THE EVALUATION OF THE MECHANICAL BEHAVIOUR OF A BOLTED JOINT CONNECTOR WITH DIFFERENT MATERIAL MODELS

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ABSTRACT

The bolted joint connection is one of the most popular fastening mechanisms to join structural components that require disassembly and reassembly during their life cycle. It forms an integral part of many modern structures, in particular in the offshore oil and gas industry, where the bolted joint connection is used in extremely challenging environments, such as high pressure wells, deep water depths and harsh ocean conditions.

To ensure operational safety and efficiency of current and future bolted joint connections, innovative and advanced numerical modelling in conjunction with analytical and experimental techniques is essential. In order to extend the application of existing bolted joint connections, more accurate and reliable numerical approaches are required for estimating the structural strength of bolted joint connections. Linear elastic finite element analysis is a popular approach that provides a framework for incorporating the mathematical models to predict the strength of the bolted joint connections. A disadvantage when applying the linear elastic approach to bolted joint connections is that it can lead to overly conservative results by not considering the plastic region of the material. Elastic-plastic finite element methods are well known approaches using an advanced analysis techniques that include more representative material models. These methods are now accepted practice by international standards, such as ISO and API, to meet the industrial demand to improve the application and performance of the component.

In this presentation, the mechanical behaviour of a subsea bolted flange connection, under the combination of internal pressure and tensile loads with different elastic-plastic material models, is reported. A three-dimensional finite element model of a subsea bolted flange connection has been constructed using ANSYS APDL. The model used higher order quadratic three-dimensional brick elements and surface-to-surface contact elements to represent the mechanical interfaces. The closed end boundary condition was achieved by applying uniform axial thrust to the end of the connection. The thread profiles in the bolt and the nut were not modelled and were attached together by using bonded contacts. The bolt preload force was considered by using ANSYS pretension elements. Linear elastic, elastic perfectly-plastic and the Ramberg-Osgood material models were used in this study. In order to

compare the solutions obtained, the same reference yield stress was adopted for each model. The effect of these different material models on the mechanical behaviour of the subsea bolted flange connection has been compared.

The comparison of the results of the finite element analyses shows the advantage of using more representative elastic-plastic material models. In particular, it is shown that by using the elastic-plastic material models the allowable pressure and tension for the bolted flange connection is increased, extending the range of potential applications.

SUGGESTED THEMES

Engineering analysis, simulation adding value to business, bolted joints analysis, 3D analysis, non-linear analysis, material models, Ramberg-Osgood material model, subsea/oil and gas