PHOTOELASTIC STUDY OF STRESS AND STRAINS IN GRANULAR MATERIAL

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Localisation of strains and stresses visibly plays the crucial role in deformation of granular materials. There are several basic, but still opened questions, concerning the relationship between stresses and strains during plastic deformation of these materials. A principal phenomenon observed in both photo-elastic models and in numerical studies is that the stress in granular materials is carried by force chains which load some particles, leaving other rather lightly loaded.

The patterns of force chains define a scale which is larger than the scale of individual particles. Radiographic and photogrammetric studies have revealed the development of more or less regular patterns of density variation as the materials are deformed. Some of the regions of lowered density may subsequently encourage the formation of marked localisations or failure zones which then define the mechanisms of failure of geotechnical systems, such as retaining walls and slopes [5].

The nature of localisation in relation to the force chains that are observed photoelastically are studied. Recent development of image processing method for granular materials (geoPIV, [7]) enables to observe both forces (stresses) and deformations during one model test. Photoelastic studies of granular material (mainly crushed glass) were extensively led some twenty years ago and are well described in literature [1], [2], [3]. Now new surrogate materials became available, having much better photoelastic and photoplastic properties, [6].

The study consists of simple model test, performed on glass balls, having relatively uniform size distribution. Test box for simple model test was placed in a big polariscope. Several test series were performed for linearly and circularly polarised monochromatic and white light, with parallel and crossed quater wave plates. No grain crushing was observed. Later stages of the tests clearly show traces of stress localisation. The regular stress pattern is visible on photographs, taken for angle of polarisation equal to 45^0. It resembles the plasticity solution for respective boundary value problem.

The appropriate FE solution is presented next. The plain strain problem of a model test, geometrically analogous to the experimental one, was calculated by the finite element method. The calculated stresses make a picture qualitatively similar to the experimental ones and also show the traces of localisation in the final stages (only qualitative comparison was possible).

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