BONNET CARRE
SPILLWAY BRIDGE
LOAD TESTING

William J. Metcalf Jr., P.E.
Permit Loads

- Promote Economic Development.
- Get Maximum Value from Existing Infrastructure.
- Protecting Public Safety.
- Protecting Infrastructure from Damage.
Project Details

- These vessels were moved as part of a construction project at the refinery in Norco, Louisiana.
- The move was performed by Mammoet.
- The gross vehicle weight of the largest two loads was 1,025,268 lbs.
- Bridge instrumentation and load testing was done by Bridge Diagnostics Inc.
- The Load crossed the bridge over the Bonnet Carre Spillway on highway U.S. 61.
# BRIDGE ANALYSIS

## OVERWEIGHT VEHICLE

**BONNET CARRE SPILLWAY**

### C-93-101 VESSEL

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross wt. Of Vehicle</td>
<td>1,025,268 lbs.</td>
</tr>
<tr>
<td>Total No. of Axle</td>
<td>18</td>
</tr>
<tr>
<td>Total No. of Tire</td>
<td>144</td>
</tr>
<tr>
<td>Total Length</td>
<td>121 ft.</td>
</tr>
<tr>
<td>Width</td>
<td>20' - 10 1/8&quot;</td>
</tr>
<tr>
<td>Height</td>
<td>24' - 7 1/4&quot;</td>
</tr>
<tr>
<td>Total Miles Traveled</td>
<td>8.5 miles</td>
</tr>
<tr>
<td>Date of travel</td>
<td>Nov. 15, 2004</td>
</tr>
<tr>
<td>Contractor</td>
<td>Mammoet, USA</td>
</tr>
</tbody>
</table>
How Can a Load Over Ten Times The legal Load Limit Safely Cross a Bridge?

- Load Distribution and other Conservatism in the Design Code.
- Less Variability.
- Specially Designed Vehicles.
SPMT Trailers

- Self Propelled Modular Transporters.
- Designed to give best possible load distribution.
- Uses Hydraulics To balance the load to every wheel. (?)
## Bridge Details

**Table 1 Description of Structure**

<table>
<thead>
<tr>
<th>Structure Identification</th>
<th>Bonnet Carre Spillway Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Highway 61, - Norco, LA</td>
</tr>
<tr>
<td>Structure Type</td>
<td>PS/C I-beam bridge</td>
</tr>
<tr>
<td>Number of Spans</td>
<td>6</td>
</tr>
<tr>
<td>Span Lengths</td>
<td>77.50’ c.c. of piers / 75.75’ c.c. of beam bearings</td>
</tr>
<tr>
<td>Skew</td>
<td>0 (Perpendicular)</td>
</tr>
<tr>
<td>Structure/Roadway Widths</td>
<td>42’-10” / 40’roadway</td>
</tr>
<tr>
<td>Beams</td>
<td>6 – AASHTO Type IV PS/C I-beams @7’– 4”</td>
</tr>
<tr>
<td>Deck</td>
<td>7.5” RC deck with 1.5” haunches on beams.</td>
</tr>
<tr>
<td>Curbs and Parapets</td>
<td>Relatively large RC barriers at the edge of the deck. Discontinuous at approximately 1/3 span locations.</td>
</tr>
<tr>
<td>Visual condition</td>
<td>Structure appears to be in good condition, with no apparent damage.</td>
</tr>
</tbody>
</table>
So what is the limit?

- Bridge capacity is not infinite.
- Typical line girder analysis uses simplified methods that can not account for some factors that effect structural analysis.
- Factors that reduce variability are difficult to quantify.
- The problem we face is inaccurate analysis and a lack of information; therefore to only way to get a reliable measurement of bridge capacity is with better analysis and better/more information.
Better Analysis

- Finite Element Method (FEM).
- Accounts for behavior of bridge system.
- Provides a logical reliable way to incorporate more accurate information.
- FEM gives very precise results but the accuracy is dependent on the accuracy of the input information.
Better Information

- Research records about the structures, materials, and construction.
- Knowledge of current structural engineering research.
- Bridge inspection.
- Monitoring of bridge response to loading.
DOTD Model

- FEM model built using shell and beam elements.
- Simple span model.
- Continuous Model.
- Pile bent model.
- Models Analyzed with STADD-Pro 2003 software.
Permit Approval Process

- Analysis using traditional methods.
- Create first FEM model.
- Revise model.
- Suggested revised vehicle configuration to hauler.
- Review and final approval.
- Hire BDI to monitor bridge structure.
Bridge Load Testing

- Verify the FEM models and analysis that was done.

- Produce a very accurate model of this structure for future use.

- Used as a tool to help determine if any damage was done to the bridge during the move.

- 57 re-usable strain transducers where used to recorded strain data.
Load Testing Process

- Set up Strain gages.
- Do a preliminary load test with a known vehicle.
- Create a FEM model of the Structure.
- Calibrate the FEM model using the data from the preliminary load test.
- Run load test during the movement.
- Analyze and post process data.
Instrumentation Plan
Load Response of Interior Girder.

Figure 9 Linear-elastic behavior from Heavy Hauler 1.
## Girder Distribution Factors

<table>
<thead>
<tr>
<th>BEAM</th>
<th>Predicted</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girder 1</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Girder 2</td>
<td>17%</td>
<td>18%</td>
</tr>
<tr>
<td>Girder 3</td>
<td>25%</td>
<td>29%</td>
</tr>
<tr>
<td>Girder 4</td>
<td>25%</td>
<td>28%</td>
</tr>
<tr>
<td>Girder 5</td>
<td>17%</td>
<td>18%</td>
</tr>
<tr>
<td>Girder 6</td>
<td>8%</td>
<td>2%</td>
</tr>
</tbody>
</table>
Conclusions

- The bridge was not significantly damaged during the move.
- FEM model was approximant, but non-conservative.
- Haulers weight information may not always be accurate.
- SPMT’s do not evenly distribute the weight between “units”.
- Load testing is a very helpful tool which has applications beyond just permitting.