Probabilistic Assessment of Bridge Loading Concurrent with Permit Vehicles

PROBLEM STATEMENT

The presence of a single permit vehicle on a bridge in addition to the loads from standard weight vehicles is arguably accounted for implicitly in the multi-presence factors in the AASHTO code. However, the presence of multiple permit vehicles may conceivably exceed the capacity of the bridge. This study provides guidance for determining the loads that should be considered concurrent for the purpose of calculating appropriate bridge operating ratings.

OBJECTIVES

The study presents a statistical analysis of permit vehicles (vehicles that exceed 80,000 lbs.) traveling in close proximity to each other over bridges within the State of Florida. The objective is to find the likelihood of exceeding various combined weights of concurrent permit vehicles on a bridge. The source of data for this study are the weigh in motion (WIM) records from 37 WIM stations in Florida, collected between January 1998 and August 2003. The study presents results from the four most heavily traveled WIM stations, denoted as 9913, 9926, 9932, 9936 and shown in Figure 1 on page two of this summary.

FINDINGS AND CONCLUSIONS

A concurrent permit vehicle occurrence is defined as two or more permit vehicles that are within close enough proximity to each other as to span a total distance no longer than the average length of all bridges within a 15-mile radius of the given WIM station. In this manner, the probability of concurrent vehicles exceeding various weight thresholds is extrapolated from the actual measurement location (WIM station) to those bridges within 15 miles of the station and along the same route.

The solution procedure detailed in the report was applied to four WIM stations (Fig. 1). Table 1 presents the results of this analysis as the probability of observing ***at least one*** occurrence of concurrent vehicles, within a one-moth time frame, whose total weight exceeds the indicated threshold at the given WIM station. Figure 2 provides this same analysis in graphical form. It is shown that, within any given month, there is an appreciable likelihood that concurrent permit vehicles will occur, and that their combined weight will exceed 250,000 lbs. The specific probabilities are quantified within the report for the four WIM stations analyzed.

Three important restrictions must be noted when viewing the results in Table 1 and Figure 2.

1) The WIM stations only record vehicles with a weight of less than or equal to 160,000 lbs. Thus the statistical results ignore the traffic of heavier vehicles. Thus the probability of exceeding weights > 250,000 lbs. may be underestimated.

2) The weight from standard (non-permit) vehicle traffic is not included, though it is likely to be present concurrent with permit vehicles.

3) Truck volumes continue to increase (based upon FDOT statistics), and there will likely continue to be an increase in the volume of permit vehicle traffic. This will increase the threshold exceedence probability presented in Table 1 and Figure 2. The influence of increased truck traffic can be evaluated on a yearly basis by re-running the analyses presented in this study on a yearly (or less frequent) basis.

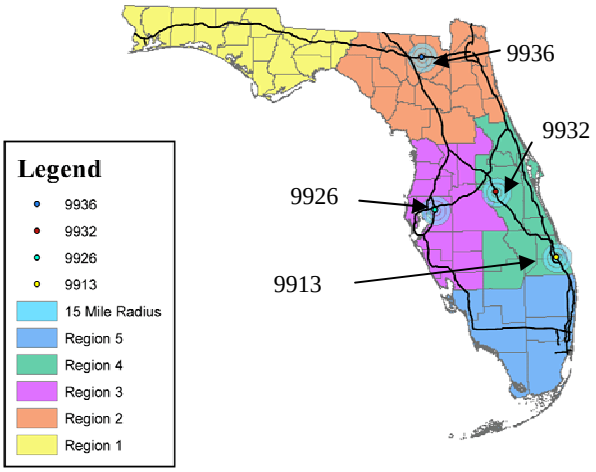

Figure 1: Locations of the four WIM sites selected for analysis.

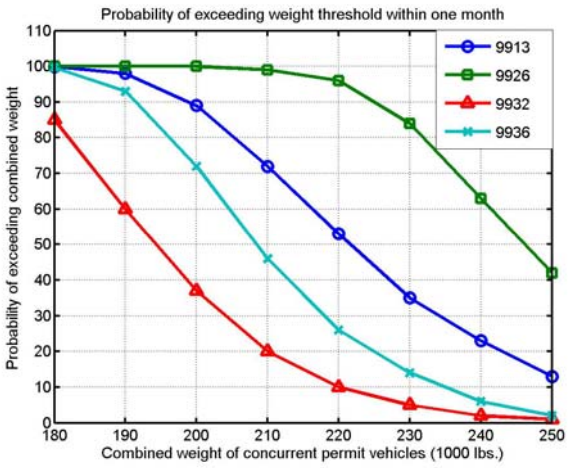

Figure 2: Probability of at least one occurrence of concurrent permit vehicles that exceed the given x-axis weight threshold within a one-month time frame.

Table 1. Probability of observing at least one instance of concurrent permit vehicles per month that exceeds a given left column weight threshold.

	WIM station [years of observation available] (average # of observed concurrent permit vehicles per month)			
Concurrent weight threshold	**9913 [‘01 ‘02 ‘03] (16)**	**9926 [‘02 ‘03] (89)**	**9932 [‘01 ‘02] (6)**	**9936 [‘98 ‘99 ‘00 ‘01 ‘02 ‘03] (21)**
	Probability of at least one occurrence of combined concurrent permit vehicle weight per month that exceeds the weight in the left column			
> 180,000	**99.9%**	**100%**	**85%**	**99.7%**
> 190,000	**98%**	**100%**	**60%**	**93%**
> 200,000	**89%**	**100%**	**37%**	**72%**
> 210,000	**72%**	**99%**	**20%**	**46%**
> 220,000	**53%**	**96%**	**10%**	**26%**
> 230,000	**35%**	**84%**	**5%**	**14%**
> 240,000	**23%**	**63%**	**2%**	**6%**
> 250,000	**13%**	**42%**	**< 1%**	**2%**

BENEFITS

The maintenance of Florida bridges and the evolution of an appropriate bridge rating system require that the frequency and weight of heavy vehicles be accounted for. Permit vehicles represent a source of loading that exceeds standard vehicle weights. The likelihood of multiple permit vehicles on a given bridge needs to be statistically evaluated to determine the adequacy of current bridge load assumptions.

This study examines the permit loads that should be considered concurrent for the purpose of calculating appropriate operating ratings. Existing weigh-in-motion records were analyzed to develop a probabilistic model of the relative likelihood of concurrent vehicle combinations, providing a realistic description of worst case loading configurations.

The FDOT will benefit from this research through the specific results of the analysis of WIM data from 1998 through 2003. As heavy vehicle traffic increases in the years to come, the specific values resulting from the current analysis will no longer be valid. The analysis methods and framework presented in this study for will be useful for future evaluation of heavy vehicle traffic as current WIM data becomes available.

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