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Numerical Buckling of Composite Cylindrical Shells under Axial Compression Using Asymmetric Meshing Technique (AMT)

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Abstract : This paper presents the details of a numerical study of buckling and post buckling behaviour of laminated carbon fiber reinforced plastic (CFRP) thin-walled cylindrical shell under axial compression using asymmetric meshing technique (AMT) by ABAQUS. AMT is considered to be a new perturbation method to introduce disturbance without changing geometry, boundary conditions or loading conditions. Asymmetric meshing affects both predicted buckling load and buckling mode shapes. Cylindrical shell having lay-up orientation [0°/+45°/-45°/0°] with radius to thickness ratio (R/t) equal to 265 and length to radius ratio (L/R) equal to 1.5 is analysed numerically. A series of numerical simulations (experiments) are carried out with symmetric and asymmetric meshing to study the effect of asymmetric meshing on predicted buckling behaviour. Asymmetric meshing technique is employed in both axial direction and circumferential direction separately using two different methods, first by changing the shell element size and varying the total number elements, and second by varying the shell element size and keeping total number of elements constant. The results of linear analysis (Eigenvalue analysis) and non-linear analysis (Riks analysis) using symmetric meshing agree well with analytical results. The results of numerical analysis are presented in form of non-dimensional load factor, which is the ratio of buckling load using asymmetric meshing technique to buckling load using symmetric meshing technique. Using AMT, load factor has about 2% variation for linear eigenvalue analysis and about 2% variation for non-linear Riks analysis. The behaviour of load end-shortening curve for pre-buckling is same for both symmetric and asymmetric meshing but for asymmetric meshing curve behaviour in post-buckling becomes extraordinarily complex. The major conclusions are: different methods of AMT have small influence on predicted buckling load and significant influence on load displacement curve behaviour in post buckling; AMT in axial direction and AMT in circumferential direction have different influence on buckling load and load displacement curve in post-buckling.

Keywords : CFRP composite cylindrical shell, asymmetric meshing technique, primary buckling, secondary buckling, linear eigenvalue analysis, non-linear riks analysis
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