Live Load Model for Puerto Rico Routine Heavy Permit Vehicles

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Abstract

An analysis was made to establish a model of vehicle loads on bridge design that represents the permits' loads that are considered as routine permits by Puerto Rico Highways and Transportation Authority. In addition, was studied if the HS30 can be a representative design guideline model for those routine permit loads. Following the parametric studies, two families of vehicles were studied by calculating the envelope of force effects from each of them. Based on this study, we conclude that the HS30 live load model is representative of the permit vehicles of Puerto Rico. It is recommended that the PRHTA consider the two families of vehicles studied, as possible vehicles to represent routine permit vehicles in their design guidelines.

Introduction

Puerto Rico as a commonwealth of the United States, is required to follow the National Bridge Inspection Standards (NBIS) [1] for the safety inspection of its bridges. Puerto Rico Department of Transportation and Public Works (DTOP) and, Puerto Rico Highways and Transportation Authority (PRHTA) follow a Regulation [2] by law, that limits the vehicle loads that travel on public highways. This Regulation says that except through the granting of a Special Permit or Authorization, no vehicle or combination of vehicles with a weight greater than 110,000 pounds will be able to travel on public roads. To comply with Federal regulation the NBIS [1] requires that bridges be evaluated for routine permits, and it establishes the codes and guidelines to follow to determine the load capacity (load rating) of the bridge.

Objectives

Considering those aspects, the main objectives of this article are:

- Establish a model of vehicle loads on bridge design that represents the permits' loads that are considered as routine permits by PRHTA which are less than 150 kips.
- Since Puerto Rico already uses the HS30 as a vehicle for load rating in bridge design, the study focused on determining if the HS30 Design Vehicle accounts for these routine permits' loads.

Background

Bridge load rating provides a basis for determining the safe load capacity of a bridge. In this project, two procedures are going to be used for the analysis. The first one, is the design load rating procedure for the design vehicle HS30 as established in the Puerto Rico Design Directive 310 [3]. On the other hand, the second procedure to be used is the permit load rating for the exclusion vehicles that are going to represent the routine vehicles that are evaluated for permits in the PRHTA.

Methodology

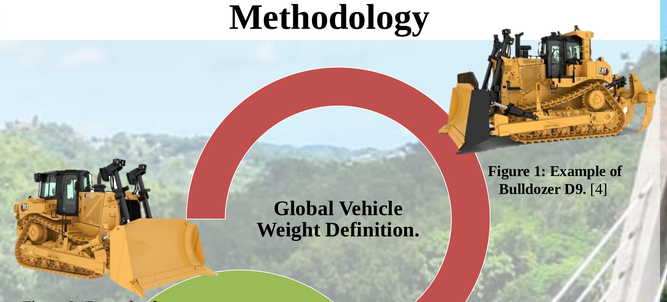


Figure 1: Example of Bulldozer D9. [4]

Figure 2: Example of Bulldozer D8. [4]

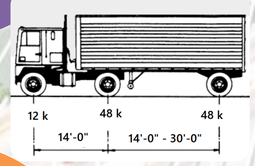


Figure 3: Design Truck HS30 [5]

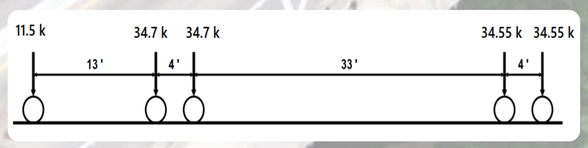


Figure 4: Exclusion Vehicle F.M.3-S2 Modified (WB54m) [5]

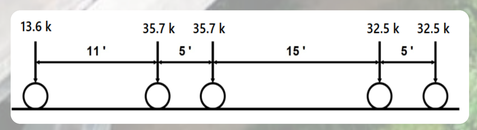


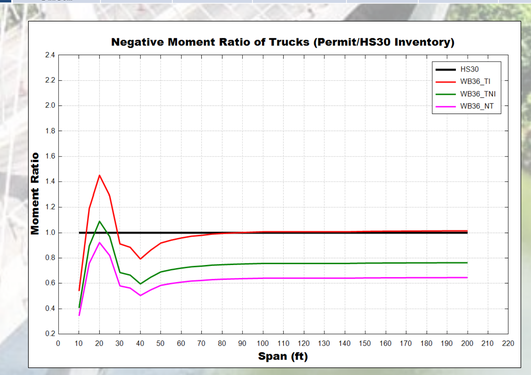
Figure 5: Exclusion Vehicle F.M.3-S2 Modified (WB36m) [5]

Results and Discussion

In Table 1 it can be seen a summary of the maximum ratio values between each permit vehicle and the HS30 in Inventory Level and Operating Level.

Table 1: Maximum Ratio of Permits Vehicles / HS30 in Inventory and Operating Level

Permit's Vehicle	Forces Effects	Maximum Ratio (Permit / HS30 in Inventory)			Maximum Ratio (Permit / HS30 in Operating)		
		Traffic + Impact	Traffic + No Impact	No Traffic + No Impact	Traffic + Impact	Traffic + No Impact	No Traffic + No Impact
WB36m	Positive Moment	1.0	0.75	0.64	1.30	0.97	0.82
	Negative Moment	1.45	1.09	0.92	1.88	1.41	1.20
	Positive Shear	0.99	0.75	0.63	1.29	0.97	0.82
	Negative Shear	1.01	0.76	0.64	1.33	0.99	0.84
WB54m	Positive Moment	0.91	0.68	0.58	1.18	0.89	0.75
	Negative Moment	1.34	1.0	0.85	1.74	1.31	1.10
	Positive Shear	0.94	0.71	0.60	1.22	0.91	0.77
	Negative Shear	0.98	0.74	0.62	1.27	0.96	0.81



After obtaining the maximum ratio results a regression analysis was made to obtain the maximum Global Vehicle Weight (GVW) these vehicles could have to be nearest or equal to a ratio of 1.0. The summary of these results is shown in Table 2.

Table 2: Maximum GVW of Permits Vehicles / HS30 in Inventory and Operating Level

Permit's Vehicle	Forces Effects	Maximum GVW (Permit / HS30 in Inventory) (kips)			Maximum GVW (Permit / HS30 in Operating) (kips)		
		Traffic + Impact	Traffic + No Impact	No Traffic + No Impact	Traffic + Impact	Traffic + No Impact	No Traffic + No Impact
WB36m	Positive Moment	150	200	235	115	155	180
	Negative Moment	110	140	160	85	110	130
	Positive Shear	150	200	235	115	155	185
	Negative Shear	150	195	235	115	150	180
WB54m	Positive Moment	165	220	260	125	170	200
	Negative Moment	115	150	175	90	120	140
	Positive Shear	160	210	250	125	165	195
	Negative Shear	155	200	240	120	155	185

Conclusions

Based on this study, it was demonstrated that the HS30 at the Inventory level, as well as considered for design, can represent the routine permit vehicles mostly with only speed restrictions. In addition, if the traffic was controlled it meets all cases. On the other hand, the study presents that in most of the cases bridges that are designed for HS30 at the operating level also resist routine permit vehicles.

Future Work

Due to the above, it is recommended that the PRHTA consider WB36m and WB54m as possible vehicles to represent routine permit vehicles in their design guideline [3].

Acknowledgements

I would like to thank my advisor, Manuel Coll Borgo, for all the guidance and support he gave during this project.

References

[1] National Bridge Inspection Standard (NBIS), 23 CFR 650 subpart C.

[2] Reglamento 8154: "Dimensiones y Pesos de los Vehículos de Motor, Arrastres y Semiarrastres que Transitan por las Vías Públicas de Puerto Rico" Gobierno de Puerto Rico, Departamento de Transportación y Obras Públicas, 2 de febrero de 2012.

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Background Image:

[9] La Perla del Sur: "Reabren carriles del puente atirantado de Naranjito" [Online]. Available: https://www.periodicolaperla.com/actualidad/reabren-carriles-del-puente-atirantado-de-naranjito/ [Accessed Oct. 15, 2024].