Extensions of the Johnson–Kendall–Roberts Theory of Adhesive Contact to Transversally-Isotropic Systems and Structures

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Abstract

Molecular adhesion is a physical phenomenon that is specific for nanometre scale interactions. The most popular theory of adhesive contact is the Johnson-Kendall-Robert (JKR) theory that has originally developed for isotropic elastic spheres. The theory is based on the use of the JKR formalism that integrates two fundamental concepts: (1) the Derjaguin balance energy approach and (2) the superposition of solutions to two non-adhesive contact problems, namely, the Hertz-type and the Boussinesq-type problems. The effectiveness of the JKR formalism could be further underscored by harnessing the characteristics of slopes in force-displacement diagrams of non-adhesive cases. This enhancement facilitates explicit transformations of force–displacement curves from non-adhesive to corresponding adhesive cases. The resultant condition could be expressed through a set of formulas, which proves to be a valuable extension of the JKR theory. The explicit transformations demonstrate practical applicability across a myriad of adhesive contact problems in diverse elastic structures. The JKR method is extended to contact problems between an axisymmetric indenter of arbitrary profile and transversely isotopic half-space or layers.
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