THE STRESS FIELD AROUND AN ELASTOPLASTIC INDENTATION

Gang Feng*, Shaoxing Qu*, Yonggang Huang**, William D. Nix***

* Engineering Division, Brown University, RI 02912. gang_feng@brown.edu
** Department of Mechanical and Industrial Engineering, UIUC, IL 61801
*** Department of Materials Science and Engineering, Stanford University, CA 94305

As a classical contact mechanics problem, the indentation stress fields are important to understand characteristics of the indentation process, such as yielding and cracking. The indentation process is generally elastoplastic, and the plastic deformation zone will make the problem very complex. There are mainly two analytical models for an elastoplastic axi-symmetric indentation: Johnson's expanding cavity model [1] and Yoffe's surface inclusion model [2]. Johnson's model predicts a stress field with spherical symmetry, which is not suitable for an indentation on a half space; Yoffe's model requires an unknown material constant, i.e. the strength of the surface inclusion *B*.

In this study, starting with Johnson's model, we demonstrate that the stress at the surface for an elastoplastic indentation can be obtained analytically, and this solution has a form identical to Yoffe's model; thus, *B* can be expressed analytically in a very simple way. Moreover, enlightened by both experimental and Finite Element (FEM) results, we present a generalized Yoffe's model that we call the Embedded-Center-of-Dilatation (ECD) model, which is a simple analytical model. Here, the stress field due to an ECD, i.e. a center of dilatation in a half-space, has been solved by Mindlin and Cheng [3, 4]. We find that the ECD model matches with FEM results nearly perfectly all the way to the edge of the plastic zone for both the fully loaded and fully unloaded states. Moreover, we find the ECD model is good for both the cases with and without strain hardening.

References

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