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Effect of coarse gravel and cobble size particles' shape on their dynamic image analysis results

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The Dynamic Image Analysis (DIA), standardised in ISO 13322-2:2006 and ISO 9276-6:2008 standards, introduces a simple and fast analysis of diverse particle shape and size parameters, compared to a manual method or static image analysis, respectively. While the DIA method is time conserving, as it is a quasi-3D method, it is susceptible to greater variations in results compared to a real-3D, time consuming static image analysis. A variation analysis of the DIA results as a function of the analysed particles' shape was the focus of our study. The particle shape plays a role in various processes, including wearing off (mechanical abrasion) during sediment transport or due to in-situ abrasion of larger sediment particles in fluvial environments.

More than 40 particles were randomly selected for the DIA analysis. Analysed particles included quarried, angular rock particles and rounded fluvial sediment particles. The selected particles had a geometric mean diameter in the range between 15 mm and 70 mm (coarse gravel to cobble size). The mass of particles was between 10 and 400 g. All particles were divided into four shape groups (bladed, prolate, equant, and oblate) according to Zingg's shape classification. Axes' lengths used for shape classification were manually measured using a caliper. All particles were also individually analysed in a dynamic image analyser (quasi-3D image analyser) Microtrac Camsizer XL, using the accompanying software, PartAn 3D. The software evaluates 33 size and shape parameters of analysed particles, including dimensional (e.g. length, width, thickness, surface area, etc.) and dimensionless (e.g. ellipticity, sphericity, convexity, etc.) parameters. Three DIA repetitions of each particle were applied to estimate the mean values and variation (coefficients of variation, CV) in its results.

Furthermore, the effect of particles' size, mass, and Zingg's shape on the variability of the DIA results was investigated. Particles' size, as well as particles' angularity, showed no obvious effect on the variation in the DIA results. Quarried, angular particles had CV of 3.54% on average for all parameter results, while rounded, fluvial particles had CV of 3.68% for all parameter results. On the other hand, Zingg's shape class showed an effect on the variation of both, dimensional and dimensionless DIA resulting parameters. Bladed particles displayed the greatest variations of all the resulting parameter values, with an average CV of 6.85%, and the greatest scatter of parameters' CVs. When analysing such particles, it would be beneficial to conduct more than three repetitions for more accurate results. Since the DIA analysis is a fast method, this is not a problem in order to get a robust estimation of coarse particle shape. Additionally, observing the

parameters themselves, “concavity” and “angularity” had the highest CVs, namely 13.35% and 10.24%, as well as the greatest scatter of the CVs. Parameters “convexity”, “solidity”, and “sphericity” had the lowest CVs, namely 0.12%, 0.26%, and 0.96%, respectively, as well as the lowest scatter of the CVs.