

## **A three dimensional efficient Galerkin meshfree formulation for large deformation analysis of soil slope failure**

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### **Summary**

Meshfree methods have experienced substantially fundamental development and various applications. One distinguished advantage for meshfree methods is that they can relieve the mesh tangling burden of FEM and are more suitable for finite deformation analysis. In this work a three dimensional updated Lagrangian Galerkin meshfree formulation with improved computational efficiency is presented to analyze the failure of soil slopes. This nonlinear meshfree formulation is featured by the Lagrangian stabilized conforming nodal integration method where the low cost nature of nodal integration approach is kept and at the same time the numerical stability is obtained as is not the case for the direct nodal integration. The stabilized conforming nodal integration is fulfilled through the gradient smoothing operation on the rate of deformation tensor located at the meshfree particles. No derivatives of shape functions are involved in the gradient evaluation. The time dimension is discretized by the Newmark algorithms with particular reference to the explicit dynamics. The initiation and propagation of failure in the soil slope is modeled by the coupled constitutive equations of isotropic damage and Drucker-Prager plasticity. Another noticeable characteristic for the current approach is that the gradient smoothing technique also plays a role as non-local averaging which is effective to capture the mechanism of shear band development. Detailed three dimensional equations are given for the proposed formulation. The performance of the present method is validated by typical numerical examples. Extension to coupled rainfall seepage and slope stability analysis is also discussed.

**Keywords:** meshfree method, soil slope, failure, large deformation, gradient smoothing

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