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The use of laser technology to investigate the effect of railway ballast roundness on shear strength

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ABSTRACT:

The heavy haul coal line of the South African railway network is facing a problem where ballast particles are becoming rounded, negatively affecting performance and thus leading to shorter planned maintenance cycles. This has been attributed to the lack of a more scientific way of evaluating the ballast shape properties. The objective of this paper is to investigate the effect of ballast particle roundness on shear strength properties of five ballast materials used on the Transnet Freight Rail heavy haul coal line. A river pebble sample was included in the study as the reference material for extremely rounded ballast. All six materials were scanned in a 3-D laser scanning system to develop models of the ballast and the river pebble particles. Based on the laser scanner results, a new empirical model has been developed to determine the surface area of ballast materials. The surface area values were further used to develop a chart to assess different particle shapes with varying degrees of roundness. Triaxial tests were conducted to determine the effect of the roundness on the shear strength properties of the materials. A Mohr-Coulomb failure model was successfully developed from the results to represent individual materials tested. The overall results show that the angle of internal friction increases with roundness of the sample greater than 0.8. More rounded particles have values between 0.6 and 0.7, whereas less rounded particles have values between 0.8 and 1.3. The outcomes of this study would assist with quality assessments in the field and whether or not a degraded ballast track layer has to be replaced.