iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VIII **Month of publication:** August 2022

DOI: https://doi.org/10.22214/ijraset.2022.46256

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VIII August 2022- Available at www.ijraset.com

Addendum Modified Gear for an All-Terrain Vehicle Gearbox

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Abstract: ***Transmission system is designed for the all-terrain vehicle consisting of continuously variable transmission, gearbox and drive shaft. A type of V-belt drive which shifts ratios in accordance with input speed and output torque has been successfully employed in the transmission for all-terrain vehicle. CVT is coupled with addendum modified dual stage helical torque reducer which amplifies the torque from the CVT and transmits it to the wheels through drive shaft. The design has evaluated using simulation software like Kissoft.***

Keywords: Helical Gears, Addendum Modified Gears, Transmission System, Profile Shift Coefficient, Positive Shifted tooth profile.

I. INTRODUCTION

Considering all other transmission systems, gears are having their own advantage of constant velocity ratio of transmission. In a situation where pinion has to be designed with the number of teeth lesser than the minimum teeth required to avoid under cutting and interference, addendum modification can be adopted. Although the tooth profile of racks is straight, the tooth profile of involute gears differs depending on the number of teeth. Involute tooth profile is curvilinear but becomes straighter like the tooth profile of a rack, if the number of teeth is increased. When the number of teeth is increased, the tooth profile gets thicker at the tooth-root and can generate more strength. As for the tooth profile of a 10-teeth gear, it is gouged at the tooth-root and under-cutting occurs. As for the tooth profile of a 10-teeth gear, it is gouged at the tooth-root and under-cutting occurs.

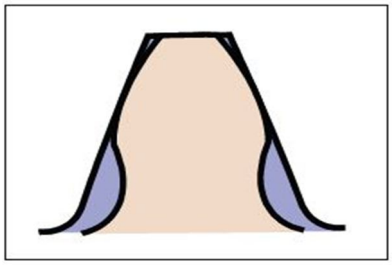


Fig. 1 Comparison of Tooth Profiles: z10 × z250 [3]

II. COMPARISON OF TOOTH PROFILES

By applying a positive correction and increasing the tip diameter and thickness, 10-teeth gears can also obtain the strength of a 200-teeth gear (z=250).

If profile shifting (Profile Shift coefficient x = +0.5) is applied, the tooth profile is changed, and the tooth thickness increases. Outside diameter (Tip diameter) also becomes larger. It is also notable that positive correction is effective to prevent undercut.

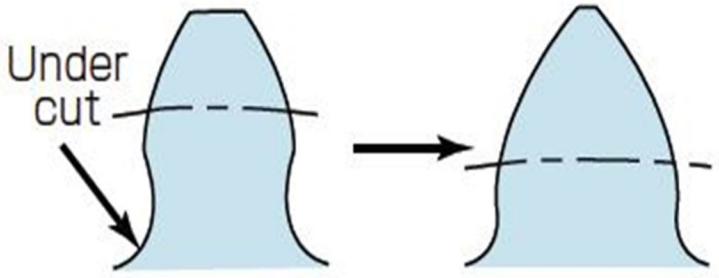


Fig. 2 Comparison of Tooth profiles [3]

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Comparison with Positive Shifted Tooth Profile

There are two type of addendum modification, positive profile shift and negative profile shift. It is seen that by positive profile shift of gears there is a significant increase in the working pressure angle. By applying a positive correction and increasing the tip diameter and thickness, 10-teeth gears can also obtain the strength of a 100-teeth gear (z=200).

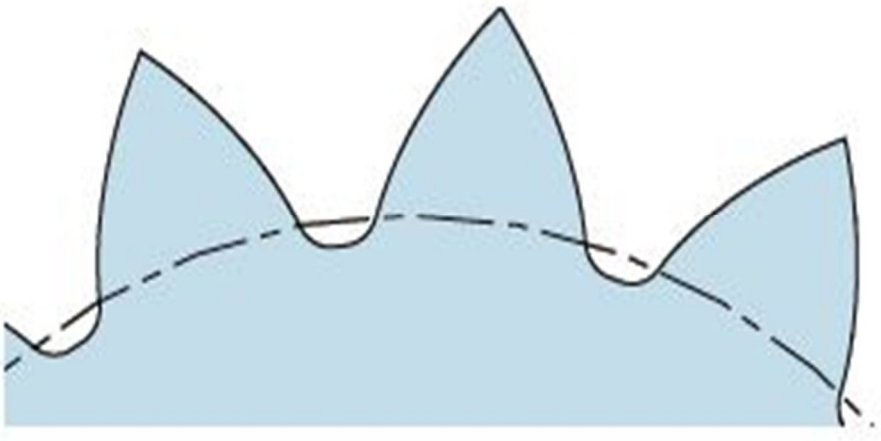


Fig. 3 Comparison with positive shifted tooth profile [3]

III. CHARACTERISTIC OF PROFILE SHIFTED GEARS

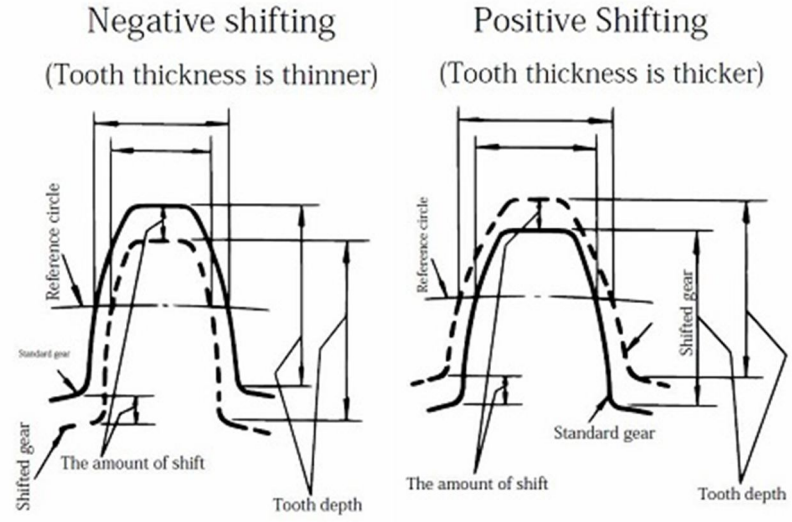
There are limits in profile shifting, for both positive correction and negative correction.

A. Positive Correction

1) Forms a tooth profile that has more bending strength, as the tooth thickness becomes thicker at the root.
2) Contact ratio becomes smaller, as the working pressure angle becomes larger by the increase of the center distance.
3) Tooth tip might be sharpening if more shifting is applied, the tooth width at the tip gets smaller, and the tooth tip becomes sharpen if it exceeds the limit in shifting.

B. Negative Correction

1) Forms a tooth profile that has less bending strength, as the tooth thickness becomes thinner at the root.
2) Contact ratio becomes larger, as the working pressure angle becomes smaller by the decrease of the centre distance.
3) Undercut may occur, more shifting is applied, the tooth width at root gets smaller, undercut occurs if it exceeds the limit in shifting.



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Fig. 4 Comparison of Negative Shifting and Positive Shifting [3]

C. Undercutting At Roots While Manufacturing

There is both positive and negative shifting. There will be change in tooth thickness; In the case of positive shifting (+), tooth thickness will become thicker, while in the case of negative shifting (-), it will become thinner. The tooth depth will not change.

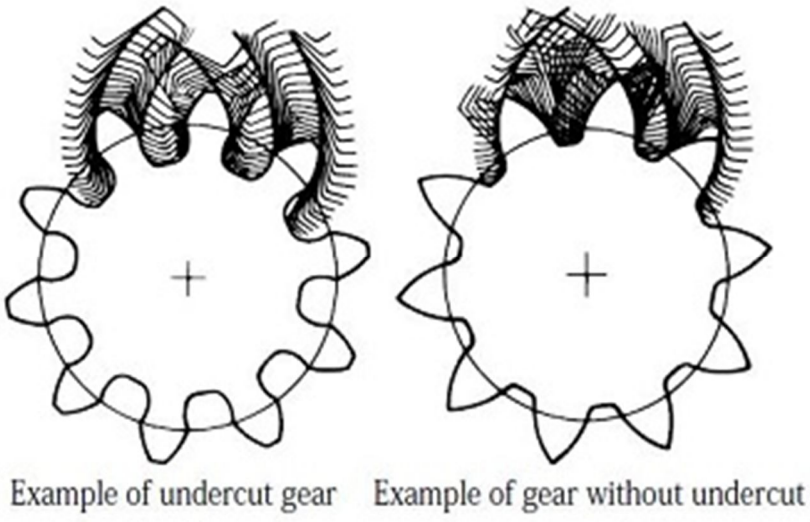


Fig. 4 Comparison of undercut and without undercut gear [3]

D. Profile Shifting Calculations

1) First stage:

Normal Module (mn)=2
No of teeth on pinion (z1) =12
No of teeth on pinion (z2) =60
Normal Pressure angle (α)=20 º
Helix angle (β)=20 º
The profile shift correction for pinion and gear is calculated with the help of KISSOFT software for optimum specific sliding velocity of gears.
The calculations to be made are:

a) Determine working pressure angle α'

$$inv\ \alpha' = 2\ \tan\alpha\left(\frac{x1 + x2}{z1 + z2}\right) + inv\ \alpha$$

$$\alpha' = 23.578\,°$$

b) Centre distance modification coefficient, y

$$y = \frac{z1 + z2}{2}\left(\frac{\cos\alpha}{\cos\alpha'} - 1\right)$$

$$y = 0.886$$

c) Determine centre distance a

$$a = \left(\frac{z1+z2}{2} + y\right)mt$$

$$a = 61.711$$

2) Second stage:

Normal Module (mn)=3
No of teeth on pinion (z1) =18
No of teeth on pinion (z2) =50

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Normal Pressure angle (α)=20 º
Helix angle (β)=20 º
The calculations to be made are:

a) Determine working pressure angle α'

$$inv\ \alpha' = 2\ \tan\alpha\left(\frac{x1 + x2}{z1 + z2}\right) + inv\ \alpha$$

$$\alpha' = 24.999°$$

b) Centre distance modification coefficient, y

$$y = \frac{z1 + z2}{2}\left(\frac{\cos\alpha}{\cos\alpha'} - 1\right)$$

$$y = 0.9778$$

c) Determine center distance a

$$a = \left(\frac{z1+z2}{2} + y\right)mt$$

$$a = 89.1208$$

IV. CONCLUSIONS

Hence it can be concluded that the modified addendum gear avoids the undercutting of the teeth when the number of teeth is less. Adjust the distance between the centre of gears. Pinion wears out quickly than the gear in larger gear ratio. Feasible to compare the strengths of gear and pinion by shifting profile. Improve (shifting) of the pinion positive and negative shifting on Gear thus resulting in more thickness of pinion and thinner Gear and so is improved wear life. Thus, making a compact gearbox for All-Terrain Vehicle by reducing the center distance between the gear's pairs.

V. ACKNOWLEDGMENT

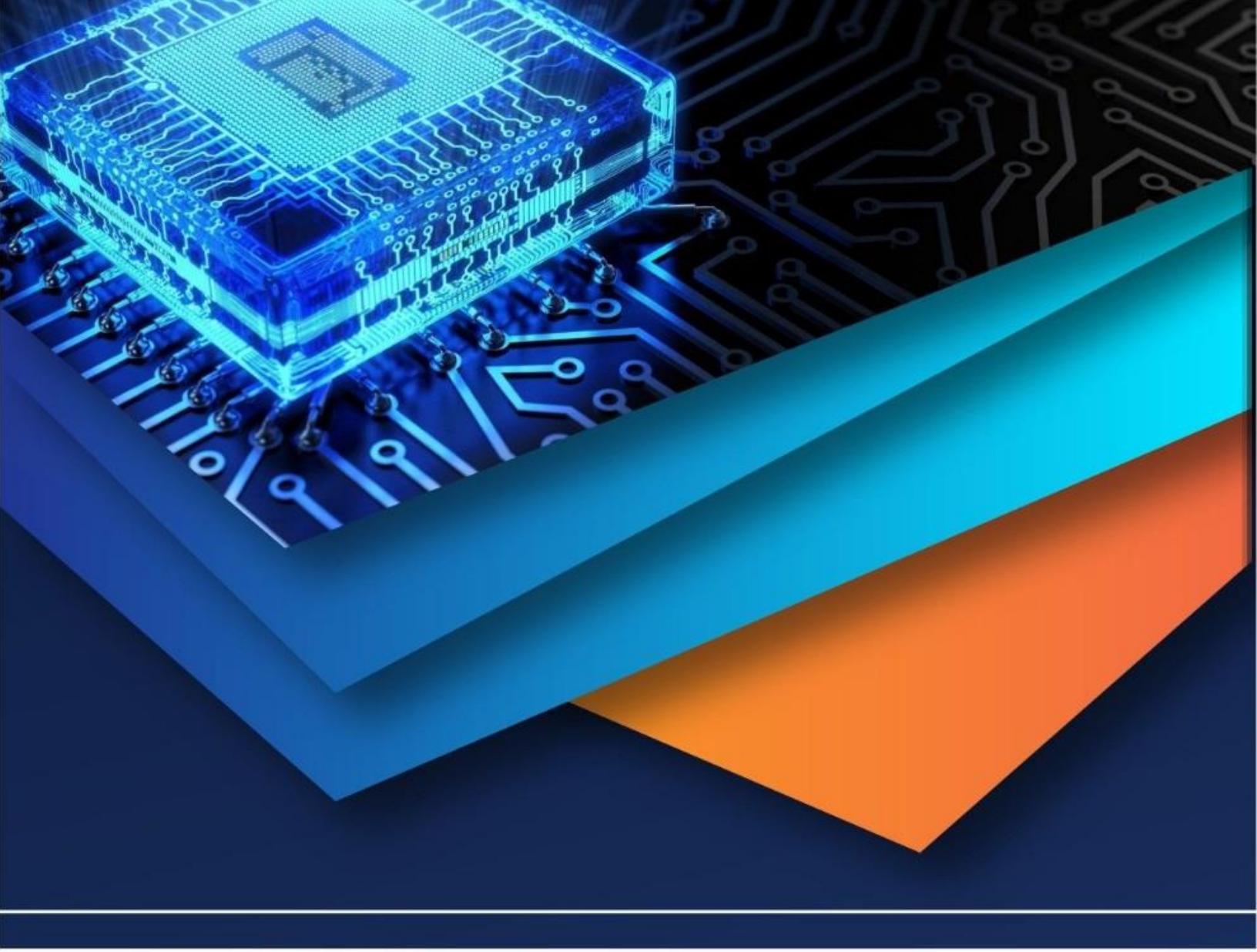
This work was completed with the grants and facilities of Pimpri Chinchwad College of Engineering. Authors are thankful to this institute and faculties for extending this cooperation.

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