INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Effects of Heavier Truck Loadings and Super-Single Tires on Subgrades

Introduction

In the last two decades, use of super-single tires has slightly increased, with the aim of improving efficiency and economy. Since the contact stresses generated by super-single tires are higher than those of conventional dual tires, this change has caused concern about possible damage to pavements designed based on the current design methods. The higher the contact stresses on the pavement surface, the larger the subgrade deformation, and the more severe the damage to the subgrade.

In order to investigate the effects of super-single tire loadings on subgrades for typical Indiana road cross-sections, static and dynamic finite element analyses were performed taking into account the realistic shape of the contact area and the increased vertical contact stress. Subgrade soils were modeled as saturated to consider the most severe conditions possibly occurring during the pavement design life.

Findings

It was found that the direction of the maximum tensile stress is dependent on the shape of the contact area and stress distribution. Super-single tires generate larger transverse tensile strain than longitudinal tensile strain at the bottom of the asphalt layer.

The analyses showed that super-single tires induce larger permanent strains in the pavement layers than conventional tires. Therefore, design of a pavement using Load Equivalency Factors (LEF) for dual tires may lead to overestimation of the pavement design life. Single axle loadings with super-single tires induce the largest vertical plastic strains on top of the subgrade rutting of all the axle configurations considered.

Analysis results also show that the higher the speed of the truck, the less the load on the subgrade. Since repeated super-single tire loadings increase vertical permanent strains in the subgrade for existing roads, either mitigation of permanent strains in the subgrade may be pursued or the number of passages of super-single tires could be limited by appropriate regulation.

For clay subgrades, the higher the Over Consolidation Ratio (OCR), the less the deformation. Positive pore pressures are generated in normally consolidated clay subgrades, while negative pore pressures are typically generated within heavily overconsolidated clays and dense sands. Therefore, in a Normally Consolidated (NC) clayey subgrade, the shear strength is reduced as a result of traffic loadings due to the pore pressure build-up.

Vertical strains induced by super-single tires can be mitigated either by subgrade modification or by adding a structural overlay.

Implementation

The research results can be helpful for designing for super-single heavier traffic loads. It would be necessary to indicate that information regarding the extent of super-single tires on INDOT highways need to be collected. This is essential in order to use the analysis

presented in this report for pavement design including factor of super-single tire loads. In addition, information regarding subgrade type, classification and strength characteristics need to be also present. With the presence of these pieces of information, the study provides two options for the design; to mitigate the effect of super-single tires, 1) improving subgrade strength or 2) adding an adequate structural overlay.

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