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Structural Analysis on Al 7075 T-651 Shaft

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ABSTRACT

The paper deals with the structural analysis on a shaft made of Al 7075 T-651. The stress analysis on Al 7075 T-651 is carried out using ANSYS software under different load conditions. The load is added by 25 MPa and the corresponding stress value is found. The chart was drawn for load vs stress for a life of 2, 00, 000 cycles. It's observed from this work that the stress of the structure increases proportionally with the increase in load with constant life of 2, 00, 000 cycles.

KEY WORDS: Al 7075 T-651, ANSYS, load, stress, constant life.

1. INTRODUCTION

Aluminium alloys are widely used in aerospace, automobile, medical industries due to their light weight and high weight to strength ratio. The alloys are numbered with their usages, Al 7075 is widely used in Aerospace and military purposes (Sivasubramanian, 2013; ASM International, 1990; Pedersen, 2011). The part "T – 651" denotes that the metal is tempered. The 7 series are light weight and their main sub metals are Magnesium, silicon. Aluminum Magnesium alloys are even more light weight compared to the other aluminum alloys. This paper gives the structural analysis of Al 7075 T-651 shaft namely the stress of the material (Broek, 1986).

Chemical Properties: The chemical properties of the material helps in finding out the application of the material. Table-1 presents the chemical properties of AL7075-T651. This alloy has almost 90% of aluminum and 5% of zinc which makes sure that the alloy is light weight and has high tensile strength (Paris, 1993).

Table.1. Chemical properties of AL7075-T651

Compounds	Weight percentage
Aluminium	87 - 91.4
Zinc	5.1 - 6.1
Magnesium	2.1 - 2.9
Copper	1.2 - 2.0
Iron	0.5 Max
Silicon	0.4 Max
Manganese	0.3 Max
Chromium	0.18 - 0.28
Titanium	0.2 Max

Mechanical Properties: The mechanical properties of Al7075 T651 are given in Table.2. The properties include density, shear modulus, Poisson's ratio. The properties shows that the density, the Ultimate Tensile strength of the material is very high (Murakami, 1994; Miller, 1982). The fatigue strength of the material is also high thus it shows that the material can withstand continuous load for a long time.

Table.2. Mechanical properties of AL7075-T651.

Properties	Units	Value
Density	g/cc	2.81
Modulus of Elasticity	GPa	71.7
Poissons Ratio		0.33
Ultimate Tensile Strength	MPa	572
Yield Strength	MPa	503
Fatigue Strength	MPa	159
Brinell Hardness	BHN	150
Shear Modulus	GPa	26.9

Shaft Model: The shaft is modeled using ANSYS software and the 2D diagram of the shaft is given in Figure.1 (Lin, 1999; De Rejick, 2001).

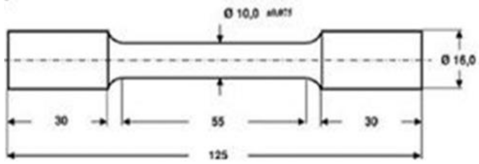

Figure.1. 2D diagram of AL7075-T651 shaft

Loads: The loads applied in the model (in MPa) are shown in Table.3.

Table.3. Load applied on the shaft

Case	Tensile load (MPa)
1	25
2	50
3	75
4	100
5	125

Dimensions of the shaft: The dimensions of the shaft considered for the study are shown in Table.4.

Table.4. Dimensions of the shaft

D	16 mm
D	10 mm
L	125 mm
L_1	30 mm
L_2	30 mm
L_3	55 mm

2. RESULTS AND DISCUSSIONS

The graph between tensile load vs. stress that is derived from ANSYS software is presented in Figure.2. The graph shows that when load increases the stress of the material also increases. Therefore this shows the material obeys Hooke's law and is also safe for working at stresses upto 125 MPa as the material didn't breaks up.

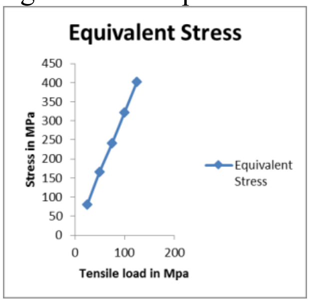

Figure.2. Tensile load vs. Stress

Figures.3-7 depict the ANSYS diagrams of distribution of stress in Al7075t651 shaft in five different cases considered respectively.

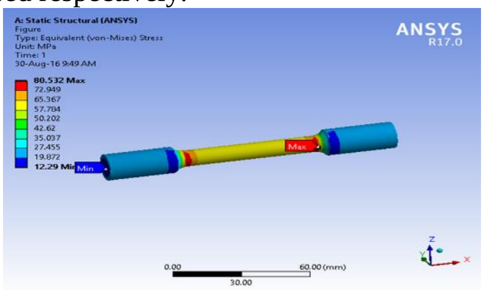

Figure.3. Stress distribution in Al7075t651 shaft in case 1

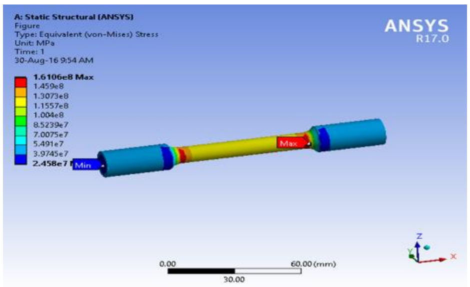

Figure.4. Stress distribution in Al7075t651 shaft in case 2

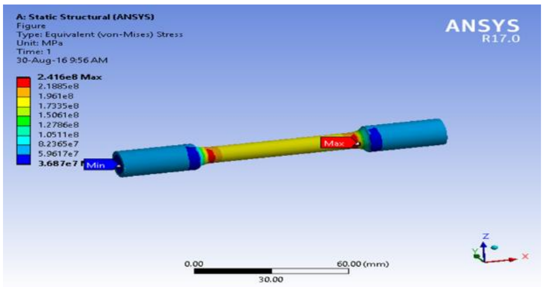

Figure.5. Stress distribution in Al7075t651 shaft in case 3

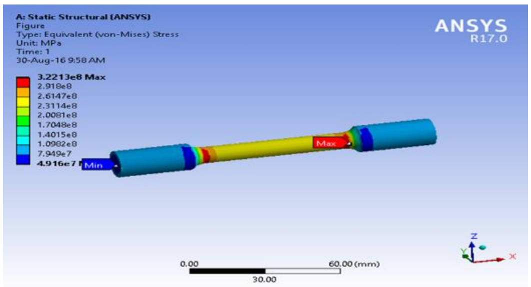

Figure-6. Stress distribution in Al7075t651 shaft in case 4

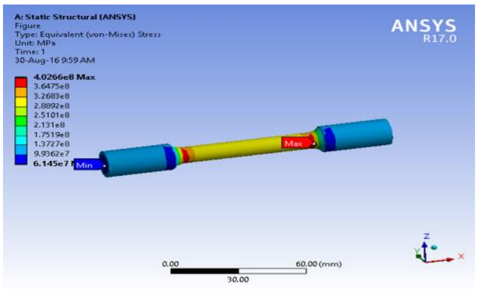

Figure.7. Stress distribution in Al7075 T651 shaft in case 5

3. CONCLUSIONS

In this work, the structural analysis on Al 7075 T-651 shaft is carried out using ANSYS software under different load conditions. Five variants of tests of structural analysis were performed by varying the load by 25 MPa and the corresponding stress value is found. The chart was drawn for load vs stress for a life of 2, 00, 000 cycles. On analyzing the structure of Al 7075 T651 using ANSYS, by applying variable load we found out that the stress increases proportionally with increase in load, therefore it proved Hooke's law it is a ductile material with a constant life of 2,00,000 cycles.

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