PHOTOELASTIC MEASUREMENT TECHNIQUES UTILIZING DIGITAL IMAGE PROCESSING FOR MODELING GRANULAR MATERIALS

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The study of the fundamental behavior of granular material requires simplified ideal models. Such models can provide insight into the particle to particle and particle to interface interaction during displacement and shear.

One possible solution is the utilization of two-dimensional round or elliptical particles made of photoelastic materials. Traditional photoelastic techniques call for detailed stationary measurements and hence are not suitable to study a phenomenon which requires motion.

A method utilizing digital image processing and analysis was developed. The method enables accurate and rapid measurement of the contact force magnitude and orientation. The measurements are based on comparisons between the size and shape of isochromatic fringes in a "measured" particle to a similar "calibration" particle under known loading conditions.

Elastic solutions were developed describing the state of stress within a disk subjected to a concentrated load in varied orientations. These solutions enabled the study of the effect of various parameters on the analytical "isochromatic" fringes.

An experimental apparatus was devised which allows the researcher to load a particle both diametrically and in a multiple contact orientation and to subject it to known frictional loads. The apparatus was built as part of a circular polariscope, hence allowing careful measurements required for the development and assessment of measurement techniques.

The resulting measurement technique of photoelastic particles in contact lays the foundation for numerous applications in the study of granular material behavior.