



National Transportation Safety Board

Bridge Design Errors

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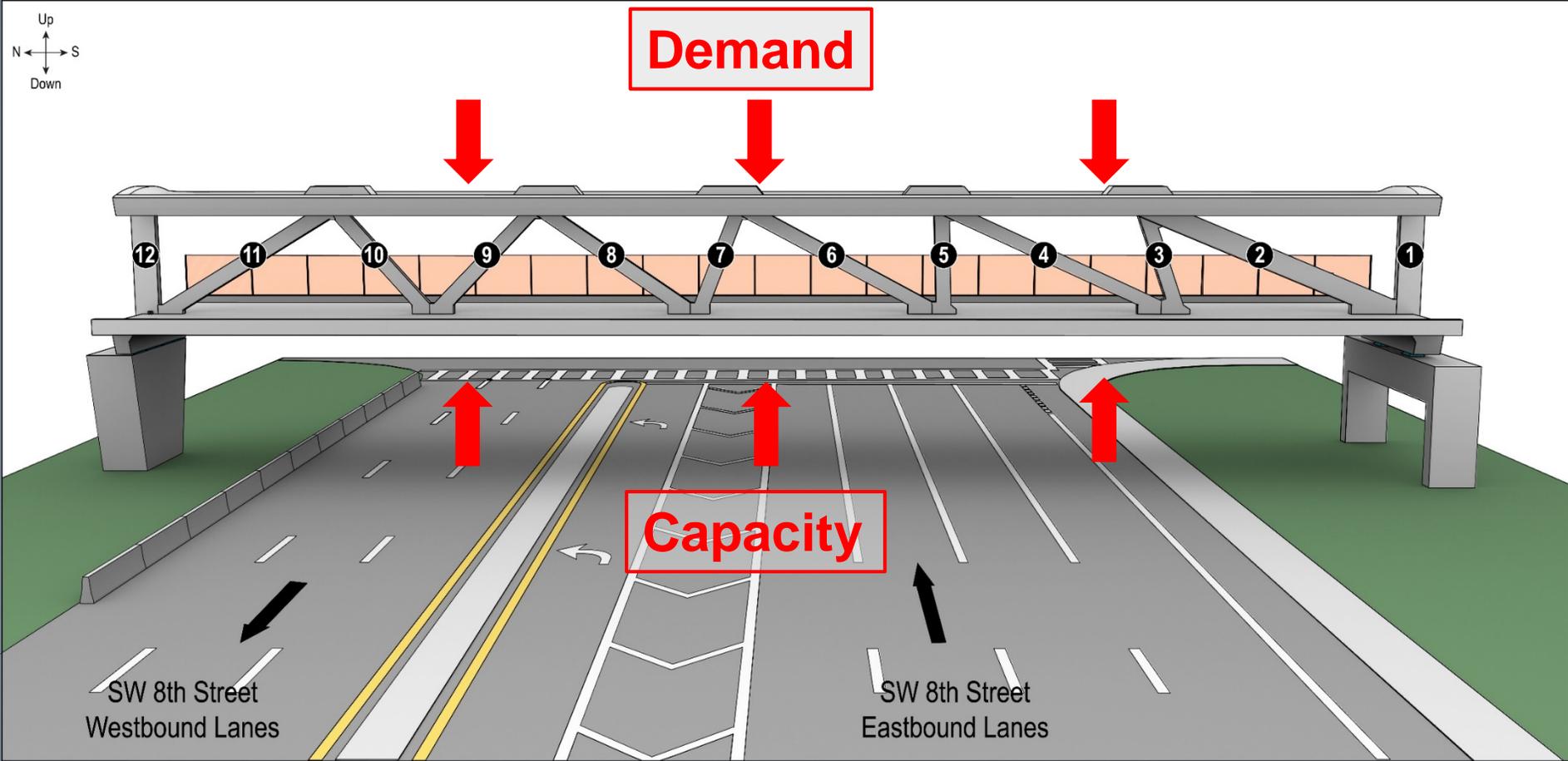
Overview

- Bridge design errors made by FIGG
- Severe underestimation of demand and significant overestimation of capacity
 - 11/12 nodal region
 - Led to collapse of pedestrian bridge

Location of Pedestrian Bridge Failure

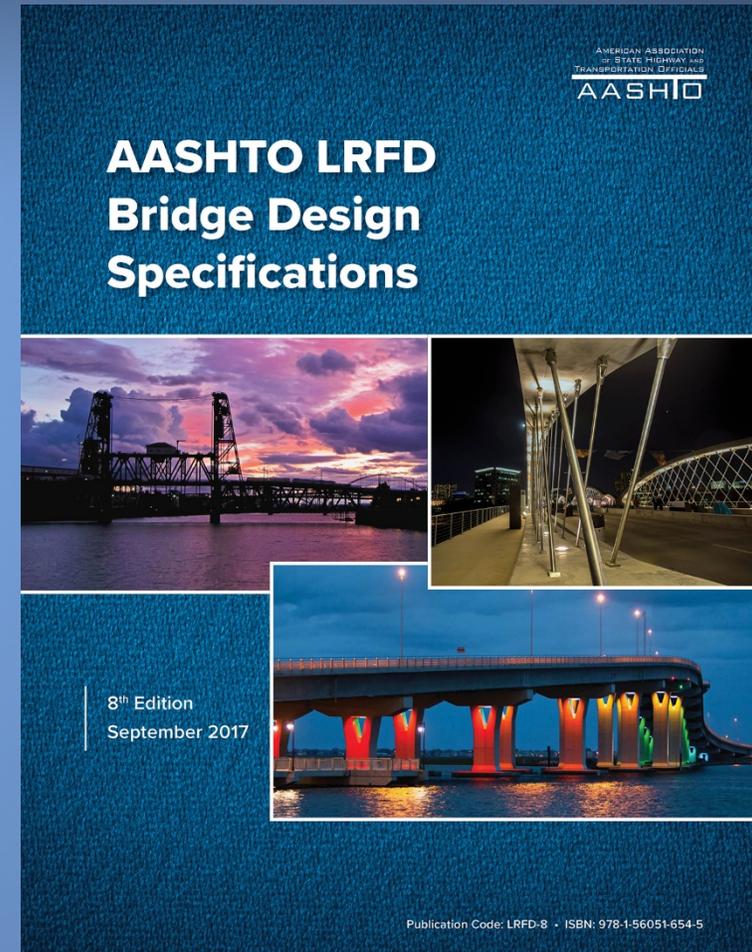


Demand and Capacity

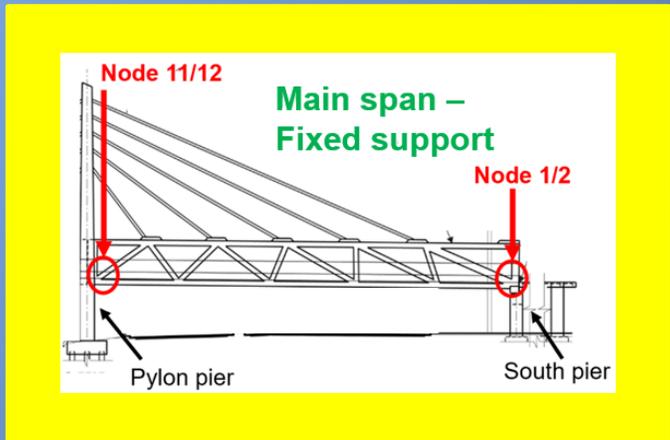
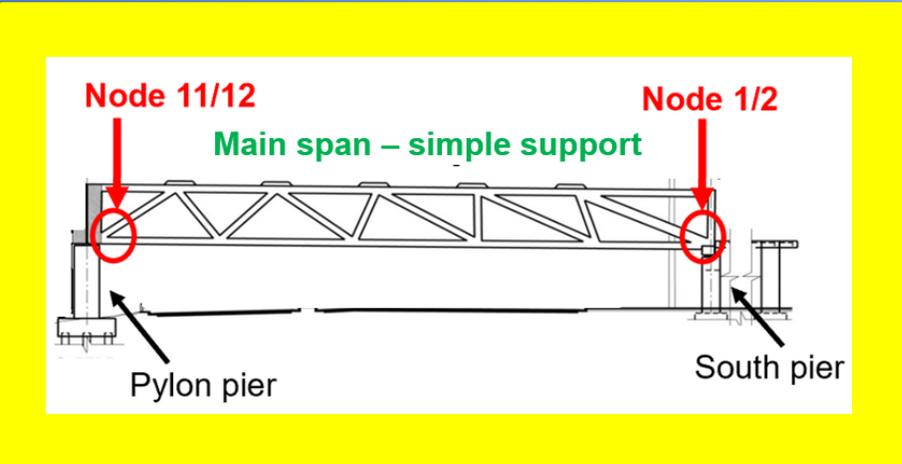
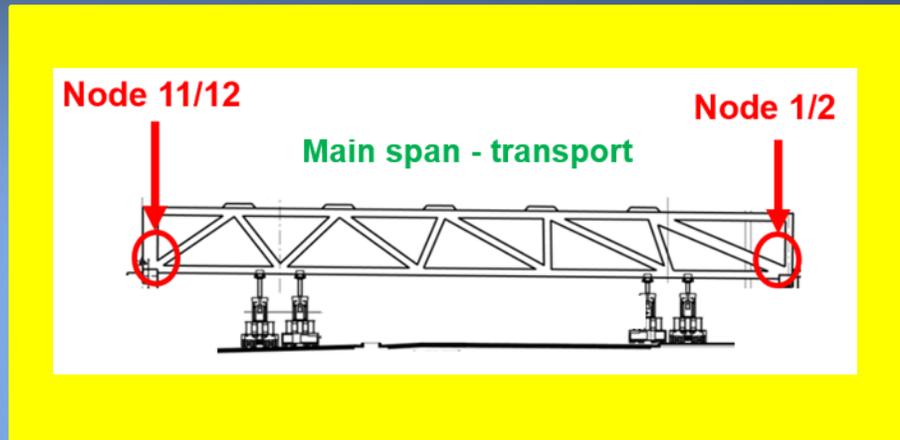
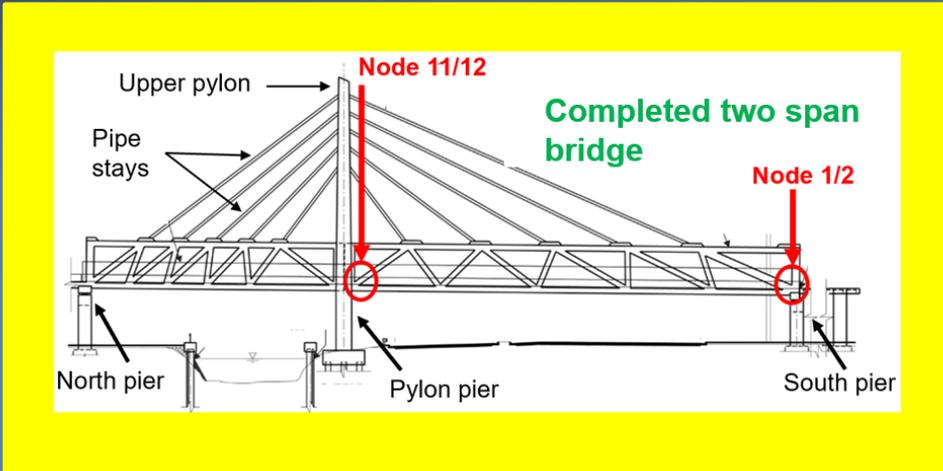


AASHTO LRFD Bridge Design Specifications

- AASHTO LRFD was the specification used in the design of the pedestrian bridge
- To achieve objectives of safety, constructability, and serviceability
- Demand is conservatively estimated, and capacity is proportioned to reliably resist loads



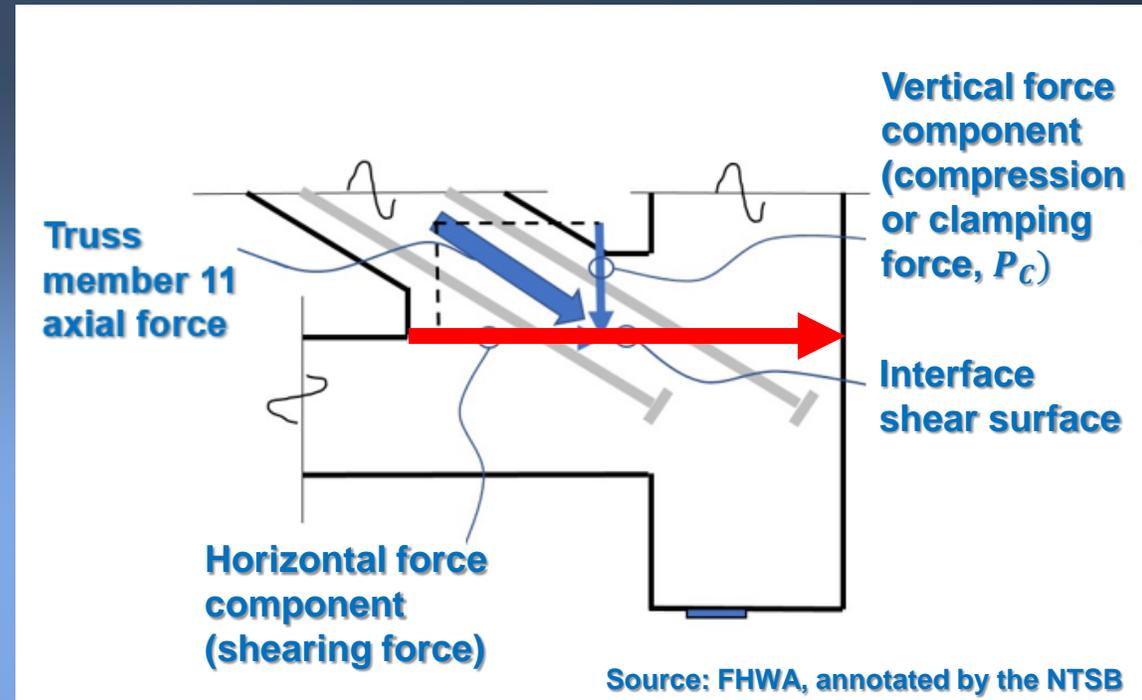
FIGG's Demand Models



Source: FIGG, annotated by the NTSB

Demand Errors

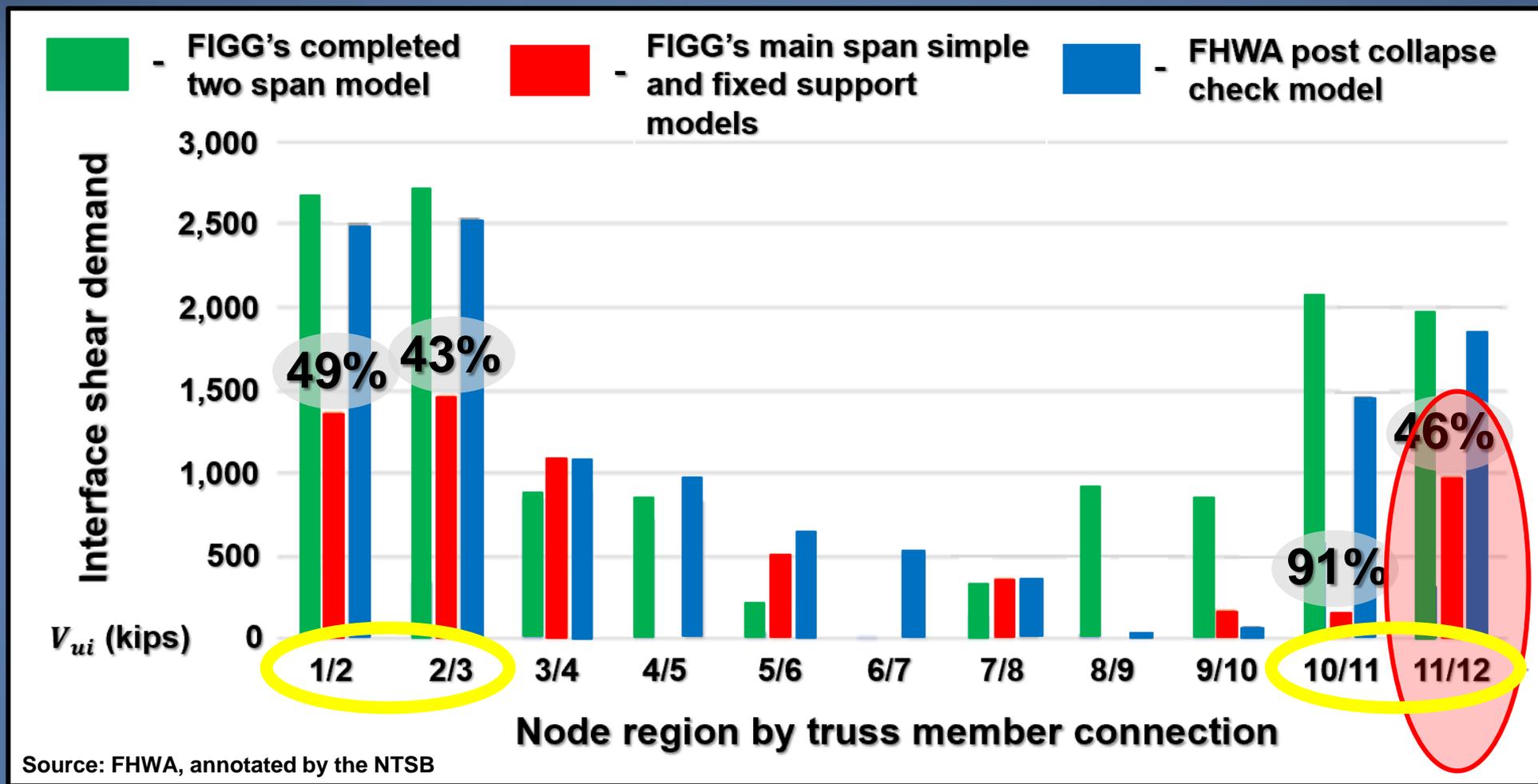
- Vertical component is compressive or clamping force
- Horizontal component is shearing force on the interface shear surface



Model	Shear Demand
FIGG's fixed support model	978 kips
FIGG's completed two-span model	1,990 kips
FHWA model	1,835 kips

1 kip = 1,000 pounds

Comparison of Modeling Results



Capacity Errors

- Permanent compressive loading, P_C , and amount of reinforcing steel
- Load factor = 0.90 (conservative estimate)
- Load factor = 1.25 (non-conservative estimate, used in FIGG design)
- Significant overestimation of capacity at the 11/12 nodal region with insufficient reinforcing across the interface shear surface

Summary

- FIGG design made significant errors in determination of loads
- Chose the wrong interface shear demand value
 - Led to a severe underestimation of demand
- Chose the wrong load factor in calculating the permanent compression loading, or P_c
 - Led to a significant overestimation of capacity