

Accepted Manuscript

Bending and free vibration analyses of in-plane bi-directional functionally graded plates with variable thickness using isogeometric analysis

Qui X. Lieu, Seunghye Lee, Joowon Kang, Jaehong Lee

PII: S0263-8223(17)32628-4

DOI: <https://doi.org/10.1016/j.compstruct.2018.03.021>

Reference: COST 9468

To appear in: *Composite Structures*

Received Date: 15 August 2017

Revised Date: 26 February 2018

Accepted Date: 8 March 2018



Please cite this article as: Lieu, Q.X., Lee, S., Kang, J., Lee, J., Bending and free vibration analyses of in-plane bi-directional functionally graded plates with variable thickness using isogeometric analysis, *Composite Structures* (2018), doi: <https://doi.org/10.1016/j.compstruct.2018.03.021>

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.

Bending and free vibration analyses of in-plane bi-directional functionally graded plates with variable thickness using isogeometric analysis

Qui X. Lieu^{a,1}, Seunghye Lee^a, Joowon Kang^b, Jaehong Lee^{a,*}

^a*Department of Architectural Engineering, Sejong University, 209 Neungdong-ro, Gwangjin-gu, Seoul 05006, Republic of Korea*

^b*School of Architecture, Yeungnam University, 280, Daehak-Ro, Gyeongsan, Gyeongbuk 38541, Republic of Korea*

Abstract

This article is firstly concerned with bending and free vibration analyses of in-plane bi-directional functionally graded (IBFG) plates with variable thickness in the framework of isogeometric analysis (IGA). The plate thickness is smoothly altered in both x - and y -axes by a predetermined power law. Two types of power-law material models with the symmetrical and asymmetrical volume fraction distribution are suggested to characterize the in-plane material inhomogeneity. A non-uniform rational B-spline (NURBS) surface for simultaneously representing both variable thickness and volume fraction distribution of each constituent is employed. By using the k -refinement strategy, the C^0 -continuous requirement at symmetrical material interfaces can be achieved, yet still ensuring material gradations elsewhere owing to the prominent advantage of NURBS basis functions in easily controlling continuity. Effective material properties are then evaluated by either the rule of mixture or the Mori-Tanaka scheme. An analysis NURBS surface separately created with the foregoing NURBS surface is utilized to exactly describe geometry and approximately solve unknown solutions in finite element analysis (FEA) based on the IGA associated with a generalized shear deformation theory (GSDT). The Galerkin C^1 -continuous isogeometric finite element model is therefore simply achieved due to the possibility of flexibly meeting high-order derivatives and continuity of analysis NURBS functions. In addition, no shear correction factors exist in the present formulation, although shear deformation effects are still considered. The influences of variable thickness, material property, length-to-thickness ratio, boundary condition on bending and free vibration responses are investigated and discussed in detail through several numerical examples.

Keywords: In-plane bi-directional functionally graded (IBFG) plates; Variable thickness; Isogeometric analysis (IGA); NURBS; generalized shear deformation theory (GSDT).

1. Introduction

As known, in mid-1980s, Japanese scientists first discovered an advanced material which is the so-called functionally graded materials (FGMs) [1]. These materials are often fabricated by at least two distinct constituents with continuously varied material properties in a certain spatial direction. Thus, failures caused by the discontinuities of strain and stress fields can be reduced. Among them, the ceramic-metal composite merits consideration as a priority choice in structural applications due to their outstanding advantages produced from the synergy. Indeed, the metal works very well under mechanical impacts, whilst the ceramic is strongly suitable for standing high temperature environments. Accordingly, a large number of research papers on using such a mate-

*Corresponding author. *E-mail:* jhlee@sejong.ac.kr

¹*E-mail:* lieuxuanqui@gmail.com

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات