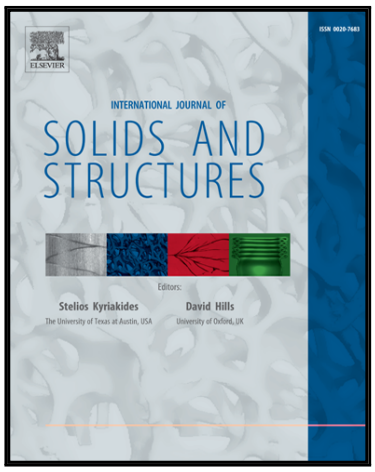

On surface waves in a finitely deformed coated half-space

Weijian Zhou , Weiqiu Chen , Xudong Shen , Yipin Su , Ernian Pan

PII: S0020-7683(17)30368-2
DOI: 10.1016/j.ijsolstr.2017.08.012
Reference: SAS 9691

To appear in: *International Journal of Solids and Structures*

Received date: 27 June 2017
Revised date: 1 August 2017
Accepted date: 13 August 2017

Please cite this article as: Weijian Zhou , Weiqiu Chen , Xudong Shen , Yipin Su , Ernian Pan , On surface waves in a finitely deformed coated half-space, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.08.012

On surface waves in a finitely deformed coated half-space

Weijian Zhou[a] Weiqiu Chen[a,b,c,*] Xudong Shen[a] Yipin Su[a] Ernian Pan[d]

[a] Department of Engineering Mechanics, Zhejiang University, Yuquan Campus, Hangzhou 310027, China

[b] State Key Lab of CAD & CG, Zhejiang University, Zijingang Campus, Hangzhou 310058, China

[c] Key Laboratory of Soft Machines and Smart Devices of Zhejiang Province, Zhejiang University, Yuquan Campus, Hangzhou 310027, China

[d] Department of Civil Engineering and Department of Mathematics, The University of Akron, Akron, OH 44325-3905, USA

Abstract: In this paper, the wave propagation in a finitely pre-deformed elastic half-space overlain by a thin coating layer (or surface film) is considered. The coated half-space is subjected to a particular uniform pre-deformation such that it is kept to be tractions-free on its surface. The first-order effective boundary conditions are introduced to approximate the effect of the overlying surface film. Then the Stroh formalism and Barnett-Lothe theory are adopted to study the surface wave characteristics. In particular, general criteria are established to identify the existence of surface waves of different modes by taking advantage of the surface impedance matrix. As an illustration, surface waves in a coated soft half-space under biasing field are investigated. Both the surface film and the half-space are modeled by the Hadamard strain energy function for soft isotropic materials. Explicit conditions for the existence of different surface wave modes (including the first-order Rayleigh waves, second-order Rayleigh waves and Love waves) are obtained, and the corresponding wavenumber ranges are also determined. Our theoretical analysis and numerical simulations show that both the surface film and the pre-deformation could remarkably affect the propagation of surface waves as well as the stability of the coated elastic half-space. Particularly, it is proved that, distinguishing from Rayleigh waves, the velocity of Love waves varies linearly with pre-stretch for a given frequency, a striking feature which is highly desirable in the sensor designs.

Key words: coated half-space, finite pre-deformation, surface waves, existence, stability

1. Introduction

Guided wave propagation in an elastic substrate coated with a thin surface layer has been investigated intensively by researchers with diverse applications in earth science, mechanical engineering, and solid state physics, to name a few. The substrate

* Corresponding author.
E-mail address: chenwq@zju.edu.cn