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MODELING AND ANALYSIS OF COMPOSITE SPUR GEAR

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Abstract

Spur gears are the simplest and widely used in power transmission. In recent years it is required to operate machines at varying load and speed. Gear teeth normally fail when load is increased above certain limit. Therefore, it is required to explore alternate materials for gear manufacturing. Composite materials provide adequate strength with weight reduction and they have emerged as a better alternative for replacing metallic gears. Composites provide much improved mechanical properties such as better strength to weight ratio, more hardness, and hence less chances of failure. So this work is concerned with replacing metallic gear with composite material so as to improve performance of machine and to have longer working life. Efforts have also been carried out for modeling using 3D modelling software called CATIA V5 and finite element analysis of gears using ANSYS WORKBENCH R 2016. Composite gears have been manufactured by stir casting, which is economical method. Composite gears offer improved properties over steel alloys and these can be used as better alternative for replacing metallic gears.

Keywords-Composite material, Coir, Glass Fiber, Epoxy resin composite

1. INTRODUCTION

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with teeth projecting radially. Though the teeth are not straight sided (but usually of special form to achieve a constant drive ratio, mainly involute but less commonly cycloidal), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears mesh together correctly only if fitted to parallel shafts. No axial thrust is created by the tooth loads. Spur gears are excellent at moderate speeds but tend to be noisy at high speeds.Spur gear teeth are manufactured by either involute profile or cycloidal profile. Most of the gears are manufactured by involute profile with 20° pressure angle. When two gears are in mesh at one instant there is a chance to mate involute portion with non-involute portion of mating gear. This phenomenon is known as "interference" and occurs when the number of teeth on the smaller of the two meshing gears is less than a required minimum. To avoid interference we can have undercutting, but this is not a suitable solution as undercutting leads to weakening of tooth at its base. In this situation Corrected gears are used. In corrected gears Cutter rack is shifted upwards or downwards.A gear or cogwheel is arotatingmachinepart having cut teeth or, in the case of a cogwheel, inserted teeth (called cogs), which mesh with another toothed part to transmittorque. Geared devices can change the speed, torque, and direction of apower source. Gears almost always produce a change in torque, creating amechanical advantage, through theirgear ratio, and thus may be considered asimple machine. The teeth on the two meshing gears all have the same shape.Two or more meshing gears, working in a sequence, are called agear trainor atransmission. A gear can mesh with a linear toothed part, called a rack, producingtranslationinstead of rotation. The gears in a transmission are analogous to the wheels in a crossed, beltpulleysystem. An advantage of gears is that the teeth of a gear prevent slippage. When two gears mesh, if one gear is bigger than the other, a mechanical advantage is produced, with therotational speeds, and the torques, of the two gears differing in proportion to their diameters.In transmissions with multiple gear ratios—such as bicycles, motorcycles, and cars—the term "gear" as in "first gear" refers to a gear ratio rather than an actual physical gear. The term describes similar devices, even when the gear ratio is continuous rather than discrete, or when the device does not actually contain gears, as in acontinuously variable transmission.

Gear Terminology:

Following are the **gear terminology** and gear terms used in the description of gears:

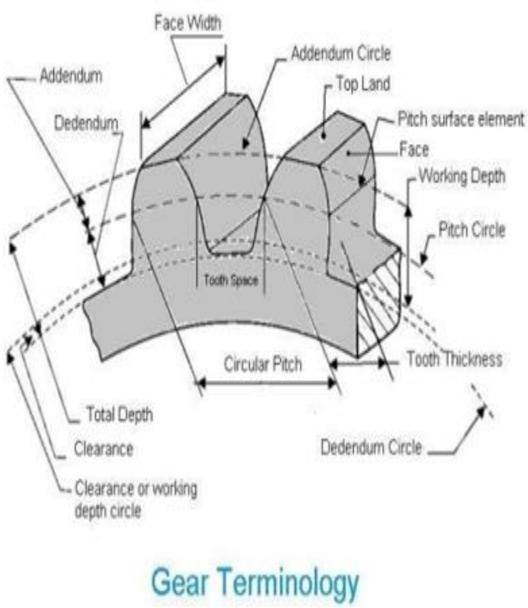

Figure 1 Gear Terminology

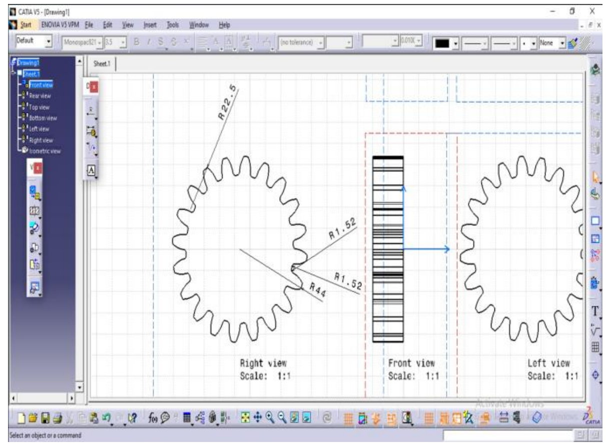

Fig 2Right view and dimensions of the spur gear.

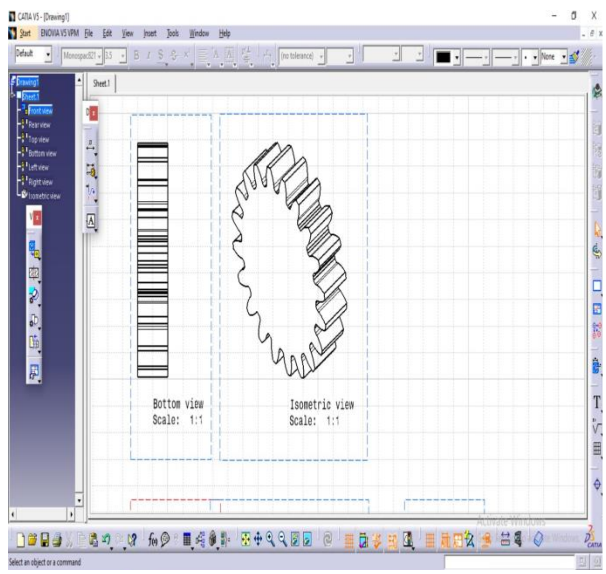

Fig 3 Isometric view of the spur gear.

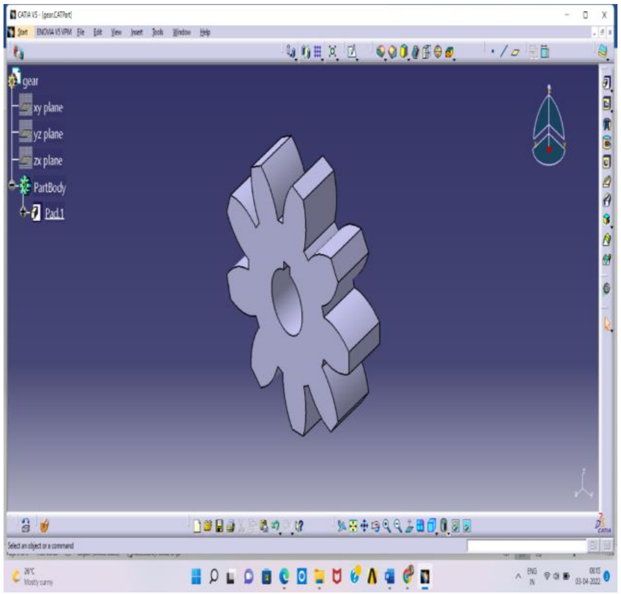

Fig 4 CATIA 3D layout of spur gear

Product Descriptions:

The electric motor is the basic produced gear which is typically used for parallel shafts in the motor speed transmission. Although high phase, loads & proportions are geared to other alternatives, spur equipment is the very first option of equipment. For other equipment, the vibration activity can also be slower. The ration range of 1:1 & 1:6 with a pitch line phase of up to 25 meter per second is normally chosen for a spur gear. The operational performance of the spur gear is 98-99%. The pinion consists of a substance that is more tough than the wheel. To have the maximum number of teeth, a gear pair should be chosen in compliance with a reasonable safety margin for force & wear. The minimal tooth on an apparatus with a normal 20° input movement is 18.

Item	Full depth & pitches coarser than 20		Full depth & pitches finer than 20	14½° full depth
Pressure angle	20°	25°	20°	14½°
Addendum (in.)	1.0/P	1.0/P	1.0/P	1/P
Dedendum (in.)	1.250/P	1.250/P	1.2/P + 0.002	1.157/P

Table 1 Specifications for standard gear teeth.

2. MATERIAL SELECTION:

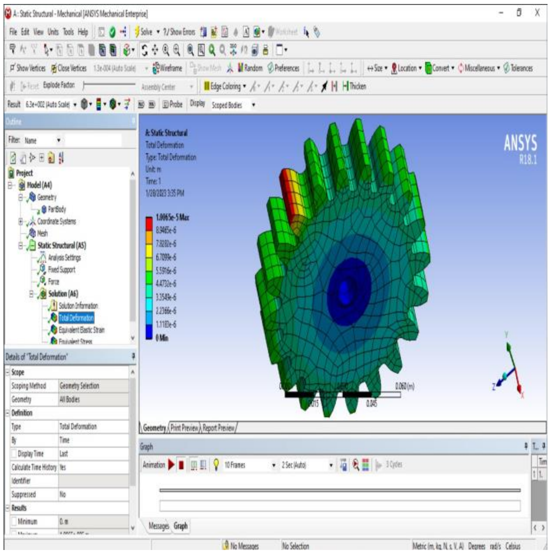

Fig 5Total deformationResults showing for directional deformation

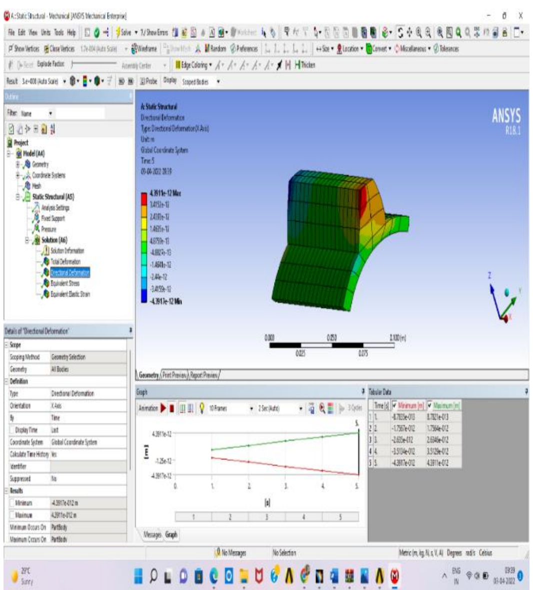

Fig 6 Directional deformationResults showing for equivalent stress

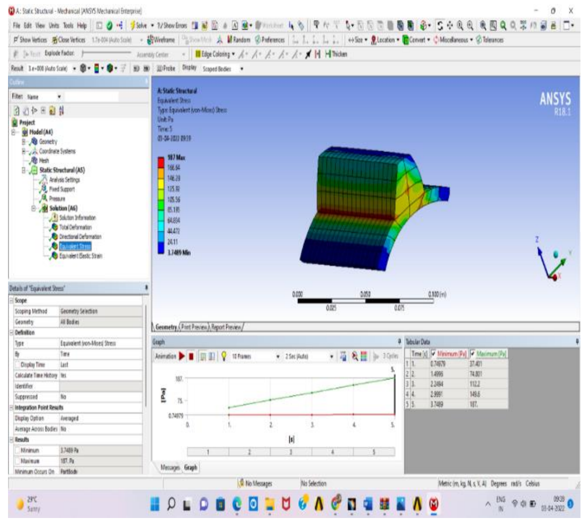

Fig 7 Equivalent stress

3. PROPERTIES OF GLASS FIBRE

Property	Value
Appearance	White
Density(g/m^3)	0.91
Fire reaction	incombustible
Tensile strength	>600mpa
Elastic modulus	>3500mpa
Crack elongation (%)	10 minimum
Melting point	12000 c
Heat condition	low

Table 2 Properties of glass fibe

Properties of Outline Row 5: glass fibre

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	2660	g cm^-3		
3	Isotropic Elasticity				
4	Derive from	Young's M...			
5	Young's Modulus	30000	MPa		
6	Poisson's Ratio	0.21			
7	Bulk Modulus	1.7241E+10	Pa		
8	Shear Modulus	1.2397E+10	Pa		
9	Field Variables				
10	Temperature	Yes			
11	Shear Angle	No			
12	Degradation Factor	No			
13	Tensile Yield Strength	3450	MPa		

Table 3Properties of glass fiber

4. PROPERTIES OF COIR FIBRE

Property	Value
Diameter(mm)	0.1-0.5
Density(g/cc)	1.4
Fire reaction	combustible
Tenacity(g/tax)	10.0
Rigidity modulus(dyne/cm^2)	1.8924
Moisture at 65%RH	10.50%
Melting point	12000 c
Swelling in water(diameter)	5%

Table 4 Properties of coir fiber

Total deformation

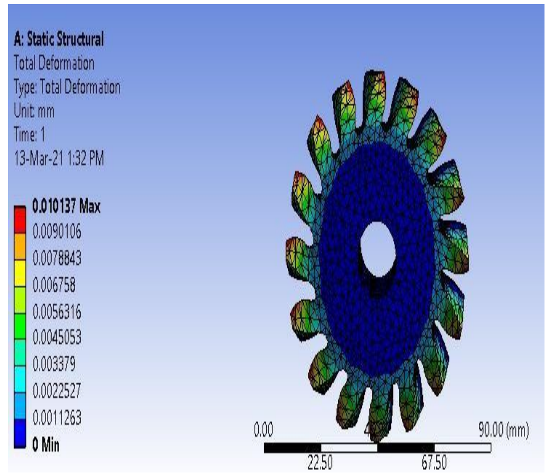

Fig 8 Total deformation

5. RESULT:

S NO	NAME	TOTAL DEFORMATION(M
1	CAST STEEL	1.1101
2	GLASS FIBER	1.0137
3	COIR FIBER	1.0428

Table 3 Total Deformations

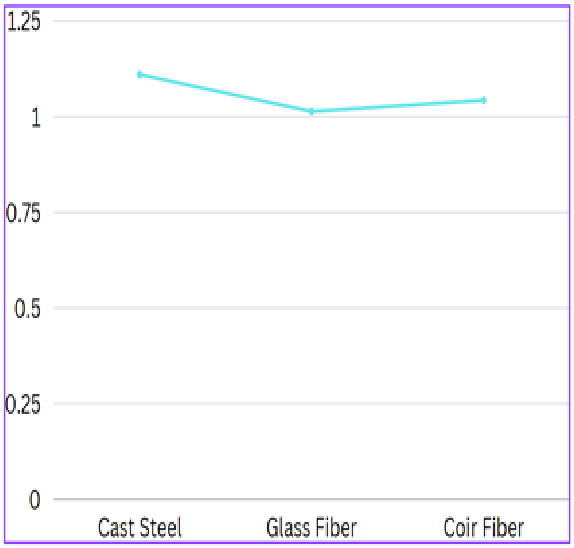

Figure9 Comparison of total deformations

Thus, we can observe that the total deformation in material consisting fiber composites or composite material is less compared to generally used alloys for spur gears. The composite material helps in providing better strength to weight ratio and also less deformation while loads applied.

6. CONCLUSION:

The literature survey of composite spur gear was performed. Then the study in weight reduction and stress distribution of spur gear for cast steel and composite materials has been done. On the basis of that study, the analysis of both cast steel and composite materials are analyzed in the application of gear box which is used in automobile vehicles. From this analysis we got the stress values for composite materials is less as compared to the cast steel spur gear. So, from these analysis results, we conclude that, the stress induced, deformation and weight of the composite spur gear is less as compared to the cast steel spur gear. So, composite materials are capable of using in automobile vehicle gear boxes up to 1.5KN in the application of Tata super ace model instead of existing cast steel gears with better results.

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