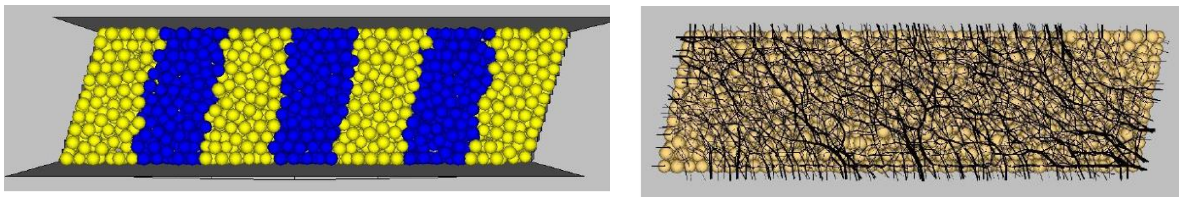
Master Thesis

Topic:

Numerical investigation of the interface behaviour for soil-structure interaction problems using the Discrete Element Method

Description:

In the field of soil mechanics generally, soil medium is considered as a continuum and thus the interface behaviour is considered only by rather simple models describing the contact between structure and soil medium mostly based on an elastic-plastic idealisation or its influence on the boundary value problem is neglected in soil-structure interaction problems such as pile foundation or tunnel construction. Many studies have shown that shear strains localize in a shear zone very close to the structural member e.g. close to the pile shaft. Furthermore, from experimental analysis of boundary value problems the need of accurate modelling of soil–structure interfaces that cover all decisive influencing soil specific parameters, state variables and parameters linked to the geometry and mechanical properties of the surface of the structural member is clearly visible. A novel interface shear device based on the principle that the soil is kept within a containment of a stacked frame allowing laminar deformation parallel to the surface of the interface has been planned to overcome some of the major shortcomings of existing concepts of experimental investigation. The negative influence of rigid boundaries can be avoided by the design principle of the novel device. Still, in a first phase of construction of the novel device and from the experiments the results will allow only an interpretation of the interface behaviour by macroscopic observation in terms of measured shear force and shear displacement.



(a) (b)

Figure 1: (a) Simulated simple shear specimen of glass beads at 20% shear strain (b) Simulated force chains of glass beads at a shear strain of 20% (Dabeet 2014)

A better understanding of macroscopic phenomena requires insight into the microscopic level as defined by the possibility to monitor the movement of single particles and the changes of contact pattern of the particle assembly. Discrete element method (DEM) has been proven to be advantageous for such kind of microscopic analysis. The result from the simulation allows the examination of particle-scale interactions to be described by localised measurements of forces at the particle contact, displacements and rotations of particles as well as quantitative analyses of the fabric made up of particle clusters. The present study focusses on the numerical modelling of the

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behaviour resulting from shear force application considering the dimensions and constraints of the novel interface shear device. The proposed DEM analysis is considered as a key to investigate micro-mechanical phenomena and shed light on the interface behaviour of soil-structure interaction problems.

Scope of work:

1. A thorough literature review covering the fundamentals of DEM, microscale parameters, behaviour of sand-steel interface, factors affecting interface behaviour shall be carried out.
2. The interface experiment shall be simulated considering suitable parameters and values defining boundary conditions and validated. The soil parameters like mean size, relative density and intrinsic interface properties like surface roughness of the steel plate shall be varied to analyse the effect on the interface shear behaviour.
3. The simulations shall be run to identify the zone of shear localization in terms of shear band/shear zone. The height of the sample and friction between walls and sample (side friction) shall also be varied to analyse its effect on shear behaviour.
4. The non-uniformity of stresses and strains particularly at the boundaries due to side friction should be analysed.
5. The results shall be summarised to ascertain the boundary effects, formation of force chains during shearing, shear localisation and effects on shear behaviour due to varying soil and interface properties.

Prerequisites:
Interest in pursuing Discrete Element Modelling using softwares YADE and/or PFC 3D.

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