Recent advances in the Material Point Method for modelling fluids, granular materials, and coupled fluid–granular behavior

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ABSTRACT

This presentation discusses recent developments in the Material Point Method (MPM) for modeling fluids, granular media, and coupled fluid–solid interactions in saturated granular systems. A stabilized mixed MPM formulation is introduced to address numerical instabilities in simulations of free-surface liquid flow and large-deformation solid response, with application to seepage-induced failure mechanisms. The coupling of MPM with the Volume of Fluid method for accurate free-surface tracking is also presented. Advances in constitutive modeling are also examined, including the incorporation of critical state soil mechanics and rate-dependent dilatancy to capture complex stress–strain responses. In addition, new MPM strategies for dynamic soil analyses are outlined, extending the applicability of the method to a broader range of geomechanics problems involving large deformation, multiphase flow, and soil–fluid interaction.

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