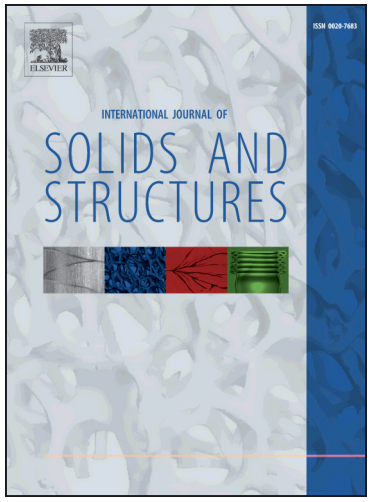

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PII: S0020-7683(15)00208-5
DOI: http://dx.doi.org/10.1016/j.ijsolstr.2015.04.033
Reference: SAS 8763

To appear in: *International Journal of Solids and Structures*

Please cite this article as: Bruggi, M., Taliercio, A., Optimal strengthening of concrete plates with unidirectional fiber–reinforcing layers, *International Journal of Solids and Structures* (2015), doi: http://dx.doi.org/10.1016/j.ijsolstr.2015.04.033

Optimal strengthening of concrete plates with unidirectional fiber–reinforcing layers

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Abstract

The problem of the optimal strengthening of concrete plates subjected to transverse loads by unidirectional FRP layers is dealt with. A topology optimization (TO) procedure is proposed to define the layout of the layers that maximizes the elastic stiffness of the reinforced plate for a given maximum amount of reinforcing material. The anisotropy of the layers is taken into account, and local orientations of the fibers are included in the set of design variables. According to the SIMP model for TO problems, the mechanical properties of the reinforcing layers are assumed to depend locally on the densities of the material in the layers, which are additional design variables. Compressive stresses along the fibers are avoided by a suitable penalization technique. The possibility of cracking in the concrete core is also indirectly taken into account. The discretized version of the constrained minimization problem that gives the optimal solution is solved by mathematical programming, using the Method of Moving Asymptotes and the finite element method in its displacement–based formulation. Numerical investigations are presented to discuss the features of the computed optimal layouts, along with the possible application as preliminary design for the structural retrofitting of concrete plates. The reliability of the achieved layouts is also investigated comparing the distribution and orientation of the reinforcing fibers with

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