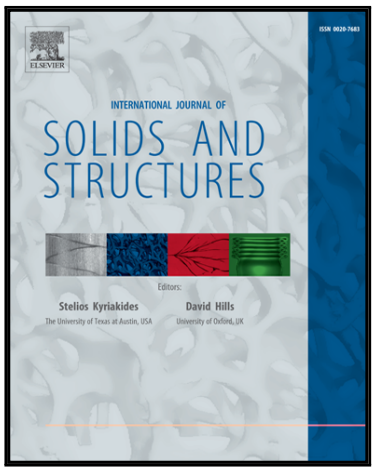

Snell's law of elastic waves propagation on moving property interface of time-varying materials

Langquan Shui , Yilun Liu , Xi Chen

PII: S0020-7683(18)30062-3
DOI: 10.1016/j.ijsolstr.2018.02.013
Reference: SAS 9901

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

Received date: 6 June 2017
Revised date: 23 December 2017
Accepted date: 10 February 2018

Please cite this article as: Langquan Shui , Yilun Liu , Xi Chen , Snell's law of elastic waves propagation on moving property interface of time-varying materials, *International Journal of Solids and Structures* (2018), doi: 10.1016/j.ijsolstr.2018.02.013

Snell's law of elastic waves propagation on moving property interface of time-varying materials

Langquan Shui[a], *Yilun Liu*[a, b*], *Xi Chen*[c,d*]

[a] International Center for Applied Mechanics, State Key Laboratory for Strength and Vibration of Mechanical Structure, School of Aerospace, Xi'an Jiaotong University, Xi'an 710049, PR China

[b] Shaanxi Engineering Research Center of Nondestructive Testing and Structural Integrity Evaluation, Xi'an Jiaotong University, Xi'an 710049, PR China

[c] Columbia Nanomechanics Research Center, Department of Earth and Environmental Engineering, Columbia University, New York, NY 10027, USA

[d] School of Chemical Engineering, Northwest University, Xi'an 710069, PR China

Abstract: In this work, Snell's law of elastic waves on the moving property interface (MPI) of time-varying materials has been studied. First, additional constraints of the elastic wave propagation on MPI are proposed to ensure self-consistence of Snell's law. Second, based on Huygens principle, a geometric approach is developed which can be used to geometrically reveal the wave propagation directions on MPI with clear geometric meanings for the additional constraints. Two criteria are proposed to determine the existence of reflected or transmitted wave on MPI. Finally, based on the two criteria, the conditions for the existence of reflected or transmitted waves are expressed by moving velocity of MPI and wave propagation velocities on both sides of MPI. Then, according to the number of reflected and transmitted waves as well as their polarization types, the propagation of elastic wave on MPI can be classified into 6 cases for SH wave incidence, 12 cases for SV wave incidence, and 15 cases for P wave incidence determined by moving velocity of MPI and wave propagation velocities on both sides of MPI. While, the traditional case of elastic wave propagation on a static material interface, i.e. 2 emitted waves for SH wave and 4 emitted waves for SV or P waves are special cases of elastic wave propagation on MPI. It is noted that for most propagation cases presented in this work, the propagation coefficients are unable to be solved with only the continuous conditions on MPI, i.e. the continuity of displacement, stress and momentum on MPI. This work indicates the elastic wave propagation on MPI can have multiple cases of emitted wave which may provide useful insights for further studying elastodynamics of time-varying materials.

Key words: reflection; refraction; snell's law; time-varying materials; elastic waves

* Corresponding author, yilunliu@mail.xjtu.edu.cn (Y.L.); xichen@columbia.edu (X.C.)