ON THE ISOTROPIC AND CUBIC MATERIAL DESIGN METHODS AND THEIR APPLICATIONS IN 3D PRINTING

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The paper (joint work with S. Czarnecki, R. Czubacki, T. Łukasiak, P. Wawruch) deals with the selected methods belonging to the class of free material design constructed by assuming: a) cubic symmetry (cubic material design, CMD), b) isotropy with: (b1) independent bulk and shear moduli (isotropic material design, IMD), and (b2) fixed Poisson's ratio (Young's modulus design, YMD). In the latter case the Young modulus is the only design variable. The moduli are viewed as non-negative, thus allowing for the appearance of void domains. The paper shows that all these methods (CMD, IMD, YMD) reduce to two mutually dual problems:

(P) the stress-based minimization problem in which the integrand is equal to a norm of the test stress field. The norm $||.||$ involved reflects the type of the constraints imposed;

(P*) the displacement-based problem in which the virtual work is subject to maximization over the adjoint displacement fields associated with strains, the dual norm $||.||^*$ of which is bounded almost everywhere.

Upon solving problem (P) and finding the minimizer one can determine the optimal moduli; they assume non-zero values within the material domain and they vanish outside this domain, thus allowing for cutting out the final shape from the initial design domain.

The YMD method has been made suitable for the 3D printing. The procedure leading from theory to the practice of 3D printing will be shown in detail.

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