Design analysis and modification worm and worm shaft in gear box

Subhash Waghmare [1], Shweta Ramteke [1]

[1]Student, Department of Mechanical Engineering Priyadarshini College of Engineering Nagpur University, India.

Corresponding Author: Shwetaramteke73@gmail.com

Abstract: The differential rear axles, wheels, and bearings are all part of the inner axle housing assembly, which also comprises the differential rear axles. The differential is a set of gears that links the propeller shaft to the rear axles. Worm gear speed reducers are made up of the phrase's "gearbox" and "speed reducer," which in the area of power transmission and motion control are interchangeable. Gearboxes are used for torque multiplication and speed decrease. When discussing gearboxes, the phrase "gear reducer" is also widely used. Simply described, this is a gearbox (or speed reduction, or gear reducer) with a motor placed directly to the input. A gearbox with a worm and worm-wheel is much smaller than one with conventional spur gears and has its drive axes at 90 degrees to one other. For each 360° round of the worm with a single start worm, the Only one tooth of the gear is advanced by worm-gear. All differential components are built and modelled in this study under structural conditions. The necessary information is gleaned from a journal article. Catia V5 is used for modelling and assembly. Solid Works is used for modelling and assembly. All parts must be supplied with full drawings. The project's major goal is to concentrate on the mechanical design and contact analysis of gear assembly in gearboxes when they transfer power at different speeds of 2500 rpm and 5000 rpm. Cast iron and cast steel are the most often utilized materials nowadays. Structural Analysis is also used to validate the design by altering the materials used for gears, such as Cast Iron and Aluminium Alloy. The analysis is carried out to determine the optimal material for the gears in the gear box at greater speeds, taking into account stress, displacement, and weight reduction.

Key Words: —*Roller conveyor, optimization in conveyor, material saving, Variable belt speed, weight optimization.*

I. Introduction

Originally, worm gearing was employed to achieve a substantial decrease in speed between the driving and driven shafts while increasing the torque of the driven shaft proportionately (save for frictional loss). Worm gearing is still employed for this, and the wheel is commonly driven by a single-thread worm with such a low helix angle that the drive cannot be reversed; that is, the wheel cannot drive the worm since the gearing locks against backward rotation. Although a multiple-threaded worm is substantially more efficient than a single-threaded worm when utilized under similar conditions, this does not mean that the multiple-threaded worm should always be used. When obtaining a high ratio is the most critical criterion, a single-threaded worm may be desirable, especially if the worm must be locking.

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The numerous threaded worms should be employed when power is the most important issue. When it comes to worm gears, lubrication is crucial. The efficiency of a system decreases as the amount of heat generated increases. As the effectiveness of the gearing improves, the quantity of power that can be transferred at a given temperature rises. Worms and worm gears are often made of steel for the worms and bronze or cast iron for the gears. When steel worms are operated at high speeds with bronze gears, they are frequently toughened with ground threads. Unlike a worm, however, the diameter of a worm gear is generally much bigger than the breadth of its face.

Manufacturing firms frequently employ both Process and Unit Load conveyors in their operations.

II. Literature Survey

Gear design entails empirical calculations, many graphs, and tables, resulting in a complex design. Furthermore, the growing need for small, efficient, and dependable gears compels the designer to employ the best design methods possible.[1]

By using normal module, number of teeth, and face width as design factors and bending strength, contact stress as a constraint, the volume of a two-stage helical gear train was reduced.[2]

A planetary gear train is a basic gear train that has a number of gears The volume of pitch diameter and face width is lowered by approximately 40%, and the error is reduced by about 40%. between the target and the result is around a reduction gear ratio by 3% [3]

Gearbox volume has been improved. The gear volume obtained by GA was 1.47 percent lower than that obtained using the analytical approach.[4]

For cylindrical gears, a multidisciplinary optimization possibility for minimal noise (sound power level) was examined. When comparing the optimal geometry scenario to the simplest geometry situation, the results demonstrate that the highest reduction in acoustic power is 10%. [5]

To determine adequate profile adjustments for a spur gear, pair, researchers employed Genetic Algorithms in combination with a suitable goal function. [6]

To minimize a product's lead time, extensive research has been conducted to forecast gear design performance parameters. Distributed support vector machines (SVM) algorithms are trained on pre-configured intranet/internet settings to obtain an effective classifier in the traditional approach. For huge data sets, these procedures are extremely difficult and costly.[7]

The purpose of this study is to offer a non-conventional technique, specifically the genetic algorithm, for minimizing the power loss of a worm gear mechanism under a set of restrictions.[8]

III. Problem Statement

From the literature survey the problem statement of the current work is, to carry out optimization of worm and worm wheel considering different objectives. These are as follows;

- Minimization of volume of worm and worm wheel.
- Minimization of center distance between worm and worm wheel.
- Minimization of deflection of worm

3.1 Calculations

Given-

No. of starts/teeth's (z1/z2) =1 Worm

Reduction ratio (Rg.) = 45

Diametric Pitch-DP = 10

Correction Factor (X) = 0.75 – (worm)

Centre Distance (a) (mm / inch) = 67

Correction Factor (X) = -0.75 – (worm wheel)

Module: m (Selected) = 25.7 x Diametric Pitch-DP – (worm and worm Wheel)

Pitch = 3.142 x Module: m – (worm and worm wheel)

Reduction ratio (Rg.) x No. of starts/teeth's (z1/z2) Worm Wheel

Pitch Circle Diameter (P.C.D.) - No. of starts/teeth's (z1/z2) x Module (m) = 114.30 – (worm wheel)

Pitch Circle Diameter (P.C.D.) – 2 x Centre Distance (a) (mm / inch) -114.30 = 19.70 - (Worm)

Throat Diameter – 114.30 + 2 x 2.54 - 2 x 0.75 x 2.54 – 2 x 0.75 x 2.54=115.57

Outer Diameter – 19.70 + 2 x 2.54 + 2 x 0.75 x 2.54 +2 x 0.75 x 2.54 = 28.59

Outer Diameter (w) – 114.30 + 3 x 2.54 – 2 x 0.75 x 2.54 = 118.11

Root Diameter-19.70 + 2.4 x 2.54 + 2 x 0.75 x 2.54=17.41

Root Diameter (w)-114.30 – 2.4 x 2.54 – 2 x 0.75 x 2.54=104.39

Radius of wheel face (w)-67-115.54/2=9.22

Pressure Angle (D^o) - 15.50

Tooth Depth-2.2 x 2.54=5.59

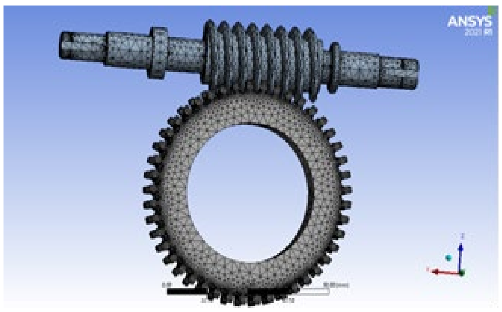
IV. Analysis

4.1 Material apply

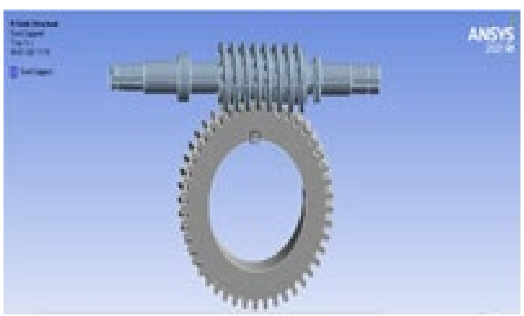
20mNcr5

Density	7.8e-06 kg/mm³
Structural	
Isotropic Elasticity	
Derive from	Young's Modulus and Poisson's Ratio
Young's Modulus	0.000219 MPa
Poisson's Ratio	0.28
Bulk Modulus	0.00016591 MPa
Shear Modulus	8.5547e-05 MPa
Other	
Melting Temperature	950 °C

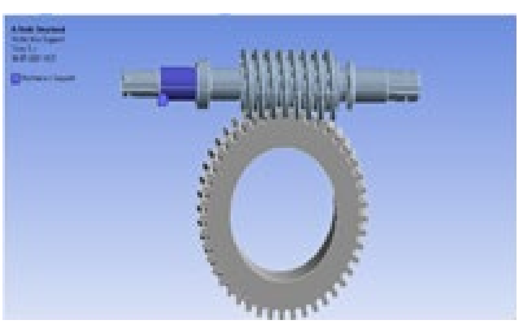
4.2 Inputs and Boundary conduction



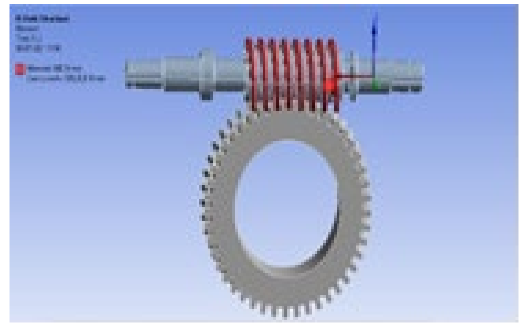
- Number of Node- 20925 Worm
  - 9795 Worm
- Number of Element- 76040 Gear
  - 41918 Gear



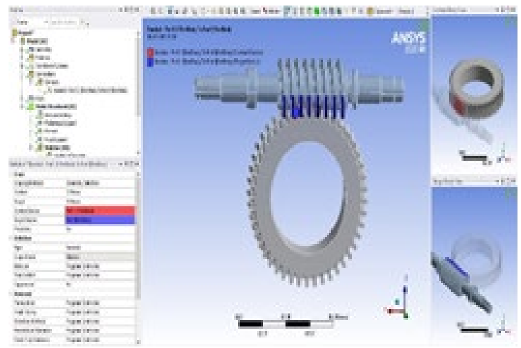
Fix support fig. A



Frictionless Support fig. B

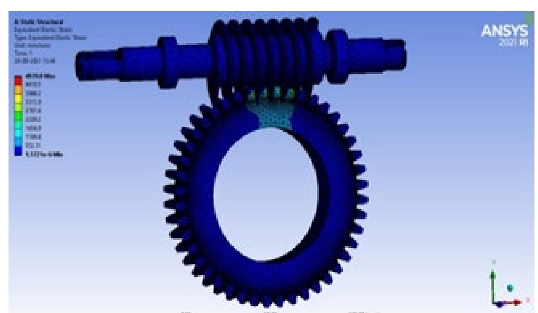


Moment fig. C

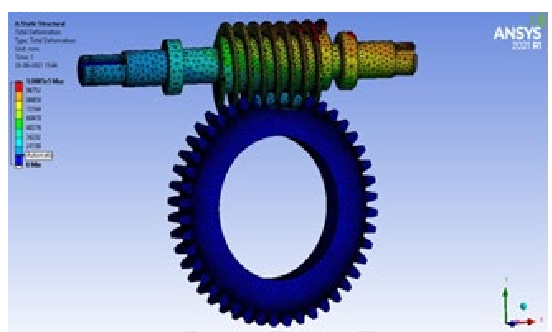


Connections

V. Analysis Results



Equivalent elastic strain fig no.1



Total Deformation fig.2

Equivalent Stress fig no.3

VI. RESULTS

The result is showing in between table

Input	Remark	Output	Remark
CAD Model	3D Step	Contact Stress 0.50184	Von-Misses Stress- 0.08364 Maximum Principle Stress- 0.75276
Material	Worm:- 20mNcR5 Gear:-Phosphors Bronze (PB2) Centrifugally Cast		
Type of Contacts	Frictionless		
Boundary Condition Pl calculate load as per 500 Nm is required output torque .	Loads on Worm:-Output Torque 500 Nm Gear:-Output Torque 500 Nmm Temperature 105°C to 120°C	Deformation 60470	Minimum-12094 Maximum-96752

VII. CONCLUSION

The Quality of FE modeling between Worm & Gear is allowable as the meshing between two connecting surface is refine which helps to find the deformations in it according to visual Observations. As it is accepted by company then run for further analysis is carried out on our system, otherwise take the help for server is necessary which is cost effective.

The goal of this study was to optimize the worm and worm wheel with many objectives in mind, including minimizing volume, center distance between the worm and the worm wheel, and worm deflection. Gear ratio, face width, pitch circle diameters of worm and worm wheel are among the criteria evaluated. The results reveal that all of the objectives have been met. As a result, GA is one of the most effective tools for solving multi objective optimization problems.

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