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Numerical and experimental distribution of stress fields for double shoulder tool joint

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ABSTRACT

A two dimensional axisymmetric finite element analysis (FEA) numerical model was established, by which the mechanical property of double shoulder tool joint (DST) could be analyzed under combined loads such as axial load, internal and external pressures and make-up torque. An elastic–plastic FEA software was developed on the basis of the model, and the wider tolerance ranges in API standard for thread were optimized with the software including tolerances of length, pitch, taper and thread angle, and the relevant standard tolerances were determined. A new tool joint was processed based on these optimized tolerances, and on which the make and break tests and hydraulic sealing tests were performed. The FEA model and make-up torque of the newly processed DST were validated by comparing the numerical results with experimental data, which can provide references for further developing the tool joint.

1. Introduction

In the modern well drilling process, drillstring connections bear a series of complex dynamic and statical loads such as make-up torque, axial force, pressure and bending moment. In the borehole, connection failures occur frequently. As the stiffness of connection is far less than that of the drillstring body, it becomes the weakest link of drillstring. The incidences of failures caused by connection damage increase annually. The failure location and cross-section of failure samples are shown in Fig. 1. Statistics show that approximately 86% of the oil country tubular goods (OCTG) failure accidents occurred at the connection in China. Many scholars at home and abroad have focused their attention on the strength of threaded connections. Methods for researching the contact stress of thread include experimentation method, analytic method and numerical method [1–8].

Furthermore, when drilling in complex formations in western China and part of southern China, the bottom hole assembly (BHA) failure is a serious problem which increases drilling cost greatly. Moreover, conventional drillstring is not suitable for drilling in complex formations. For example, conventional drillstring cannot work with large weight of bit (WOB), high pump pressure and large torque, so the rate of penetration (ROP) is undesirable to prevent the drillstring from damage; when the drilling problems happen, conventional drillstring does not have enough ability to deal with them because of its low torsional strength and tensile strength. In order to improve the situation, a 2D axisymmetric finite element analysis (FEA) numerical model was established, and an elastic–plastic FEA software was developed on the basis of the model, and the wider tolerance ranges in API standard for thread were optimized with the software including tolerances of length, pitch, taper and thread angle, and the relevant standard tolerances were determined. A new tool joint with high torsional strength

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