Design and Analysis of Internal Gear Ring and External Wobble Gear for Shaft Mounted Speed Reducer

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Abstract— Speed reducer is required in industrial as well as in some other areas such as in Agriculture area .In industrial area Conveyors, Packaging Machinery, Cranes/Hoist/Winches, Mixers/Agitators; lifting devices required the speed reduction. The Speed Reducer is used to maximize the speed reduction ratio. The conventional design of speed reducer is difficult to design and required more space. So that the simple and compact speed reducer which having easy design, easy of assembly and good for manufacturing tolerances is made. The shaft mounted speed reducer input and output shaft are parallel. In this speed reducer Internal gear ring and external gear which is mounted on driving shaft of motor eccentrically known as external wobble gear are used in speed reducer. The speed reduction ration we are getting is 1:14. By using CATIA V5 we have created a model of Internal Gear and External Wobble Gears and then imported in ANSYS workbench for analysis. We have conducted static structural analysis of both the gears by using ANSYS .The values of maximum stresses from structural analysis are compared with theoretical calculation.

Key words: ANSYS, CATIA V5, External Wobble Gear, Internal Gear, Speed Reduction, Stresses

I. INTRODUCTION

The simple construction of shaft mounted speed reducer as shown in Fig. 1 contains internal gear ring and external wobble gear. The arranegement of shaft mounted speed reducer is so selected that it gives maximum reduction ration (1: 14) in minimum space and minimum weight A standard internal gear and External gear are meshed without tooth interference. In some devices used for speed reduction earlier are as the input speed is given to sun gear and it rotates the planetary gear, which ultimately drives the ring gear. The speed of the ring gear is lesser than the input speed [1].this type of reducer are not simple to design and not simple to assembly also some other speed reducer known as Hypocycloidal Gear Transmission (HGT) which have The operating principle of speed reducer is as the eccentric shaft is connected to the motor input and drives the wobble gear against the stationary internal gear. The small eccentricity of the shaft makes the wobble gear generate the hypocycloidal motion; the wobble gear rotates not only about its own axis but also about the axis of the gear train inside the internal gears .this type of speed reducer we have to use [2-Page No-18].

II. SHAFT MOUNTED SPEED REDUCER

The setup shows 2D sketch of the arrangement used for speed reduction in the proposed work. It contains one external toothed gear which is mounted eccentrically on input shaft of a motor. The internal toothed gear is placed on output shaft. On the driving shaft is mounted an eccentric , the axis of the driving external gear follows the motion of eccentric , but is kept from rotating about its own axis by pin , which works in the slot . Parallel Linkage is actuated by the eccentric, which constantly maintains slot in a perpendicular position through the action of parallel links, pivoted on studs. Since the axis of external gear follows the motion of Eccentric and the gear does not rotate about its own axis, the motion imparted to the driven internal gear will be uniform.

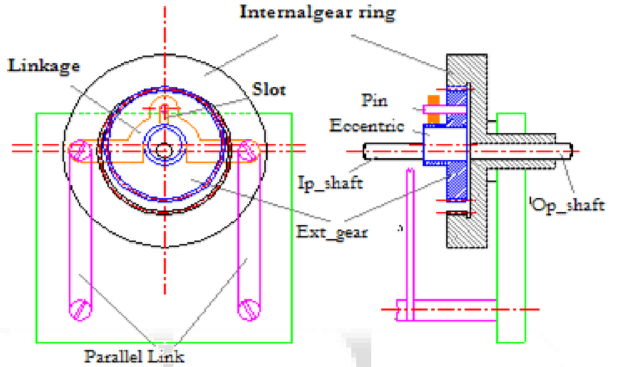

Fig. 1: 2D sketch of speed reducer

III. DESIGN OF CRITICAL COMPONENTS SELECTION OF MOTOR DRIVE

Specifications:
12 V DC motor
Power 1/15 HP = 50 watt
Speed = 0-2000 rpm (variable)

$$P = \frac{2\pi NT}{60}$$

Assume operating speed= 800 rpm

$$T = 0.5968\ \mathrm{N.m}$$

Assume 100% overload

$$T\ design = 1.19 \times 10^{3}\ \mathrm{N.mm}$$

A. *Design of Internal Gear*

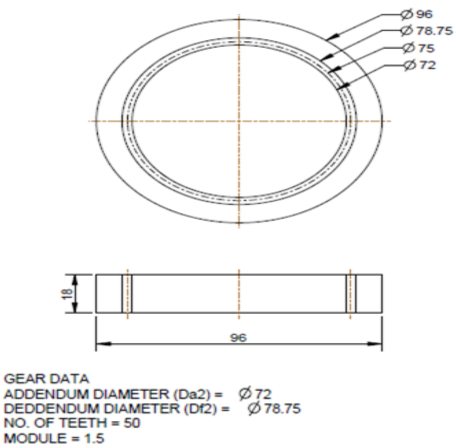

Fig. 2: 2D Drawing of Internal Gear

Theoretical design of Internal Gear

Material selection [3]

Designation	**Ultimate Tensile Strength N/mm^2**	**Yield Strength N/mm^2**
EN24	800	680

As Per ASME Code;

fs_{max} = 108 N/mm^2

Where, fs is Torsional Shear Stress in N/mm^2

Check for torsional shear failure:-

$$T = (\pi/16) \times fsact \times \frac{(D_0^4 - D_i^4)}{(D_0)}$$

$$1.19 \times 10^3 = (\pi/16) \times fsact \times \frac{(96^4 - 75^4)}{(96)}$$

$$fsact = 0.01\ N/mm^2$$

Where fsact is Actual Shear Stress in N/mm^2

T is Torque applied in N-mm

As; fs_{act} < fs_{all}

Internal Gear is safe under torsional load

B. Structural Analysis of Internal Gear

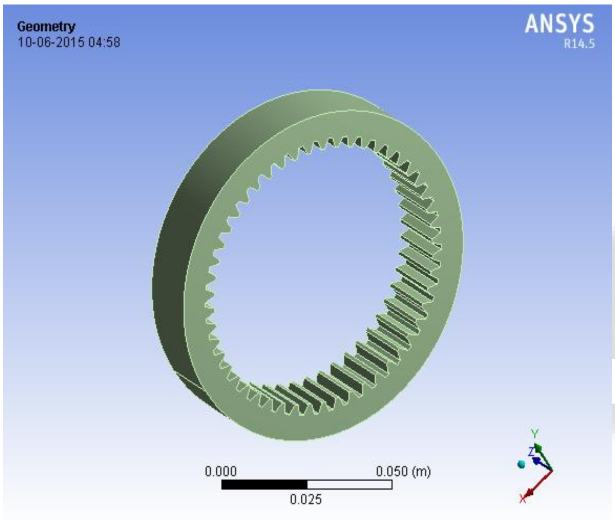

Fig. 3: Importing of Internal Gear using into

1) *ANSYS Workbench*

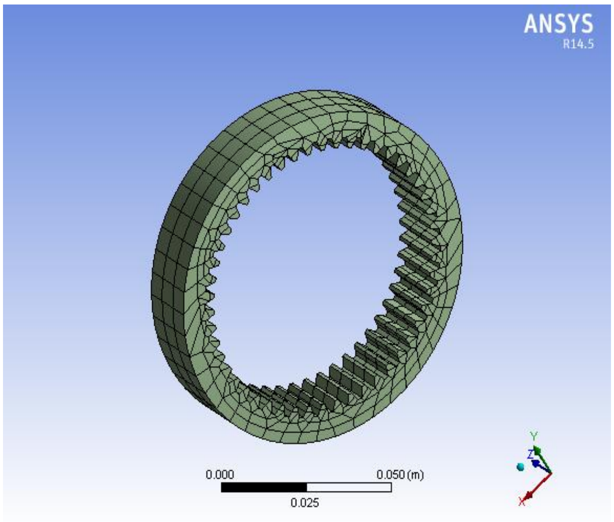

Fig. 4: Meshing of Internal Gear

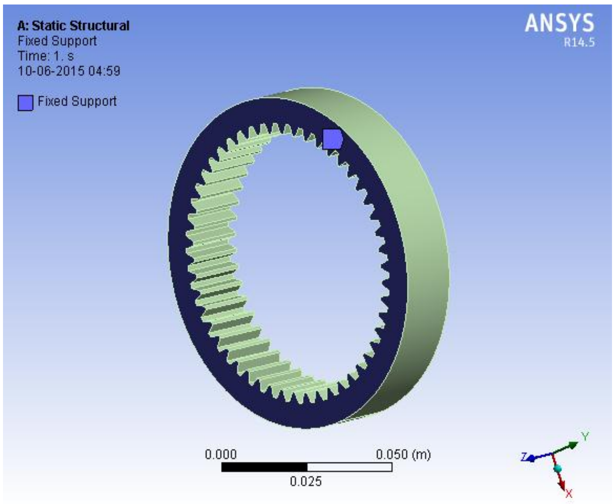

Fig. 5: Using Boundary Condition

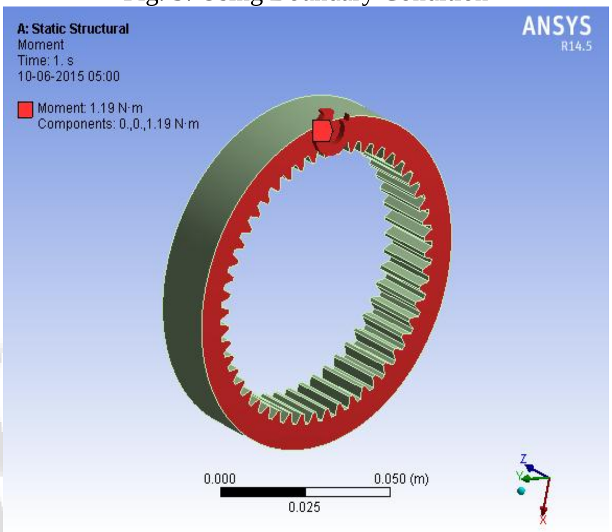

Fig. 6: Application of Torque

(Torque = 1.19 N-m)

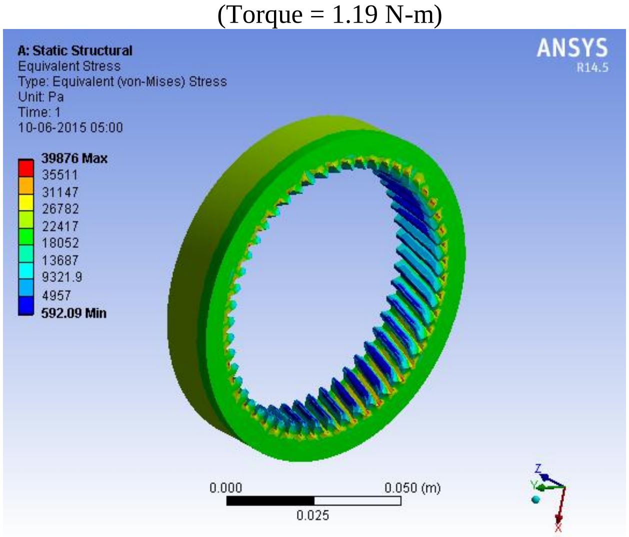

Fig. 7: Von-Mises Stress

C. Design of External Gear

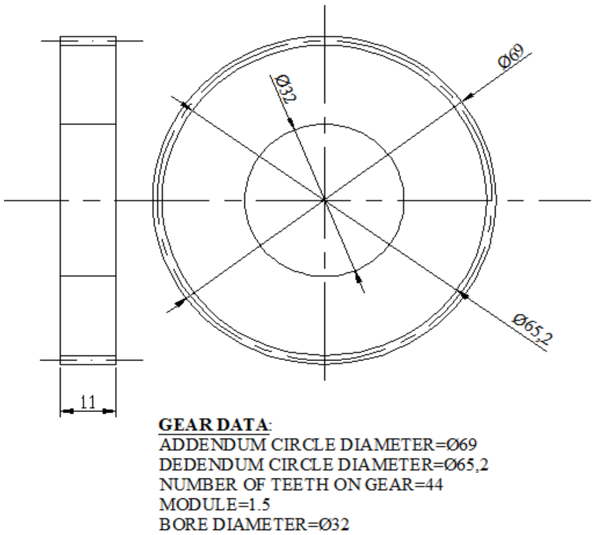

Fig. 8: 2D Drawing of External Gear

Theoretical design of External Gear

Material selection [3]

Designation	Ultimate Tensile Strength N/mm^2	Yield Strength N/mm^2
EN24	800	680

As Per ASME Code; $fs_{max} = 108$ N/mm^2

Check for torsional shear failure:-

$$T = (\pi/16) \times fsact \times \frac{(D_0^4 - D_i^4)}{(D_0)}$$

$$1.19 \times 10^3 = (\pi/16) \times fsact \times \frac{(69^4 - 32^4)}{(69)}$$

$$fsact = 0.02\ N/mm^2$$

Where fsact is Actual Torsional Shear Stress in N/mm^2

T is Torque applied in N-mm

As; $fs_{act} < fs_{all}$

Where fs_{all} is allowable Torsional shear stress in N/mm^2

External Gear is safe under torsional load.

D. Structural Analysis of External Gear

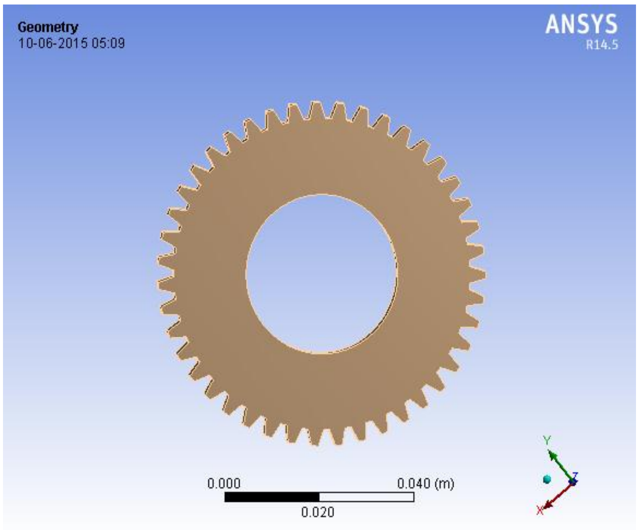

Fig. 9: Importing of External Gear

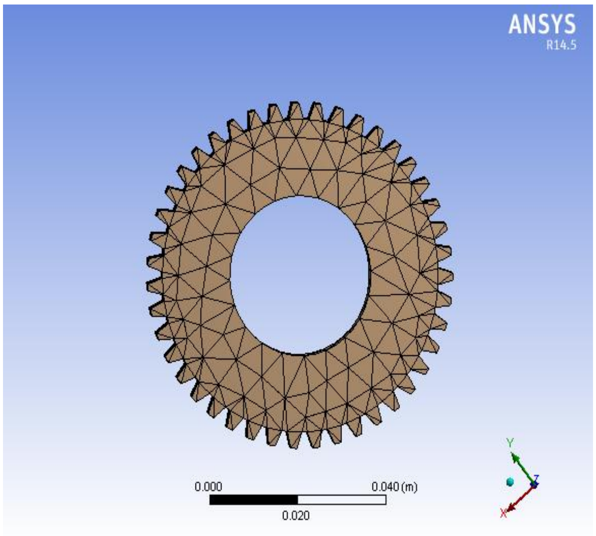

Fig. 10: Meshing of External Gear

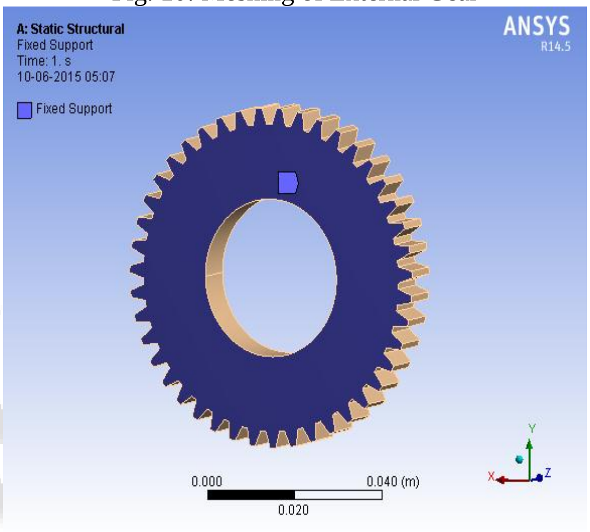

Fig. 11: Application of Boundary Conditions

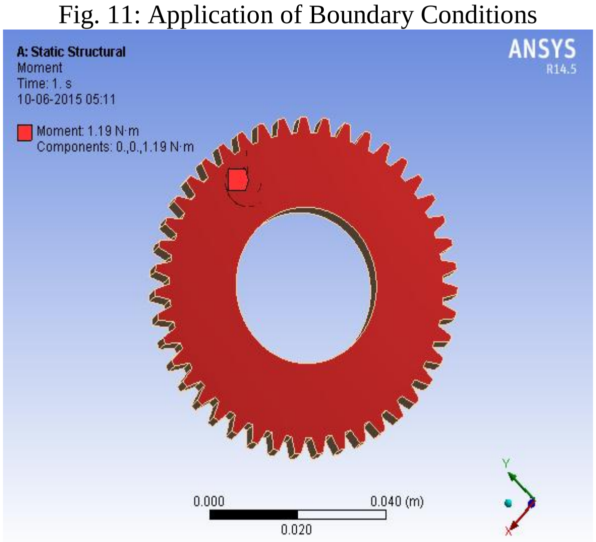

Fig. 12: Application of Torque
(Torque = 1.19 N-m)

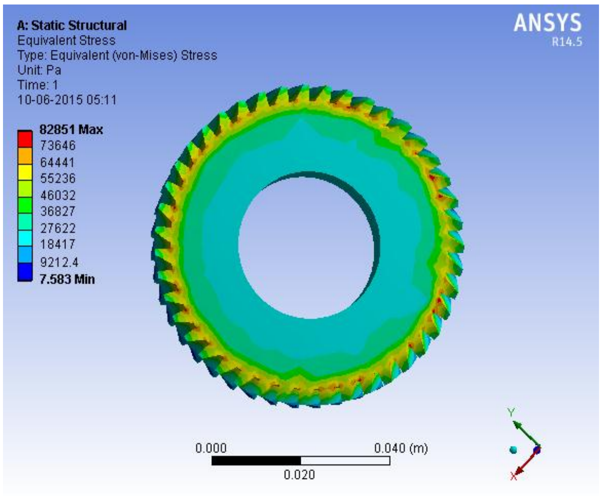

Fig. 13: Von-Mises Stress

IV. RESULT

Part Name	Maximum stress N/mm^2	Therotical Stress N/mm^2	Result
Internal Gear	0.3896	0.01	Safe
External Gear	0.82851	0.02	Safe

V. CONCLUSION

The proposed set up of internal gear ring and external wobble gear are used for the speed reduction. In the above work we have modeled an Internal and External gears for shaft mounted speed reducer from theoretical calculation and the 3D drafting is done through CATIA V5. The both gears are analyzed through ANSYS. It is found that maximum stress by theoretical and analytical methods are well below the allowable limit of 108 N/mm2 hence the internal gear and external gears are safe under the rated torque.

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