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DESIGN ANALYSIS OF MESHING OF TWO WORM GEARS

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ABSTRACT

This research paper presents the analysis of meshing of two worm gears mainly used for gear reduction and self-locking purpose such as material handling equipment conveyors etc. For such types of applications when driving torque is suddenly decreased due to the sudden power off or failure of any mechanical part then the gear will be rotating either in the same direction driven by the system or in the opposite direction due to the gravity. For this self-locking property of worm gear is the most suitable solution to avoid back driving.If worm gear drives are used for lifting applications with self-locking and our primary objective for safety considerations the drives are extremely inefficient that is why there is a need of special purpose drive that will provide better transmission efficiency in self-locking condition so as to reduce power consumption by the device and lowering the running cost of device. Worm gears also have proper operating behaviour under the different load conditions.

KEYWORDS: *Self-locking, Stain gauge, Worm gear.*

I. INTRODUCTION

The "self-locking" represents the drive that gives the input gear easy to rotate the output gear in both direction. But the output gear locks with the input when an outside torque attempts to rotate the output in either direction and avoid back driving. These advantages are often useful to the many designers who want to be sure that loads on the output side of the system don't affect the position of the gears. Worm gears are one of the gear systems which having self-locking, but at the expense of efficiency. It seldom exceeds40% when the gears are self-locking.

1.1 Types of worm gears:

a) In Non-throated worm gears, both the worm and the driven gear are not throated.

b) In Single throated worm gears, one element generally the driven gear is throated. Tooth contact takes place in a single moving point on a worm drive

c) In Double throated worm gears, the driven gear as well as the worm is throated. Higher loads are permissible without undergoing excessive wear.

Worm gear reducers are composed of the terms "gearbox" and "speed reducer" that are used interchangeably of power transmission and motion control. Gearboxes are used for speed reduction and torque multiplication. The term speed reducer became important when gearboxes were first implemented in industry. Speed reduction was an important function for the gearbox to replace more bulky belts and pulleys technology. Demand for worm gear speed reducers is increasing as more mechanical applications in lot of industries require speed reduction, ranging from rock crushers and robots.

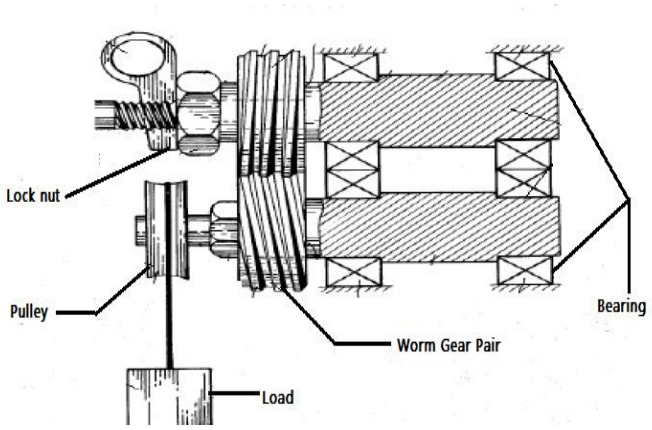

Fig.1. Lifting Mechanism of Worm Gear [9]

Many engineers invented a simple dual-worm gear system that not only provided with over 90%efficiency but also exhibits self-locking property. Two threaded rods, or "worm" screws, are meshed together. Each worm is wound in a different direction and has a different pitch angle. For proper mesh, the worm axes are not parallel, but little bit skewed. But by selecting proper and different pitch angles, the drive will exhibit either self-locking or a combination of self-locking as required. When the input gear decelerates the entire transmission immediately locks up and comes to a sudden stop, moderated only by any elastic stretch in the system. Hence, the worms can be manufactured on standard machine-shop equipment.

II. FEA RESULTS AND DISCUSSION

The finite element method (FEM), sometimes referred to as finite element analysis (FEA), is a computational technique used to obtain approximate solutions of boundary value problems in engineering. Due to the complexity of the structures are usually calculated by numerical methods such as the finite element method. The finite element analysis (FEA) is a numerical technique for finding approximate solutions of partial differential equations (PDE) as well as of integral equations. The solution approach is based either on eliminating the differential equation completely, or rendering the PDE into an approximating system of ordinary differential equations, which are then numerically integrated.

A finite element analysis is able to determine stress and strain distributions throughout a bolted joint structure resulting from an applied force or displacement. It is possible to calculate the stiffness of the joint and to locate regions of stress and strain concentration where failure is expected to initiate. Using a suitably fine mesh the influence of geometrical features, such as the size and shape of fillets at the ends of the adhesive layer, on stress and strain distributions can be evaluated. The relevance of finite element methods to the design of bolted joints is therefore apparent. The accuracy of design calculations is however dependent upon the validity of the materials models used in the analysis to describe the deformation behaviour of the fasteners and the availability of suitable materials property data for these models.

FEA solution of engineering problems, such as finding deflections and stresses in a structure, requires three steps:

2.1 Pre-process or modelling the structure
2.2 Analysis
2.3 Post processing

2.1. Pre-processing:

In this stage the material properties and geometric model is developed. The model is then discretized or meshed using proper type of element. The boundary conditions are applied like constrains, loadings etc.

2.1.1 CAD model

CAD model is imported in the ANSYS workbench

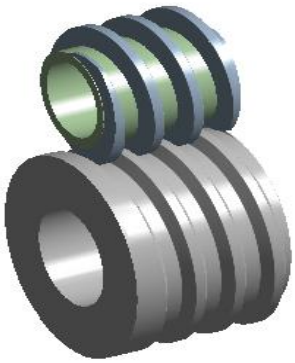

Fig.2.CAD model of Worm Gear

2.1.2 FE model and Meshing

The Finite Element Method only makes calculations at a limited (Finite) number of points and then interpolates the results for the entire domain (surface or volume) by using shape function. Any continuous object has infinite degrees of freedom and it is not possible to solve the problem in this format. The Finite Element Method reduces the degrees of freedom from infinite to finite with the help of discretization or meshing (nodes and elements).

The model was meshed with element solid 185. SOLID185 is used for the three-dimensional modelling of solid structures. The element is defined by eight nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions.

The element has plasticity, stress stiffening, large deflection, and large strain capabilities. See Section 14.185 of the ANSYS Theory Reference for more details about this element. The FE model of knife edge valve with number of nodes and elements is shown in figure 3.

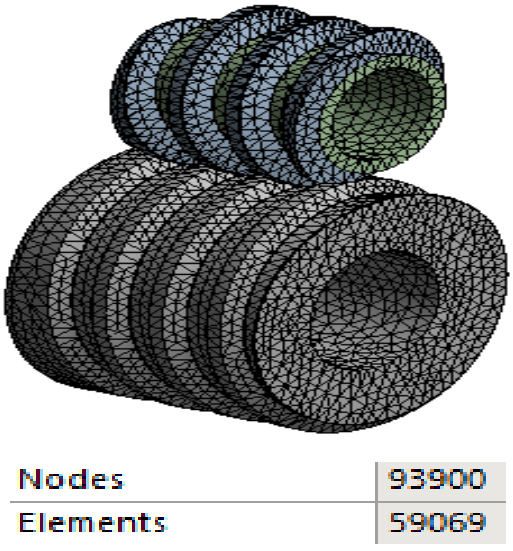

Fig.3. Meshed model of Worm Gear

2.1.3 Boundary conditions

To do analysis, it necessary to give the boundary conditions. The displacement constraint of bolt hole, on both the flanges is fixed in all direction which is shown in the figure 11. The pressure constraint applied on the knife is shown in figure 4.

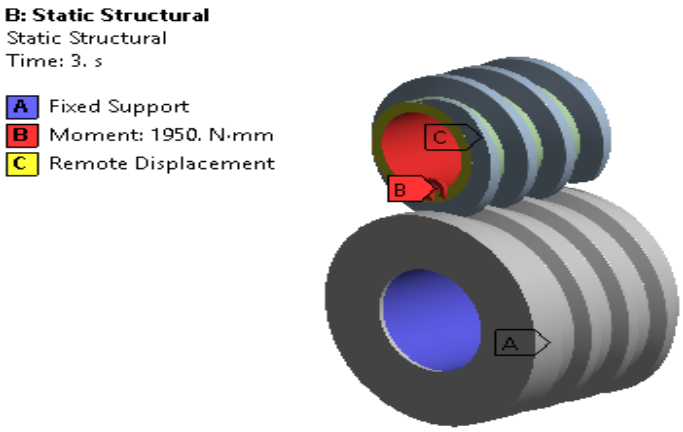

Fig.4. Boundary conditions for meshed model

2.2 Solution

In this stage the matrices are generated and solved for the unknown variables. This part is fully automatic. The FE solver can be logically divided into three main parts; the pre-solver, the mathematical engine and the post-solver. The pre-solver reads the model created by the pre-processor and formulates the mathematical representation of the problem. All parameters defined in the pre-processing stage are used to do this so if something is left out the pre solver will complain and cancel the call to the mathematical engine if the model is correct the solver proceeds to form the element stiffness matrix for the problem and calls the mathematical engine which calculates the result (displacement, temp and pressures etc.). The result are returned to the solver and the post solver is used to calculate strain, stresses, heat fluxes, velocity etc) for each node within the component or continuum. All these result are sent to a file which may be read by the post processor.

2.3 Post processing

Post-processing is the most important step in analysis. You may be required to make design decision based on the result. Post processor is used to review the result carefully and check the validity of the solution.

2.3.1 Total Deformation

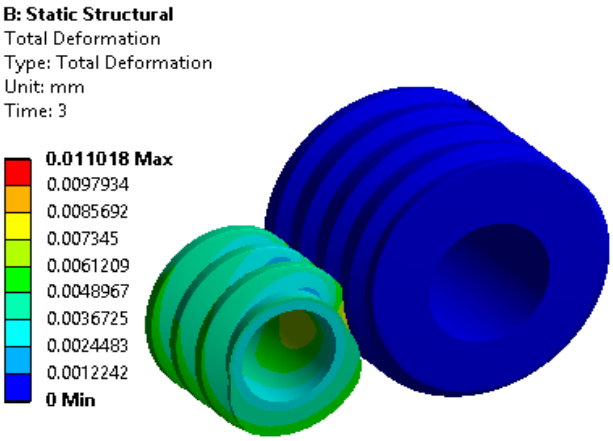

Fig.5. Total Deformation

2.3.2 Equivalent stress plot

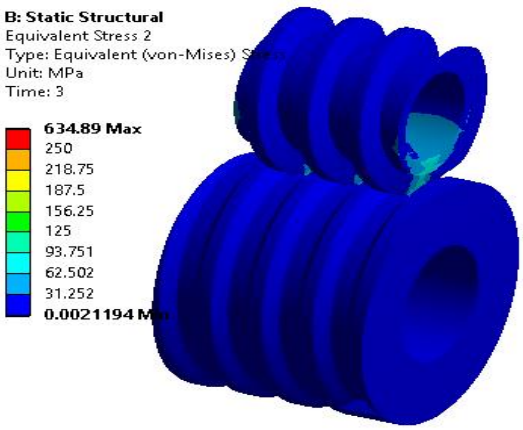

Fig.6. Equivalent stress plot

2.3.3 Equivalent strain point

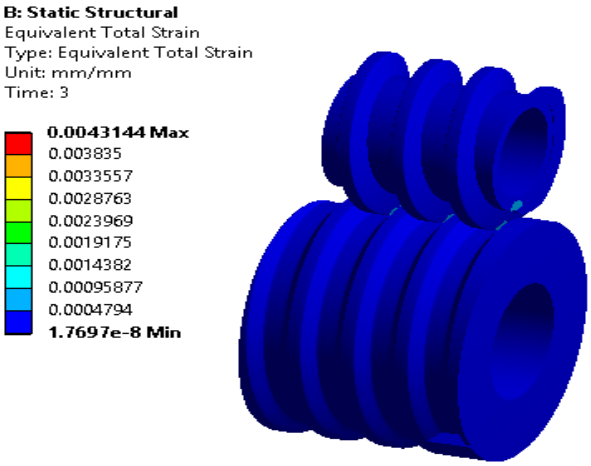

Fig.7. Equivalent stain plot

2.3.4Frictional or contact stress.

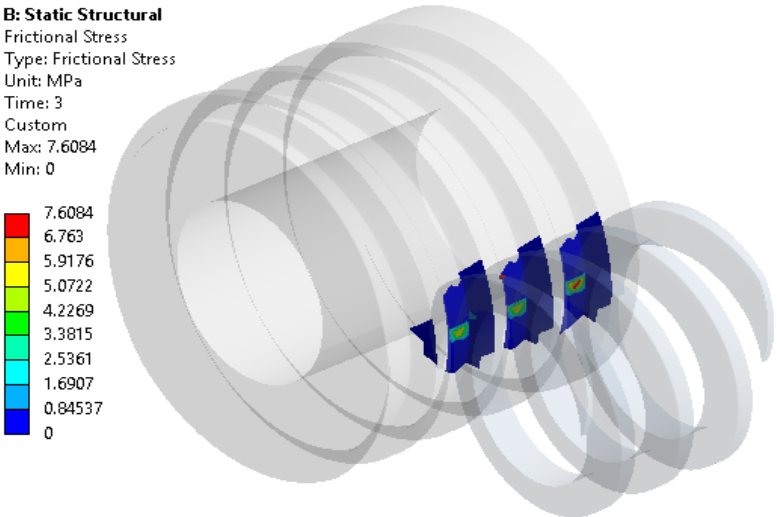

Fig.8. Contact stress of worm gear

III. CONCLUSIONS

A Design of critical components on safety condition by using analytical shows that the proposed system parts are safe because the value for the stress is 250Mpa and the maximum stress is 650Mpa so the factor of safety is well above 2.5. Hence from this motivation now it is decided to carry out the Experimental validation of FEA result. In order to carry out experimentation, the strain gauge method of Experimental stress analysis will be used.

IV. FUTURE WORK

In this paper we have done the stress and strain analysis of worm gear pair and for the same one can do the fatigue analysis of worm for finding the life of gear.

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BIOGRAPHY

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