Design and Analysis of A Gear Box of A Universal Motor

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***Abstract*—This project reports an investigation of mechanical gear box and development of a universal motor. Electrical motor is a device used in converting electrical energy into use full form of mechanical work, where gear box is mechanical element used for speed regulation i.e. in order to increase the output torque. In this work we come across the design and development of a universal motor of induction type which is works on the principle of electro-magnetic induction and produces high stating torque general universal motors are rotated with high synchronous speed, which has to be reduced for desired speed for effective controlling operation.**

I. INTRODUCTION

A gear box is a mechanical technique used to change the velocity of an engine or expansion the yield torque [1]. Typically the motor is connected to the one end of the gear box and through inward setups of apparatuses of a gear box, offers a specific yield torque.

The casting of gear box is one of the principle segments in a consistent cross section gear box. In this, casting encompasses the arrangements of the helical apparatuses and the orientation to shaft of the motor. Pulsation generated at the gear mesh is transmitted to the gear box housing through the shafts and the bearings [2].

A. working principle of universal motor

Universal motor have both field curl and armature winding, at whatever point the present goes through these field loop which presents an attractive flux which results in era of attractive field .this field is produces a torque at long last bringing about revolution of the shaft.

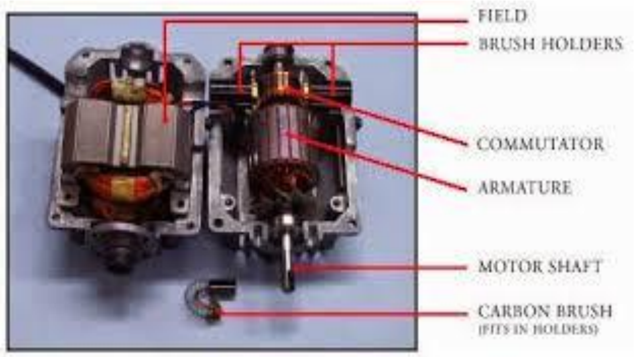


Fig. 1. Universal motor

B. Mechanical gears

Gear box are machine components, these are most normal individuals utilized as a part of force transmission starting with one shaft then onto the next shaft. Any kind of tooth profile utilized as a part of request to get a uniform rotational movement. Most normally utilized profiles are involutes profiles. Like cycloids and others can be utilized to preferences now and again.

II. LITERATURE REVIEW

A. *Shrenik M. Patel et al:* Depicts about the streamlining of a differential apparatus box and to assess the differential gear box casting of a get van vehicle for stress and modular examination. In this the casting encases the diverse arrangements of helical apparatuses, For this situation the dynamic connection, regular frequencies and correlation of mode shapes, is an extreme apparatus for finding the exactness of a limited component model. [7]

B. *Pavol Lengvarsky et al:* illustrate about assessing the mode shapes and the natural frequencies of a titan cantilever beam. The model of this titan cantilever beam was modeled in the ANSYS and the solid works program. And the modal analysis of the titan cantilever beam was performed and their natural frequencies and mode shape were calculated. Outcomes obtained from mode shapes were identical for both the programs. Hence the results of the ANSYS have a better option of the finite element mesh creating. [9]

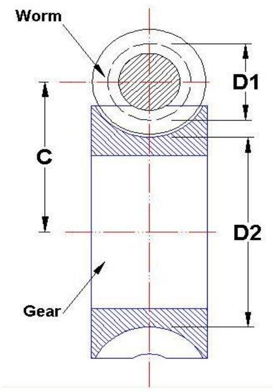
C. *E.Poursaeidi et al:* this paper represents about the factual investigation of temperature circulation consequences for the contortion of the compressor lodging and subsequently the break of these edges utilizing the ANSYS Software. The tip freedom between the compressor turning sharp edges and its lodging has an unfavorable on execution, which results in the vitality misfortunes. The warm investigation of compressor packaging has been done utilizing Ansys programming. Thusly changing the cooling procedure will expand the compressor lifetime and adjusts this non-uniform temperature dissemination.

D. *Bagul A.D. et al:* portrays about the use of the ANSYS programming furthermore the FEM analyzer for the determination of the characteristic vibration modes and the free recurrence of the apparatus box packaging, by finding the regular recurrence of it we can without much of a stretch keep the reverberation for gearbox packaging. From the outcomes acquired we can demonstrate the scope of normal frequencies of the gearbox packaging segment with greatest plentifulness of it.

III. DESIGN OF UNIVERSAL MOTOR

Specifications:
Voltage = 230AC/DC
Full load speed= 125 rpm
Power output=$\pi^2(B_{avg}\ AC)$ D L N.
AC= (IZxZ)/ πD
IZ = total current drawn/2 = 2.5/ 2
Z = number of turns per coil x 4 x 12
AC = (1.25 x 1440)/ π x 41
AC = 13.975
P = 148.65 W

IV. WORM AND HELIX GEAR BOX DESIGN



- Module of the worm as well as the gear must be equal for a meeting worm and gear
- Worm acts as a single tooth gear

Speed ratio (i)
$(n_1/n_2) = (z_1/z_2) = (\pi d2/p_z)$
According to AGMA for module 1
Pitch = 3.2329mm
Pitch circular diameter (D_1)
$D_1 = 2.4P+2.8$
$D_1 = 10.85$mm
Pitch circular diameter (D_2)
$D_2 = (T_{2*}p)/\pi$
D_2=74.35mm
Centre distance (C)
$C = (d_w+d_g)/2$
C = 42.114mm
Recommended value of pitch diameter as per AGMA for speed reducer with integral-worm
$(C^{.875})/2 \leq D_1^{1} \leq (C^{.875})/2$
$13.192 \leq 17.59 \leq 24.659$
Hence the design is safe.

V. 3D MODELING AND 2D DRAFING.

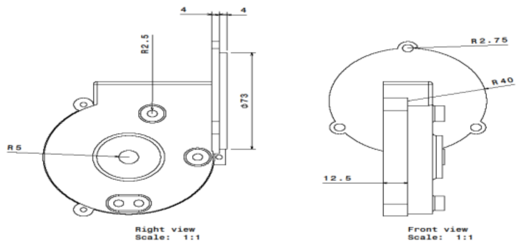


Fig. 2. Gear box plate

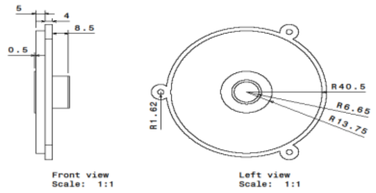


Fig. 3. Gear box cover plate

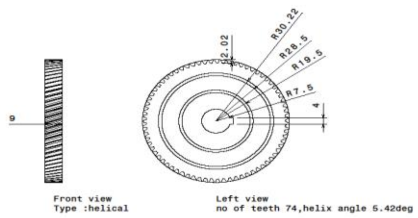


Fig. 4. worm wheel

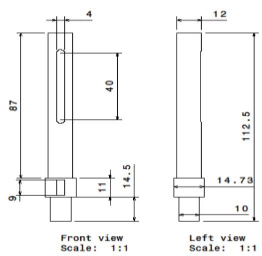


Fig. 5. . Output shaft

VI. RESULTS AND DISCUSSION.

A. Rope and pulley setup

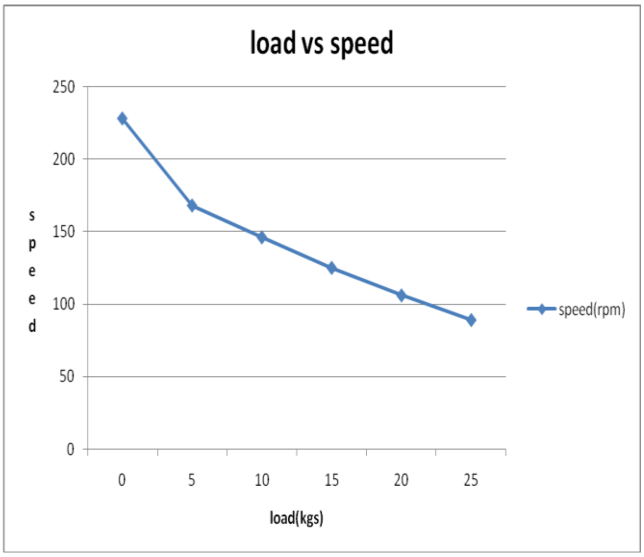
The rope and pulley setup work is done fundamentally to know the basic critical load, i.e. universal motor is joined to the pulley (setup) and the rope is twisted around it and by applying the different loads in the equivalent interims, comparing velocity is acquired.

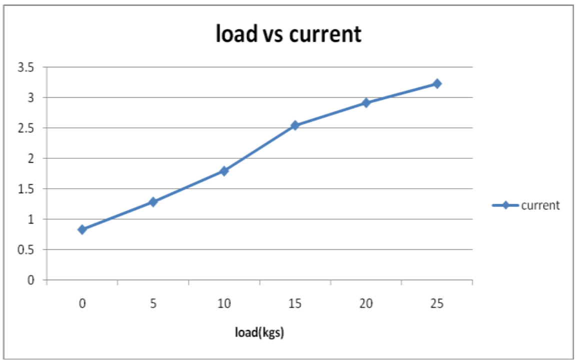
Fig. 6. rope and pulley setup

TABLE I. LOAD TEST RESULTS

LOAD TEST RESULTS		
load (kgs)	*speed(rpm)*	*current(amp)*
0	228	0.83
5	168	1.284
10	146	1.79
15	125	2.542
20	106	2.912
25	89	3.227

B. Universal motor characteristics curve





B. Static analysis

Performing a Static analysis:

- Build the model
- Defining the material property and meshing.
- Appling boundary conditions
- solution
- Evaluation of results.

TABLE II. MESHING DETAILS

Sizing	coarse
number of nodes	420306
number of elements	286456

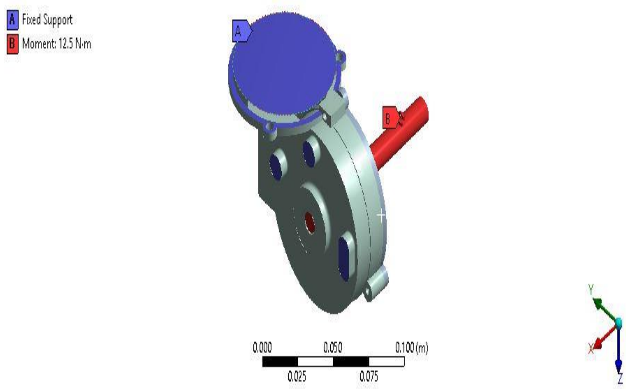


Fig. 7. boundary constraints

TABLE III. RESULTS OF STATIC STRESS ANALYSIS

Description	Minimum	Maximum
Total Deformation	0m	6.4106e-5 m
Von Misses Stress	939.64pa	2.802e+008 pa
Maximum Shear Stress	494.94pa	1.4076e+008pa

VII. CONCLUSION

The gear box casing utilized for universal motor has been effectively outlined utilizing CATIA V5 and is analyzed by ANSYS workbench programming.

The deformation of the gear box casing under the use of known measure of loads was observed to be extremely least. This is expected the way that most of the load is taken up by the gear and shaft as compared to the casing. As an outcome of this, the gear box casing is practically deformation free.

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