Geotechnical Properties of Recycled Materials for Use as Highway Embankment Fill

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Abstract

Use of recycled materials is one way to provide more sustainable roadway construction. In this study, engineering properties of a number of recycled materials were reviewed for use in highway embankment fill. Compaction characteristics, hydraulic conductivity, shear strength and compressibility of recycled asphalt pavement (RAP), foundry slag (FS), bottom ash (BA), and recycled asphalt shingles (RAS) that are produced in large quantities in the US were characterized. From the standard compaction test results, the four recycled materials have lower dry unit weight than compacted sand. Results of triaxial compression tests showed that shear strength of these materials are appropriate to provide stability for typical highway embankments. The measured hydraulic conductivities provide sufficient drainage capacity for embankment fill. Results of one-dimensional compression tests showed that bottom ash and foundry slag have comparable compressibility to that of compacted sand up to vertical effective stress ($\sigma_v'$) of 200 kPa. At $\sigma_v'$ higher than 200 kPa, bottom ash exhibits 40% higher strain than sand. The compressibility of foundry slag significantly increases primarily due to crushing of individual particles. Compressibility of RAS is significantly higher than that of sand which makes the material unacceptable as embankment fill. RAP consistently has higher compressibility than glacial sand; however, settlement of typical highway embankments constructed with RAP is below the maximum limit. Bottom ash, foundry slag, and RAP have appropriate engineering properties for use as structural fill in typical highway embankments. Recycled asphalt shingles should be mixed with at least 50% of granular additive to reduce the compressibility to an acceptable limit. Increasing temperature increased the compressibility of compacted RAS and RAP. To minimize settlement of embankments constructed with RAP and RAS, embankment construction is recommended during summer to induce preloading at higher temperatures.

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