A Coupled Extended-Finite-Discrete Element Method: On the Different Contact Schemes between Continua and Discontinua

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Abstract : Recently, advanced geotechnical engineering problems related to soil movement, particle loss, and modeling of local failure (i.e. discontinua) as well as modeling the in-contact structures (i.e. continua) are of the great interest among researchers. The aim of this research is to meet the requirements with respect to the modeling of the above-mentioned two different domains simultaneously. To this end, a coupled numerical method is introduced based on Discrete Element Method (DEM) and eXtended-Finite Element Method (X-FEM). In the coupled procedure, DEM is employed to capture the interactions and relative movements of soil particles as discontinua, while X-FEM is utilized to model in-contact structures as continua, which may consist of different types of discontinuities. For verification purposes, the new coupled approach is utilized to examine benchmark problems including different contacts between/within continua and discontinua. Results are validated by comparison with those of existing analytical and numerical solutions. This study proves that extended-finite-discrete element method can be used to robustly analyze not only contact problems, but also other types of discontinuities in continua such as (i) crack formations and propagations, (ii) voids and bimaterial interfaces, and (iii) combination of previous cases. In essence, the proposed method can be used vastly in advanced soil-structure interaction problems to investigate the micro and macro behaviour of the surrounding soil and the response of the embedded structure that contains discontinuities.

Keywords : contact problems, discrete element method, extended-finite element method, soil-structure interaction

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