Bolted Component Miter Gate Replacement Project

by

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One Team: Relevant, Ready, Responsive and Reliable
UMR-IWW NAVIGATION SYSTEM

- 37 Lock Sites
- 1,200 Miles of River
- Constructed 1930-45

Typical Upper Mississippi & Illinois River Lock
**Typical Miter Gate**

**Typical Repair Method**

Lift out Gate  Place Spare Gate  Repair Gate
Need for Maintenance - Friendly Gates

- Barge Impact Happens
- Routine maintenance
- Increased maintenance frequency as gate gets older
- Declining O & M budgets
In-place Repair

- Allowing maintenance without lifting gate out of water
  - Place Diagonal tensioning nuts above water

Customer Feedback (Operations)

- Problems:
  - All-welded structures are hard to repair piece-wise and require extensive weld testing
  - Time consuming: Transport gate off-site, Fabricate new parts, Transport gate to lock

- Suggestions:
  - Make gate easier to work on: bolted connections
  - Standardize gates: use interchangeable parts
Goals

- Divide the gate into components
- Bolt components to gate for easy replacement
- System-wide component interchangeability
- Allow for in-place repair

Component Design

- Main Gate Components
  - Top Girder
  - Bottom Girder
  - Vertical Beams/Girders
  - Skin Plate panels
  - Diagonals
  - Gudgeon Hood
  - Pintle Socket
  - Quoin Girder
  - Miter Post
  - Strut Hood

- Individual components can be welded and then bolted to the gate
- Larger diameter bolts to reduce installation time/cost
- Maximize use of readily available structural shapes
Interchangeability

- Use one design for 14 locks (more Regionally)
- Spare components (top girder, skin plate panels) on hand for quick replacement
- No fabrication delays

Project Overview

- Design Replacement Miter Gates for Locks 20-22 on the Upper Mississippi River
- 3 Gate Heights: 20-ft, 27-ft and 33-ft
- Weights: 110 tons (20), 115 tons (27) and 130 tons (33)
- Total contract $10.9M
- Maintenance-Friendly Design: Bolted Connections
- Tight Schedule: 5 months to produce Plans & Specs
- Schedule and Design Accuracy Required 3D BIM CADD
What is BIM?

- Building Information Modeling (BIM)
- **Building** - The design project, as you envision it for the client
- **Information** - The drawings, schedules, and specifications, fully coordinated
- **Modeling** - The digital description that can be explored and evaluated before you build

Traditional 2D Drawing
Component Design
Miter Gate Model

Model.dgn
- Source of geometry/information

Extraction.dgn
- 2D Snapshot of Model
- Manual “re-calculating” in Model.dgn

Drawing.dgn
- Reference ‘Extraction.dgn’

Drawing Production
(Overall Sections/Views)
Of Design Interest

- ASTM A709 Steel with AWS D1.5
- AISC Quality Certification Program, Category III, Major Steel Bridges (CBR) Category with:
  - Fracture Critical endorsement (F)
  - Sophisticated Paint System endorsement (P)
- Slip-Critical and Pretensioned Bolted Connections (No Snug-Tight)
- 4,500 Bolts per Gate Leaf

Of Design Interest

- Diagonals: Pinned Ends with Hydraulic Tensioning Capability
Interactive Review

Review
- Monthly Review Meetings with Operations (Chiefs, Structural Maintenance Crew, Lockmasters, Divers)
- Changes emailed with 3D Adobe PDF's
- BCOE Review in 4-Sided Virtual environment

Results
- Very productive dialogue = better operable/maintainable design
- Incorporated changes early in design vs. last minute changes

Technical Reviews and Regional Teaming

- Multidistrict reviews – St. Paul and St. Louis Districts
- Utilized lessons learned from Portland District to prepare the technical specifications

Courtesy of U.S. Army Research, Development and Engineering Command
Conclusion

- Bolted Component Design
- 3D Interactive Reviews
- System-wide Interchangeability
- In-place Repair

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