LOAD & RESISTANCE FACTOR RATING OF HIGHWAY BRIDGES

FHWA LRFR Seminar

SESSION 2

LOAD MODELS FOR LRFR

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LIVE LOADS ON OUR HIGHWAYS

- FEDERAL LEGAL LOADS < HS20
- EXCLUSION VEHICLES (Grandfathered Trucks)
- OVERWEIGHT PERMIT VEHICLES
FEDERAL TRUCK WEIGHT LIMITS

• FOUR BASIC FEDERAL WEIGHT LIMITS APPLY:
  • SINGLE AXLE (20,000 #)
  • TANDEM AXLE (34,000 #)
  • BRIDGE FORMULA B
  • GROSS VEHICLE WEIGHT (80,000 #)

\[ W = 500 \left( \frac{LN}{N-1} + 12N + 36 \right) \]

• ONLY SEVEN STATES APPLY THESE LIMITS STATEWIDE WITHOUT MODIFICATION.
• OTHER STATES ALLOW TRUCKS EXCEEDING THESE LIMITS UNDER THE “GRANDFATHER PROVISIONS”.

EXCLUSION VEHICLES
AASHTO HS20

M POS 0.4L + M NEG 0.4L * M SUPPORT → Mas

SPAN IN FT

MOMENT RATIO

0 20 40 60 80 100 120 140 160
UNIFORM RELIABILITY IN DESIGN & EVALUATION

• TO ACHIEVE UNIFORM RELIABILITY YOU NEED UNIFORM BIAS (MOMENT & SHEAR RATIOS) FOR LOAD EFFECTS ACROSS ALL SPAN LENGTHS.

• HS20 LOAD MODEL DOES NOT PROVIDE A UNIFORM BIAS

• A NEW LOAD MODEL WAS NEEDED TO ACHIEVE UNIFORM RELIABILITY

(a) **Track and Uniform Load**

(b) **Tandem and Uniform Load**

(c) **Alternative Load for Negative Moment (reduce to 90%)**

**HL-93 DESIGN LOADING**

Min headway separation of 50 ft
LIVE LOADS ON OUR HIGHWAYS

- FEDERAL / STATE LEGAL LOADS
- EXCLUSION VEHICLES (Grandfathered Trucks)
- OVERWEIGHT PERMIT VEHICLES
LRFR LEGAL LOADS FOR RATING & POSTING

- Truck Load Models
- Lane Load Models
- New AASHTO Legal Loads (2005)

AASHTO LEGAL TRUCKS
LRFR LEGAL LANE LOAD MODEL FOR SPANS BETWEEN 200 FT. and 300 FT.

LEGEND
Truck = 75% of Type 3-3
= 60 Kips
Lane Load = 0.2 KLF

LRFR LEGAL LANE LOAD MODEL FOR NEGATIVE MOMENTS

LEGEND
Each Truck = 75% of Type 3-3
= 60 Kips
Lane Load = 0.2 KLF
Headway Distance = 30 Ft
NCHRP Project 12-63 Results

NEW AASHTO LEGAL LOADS
SPECIALIZED HAULING VEHICLES (SHV)

- AASHTO legal loads were adopted in the 1970s
- Trucking industry has in recent years introduced Specialized Hauling Vehicles with closely-spaced multiple axles:
  - Dump trucks, construction vehicles, solid waste trucks and other hauling trucks.
- Under 80,000 # and satisfy Bridge Formula B. They are legal in all states.

FEDERAL BRIDGE FORMULA B

\[ W = 500 \left( \frac{LN}{N - 1} + 12N + 36 \right) \]

- **W** = Maximum weight in pounds that can be carried on a group of two or more axles
- **L** = Distance in feet between the outer axles of any two or more consecutive axles.
- **N** = Number of axles being considered.
THE PROBLEM

• AASHTO Type 3 posting load is not representative of these newer legal loads.

Type 3
Weight = 50 Kips

• It is considered likely that these specialized vehicles may be severely overstressing some non-posted bridges.

EXCLUSION TRUCKS
SPECIALIZED HAULING VEHICLE

5-AXLE SHV

NCHRP PROJECT 12-63 OBJECTIVE

• Project timeline: Initiated in 2003
• Investigate recent developments in specialized truck configurations and state legal loads
POSTING LOADS FOR SPECIALIZED HAULING VEHICLES THAT MEET BRIDGE FORMULA B

A SINGLE “NOTIONAL” RATING LOAD

• A SINGLE ENVELOPE RATING LOAD MODEL FOR ALL FORMULA B TRUCKS:
  • MAY NOT REPRESENT AN ACTUAL TRUCK (NOTIONAL TRUCK)
  • SIMPLIFIES THE RATING ANALYSIS
2005 AASHTO BRIDGE MEETING

AASHTO ADOPTED:

• A NEW NOTIONAL RATING LOAD FOR LOAD RATING OF BRIDGES
• NEW POSTING LOAD MODELS FOR SINGLE UNIT TRUCKS
• APPLIES TO: ALLOWABLE STRESS, LOAD FACTOR, LOAD AND RESISTANCE FACTOR METHODS

2005 AASHTO BRIDGE MEETING

AASHTO ADOPTS: “NOTIONAL RATING LOAD” NRL

• GVW = 80 KIPS
• V — 6’0” TO 14’-0”. SPACING
• AXLES THAT DO NOT CONTRIBUTE TO THE MAXIMUM LOAD EFFECT UNDER CONSIDERATION SHALL BE NEGLECTED.
BRIDGE POSTING LOADS

• A wide variety of vehicle types cannot be effectively controlled by any single posting load
• A single posting load based on a short truck model would be too restrictive
• Setting weight limits for posting should consider legal truck types that operate within a state.
2005 AASHTO POSTING LOADS

SU4 TRUCK
GVW = 54 KIPS

SU5 TRUCK
GVW = 62 KIPS

SU6 TRUCK
GVW = 69.5 KIPS

SU7 TRUCK
GVW = 77.5 KIPS
LRFR FOR OVERWEIGHT PERMIT CHECKING

- LRFR provides permit load factors by permit type:
  - Routine/Annual Permits < 150 K
  - Special Permits > 150 K

- Load factors calibrated to provide uniform reliability: \( \beta = 2.5 \) for Routine Permits, \( \beta = 3.5 \) for Special permits.
THANK YOU

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