Impact of Heavy Loads on State and Parish Bridges

Aziz Saber, Ph.D., P.E.
Program Chair Civil Engineering
Louisiana Tech University

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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

Senate Concurrent Resolution 123

- **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

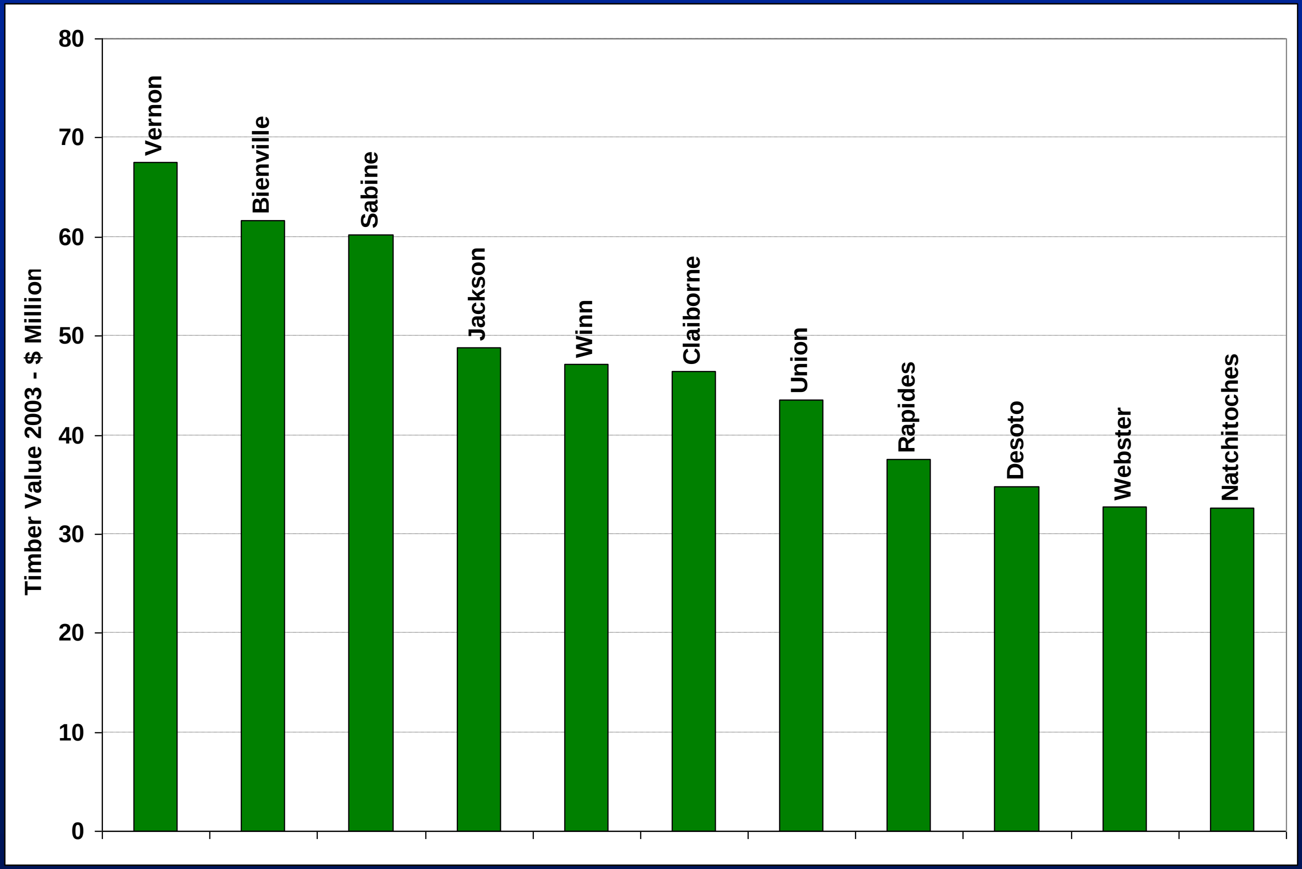
Timber Trucks

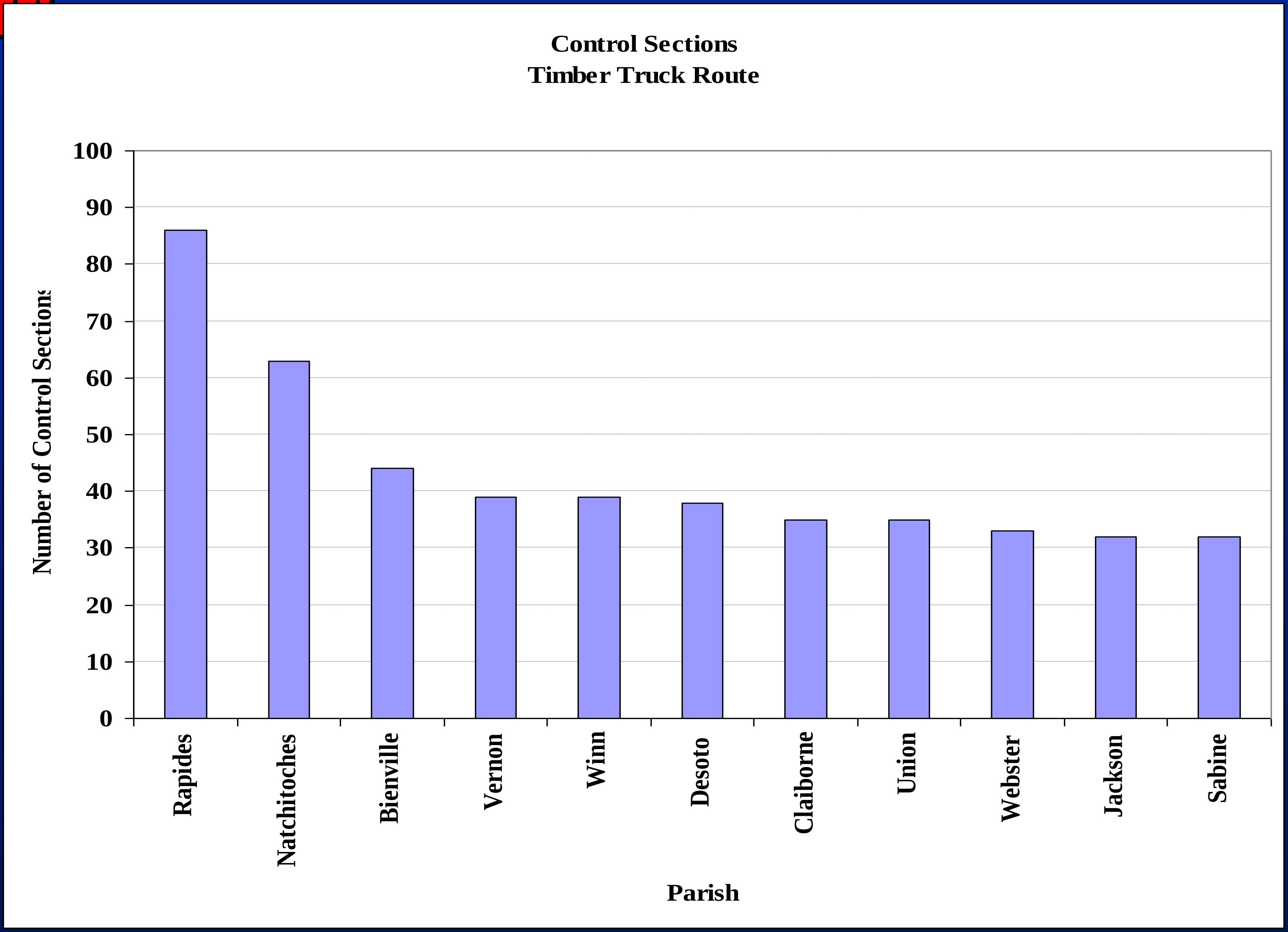

Marlboro
$ 3.19
Pack

Work Plan – Timber

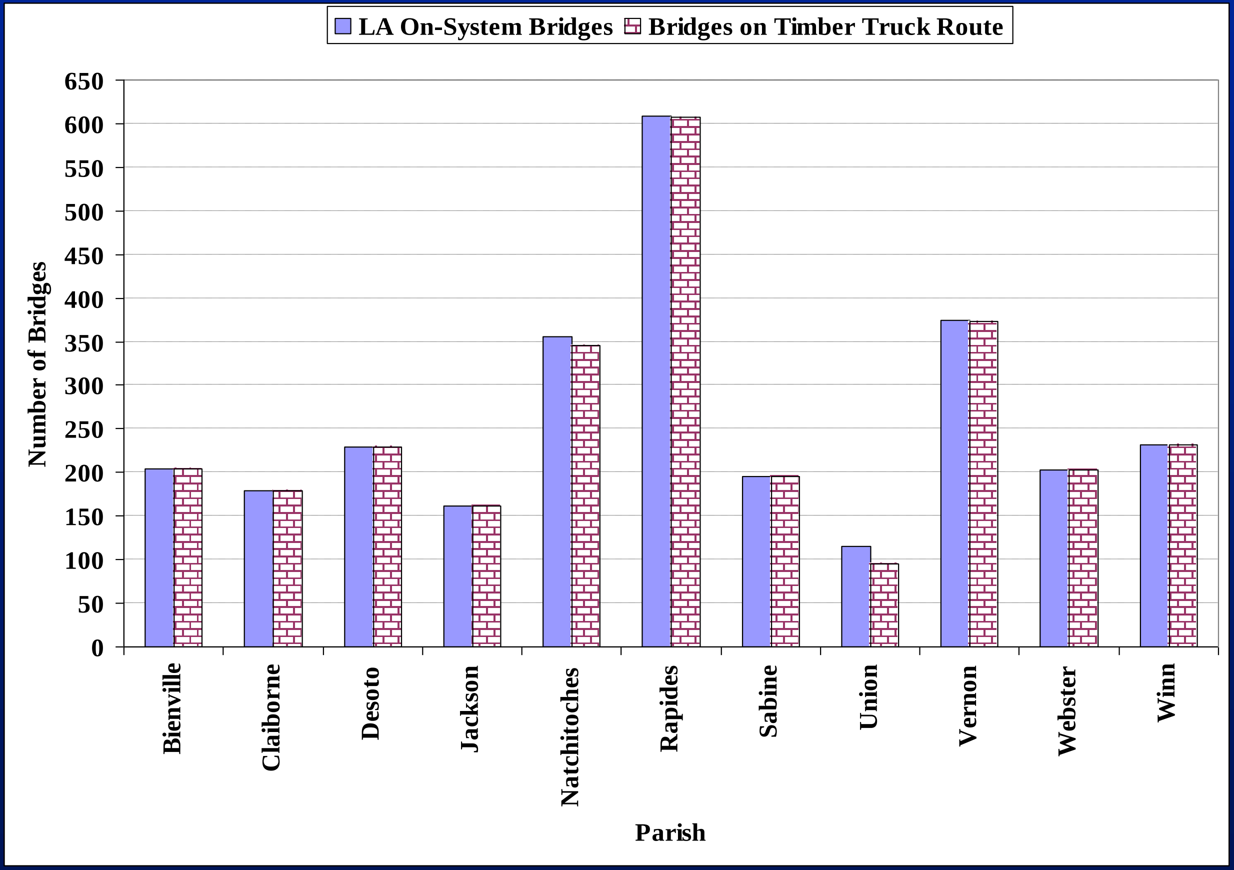
- ID bridges used to transport Timber & select a sample for study
  - Work with La Forestry Association to ID routes timber hauled on La, US, & Parish
- Selection criteria based on:
  - The amount of timber harvest each parish produces
  - Geographic location in the state
- Select a sample for study
  - 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



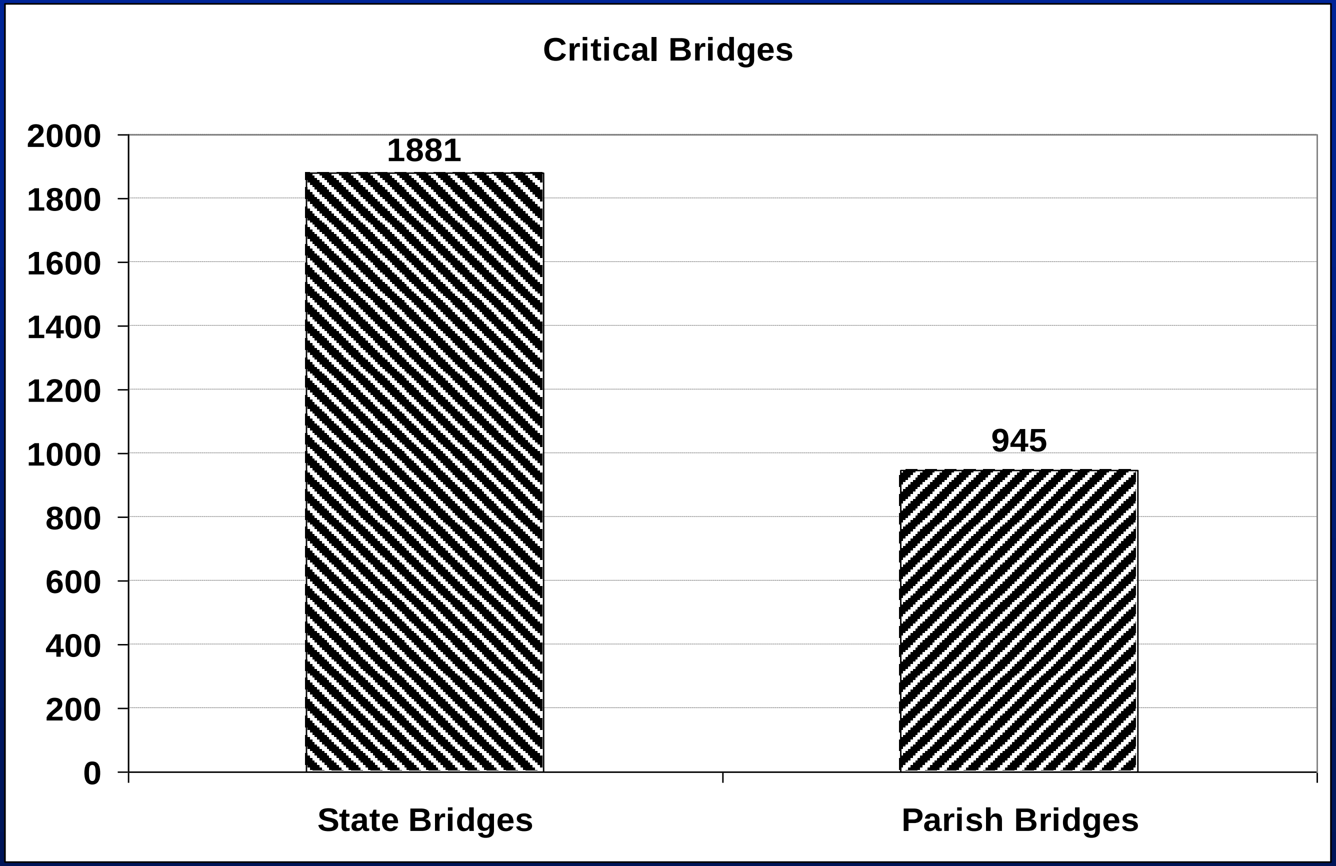

Control Sections
Timber Truck Route
Number of Control Sections
100
90
80
70
60
50
40
30
20
10
0
Rapides
Natchitoches
Bienville
Vernon
Winn
Desoto
Claiborne
Union
Webster
Jackson
Sabine
Parish

Bridge Data



LA On-System Bridges
Bridges on Timber Truck Route
Number of Bridges
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Bienville
Claiborne
Desoto
Jackson
Natchitoches
Rapides
Sabine
Union
Vernon
Webster
Winn
Parish

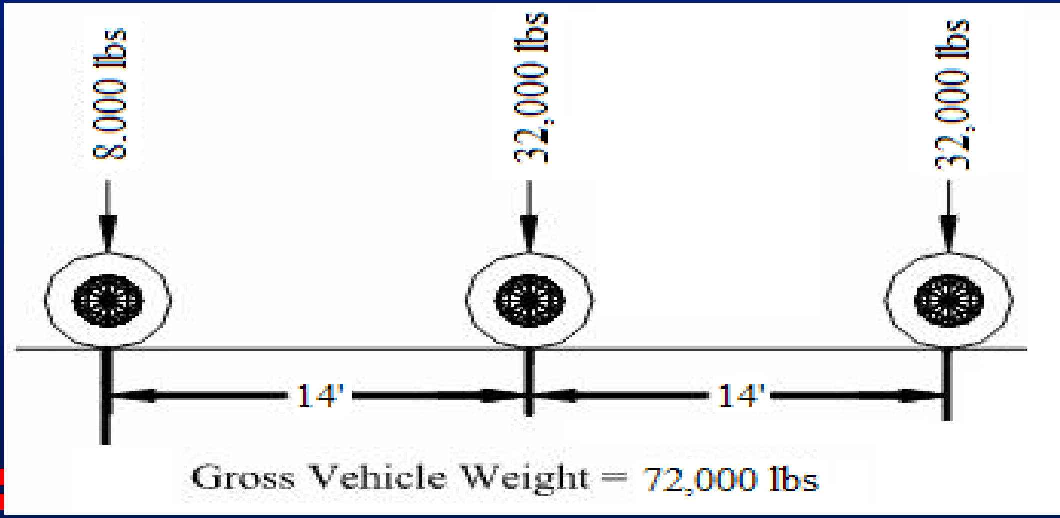
Critical Bridges Considered

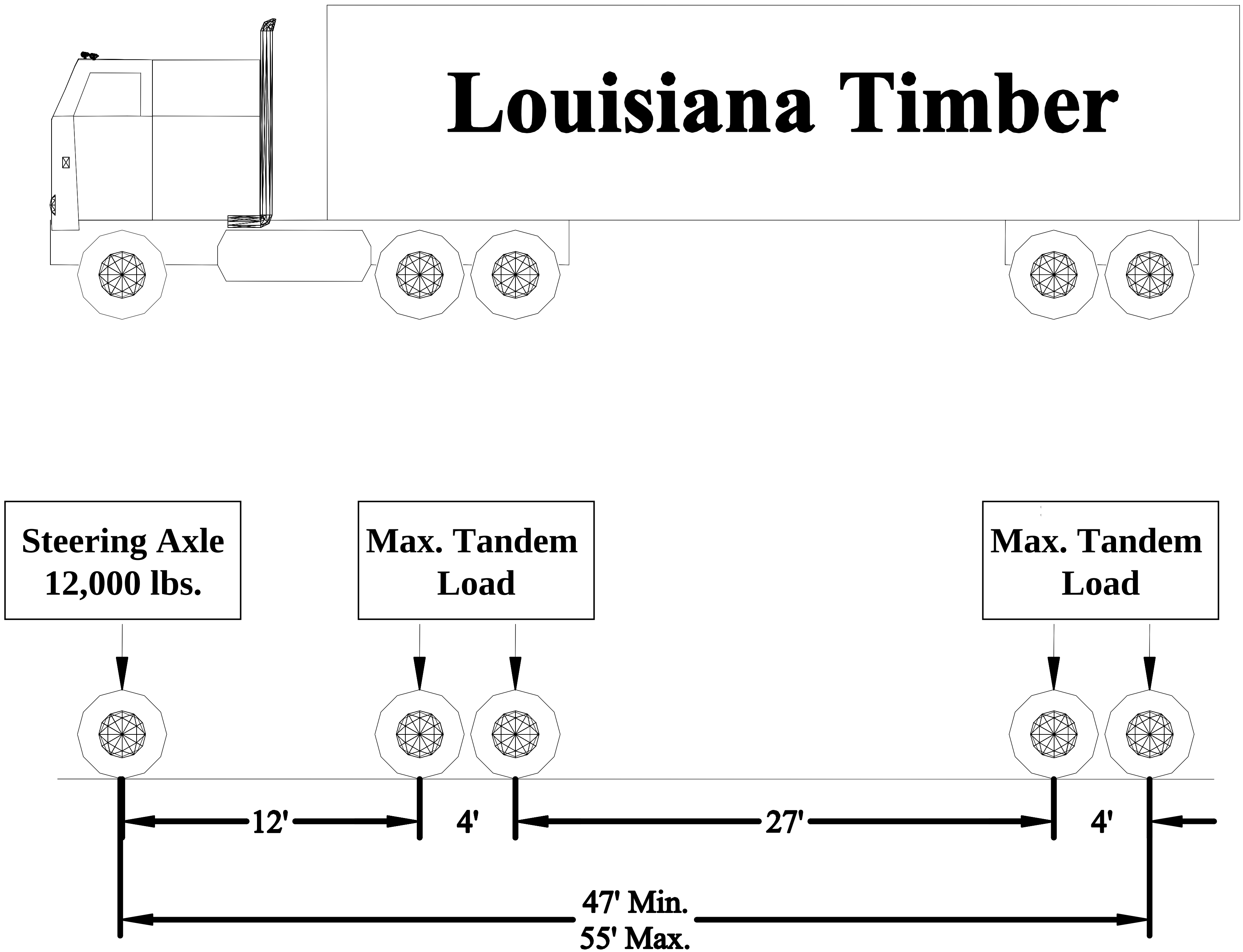


Sugarcane Truck Loads

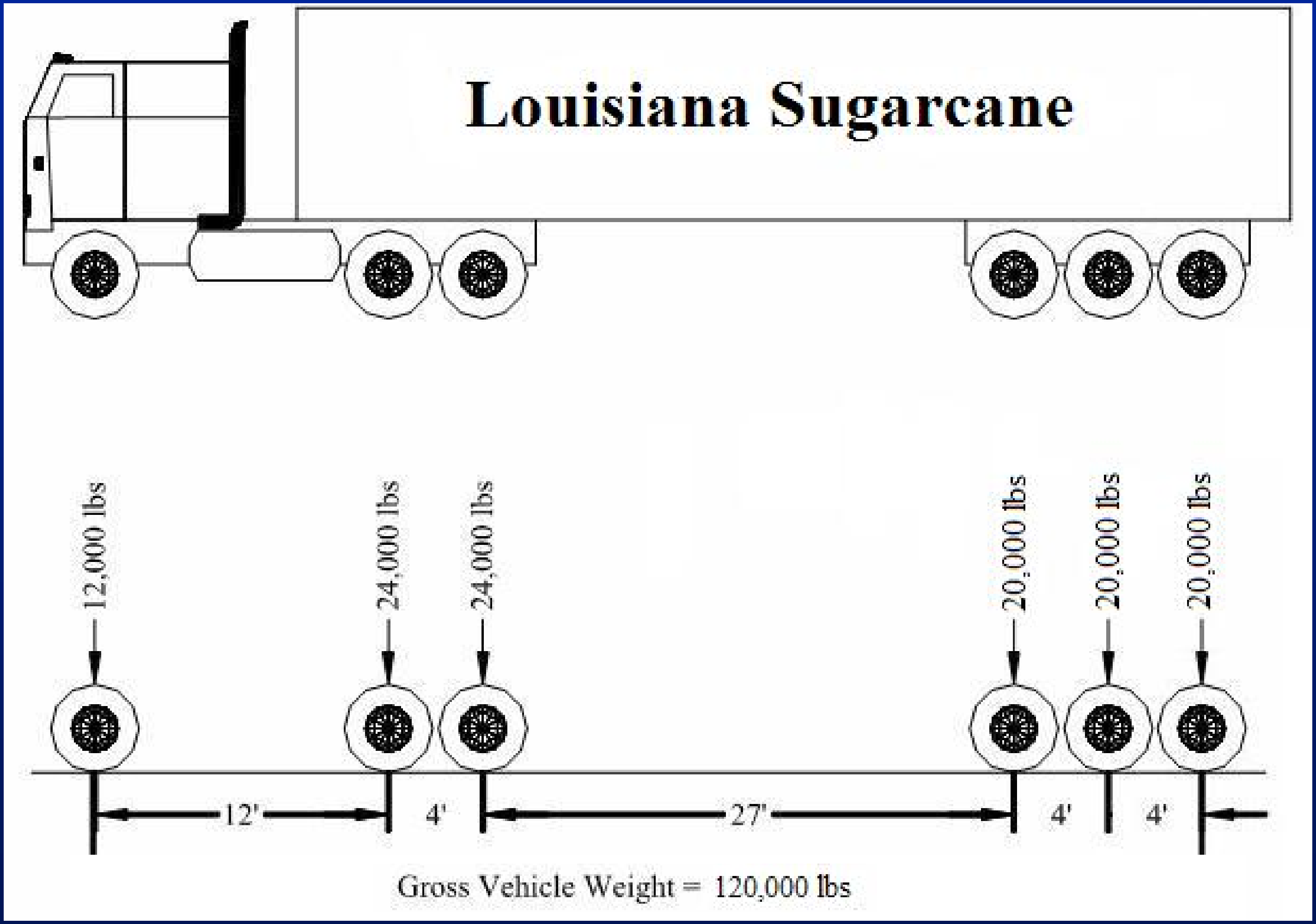
- Study funded in 2004
- Impact on State Bridges
- Sugarcane fields in 24 parishes
- Truck GVW 100,000lbs can we increase GVW to 120,000lbs

Truck Load Applied in Analysis

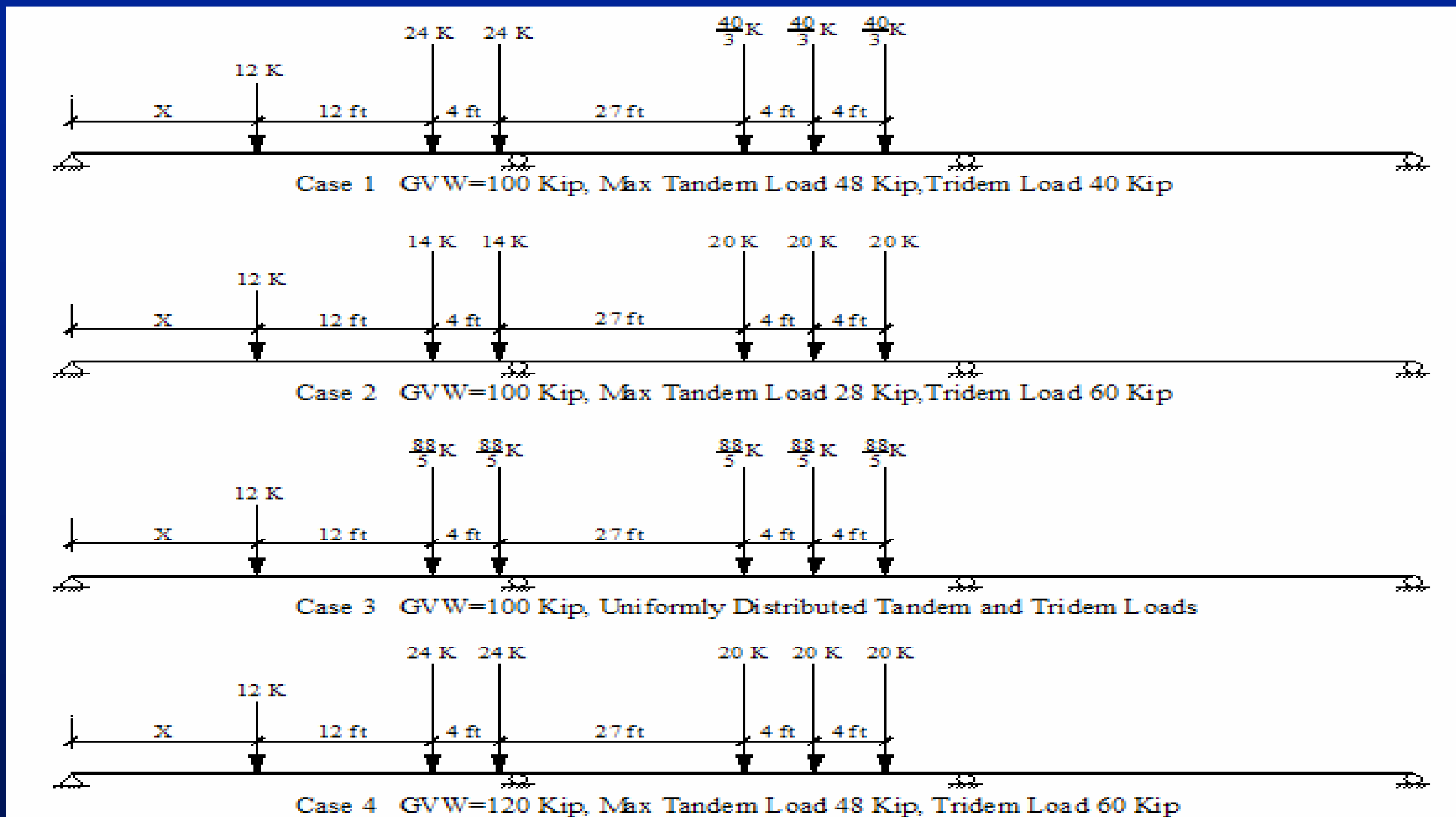



Louisiana Timber
Steering Axle
12,000 lbs.
Max. Tandem
Load
Max. Tandem
Load
12'
4'
27'
4'
47' Min.
55' Max.

Truck Load Applied in Analysis



Truck Load Applied in Analysis



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

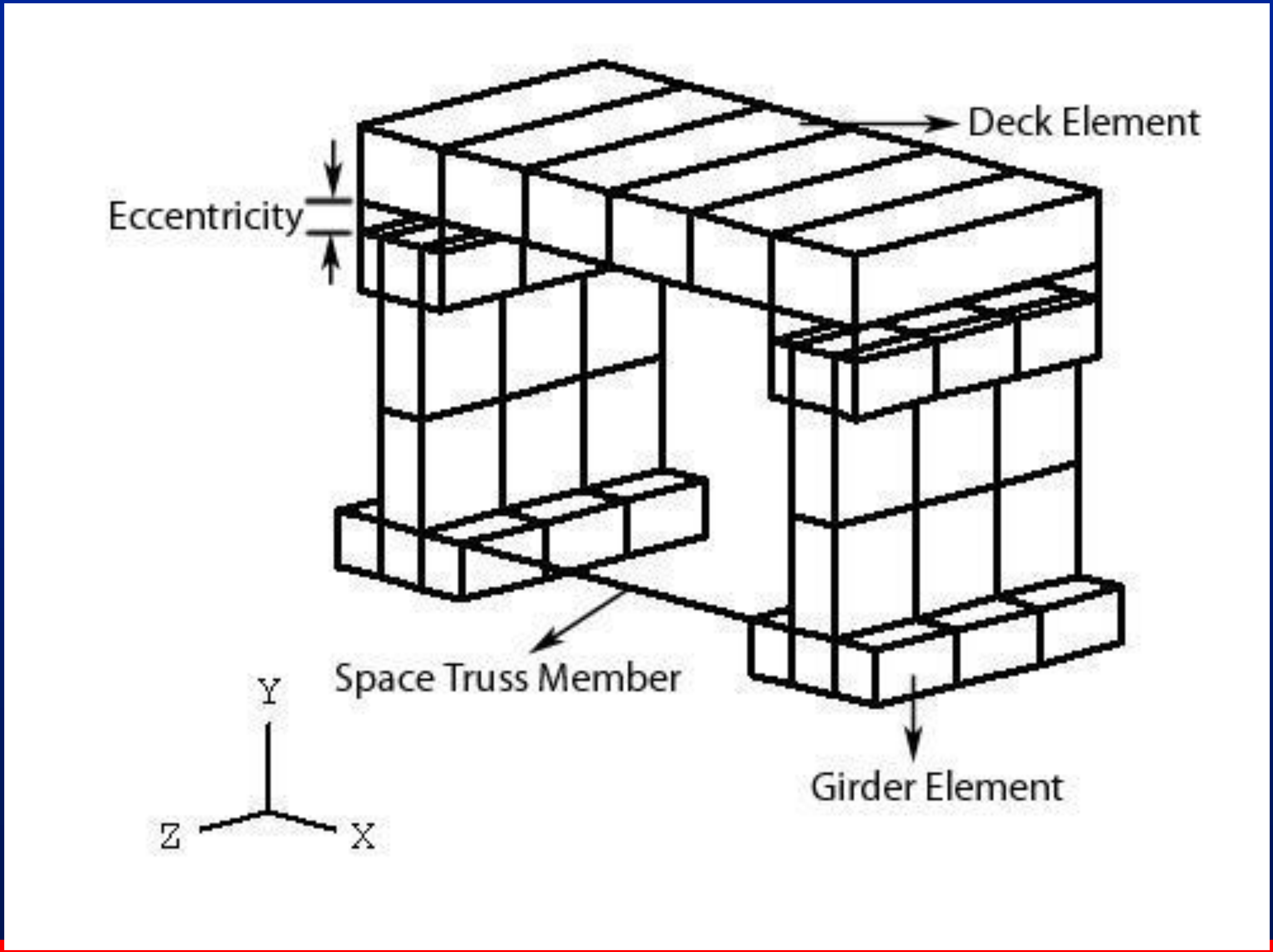
Short Term Effects on Bridges

- 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

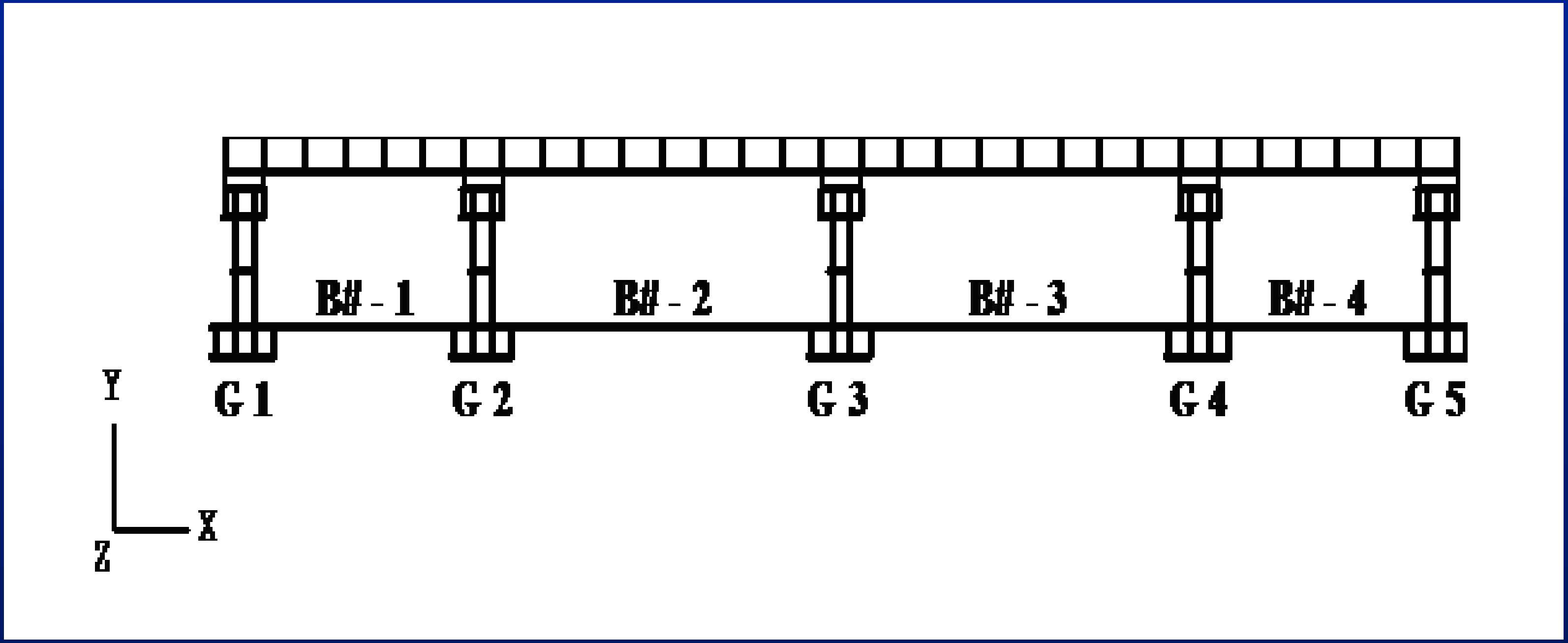
Finite Element Approach

- 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)

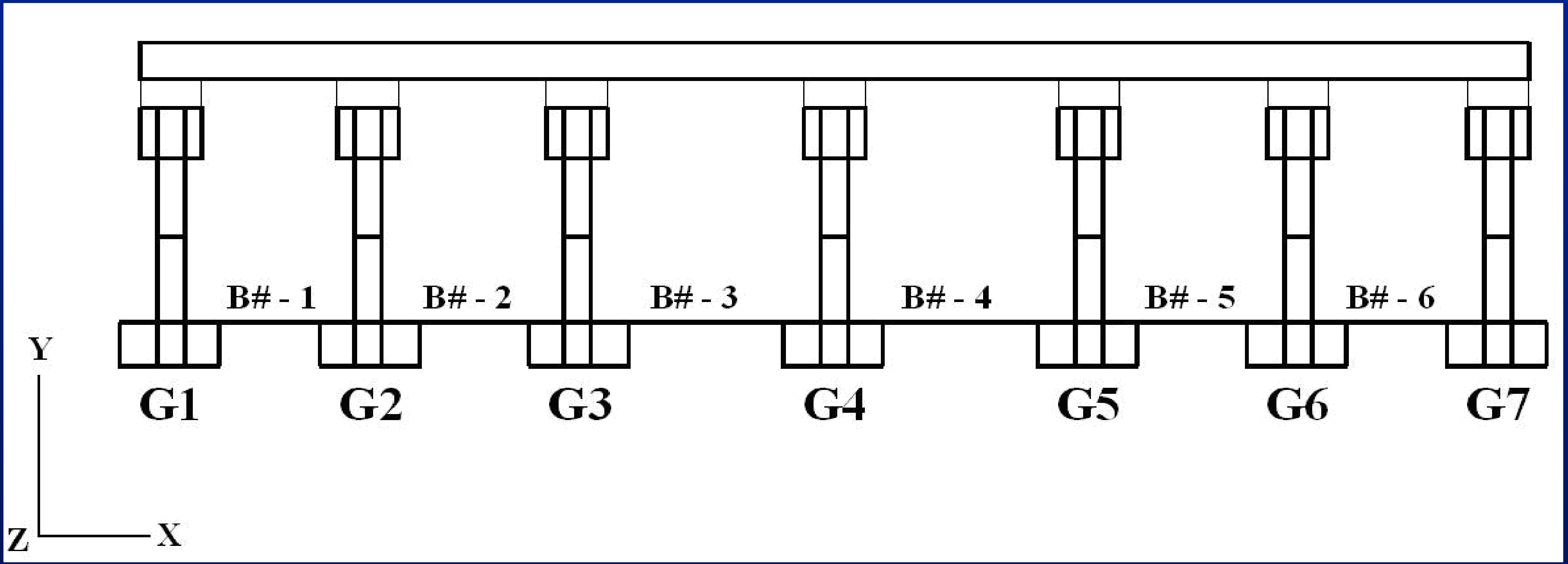
Finite Element Model



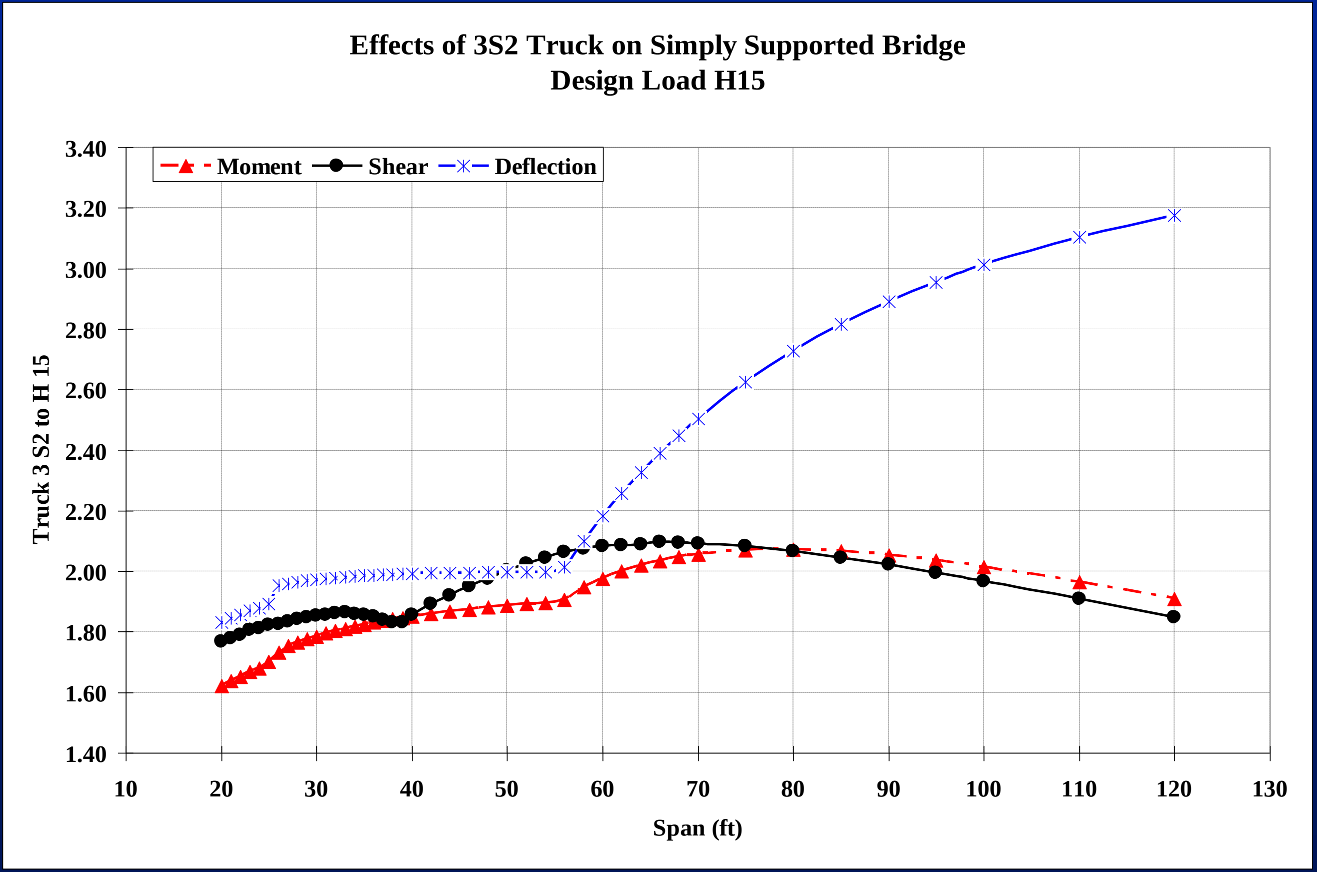
Finite Element Model



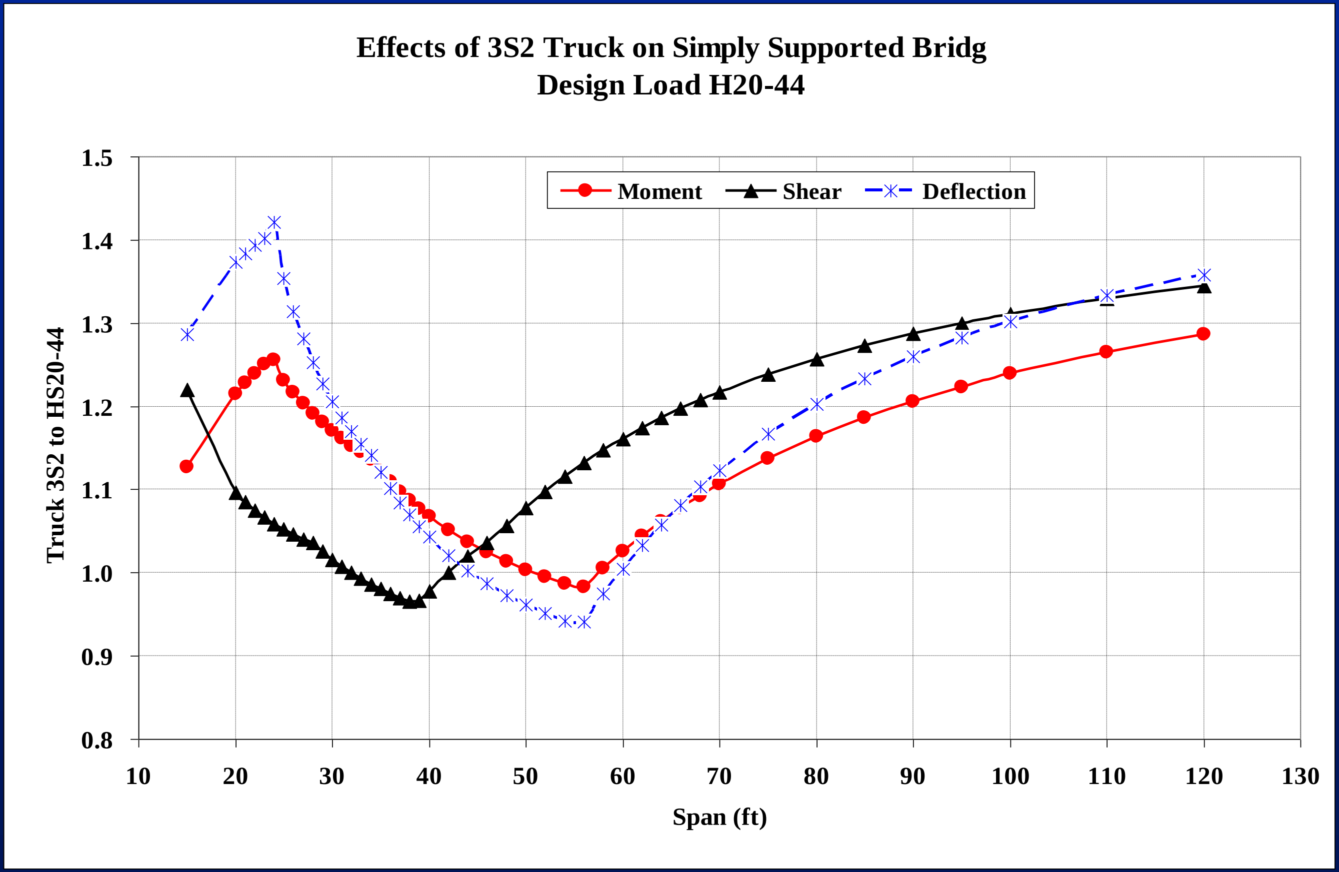
Finite Element Model



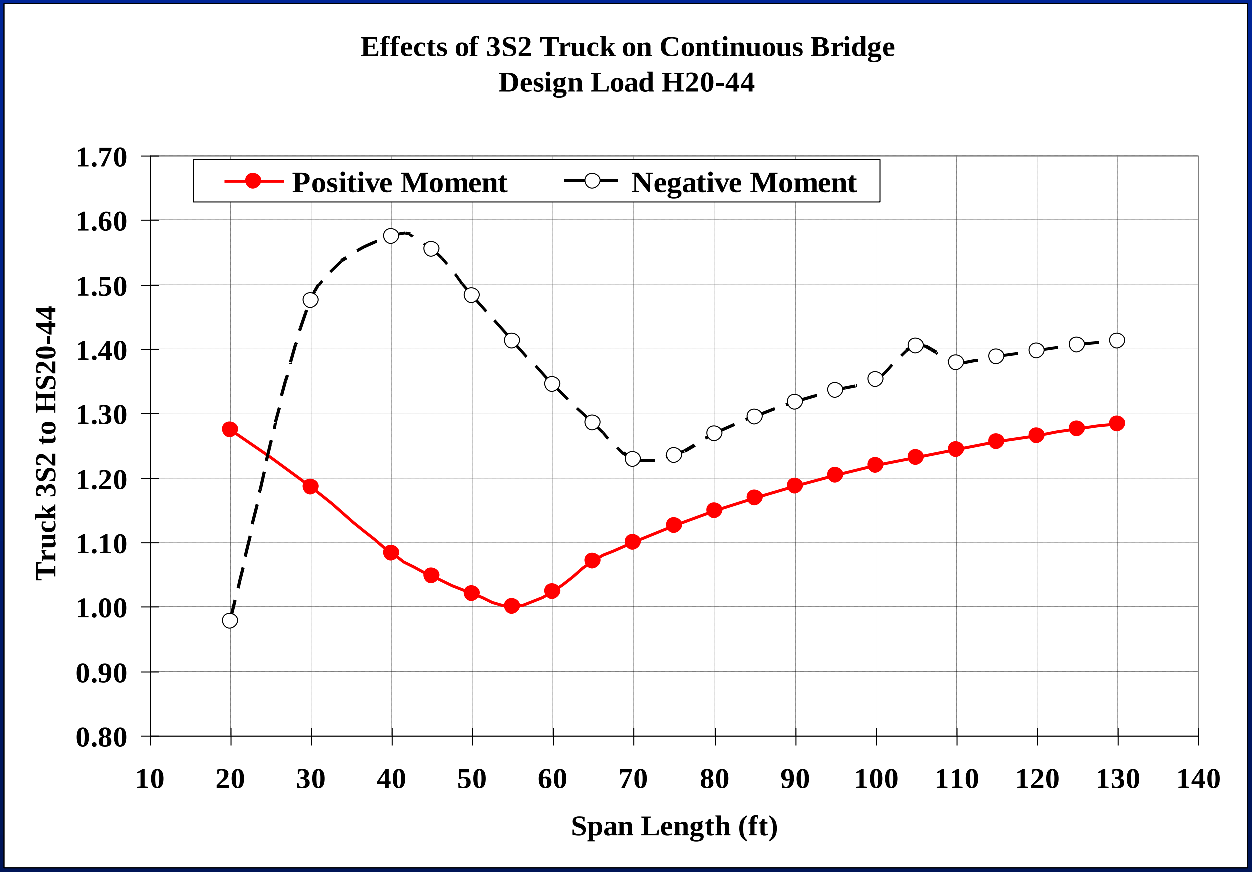
Short Term Effects on Simply Supported Bridges Design Load H15



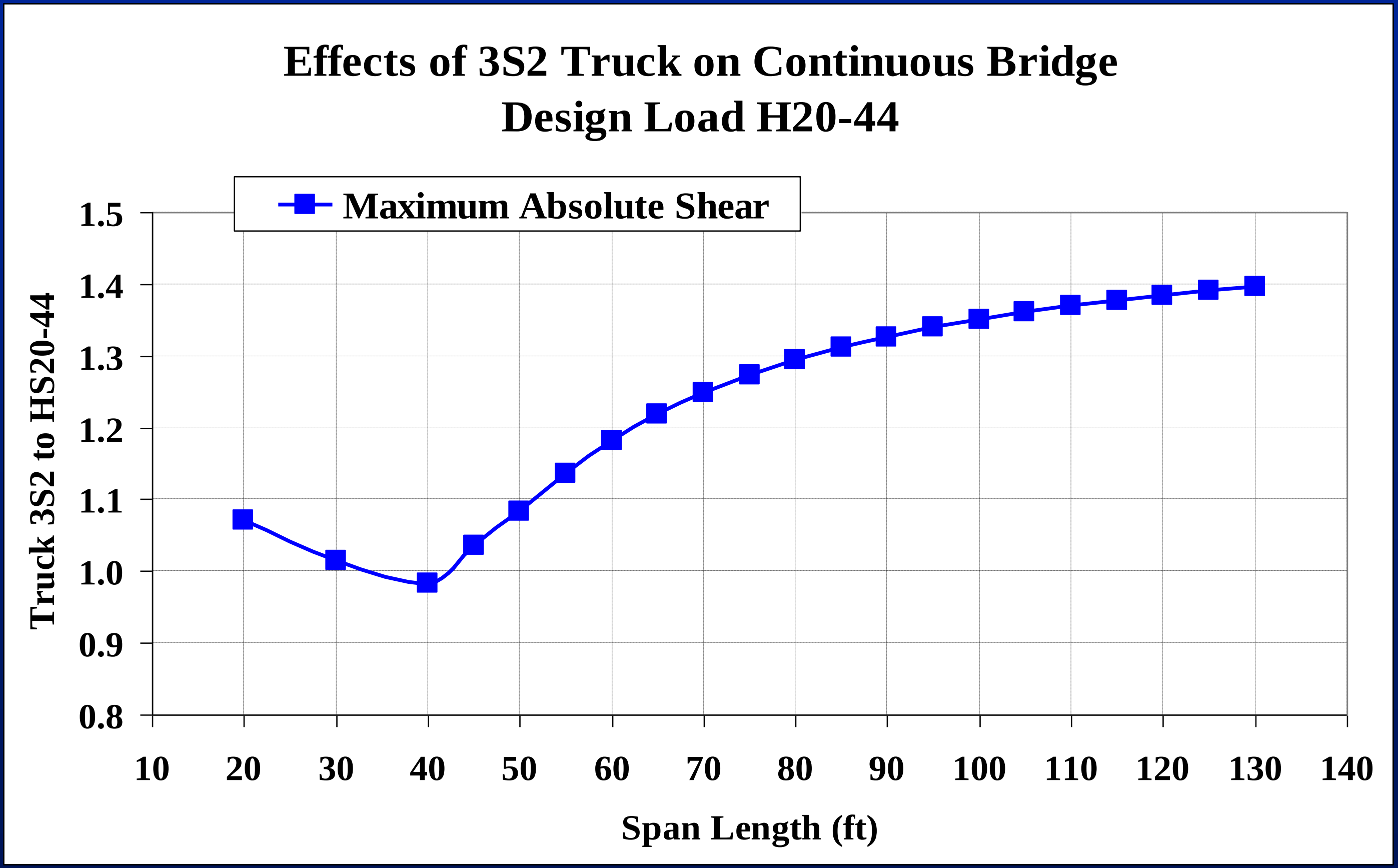
Short Term Effects on Simply Supported Bridges Design Load HS20-44



Short Term Effects on Continuous Bridges Design Load HS20-44

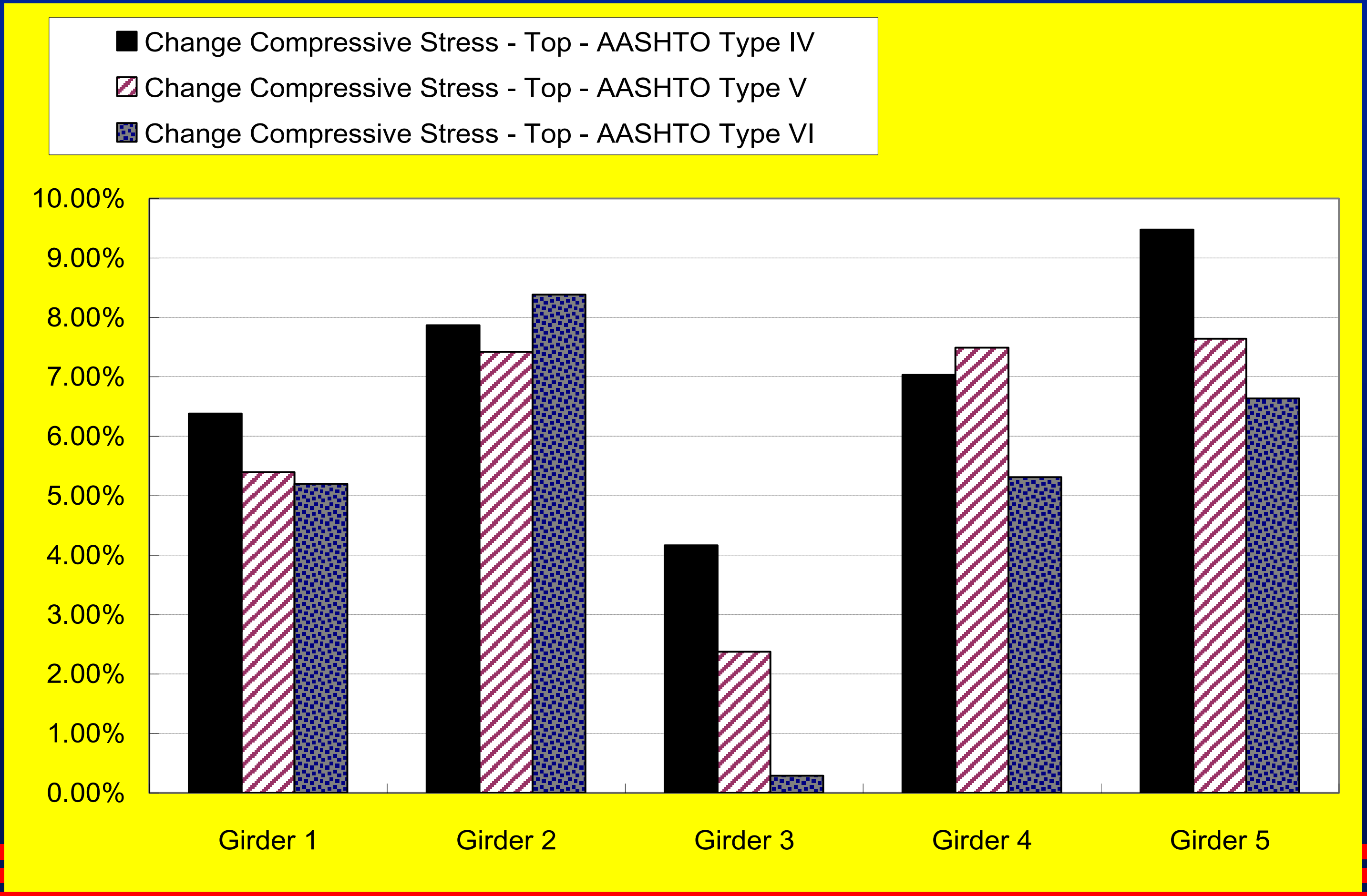


Short Term Effects on Continuous Bridges Design Load HS20-44



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.



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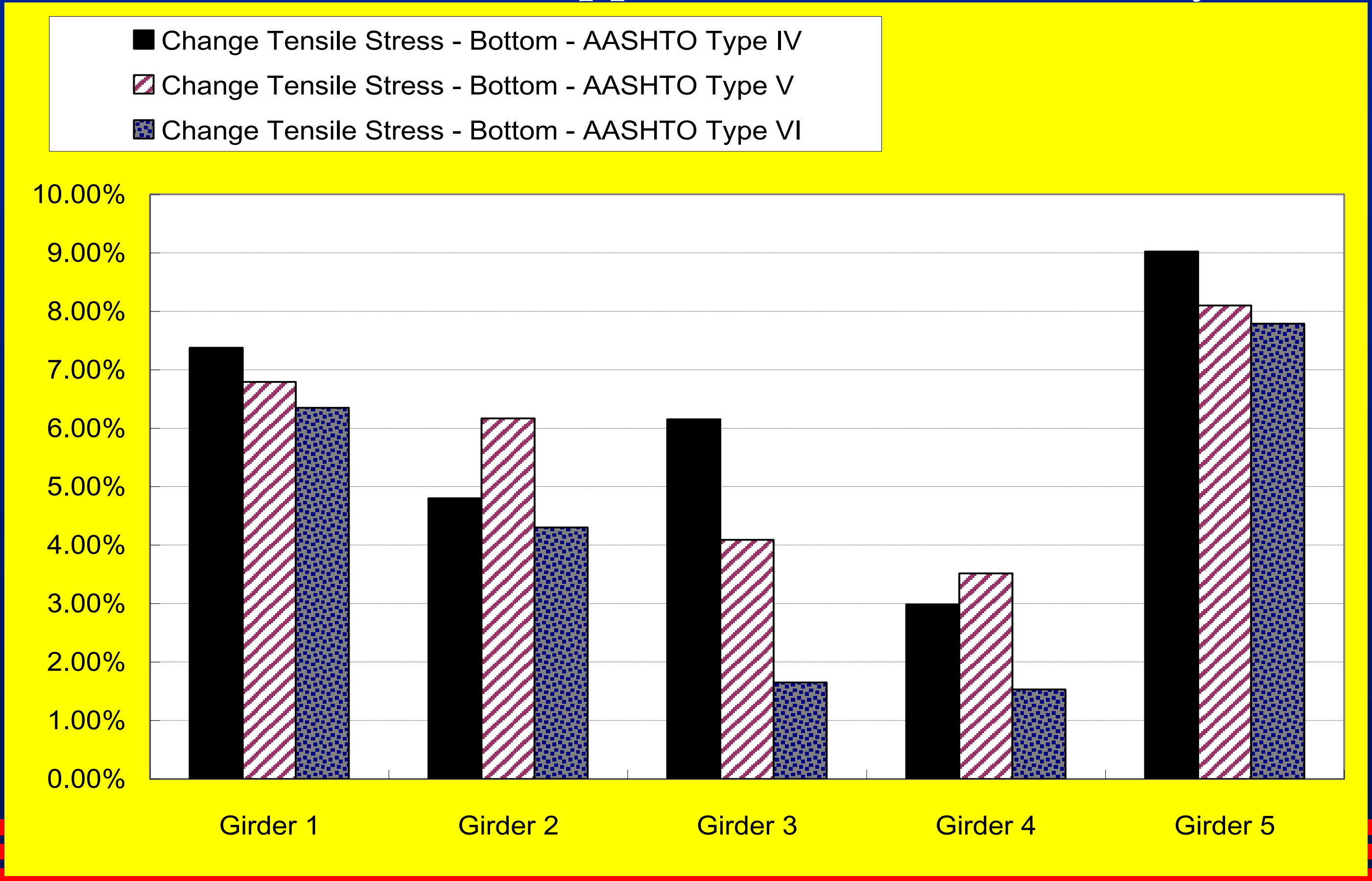

Estimate Long Term Impacts On Bridge Girders

- 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:**

(Ratio from analysis)^3

% of life = --- 100*

*(2500 trucks per day * 365 days per year * 50 years)*

- **Average cost to replace bridge girders and bridge decks in 2004 was $90 per square foot**

Summary of Cost Bridges

Bridge Type	Design Truck	Truck Type	GVW	Cost per Trip
Simple	H15	FHWA 3S2	100k	$8.5
Simple	HS20-44	FHWA 3S2	100k	$5.75 Parish $1.05
Continuous	HS20-44	FHWA 3S2	100K	$8.9
Continuous	HS20-44	FHWA 3S3	100k	$8.9
Simple	HS20-44	FHWA 3S3	100k Uniform	$0.9
Simple	HS20-44	FHWA 3S3	120k	$11.75

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


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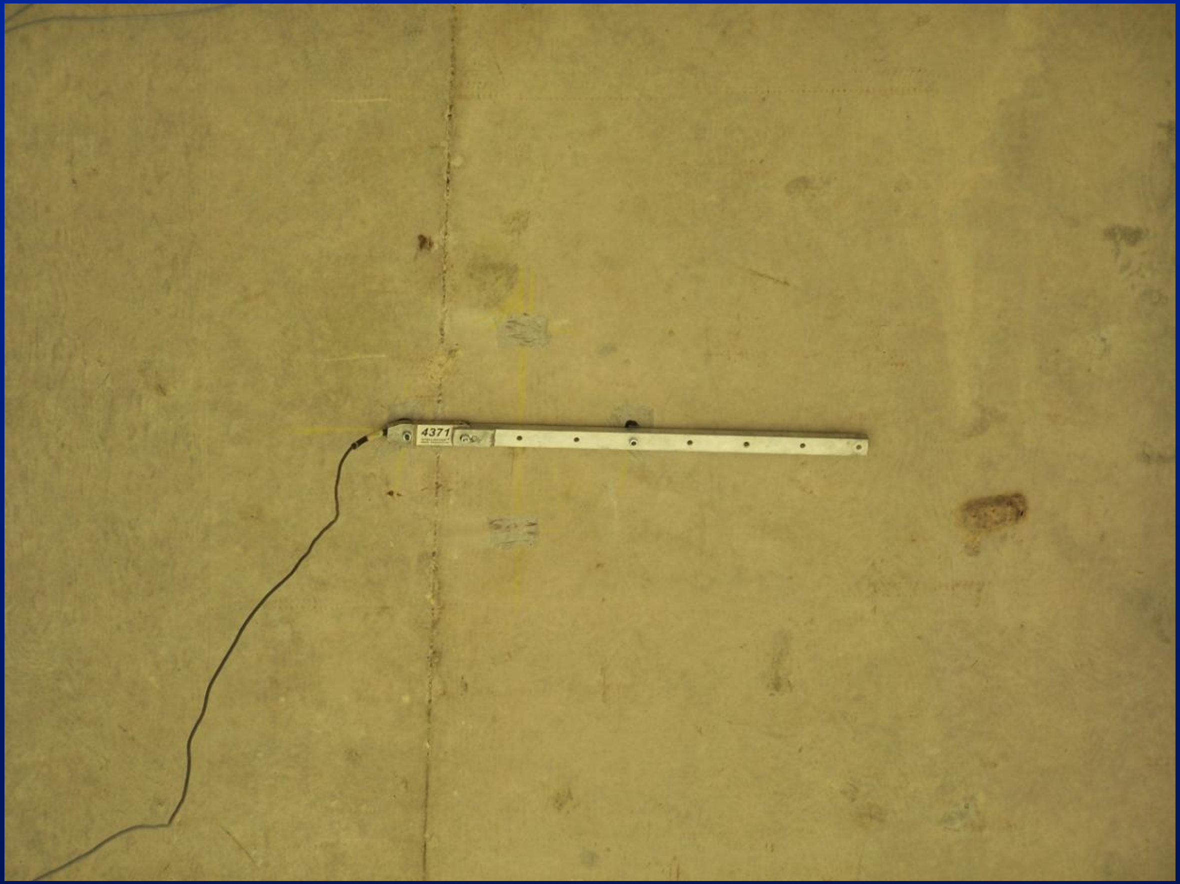
Long Term Monitoring System

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