POSTBUCKLING FAILURE MECHANISM OF SQUARE ALUMINUM PLATES UNDER SHEAR LOADING

Costas D. Kalfountzos[1], George S.E. Bikakis[1] and Efstathios E. Theotokoglou[1,*]

[1] Laboratory of Strength of Materials, National Technical University of Athens, 9 Iroon Polytechniou, Zografou, GR 15773, Athens, Greece, koskalf@yahoo.gr, bikakis.george@yahoo.com, [*]stathis@central.ntua.gr

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Buckling is very important for structural design, especially when the structure is thin-walled. Slender plates are widely used as structural members in civil, naval and aerospace engineering and they are able to carry considerable additional loads in the postbuckling range. Engineers take advantage of this postbuckling reserve and design structures that are allowed to buckle and operate below their ultimate loads for further weight and cost reduction. Consequently, both buckling and postbuckling behavior of slender plates are of critical importance during the design of lightweight thin-walled engineering structures.

The present numerical study deals with the buckling and postbuckling response of square aluminum simply supported plates subjected to shearing stresses. More specifically, the main objective is the investigation of the failure mechanism of thin plates with different slenderness ratio, taking into account yielding and secondary buckling, which is located using a novel Finite Element Modeling (FEM) procedure. The design of postbuckling structures must include the capability of predicting when secondary buckling occurs, since it is often combined with abrupt mode-shape jump which may give rise to fatigue problems and other degradation factors.

The aforementioned novel procedure is implemented using ANSYS software and combines eigenvalue buckling analysis, nonlinear FEM analysis and linear perturbations in order to locate the secondary buckling point. The elastoplastic material behavior of 2024-T3 aluminum is modeled using a bilinear stress-strain relationship. The convergence of FEM results is always verified by comparison of results corresponding to a fine and a very fine meshed plate. The FEM procedure, the suitability of the applied shear loading and simply supported boundary conditions have been compared and validated with literature results [1, 2]. The slenderness ratio of all plates of this research has been selected so that the elastic shear primary buckling precedes yielding.

Load-deflection amplitude curves have been constructed in order to predict the postbuckling reserve and the load-carrying capacity of the plates. It is found using also von Mises stress contours that variations of the slenderness ratio can affect significantly the failure mechanism of the plates, since they can alter the order of first occurrence of the following phenomena as the loading increases: onset of yielding, secondary buckling, collapse of the shear panels. As the plate becomes more slender secondary buckling precedes the onset of yielding.

REFERENCES

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