The effect of stone contact compliance on large deformations of asphalt mixtures

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Asphalt is the most common pavement material. Failures in asphalt layers result in high costs both for the construction industry and for the road users. Large deformations occur at all stages of asphalt mixtures life: from materials production, transportation and installation to traffic induced pavements degradation, such as rutting. Hence, understanding the behaviour of mixtures and compacted asphalt at large deformation is crucial for improved performance predictions of the material as well as for optimizing material design, transportation and installation techniques, cf. e.g. [1]. In the present study the discrete element method (DEM) is applied for evaluating the behaviour of asphalts mixtures at large deformations. Emphasis is put on the influence of the stone-to-stone contact compliance on the materials performance.

Large deformations in asphalt mixtures are associated with rearrangement of stones that not only change their position but also their orientation and interaction with other aggregates. Stone to stone contact is the main load transferring mechanism that can best be accounted for by applying micromechanical principles. The use of DEM is especially advantageous for these purposes as it allows to describe the specific contact conditions and to account for large deformations including rearrangements. The DEM has been used in several recent studies to investigate the mechanical behaviour of asphalt mixtures, cf. e.g. [2],[3]. However, it appears that previous studies focussed on a simplified empirical contact/separation model, using parameters from calibrating the DEM results against experimental measurements. No attempt has been made so far to establish a contact law based on contact mechanics and to identify it's parameters with micromechanical testing.

The present study is trying to address this gap. The mechanics of the frictional contact cycle, i.e. both loading and unloading phases, is investigated experimentally and numerically for two different types of stones. The experiments are performed at controlled contact profiles. Furthermore a methodology to evaluate contact compliance at arbitrary stone shapes is proposed. The effect of material parameters properties of stones as well as of friction coefficient on their contact compliance is studied and a contact law governing the stone interaction in the material is developed. In order to develop stone breakage laws for the DEM modelling of asphalt mixtures, stone resistance to contact induced fracture initiation is examined experimentally. The proposed stone contact law is incorporated into the in-house DEM code [4], and the effect of stone contact compliance on the performance of asphalt mixtures is examined numerically for triaxial test.

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