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DESIGN AND ANALYSIS OF STRESS FOR SPUR GEAR

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***Abstract*: - A gear or "gear wheel" is a part of a spinning machine with cut teeth or cogs that mesh with another toothed part to transmit electricity. Two or more tandem-operated gears are called a transmission and via a gear ratio, create mechanical advantages and can therefore be considered a simple machine. In this project report on stress analysis of spur gears, gears are mainly used in the mechanical sector for power transmission. In this project, spur gear made of cast iron is regarded as the traditional model. The traditional model is optimized and the study is done with high modulus content from carbon fiber. Boundary constraints are established and the overall model deformation is measured and the results are tabulated.**

Keywords: - spur gear, stress analysis, ANSYS, CATIA

I INTRODUCTION

The simplest and most popular type of gear is spur gear. A cylinder or disc is their general shape. The teeth project radially, and the leading edges of the teeth are aligned parallel to the axis of rotation with these straight-cut gears. These gears can be correctly meshed only if they are attached to parallel axles. You can determine the torque ratio by taking into account the force exerted by the tooth of one gear on the tooth of the other gear. At a point on the line connecting the shaft axes of the two gears, imagine two teeth in contact. There will be both a radial and a circumferential element in the force. Gears are a simple and very useful machine.

A gear within a transmission device is a component. Transmit to another gear or device the rotational force. A gear is distinct from a pulley in that a round wheel is a gear. Mesh with other gear teeth to enable the full transfer of force without slippage. From the power source, geared devices can transmit forces at varying speeds, torques or in different directions, depending on their construction and arrangement. Gears are a simple and very useful machine. For a gear to mesh with another gear, the most common situation is, but with any device with compatible teeth, such as linear moving racks, a gear can mesh.

1.1 Need of Analysis

Transmitting rotation and torque between axes is the main purpose of gear mechanisms. The gear wheel is a component of the machine that has intrigued many engineers because a full mesh cycle presents numerous technological problems. In order to accomplish the need for high load carrying capacity with reduced gear drive weight but with increased gear transmission strength, major research areas are developing design, gear tooth stress analysis, tooth modifications and optimum gear drive design. Due to the low production cost, gears with involute teeth have been commonly used in industry.

II LITERATURE REVIEW

Mahebub Vohra *et al.* (2014) explained the Metallic material Cast iron and Non Metallic material Nylon are for spur gear. The stress analysis of the lathe machine headstock gear box is analyzed by finite element analysis (FEA) and ANSYS. They got the theoretical results are about to same with minor differences. [1]

Sangamesh Herakal *et al.* (2014) investigated the dynamic analysis of natural frequency of spur gear FEA and MATLAB. The results of FEA and MATLAB analysis are compared and they found that the natural frequency is increases with increase in fiber orientation. [2]

Siva Prasad *et al.* (2012) analyzed design of spur gear and proposed a gear for sugarcane juice machine. They created a model in PRO-E and analyzed in ANSYS10.0. From the analysis they found the Nylon gear is suitable for the application of sugarcane juice machine under limited load condition compared with cast iron spur gear. [3]

N.Lenin Rakesh *et al.* (2013) investigated a spur gear is modeled using a modeling software Pro-E and using software ANSYS. The theoretical stresses of both bending and contact stress is found manually and then analyzed in ANSYS software. The readings are shown in the tabular column. It is found that comparing with manual results; results are approximate or closer to it. [4]

Moya, *et al.* (2007) they have performed a theoretical analysis of aprocedure to determine the Lewis Factor and also performed the contact analysis of spur gears to find the stress distribution between gear teeth. [5]

L. kavin Rajkumar *et al.* *(*2014) the pressure in the gear tooth was analysed to decrease the stress in the gear tooth. A study of spur gear by ANSYS is used. In order to reduce the stress in the spur gear contact tooth, a Finite Element model with an aero-fin shaped hole along the direction of stress flow gives better results. When an aero-fin hole is introduced and the stress in the gear teeth is reduced, the study produces the best result. [6]

Nitin kapoor *et al.* (2014) Glass filled polyamide composite and metallic materials (Aluminum alloy, Alloy Steel and Cast Iron) are also being performed and analyses are being performed under static conditions using ANSYS for equivalent (Von-Misses) stress, displacement and maximum shear elastic strain for different revolutions. In comparison, the composite material of Glass Filled Polyamide is selected as the best material for the Differential gear box. [7]

Pradeep Kumar singh *et al.* (2014) compared analysis with ANSYS and AGMA. The Hertz theory and Lewis formula are used for theoretical calculation of contact stress and bending stress of spur gear. They observed that theoretically results obtained by Lewis formula and Hertz equation are quite similar with little differences. [8]

III MATERIAL PROPERTIES

A. Cast Iron

Except for malleable cast irons, cast iron appears to be brittle. Cast iron is becoming an engineering material with a wide range of implementations, such as pipes, machinery and automotive parts, such as cylinder heads (declining use), cylinder blocks, and gearbox cases, with its low melting point, good fluidity, castability, great machinability, deformation resistance, and wear resistance (declining usage). It is immune to destruction by oxidization and weakening.

Youngs modulus	1.88e+.11pa
Poisons ratio	0.3
Density	7197 kg/

Table 1. Properties of cast iron

B. Carbon Fiber High Modulus

Three types can be categorised as high-performance carbon fibres, high resistance (HR), intermediate modulus (IM) and high modulus (HM) (HM). Fibers with a modulus greater than 400 GPa are also described as the latter. Both of these fibres are used in sports products, such as golf clubs and fishing rods, but in aeronautical applications, the high modulus fibres are essentially used. However, the use of HM fibres has also grown over the past ten years for the masts of ocean racing yachts, and particularly for multi-hulls of the 60 foot Open Class. These structures are typically manufactured from preparation either in ovens under vacuum or autoclaves in composite sandwich, carbon composite facings on honeycomb core, with a length of around 30 metres and a weight of around 450 kg.

Young's modulus	0.2
Poisons ratio	.2Mpa
Density	7.85e-006
Thermal expansion	0.1/0 c

Table 2. Properties of carbon fiber

3.1 Specification and Design Calculation

1) Specification

Model = VMT (valve maintenance trailer)
Engine = 1198
Engine capacity = 1497cc

Maximum engine output = 117hp@6600 rpm

Maximum engine torque = 145 Nm @4600 rpm

Fuel tank capacity = 35 liters
Tyre size = 175/65 R1482T Wheel
base =2345 mm
Width =1680 mm
Length = 3610mm
Height =1500 mm

2) Calculation:

Torque (T) = 145000 N-mm
Speed (N) = 4600 rpm
Power (P) =2*3.14*N*

= 2*3.14*4600*

= 69.812 watt

Torque (T) = F*

D = z*m

= 25*3.5

= 87.5 mm

F = 145000/43.75

=3314.28 N

The Maximum allowable stress = 8.7413 N
Ultimate tensile strength for cast steel = 540mpa
Ultimate tensile strength for composite = 52map
Allowable stress for cast steel = ultimate tensile strength
= 540/3 = 180N/ >8.74134 N/
So the design is safe.

Calculation of gear tooth properties

Pitch circle diameter =z*m = 25*3.5 =87.5 mm
Basc circle diameter = D*cos20
= 87.5*cos20
=82.145mm

Outside circle diameter = (z+2)*m
= (25+2)*3.5
=94.5mm

Clearance = circular pitch/20 = 31.4/20
=1.57mm

Module =D/Z =87.5/25 =3.5mm
Thickness of the tooth =1.571*10 =15.71mm
Face width (b) = 0.3*87.5 =54mm
Center distance between two gears =180mm

Pitch circle diameter (pc) = m*z = 3.5*25 =87.50mm
dedendum = addendum + clearance =10 + 1.57 = 11.57mm.
diametral pitch = number of teeth/ pitch circle diameter
= 25/87.5 =0.28mm

3.2 Modeling and Analysis of Spur Gear

Modeling

The spur gear modeling was done by using CATIA software based on spur gear design calculation and modeling diagram shown in fig 2.

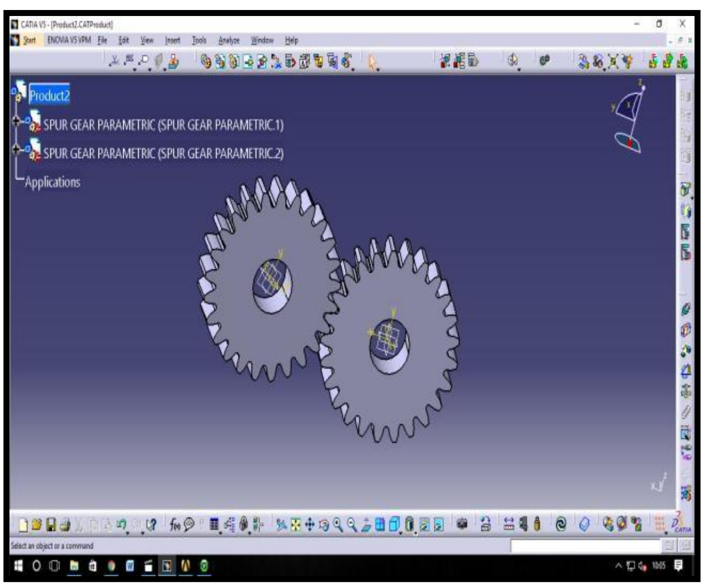


Fig 2. Spur gear modeling in CATIA

Analysis

The stress analysis of spur gear was done by using ANSYS software, the ANSYS diagrams are shown in fig 3.

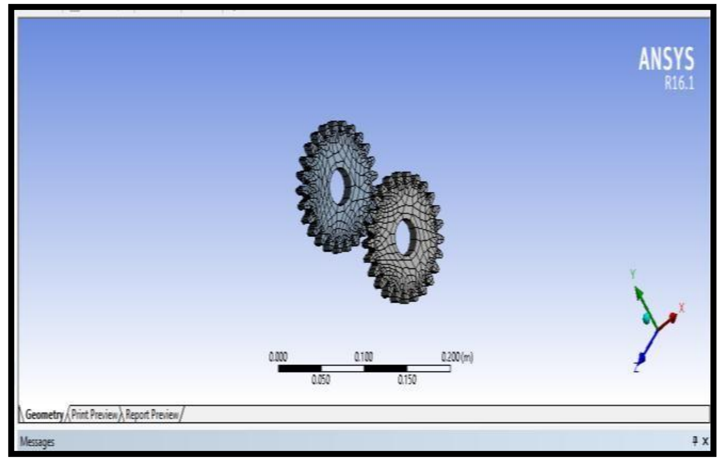
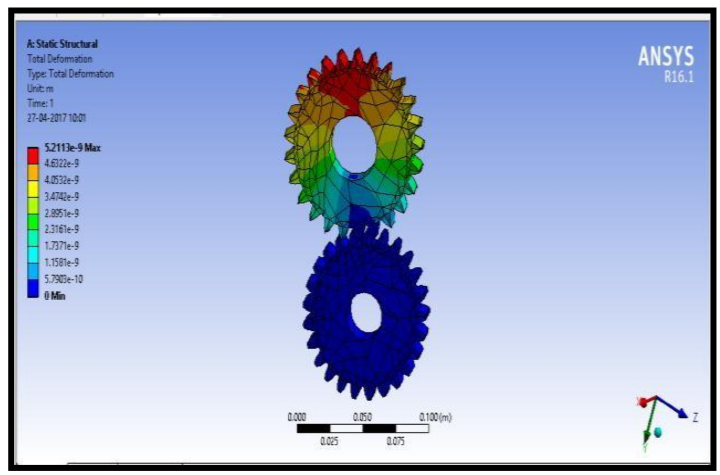


Fig 3. Mesh view of spur gear in ANSYS workbench

IV RESULTS



Results of cast iron

Fig. 4. Cast iron-total deformation

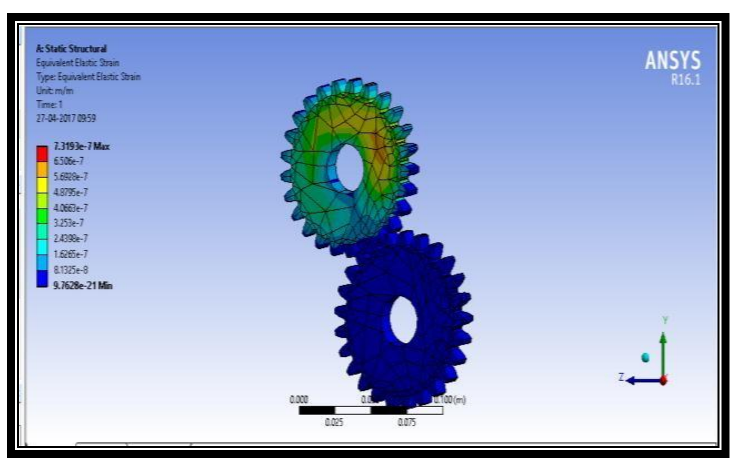


Fig.5. cast iron –equivalent elastic strain

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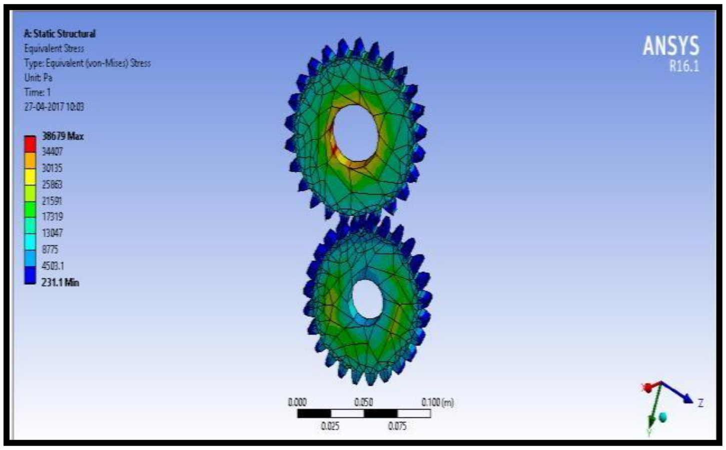

Fig. 6. Cast iron-equivalent stress

Result of carbon fiber high modulus

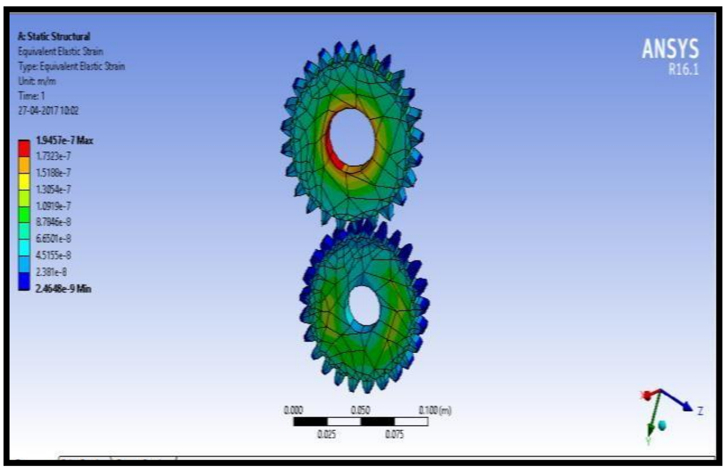

Fig.7. carbon fiber-total deformation

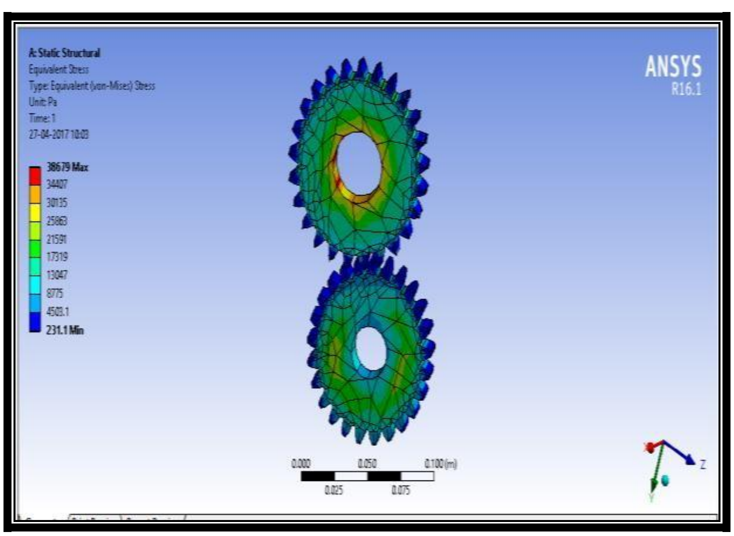

Fig.8. carbon fiber-equvalent elastic strain

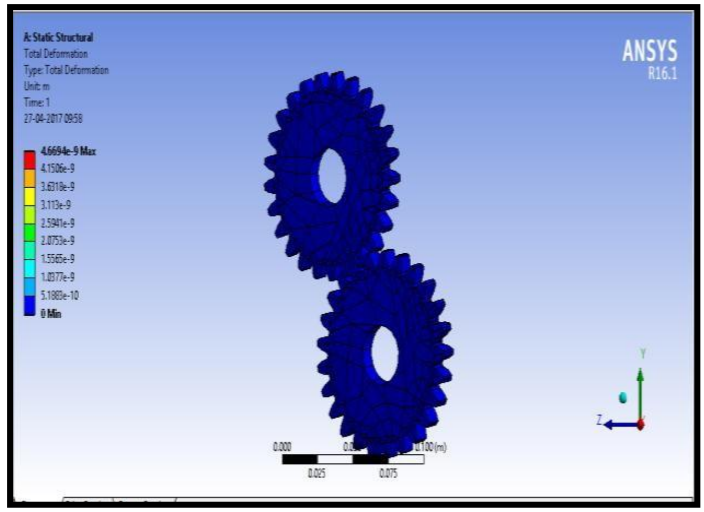

Fig.9. carbon fiber-equivalent stress

CAST IRON	MIN	MAX
Total deformation (m)	0	0.010307
Equivalent Elastic Strain(m/m)	9.765611e-7	2.39
Equivalent stress	6.11679	179.2

Table 3. Result of analysis of cast iron

CARBON FIBER HIGH MODULUS	MIN	MAX
Total deformation (m)	0	0.0047467
Equivalent Elastic Strain(m/m)	2.9338e-7	0.00044866
Equivalent stress	0.11735	179.46

Table 4. Result of analysis of carbon fiber high modulus

IV CONCLUSION

The table lists experimental results from testing the spur gear at the moment. Analysis was performed by optimizing high modulus materials such as carbon fiber. The results are determined for each material, such as total deformation, equivalent elastic strain and equivalent stress. The low values of total deformation, stress and strain are compared with the optimized materials and the conventional material, carbon fiber high modulus material. It is therefore concluded that the high-modulus material of carbon fiber is suitable for the production of spur gear.

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