APPLIED MECHANICS

Associate Professor **Abbas Khayyer**

Associate Professor **Jun Saito**

Assistant Professor **Tomohiro Tanaka**

Modeling of mechanical behavior and numerical simulation

Safety evaluation of structures from the viewpoint of mechanics is the most important issue at every stage of the infrastructure development. "Comprehensive and reliable modeling of fundamental mechanical behavior" is a key point in applied mechanics and development of a numerical prediction method is necessary in order to explain a measurement of observation or a laboratory experiment, scientifically. Our laboratory studies mechanical theory and its application, and aims to cultivate human resources who can develop studies and pass research achievements to the next generations.

Lagrangian particle methods for multi-physics simulations

The main target is to develop advanced multi-physics multi-scale particle-based computational methods for practical simulation of engineering problems. The main areas of interest include violent fluid flows, multiphase flows and fluid-structure interactions.

The so-called particle methods or Lagrangian mesh-free methods are appropriate candidates for fluid flow simulations (and their interactions with the environment) in view of their flexibility and potential robustness in dealing with complex moving boundaries. However, since particle methods are relatively new computational techniques there have been several issues corresponding to non-exact momentum/energy conservation, unphysical pressure fluctuations and numerical instability. These issues have almost been resolved by development of accurate schemes for discretization of the constitutive governing equations. The main future/ongoing studies are focused on:

1. further enhancement of accuracy and stability of particle methods by development of further accurate numerical schemes/algorithms
2. further enhancement of the developed multiphase particle-based method by a more meticulous modeling of the governing physics
3. extension of developed particle methods to model hydroelastic fluid-structure interactions (FSI) as well as fluid-porous media interactions (FPI) with rigorous treatment of interface boundary conditions

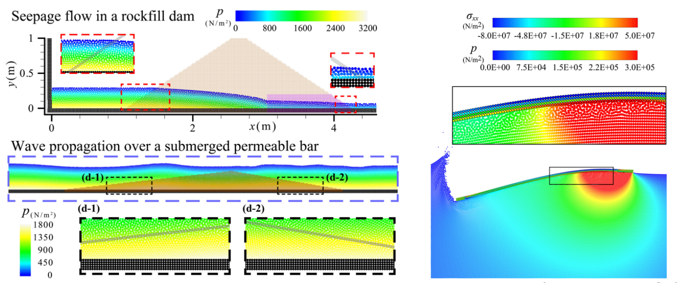

Fig.: Multi-physics simulations by particle methods (FPI and FSI)

Rigid plastic finite element method for soil structures

Bearing capacity and slope stability problems are often treated as rigid-plastic boundary value problems, because elastic deformation is small and negligible in comparison with plastic deformation. Rigid Plastic Finite Element Method (RPFEM), which is based on limit analysis, is well known as a robust basis to solve such kinds of problems. The aim of this research is to develop the RPFEM by improving of accuracy and considering ground anchors or rock bolts.

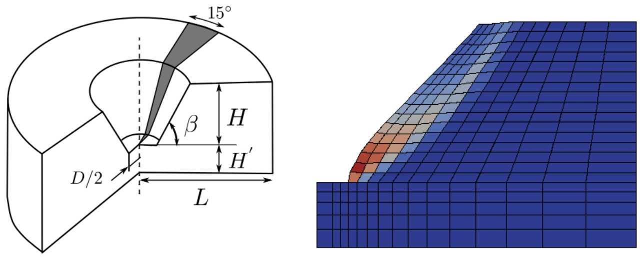

Fig.: Stability analysis of excavation

Numerical analysis of non-Newtonian fluid for civil engineering

Numerical analysis of non-Newtonian fluid is of importance in civil engineering. For instance, fluid behavior of fresh concrete, avalanche or mudslide is modeled as non-Newtonian fluid. The aim of the study is to develop numerical schemes for the fluid analysis and apply them to various problems.

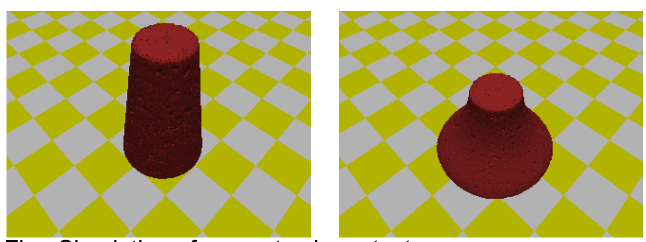

Fig.: Simulation of concrete slump test