A "*worst*" imperfection theory based on initial stiffness reduction

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ABSTRACT

For many structures the classical critical loads are in good agreement with experimentally observed collapse loads, but for some shells problems for example, the buckling of cylindrical shells under axial compression or bending, as well as the buckling of spherical shells, the observed collapse loads are much smaller, typically about 30 percent of the classical critical load. It is well known that this is due to the presence of initial imperfections that made this shells very imperfection sensitive.

Modern steel codes specify the inclusion of imperfections in a nonlinear analysis to verify the load carrying capacity of the structure. Among various types of imperfections, the eigen-mode shape imperfection is the most commonly adopted one at the design stage. The European standard for steel shell structures recommends that the imperfection should be specified in the form of eigen-mode shapes, with its amplitude linked to fabrication quality, unless a different unfavorable pattern is justified.

Several authors have proposed to directly determine the worst imperfection shape which yields the lowest limit point and thereby a lower bound for the load carrying capacity of structures. In this work an alternative approach is proposed to obtain the worst imperfection shape analyzing the effect in the reduction of the initial stiffness. This leads to an eigenvalue problem whose eigenvectors are called imperfection modes with the worst imperfection mode associated with the minimum eigenvalue. It can be proved that for pure axially loaded structures these imperfections modes coincides with the classical buckling modes, but for bending coupling their shape varies.