Buckling-Driven Crack Growth in Elastic Plate Devices

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Buckling of an elastic plate subjected to plane stress compression is investigated in the light of potential energy concept and by applying the Rayleigh-Ritz method. Double Fourier series are used to provide displacement fields parametrization involving trigonometric functions. An energy minimization procedure is applied to calculate the unknown parameters to describe the buckling shape and amplitude. Critical buckling values representing the physical thresholds for the instability transition in the system are estimated from the eigenvalues of the Hessian of the potential energy. On another hand, cracks could be sometimes initiated due to buckling. This occurs for example, at the clamped boundaries of a plate where delamination is expected as result of post-buckling stress. Or also, due to imperfections in a material, a buckling-driven crack can also be initiated in the middle of the surface. Therefore, we perform crack growth simulation using the eXtended (or enriched) Finite Element Method (XFEM). This approach allows to avoid the remeshing along the internal boundary of the crack and to represent accurately the stress singularity at the crack tip and the discontinuity on crack faces. Within the framework of XFEM, the concept of the partition of unity is employed to incorporate special local enrichment functions into the basis of the standard FEM to take into account the presence of the aforementioned singularity and discontinuity.
The XFEM method has been implemented into the GETFEM package and later into the commercial software package Abaqus.