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An effective method for calculating elasto-plastic contact pressure and contact patch size under elliptical, circular and line contact conditions. (English) Zbl 1481.74581

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Summary: According to the Hertz's contact theory (HCT) and considering the strain hardening of materials, an effective calculation method is proposed for solving the elasto-plastic contact pressure and the contact patch size under arbitrary smooth and continuous contact conditions. Firstly, it is assumed that the outer and inner edges of the contact patch are elastic and elasto-plastic contact zones, respectively, the contact pressure in the elastic contact zone satisfies the HCT, while the contact pressure in the elasto-plastic contact zone is the superposition of a constant contact pressure and several small ellipsoidal distribution contact pressures. Then, the explicit expressions of contact patch size and contact pressure under the elasto-plastic elliptical, circular and line contact conditions are derived, respectively. Subsequently, the accuracy and applicability of the proposed method are evaluated by comparing the predicted results with the finite element simulations. Finally, the accuracy of the proposed method is further verified by comparing the predicted results with the typical results in literature. It is shown that the proposed method has high calculation accuracy, and the maximum relative errors are 9.32% for the elliptical contact, 4.61% for the circular contact and 11.84% for the line contact, respectively. Meanwhile, the proposed method can effectively predict the contact pressure distribution under the elasto-plastic elliptical, circular and line contacts, and shows a general applicability for different contact materials, contact-body's sizes and normal external loads, as well as for the elasto-plastic wheel-rail contact analysis.

MSC:

74M15 Contact in solid mechanics
74C05 Small-strain, rate-independent theories of plasticity (including rigid-plastic and elasto-plastic materials)

Keywords:

elasto-plastic contact; contact pressure; contact patch size; Hertz's contact theory; prediction accuracy

Software:

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