Dynamic Sliding Instability of Elastic Solids with a Functionally Graded Coating

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Abstract
Frictional motion is often unstable giving rise to non-uniformities, noise and vibrations of interest in science and technology, ranging from nano-tribology to “squeal” or “hot-spotting” in brakes or clutches, up to the scales of sliding of tectonic plates in earthquakes. In this paper, dynamic instability due to self-excited motion of a homogeneous half-space sliding against a functionally-graded-material-coated half-space with a constant frictional coefficient is analyzed. The effects of the coating gradient index, friction coefficient and sliding speed for various material combinations on the dynamic instability are discussed in detail. Additionally, the stress distribution in both coating layer and bonded half-space is calculated. The numerical results show that the effect of the coating gradient index on the dynamic stability is significant. The use of the functionally graded material layer may improve the dynamic stability of sliding as well as reduce the stress concentration at the interface between the coating layer and half-space if the gradient index of the functionally graded material is chosen carefully. It is also shown that there is an optimum coating layer thickness which corresponds to very small stresses at both contacting and bonding interfaces.

Keywords: instability, wave, functionally graded material, sliding, friction