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Abstract

Laboratory Study on the Mechanical Behavior of Tire Chip-Sand Mixtures

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Stockpiling of scrap tires in Macao brings out environmental and economical problems which may be resolved by using them as lightweight backfill material. The objective of this study is to investigate the mechanical behavior of tire chip-sand mixtures, as a potential backfill material, based on laboratory testing. The tire chips are pieces of scrap tires cut into about 3 cm with specific gravity of 1.17-1.25. The tested sand is ZhongShan sand with specific gravity of 2.67, which was dredged from the Pearl River and is usually used in Macau for land reclamation.

Permeability of the tire chip-sand mixtures with varying chip/mix ratio was estimated in constant head test. Compaction densities of the mixtures were determined in both standard and modified proctor tests. Compressibility test that follows six loading and unloading cycles was carried out to simulate the loading condition of the mixtures in the field and find out the compressibility parameters of the mixtures. The stress-strain-strength and volumetric behavior and the strength parameters of the mixtures were determined in consolidated-undrained (CU) and drained triaxial tests (CD). The variation of mechanical behavior with respect to the chip/mix ratio suggested the optimum mixing ratio to be about 40%.

The CD triaxial test results were also used to determine the modeling parameters and to compare with the numerical simulations from the hyperbolic model and artificial neural network model. Hyperbolic model was found to be not suitable for modeling

the post-failure stress-strain and volumetric behavior of the tire chip-sand mixtures except pure tire chips samples, while artificial neural network could predict the pre- or post-failure stress-strain relation fairly well. The volumetric behavior due to shear dilatancy could be modeled, but was not modeled as well as the stress-strain relationship by the ANN model probably because the inconsistent volumetric behavior of the tire chip-sand mixtures. Further investigation for more suitable models should be necessary.

The use of tire chip-sand mixtures as lightweight geomaterial is very promising and should be promoted. It is proposed that the strength and compressibility parameters determined as part of this study be used for design and evaluation of embankments, retaining wall, etc., until such time as more extensive testing results are available.