Impact of Heavy Loads on State and Parish Bridges

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Acknowledgement

- Funds from Louisiana Transportation Research Center
- LA DOTD Personnel
- Project Review Committee
- LTRC Personnel
  - Mr. Harold “Skip” Paul,
  - Mr. Mark Morvant,
  - Mr. Walid R. Alaywan,
  - Mr. Masood Rasoulian,
  - Doc Zang
- Louisiana Tech University
- Dr. Xiang “Shawn” Zhou, Arun Guduguntla, Shouxin Wu, Shelly Brock, Derek Guillot
Outline

- Current truck load limits in Louisiana
  - Sugarcane truck loads study
  - Senate Concurrent Resolution 123
- Objectives of the study
- Scope of work
- Methodology
- Analyses, Results, and Fiscal Impact
- Field Verification – Long Term Monitoring
- Conclusions & Recommendations
Current Situation in Louisiana

- 80,000 lbs. GVW legal truck weight
- 86,600 lbs. GVW for trucks hauling timber with a permit for $10 per year
- 100,000 lbs. GVW for trucks hauling sugarcane with a permit for $100 per year
Sugarcane Truck Loads

- 2004 Study was funded by LTRC to Investigate the effects of sugarcane truck loads on Bridges in Louisiana
- GVW limits 100,000lbs and 120,000lbs
Study laws governing vehicles hauling La products in excess of standard limitations

Make recommendations / proposals for legislation to update such laws

Include in the study vehicles transporting the following La products:
  - Forestry products in their natural state

Evaluate the economic impact to the state & the industry if GVWs exceed present legal limits
Objectives

- If GVWs exceed present limits
  - Evaluate the characteristics of bridge girders and bridge decks under the heavy load
- Cost Study – determine the fiscal impacts on bridge systems
- Keeping in mind that timber and sugarcane economically viable to LA
SCOPE OF WORK

• Truck Loads
  - Standard Design Truck HS20-44, H15
  - FHWA 3S2 – Trucks hauling timber
    » (FHWA - Type9)
  - FHWA 3S3 – Trucks hauling sugarcane
    » (FHWA - Type10)

• Bridges
  - Louisiana State Routes
  - U.S. Numbered Routes
  - Parish Roads
Timber Trucks
Timber Trucks
**Work Plan – Timber**

- ID bridges used to transport Timber & select a sample for study
  - Work with La Forestry Association to ID routes timber hauled on La, US, & Parish
- Selection criteria based on:
  - The amount of timber harvest each parish produces
  - Geographic location in the state
- Select a sample for study
  - based on a review of the bridge inventory
- The selected bridges in the sample reviewed and grouped based on their Structure Types
Identification of the Critical Bridges

<table>
<thead>
<tr>
<th>County</th>
<th>Timber Value 2003 - $ Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernon</td>
<td>80</td>
</tr>
<tr>
<td>Bienville</td>
<td>60</td>
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<tr>
<td>Sabine</td>
<td>50</td>
</tr>
<tr>
<td>Jackson</td>
<td>40</td>
</tr>
<tr>
<td>Winn</td>
<td>40</td>
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<tr>
<td>Claiborne</td>
<td>30</td>
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<tr>
<td>Union</td>
<td>20</td>
</tr>
<tr>
<td>Rapides</td>
<td>20</td>
</tr>
<tr>
<td>Desoto</td>
<td>10</td>
</tr>
<tr>
<td>Webster</td>
<td>10</td>
</tr>
<tr>
<td>Natchitoches</td>
<td>10</td>
</tr>
</tbody>
</table>
Critical Bridges Considered

![Critical Bridges Chart](chart.png)
Sugarcane Truck Loads

- Study funded in 2004
- Impact on State Bridges
- Sugarcane fields in 24 parishes
- Truck GVW 100,000lbs can we increase GVW to 120,000lbs
Truck Load Applied in Analysis

- HS20-44
- 8,000 LBS.
- 32,000 LBS.
- 32,000 LBS.

Gross Vehicle Weight = 72,000 lbs
Truck Load Applied in Analysis

Louisiana Sugarcane

Gross Vehicle Weight = 120,000 lbs
Truck Load Applied in Analysis

Case 1  GVW=100 Kip, Max Tandem Load 48 Kip, Tridem Load 40 Kip

Case 2  GVW=100 Kip, Max Tandem Load 28 Kip, Tridem Load 60 Kip

Case 3  GVW=100 Kip, Uniformly Distributed Tandem and Tridem Loads

Case 4  GVW=120 Kip, Max Tandem Load 48 Kip, Tridem Load 60 Kip
Bridge Analysis Methodology

(Capacity vs. Demand)

- Methodology utilized
  - AASHTO LRFD, and Standard specifications
  - Spread sheets
  - Finite element models (FEM)
- Demand on the bridge girders based on
  - Span type, (simple span, continuous span)
  - Length of main span
- Capacity LRFD design recommendations
  - Strength criteria (flexure, shear and fatigue)
  - Serviceability (deflection)
- Short and long term effects on strength and safety of the bridges
- Cost models were set up and analyzed based on results from the analyses
Short Term Effects on Bridges

- The influence line analysis was performed first to determine the critical location of trucks on the bridges.
- The magnitude of the maximum moments and shear forces were calculated.
- The ratios of the results for overload truck and the design truck for flexural and shear forces were obtained.
- The serviceability criteria were evaluated for bridge girders based on their deflections.
Finite Element Approach

- Influence Line Analysis was Performed First to Determine the Critical Truck Location.
- Bridge Models 30ft wide and different Girder Spacing were Evaluated
- Both of Short Term and Long Term Effects were Evaluated
- Effects of Heavy Truck Load on Bridge Girders were Determined
  - FHWA 3S2 Truck Load (Type 9)
  - FHWA 3S3 Truck Load (Type 10)
Finite Element Model
Finite Element Model
Finite Element Model
Short Term Effects on Simply Supported Bridges
Design Load H15

Effects of 3S2 Truck on Simply Supported Bridge
Design Load H15

- Moment
- Shear
- Deflection

Span (ft)

<table>
<thead>
<tr>
<th>Span (ft)</th>
<th>Moment</th>
<th>Shear</th>
<th>Deflection</th>
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<tbody>
<tr>
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<tr>
<td>130</td>
<td>3.80</td>
<td>4.40</td>
<td>5.60</td>
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Short Term Effects on Simply Supported Bridges
Design Load HS20-44
Short Term Effects on Continuous Bridges
Design Load HS20-44

Effects of 3S2 Truck on Continuous Bridge
Design Load H20-44

- Positive Moment
- Negative Moment

Span Length (ft):

Truck 3S2 to HS20-44:

0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
1.60
1.70
20 30 40 50 60 70 80 90 100 110 120 130 140
Short Term Effects on Continuous Bridges
Design Load HS20-44
Short Term Effects on Simply Supported Bridges - FHWA 3S3 Truck Load – 5 Girders

- 5% to 10% Margin of Safety in Bridges Designed for HS20-44 Truck Load could be Applied from Previous Study.
5% to 10% Margin of Safety in Bridges Designed for HS20-44 Truck Load could be Applied from Previous Study.
Estimate Long Term Impacts On Bridge Girders

- Evaluate impact on
  - Fatigue
  - Serviceability of the bridges
- Results from analyses used to formalize a load rating approach to determine additional maintenance costs for highway bridges
Procedure to Calculate Weighted Average Cost per Trip

- Calculating the percent of Bridge Life:

\[
% \text{ of life} = \frac{(\text{Ratio from analysis})^3}{(2500 \text{ trucks per day} \times 365 \text{ days per year} \times 50 \text{ years})} \times 100
\]

- Average cost to replace bridge girders and bridge decks in 2004 was $90 per square foot
## Summary of Cost Bridges

<table>
<thead>
<tr>
<th>Bridge Type</th>
<th>Design Truck</th>
<th>Truck Type</th>
<th>GVW</th>
<th>Cost per Trip</th>
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<tbody>
<tr>
<td>Simple</td>
<td>H15</td>
<td>FHWA 3S2</td>
<td>100k</td>
<td>$8.5</td>
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<tr>
<td>Simple</td>
<td>HS20-44</td>
<td>FHWA 3S2</td>
<td>100k</td>
<td>$5.75</td>
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<td></td>
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<td></td>
<td>Parish $1.05</td>
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<td>HS20-44</td>
<td>FHWA 3S2</td>
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<tr>
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<td>HS20-44</td>
<td>FHWA 3S3</td>
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<tr>
<td>Simple</td>
<td>HS20-44</td>
<td>FHWA 3S3</td>
<td>100k</td>
<td>Uniform $0.9</td>
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<tr>
<td>Simple</td>
<td>HS20-44</td>
<td>FHWA 3S3</td>
<td>120k</td>
<td>$11.75</td>
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</table>
Field Verification

- A field calibrated finite element model was used for live load test and load rating
- Results indicate that the structure has adequate strength to resist both bending and shear forces
- Installed Long Term Monitoring System
Long Term Monitoring System
Long Term Monitoring System
Long Term Monitoring System
Long Term Monitoring System
Data Acquisition
Recommendations

- The current permit fees on 3S2 and 3S3 trucks will Not cover the additional maintenance and repair cost for concrete bridge girders due to the new loads.
- Agriculture harvest is important part of LA’s economic base.
- If GVW to be increased then axle configuration should be modified.
- Long Term Monitoring Systems.
Thank you

Comments / Questions