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Spherical indentation into elastoplastic materials: Indentation-response based definitions of the representative strain

Yan-ping CAO, Xiu-qing Qian, Norbert Huber

Summary

In the development of a systematic method to determine the mechanical properties of materials using depth-sensing instrumented indentation tests, a key issue is to find the connection between the indentation response and the properties of the indented material. For spherical indentation into power law engineering materials, we showed that this problem can be solved by using the concept of the representative strain. In the present research, using finite element analysis based on the incremental plasticity theory and large deformation formulations, we proposed four indentationresponse based definitions of the representative strain. Each of them leads to a simple and explicit expression of the relationship between the material properties (i.e., representative stresses, or reduced modulus and representative stresses) and the directly measurable quantities given by the spherical indentation loading-unloading curves. In addition, the effect of friction on the indentation load-depth curve is further investigated. Based on the results reported in thiswork, a number of novel approaches to identify the mechanical properties of elastoplastic materials using spherical indentation tests have been established. Numerical experiments were performed to verify the effectiveness of the proposed methods. Experimental uncertainties caused by the effects of the surface roughness and the indenter compliance are also discussed which highlights the precautions of applying the novel methods in practice.