Innovative Approach to Cost Benefit Analysis of Granular Roads

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The sustainability of granular roadways is very important to the rural economy, since these roads provide access to rural land and enable the transportation of agricultural products. Any interruption in access via these granular roadways can thus have a significant impact on agricultural productivity and the economy of Iowa. Heavy traffic loads and freeze/thaw cycles during the winter and spring seasons can cause extensive damage to granular roads. Such damage leads to many problems such as material loss, gradation change, loss of crown, surface erosion, rutting, and potholes. The rate of deterioration (or damage) is directly correlated to the quality of the granular aggregate materials used in the design of unpaved roads, and the granular materials have a range of prices. The major maintenance costs for such roads are aggregate material and hauling costs from the quarry to the maintenance site. Accordingly, acquiring a cost-effective and high-performance surface material to be utilized in granular roadways can be a challenge. In this study, three conventional granular roadway materials and four coarser aggregate materials from different quarries were used to construct seven test sections to assess their relative performance and costs. The first three test sections were constructed with conventional materials, and the other four sections used optimum mixtures of the four coarse aggregate materials with the local conventional aggregate material. The long-term performance and mechanistic behaviors of the different surface materials, including stiffness, strength, and material and thickness loss were evaluated for three years. In this study, a mechanistic life cycle benefit-cost analysis approach was developed via use of field performance data to evaluate the transport of coarse aggregate materials for granular roadway maintenance. The benefit-cost analysis results for different aggregate materials are presented in the form of benefit-cost ratios for service lives ranging from 20 and 50 years. Three different scenarios are presented based on the field test results, and the corresponding benefits in terms of stiffness, strength, and material and thickness loss are evaluated for each test section.

Keywords: benefit-cost analysis; granular roads; stiffness; strength; material loss