.04 Site Investigation

GP 2.04 Site Investigation

c) All dimensions affected by the geometrics and/or location of the existing structure shall be measured in the field by the Contractor and submitted to the Engineer for verification. All field measurements shall be verified before any construction or casting of precast units or slabs is done, and before any reinforcing steel, etc. is ordered or fabricated. The locations of the existing stringers and flanges is critical for the through truss spans. The ± marks shown with dimensions and stations do not indicate any degree of precision. These marks (±) indicate as-built dimensions and stations that may vary and do require field verification by the Contractor.

GP 2.04 Site Investigation

d) The Contractor shall survey the existing through truss spans for dimensions unrecorded, modifications to the structure, and to determine the relative locations and, elevations of the stringers and floorbeams to determine shop detail dimensions necessary for fabricating the deck panels and all connections. The survey shall be performed by a Registered Land Surveyor. The through truss span survey for elevation shall be performed with no live load traffic on the through truss span. The survey shall include, but not be limited to, the floorbeam elevations at all stringer intersections, the elevations at each end of the stringers, the finished grade elevation of the existing deck, and the positions of the stringer flanges within each bay. A datum shill be provided with the survey. The steel survey shall be submitted with shop drawings. Two such surveys shall be conducted independently, and all discrepancies shall be resolved prior to shop drawing approval and fabricating any materials.

PERFORMANCE OF CONTRACTOR

Scope of AB's Work

- Perform a survey of the existing through truss steel stringers
- Engineer the deck panels - prepare Integrated Shop Drawings for deck panels and all connections
- Manufacture structural precast match-cast concrete deck panels
- Store, transport and erect the deck panels into the structure

Scope of AB's Work

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- Manufacture structural precast match-cast concrete deck panels
- Store, transport and erect the deck panels into the structure

Survey of Existing Steel Stringers

- Construct Survey Pockets
- Conduct field survey of the existing through truss steel

Survey of Existing Steel Stringers

- Construction of Survey Pockets

Survey of Existing Steel Stringers

- What was required
  - Contract Requirements / Special Provisions
    - The contractor was required to perform two independent surveys of the existing through truss span for:
      - dimensions unrecorded
      - modifications to the structure
      - to determine the relative locations and elevations of the stringers and floor beams to determine shop detail dimensions necessary for fabricating the deck panels and all connections.
    - The contractor was to resolve all discrepancies between the two independent surveys prior to preparing integrated shop drawings

Survey of Existing Steel Stringers

- What was required
  - Contract Requirements / Special Provisions
    - The contractor shall submit detailed shop drawings which include but are not necessarily limited to, the following:
      - "Fully integrated drawings showing structural steel, reinforcing steel, post-tensioning hardware, inserts, lifting devices, slab connection plates and other items to be embedded in a segment. The field measurements shall be incorporated into and included with the submittal."

Survey of Existing Steel Stringers

- What was the intent of the survey?
  - To determine the elevation(s) and alignment of the existing stringers and floor beams in order to engineer and fabricate the deck panels.

What did AB plan to do?

- AB's initial As-Built Survey Plan Submittal, May 17, 2006 stated:

2. Intent of the Survey

The overall intent of the survey is to verify the accuracy of the existing as-built drawings with respect to the parts of the structure that is necessary in fabricating and installing the new deck panels. Specifically, the structure will be surveyed for the following information. If any conditions that are not anticipated present themselves during the course of the as-built survey, AB will work with the Authority to develop new procedures to account for any unknowns while meeting the intent of the survey.

- AB misinterpreted the intent.

What did AB plan to do?

- AB's initial As-Built Survey Plan Submittal, May 17, 2006 stated:

Survey Equipment Specifications

Below is the equipment information that we propose to use during the as-built survey. In the interest of speed and efficiency, all work will be attempted with GPS. However, if we believe we are not achieving acceptable accuracy or we are receiving any interference, then conventional methods will be employed. GPS has the ability to allow the survey to take place up to 4 times as fast as total station which will reduce bridge closures. It also allows us to produce the as-built survey faster. We are still in the process of evaluating our options with GPS and will be visiting the bridge during the day before our first closure to better plan its use.

- AB failed to recognize the required survey accuracy.
- AB was focused on speed and efficiency rather than accuracy.

What did AB plan to do?

- AB's initial As-Built Survey Plan Submittal, May 17, 2006 stated:

7. Final Submittal

The final submittal will consist of the following:

1. A new as-built drawing of the location of the floorbeams along the stiffening truss of the Suspension Span.
2. A new as-built drawing of the entire floor beam and stringer system in the Through Truss as well as an as-built contour of the existing road deck.
3. A report evaluating the existing as-built drawing with the as-built survey, showing any differences between the two.
4. A comparison between the two independent surveys.
5. Any additional information discovered while we are on the bridge.

- AB acknowledged the requirement for two independent surveys.

What did AB plan to do?

- AB's revised survey proposal: May 31, 2006

Survey Equipment Specifications

Below is the equipment information that we propose to use during the as-built survey. We do not believe GPS will be usable on the bridge but are keeping in available as an option. We anticipate all work will be done with Total Station. GPS has the ability to allow the survey to take place up to 4 times as fast as total station which will reduce bridge closures. However, structural steel interference is expected.

GPS Equipment:
- Ashtech Z Surveyor, Serial # UZ119991844
- Ashtech Z Surveyor, Serial # UZ120001914
- Ashtech Z Extreme, Serial # ZE120012003

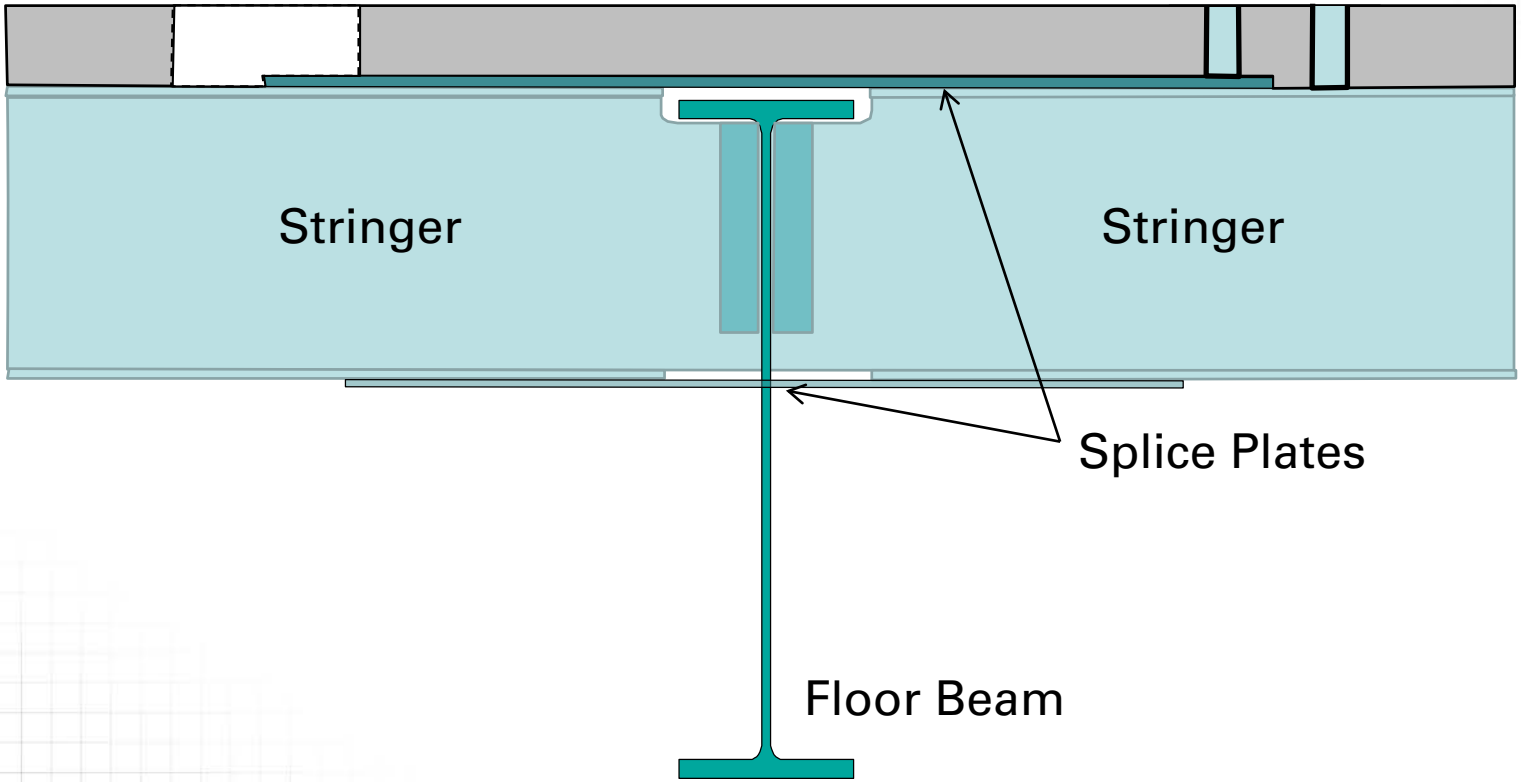
Digital Level
- Topcon Digital DL-101, Serial # HX0374

Total Station
- Topcon GT 3003 LW Reflectorless Total Station, Serial # 4N0128

- AB should have known that GPS was not a viable option.

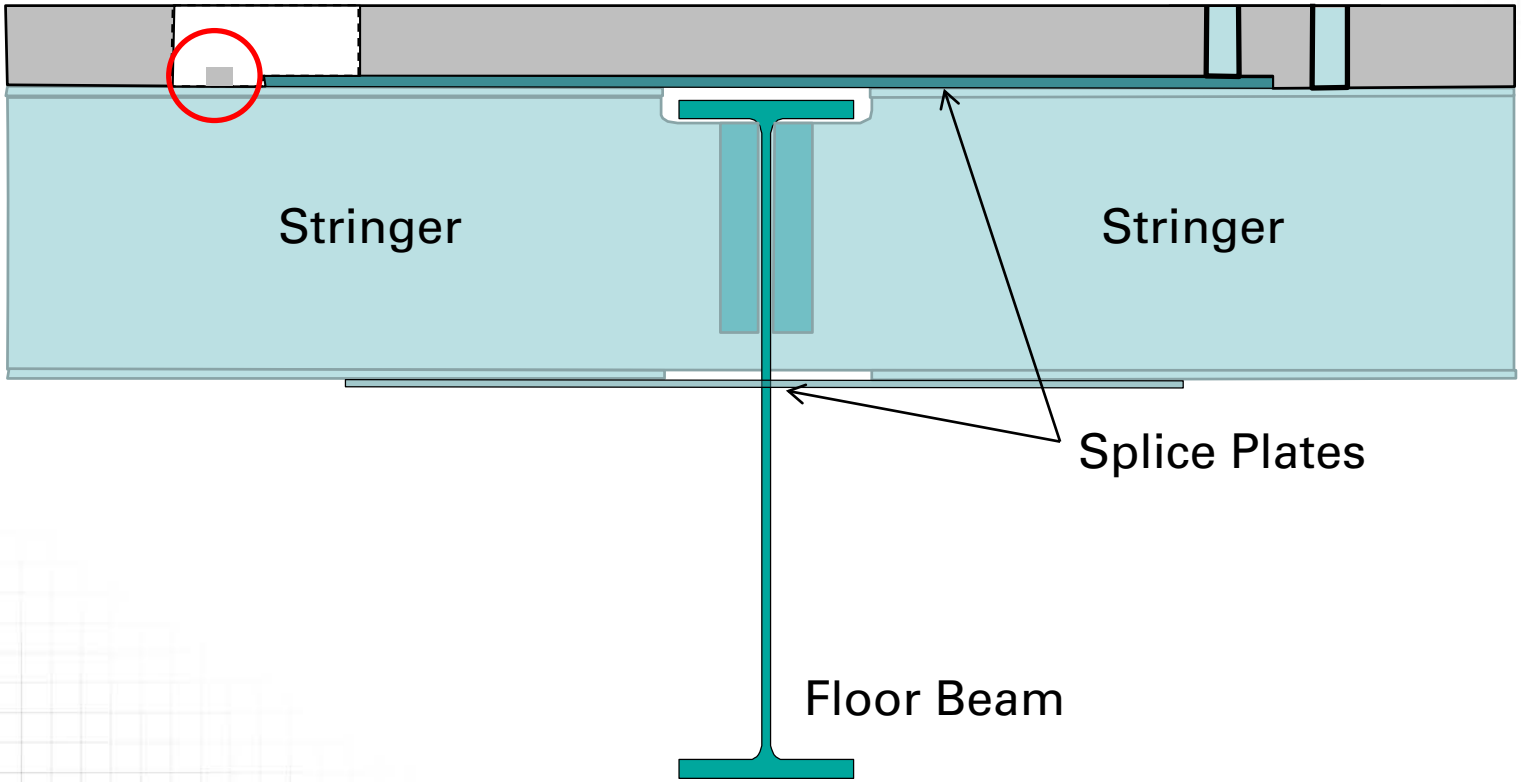
What did AB plan to do?

- Scope of Work - Construction of Survey Pockets



What did AB actually do?

- Survey Pockets Construction **Errors**



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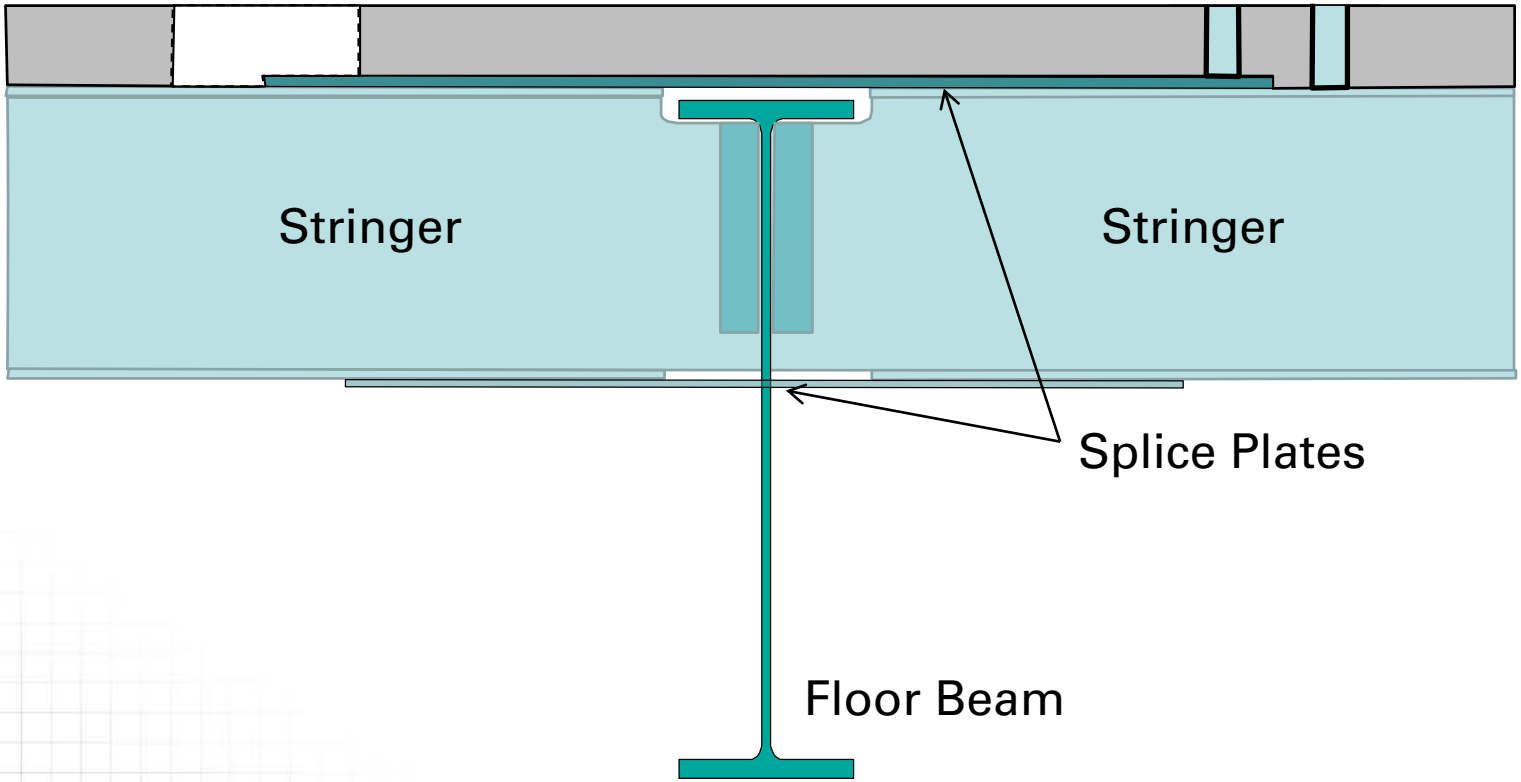

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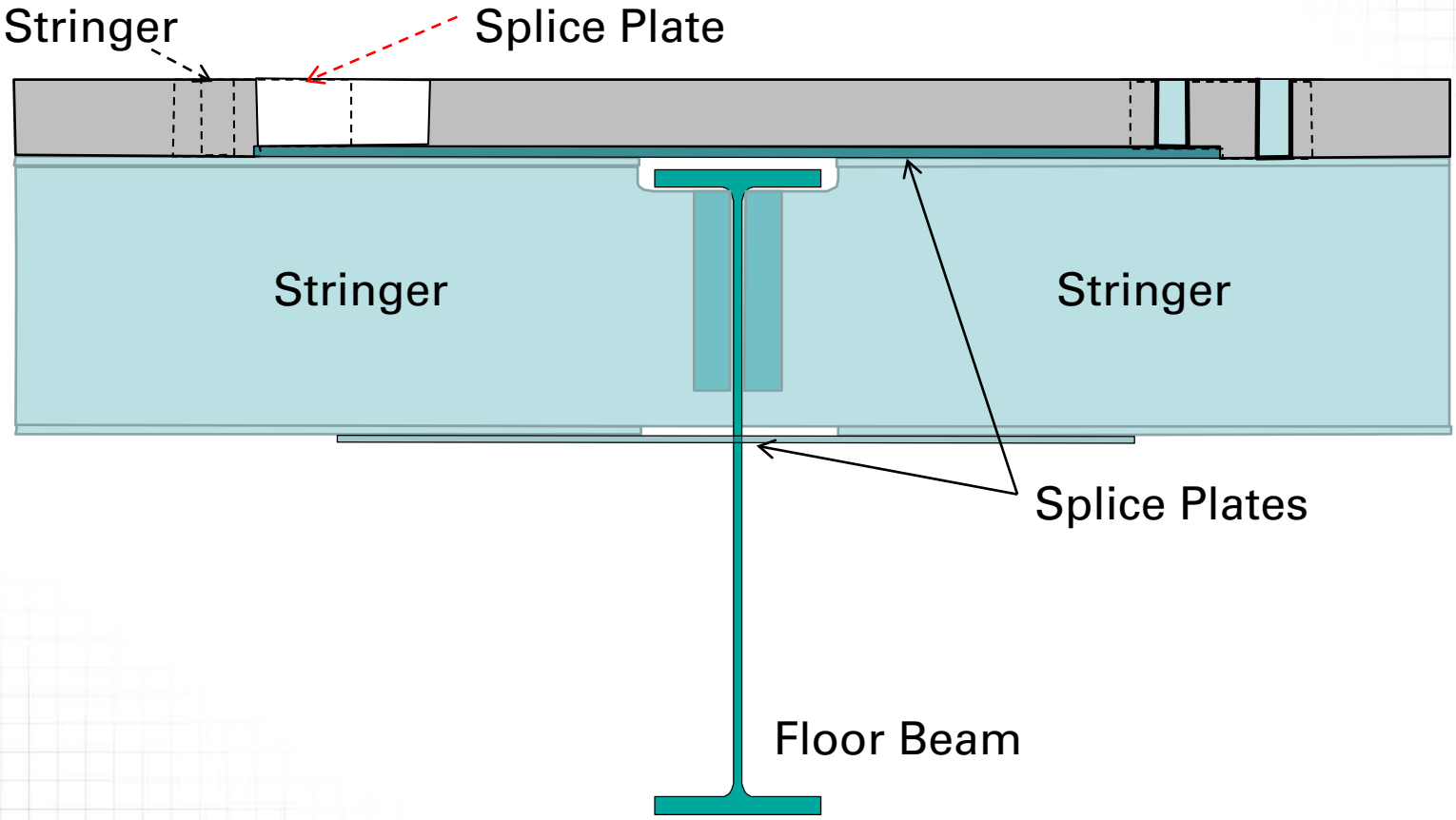


What did AB actually do?

- Horizontal survey
  - Performed with a total station
  - Conducted two surveys
  - Results were averaged together to resolve discrepancies
  - Survey data erroneously created the appearance of significant horizontal sweeps in the stringer system

What did AB actually do?

- Horizontal survey

Survey No.:	1
Unit No.:	10

Stringer No. 6		
Point Number	Centerline Offest (ft)	Convert (in)
60012	-0.0547	-0.66
60011	-0.4720	-5.66
60010	-0.0378	-0.45

Survey No.:	2
Unit No.:	10

Stringer No. 6		
Point Number	Centerline Offest (ft)	Convert (in)
16012	-0.0484	-0.58
16011	-0.0634	-0.76
16010	-0.0393	-0.47

What did AB actually do?

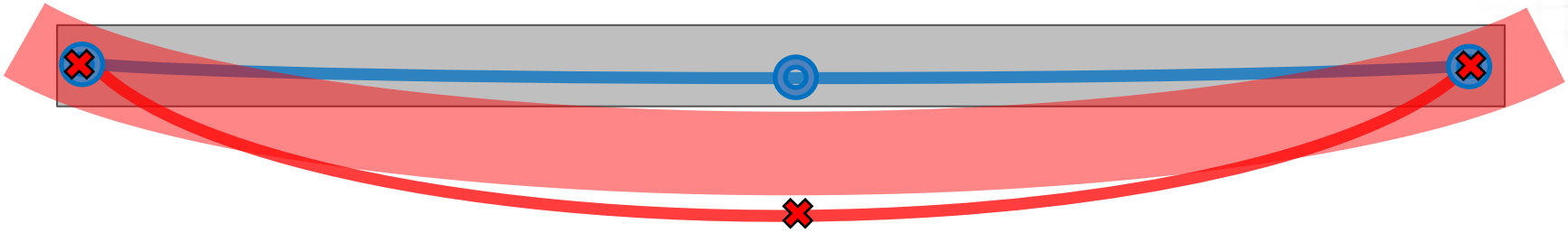
- Horizontal survey

Survey No.:	Average
Unit No.:	10

Stringer No. 6		
Point Number	Centerline Offest (ft)	Convert (in)
	-0.05155	-0.62
	-0.2677	-3.21
	-0.03855	-0.46

What did AB actually do?

- Illustration



What did AB actually do?

- Vertical survey
  - Performed with an Engineer's level
  - Performed only a single survey
    (stated that it performed two)
  - Performed limited "survey checks"
  - Failed to resolve discrepancies from "survey checks"
  - Failed to verify the adequacy of the existing control points
  - Failed to acknowledge significant closure errors
- Survey data created the appearance of significant vertical deformations in the stringer system

What did AB actually do?

- Comparison of AB's Own Vertical Survey Data

Pocket #	Type	Level Check 2	Level Check 1	Initial Survey	Diff	Survey Report
5057	Beam		96.02	96.07	0.05	96.02
1058	Bolt	96.21	96.18	96.14	0.07	96.14
1060	Bolt	96.70	96.68	96.62	0.08	96.70
1080	Beam		100.90	100.85	0.05	100.90
1081	Beam		101.21	101.14	0.06	101.20
1063	Beam	97.36	97.35	97.30	0.06	97.30
6075	Bolt		100.06	100.01	0.05	100.01
6075	Beam		100.01	99.96	0.05	99.96

What did AB actually do?

- Problems with AB's initial survey
  - Survey Pocket Construction Errors:
    - Pockets constructed over splice plates
    - Pockets partially filled with concrete
    - Pockets installed at an angle (not plumb)
  - Survey Errors:
    - Control network
    - Backsights
    - Averaging of horizontal data
    - Failed to perform two vertical surveys

What did AB actually do?

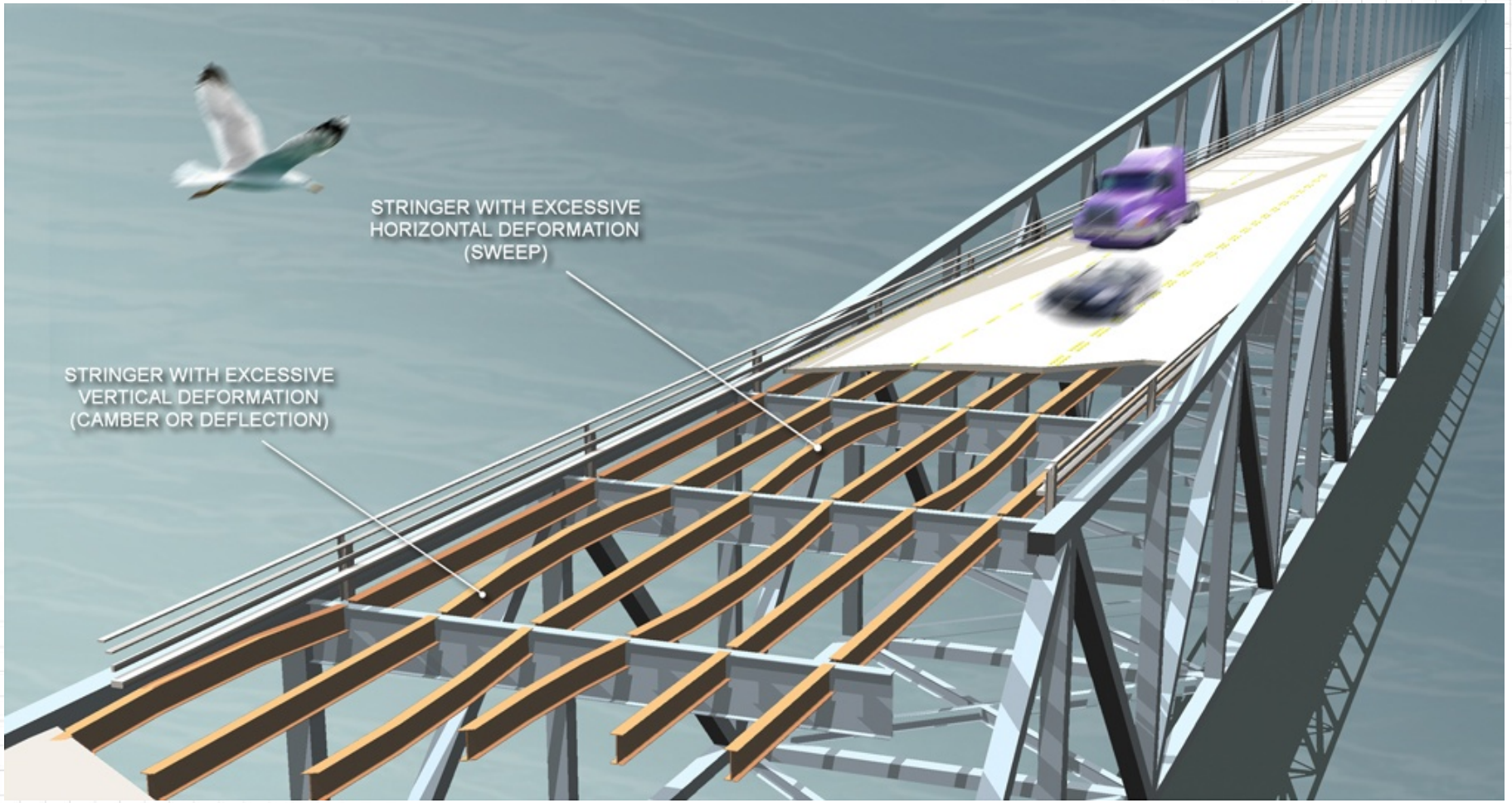
- What AB stated in its survey submittal to MdTA

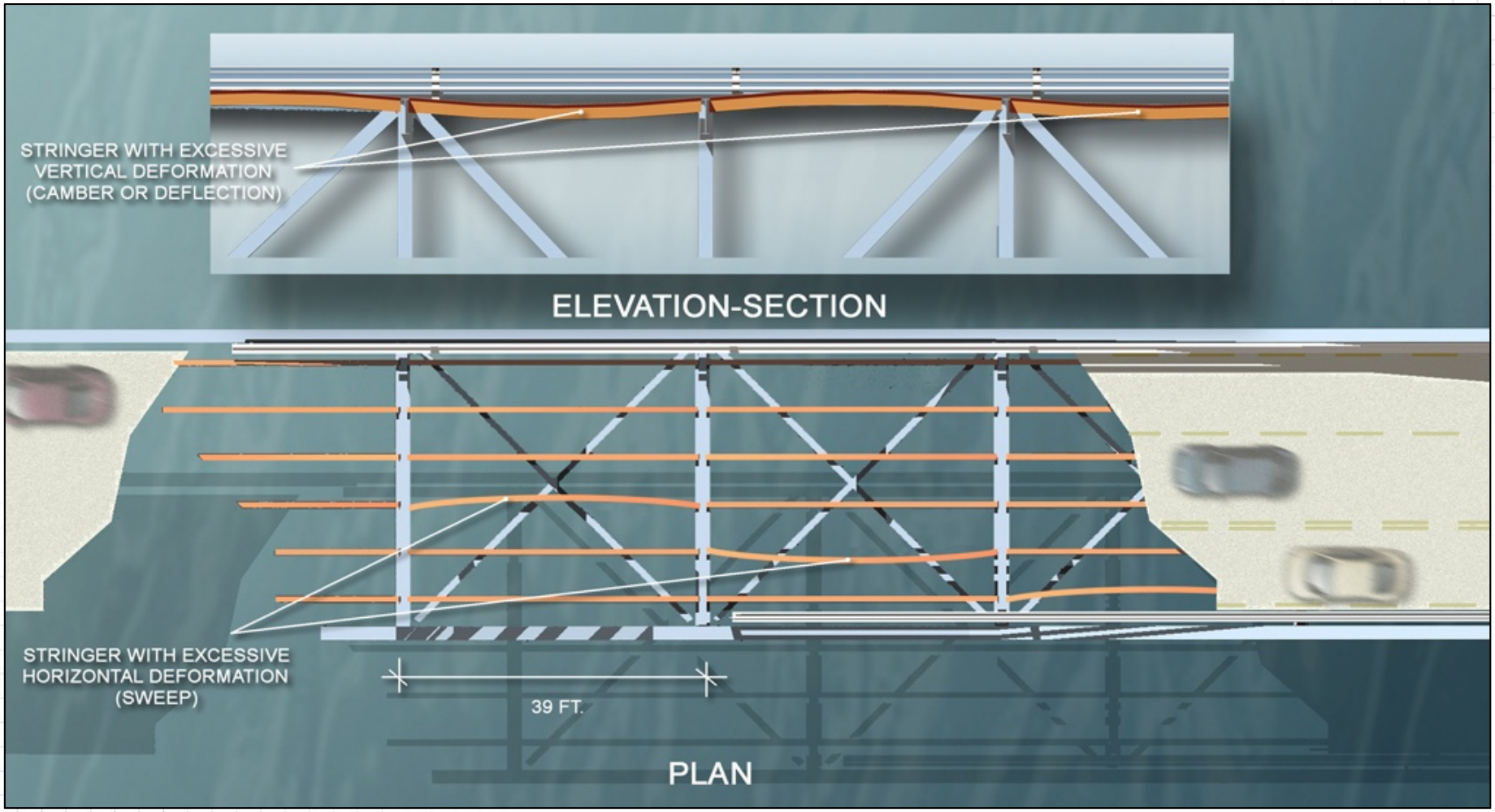
survey pockets were completed and the signal bridges were operational and full bridge closures could be provided, AB began the survey. AB utilized 2-3 survey crews at various times depending on when the bridge could be shut down to traffic as well as coordination with other activities. 2 independent surveys were done of all points for location and elevation and checked against each other for accuracy. The survey began after Labor Day in early September and was completed in early November. At the end of November, AB began reviewing the information. It was discovered that the locations of certain members

The Problem with AB's Survey

- Contractor says stringers are not straight vertically or horizontally

- Contractor alleges Differing Site Condition


STRINGER WITH EXCESSIVE
HORIZONTAL DEFORMATION
(SWEEP)
STRINGER WITH EXCESSIVE
VERTICAL DEFORMATION
(CAMBER OR DEFLECTION)


STRINGER WITH EXCESSIVE VERTICAL DEFORMATION (CAMBER OR DEFLECTION)
ELEVATION-SECTION
STRINGER WITH EXCESSIVE HORIZONTAL DEFORMATION (SWEEP)
39 FT.
PLAN

The Problem with AB's Survey

- The data contained in the contractor's as-built survey indicated that numerous recesses would be needed in the pre-cast panels to accommodate the existing elevations of the stringers.
- A series of redline revisions were made to accommodate the data contained in the as-built survey.
- The contractor claimed that due to the differing site condition of the through truss steel, an additional cost of approximately $59 million would be incurred in completing the project.

MDTA'S INVESTIGATION

MdTA's Investigation

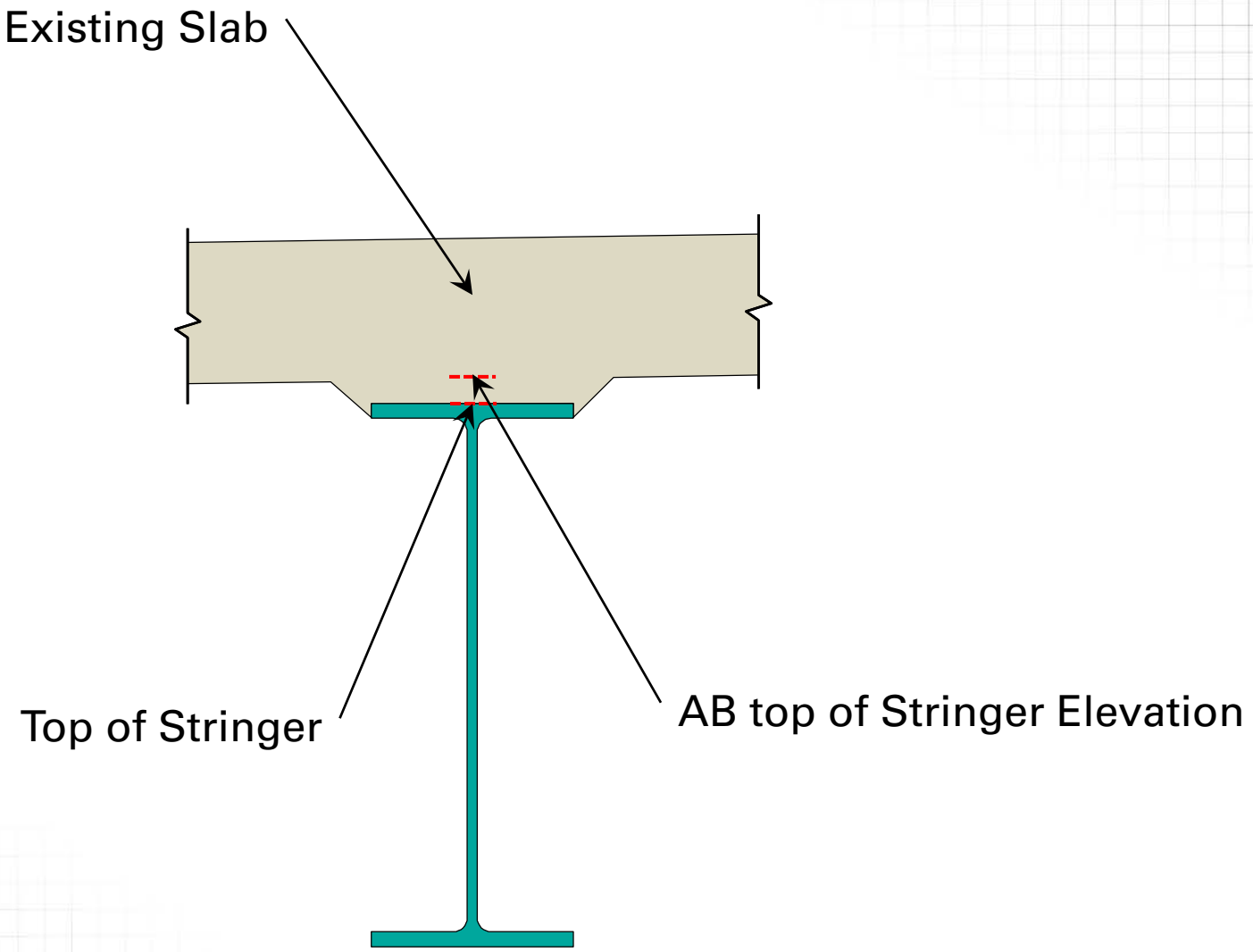
- MdTA begins analysis of AB's allegations of Differing Site Condition (DSC) and $59 million Change Order Request
  - O'C&L reviews project record
  - O'C&L analyzes DSC claim and performs independent survey of through truss steel
  - Forensic Accountant requests financial documents

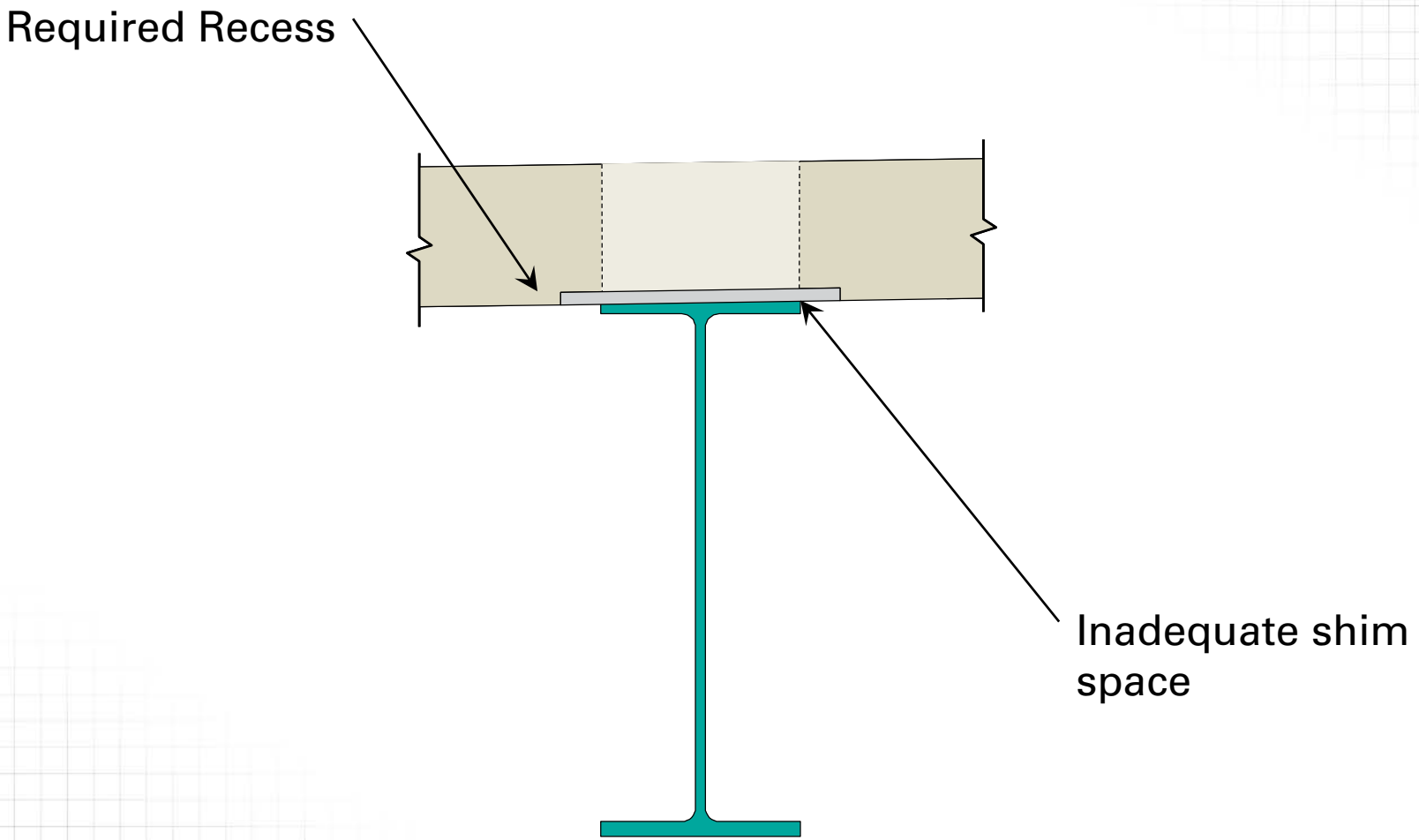
MdTA's Investigation

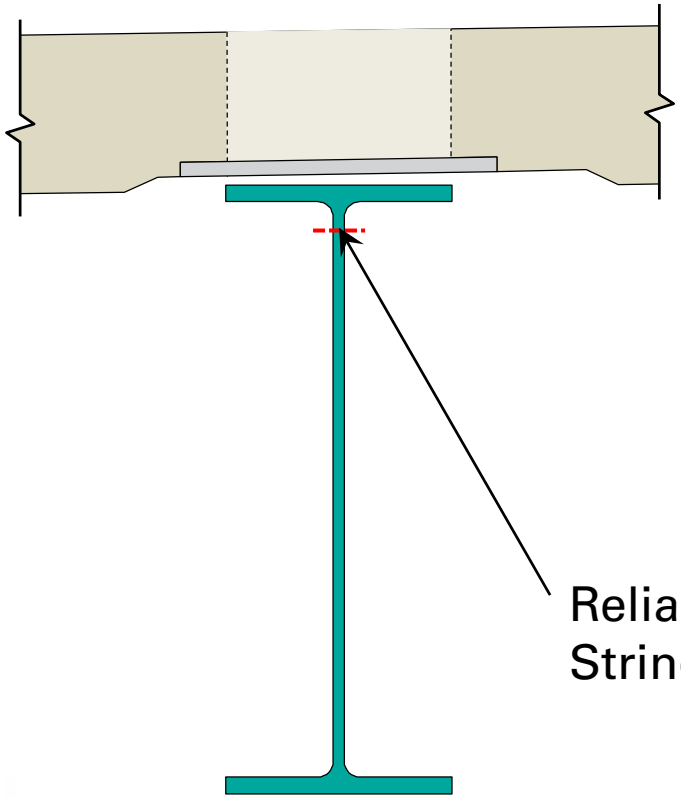
- MdTA's Survey Analysis (O'C&L)
  - In December 2007, O'C&L resurveyed the stringers of the through truss for elevation.
  - The elevations from the resurvey were not consistent with those from the contractor's survey.
  - Upon review of the contractor's survey notes it was discovered that the contractor failed to perform two independent surveys for elevation.

MdTA's Investigation

- MdTA's Survey Analysis (O'C&L)
  - Based on this discovery and the results of the resurvey MdTA directed Atlantic Bridge to conduct the second independent survey of the Through Truss Steel as required by the contract.
  - The results of the second survey conducted by the contractor were wholly consistent with the results of MdTA's survey and confirmed errors in AB's survey.
  - Further, the elevations from the resurvey indicated that, with minimal modification, the pre-cast deck could be constructed per plan.


Existing Slab
Top of Stringer
AB top of Stringer Elevation


Required Recess
Inadequate shim space


Reliable Surveying top of
Stringer Elevation

Results of Investigation

- MdTA determined that the Contractor's initial survey was flawed due to construction and survey errors
- AB's second surveyor confirmed these errors
- AB's initial survey caused the unnecessary redesign and the subsequent delays to the project
- AB constructs panels per plan with minimal modifications
- MdTA denies AB's Differing Site Condition Claim and Change Order

Questions/Comments?

Thank you!