An Extended Hertz Model for Incompressible Mooney-Rivlin Half-Space Under Finite Spherical Indentation

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Abstract

In this paper, a contact model is proposed to predict the contact response of an incompressible Mooney-Rivlin half-space under finite spherical indentations. The contact behaviors are systematically investigated through the axisymmetric finite element (FE) model using various constitutive parameter ratios. Based on the numerical results, the contact radius of the contact zone is first derived by adopting the exact function of the indenter shape. A reliable prediction of contact force, for the incompressible neo-Hookean materials, is then obtained by substituting newly modified contact radius into the Hertz model. From this base, a correction factor, which characterizes the effect of constitutive parameter ratio, is introduced to develop the contact force for the incompressible Mooney-Rivlin half-space under spherical indentation up to the indenter radius. The form of the contact pressure distribution that is analogous to the Hertz model, is also developed. The proposed contact model related to constitutive parameters is validated effectively through FE simulations and experimental indentation results under finite spherical indentation. However, the Hertz model is unable to predict the strong effect of constitutive parameter ratio on the contact behaviors for the incompressible Mooney-Rivlin materials, except the indentation depth within 10% of the indenter radius implementation.