0-6883: Compaction of Soils and Base Materials Using Superpave Gyratory Compactors

Background

Impact hammer compaction has historically been used to develop moisture-density curves and fabricate specimens for strength testing for flexible base and subgrade materials. But the impact hammer compaction's precision of compressive strength can cause conflicting test results about whether a material meets specification requirements. This project used the Superpave gyratory compactor (SGC) to analyze if SGC compaction improves the precision of compressive strength tests for flexible base and subgrade materials, and analyzed a procedure for determining the moisture-density curve of base and subgrade materials using the SGC. Also, researchers evaluated the applicability of SGC for base materials in mechanistic-empirical (M-E) pavement design methods.

What the Researchers Did

Researchers conducted a literature review on using SGC and SGC equipment capabilities. Researchers selected five flexible base materials (from Pharr, Waco, Atlanta, Amarillo, and San Antonio Districts) and one subgrade soil (from the Paris District). Researchers then developed a procedure to get the applicable Tex-113-E or Tex-114-E maximum dry density (MDD) using the SGC machine and tested the sample materials.

What They Found

While the materials compacted with the SGC showed slightly lower compressive strength than materials compacted with the impact hammer, the statistical analysis indicated that the averaged strength test results from the SGC compaction are generally not statistically different from the test results from impact hammer compaction. SGC compaction generated the compressive strength results with less variability and improved precision compared to impact hammer compaction.

SGC compaction for base materials produced slightly higher optimum moisture content (OMC) and MDD compared to impact hammer compaction. However, for the subgrade soil, the OMC from SGC compaction is higher than that of the impact hammer, while the MDD from SGC compaction is lower. This discrepancy might be the result of different compaction mechanisms between gyratory compaction and impact hammer.

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From the measurement of M-E design properties through repeated load triaxial testing, the following findings and conclusions were drawn:

- The base materials compacted with the SGC were associated with lower accumulated permanent strains than ones compacted with the impact hammer.
- Similar to the result of the permanent deformation behavior, the resilient modulus measured using the samples compacted with the SGC was higher than that with the impact hammer.
- The M-E design properties are not unique soil characteristics but may depend on the compaction method, where the compaction process can change aggregate shape properties and thus influence the M-E design properties.

What This Means

SGC compaction can offer an alternative lab method for constructing flexible base test specimens with improved precision in compressive strength. Improvement in compressive strength precision would reduce risk to both the Texas Department of Transportation and producers. SGC compaction may also be used for establishing the OMC and MDD. However, as compared to using the impact hammer for establishing the OMC and MDD, using the SGC to establish the moisture-density relationship would likely result in slightly different field compaction targets.

For M-E design inputs, the Aggregate Image Measurement System results showed that the samples compacted with the SGC generally had higher angularity and slightly increased sphericity, where the angularity effect dominated and resulted in lower permanent strains and higher resilient modulus compared to specimens compacted with the impact hammer. The method of compaction should be considered a possible factor that influences results in the development of M-E inputs from laboratory testing.

For More Information

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