

JOINT TRANSPORTATION RESEARCH PROGRAM

Principal Investigator: Kumares C. Sinha, Purdue University, sinha@purdue.edu, 765.494.2211

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-3229

2011

Truck Travel Characteristics as an Indicator of System Condition and Performance

Introduction

Truck traffic has significantly increased in past decades. The effect of trucks on the level of service is determined by considering passenger car equivalents (PCE) of trucks. The Highway Capacity Manual (HCM) uses a single PCE value for all trucks combined. However, the composition of truck traffic varies from location to location; therefore a single PCE-value for all trucks may not correctly represent the impact of truck traffic at specific locations. Consequently, the Indiana Department of Transportation (INDOT) wanted to develop separate PCE values for single-unit and combination trucks to replace the single value provided by the HCM. Traditionally, equivalent delay and microscopic simulations have been used to estimate PCE values. In order to facilitate the development of site specific PCE values, an alternative PCE-estimation methodology was explored in the present study on the basis of lagging headways measured from real traffic data. Lagging headway, defined as the distance from the rear bumper of a leading vehicle to the rear bumper of the following vehicle, is the actual space a vehicle consumes while in the traffic stream. The study used data from four locations on a single urban freeway and three different rural freeways in Indiana. Three-stage-least-squares (3SLS) regression techniques were used to estimate models that predict lagging headways for passenger cars, single-unit and combination trucks. The models were then expanded to predict lagging headways for each of nine vehicle-following combinations which were used to predict class average lagging headways. After determining lagging headways by vehicle class, the PCE values were calculated as the ratio of the lagging headway of each truck class to that of passenger cars.

Findings

The present study determined separate PCE values for single-unit and combination trucks. The estimated PCE values for single-unit and combination truck for basic urban freeways (level terrain) were 1.35 and 1.60, respectively. For rural freeways, the estimated PCE values for single-unit and combination truck were 1.30 and 1.45, respectively. Due to the lack of sufficient quality data for rural freeways,

the estimated rural PCE values are not recommended for use. As expected, traffic variables such as vehicle flow rate and speed have significant impacts on vehicle headways. Further, the study results indicated that not only do different vehicle classes have different headways, but they directly depend on headways of other vehicle classes. The study further examined the impact of headway models on predicted LOS values. The separate PCE values can have significant influence on the LOS estimation. Since roadway design depends on estimated LOS, estimated PCE values may result in different design specifications and different conclusions from evaluation studies as compared to standard HCM procedure.

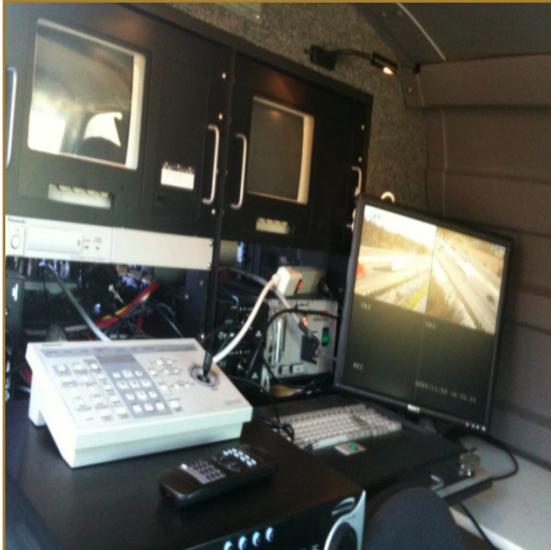
This study also explored regional variation of PCE values by developing headway models using data from different sources and from different geographical locations. The results of the likelihood ratio test indicated that it is more appropriate to combine data from similar regions (freeway sections at different geographical locations) for the PCE estimation. It was found that 9-equation 3SLS models (expanded models estimated to predict lagging headways for each of nine vehicle-following combinations, thus used to predict class average lagging headways) predicted more accurate headways than that of 3-equation 3SLS models. Forecasting accuracy comparisons showed that these alternative modeling techniques reliably predict vehicle class lagging headways.

Implementation Recommendations

A PCE value of 1.6 for combination trucks and 1.35 for single-unit trucks can be used by INDOT to assess the impact of trucks on LOS as compared to a single PCE value provided by HCM. These numbers are applicable to only level terrain urban freeways. The developed headway models allow for the prediction of site-specific PCE values. In the case of the 3-equations 3SLS model, one can accurately predict lagging headways, thus PCE values; using only 6 simple inputs (the speed and number of vehicles for each class i.e., passenger cars, single-unit and combination trucks) for any desired freeway segment. These inputs can be observed using existing traffic monitoring infrastructure/ procedures, and the output (lagging headways and PCE values) can be calculated using a

simple Excel spreadsheet.

The developed models are expected to enhance INDOT's ability to assess the impact of changes in number of single-unit and combination trucks at a level terrain urban freeway segment in the state highway network. This way the agency may be in a better position to monitor site specific impacts of various compositions of truck traffic on highway LOS.



Interior of the Mobile Traffic Laboratory



Exterior setup of the Mobile Traffic Laboratory

References

Ahmed, A., Van Boxel, D., Volovski, M., Labi, S., & Sinha, K. C. *Truck Travel Characteristics as an Indicator of System Condition and Performance*. Publication FHWA/IN/JTRP-2011/07. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2011. DOI: 10.5703/1288284314627

View the full text of this technical report here:
<http://dx.doi.org/10.5703/1288284314627>

Published reports of the Joint Transportation Research Program are available at: <http://docs.lib.purdue.edu/jtrp/>