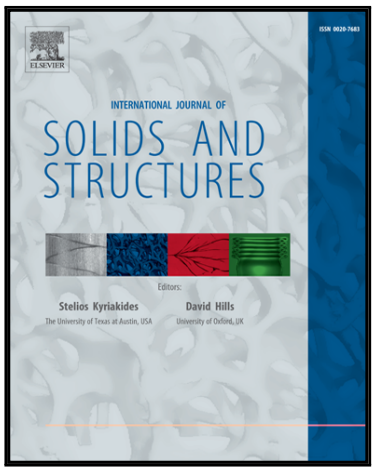

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R. de Böck, A.A.F. van de Ven, L.H. Saes, J.M.L. Maubach, B. Koren

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Moisture-induced buckling of paper sheets, analysis and simulation

R. de Böck[1,*], A.A.F. van de Ven[1], L.H. Saes[2], J.M.L. Maubach[1], B. Koren[1]

Abstract

Understanding the effects of water absorption on the geometry of a paper sheet is important for inkjet printing applications, since internal moisture content differences may cause unacceptable out-of-plane deformations. The present work focuses on moisture-induced deformations due to a moisture content that is uniform over the thickness of the sheet. Large enough in-plane differences will cause the sheet to buckle, leading to a wavy pattern at the edges of the sheet. Two approaches are utilized to study this for levels of moisture content up to and including the threshold for buckling. An analytical approach, based on geometrically nonlinear plate theory (von Kármán theory), and a numerical one, using commercially available finite element software, are presented. As a first reference problem an isotropic circular plate, wetted uniformly at its center, is solved both analytically and numerically for the in-plane stress distribution, the buckling threshold, and the resulting buckling mode. Secondly, the same is done for an orthotropic rectangular plate, wetted at its edges. Here, in the analytical approach a Rayleigh-Ritz analysis is employed to approximate the buckling threshold. The latter is also calculated by numerical means. The results show that the methods provide results consistent with each other.

Keywords:
Paper deformation, Buckling, Von Kármán plate theory, Rayleigh-Ritz method, Nonlinear simulation

*Corresponding author
Email address: r.d.bock@tue.nl (R. de Böck)
[1]Department of Mathematics and Computer Science, Eindhoven University of Technology, the Netherlands
[2]Océ Technologies B.V., Venlo, the Netherlands