

## Shear Strength Characteristics of Sand Mixed with Particulate Rubber

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**Abstract :** Waste tyres is a global problem that has a negative effect on the environment, where there are approximately one billion waste tyres discarded worldwide yearly. Waste tyres are discarded in stockpiles, where they provide harm to the environment in many ways. Finding applications to these materials can help in reducing this global problem. One of these applications is recycling these waste materials and using them in geotechnical engineering. Recycled waste tyre particulates can be mixed with sand to form a lightweight material with varying shear strength characteristics. Contradicting results were found in the literature on the inclusion of particulate rubber to sand, where some experiments found that the inclusion of particulate rubber can increase the shear strength of the mixture, while other experiments stated that the addition of particulate rubber decreases the shear strength of the mixture. This research further investigates the inclusion of particulate rubber to sand and whether it can increase or decrease the shear strength characteristics of the mixture. For the experiment, a series of direct shear tests were performed on a poorly graded sand with a mean particle size of 0.32 mm mixed with recycled poorly graded particulate rubber with a mean particle size of 0.51 mm. The shear tests were performed on four normal stresses 30, 55, 105, 200 kPa at a shear rate of 1 mm/minute. Different percentages of particulate rubber content were used in the mixture i.e., 10%, 20%, 30% and 50% of sand dry weight at three density states, namely loose, slight dense, and dense state. The size ratio of the mixture, which is the mean particle size of the particulate rubber divided by the mean particle size of the sand, was 1.59. The results identified multiple parameters that can influence the shear strength of the mixture. The parameters were: normal stress, particulate rubber content, mixture gradation, mixture size ratio, and the mixture's density. The inclusion of particulate rubber to sand showed a decrease to the internal friction angle and an increase to the apparent cohesion. Overall, the inclusion of particulate rubber did not have a significant influence on the shear strength of the mixture. For all the dense states at the low normal stresses 33 and 55 kPa, the inclusion of particulate rubber showed a slight increase in the shear strength where the peak was at 20% rubber content of the sand's dry weight. On the other hand, at the high normal stresses 105, and 200 kPa, there was a slight decrease in the shear strength.

**Keywords :** shear strength, direct shear, sand-rubber mixture, waste material, granular material

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