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Effect of overweight trucks and natural conditions on the durability of concrete bridges

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ABSTRACT

Durability of concrete bridges is greatly influenced by environmental factors, such as seasonal and diurnal temperature changes, presence of corrosive elements, application of salt for deicing, ettringite formation, alkali-silica-reaction, etc. In addition to environmental factors, traffic and usage patterns, such as high incidence of overweight truck traffic on a bridge, can also affect its service life. In this study, a finite-element-based durability model for reinforced concrete bridges is presented. The model is capable of capturing damage of various bridge components caused by overweight truck traffic and can be used to predict the reduction in service life of a bridge under such a scenario. Damage is modeled as a reduction of material moduli at different material points in the bridge. The rate of damage progression of these moduli is in-turn governed by a refined, realistic model that simulates transport of corrosive elements through the concrete material and also models the effect of localized stresses and strains on these transport processes. The resulting deterioration curves for the condition rating of the bridge and its components are calibrated with data from the inspection reports of several representative bridges in the state of Indiana. In addition, the restoring effect of maintenance, repair, and rehabilitation practices is modeled through damage reversal. The performance of this durability model is documented by studying different overweight traffic loading scenarios for a chosen set of representative bridges, and predicting the resulting reduction in service life of these bridges under those scenarios. This durability model can be an effective tool for planning the infrastructure needs of a community and the approach can also be extended to study the durability of constructed facilities in general.