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Abstract

Numerical Simulation of Pavement Subbase Layer Modified with Recycled Concrete Aggregates and Tire Derived Aggregates †

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The utilization of waste materials in pavement systems such as recycled concrete aggregates (RCA) and tire derived aggregates (TDA) has become a common practice in the design of surface wearing course layers. Though research is emerging on the use of RCA and TDA in the subbase layers, very limited studies are available that quantify their effect on the overall behavior of the pavement systems. Therefore, the major objective of this study was to develop a framework that could assist in quantifying pavement performance responses by using finite element method under standard wheel load of 80 kN. The information pertinent to the material characteristics of pavement systems comprising three distinct subbase layers were collected, and the designs were performed in accordance with global pavement design guidelines. The control pavement system comprised granular subbase layer, while the other two pavement designs consisted of subbase layers, which utilized RCA, and blends of RCA and TDA (RCA-TDA) as alternatives to natural aggregates. Further, axisymmetric finite element models of the three pavement systems resting over the subgrade were generated, and the stresses and strains developed in the different layers of the pavement were quantified. The test results indicated that the magnitude of vertical compressive strains for the combined RCA-TDA subbase were the highest, followed by subbase layers with RCA and natural aggregates designed separately. However, it is important to mention that the cost of 1 km long and 3.5 m wide pavement subbase with coarse granular aggregates was about 45.34% higher than the RCA subbase course and 18.74% higher than the combined RCA-TDA subbase layer. Though recycling of waste materials such as RCA and RCA-TDA resulted in slightly higher stresses and strains compared to pavement systems with virgin granular materials, the cost of construction reduced significantly along with the decreased need for extraction of virgin materials, which is certainly an approach towards low-impact development sustainable infrastructure. The framework proposed in this research may be extended further by incorporating variable traffic and different layer thicknesses or materials to ascertain the performance of a diversified set of pavements. It is envisioned that this research will not only assist in understanding the structural response of various pavement systems from a holistic design point of view, but also in promoting recycling of waste materials as applications in pavement technology from sustainability perspective, i.e., focused on waste-to-wealth and circular economy concepts.

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