Comparison of Stress Distribution Patterns Within Quadrangle, Hexagonal and Octagonal Impact Socket Drive Designs of a Torque Wrench using Finite Element Analysis

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Abstract

A torque wrench is applied to the fastener either directly or in conjunction with an impact socket. An impact socket failure occurs during the bolting application. Failure of socket is investigated by using different socket head design. Comparison of stress distribution patterns within quadrangle, hexagonal and octagonal impact socket drive designs are made. A 3D modeling software Cero 1.0 is used to prepare a CAD model of impact socket and evaluate the results in the form of stresses by applying calculated loads in the finite element analysis software ANSYS 12.0. In order to eliminate failure of Impact socket of torque wrench due to stripping and breaking, it is necessary to decrease the maximum stress values and increase the stress distribution. This can be done with drive designs that have greater contact area with the socket drive.
Keywords: CAD model, torque wrench, 3D modeling software

I. INTRODUCTION

A torque wrench is a tool designed to exert a torque on a fastener to achieve proper tightening or loosening of a connection through the use of hydraulics. A torque wrench is applied to the fastener either directly or in conjunction with an impact socket [3]. A torque wrenches are applied to the nut or Allen bolt either directly or in conjunction with an impact socket. Torque wrenches apply control amount of torque to a properly lubricated fastener through impact socket [4].

There are two classes of materials commonly used for Impact socket design, SAE9840 and EN31. The ideal interference socket can be described as “best of both worlds” having high mechanical strength, creating a secure initial fixation. In spite of numerous advances in material development, questions remain about the impact of design on impact socket performance. This is particularly important with regard to design of the socket head. Stripping/breakage of the socket head or drive was observed in the head of the socket in previous studies [5]. Once a socket head is stripped, it cannot be fully inserted, reducing contact area between the socket head and screw head of the bolt. Consequently, reducing the ultimate pullout load and increasing graft slippage. The objective of this study was to use finite element analysis to compare three different drive designs (quadrangle, hexagonal and octagonal) to evaluate stress in the socket head. This can provide critical insight into the causes of the stripping mechanism within the socket drive.

II. METHODS

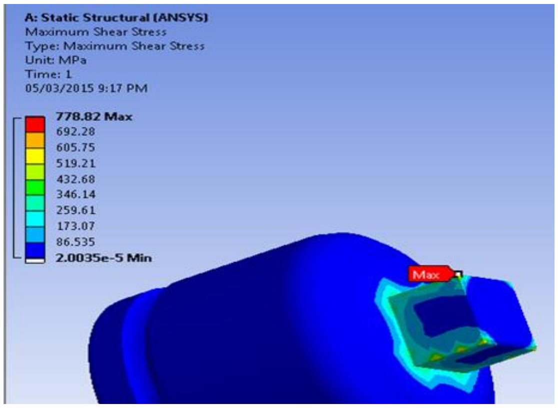
Three 3-D computer models of an impact socket were designed in Creo. 1.0. They each had a different drive design in the socket head, a quadrangle drive, a hexagonal drive and an octagonal drive (Figure 1). The socket geometry was imported into the ANSYS 12.0 (ANYS, Inc., Canonsburg, PA) finite element software. Within ANSYS Workbench, the model was meshed and a static analysis was run to simulate a torque within the drive of the socket. In all the simulations the model was constrained by eliminating all degrees of freedom of the nodes on the outer surface of the socket. In addition, all Simulations used SAE 9840 material properties (E = 2E9 Pa, μ = 0.29) with a 4500 Nm torque applied within the socket drive of torque wrench. The model with the quadrangle drive design had 22846 nodes and 13110 elements, the model with the hexagonal drive design had 22494 nodes and

12950 elements, and the model with the octagonal drive design had 22012 nodes and 12102 elements. The monitored outputs were shear and von Mises' stress distribution within the drive design of the screw head.

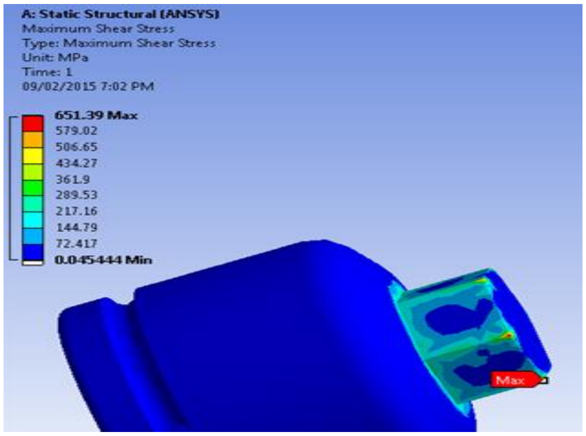
III. RESULTS AND DISCUSSION

The maximum shear stress and maximum von Mises' stress were observed in the corners of the drive design, an example of the von Mises stress is seen in (Figure 1). The quadrangle drive design had a maximum shear stress of 778.82MPa and a maximum von Mises' of 1349.6 MPa. The hexagonal drive design had a maximum shear stress of 651.39 MPa and a maximum von Mises' of 1150.5 MPa. The octagonal drive design had a maximum shear stress of 582.84 MPa and a maximum von Mises' of 1047.8 MPa.

From these results, the maximum stress values of the quadrangle and hexagonal drive designs were similar, while the quadrangle drive designs stress values were greater. It also appears like the stress has a greater distribution for the octagonal drive design which has the greatest surface area.



(A)



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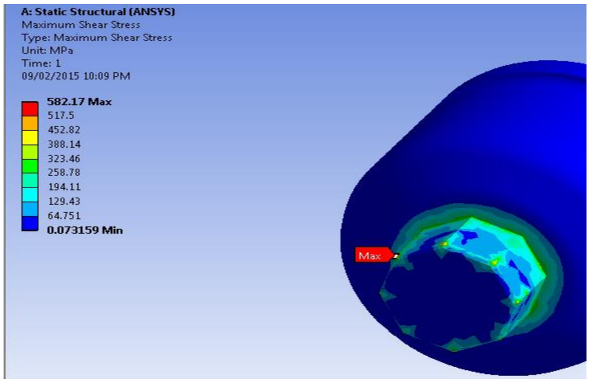

(C)

Fig. 1: Maximum Shear Stress Results, A. Quadrangle Drive Design, B. Hexagonal Drive Design, C. Octagonal Drive Design

IV. CONCLUSIONS

In order to eliminate failure of Impact socket of torque wrench due to stripping and breaking, it is necessary to decrease the maximum stress values and increase the stress distribution. This can be done with drive designs that have greater contact area with the socket drive. Future studies could investigate other socket drive designs such as the torx, turbine, and trilobe drive designs.

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