A New Lift Bridge in Bordeaux
Topics of Discussion

• The Project
• The Selection Process
• The Tender Designs
• The Winning Design
• Unique Design Features
• Awards
• Conclusion
Bridge Conception and Design

ENTRANCE GATE TO THE HISTORICAL BORDEAUX HARBOR
Bordeaux City
Center Crossing
The Garonne River
Acknowledgements

Owner
La CUB-Urban Community of Bordeaux

Contractor
• Vinci Group: Design-Build Contractor
• GTM: Civil Works Construction
• NFM Technologies: Mechanism supply
• Cimolaï : Steel Structure

Design Consortium
• EGIS Jean Muller Int’l: Lead Design Consultant
• Michel Virlogeux: Conceptual Bridge Designer
• Charles Lavigne: Bridge Architect (Concept Phase)
• Hardesty & Hanover: Movable Bridge Systems Designer
• Lavigne-Cheron Architects: Bridge Architect
“Provide A Crossing Over the River Garonne for Cars, Pedestrians and Bicycles, as well as, at a Later Date, a Tram Line”

“Allow the Passage of Boats and, in Particular, Very Large Ships”
An Open Design-Build Process

- Satisfy Basic Project Objectives
- Meet EuroCode
- Meet FEM
- Aesthetically Stimulate Review Committee

- Provide Economically Viable Solution
- Meet Minimum Tender Requirements for Stipend of 1M Euros ( $1.4M) per unsuccessful team
Proposal # 1
Proposal #1
Proposal # 2
Proposal # 3
Proposal # 3
Proposal # 3
Proposal # 4
Our Proposal

Movable Bridge Engineering
Jacques Chaban-Delmas Bridge

Presented by Paul Skelton
Hardesty & Hanover
Our Proposal
Our Proposal
Design-Build Process Results

Our Proposal

Proposal # 1

Proposal # 3

Proposal # 4

Proposal # 2
The Winning Proposal

Our Proposal

Movable Bridge Engineering
Jacques Chaban-Delmas Bridge

Presented by Paul Skelton
Hardesty & Hanover
### Structural Facts

#### MAIN CHARACTERISTICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Bridge Length</td>
<td>1421 feet</td>
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<tr>
<td>Lift Span</td>
<td>387 feet</td>
</tr>
<tr>
<td>Raised Position Clearance</td>
<td>190 feet <em>(Pont d’Aquitaine)</em></td>
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<tr>
<td>Seated Position Clearance</td>
<td>42 feet <em>(Pont de Pierre)</em></td>
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<tr>
<td>Variable Span Width</td>
<td>115 feet <em>(at Abutments)</em> to 148 feet <em>(Lift Spans)</em></td>
</tr>
<tr>
<td>Lift Towers</td>
<td>262 feet</td>
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#### Key Figures

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tr>
<td>Lift Span Mass</td>
<td>5.54 million pounds</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>≈ 13.0 million pounds</td>
</tr>
<tr>
<td>Reinforced Concrete</td>
<td>≈ 40 000 cubic yards</td>
</tr>
<tr>
<td>Reinforcement Bars</td>
<td>≈ 1.0 million pounds</td>
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Unique Design Features

- Orthotropic Deck
- Four Independent Towers
- Closed Loop Rope Drive
- Heavy Span Imbalance
- Span Guide Design
- Counterweight, Rope and Sheave Design
- Unique Span Testing Methods
- Planetary Gear Boxes
ORTHOTROPIC DECK

- Low Mass to Optimize the Lifting System
- Slender Aspect For a Thin, Modern Structure
- All Spans Orthotropic Box-girder
- 12 Feet High / 87 Feet Wide
- Outboard Sidewalks also Orthotropic Box-girders
Four Independent Towers
Four Independent Towers
TENDER REQUIREMENTS (RECOMMENDATION)

- 750 kip Span Imbalance
- Span Raising Machinery Only
- Span Locks Forbidden

POST TENDER PROPOSAL

- Design Alternative → 220 kips(seated)
- Minimum to Maintain Tendency to Close in Raised Position
- Two-way Rope System
- Motor Size- Reduced from 300+ to 175 HP
- Operating Rope Size Reduced
- Very significant impact on tower design opportunities
Mechanics – Operating System
WIND DESIGN CONCLUSIONS

- Favorable Geometry of the Lift Deck Cross-section:
  - Inverted Plane Wing Section => Deck Naturally Tends to Seat
  - Stabilization of the Deck with the Sidewalks Acting as Floaters
    - Dynamic and Turbulent Studies Required: Turbulent Effects Five Times Greater than Static Effects of the Wind
    - Service Forces Occurring During Lifting Operation:
      - 180 kip Upwards/230 kip Downwards
      - 30 kips Horizontal on Span Guides
**OPERATING ROPES**

- 1-3/4 Inch Diameter
- Four Ropes Per Drum (Two Uphaul, Two Downhaul)
- 5.5 feet Pitch Diameter - Drum and Upper Deflector Sheave
- 6.5 feet-long Drum with Opposite Hand Grooves
Mechanisms-Operating System
COOPERATIVE DESIGN DUE TO BRIDGE ARCHITECTURE

- Independent Pylons
- Potential for Differential Movements
Mechanisms-Span Guide System

- Blend with Visual Character
- Low Friction System
- Low Maintenance System
- Facilitate Alignment at Site

OBJECTIVES
Lift Span Tower Guides
Mechanisms-Span Guide System

SECTION A-A

SECTION B-B

LONGITUDINAL GUIDE ROLLER ASSEMBLY

ANCHOR BOLT

JACKING SCREW

GUIDE CHANNEL

END FLOORBEAM

TRANSVERSE GUIDE ROLLER ASSEMBLY

LONGITUDINAL GUIDE ROLLER ASSEMBLY

AT FULLY SEATED POSITION (UPPER CHANNEL GUIDE TO PERMIT SPAN CENTERING WITH CENTER GUIDE)

TRANSVERSE GUIDE ROLLER ASSEMBLY

Movable Bridge Engineering
Jacques Chaban-Delmas Bridge

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Hardesty & Hanover
LONGITUDINAL GUIDES-LEFT BANK END

LONGITUDINAL GUIDE ASSEMBLY
SEE DWG. 40552

LONGITUDINAL GUIDE ASSEMBLY (TRANSVERSE GUIDE ASSEMBLY NOT SHOWN)

TRANSVERSE GUIDE ASSEMBLY
SEE DWG. 40553

TRANSVERSE GUIDE ASSEMBLY
EVALUATED MULTIPLE CONFIGURATIONS FOR SUPPORTS

- Springs, Elastomers, Hydraulic Actuators, Equalizers
- Equalizer was Most Effective in Load Balancing

SELECTED SYSTEM

- Two -One Foot Diameter x 3.25 Inches Wide Rollers
- Mounted on Equalizer Frame Attached to Span Structure
Counterweight System

- Central Spine Plat-Four Quadrants
- 10.5 foot \times 10.5 \text{ foot} \times 40 \text{ foot-Filled With Cast Steel Ingots}
Counterweight
Counterweight
Counterweight
Load Testing Prior to Span Placement
Counterweight Rope Design
Main Counterweight Sheaves
Planetary Gear Drives
December 2009
Tower Pier and Dolphins in Place
Tower Construction Begins
Specific Design - Prefabricated Erection

STEEL STRUCTURE TRANSPORTATION AND INSTALLATION

<table>
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<th>Date</th>
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<tr>
<td>June 2011</td>
<td>Right Bank Spans</td>
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<tr>
<td>November 2011</td>
<td>Left Bank Spans</td>
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Movable Bridge Engineering
Jacques Chaban-Delmas Bridge

Presented by Paul Skelton
Hardesty & Hanover
Sheave Placement
Counterweight Rope Installation
Operating Rope Installation
Operating System Load Tested
Lift Span Float-In
As Envisioned In 2005
Completed 2013
Bridge Honored With Numerous Awards

- American Council of Engineering Companies (ACEC-National) – Engineering Excellence Awards – Honor Award
- American Council of Engineering Companies (ACEC-New York) – Engineering Excellence Awards – Diamond Award
- Jury Grand National Prize of France - Grand National Prize for Engineering
- International Federation of Consulting Engineers - Outstanding Project of the Year
Conclusion

“IT'S NEVER BEEN DONE BEFORE” IS A OPPORTUNITY, NOT A BARRIER

- Open Design-Build Process
- Innovative and Open Minded Tenders
- Pushing the envelope of US design constraints
- Landmark Bridge Efficiently Realized and Operating as Intended
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Time Lapse of Construction