



Site-Specific Live Load Model USA Example

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Traffic on Bridges

- Site-specific
- Seasonal
- Truck Size and Weight regulations
- Average Daily Truck Traffic
- Gross Vehicle Weight
- Vehicle Configurations



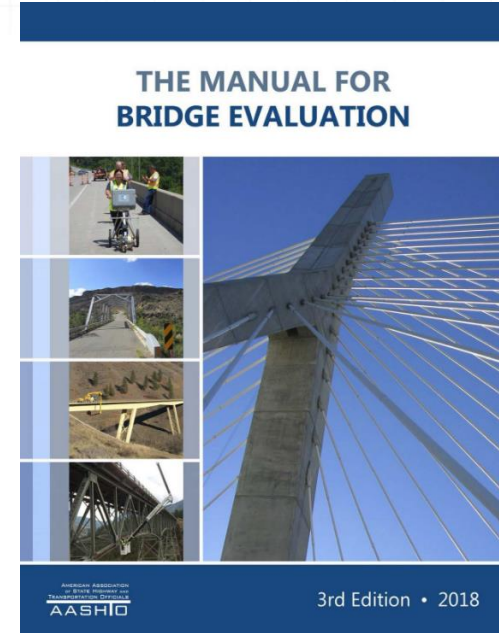
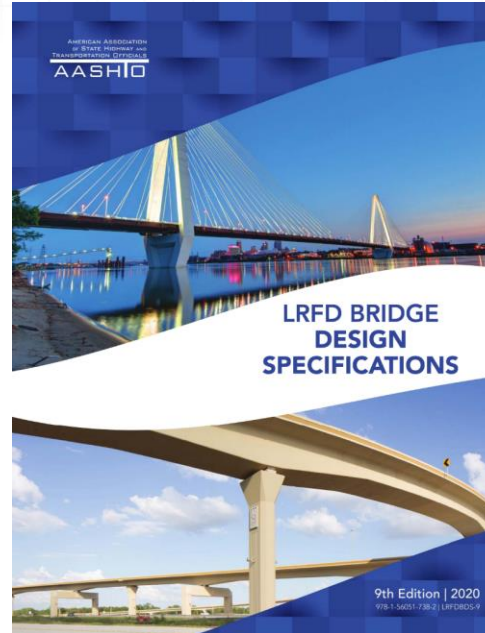
Traffic Weight Data

- Weigh Station, Portable Scales, Weigh-in-Motion
- Gross Vehicle Weight
- Axle Weight
- Axle Spacing
- Traffic Volume
- Traffic Composition
- Multiple presence



Bridge Design and Evaluation

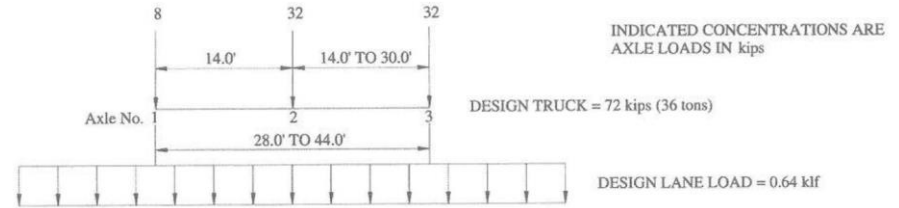
- AASHTO provide live load models for:
 - Design
 - Evaluation
- Live Load Models:
 - Design Loads
 - Legal Traffic
 - Specialized Hauling Vehicles
 - Permit Trucks
 - Emergency Vehicles
 - State Specific Trucks



Live Load Model

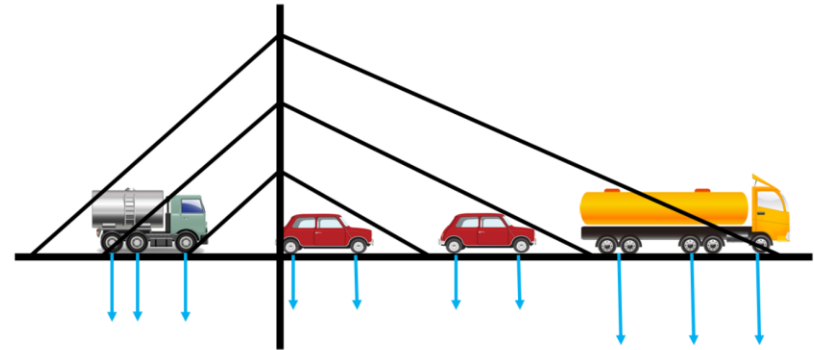
- Notional Truck
- Calibrated Live Load Factor
- Encompass traffic-induced load effects on bridges
- Live load is a random variable described by statistical models
- Provide a consistent safety

AAHSTO LRFD HL-93 Truck



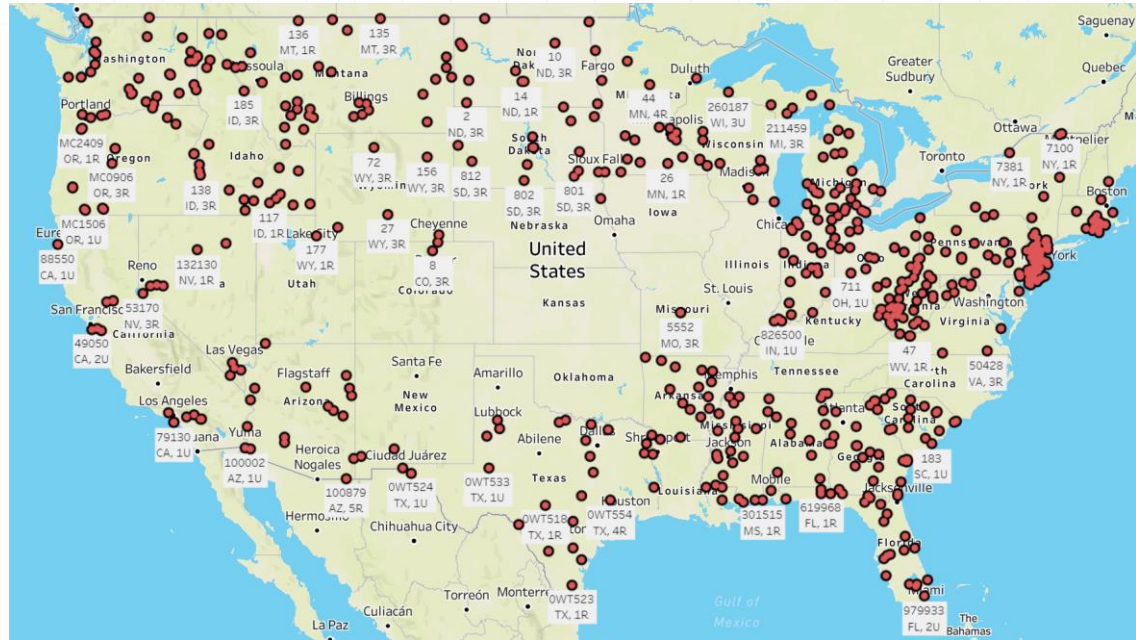
Live Load Model

- Traffic Weight Data
- Live load envelope on representative bridges
- Comparison of the traffic-induced load effects to the notional truck(s)
- Calibration of live load factor at the acceptable safety



Weigh-in-Motion in the USA

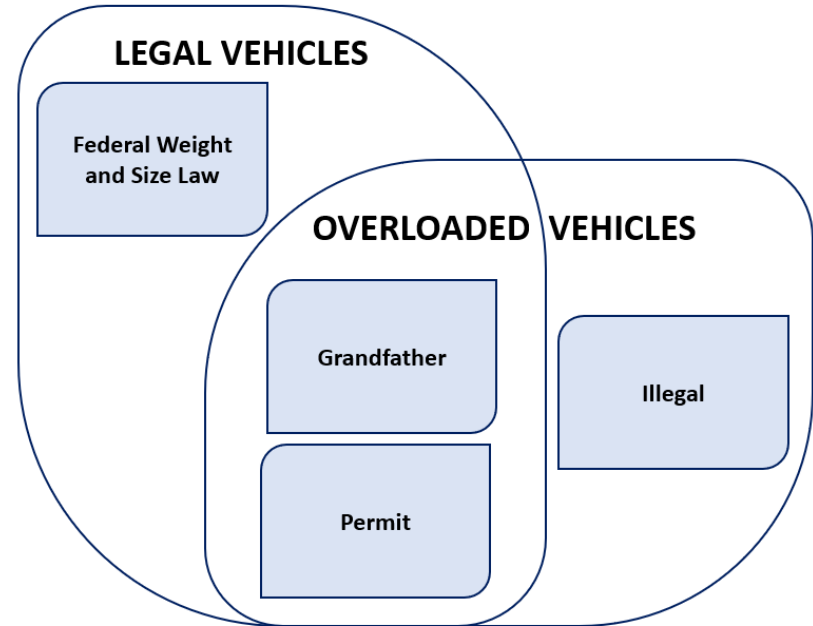
- Available data from the State Departments of Transportation, Federal Highway Administration (FHWA)
- Reliable data with appropriate calibration and data quality control
- Continuous WIM traffic measurements



Source: Workbook: Weight Station Map (dot.gov)

When is Site Specific Live Load Model needed?

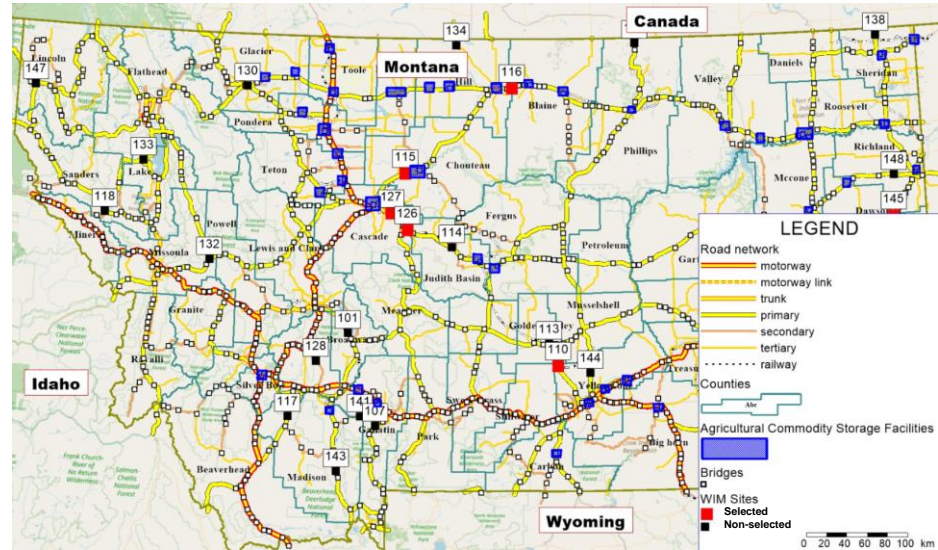
- Excessive loads
- Unusual loading conditions
- Exemptions from Federal Truck Weight and Size Law
- Posting decisions



PROJECT EXAMPLES

Montana Agricultural Vehicles

- Montana allows 20% overload for agricultural vehicles based on grandfather provisions
- The goal was to develop Montana live load model and assess the load effects of agricultural vehicles on bridges



Montana Agricultural Vehicles

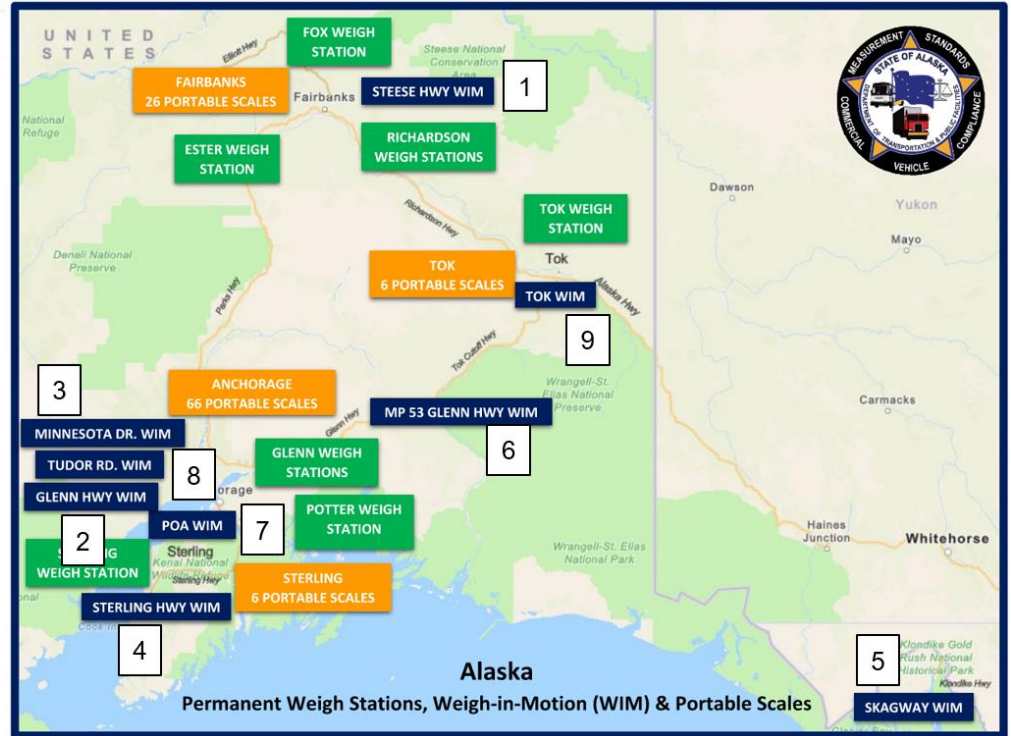
- Determine Configurations of Agricultural Trucks by:
 - Agricultural Commodity
 - Vehicle Class
 - Number of axles
 - Wheelbase
 - Active Dates
- Find potential Agricultural Trucks in WIM data
- Assess live load envelope
- Conduct calibration and determine the live load factor
- The existing AASHTO legal rating truck was used, and the live load factor was proposed to be increased from 1.30 to 1.45 to encompass Montana agricultural trucks
- Calibration is complex, but the implementation of state rating procedure is simple



Alaska Legal Loads

- Alaska legal loads different than most of the states
- Improve bridge evaluation procedures for Alaska legal loads

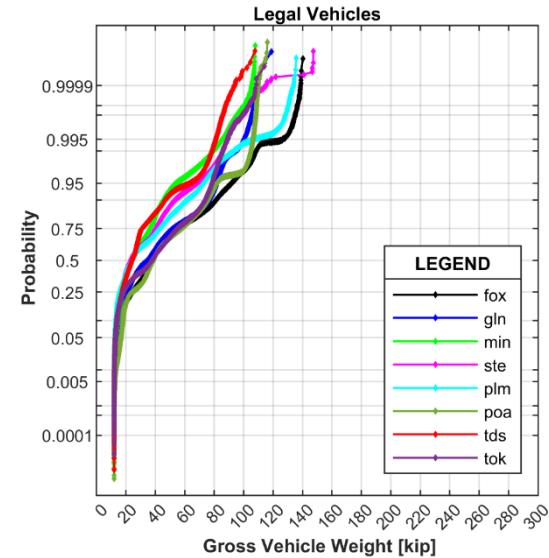
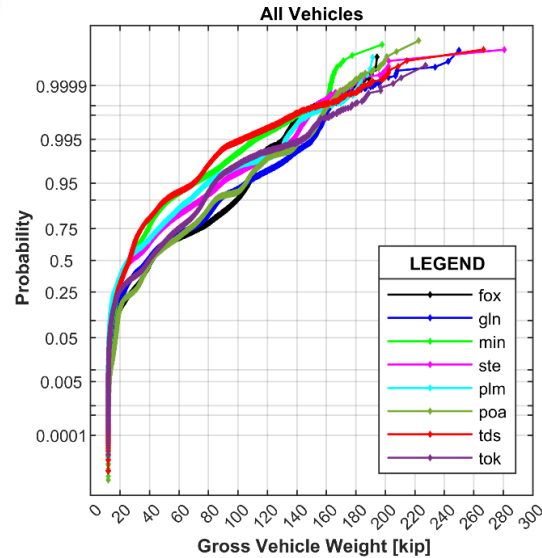
| WIM Site | WIM Records Years: 2015-2018 | WIM Records Years: 2019-2023 | Total WIM Records |
|----------|------------------------------|------------------------------|-------------------|
| 1 | 782,973 | 868,013 | 1,650,986 |
| 2 | - | 4,164,167 | 4,164,167 |
| 3 | - | 1,690,478 | 1,690,478 |
| 4 | 1,096,376 | 1,867,183 | 2,963,559 |
| 6 | 398,988 | 919,882 | 1,318,870 |
| 7 | 1,226,947 | 1,294,754 | 2,521,701 |
| 8 | - | 1,192,709 | 1,192,709 |
| 9 | 205,857 | 315,416 | 521,273 |
| | | Total: | 16,023,743 |



Alaska Legal Loads

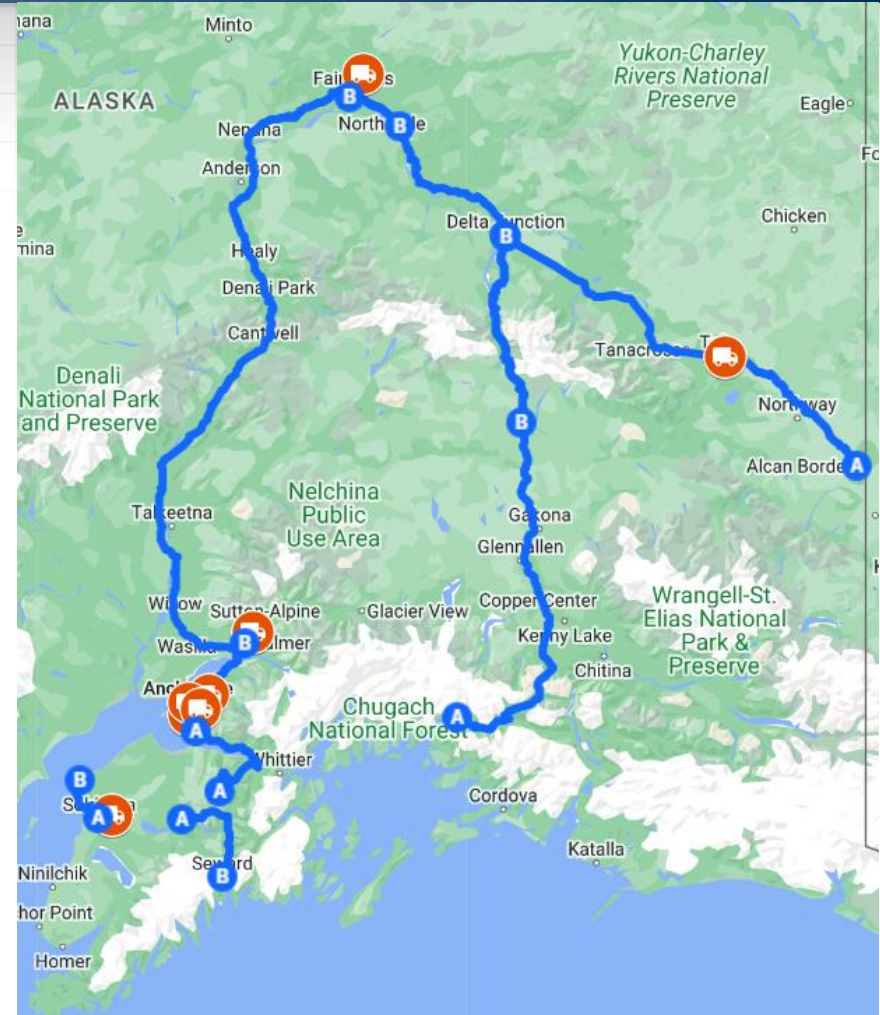
- Process WIM Data
- WIM Data Quality Control
- Filter Legal Trucks by Weight and Length Limits:

| No | Rule | Weight/Length Limits |
|----|--|----------------------|
| 1 | Single Axle (1st and 2nd) | 20,550 lbs |
| 2 | Single Axle | 20,000 lbs |
| 3 | Tandem Axle | 38,000 lbs |
| 4 | Tridem Axle Rule 1 (spacing > 3.5 ft) | 42,000 lbs |
| 5 | Tridem Axle Rule 2 (spacing > 5.0 ft) | 43,500 lbs |
| 6 | Tridem Axle Rule 3 (spacing > 6.0 ft) | 45,000 lbs |
| 7 | Quad Axle | 50,000 lbs |
| 8 | Federal Bridge Formula | Equation + 4,500 lbs |
| 9 | Cargo-carrying length, class 5,6,7 | 53 ft |
| 10 | Cargo-carrying length, class 8, 9, 10 (from second axle) | 53 ft |
| 11 | Single Trailer, class 8, 9, 10 | 75 ft |
| 12 | Multi Trailer, class 11,12,13 | 75 ft |
| 13 | LVC a, class 8, 9, 10,11,12,13 (from second axle) | 95 ft |
| 14 | LVC b, class 8, 9, 10 | 90 ft |
| 15 | LVC c, class 11,12,13 | 95 ft |



Alaska Legal Traffic

- Distinct vehicle configurations
- Low traffic volume
- Variability between WIM sites
- Requires a unique approach
- Provide guidance on bridge rating under legal loads



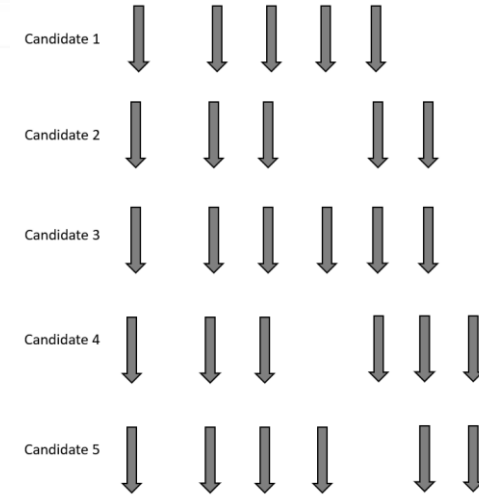
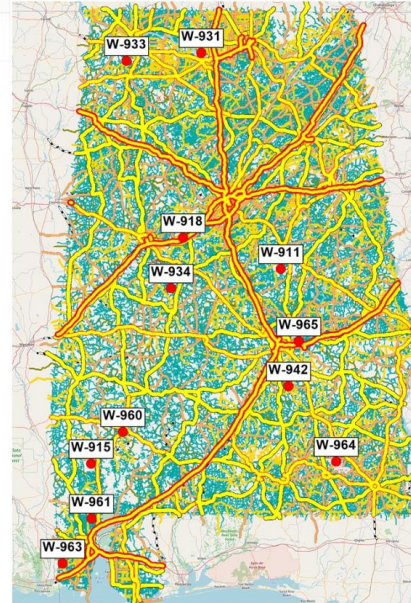
Permit Traffic

- AASHTO does not provide notional permit truck
- Every state has different permit regulations and notional rating trucks
- Agencies are seeking to establish state-specific permit live load models

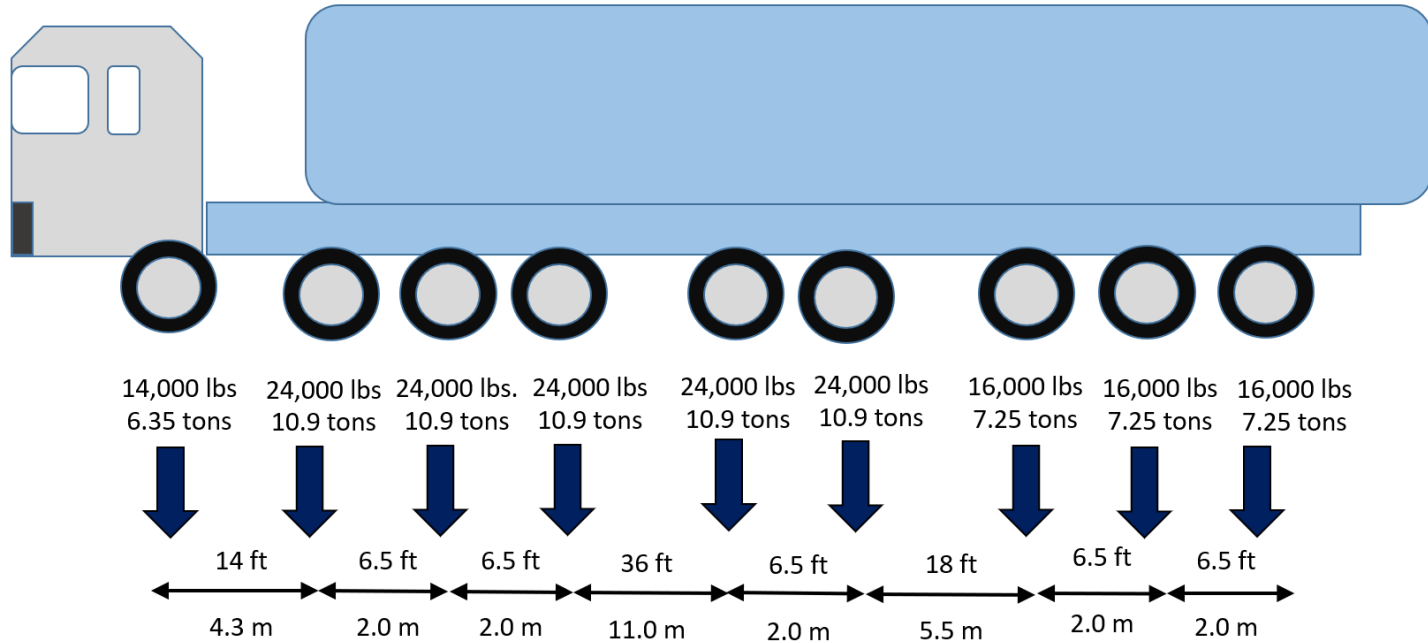


Alabama Permit Loads

- Review permit regulations
- Use WIM and permit data
- Develop notional permit truck(s):
 - Analyze characteristics of overloaded trucks
 - Group trucks by number of axles
 - Determine the typical range of axle weight and spacing
- Determine notional permit truck(s)
- Calibrate live load factor for permit loading



Alabama Notional Permit Truck



Number of axles: 9 Gross Vehicle Weight: **188,000 lbs/85 tons** Total length: **100.5 ft/31 m**



Truck Platooning on Bridges

- FHWA project - Truck Platooning Impact on Bridges: Phase II Structural Serviceability
- Truck platoon - group of Connected Autonomous Vehicle (CAV) driving together in a column connected by a computer system. Lead truck is wirelessly linked to following trucks controlling speed, headway distance, and brakes

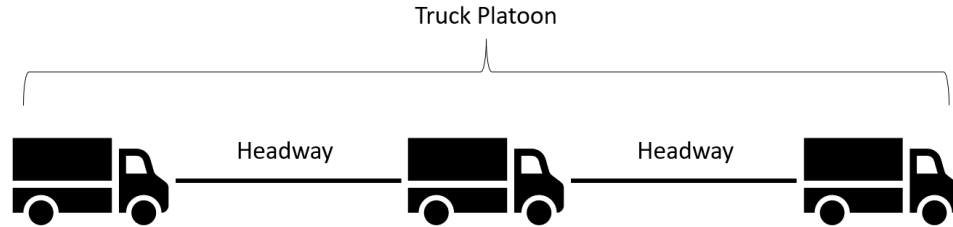


Source: <https://www.ioscm.com/blog/what-you-really-need-to-know-about-truck-platooning/>

Platoon Live Load Model

➤ Platoon live load model uses 32 WIM sites from:

- Alabama
- California
- Indiana
- Texas
- Florida
- New Jersey



➤ Synthetized WIM model with 5-axle trucks, and Gross Vehicle Weight < 100,000 lbs (50 tons)

➤ Platoons with 2, 3, and 4 connected trucks, and headway spacing of 30 ft (9m), and 50 ft (15m)

Truck Platooning on Bridges

- Assess the effect of platoon trucks on bridges
- Determine the number of US bridges that could potentially be impacted by platoons
- Develop a platoon live load model for the AASHTO Manual for Bridge Evaluation
- Conduct probabilistic calibration for platoon loading
- Provide recommendations for bridge rating under platoon loading

Summary

- WIM data is an excellent source of information on traffic-induced load effects on bridges
- WIM data allows to:
 - Determine notional vehicle
 - Simulate the maximum expected truck load
 - Develop the live load statistical model
 - Develop bridge design and rating procedures
- National load models for efficient design and evaluation procedures
- Site-specific models for unusual loading conditions

