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YIELD DESIGN OF AXISYMMETRIC MULTILAYERED SHELLS

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The present contribution aims at evaluating the limit load of axisymmetric shell structures made of a single homogeneous material or different multilayered materials. One main objective is to formulate the strength criterion of the shell in terms of generalized internal forces using the expression of the local strength criterion of the constitutive material. Unfortunately, shell strength criteria expressed in generalized forces (membrane forces and bending moments) are very rare and correspond to crude approximations only (especially concerning the interaction between membrane forces and bending moments).

The present work contributes in this direction, by computing the support function of the generalized strength criterion as an integral over the shell thickness, assuming Love-Kirchhoff type kinematics. The integral quadrature rule is chosen so as to ensure the upper bound status of the subsequent approximation. Therefore, the generalized support function can easily be expressed using conic constraints for classical constitutive strength criteria and the formulation may also be easily generalized to multilayered materials. A parametric study with respect to the number of integration points in the thickness direction is performed in order to assess the degree of accuracy of the approximate strength criterion, which is also compared to existing approximate criteria.

In a second step, yield design computations on axisymmetric shell structures are performed using the so-obtained generalized strength criterion. Very simple 1D axisymmetric shell finite elements are used for the discretization of the upper bound kinematic approach, the global optimization problem being formulated as a second-order cone program. The approach will be validated by comparing numerical results to existing analytical lower and upper bounds on simple problems [1, 2]. More complex problems, such as for instance

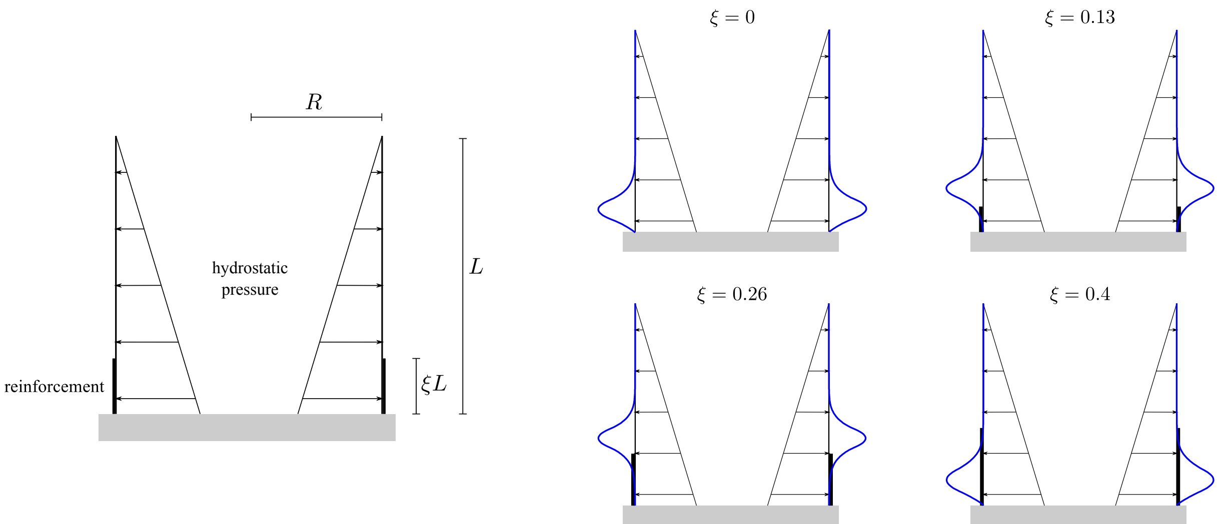

Figure 1: Reinforced cylindrical tank problem and associated failure mechanisms

reinforced cylindrical tanks [3] (Figure 1), will be also investigated.

Various generalizations of the proposed approach will also be discussed. In particular, the extension to shakedown analysis is straightforward such as the case of functionally graded materials (e.g. reduction of local strength properties due to a gradient of temperature). Finally, the extension to the case of three-dimensional shells will be discussed in more details.

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