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Multi-Angular Gearless Drive

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Abstract— The modern gear drives has been widely applied due to excellent accuracy and reliability. However, the major downside of even the most efficient gear drive is the low efficiency due to errors like backlash and considerable vibrations. These vibrations engender noisy operation and cause more wear and tear resulting in low life span. The development of a more efficient multi-angular gearless drive has been explored relatively unsuccessfully and negligently regardless of its advantages over both gear drives and simple gearless drives. Recent advances in technologies, material, analytical modeling and simulation capabilities has opened the possibility of major advances towards the design and development of a reliable, cost effective and ultra-efficient multi-angular gearless drive.

Keywords— Angular, Transmission, Gearless, Bevel

1. Introduction

The motion transmission is relaying the same type of motion from one part of an object to another (rotational to rotational, translational to translational).Multi-Angular Gearless Drive is a motion transmitting device used for transmitting motion at multiple angles between the driving and the driven shaft. The scrutiny of this mechanism would reveal that it comprises of pins ranging from 3 to 8 pins per assembly and with increase in the number of pins operation becomes smoother. These pins slide inside symmetrically spaced holes machined on solid cylindrical disc. Thus, the sliding pairs help the shaft to revolve at various angles.

2. Objective

The main objective of the project is to analyze, validate and obtain the most optimal design for the Multi-Angular Gearless drive. The second most important objective is to discover its scope and applications.

3. Design

The scrutiny of the Multi-Angular Gearless Drive mechanism would reveal that it comprises of a number of pins ranging from 3 to 8, our project has three such pins, more the pins smoother the operation. Every pin is capable of turning at varied angles by virtue of universal joints. The design has two discs with three equal holes symmetrically machined each to the driving and driven shaft. Various pins slide as well as rotate along the symmetrical holes drilled in discs also called as 'Sliding Pairs', because motion captured by naked eyes is sliding one.

4. Mechanism

Motion is transmitted from driving to the driven shaft through the sliding pairs which remain either straight or bent using universal joints, as per requirement between the shafts. These sliding pairs are placed in equally spaced holes around a solid cylindrical disc, which allow it to move freely. Thus, when the torque is applied at the input shaft, a uniform torque is generated at the output.

Depending on the precision with which the gearless drive has been designed and the limitation of the universal joint, the angular range within which the Multi-Angular Gearless drive would operate smoothly is decided. This type of drive is especially suitable where quite operation at high speed and at various angles is required. Also, this type of gearless drive has low vibrations as compare to other motion transmission systems like simple universal joint which makes it preferable.

5. Applications:

1- Wind powered gearless power generation.
2- Angular machining i.e. shape cutting.
3- Movement of periscope in submarines.

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6. Analysis

6.1 Motor Selection

The model development was to be undertaken on a specific motor selected to meet all the desired torque requirements as per our design. Selection of motor configuration is based on moment of inertia of input shaft i.e 0.63 (based on modelling in Solidworks).

Motor Power, P = 2πNT/60

Where, N = Revolution per Minute

T = Torque transmitted by motor to input shaft (T=Iα)

Net Power Transmitted = Input Power – Frictional Losses in Joints and Sliding Pairs

6.2 Mechanism Analysis

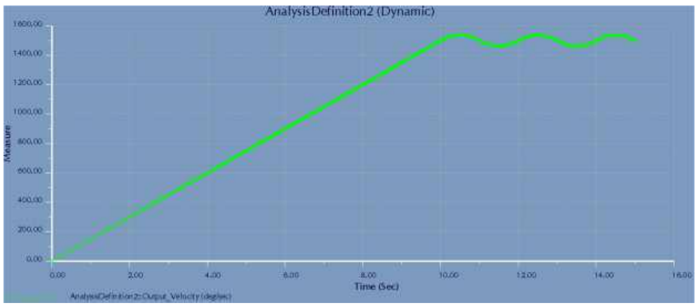

Figure 5 – Output Shaft Velocity vs. Time

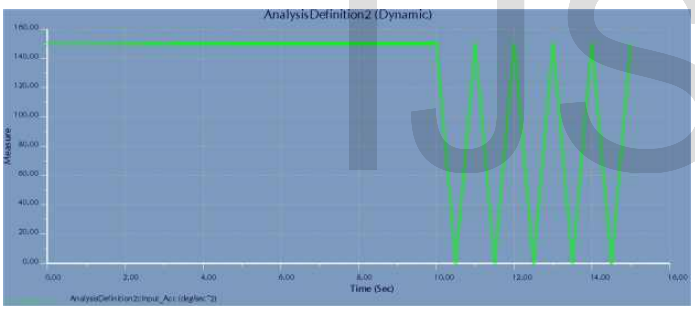

Figure 6 – Output Shaft Acceleration vs. Time

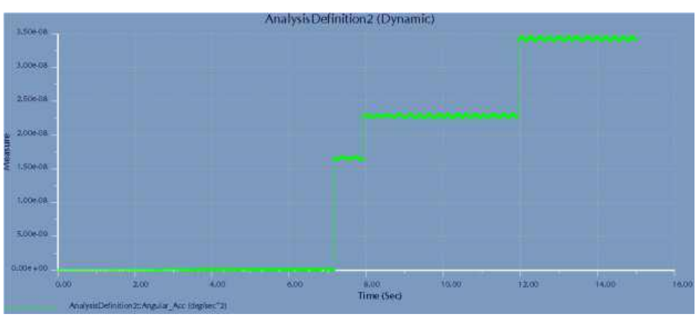

Figure 7 – Sliding Pair Angular Acceleration vs. Time

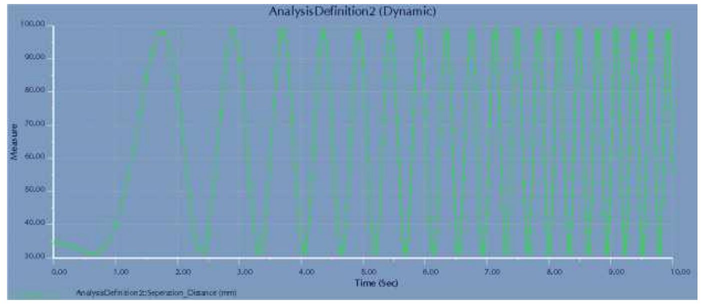

Figure 8 – Seperation Distance (b/w Rod and Disc) vs. Time

By conducting mechanism analysis, we obtained cogent information about various parameters and their relations such as position, velocity, acceleration, etc. from kinematic analysis. While from dynamic analysis, we found out all the forces and moments acting on the various components of the system.

6.3 Static and Modal Analysis

Various results which we obtained from above analysis were utilised for defining constraints and forces applied at various positions. Thus, obtaining stress, strain, displacement, and factor of safety plots for the designed model to standarize the dimensions.

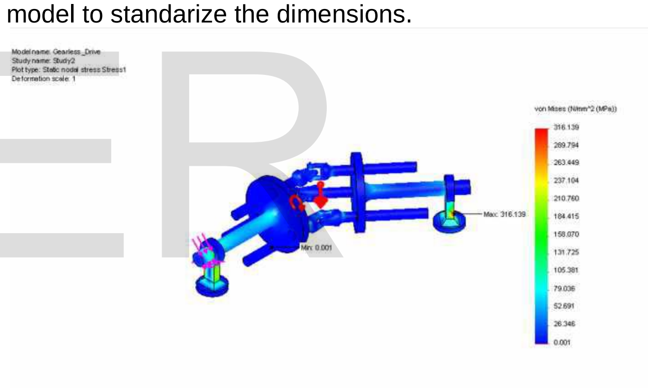

Figure 9 – Von Mises Stress Plot

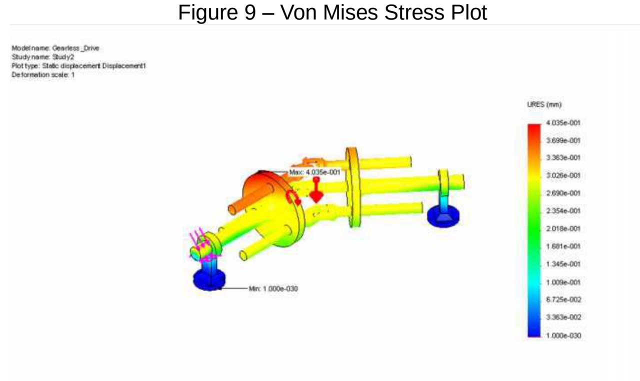

Figure 10 – Displacement Plot

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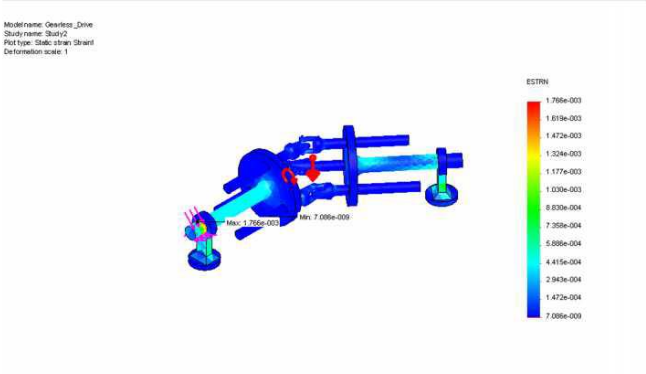

Figure 11 – Strain Plot

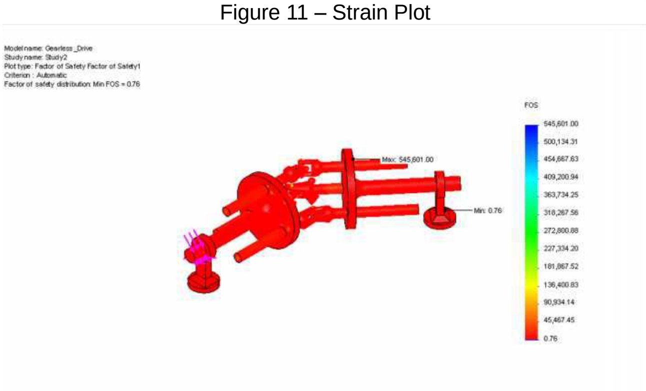

Figure 13 – Factor Of Safety Plot

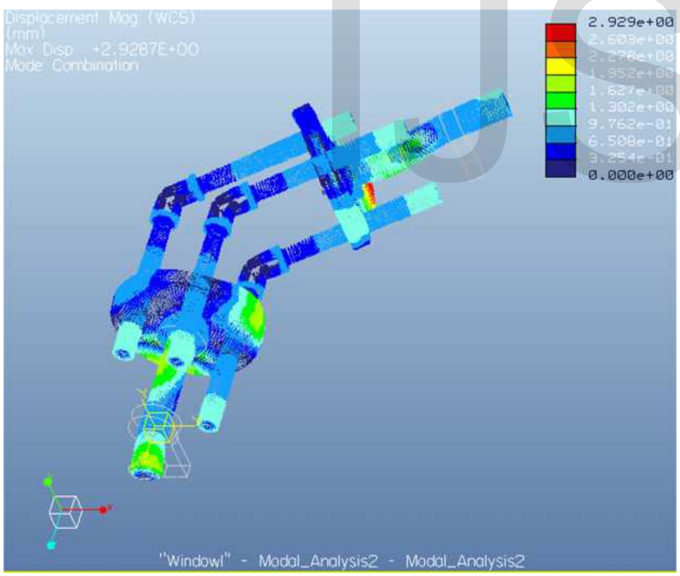

Figure 14 – Modal Analysis Result

7. Conclusion

Designing of Multi-angular gearless drive instigated with assumptions and random dimensions because no significant development has been done before in this unchartered territory. With software support and assiduous endeavour the final optimal design has been obtained. The final design thus obtained is capable of transmitting torque and power at varied angles depending on the angular limitation of the hooks joint. With further research and advanced analysis in the design wide-ranging applications of the drive can be discovered.

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