St. Anthony Falls I-35W Bridge Replacement

ASHE National Conference
June 13, 2014

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I-35W Bridge Construction Engineer

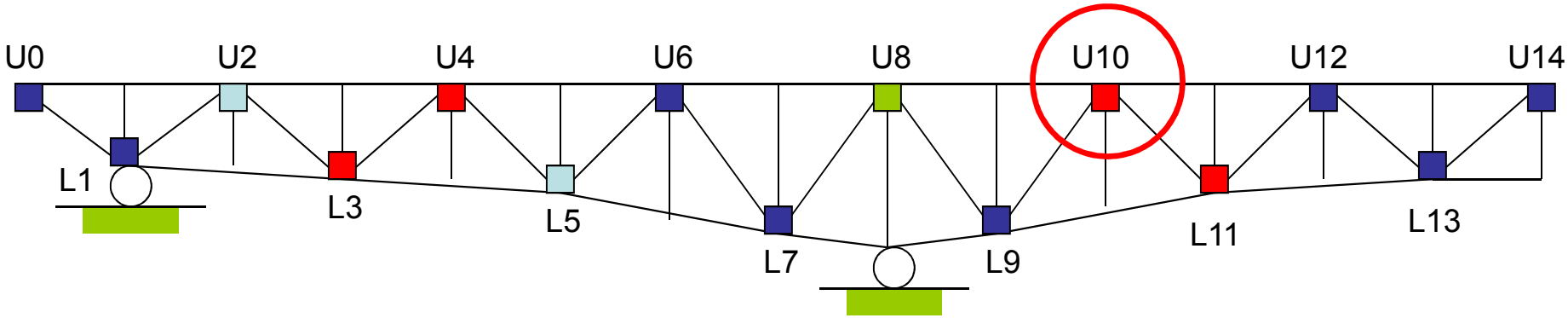
The Former Bridge - 9340

- Opened to traffic in 1967
- Steel truss bridge design
- Fracture critical bridge
  - If certain components fail, bridge can fail
- Bridge and Roadway Repair Project Underway at time of collapse

The Collapse

- **Bridge Collapsed at 6:05 p.m. Wednesday, August 1, 2007**
  - Plunged nearly 100 vehicles into the Mississippi River
    - 13 fatalities
    - 145 injuries

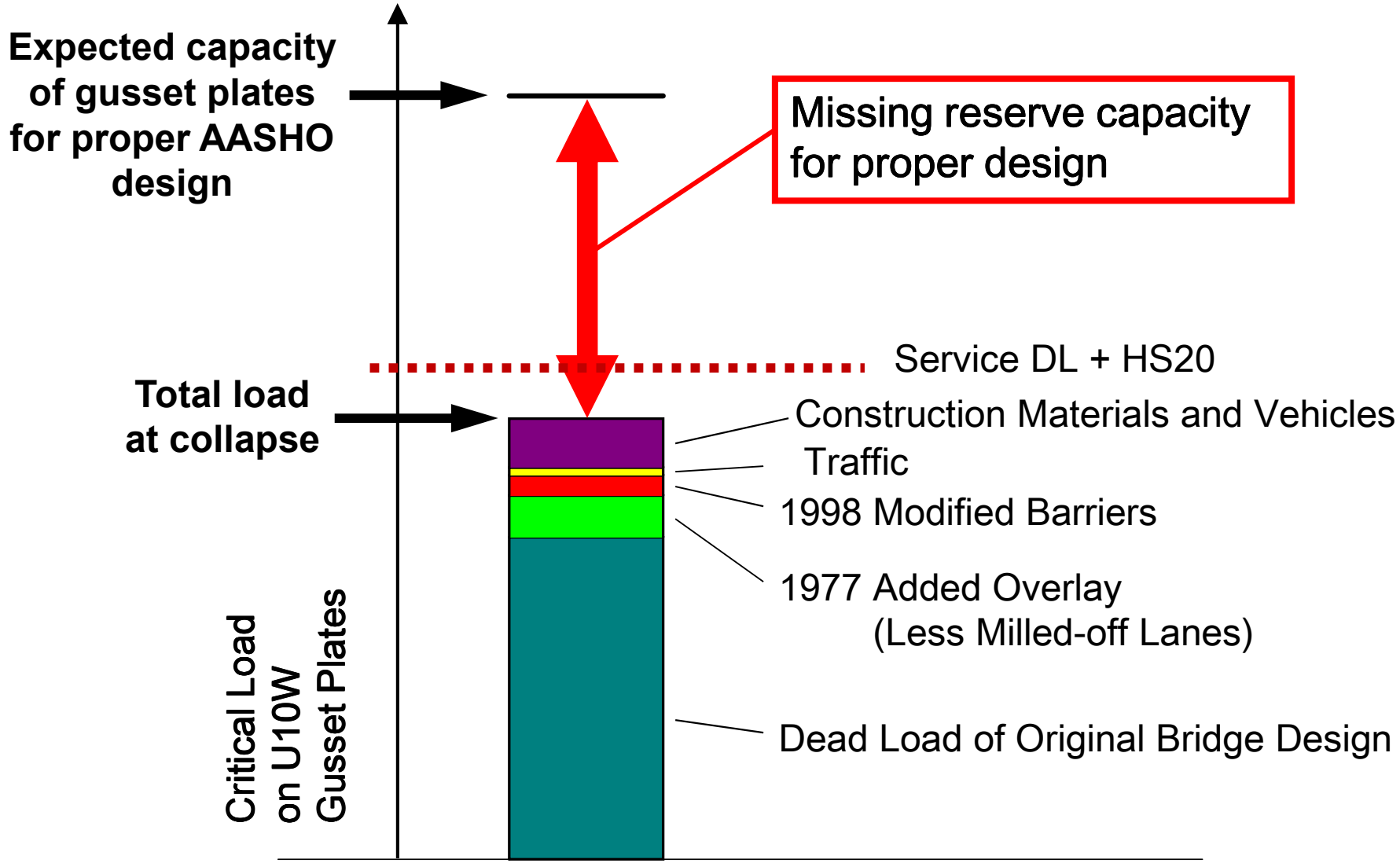
Gusset Plate Thickness



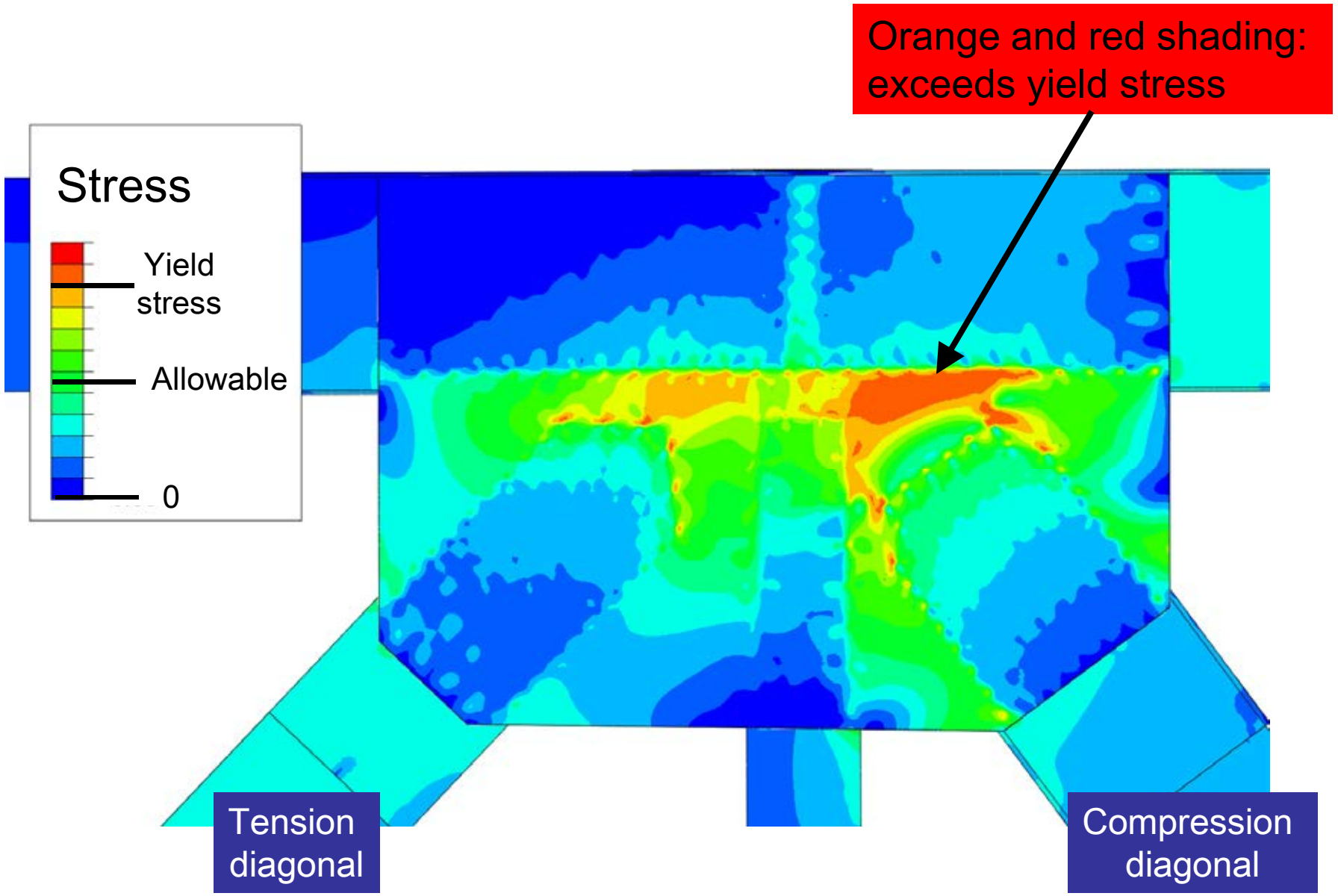
- 1 3/8” thick gusset plate (100 ksi) → 2 of 29 gusset plates
- 1” thick gusset plate (50 ksi) → 13 of 29 gusset plates
- 5/8” thick gusset plate (50 ksi) → 4 of 29 gusset plates
- 1/2” thick gusset plate (50 ksi) → 10 of 29 gusset plates


JUN 10 2003

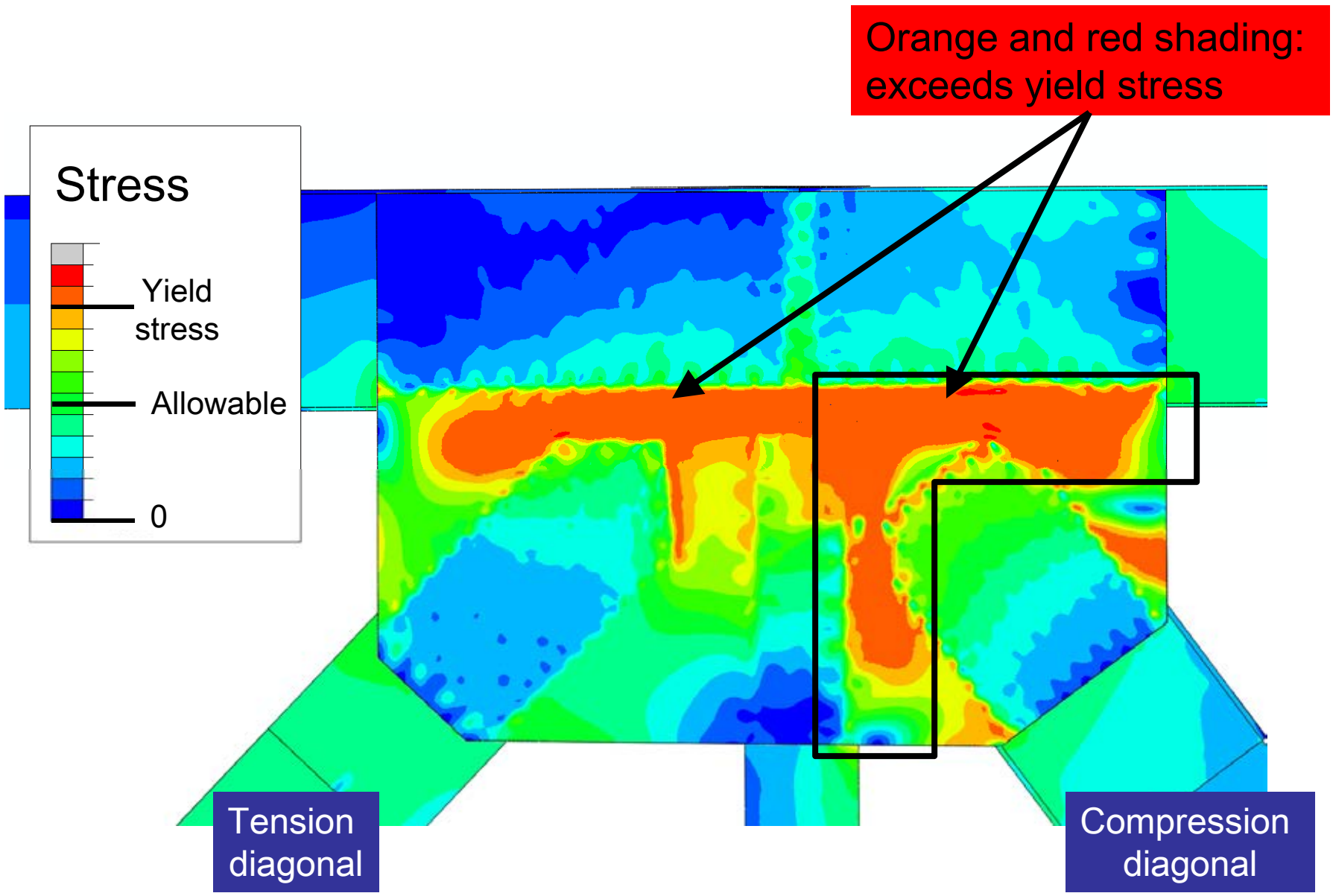
Loads on U10W Gusset Plate



Dead Load of Original 1967 Bridge



Loads at Time of Accident



NTSB Findings

- Collapse resulted due to inadequate load capacity of U10 gusset plates
- The design error was not initially detected during reviews by the design consultant
- The design error remained undetected through subsequent load ratings and through annual bridge inspections.

Need for Accelerated Delivery

- 141,000 cars a day used the bridge
  - One of the busiest bridges in the state
- Close to major traffic areas
  - U of M
  - Downtown Minneapolis
- $400K a day in road users costs
- $113,000 a day in economic impacts

ST. ANTHONY FALLS
BRIDGE REPLACEMENT

New St. Anthony Falls Bridge

GOALS

- **Safety**
- **Quality**
- **Aesthetics**
- **Public Relations**
- **Enhancements**
- **Environmental Compliance**
- **Time and Budget**

Evaluation Criteria

- **Quality (50 percent)**
  - Key individuals
  - Quality Control / Quality Assurance
  - Safety
  - Performance in construction
- **Aesthetics/Visual Quality (20 percent)**
  - Visual Enhancements
  - Public Involvement
- **Enhancements (15 percent)**
  - Roadway
  - Structural
- **Public Outreach/Involvement (15 percent)**
  - Impacts to the public
  - Approach to communications

Best Value Selection Process

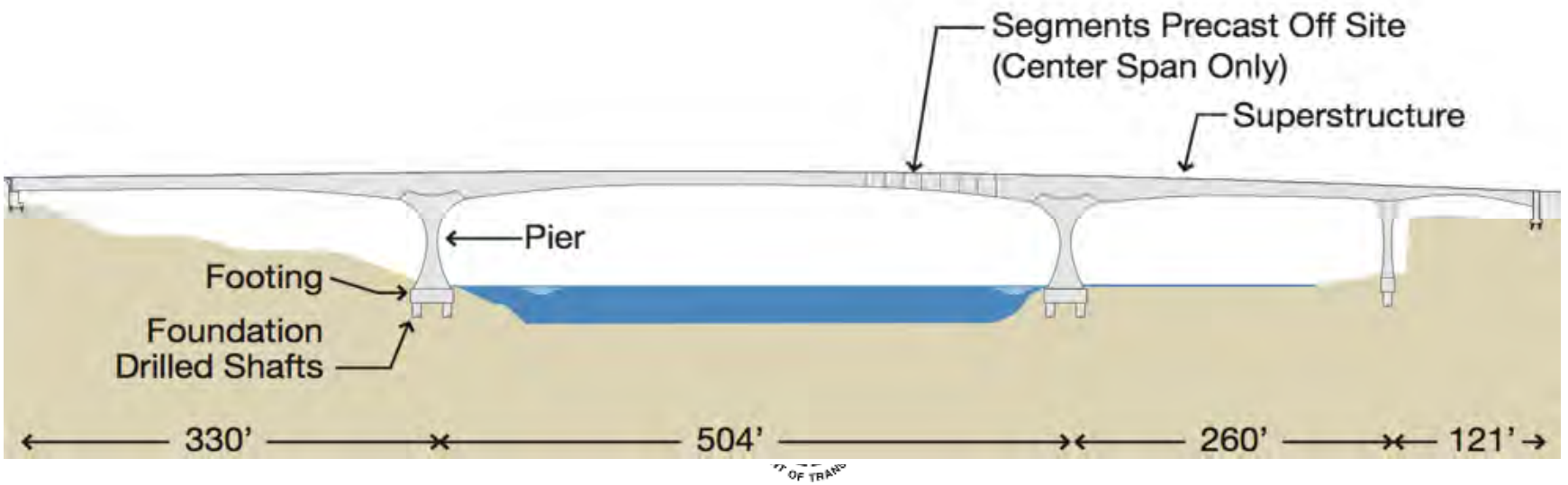
- **Formula**:
  - (Cost + (Time in days * $200,000))/Technical Score
  - Allowable Timeframes – 337 to 437 Calendar Days
- **Best-Value = Flatiron/Manson**
  - 91.47 technical score $233.8 million cost
  - 437 days to complete
- **Other Proposals**
  - Costs Ranged From $177 to $219 Million
  - Days Ranged From 367 to 437

Procurement Timeline

- August 1 – Collapse Occurs
- August 4 – Issue Request for Qualifications
- August 8 – Short Listed Teams
- August 23 – Request For Proposals Released
- September 14 – Technical Proposals Received
- September 18 – Financial Proposals Received
- September 19 – Project Letting
- September 20 – City of Minneapolis Grants Municipal Consent
- November 15 – Construction Began

Bridge Description

- Four-span bridge approximately 1225’ in length
- Concrete piers supported by footings and drilled shafts socketed into rock
- Cast-in-Place approach spans and Precast Segmental river span (120 segments)
- Variable depth superstructure 25’ to 11’
- 17 million pounds of rebar, 740 miles of strand, 50,000 c.y.of concrete

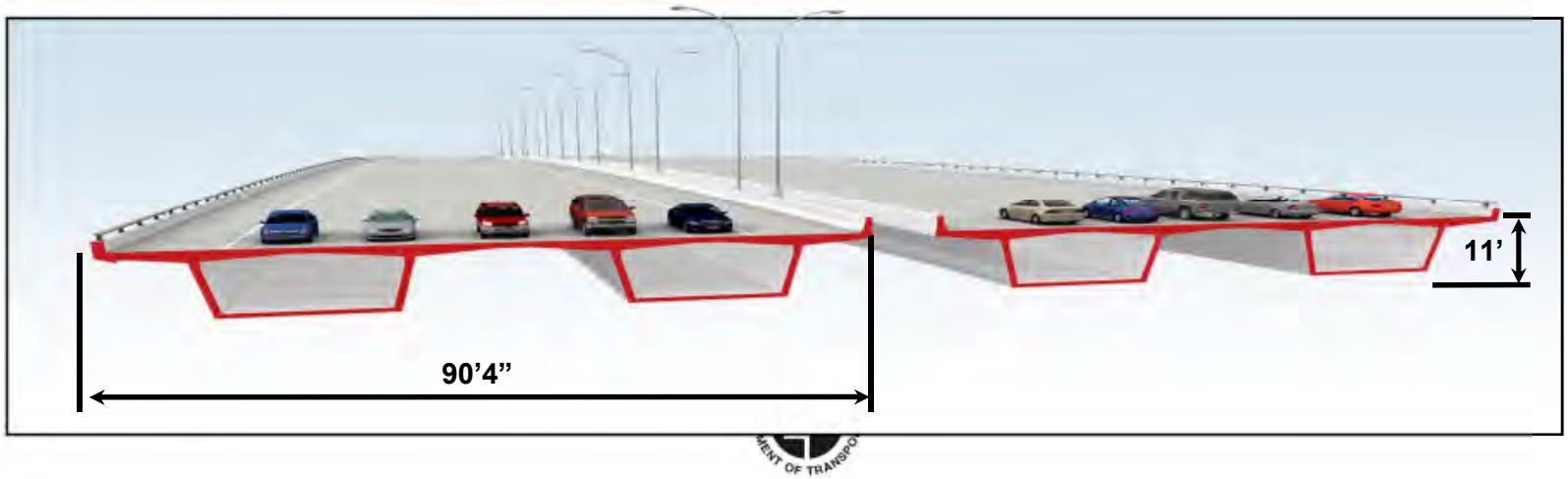


Bridge Description

- Two parallel bridges, each with two box girders

- Striped for 5 lanes each direction (10 total) with 13’ and 14’ shoulders (actual design loading considers for 7 lanes each direction)

- Future configuration of 4 lanes each direction plus light rail line or bus transit lane (lane drop for ramps)



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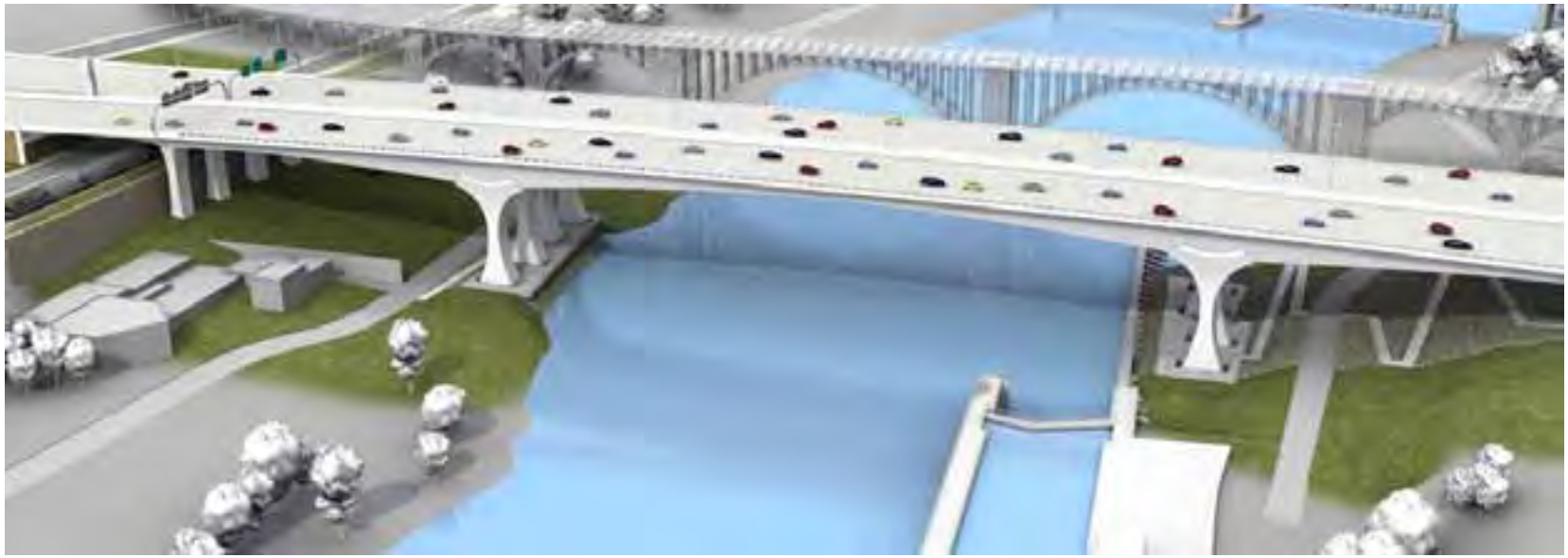
100 Year Design Life

- Include corrosion resistant design details with post-tensioning
- Utilize high performance materials
- Provide multiple layers of protection of key structural elements
- Provide high quality construction



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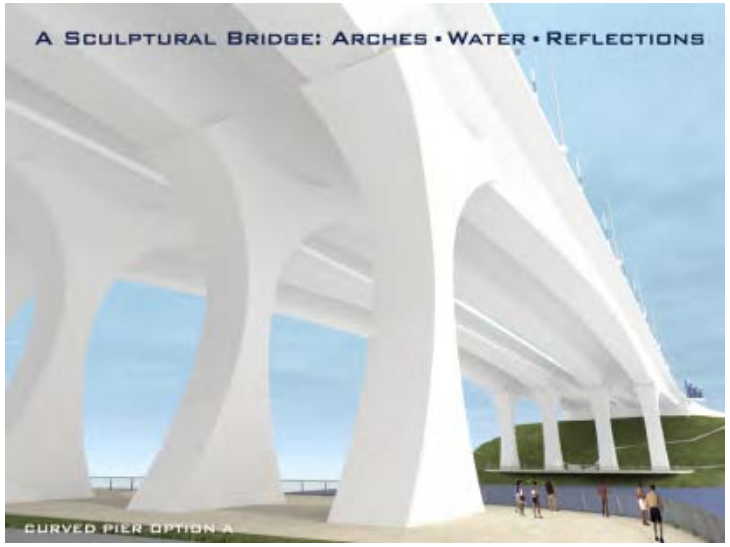
Public Input in Design

- Pier Shape
- Color of Bridge
- Native Stone Abutments



Sidewalk Talks every Saturday

More than 400 people attended on July 5, 2008

Signs mounted on 10th Avenue Bridge for self-guided tours

Project Site Challenges

- Utility Coordination
- R/W Acquisition (13 Parcels)
- Demolition Contract
- Limited Soil Investigation
- Railroad Coordination
- Hydraulic Scour
- Contaminated Materials
- Environmental Permitting (10)

Substructures

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Drilled Shaft Construction

Pier #3

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Drilled Shaft Foundations

90’ Average Length
Socketed into Rock

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Footing Construction

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Mass Concrete

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Pier Construction

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Pier Construction

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Safety Management

- Partnership
  - Mn/DOT
  - Flatiron-Manson
  - Mn/OSHA
- Training of all workers assigned to project
  - Required escorts for visitors
- Large Safety Team
- Audits performed weekly
- Consistency from Top to Bottom

Erect Falsework

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Falsework

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South side falsework

Apr. 1, 2008

Cast Superstructure Spans 1,3 & 4

High Performance Concrete

- Performance Specifications
  - Impacts on Schedule and Quality
  - Strength, Permeability, Chloride resistance
    - Slag, Fly ash, Micro Silica
- Self Consolidating Concrete
  - Primarily used for drilled shafts
  - Volumetric Modifying Agents (VMA)
    - Helped prevent segregation in mix
- Contractor and Supplier Innovation
  - Solved past performance issues
  - Composite Gradations
    - Paving Mix includes incentives for well graded
  - Developed mix designs
    - 45 mix designs
    - Ex: 365 lbs slag, 98 lbs fly ash, 82 lbs portland
    - Silica Fume in Superstructure (approx. 3% by vol)
    - Used high range water reducing agents and retarders
    - Multiple test pours and mock ups

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Elevation of Long-Line precasting system

Precast Span 2 Segments Off-Site | Phase 7

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Casting Yard

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Pre-cast segment work

Pouring top slab, road bed, first segment, Feb. 19, 2008


BED 3

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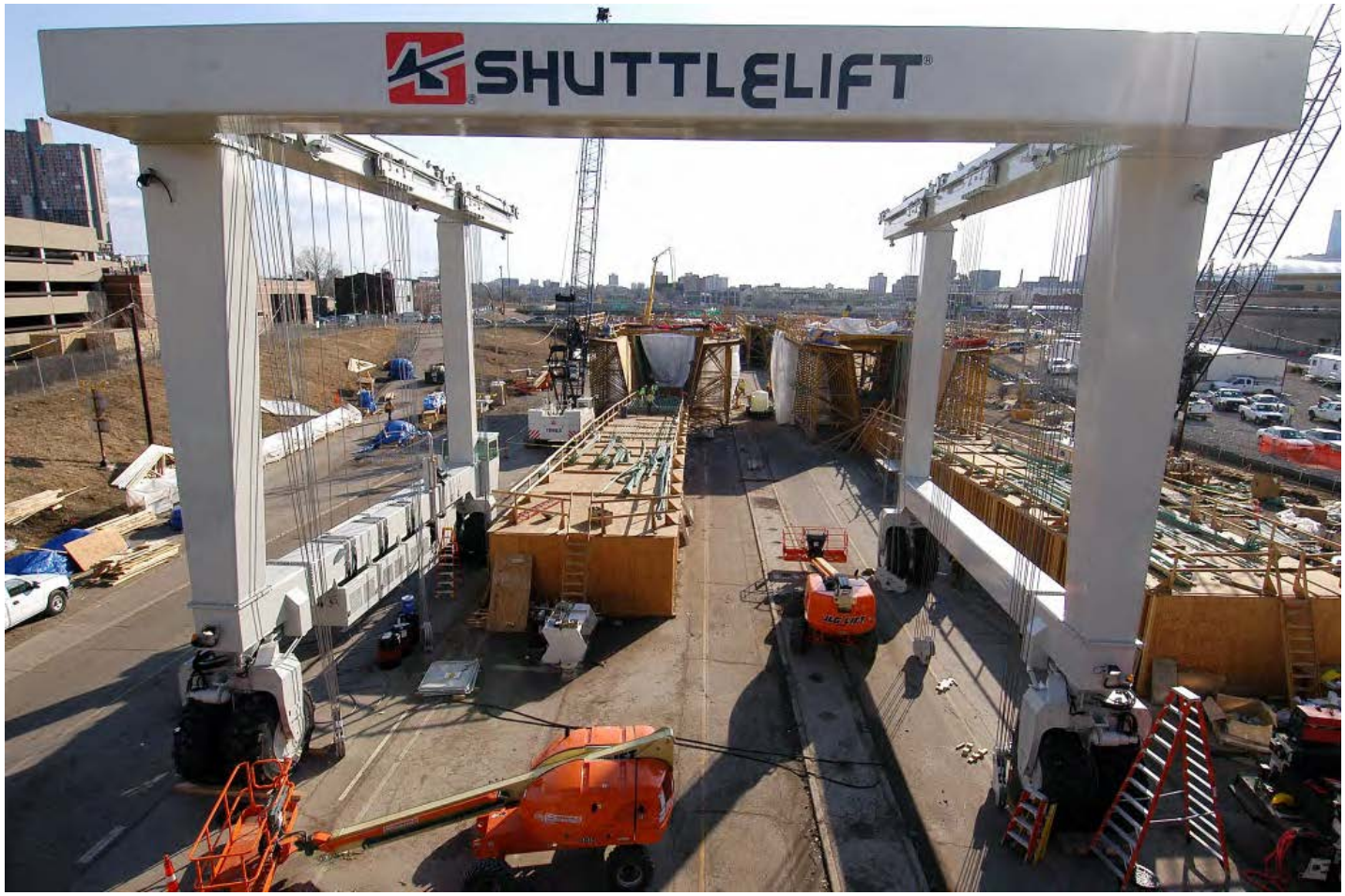
Lifting Segments



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Transporting Segments

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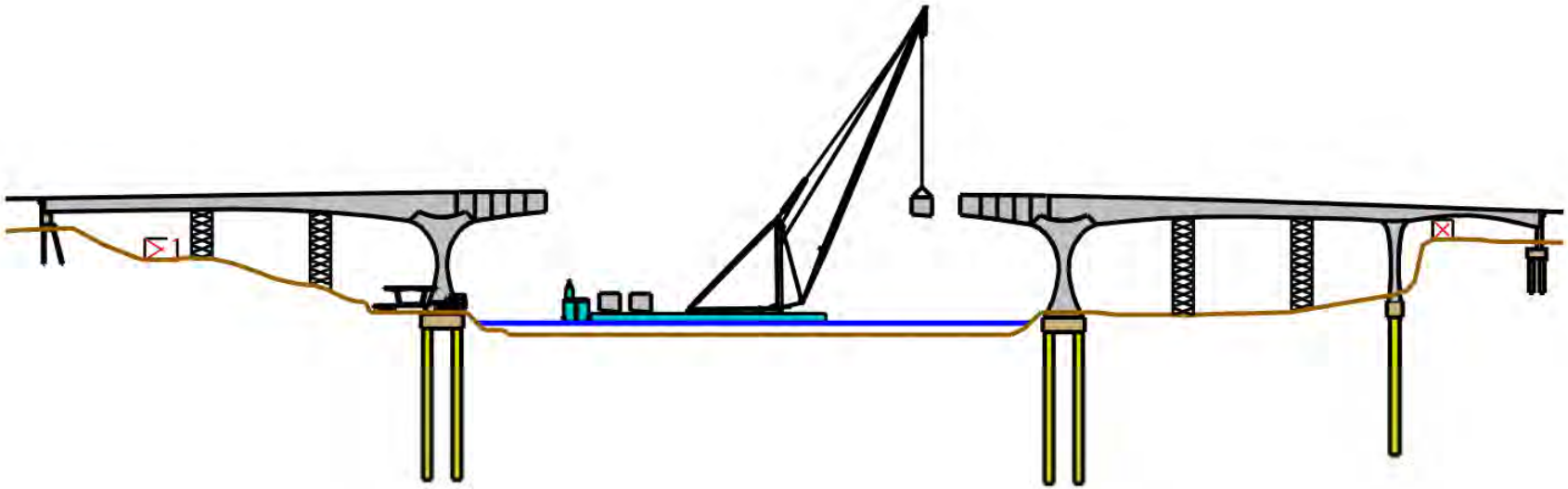
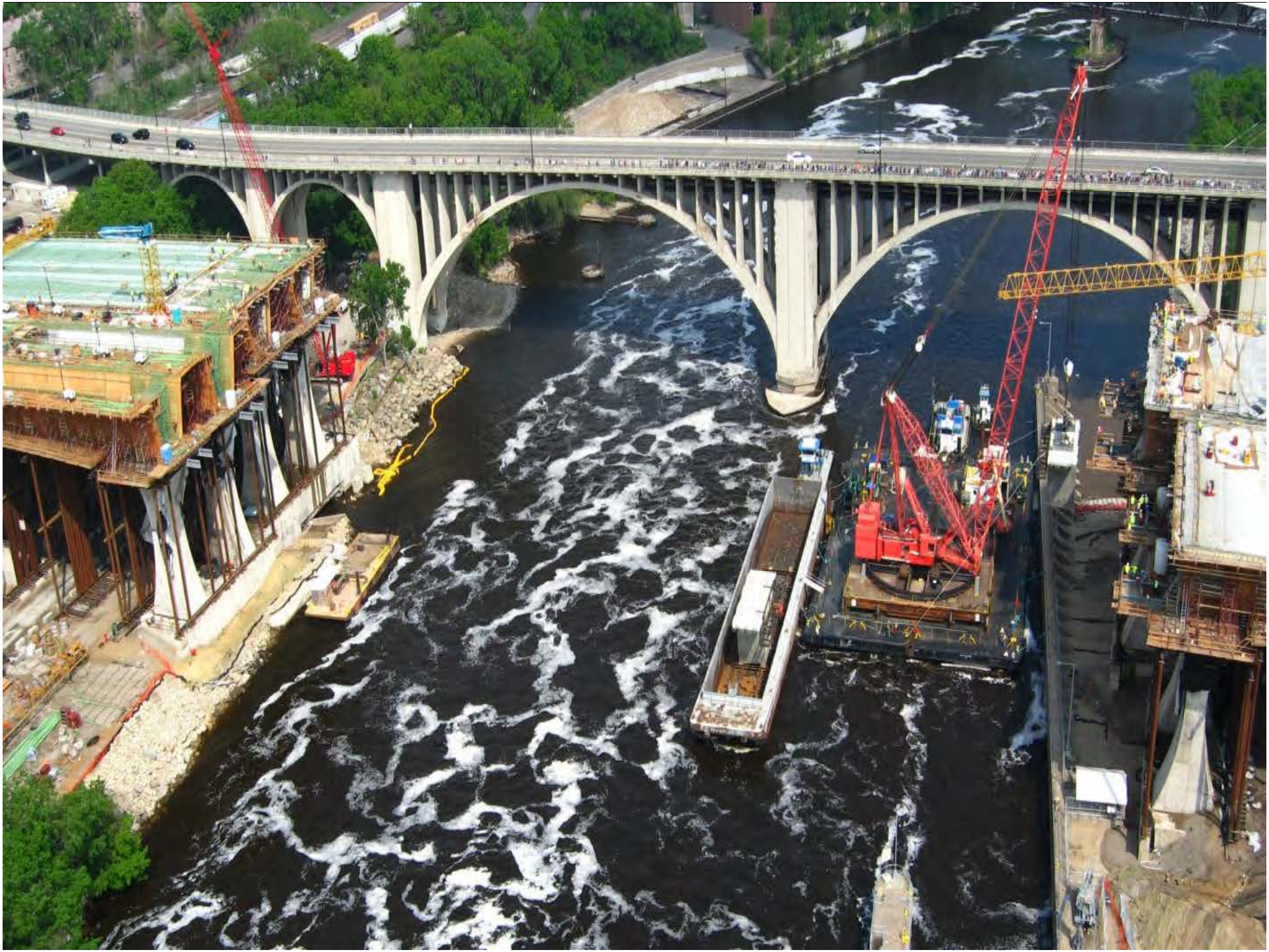


Erect Cantilevered Main-Span

Phase 10



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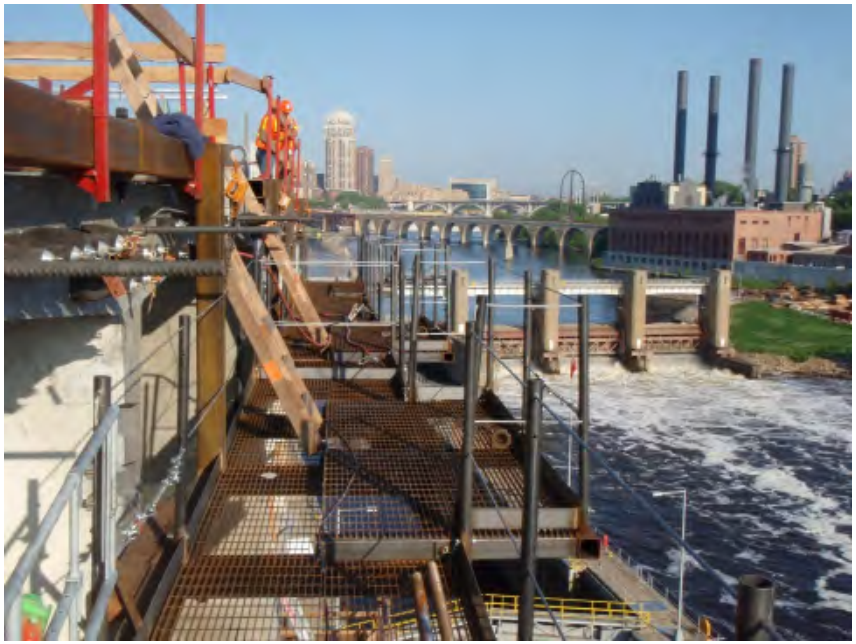
Post-Tensioning Bars



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Post-Tensioning Tendons

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Closure Pours

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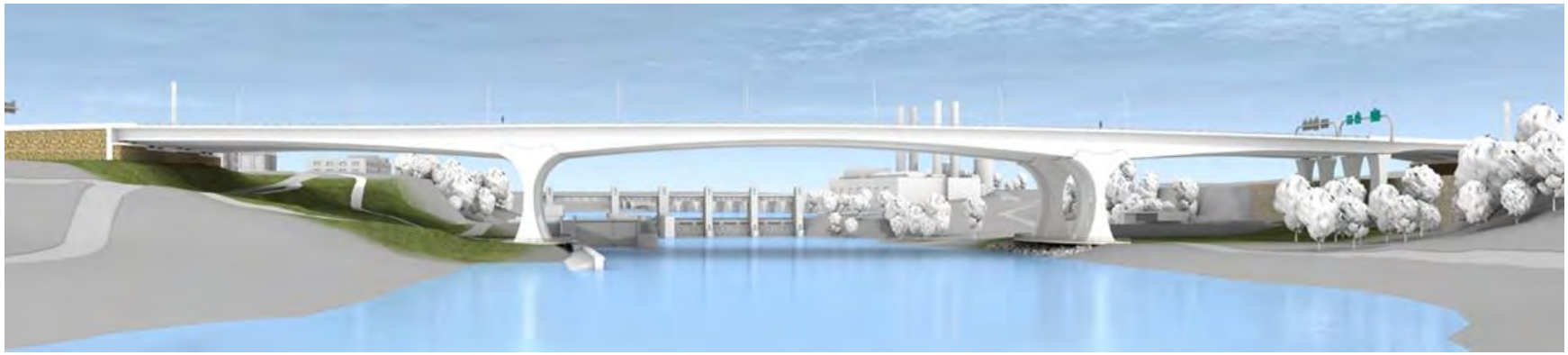
LED Lights

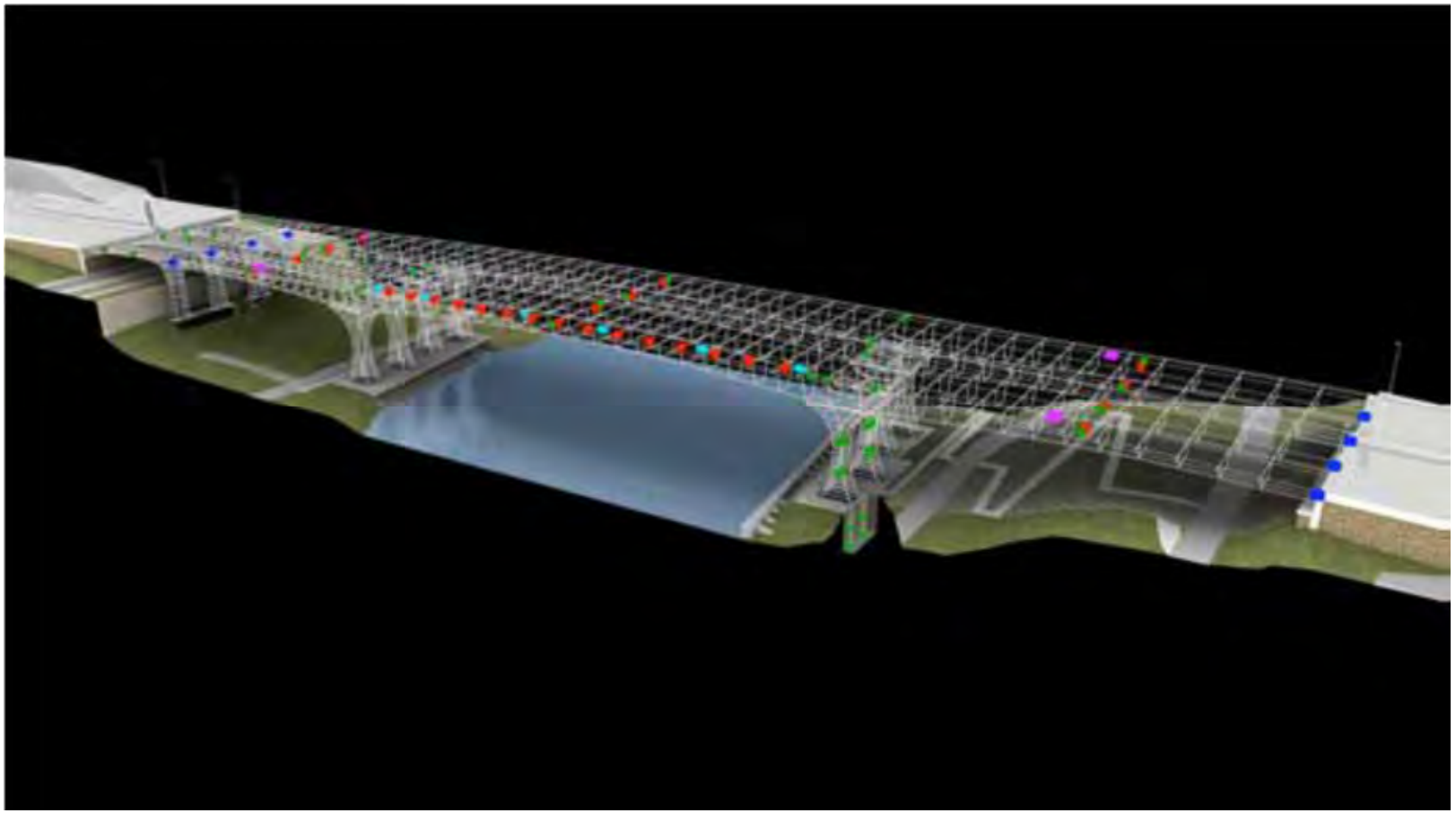
“Smart Bridge” System

Integrated Bridge Sensor Monitoring System covering five areas:

- Support construction processes
- Record of structural behavior (structure monitoring)
- Control of the automated anti-icing system
- Intelligent Transportation System (ITS)
- Bridge security



- Vibrating Wire Strain Gauge with Temperature Reading
- Linear Potentiometer
- Accelerometer
- Corrosion Potential Sensor



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Load Calibration of Sensors

8 Trucks @ 25 Tons Each

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Aesthetic Lighting

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Monuments

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SCHEDULE

(DAYS FROM NTP – OCTOBER 8, 2007)

ACTIVITY		DAY
DRILLED SHAFTS	-	50
FOOTING	-	92
PIERS	-	100
PRECASTING	-	107
CIP SPAN	-	170
PRECAST ERECTION	-	223
ERECTION COMPLETED	-	269
OPENING (SEPT. 18)	-	339
SUBSTANTIAL COMPL.	-	346

COMPLETED IN 11 MONTHS
OPENED OVER 3 MONTHS AHEAD OF SCHEDULE

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Open to Traffic September 19, 2008

Completed in 11 Months – 3 Months Early

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Schedule and Budget

- Schedule
  - Contract Completion Date: December 24, 2008
  - Open to Traffic: September 18, 2008
  - Substantial Completion Reached 90 days ahead of schedule
- Budget
  - Little cost growth (1% +-)
- Incentives
  - $18 million in time
  - $7 million No-Excuse Bonus

35W Innovation

- High Performance Concrete
- Mass Concrete
- Self-consolidating concrete
- Cold Weather Protection
- Involvement of Engineer of Record
- LED Lighting
- Smart Bridge Technology

35W Keys to Success

- Approach to Safety
- Approach to Quality
  - Involvement of Engineer of Record in Construction
- Innovation
- Partnership
- Communication
- History of Working Together
  - Flatiron and Figg Engineering
  - Mn/DOT Team
- Risk Management
  - Who can best manage the risk


QUESTIONS ???
JWC
6/30/2008