INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact Factor: 6.078

(Volume 7, Issue 2 - V7I2-1417)

Available online at: https://www.ijariit.com

Structural analysis of spanner bolt assembly

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ABSTRACT

A spanner or span is a metallic tool whose end fits around a nut or bolt so that you can turn it to loosen or tighten it. Spanner is designed to grip a nut or bolt head. In this paper, Open Ended Spanner is taken into consideration for the study of structural analysis. Open ended spanner has U-Shaped that grips the two opposite faces of a hexagonal bolt or nut. The main aim of this paper is to evaluate the structural analysis of Spanner Bolt Assembly. Input will be Spanner Bolt Assembly CAD model and output will be deformation and stress plots. The CAD model and Analysis operations are performed using CATIA and ANSYS Workbench respectively. Structural analysis is performed on Spanner Bolt Assembly with Structural Steel material to validate Equivalent stress and Total Deformation.

Keywords: *Spanner, Bolt, CATIA, ANSYS, Stress, Deformations*

1. INTRODUCTION

To start working or performing analysis knowledge of component is necessary. Spanner and bolt are the essential need for the Mechanical Engineers to deal with machines. It is important to use a correct fitting spanner. Excess play may lead the spanner slipping and causing personal injury while working or damage can be happened to the nut or bolt. Spanner have types like Open Ended Spanner, Ring Spanner, Combination Spanner. Open ended spanner (Fig 1) is one-piece spanners with a U shape that grips the bolts or nuts. They are usually double-ended. Ring spanner have enclosed opening that grips the faces of the bolt or nut making them less likely to slip, but they have limitations to their ability to access nuts and bolts. They are also double-ended, with a different-sized opening at each end and often with offset handles to improve access to the nut or bolt. A combination spanner usually has an Open-ended Spanner at one end and a Ring Spanner of the same size at the other.

Fig. 1

Properties of Material

The material used for Analysis is Structural Steel. Common material properties are mentioned in the table.

Table 1: Material Properties

Density	**7.85e-06 kg/mm³**
Young's Modulus	**2e+05 MPa**
Thermal Conductivity	**0.0605 W/mm·°C**
Specific Heat	**4.34e+05 mJ/kg·°C**
Tensile Yield Strength	**250 Mpa**
Tensile Ultimate Strength	**460 Mpa**
Nonlinear Behavior	**False**

2. METHODOLOGY

2.1 Modelling

The Spanner Bolt assembly was modeled in CATIA modeling software. Structural Analysis was performed in ANSYS software. Total Deformation and Equivalent stress were validated by Structural Analysis in Ansys. First of all, Create Span and Bolt separately in CATIA and make their assembly and save it as IGES format. Followed by import this file into Ansys for further operations.

2.2 Meshing

In Finite element analysis, Meshing is a crucial part. After importing IGES file into Ansys, the first step is to select material that is Structural Steel. To begin with meshing, we are supposed to change global settings. We have performed structural analysis of Spanner bolt assembly by changing span angle and curvature angle in meshing. That will be used to set the goal for curvature-based refinement. To perform this meshing change the span angle size accordingly to your choice as medium, coarse, fine. As shown in the Fig 2, Span bolt Assembly is meshed to the span angle size as FINE. To change the normal curvature angle set "advanced size function" and then specify the angle at which you want to do meshing. Then right click on meshing and select generate mesh then the mesh will generate.

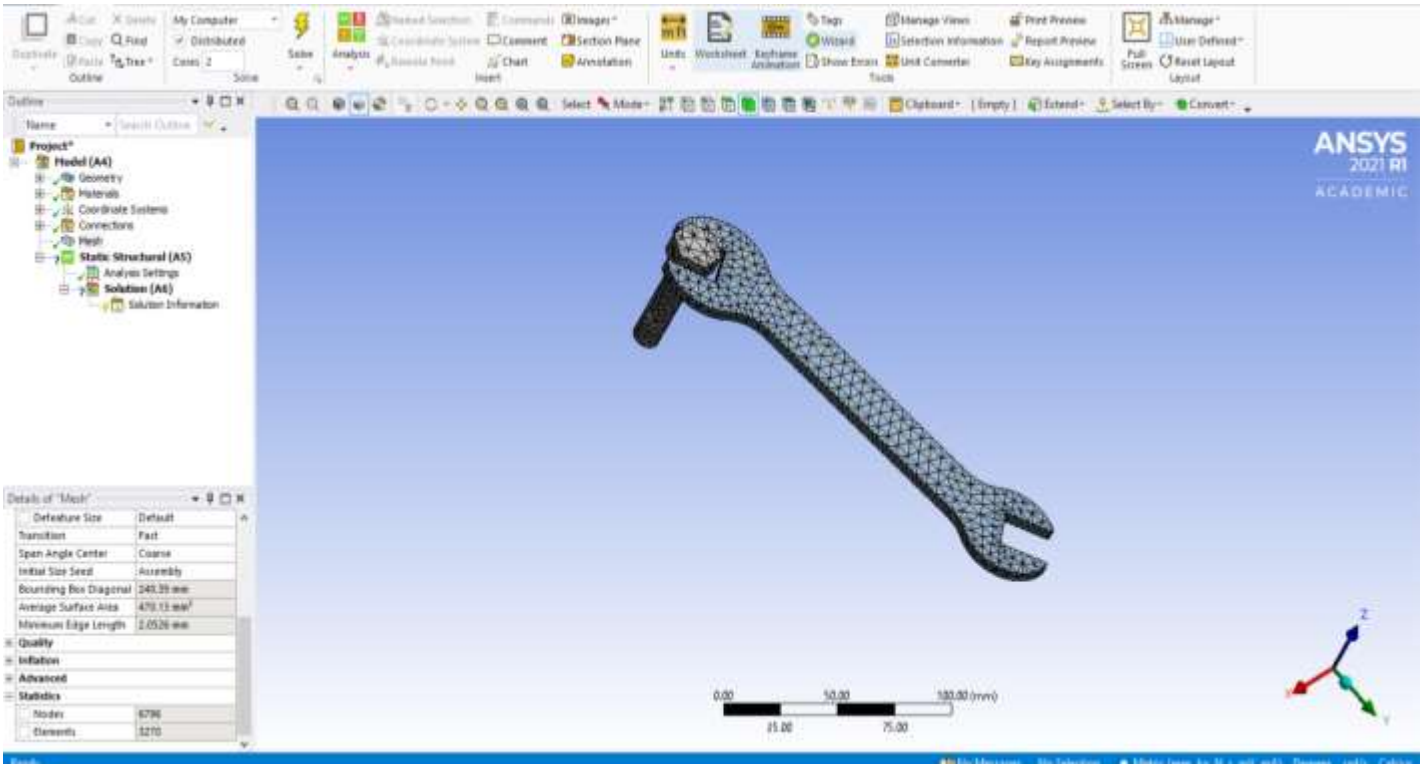

Fig. 2

Two types of meshing were performed:

1. Hex-dominant method (Figure 3)
2. Tetrahedron method or Patch confirming method (Figure 4)

As observed after meshing, nodes and elements changes after both type of meshing. Figures are shown below:

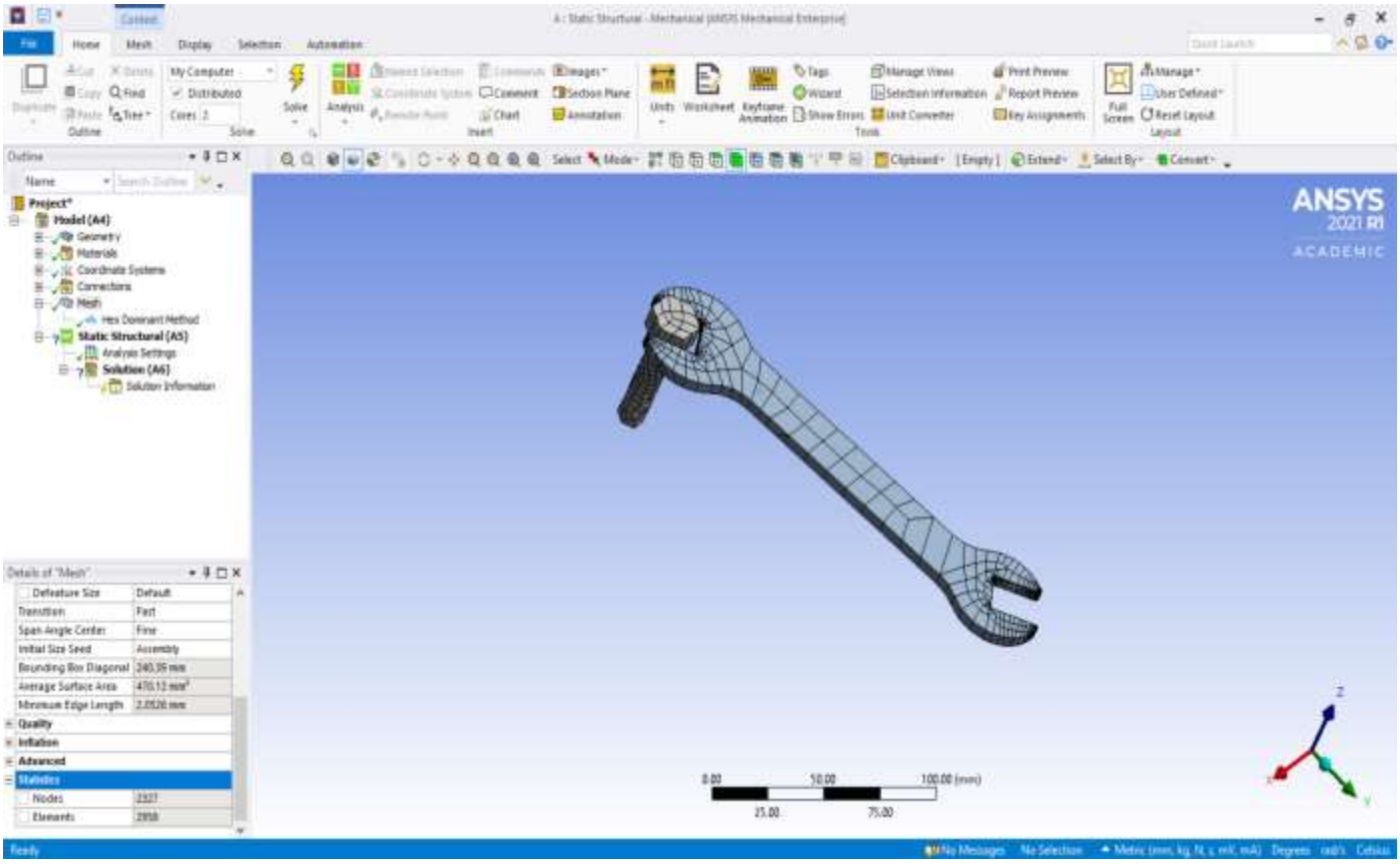

Fig. 3: (Hex Dominant method)

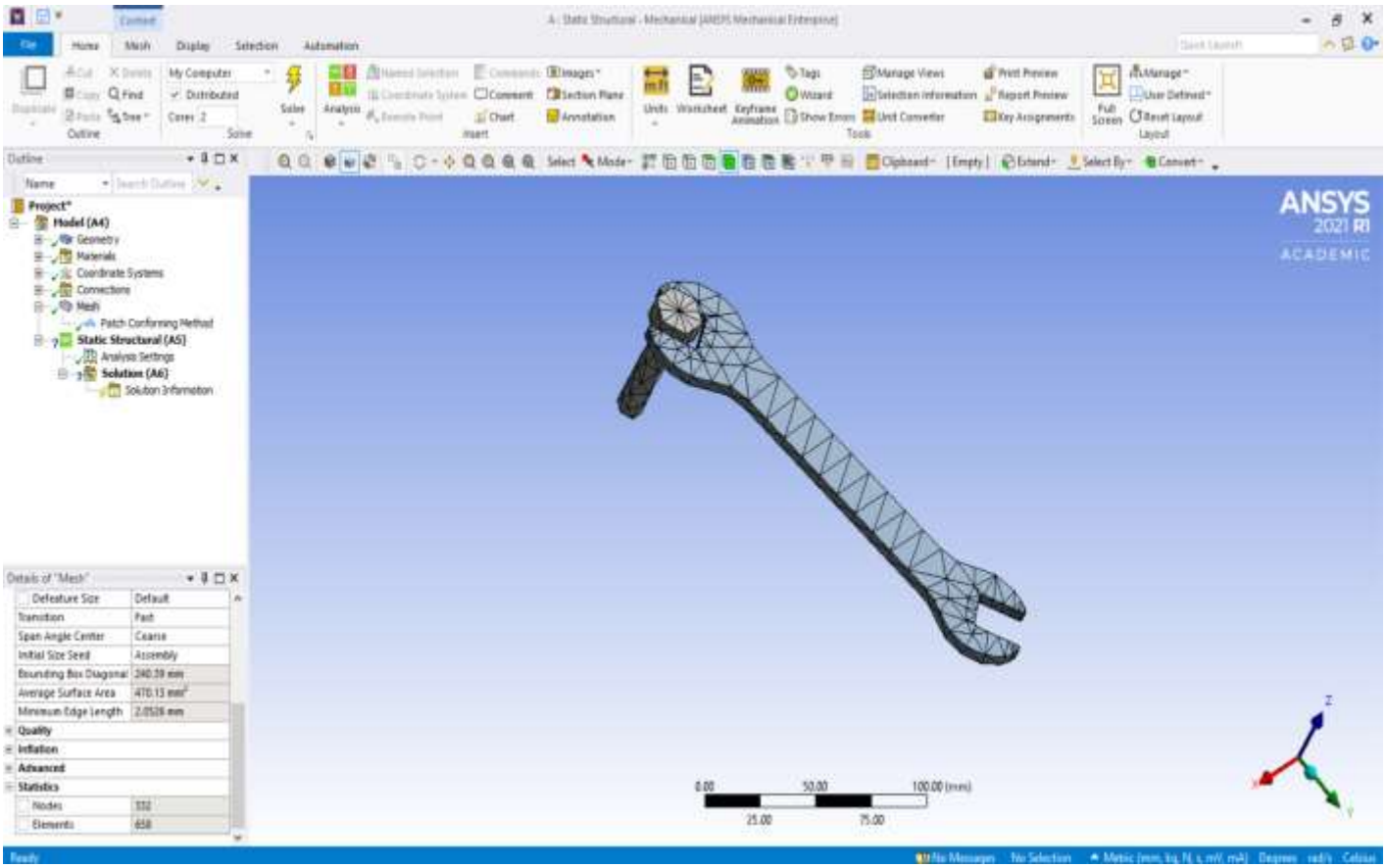

Fig. 4: (Tetrahedron Method)

2.3 Structural Analysis

After meshing, the main part is Structural analysis of Spanner bolt Assembly. Then the initial boundary conditions are applied such as displacement, fixed support and Force acting. After the boundary conditions are being inserted the solution of Structural analysis is solved. Equivalent stress (Figure 5) and Total deformation (Figure 6) is validated in the solution.

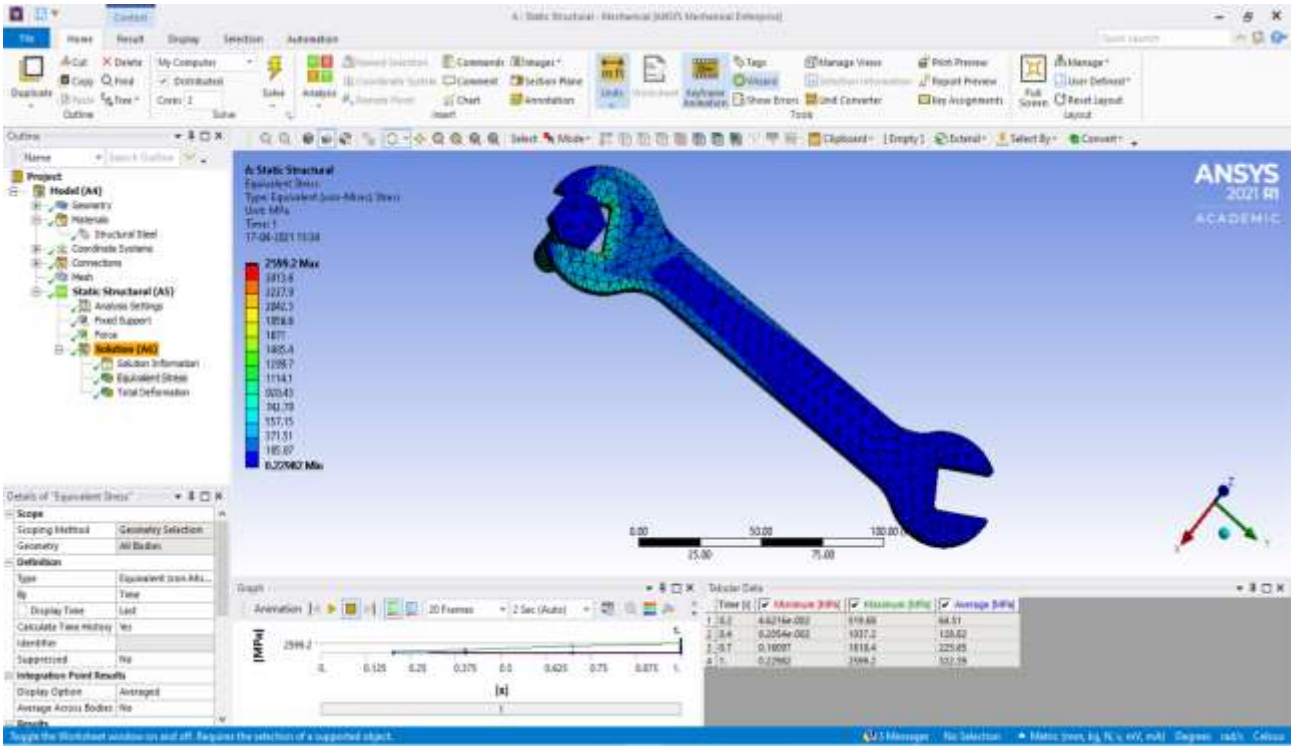

Fig. 5: (Equivalent Stress)

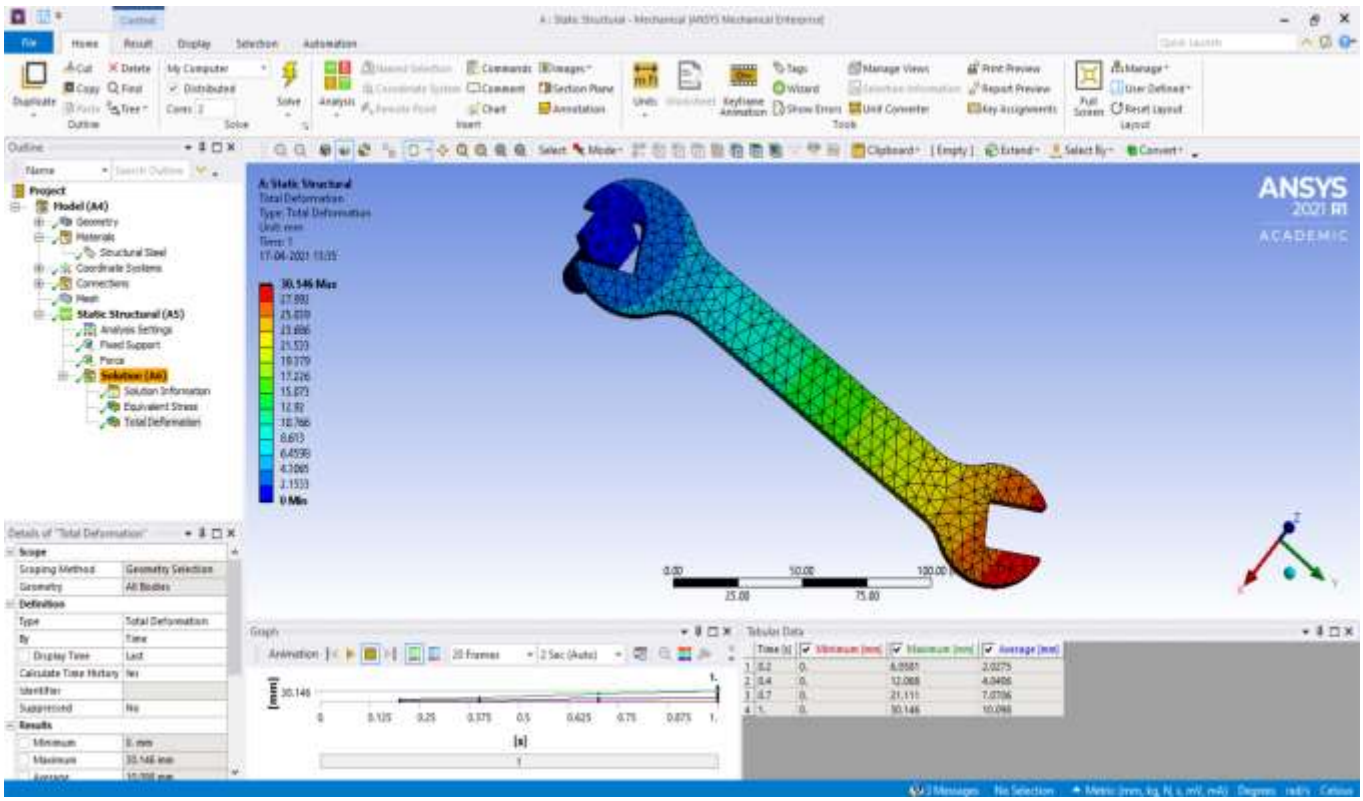

Fig. 6: (Total Deformation)

2.4 Results:

The structural analysis of the Spanner Bolt Assembly calculates the Equivalent stress and Total deformation. Following result provides the comparison between Equivalent stress and Total deformation. (Table 2)

Table 2

	Equivalent Stress	Total Deformation
Minimum	**0.22982 MPa**	**0 mm**
Maximum	**2599.2 MPa**	**30.146 mm**
Average	**322.39 MPa**	**10.098 mm**
Minimum occurs on	**Spanner**	**Bolt**
Maximum occurs on	**Spanner**	**Spanner**

Equivalent Stress

Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
0.2	4.6216e-002	519.68	64.51
0.4	9.2054e-002	1037.2	128.82
0.7	0.16097	1818.4	225.65
1.	0.22982	2599.2	322.39

Total Deformation

Time [s]	Minimum [mm]	Maximum [mm]	Average [mm]
0.2	0.	6.0581	2.0275
0.4		12.068	4.0406
0.7		21.111	7.0706
1.		30.146	10.098

3. CONCLUSION

The structural analysis of Spanner and Bolt Assembly has been performed successfully. The Spanner Bolt Assembly was modelled in CATIA software and structural analysis were performed in ANSYS software. Coming to practical applications of Spanner and bolt, there are limitless applications in Industrial Sector. Spanner is the main equipment that a machinery requires. This study of Structural analysis of Spanner and bolt assembly has given comparison data between Equivalent stress and Total deformation.

4. REFERENCES

[1] https://www.britannica.com/technology/wrench
[2] https://www.diydoctor.org.uk/projects/spannersandwrenches.htm

