UTC Conference

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Impact of doubling heavy vehicles on bridges

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Introduction

- Use of heavy vehicles (18 wheelers) is critical for logistics and economic success
  - National projections predict that freight shipments will double in the next ten years.
  - In 2007 in United States, 12.8 billion tons of freight was transported by trucks and it is expected to be 18.40 billion tons in 2040.
  - Increase must be accommodated by increasing the number of trucks, increasing the weight of trucks, or both.

Introduction (cont.)

- Increasing the number of heavy vehicles or the weight of heavy vehicles is detrimental to bridge lifetime.
  - Congestion problem due to increased number (i.e., doubling) of heavy vehicles thus must be attacked.
  - Moreover, additional repetitive loading may cause fatigue cracking in these bridge superstructures and limit the service life of a bridge.

Introduction (Cont.)

- One essential issue is then how to increase the load capacity of trucks.

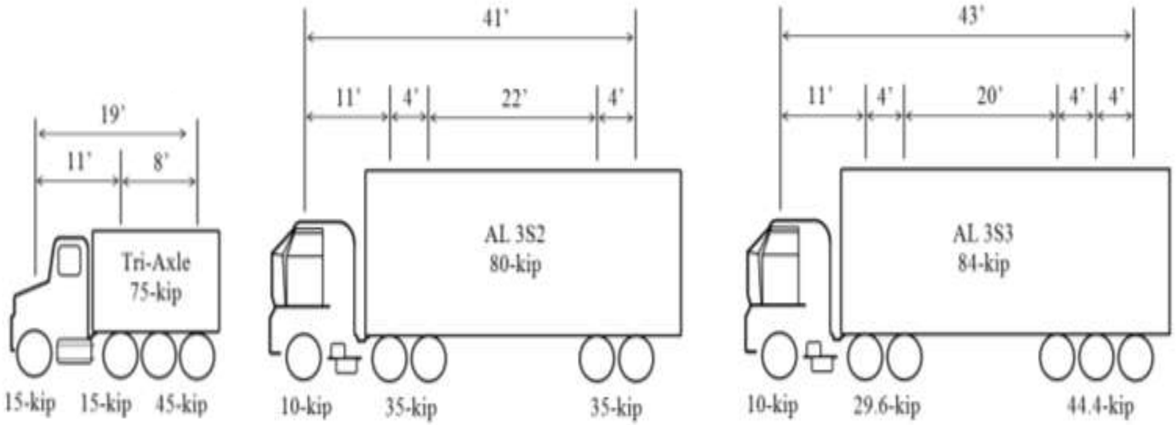
- Today this is to a very large extent connected to the masses and dimensions, which are strictly regulated. The state of Alabama is designated “a focused state” for truck issues.

- Consideration will be given to the congressionally proposed 97,000 lbs., six-axle configuration, as well as other configurations of heavy trucks in use in Canada, a NAFTA partner of USA. The state of Florida with major ports serving as hubs for surface transportation with heavy vehicles will benefit greatly from this research.

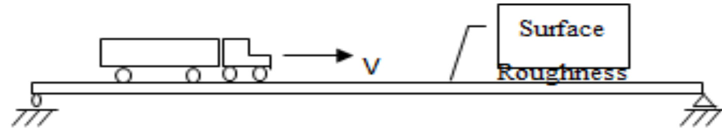
Objectives

1. Investigate the effect of meeting increasing freight demands on bridges.
2. Compare the effect of heavier trucks to the effect of doubling the number of heavy vehicles under the present legal weight restrictions.
3. Calculate the characteristic bridge traffic load effects bridges of different lengths.
4. Characterize the traffic measured by WIM data in terms of its influence on characteristic bridge load effect
5. Calculate the cost effect of increasing loads on bridges

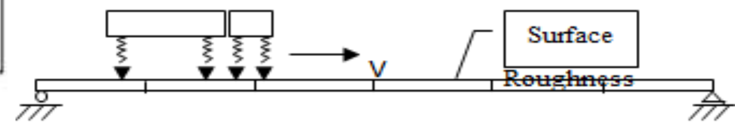
Possible Trucks for Modeling Purposes



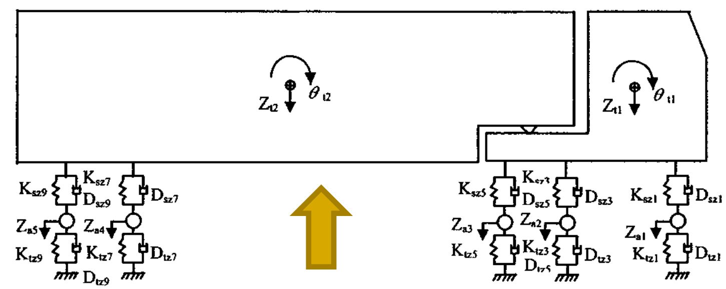
AL-Tri-axle AL 3S2 AL 3S3

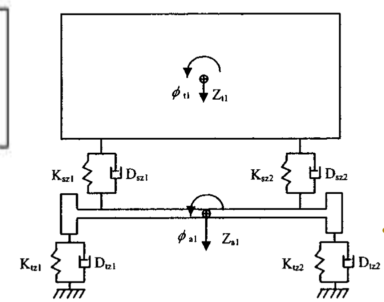


Realistic Truck-Bridge System

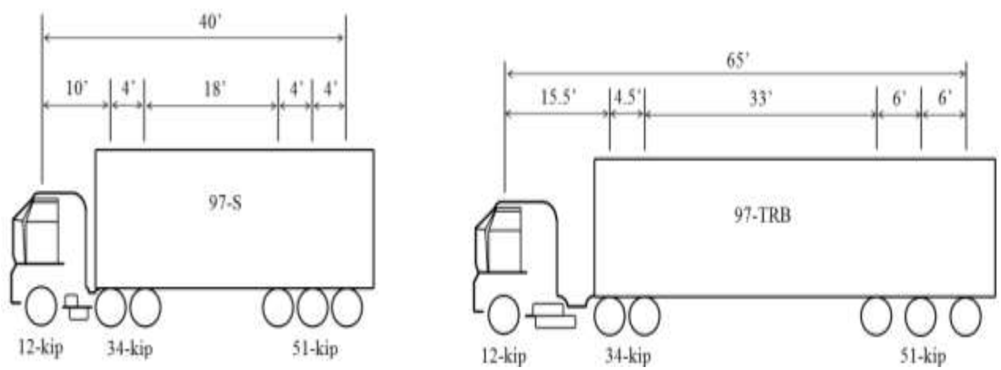


Simplified Truck-Bridge Model



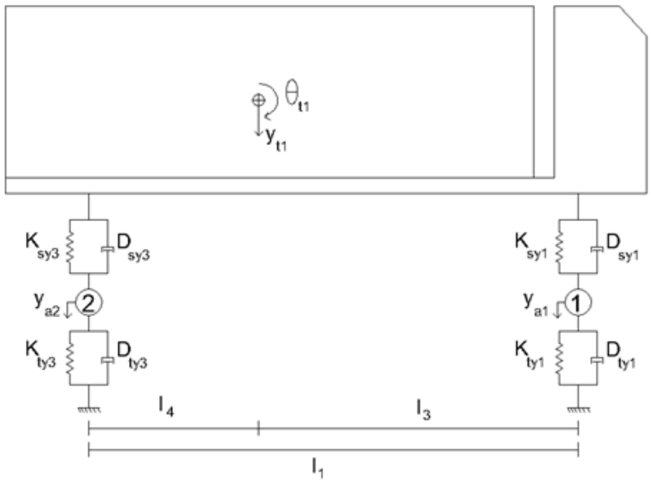


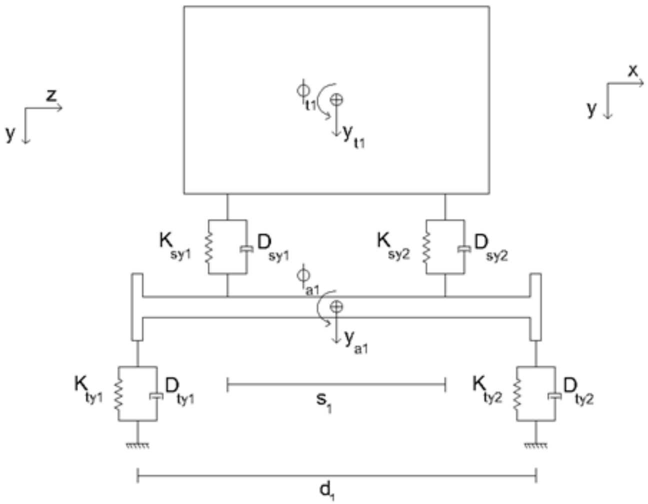
Side and front View of Simplified Truck-Bridge Model

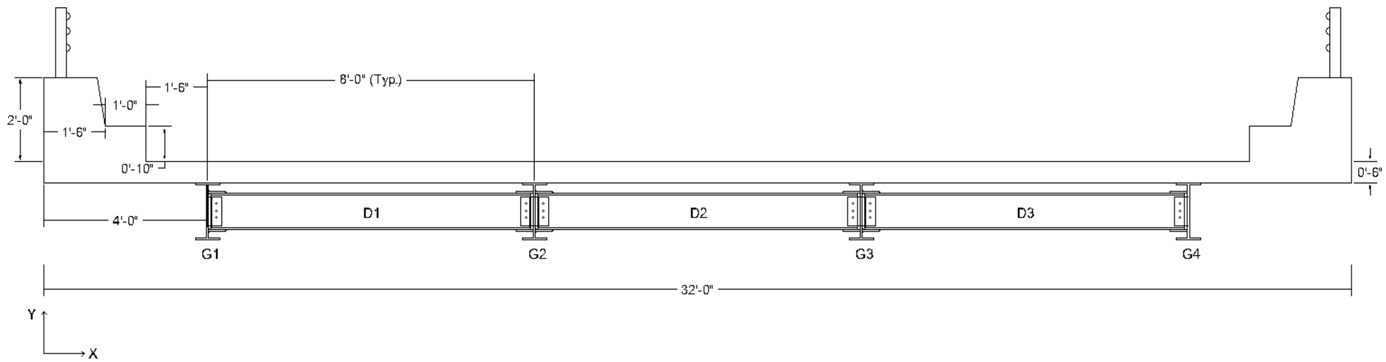


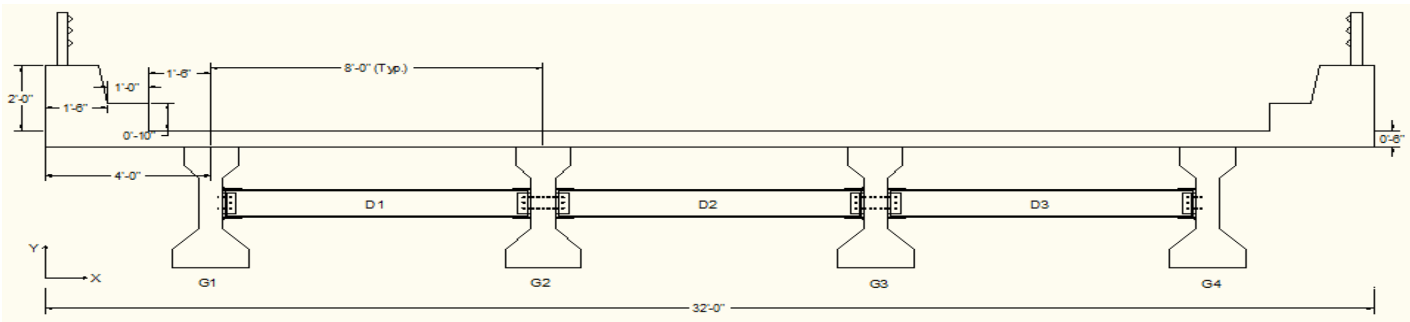
Proposed 97 kip Trucks (97-S & 97-TRB)

Truck Models (Equations of Motion for "H20-44 Truck") and Bridge Types for Fatigue Analysis



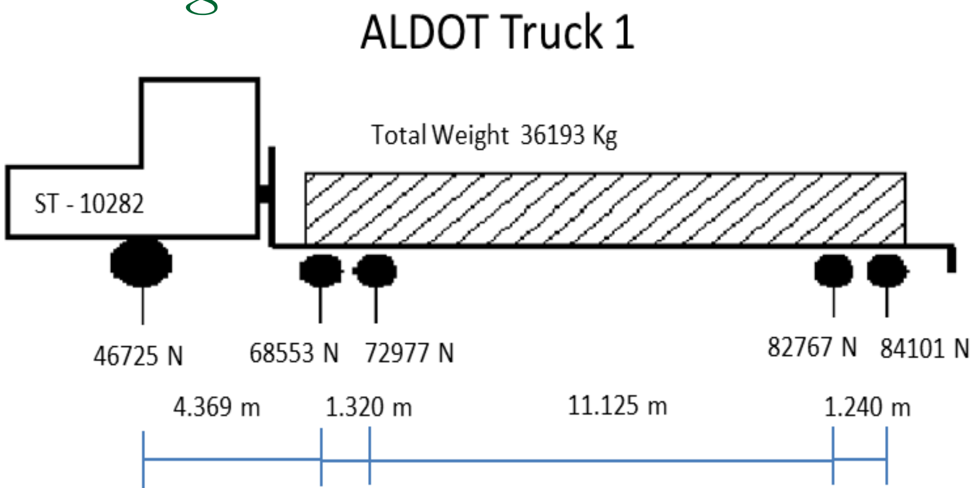




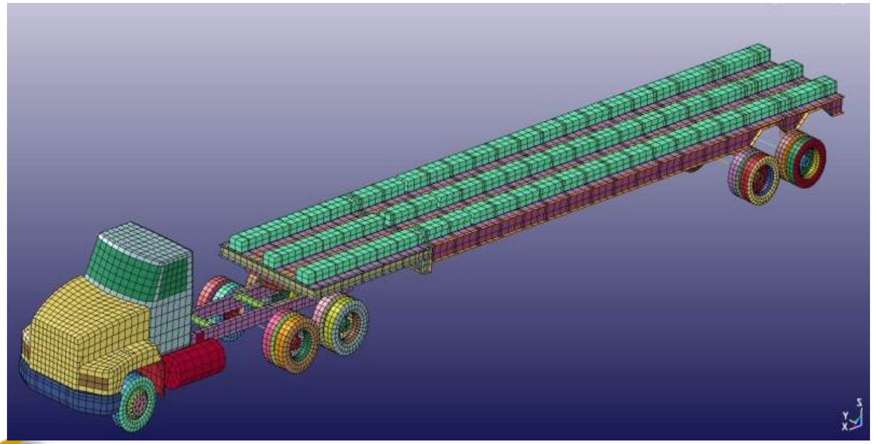


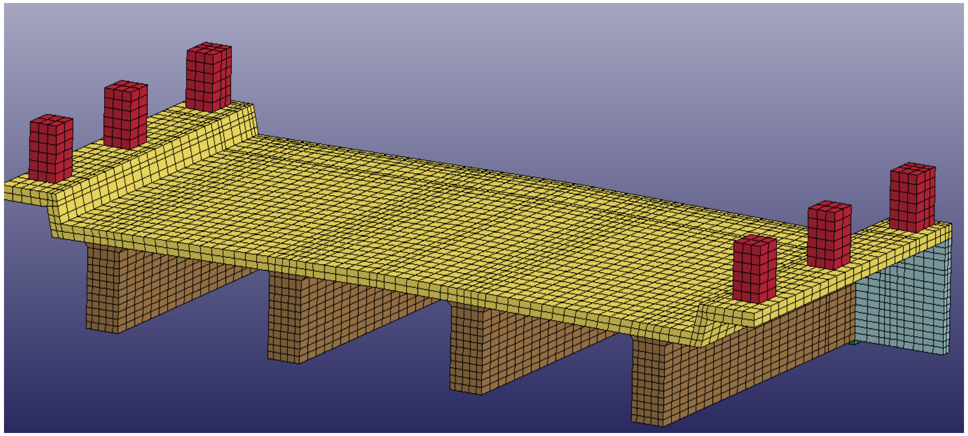
Detailed FE Modeling of a Bridge

for proposed congressional legislation on increasing truck weight



ALDOT 5Axle Calibration Truck (Left) Schematic (Right) Real



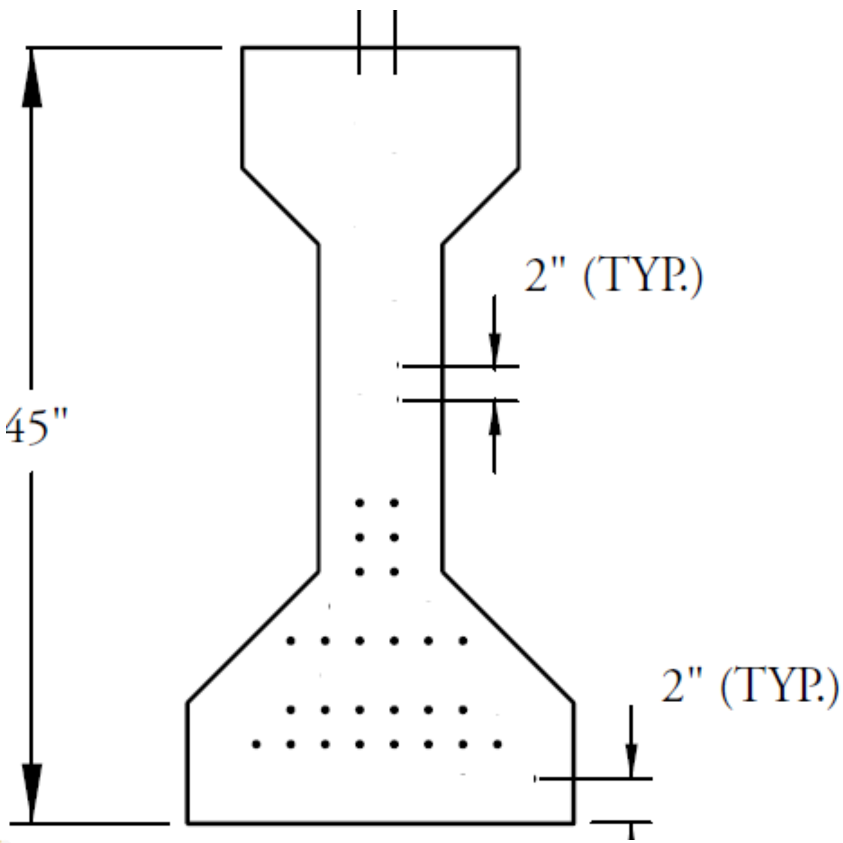


Modeled of ALDOT 5Axle Truck and Bridge using LS-DYNA for B-WIM FEA

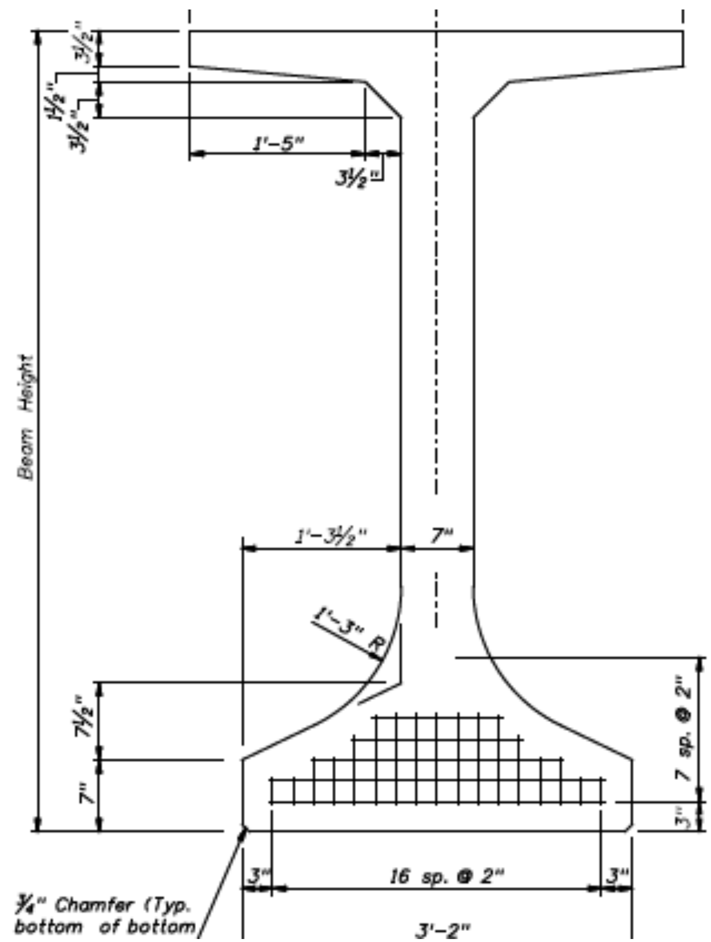
We explore how existing (conventional AASHTO) and future bridges (Florida I-Beam Girder) will perform

This presentation will focus on this specific results obtained at UCF

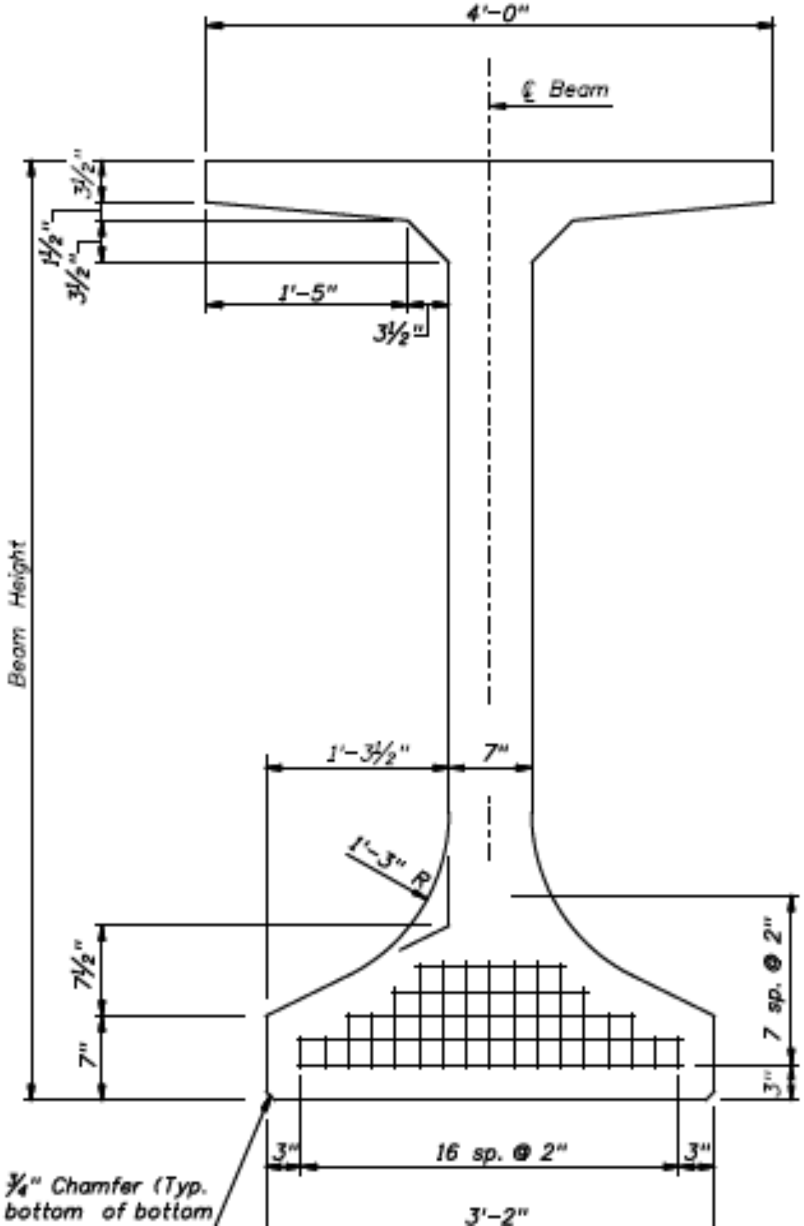
AASHTO Girder



Florida I-Beam Grider



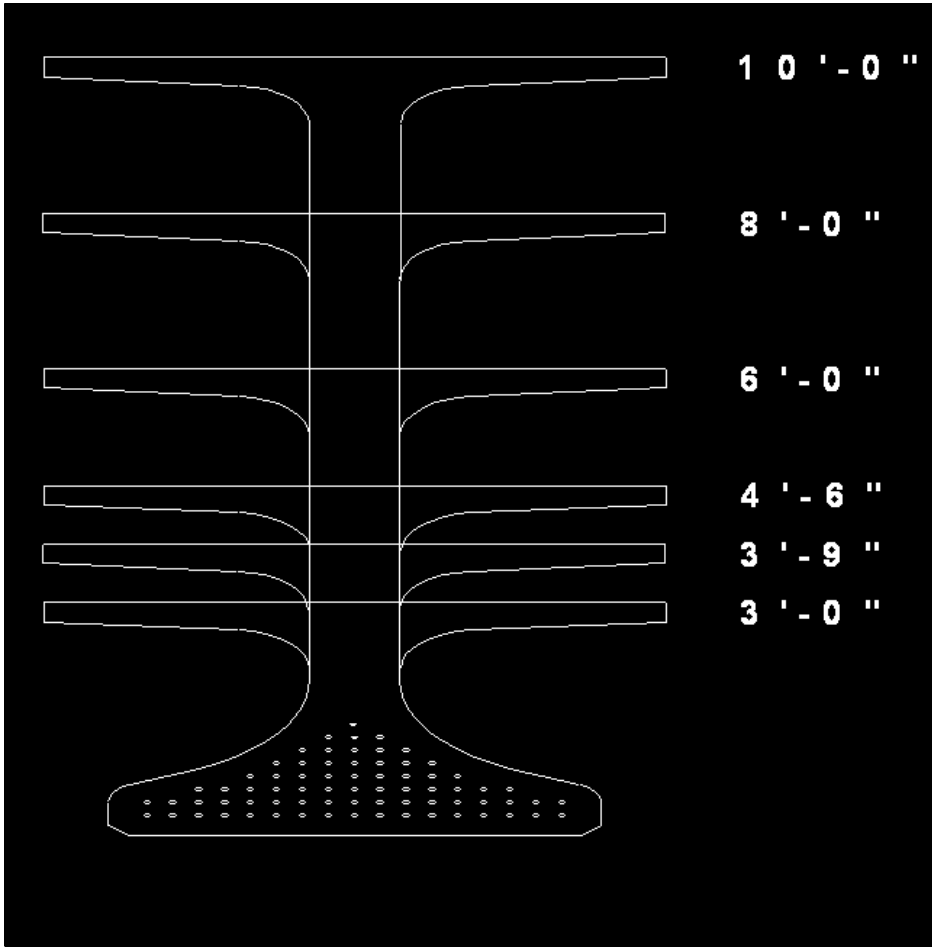
FIB Cross-section



FIB installation

FIB Benefits

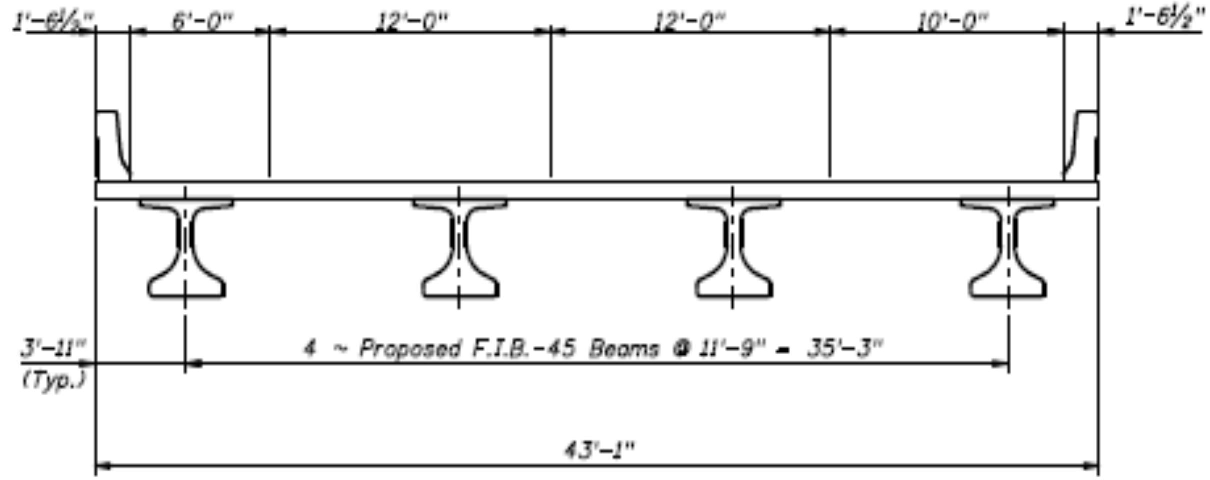
- Various depths are envisioned
  - From 36”-78” (standard details)
- Can accommodate the largest number of prestressing strands in the USA,
  - up to 72 – 0.6 in diameter strands
- Can provide larger vertical clearance
- More stable during fabrication, shipping , and construction due to the wide bottom flange and low center of gravity.



Source: Sam Fallaha, PE, FDOT Presentation

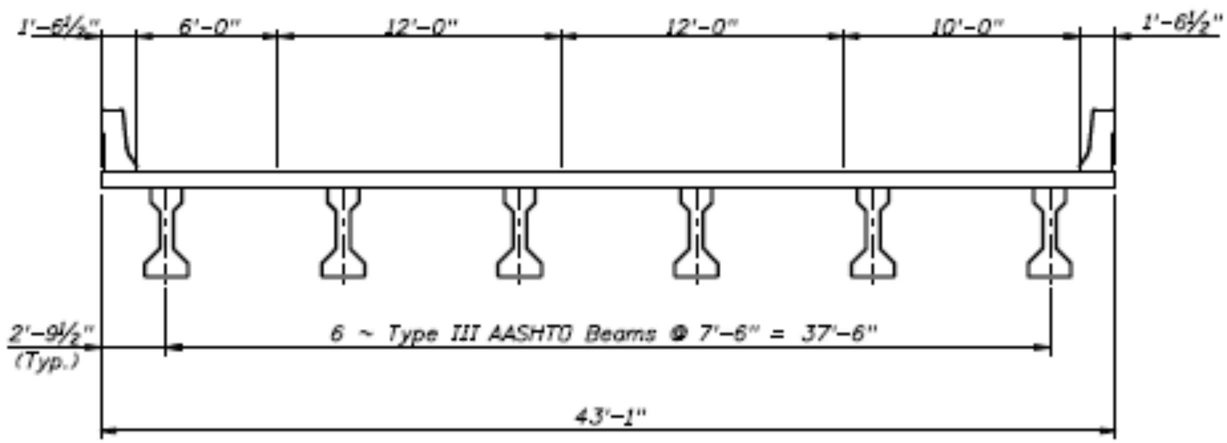
Cost Comparison (based on $ / ft)

FIB 45 Girder



"Florida I-Beam 45" w/42 ~ 0.6 Low Lax Strands
2008 FDOT Standards Index No. 20130 Reinforcing Steel
[Substitute 5K (No. 5 bars) for 4K]
8.5 ksi Concrete; 6 ksi @ Release

AASHTO Type III Girder



"AASHTO Type III" w/26 ~ 0.6 Low Lax Strands,
2008 FDOT Standards Index No. 20130 Reinforcing Steel
8.5 ksi Concrete; 6 ksi @ Release

<u>3-90 ft Span Bridges:</u>

~24% Cost Saving

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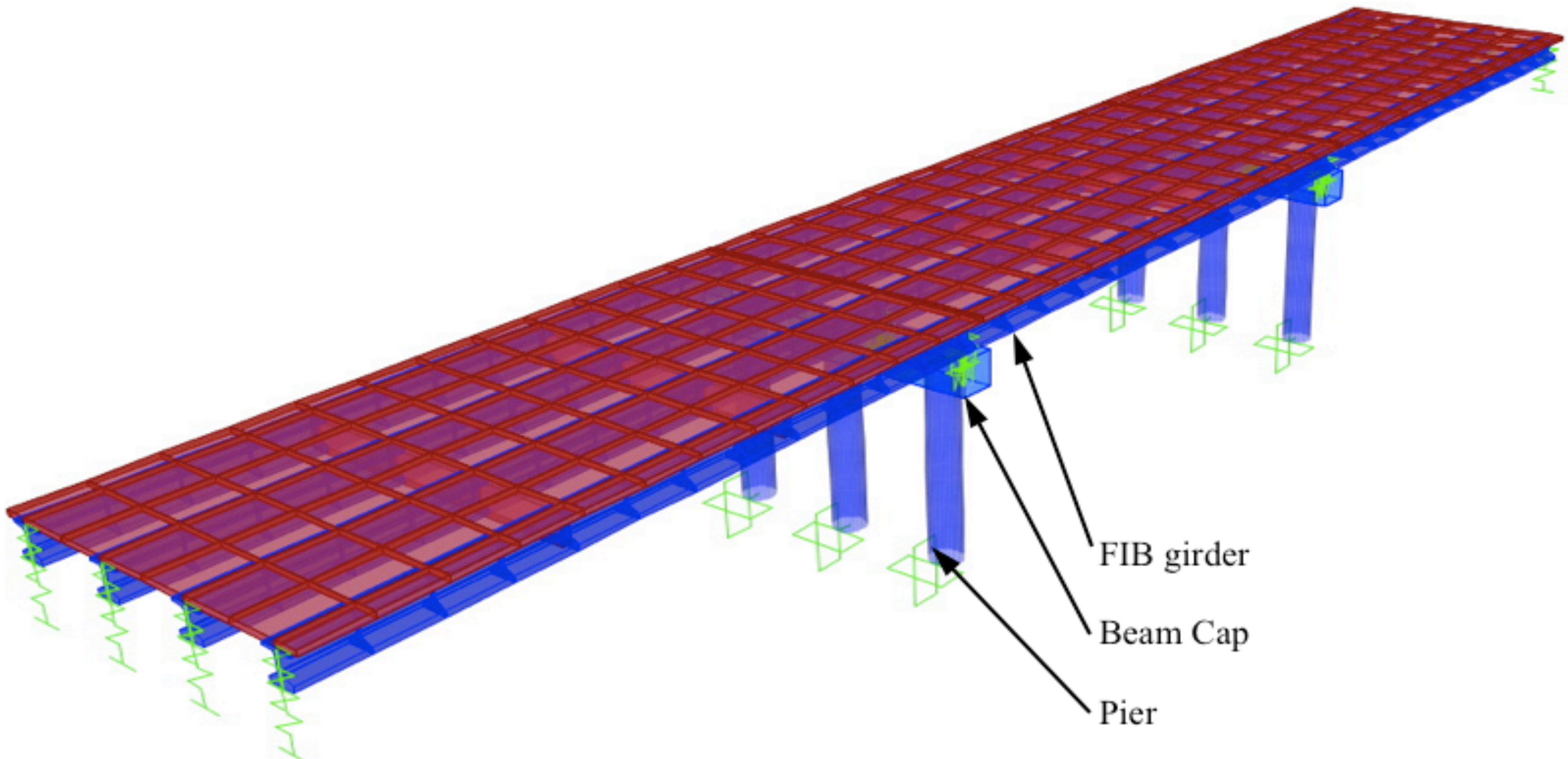
Ref: FDOT Design Bulletin and Presentations

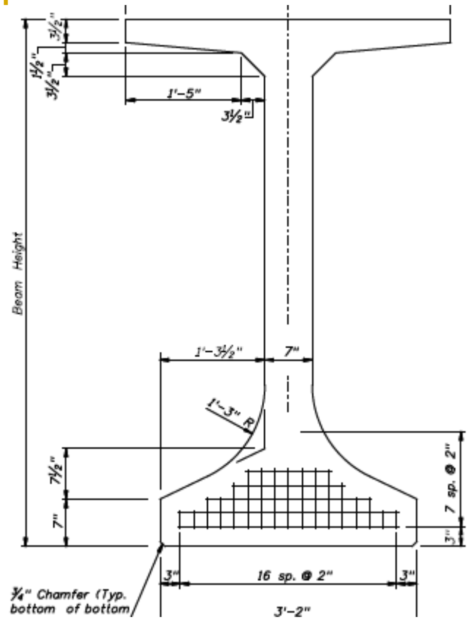
Modeling Deck and Girders – (FIB Girders)

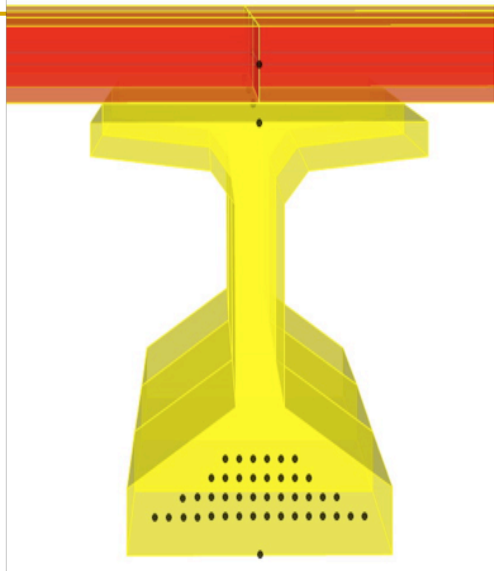


- 356 shell elements
- 9330 frame and tendon elements.
- 10344 joints constraints.
- 72 link elements.
- 28057 DOFs.

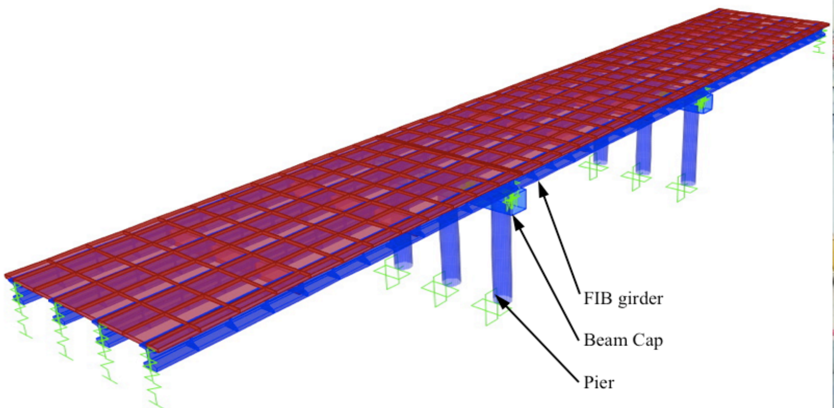
Conclusions

- FIBs are expected to be
  - Higher capacity, less girders, safer and more economical, more efficient fabrication
  - Provide larger vertical clearance
  - More stable during fabrication, shipping , and construction due to the wide bottom flange and low center of gravity.
- Detailed FE Models of 2 Bridges
  - AASHTO Type III and FIB (24% Cost Effectives (as per FDOT)
- Model evaluated under dynamic loads as well
  - Moment demand is higher for FIB ~1.55 DL and ~1.51 LL
  - Moment capacity is higher for FIB ~1.77
  - Load rating is higher 1.42 (ext.) and 1.20 (int.)





Explore the Effects of Heavy Loads on New Designs Used in Florida and other States



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