Accepted Manuscript

Guiding and splitting Lamb waves in coupled-resonator elastic waveguides

Yan-Feng Wang, Ting-Ting Wang, Jin-Ping Liu, Yue-Sheng Wang, Vincent Laude

PII: S0263-8223(18)31351-5
DOI: https://doi.org/10.1016/j.compstruct.2018.08.088
Reference: COST 10138

To appear in: *Composite Structures*

Received Date: 12 April 2018
Revised Date: 11 July 2018
Accepted Date: 29 August 2018

Please cite this article as: Wang, Y-F., Wang, T-T., Liu, J-P., Wang, Y-S., Laude, V., Guiding and splitting Lamb waves in coupled-resonator elastic waveguides, *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.08.088

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Guiding and splitting Lamb waves in coupled-resonator elastic waveguides

Yan-Feng Wang,[1,*] Ting-Ting Wang,[1] Jin-Ping Liu,[1] Yue-Sheng Wang,[1,†] and Vincent Laude[2]

[1]*Institute of Engineering Mechanics, Beijing Jiaotong University, 100044 Beijing, China*
[2]*Institut FEMTO-ST, Université de Bourgogne Franche-Comté, CNRS, 25030 Besançon, France*

We investigate experimentally Lamb wave propagation in coupled-resonator elastic waveguides (CREWs) formed by a chain of cavities in a two-dimensional phononic crystal slab with cross holes. Wide complete bandgaps, extending from 53 to 88 kHz, are first measured in a finite phononic crystal slab sample. A straight waveguide and a wave splitting circuit with 90° bends are then designed, fabricated and measured. Elastic Lamb waves are excited by a piezoelectric patch attached to one side of the phononic slab and detected using a scanning vibrometer. Strongly confined guiding and splitting at waveguide junctions are clearly observed for several guided waves. Numerical simulations are found to be in excellent agreement with experimental results and allow for the identification of the involved resonant cavity modes. The influence on the dispersion of guided waves of the slab thickness and of the hole length is also investigated. The results have implications for the design of innovative phononic devices with strong confinement and tailorable dispersion.

Keywords: Phononic crystal, phononic crystal waveguide, Lamb wave, phononic circuits

I. INTRODUCTION

Over the past two decades, phononic crystals (PCs)[1], i.e. artificial functional composites composed of periodic scatterers embedded in a matrix, have attracted a lot of interest[2,3]. In particular, wave propagation can be fully forbidden if the frequency falls inside a phononic bandgap. The factors influencing bandgaps, such as material[4] and geometrical[5] parameters, are now well understood. Furthermore, when the geometrical or material properties of one or several unit cells are locally altered, defect states can appear inside bandgaps. As a result, waves can be guided either along a line of defects[6,7] or along a linear chain of defect cavities[8,9]. As a general rule, confinement of the guided waves is favored by wider bandgaps.

Recently, there has been a growing interest in harnessing the propagation of Lamb waves in PC slabs[10–13]. PC slabs are periodic and infinite in two directions, but finite in the third direction and hence do not suffer from leakage[14]. Lamb waves are strongly confined between the free surfaces but can still be manipulated in the periodic plane, making them interesting candidates for the design of phononic circuits and devices. Generally, two kinds of PC slabs have been considered: either flat slabs perforated with holes[15] or containing solid inclusions[16], or slabs supporting attached pillars[17] or mechanical resonators[18]. Phononic bandgaps were reported experimentally in slabs at ultrasonic frequencies[16,19], up to the GHz range[20,21]. Bandgaps in PC slabs can be optimized by adding holes[22] or by using topology optimization[23]. They can also be enlarged by erecting pillars on the solid regions of a perforated slab[24] or by adding pillars on both sides of the slab[25].

Much attention has also been paid to defect-based waveguides in PC slabs. Investigations have mainly focused on guiding Lamb waves along linear waveguides[26]. Since Lamb wave are channeled along a line defect, complex waveguides can be tailored in the plane at frequencies within a complete bandgap. The propagation of Lamb waves can be changed by 90° through a polyline sharp waveguide[27] or at a waveguide bend with slightly perturbed lattice in the bent region[28]. Waveguides with many sharp corners (90°) have also been reported, though with a relatively large width[17]. In contrast to linear waveguides, waveguides based on linear chains of coupled cavities have been shown theoretically to allow simultaneously for very strong wave confinement and for low group velocity transmission[8,9]. In this paper, we present the first experimental demonstration of highly confined propagation of Lamb waves along coupled-resonator elastic waveguides (CREWs). We also show that sharp 90° bends can be included to form

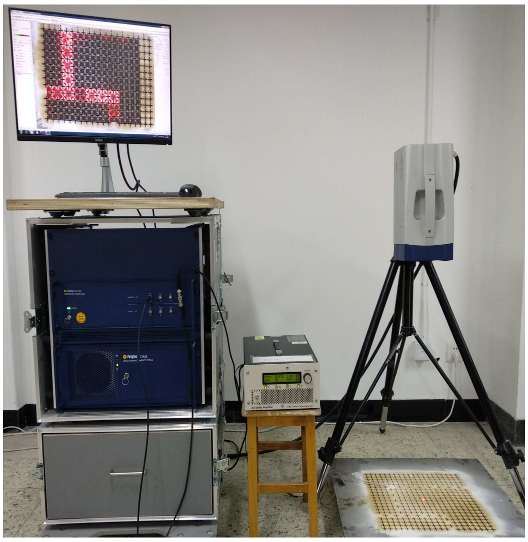

Figure 1: Photograph of the experimental setup illustrating the measurement of vertical displacements of Lamb waves excited in a PC slab sample.

Download English Version:

https://daneshyari.com/en/article/10131666

Download Persian Version:

https://daneshyari.com/article/10131666

Daneshyari.com