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Design and Analysis of High Speed Helical Gear with Different Helical Angles

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ABSTRACT:

Marine engines are among heavy-duty machineries, which need to be taken care of in the best way during prototype development stages. These engines are operated at very high speeds which induce large stresses and deflections in the gears as well as in other rotating components. For the safe functioning of the engine, these stresses and deflections have to be minimized.

In this project, we created one helical gear with calculations in CAD tool Creo-2/Pro-E which is having helical angle 20 degrees and face width 32mm and pressure angle 20, by using CAE tool ANSYS WORKBENCH we applying high rotational speed and high pressure and high torque values in static structural then we finding deformation of the object and maximum stress values and safety factor values

The aim of this project is reducing the stress values on the object, to minimizing the stress we following 3 methods

1. *Design constant material change*
2. *Design changing material constant*
3. *Design and material both changing*

The present used material for helical gears is Steel. In this project, we modifying design by changing helical angle from 20 degrees to 45 and 15 degrees respectively and also analyzing these models with another two different materials and then finding which material is most suitable for this object from all the results and graph values.

INTRODUCTION

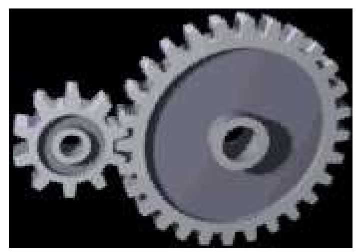
A gear or cogwheel is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part in order to transmit torque, in most cases with teeth on the one gear of identical shape, and often also with that shape (or at least width) on the other gear. Two or more gears working in tandem are called a transmission and can produce a mechanical advantage through a gear ratio and thus may be considered a simple machine. Geared devices can change the speed, torque, and direction of a power source. The most common situation is for a gear to mesh with another gear; however, a gear can also mesh with a non-rotating toothed part, called a rack, thereby producing translation instead of rotation.

The gears in a transmission are analogous to the wheels in a pulley. An advantage of gears is that the teeth of a gear prevent slipping.

When two gears of unequal number of teeth are combined, a mechanical advantage is produced, with the rotational speeds and the torques of the two gears differing in a simple inverse relationship.

In transmissions which offer multiple gear ratios, such as bicycles and cars, the term gear, as in first gear, refers to a gear ratio rather than an actual physical gear. The term is used to describe similar devices even when the gear ratio is continuous rather than discrete, or when the device does not actually contain any gears, as in a continuously variable transmission.

The earliest known reference to gears was circa A.D. 50 by Hero of Alexandria, but they can be traced back to the Greek mechanics of the Alexandrian school in the 3rd century B.C. and were greatly developed by the Greek polymath Archimedes (287–212 B.C.). The Antikythera mechanism is an example of a very early and intricate geared device, designed to calculate astronomical positions. Its time of construction is now estimated between 150 and 100 BC.



Two meshing gears transmitting rotational motion. Note that the smaller gear is rotating faster. Although the larger gear is rotating less quickly, its torque is proportionally greater. One subtlety of this particular arrangement is that the linear speed at the pitch diameter is the same on both gears.

2.COMPARISON WITH DRIVE MECHANISMS

The definite velocity ratio which results from having teeth gives gears an advantage over other drives (such as traction drives and V-belts) in precision machines such as watches that depend upon an exact velocity ratio. In cases where driver and follower are proximal, gears also have an advantage over other drives in the reduced number of parts required; the downside is that gears are more expensive to manufacture and their lubrication requirements may impose a higher operating cost.

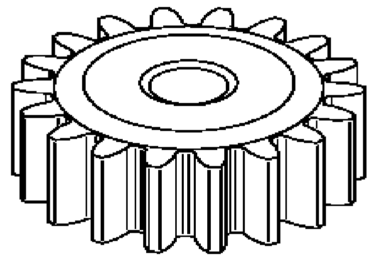
Types

External vs internal gears

Internal gear

An external gear is one with the teeth formed on the outer surface of a cylinder or cone. Conversely, an *internal gear* is one with the teeth formed on the inner surface of a cylinder or cone. For bevel gears, an internal gear is one with the pitch angle exceeding 90 degrees. Internal gears do not cause output shaft direction reversal.[5]

Spur



Spur gear

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form (they are usually of special form to achieve constant drive ratio mainly involute), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.

Helical

Helical gears

Top: parallel configuration

Bottom: crossed configuration

Helical or "dry fixed" gears offer a refinement over spur gears. The leading edges of the teeth are not parallel to the axis of rotation, but are set at an angle. Since the gear is curved, this angling causes the tooth shape to be a segment of a helix. Helical gears can be meshed in *parallel* or *crossed* orientations. The former refers to when the shafts are parallel to each other; this is the most common orientation. In the latter, the shafts are non-parallel, and in this configuration the gears are sometimes known as "skew gears".

The angled teeth engage more gradually than do spur gear teeth, causing them to run more smoothly and quietly. With parallel helical gears, each pair of teeth first make contact at a single point at one side of the gear wheel; a moving curve of contact then grows gradually across the tooth face to a maximum then recedes until the teeth break contact at a single point on the opposite side. In spur gears, teeth suddenly meet at a line contact across their entire width causing stress and noise. Spur gears make a characteristic whine at high speeds. Whereas spur gears are used for low speed applications and those situations where noise control is not a problem, the use of helical gears is indicated when the application involves high speeds, large power transmission, or where noise abatement is important. The speed is considered to be high when the pitch line velocity exceeds 25 m/s.

A disadvantage of helical gears is a resultant thrust along the axis of the gear, which needs to be accommodated by appropriate thrust bearings, and a greater degree of sliding friction between the meshing teeth, often addressed with additives in the lubricant.

CONCLUSION

In this project we designed one helical gear with calculations in Creo-2 with helical angle 20 degrees and face width 32mm and pressure angle 20, by using ANSYS WORKBENCH we analyzing this model at high rotational speed and high pressure and high torque values in static structural then we finding deformation of the object and maximum stress values and safety factor values

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minimizing the stress. In this process we changed helical angle from 20 degrees to 15 and 45 degrees and remain all dimensions are constant. The present used material for helical gears is Steel and to get better results we also chosen another two materials (Al-6061 and Al 7475) having high strength values and low weight compare to steel. And then applying same boundary conditions for all models and all material properties. From the above results we observe that while increasing angle the stress values are reduced and while decreasing the angle stress values are increased from the tables.

And then finally we can conclude that from all the results the 3rd method is producing much better results compare to other two methods i.e the 45 Degrees Helical angle with 32mm face width with **Al -7475** material is producing very less stress **131.31 Mpa** and high safety factor **3.427** values compare to all models. By these changes we reduced nearly **27 Mpa** stress and also reduced weight up to 34% from original modal.

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