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Structural Analysis and Life Cycle Cost Evaluation of Road Infrastructure Systems Subjected to Superloads

Yongsung Koh, Iowa State University
Halil Ceylan, Iowa State University
Sunghwan Kim, Iowa State University
In Ho Cho, Iowa State University

Abstract

Super-heavy loading vehicles, also called superloads, have non-standardized loading configurations as well as high gross vehicle weights (GVW) and axle loadings, all of which may cause unexpectedly greater distresses on the roads than those caused by conventional vehicle class types categorized by the Federal Highway Administration (FHWA). In general, superloads include "Implements of Husbandry (IoH)" and "Superheavy Loads (SHL)," both known to be the main types of heavy transport vehicles in the Midwestern region of the U.S. To evaluate the impact of the non-standardized loading configurations of superloads on the pavement structures and granular roads, an efficient and structured analysis method is needed to predict unexpected damages that can be occurred in each type of road (i.e., flexible pavement, rigid pavement, and granular road) subjected to superloads. For example, the critical loading locations are determined and categorized according to the loading configuration of each superload on Jointed Plain Concrete Pavements (JPCP). On the other hand, the nucleus segment approach can be applied to analyze flexible pavements and granular roads to determine the loading range and magnitude of each superload. The critical pavement responses from road structures under those loading conditions are calculated by performing Finite Element Analysis (FEA) and Layered Elastic Theory (LET)-based analysis, respectively, and then converted to damage ratios by comparing them with critical pavement responses resulting from FHWA class 9 truck loading. Furthermore, a mechanistic-based life cycle cost analysis of pavement structures and granular roads is performed to quantify the pavement damage-associated costs (PDAC) of a single pass of superload over the road's service life.