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Nonlinear analysis of multilayer composite pipes

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ABSTRACT

The use of composite materials has constantly increased in aerospace and offshore applications. One of typical composite structures for offshore application is multilayer unbonded composite pipe. The composite pipe comprised of several layers such as helically wound steel layers and polymeric layers, among which the helically wound steel wires play essential roles in providing axial and flexural stiffnesses of the pipe. Because of the geometric nonlinearity of each layer of the composite pipe and the flexibility in motion of individual layers against their adjacent layers, analyses of the composite pipe are highly nonlinear and computationally challenging. In this study, detailed three-dimensional Representative Volume Element models of the multilayer unbonded composite pipe are developed, and nonlinear analyses of the composite pipe are performed. The developed FE models effectively predict nonlinear responses of the pipe including slipping effects of steel layers under application of axial loading, bending, internal and external pressures. Based on the predicted results, a constitutive model of the pipe under various loadings is obtained which can be employed in the large scale analysis of the composite pipe to improve the accurate and computational efficiency of the global analysis.