Accepted Manuscript

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PII: S0045-7825(16)30729-0
DOI: http://dx.doi.org/10.1016/j.cma.2016.07.008
Reference: CMA 11043

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Please cite this article as: J. Niiranen, J. Kiendl, A.H. Niemi, A. Reali, Isogeometric analysis for sixth-order boundary value problems of gradient-elastic Kirchhoff plates, *Comput. Methods Appl. Mech. Engrg.* (2016), http://dx.doi.org/10.1016/j.cma.2016.07.008

Isogeometric analysis for sixth-order boundary value problems of gradient-elastic Kirchhoff plates

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Abstract

Sixth-order boundary value problems of a one-parameter gradient-elastic Kirchhoff plate model are formulated in a weak form within an H^3 Sobolev space setting with the corresponding equilibrium equations and general boundary conditions. The corresponding conforming Galerkin method is proposed with error estimates for discretizations satisfying C^2 continuity requirements. Continuity, coercivity and consistency of the corresponding bilinear form are utilized for proving the theoretical results. Numerical computations with conforming isogeometric discretizations of C^{p-1}-continuous NURBS basis functions of order $p \geq 3$ confirm the theoretical results and illustrate the features of the problem for both statics and free vibrations. In particular, the effects of the additional boundary conditions and parameter-dependent boundary layers corresponding to the gradient elasticity theory are addressed by the numerical examples.

Keywords: Generalized continuum, Gradient elasticity, Kirchhoff plate, Isogeometric analysis, Convergence analysis, Error estimates
PACS: 46.70.-p, 46.70.Hg, 46.70.De, 46.15.-x, 46.15.Cc, 46.25.-y, 46.25.Cc
2000 MSC: 74A60, 74K10, 74K15, 74K20, 35J35, 35J40, 65M12, 65M15, 65M60, 74S05

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