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AN ADAPTIVE MESHLESS MODEL FOR THERMAL ELASTO-PLASTIC CONTACT OF ROUGH SURFACES

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ABSTRACT

In order to simulate the contact condition factually and improve computational efficiency, an adaptive thermal elasto-plastic contact model of rough surfaces is developed to investigate the influences of the steady-state frictional heating on the contact performance of surface asperities and subsurface stress fields between two contacting bodies. Differing from the Finite Element Method (FEM), the element-free Galerkin method (EFGM) does not need any mesh information. It is perfectly suitable for adaptive analysis to achieve higher computation precision with a fewer nodes and less computer time for a given error tolerance. The element-free Galerkin-finite element (EFG-FE) coupling meshless method[1] is used to save CPU time and overcome the major difficulty that the moving least-squares shape functions do not satisfy the Kronecker delta condition,.

Adaptive analysis[2] includes error estimation and nodal refinement. In this paper, the local adaptive refinement strategy and the strain energy gradient-based error estimation model are combined[3]. The EFG-FE coupling meshless method for thermal elasto-plastic contact problems using the initial stiffness method is presented. Formulation of thermal elasto-plastic contact problems, an adaptive EFG-FE meshless model and its implementation for thermal elasto-plastic contact problems are given. The proposed adaptive EFG-FE coupling meshless model takes into account the asperity distortion caused by the temperature variation in a tribological process, micro plastic flow of surface asperities, and the coupled thermo-elasto-plastic behavior of the materials, with and without considering the strain-hardening property of the materials.

The adaptive model is verified through the contact analysis of a rigid, isolated cylinder with a conductive, elasto-plastic plane. Furthermore, the thermal effects on the contact pressure, real area of contact, and average gap of real rough surface with different frictional heat inputs under the thermal elasto-plastic contact conditions are studied. Finally, the thermal elasto-plastic contact problems between rough surfaces including elastic-perfectly-plastic and elasto-plastic properties are investigated for two different kind of steels, respectively. By comparing the contact pressure and the von

Mises stress distributions of every refinement stage with the solution from the uniform refinement model, the accuracy of the solutions from the adaptive refinement model is satisfactory but the cost of the CPU time is much less than that for the uniform refinement calculation. The comparisons show that the adaptive meshless model is highly capable of solving contact problems with excellent calculation accuracy and computational efficiency.

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