

Accepted Manuscript

Numerical investigation of dispersive behaviors for helical thread waveguides using the semi-analytical isogeometric analysis method

Yijie Liu, Qiang Han, Yingjing Liang, Gang Xu

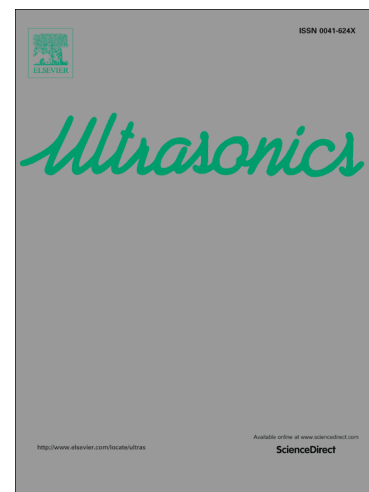
PII: S0041-624X(16)30339-0

DOI: <http://dx.doi.org/10.1016/j.ultras.2017.06.004>

Reference: ULTRAS 5553

To appear in: *Ultrasonics*

Accepted Date: 1 June 2017



Please cite this article as: Y. Liu, Q. Han, Y. Liang, G. Xu, Numerical investigation of dispersive behaviors for helical thread waveguides using the semi-analytical isogeometric analysis method, *Ultrasonics* (2017), doi: <http://dx.doi.org/10.1016/j.ultras.2017.06.004>

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.

Numerical investigation of dispersive behaviors for helical thread waveguides using the semi-analytical isogeometric analysis method

Yijie Liu^{a,b}, Qiang Han^{a,*}, Yingjing Liang^b, Gang Xu^c

^a*Department of Engineering Mechanics, School of Civil Engineering and Transportation, South China University of Technology, Guangzhou, P.R.China*

^b*Department of Engineering Mechanics, School of Civil Engineering, Guangzhou University, Guangzhou, P.R.China*

^c*College of Computer Science, Hangzhou Dianzi University, Zhejiang, P.R.China*

Abstract

In this paper, we propose a semi-analytical isogeometric analysis(S-IGA) approach in the twist space to investigate the dispersive properties in helical thread waveguides, which combines the advantages of the spectral approach and IGA. The convergence and accuracy of the proposed method are discussed, by comparing S-IGA results with reference solutions. Additionally, the analytical expression of axial offset wavenumbers is derived to explain the difference of spectrograms between the Cartesian and twisted systems. In order to illustrate the effectiveness of the proposed method, some dispersion curves of elastic wave propagation in helical thread waveguides are presented for a wide range of thicknesses and tortuosities.

1. Introduction

Helical thread structures are widely employed for rock bolts[1] and bolted joints[2] in engineering and aeronautics. Mainly because of corrosion, damage and fatigue, the material degradation and cracks may lessen components strength, which leads to the failure of the whole structure. Guided ultrasonic waves (GUWs) technology usually is chosen as a highly efficient tool of the nondestructive evaluation (NDE) and structural health monitoring (SHM)[3, 4] for structural detection and material discontinuities. Analyzation of elastic wave is of great interest in the practical use of GUWs, owing to the dispersion and multimode of waveguides. It can be in favor of the control of the frequency range and determination of wave modes, excited by a given source. Hence, these fundamental works on dispersion curves of waveguides allow to further optimize the function and location of sensors to be unutilized.

Helical threads play an important role in the performance of machinery. Their mechanical behaviors, such as the strength and fatigue, have been investigated by experiments [5], theoretical analysis and numerical methods[6, 7]. Although special research on wave propagation of helical threads is not almost shown, the numerical investigations of similar structures, such as prestwisted waveguides and helical rods, has been reported. Onipede et al.[8] has shown the semi-analytical finite element (SAFE) method based on the twisted coordinate and studied elastic wave propagation of prestwisted beams. Tryessede [9] has proposed the relationship of the strain and displacement in the helical coordinate and given the dispersion curves of helical waveguides by using the SAFE approach.

Widely adopted techniques on guided wave are represented by analytical methods and semi-analytical methods. The former generally develops expressions on accurate solutions, but their applications are restricted to waveguides of regular cross-section. The latter, such as wave finite element (WFE) and (SAFE) methods calculate dispersive relationships via solving the algebraic generalized eigenvalue problem rather than the transcendental dispersion equation. The WFE approach[10–13] based upon the Floquets principle is applied to not only elongated waveguides with uniform cross section but also periodic structures. However, the spatial periodic discretization [14]can produce an

*Corresponding author

Email address: emqhan@scut.edu.cn (Qiang Han)

Download English Version:

<https://daneshyari.com/en/article/8130073>

Download Persian Version:

<https://daneshyari.com/article/8130073>

[Daneshyari.com](https://daneshyari.com)