

# Frictionless elliptical contact of thin viscoelastic layers bonded to rigid substrates

Ivan ARGATOV and Gennady MISHURIS

*Institute of Mathematics and Physics, Aberystwyth University, UK*

Contact problems involving transmission of loads across joints of coated parts are of considerable practical importance in industry. There are emerging applications for viscoelastic coatings in bearings and seals. The coatings protect the components from impact damage, suppress noise and increase the wear resistance. Indentation contact problems for thin viscoelastic layers are recently encountered in applications of the atomic force microscope for determining the mechanical properties of thin biological samples.

We study a three-dimensional unilateral contact problem for thin viscoelastic layers bonded to rigid substrates shaped like elliptic paraboloids. Two cases are considered: (a) Poisson's ratios of the layer materials are not very close to 0.5; (b) the layer materials are incompressible with Poisson's ratio of 0.5. The analogous viscoelastic axisymmetric contact problems were considered in the papers by *Naghieh, G.R., Jin, Z.M., Rahnejat, H.*, 1998. Contact characteristics of viscoelastic bonded layers. *Applied Mathematical Modelling* **22**, 569–58. *Naghieh, G.R., Rahnejat, H., Jin, Z.M.*, 1999. Characteristics of frictionless contact of bonded elastic and viscoelastic layered solids. *Wear* **232**, 243–249.

It can be shown (*Ateshian, G.A., Lai, W.M., Zhu, W.B., Mow, V.C.*, 1994. An asymptotic solution for the contact of two biphasic cartilage layers. *J. Biomech.* **27**, 1347–1360.) that a thin biphasic layer in the contact interaction involving transmission of loads across joints behaves like an incompressible viscoelastic material following the Maxwell model. Thus, the previously developed analytical method (*Argatov, I., Mishuris, G.*, 2010. Elliptical contact of thin biphasic cartilage layers: Exact solution for monotonic loading. *J. Biomech.* doi:10.1016/j.jbiomech.2010.11.010) can be extended by analogy to the case of elliptical contact between thin layers of general viscoelastic materials.

The presented analytical solutions are valid for monotonically increasing loading conditions. Explicit formulas are obtained in the case of a standard viscoelastic solid.