

The power of soil-water coupling analysis based on u - w - p formulation

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ABSTRACT

The authors have developed the dynamic/static soil-water coupled finite deformation analysis based on u - w - p formulation^[1] considering dynamic fluid motion among saturated soil^[2] (Fig. 1). The developed analysis is characterized in terms of the considerations of relative convection of pore water and strict satisfaction of mass conservation at the moving boundary in the finite deformation regime. The u - w - p formulation has an extensive capability of solving coupling problems of highly permeable soils as well as instability problems by overcoming the limitation of u - p formulation assuming the static flow of pore water. In this workshop, the power of the u - w - p formulation will be demonstrated with confirmation of its unconditional stability (Fig. 2), and several applications including dynamic seepage problems (Fig. 3), dynamic deformation analysis of highly permeable soils (Fig. 4), liquefaction analysis of ground embankment system with gravel drain (Fig. 5), boiling analysis (Fig. 6), and “consolidation wave” propagation analysis. The recent works for sophisticating the u - w - p formulation-based analysis code including consideration of fluid viscosity (Fig. 7), and cross-diffusion terms into dynamic/static fluid analysis will also be introduced.

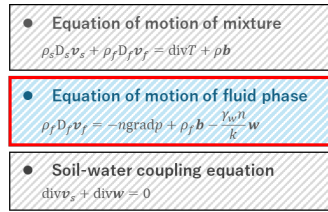


Fig. 1. u - w - p formulation

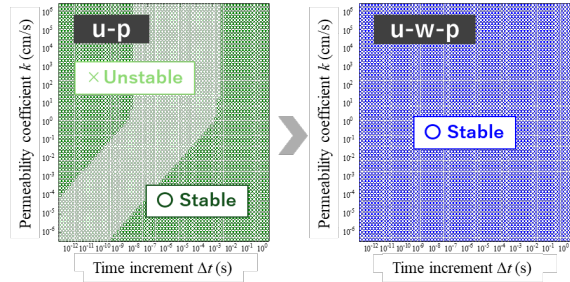


Fig. 2. Numerical stability evaluation

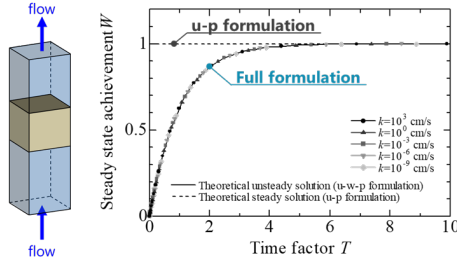


Fig. 3. Dynamic seepage analysis

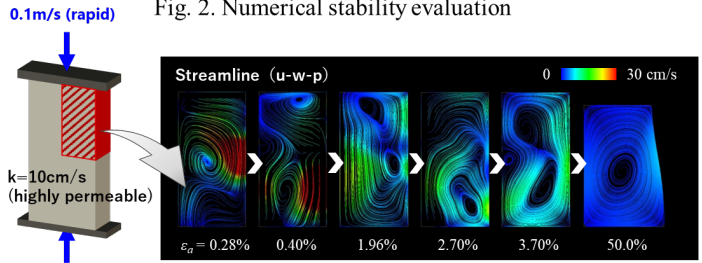


Fig. 4. Dynamic deformation analysis of highly permeable specimen

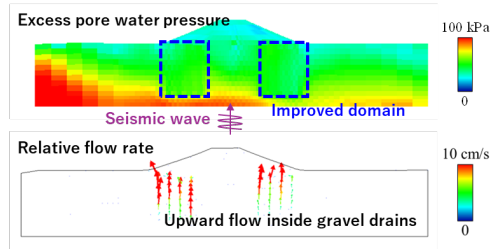


Fig. 5. Liquefaction analysis of soil-embankment system with gravel drain

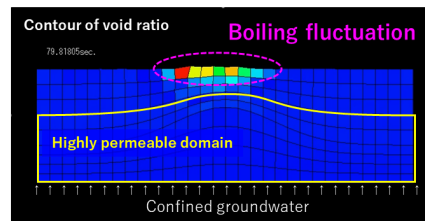


Fig. 6. Boiling analysis

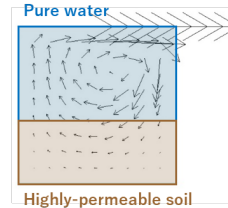


Fig. 7. Cavity flow in porous media

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- [2] Noda, T., Toyoda, T. 2019. Development and verification of a soil–water coupled finite deformation analysis based on u - w - p formulation with fluid convective nonlinearity. Soils Found. 59 (4), 888–904.