0-6965: Characterization and Quantification of the Traffic Load Spectra in Texas Overweight Corridors and Energy Sector Zones

Background

In recent years, Texas has experienced a significant increase in energy-related activities such as natural gas and crude oil productions. Despite many positive economic impacts, these energy development activities create large volumes of overweight truck traffic operations in the network, adversely affecting the longevity of transportation infrastructure systems. A prime example is the unprecedented energy production activities in highly active oils fields such as Permian Basin and the Eagle Ford Shale region in the past decade. The quantification of the energy development impacts and taxing loading conditions on the highway network is the prelude to adopting proper rehabilitation strategies to meet the future growth of traffic in overload corridors. Consequently, there is a pressing need to accurately quantify the damages imparted by the oversize/ overweight truck operations.

What the Researchers Did

The primary goal of the project was to develop a database of the site-specific axle load spectra for overload corridors in the energy-developing areas of south Texas. The secondary goal was to establish a mechanistic framework, based on the axle load spectra, to quantify the pavement damages associated with the overweight truck operations in overload corridors of east and southeast Texas.

To achieve the project objectives, initially, the research team deployed portable weigh-in-motion (P-WIM) units in summer 2018 and winter 2019 in ten representative sites located in the Eagle Ford Shale region. The results were instrumental for the development of axle load spectra.

In combination with the field traffic characterization, the research team conducted a series of nondestructive tests such as ground penetrating radar and falling weight deflectometer (FWD) on representative pavement sections to develop a database of the pavement layers characteristics. Post-processed data such as pavement profile and back-calculated layer modulus were instrumental for further development of modified Equivalent Axle Load Factors (EALF) and the remaining life analysis of the representative pavement sections in this study. To fulfill the secondary objective of the project, the research team developed a mechanistic framework for the quantification of the pavement damages associated with overweight truck operations in the region. The research team also conducted FWD testing to investigate the influence of environmental factors on the pavement stiffness properties and the damage equivalency factors. Finally, the research team developed a mechanistic framework to assess the reduction of pavement service life due to changes in the traffic characteristics post energy-developing era. Figure 1 provides a schematic diagram of the service life reduction analysis.

What They Found

The analyzed P-WIM data showed an alarming number of overweight vehicles, significantly above the Texas permissible limits, in the network. On average, farm-to-market (FM) roads were found to be subjected to approximately 64% overweight vehicles. The average overweight truck percentages for State and US Highways were 36% and 45%, respectively. Additionally, the proposed mechanistic

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approach for calculation of the damage equivalency factors confirmed that the modified EALF values were substantially higher than traditional industry-standard axle load factors currently employed by the pavement design industry. Another noteworthy finding of this project pertains to the relevance of the time of the year and the modified damage factors. Based on the proposed mechanistic approach, the EALF values

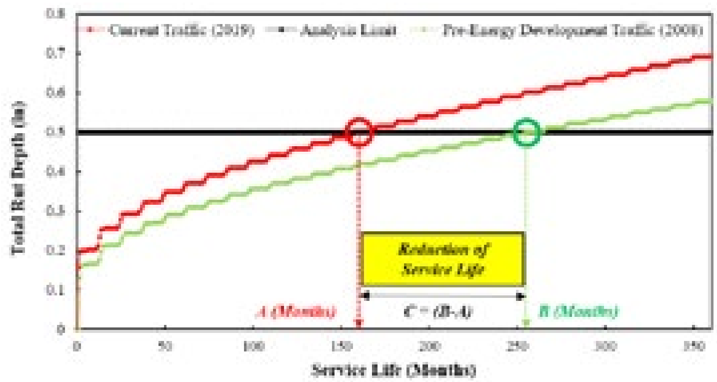

Figure 1. Schematic Diagram of the Service Life Reduction Analysis.

Figure 2. Developed Web-Based Tool.

derived from the numerical simulations with summer-based layer modulus were significantly higher than the winter-based damage factors.

The numerical simulations using Texas-ME for ten representative pavement sections indicated that the reduction of service life was more pronounced for FM roads, with less robust structural capacity compared to state and US highways. The analysis also indicated that the majority of studied FM roads either closely approaching their expected service life or exceeded the distress limits set forth by TxDOT.

The study results are summarized in a web-based module (Figure 2), allowing for graphical visualization of site-specific information, such as EALF values, traffic distributions, axle load spectra, vehicle classifications, seasonal variations of truck traffic, and the results for the remaining life analysis. This module also incorporates provisions to export the axle load spectra for further analysis by TxDOT engineers and the Texas pavement design industry.

What This Means

Based on extensive field testing, field data collection, and numerical simulations, new tables of site-specific axle load factors were developed in this study. This allows for realistic characterization of the damages imparted on pavement facilities due to overweight truck operations. Accurate quantification of the load-related distresses can further optimize the rehabilitation plans and strategies to mitigate deterioration of ride quality in the impacted network. This can potentially protect state assets by reduction or elimination of reconstruction costs associated with the premature failure of the transportation facilities. Additionally, having an accurate read on the loading characteristics of the overweight corridors is the precursor to the development of strategies for strengthening and armoring transportation assets in the energy-developing corridors in Texas.

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