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WORST GEOMETRIC IMPERFECTIONS OF RODS AND SHELLS

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Abstract: Various forms of geometric imperfections of compressed rods which are subjected to loss of stability have been considered in the normative literature. Similar investigations are also intensively carried out for the shells with imperfections, taking into account sub- and post-critical behavior of the systems, as well as an inelastic deformation of materials. However, there are no recommendations regarding the choice of the worst forms of such imperfections. The existing intuitive hypothesis regarding the choice of a shape with which the rods lose their stability can only be considered as a prerequisite for a proof or disproof of this hypothesis. Besides, references to extensive engineering experience are not sufficient; furthermore, already known various counterexamples contradict this hypothesis. In this paper, we formulate a general optimization mathematical model for selecting worst geometric imperfections for rods and shells as a problem of optimum control. Analytical solution of this model has been obtained for subcritical behavior of elastic rods with different boundary conditions. It is shown that the optimal solutions for worst geometric imperfections do not belong to smooth functions, but to the discontinuous piecewise smooth functions. Differences between behavior of simply supported rods with the obtained anti-optimal (worst) geometric outlines and that of those with the currently used imperfect functions reach 19.2%. The presented formulation makes it also possible to evaluate and obtain more precise recommendations for the shells with imperfections.