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Characterization and Development of Truck Load Spectra and Growth Factors for Current and Future Pavement Design Practices in Louisiana

Introduction

Current roadway pavement design practices follow the standards set by the American Society of State Highway and Transportation Officials (AASHTO), which require the use of an equivalent single axle load (ESAL-18 kip single axle load) for design traffic input. In the past few years, a new mechanistic-empirical pavement design guide (MEPDG) was introduced to improve the current pavement design practices. The new guide requires the use of truck axle load spectra rather than ESAL, which imposes additional data requirements and raises the need for better utilization of existing traffic data sources. The axle load spectra method directly applies the number of load applications of various axle configurations (single, tandem, tridem, and quad) within a given weight classification range. In order to adopt the new pavement design procedures in Louisiana, the Louisiana Department of Transportation and Development (LADOTD) launched a research study in 2007 to address traffic data needs and requirements associated with the implementation of the new pavement design guide.

Objective

This research study primarily addresses the current traffic characterization techniques used in Louisiana for pavement design practices in order to identify critical changes needed as well as certain gaps and areas of potential development in the traffic monitoring process statewide. In addition, the study developed Louisiana's traffic load spectra from the available truck traffic data sources and updated Louisiana's Load Equivalency Factor (LEF) tables. More specifically, the research objectives of this study were to: (1) review current practices adopted by the state of Louisiana on traffic data collection within the scope of this study, (2) develop a strategic plan to improve the current traffic data monitoring program, (3) evaluate the quality of Louisiana's traffic data, (4) develop the traffic load spectra and update the current LEF tables in Louisiana using the available traffic data, and (5) make recommendations on future implementation of the MEPDG in Louisiana.

Scope

The scope of the study is limited to the current practices and traffic monitoring system within the state of Louisiana. All findings and guidelines will be geared toward the needs of LADOTD with the purpose of improving traffic data quality for current and future pavement design practices. Appropriate statistical models and procedures were applied to identify the main traffic characteristics that influence the pavement design process.

Methodology

The study reviewed current data collection practices in Louisiana, as well as other states, in order to gain a comprehensive understanding of all elements required to improve the data collection process in Louisiana. Consequently, the study developed a strategic plan to initiate a weigh-in-motion (WIM) data program to improve the traffic data collection process and meet the requirements of the new pavement design guide. To achieve this, geographic zones, truck routes, WIM enforcement locations, and truck volumes were considered to estimate the number and location of permanent and portable WIM sites needed. This study attempted to develop truck axle load spectra using data measured from portable WIM stations in 2004, 2005, and 2006 in the state of Louisiana. Before developing axle load spectra, WIM sites were evaluated against the steering axle test and gross vehicle weight test to eliminate erroneous traffic data that may result from the use of inadequately calibrated devices. WIM sites with underestimated and/or overestimated steering and gross vehicle weight distributions were eliminated from the analysis. Out of the 96 portable WIM stations available, 51 sites

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passed data quality control tests and were used in further analysis. Since the dominant vehicle class is different for WIM sites, the WIM sites were separated into three groups using the sum of squared errors method as a measure of axle load spectra proximity for different sites. These grouped sites were checked against permanent WIM sites proposed in the strategic plan to determine if two or more of the newly proposed sites were located in close proximity to existing portable WIM sites with similar truck traffic characteristics. Based on similar truck traffic characteristics of each group, only one permanent WIM station in the vicinity of that group could be used.

Conclusions

Based on the analysis, single, tandem, and tridem axle load spectra and vehicle class distributions were developed with the truck traffic classification procedure. Quad axles were not monitored at portable WIM sites. All WIM sites grouped with the truck traffic classification procedure had a good agreement with vehicle class distribution and single axle load spectra default values. Default tandem and tridem axle load spectra were entirely different when compared to truck traffic classification (TTC) groups. It was observed that a significant variability exists in vehicle class distribution within the same functional classification. The study used portable WIM data in order to develop LEF for both flexible and rigid pavements. Based on a thorough review of current and anticipated data needs, two alternative plans were proposed. Plan I requires the construction of 29 new permanent WIM sites, while plan II requires only 17 new permanent WIM sites, assuming data from the current weight enforcement sites are available to supplement data from new permanent WIM sites. Also, guidelines and cost estimates to build permanent WIM stations were proposed.

Recommendations

Given the limited amount of data collected by portable WIM sites and the effect of calibration problems with portable devices on the quality of data, it was strongly recommended that traffic data should be collected for a longer monitoring period of at least seven days. In addition, a more frequent calibration of the portable devices is essential to improve the quality of data. Such improvements could potentially lead to a more accurate estimation of actual axle load spectra for single, tandem, and tridem axles. Another strong recommendation made to LADOTD was to adopt a strategic plan for installing permanent WIM sites, as well as tap into axle load data from existing weight enforcement sites to supplement data collected by portable WIM sites. A pilot study is recommended for implementing the proposed permanent WIM sites. In this test, proposed sites should be monitored for seven continuous days in every quarter of the year with calibrated piezoelectric sensors. Other recommendations include the use of single load cell technology for the proposed permanent WIM sites located on interstates and bending plate technology for sites located on principal arterials. For low volume roads, it was recommended that calibrated portable WIM sensors be used and evaluated periodically.

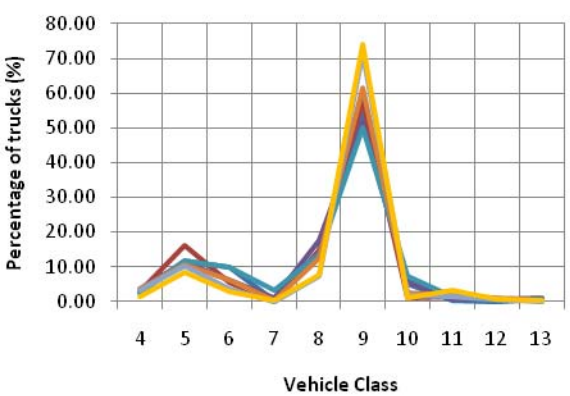

Figure 1
Vehicle class distribution for truck traffic classification #1

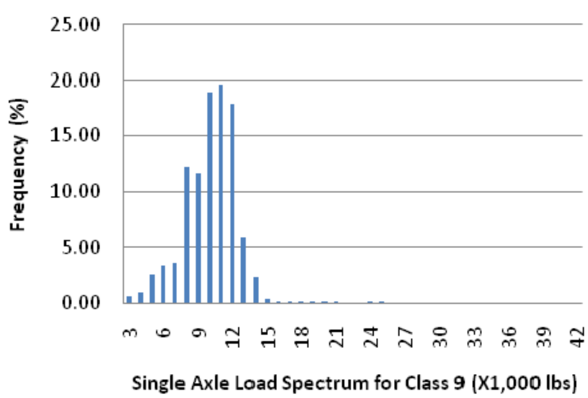

Figure 2
Single axle load spectrum for vehicle class 9 for truck traffic classification #1

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