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INFLUENCE OF HEAVY TRUCKS ON HIGHWAY BRIDGES

PROBLEM STATEMENT

Studies have shown that the gross weight, axle weight, and axle configuration of heavy trucks directly affect the service life of highway bridge superstructures. Damage typically occurs in the bridge deck and in the main superstructure elements, including floor beams and girders, diaphragms, joints, and bearings. With the rapid growth of highway transportation, the increasing frequency of passing heavy trucks contributes to fatigue damage. As a result, bridge maintenance becomes more difficult and more costly, since maintenance, rehabilitation, and/or replacement become more frequent.

Reliable truck weight data could contribute to the knowledge of actual truck-load spectra, and may reduce the uncertainty involved in the detrimental influence of heavy trucks. Such data would allow for the evaluation of load-carrying capacity, the estimation of remaining life, and the prediction of deterioration rate. To monitor the gross vehicle weight (GVW) of passing heavy trucks, stationary weight scales have been established over major highways. However, this conventional scale measurement has several drawbacks, such as the limitations imposed by driver awareness and delay of traffic. More recently, weigh-in-motion (WIM) measurements have been developed and used throughout the nation. WIM databases can facilitate more accurate truck loading, since they can overcome shortcomings inherent in stationary weight scales.

It is estimated that some 3,000 to 14,300 heavy trucks travel each day on I-75 between the Georgia State line and Florida's turnpike. Florida has thousands of small to middle span bridges. However, accurate truck traffic data is not available on specific highway bridge sites.

OBJECTIVES

The objective of this research is to develop a truck traffic database (including axle weight and spacing). Such a database is essential for estimating histograms of heavy trucks in association with their gross weight, axle weights, and axle configurations, and for providing the fatigue life of the existing bridges to ensure their operational safety.

Specific objectives include:

1. Synthesizing truck traffic data collected through WIM measurements.
2. Establishing live-load spectra.
3. Performing fatigue damage analysis for typical bridges.
4. Performing static and dynamic analyses.

FINDINGS AND CONCLUSIONS

The following are among the conclusions:

1. For simply supported steel bridges, static analysis indicates that truck traffic-induced flexural stress at midspan and shear at entrance end vary with bridge span length. The gross weight of the heaviest trucks can be twice that of the AASHTO standard design truck HS20-44. Several of the heaviest truck types generate more loading on bridge structures than HS20-44. Based on single truck loading, the observed overloading can be as high as 42%. Truck loading does not necessarily increase with GVW; thus, it is closely related to axle configuration. The axle weights of the heaviest trucks are less than the heavy one of HS2O-44. However, if tandem axles spaced at about 1.5*m* are considered, axle weight will significantly exceed that of HS2O-44 and the limiting value in the AASHTO *Guide* (1991). The overweight may severely deteriorate the bridge deck and secondary members.

2. For simply supported steel bridges, the average impact factors induced by heavy truck types (9, 10, and HS20-44) are lower than the values specified in the AASHTO *Specifications* (1996). Also, the total average of the computed impact factors of moment for loaded types 9 and 10 is 10%, which is in accordance with the *Commentary* of the AASHTO *Guide Specifications* (1990). Dynamic impact factors under light truck loading (types *5* and 8) are higher than the specified values. The light trucks have very low GVWs compared to HS20-44.

3. For simply supported prestressed concrete bridges, the mean values of impact factors of moment at midspan induced by heavy trucks (types 9, 10, and HS20-44) are generally well below the values specified in AASHTO *Specifications*. Occasional exceptions occur at the span length of 9.14*m* (30ft) with type 9 loading (GVW of 294kN or 66kips). For light trucks (types *5* and 8), the mean values of impact factors may significantly exceed the specified values.

4. Fatigue damage accumulation analysis at two stations with heavy truck traffic demonstrated that heavy traffic will not cause severe fatigue problems on steel girders of categories A, B, and C.

5. Damage accumulation analysis for six bridge span lengths revealed that the fatigue design truck of the AASHTO *Guide* (1990) induces damage close to that caused by the simulation of the actual truck-traffic flow based on WIM measurements. The comparison of fatigue damage accumulation demonstrates that loaded truck types 9, 8-l (2S2), 7, and 8 (3S1), either 4- or 5-axle, contribute the most to the fatigue damage.

6. Truck type 9, the most important truck accounting for fatigue damage, induces a number of cycles higher than the value specified in the AASHTO *Specifications* (1996) for short span lengths less than 10 *m*.

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