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DESIGN AND ANALYSIS OF A MECHANICAL SYSTEM FOR DEPLOYMENT OF GOODS

D.Suresh[1] , A.Purushotham[2]

[1]Research Scholar, Department of Mechanical Engineering, Sree Nidhi Institute of Science & Technology Hyderabad, India.

[2]Supervisior & Professor, Department of Mechanical Engineering, Sree Nidhi Institute of Science & Technology Hyderabad, India.

ABSTRACT

This paper aims at design a mechanized mechanical system which enables to stop and drop object at regular interval. The development of this mechanized system has several advantages, one of the applications is to drop objects such as food packets, cloths…etc from the helicopter during cyclone. This paper gives full details of design of the mechanized system along with structural analysis. This structure consists of two worm gear drives and L-shaped arms mechanism. This paper also carries out structural ansys of worm gear drive to stop lodes for while and then drop. The analysis is carried out using ansys soft ware. The structural ansys enables to modify the initial design of mechanism to meet the requirement of varies drooping intervals of goods such as food items, and cloths bags during cyclone. Sensitive analysis is also carried out to bring out the influence of design parameters on stress and natural frequency of worm gear mechanisms.

KEY WORDS:- worm, worm gear, bearings, gear shaft, stepper motor

1. INTRODUCTION

Deployment of essential goods such as food packets, cloth bags,….etc are very important at the areas when there was digesters such as cyclone and earth quick…..etc Dropping items to those area is quick activity when it is made from helicopter. Dropping items at regular interval in the affect area is the main key issue. The manual drop will not insure to reach the exacted location in equal interval of time. In this regard we attempted an automatic mechanical system which enables to stop goods short while and then drop.

The paper is organized in following manner .Section 2 describes design details of mechanical system proposed. The analysis on worm gear drive is worked out in section3 section 4 give the sensitivity of design parameters of mechanical system. Finally the conclusions are drawn in section 5.

2. DESIGN DETILS OF MECHANICAL SYSTEM

The objective of the work is to design a mechanism to stop and deploy goods automatically without manual intervention. The varies elements of mechanical system are show in figure 2.1. The following components are identified for which detailed design is carried out.

- Gear
- Worm
- Bearing
- Gear shaft
- Stepper motor
- L-shaped follower

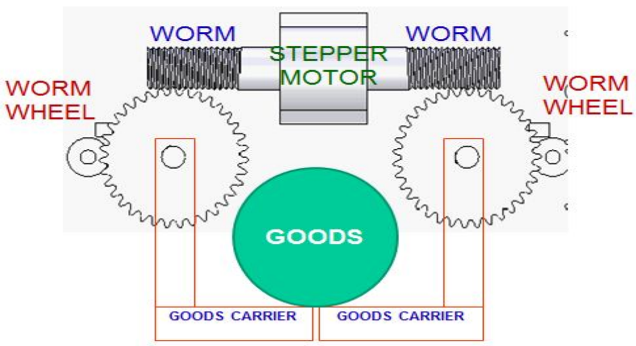

Fig.2.1 varies elements of mechanical

Preferred driving power source for actuating the mechanism is a stepper motor whose speed in general will be very high i.e. of the order of 3000 rpm. Speed of the follower i.e. goods carrier is worked out to be 30 rpm based on the time frame set (Chosen as 0.5 second) against the driver's speed of 3000 rpm. From this relation it is evident that the required speed reduction is very high i.e. 100:1. Additional constraint associated with this requirement is that once the goods carrier is deployed it should not get back to original position. Only possibility to achieve the above two requirements is incorporating worm and worm gear concept as they possess these characteristics. Hence it is planned to incorporate worm as driver and worm gear as follower.
However another requirement is that when one goods carrier rotates in anticlockwise direction (Viewed from top) another goods carrier has to rotate in clockwise direction. In order to ensure this with single power source, worm is extended on either side of motor.
Design calculation are made based up on the following requirement

- Gap between worm gear: 620mm
- Maximum load to support and drop is :25 kg
- Length of follower is:548mm
- Speed of motor: 3000 rpm
- Desired angular motion of worm gear : 90^0
- Time of deployment: 0.5 sec
- Torque requirement: 7 N-m
- To stop and drop 25kg load the required approximated torqe:7NM

The design details of varies are found using worm gear design approach and results are show in table

Sl. No.	Design Parameter	Value
Worm		
1.	Outside diameter	50 mm
2	Axial load on worm	1670N
	Lead angle	4degrs
3	Number of teeth	Single start screw
Gear		
	Diameter of gear	321.3mm
1.	Face width	25 mm
2.	Number of teeth	100
3.	Tangential force	1670 N
Shaft		
1.	Diameter gear shaft	45 mm
2.	Length	(100+100) mm
Bearing		
1.	Outer diameter	75 mm
2.	Width	10 mm
3.	Designation	16009
Motor		
1.	Power rating	2 KW
2.	Model No.	HPM5000B

3. STRUCTURAL ANALYSIS

Structural analysis of mechanized deployment system is carried out using Finite Element Method (FEM) in ANSYS software in order to assess the design adequacy against the functional load. Maximum Von Misses stress thus obtained is compared with allowable stress and obtained the available factor of safety.

Criteria

Static analysis

- Minimum available factor of safety should be more than the desired factor of safety (1.5).

Modal analysis

- First natural frequency should be above frequency associated with operating speed of gear i.e. 0.5 Hz (30rpm).

Load bearing members of the intended system alone are considered for analysis. Geometric model of the intended design built in 3D CAD software from its dimensions is converted into FE model by discretizing gear with shell

(SHELL63) elements, shaft with beam (BEAM4) elements and goods with mass (MASS21) elements. As all the subsystems are made of steel its material properties are considered for the analysis. Node corresponding to bearing support constrained for all DOF except rotation about bearing axis.

FE model with boundary conditions is shown in Fig. 3.1.

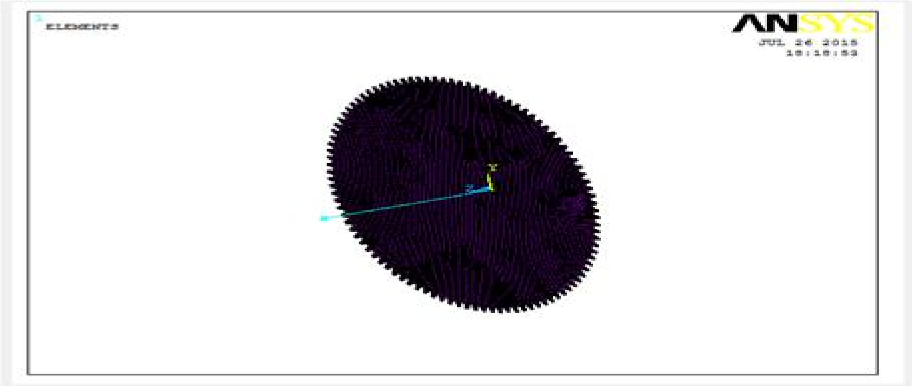

Fig. 3.1.FE model

The von misses stress are found from software is present in figure 3.2

Von misses stress = 9.4MPa

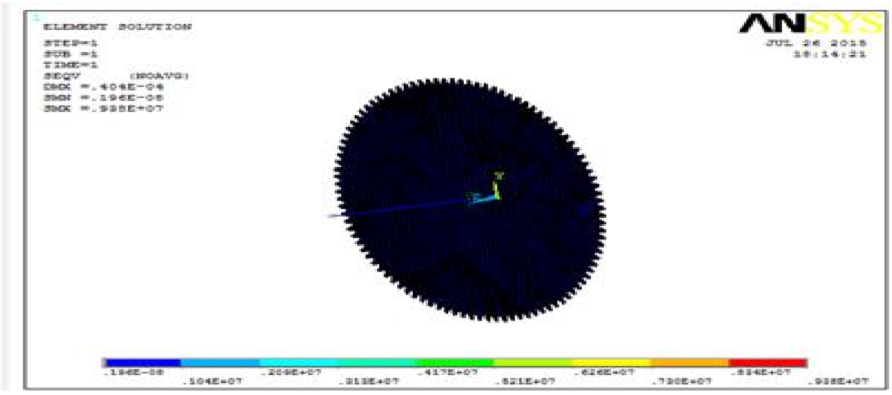

Fig.3.2 Stress plot

Then dynamic (Modal) analysis is also carried out. Modal analysis is the study of the dynamic properties of structures under vibration excitation. In structural engineering, modal analysis uses a structure's overall mass and stiffness to find the various periods that it will naturally resonate at. A modal analysis calculates the undamped natural modes of a system. Mode shape plot corresponding to first natural frequency is shown in Fig. 3.3

First Natural Frequency = 81 Hz

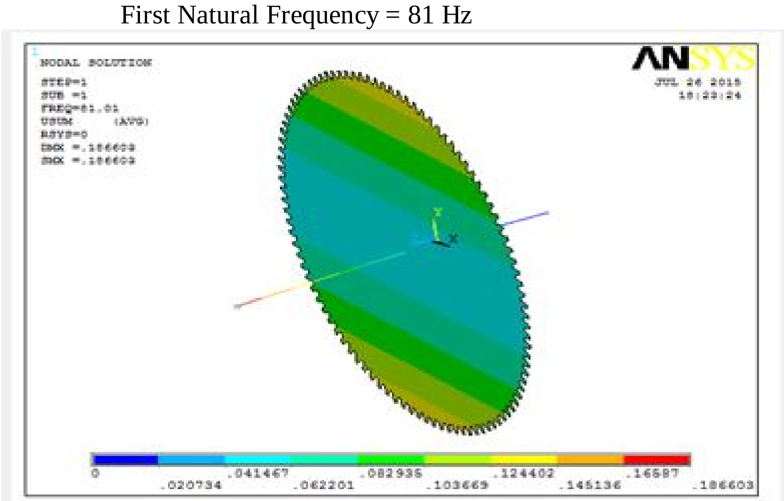

Fig3.3 Mode shape plot

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Table 2: Analyses results

Sl.No.	Result	Maximum Value	Allowable value	Factor of safety
	Static			
1	Von Misses stress	9.4MPa	330MPa	> 10
	Modal			
2	First natural frequency	81 Hz	> 0.5 Hz	----

- Available factor of safety is observed to be > 10 which is more than minimum desired factor of safety (1.5). Hence the design is safe.
- System doesn't experience resonance.

3. SENSITIVITY ANALYSIS

The objective of sensitivity analysis is to study the influence of variation in various critical parameters that govern the design on static stress and first natural frequency. Critical design parameters identified for this analyses is areas follows.

Table 2: Design parameters for sensitivity analysis

Sl.No.	Design parameter	Minimum value	Design value	Maximum value
1.	Gear thickness	15 mm	25 mm	35 mm
2.	Shaft diameter	35 mm	45 mm	55 mm

Influence of gear thickness on maximum Von Misses stress is represented in graphical form in Fig. 7.

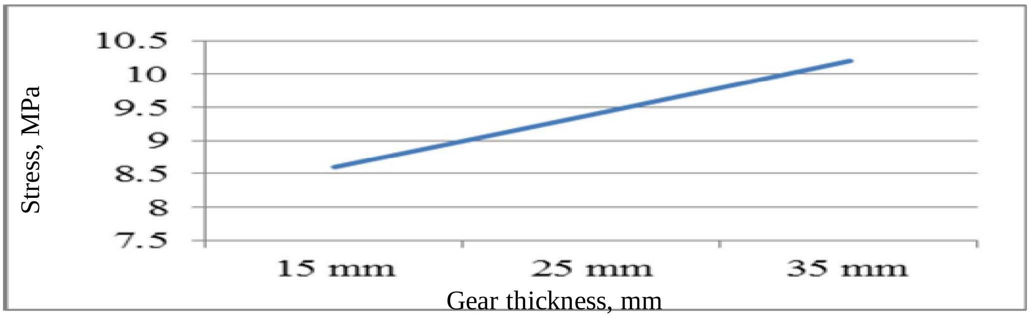

Fig. 4.1. Variation of stress with gear thickness

Influence of gear thickness on first natural frequency is represented in graphical form in Fig. 4.2

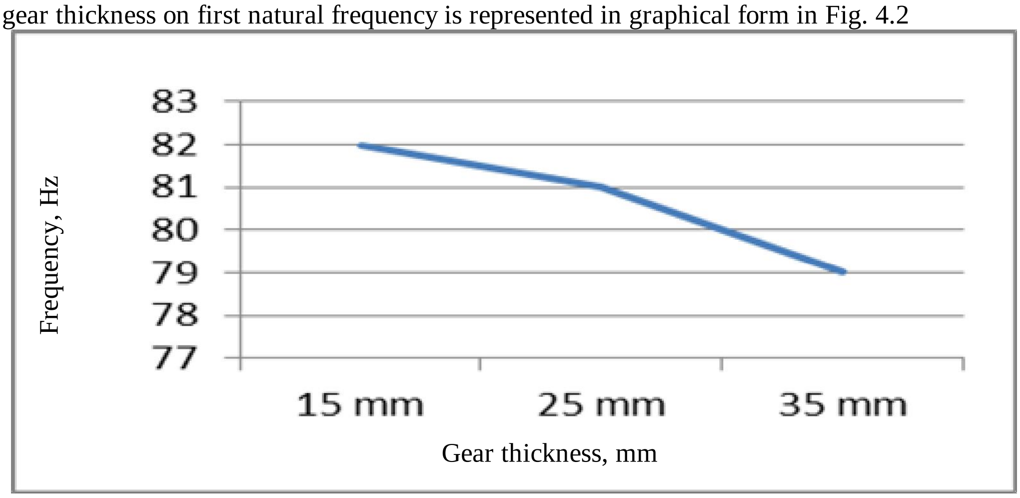

Fig. 4.2: Variation of frequency with gear thickness

Influence of shaft diameter on maximum Von Misses stress is represented in graphical form in Fig. 4.3

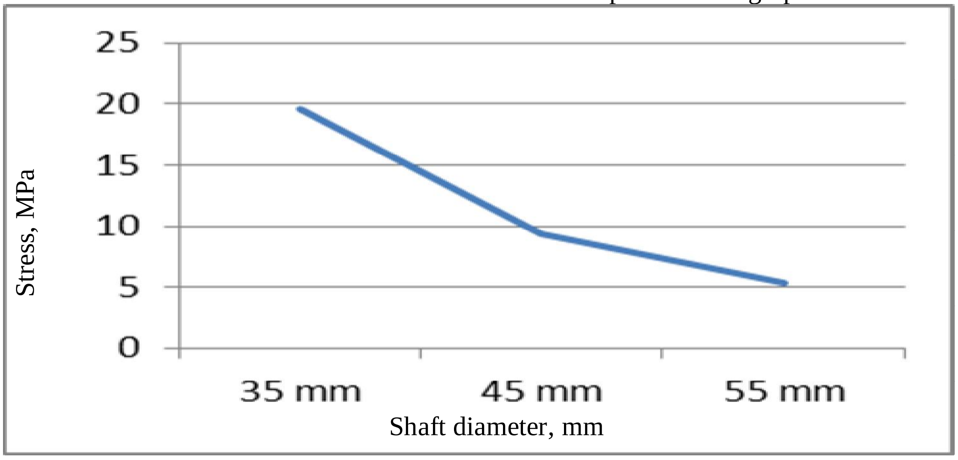

Fig. 4.3 Variation of stress with shaft diameter

Influence of shaft diameter on first natural frequency is represented in graphical form in Fig. 4.4

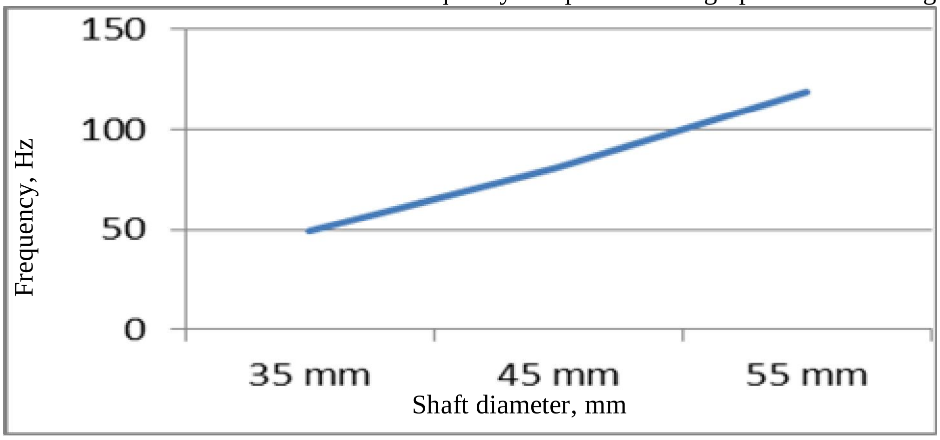

Fig. 4.4 Variation of frequency with shaft diameter

- Gear thickness varies in direct proportion to that of maximum bending stress and varies in inverse proportion to that of first natural frequency.
- Whereas shaft diameter varies in inverse proportion to that of maximum bending stress and varies in direct proportion to that of first natural frequency

5. CONCLUSION

Design of automated goods delivery system for cyclone scenario is taken up in this paper. A simple mechanical system to perform above task is design Structural analysis conveyed a message that the design is safe against functional loads. Sensitivity analysis is also carried out and brought out the influence of various design parameters.

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REFERENCES

[1] K Hughes, R Vignjevic and J Campbell, "Experimental observations of an 8 m/s drop test of a metallic helicopter underfloor structure onto a hard surface", Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, Volume 221, Number 5 (January 2007), pp. 661-678.

[2] A. D. Jolly, L. Chardot, J. Neuberg, N. Fournier, B. J. Scott and S. Sherburn, "High impact mass drops from helicopter: A new active seismic source method applied in an active volcanic setting", Geophysical research letters, Vol. 39, L12306, doi:10.1029/2012GL051880, 2012.
[3] Noah Kuntz and Paul OH, "Autonomous Cargo Transport System for an Unmanned Aerial Vehicle, using Visual Servoing", ISSN: 1690-4524 Systemics, Cybernetics And Informatics Volume 7 - Number 6, 2009.
[4] Christopher James Adams, "Modeling and control of Helicopters carrying suspended loads", MS thesis, Georgia Institute of Technology, 2012.

AUTHOR

D.SURESH received the B.TECH degree in MECHNICAL Engineering from BRILLINAT INSTUTIONS ENGINEERIN AND TECHNOLOGY in 2013.Now I am pursing m-tech in SREE NIDHI INSTRUCTIONS OF ENGINEERING AND TECHNOLOGY IN CAD/CAM. And have done B.TECH project in CITD (CENTRAL INSTATED FOR TOOL DESING).