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Static And Dynamic Analysis Of Bevel Gear Set

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Abstract: *This paper presents a static and dynamic simulation and analysis of the bevel gear set using Solidworks software, stress, strain, deformation, reactions and torque are calculated. Dimensions and materials of the bevel gears are important factors in determining the values of stress, strain, and displacement. The change in angular velocity and torque applied also change the values of stress, strain, and displacement of the bevel gear.*

Keywords: *Bevel gears, static, dynamic, stress, strain, deformation, solidworks.*

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I. Introduction

Gears have many types, forms, and designs, spiral bevel gear is considered as the most important industrial and mechanical part. The main function of gears is to translate motion and power. Its main feature is that the axis of drive gear and that of driven gear would intersect vertically here. Due to the influence of overlapping of gear end-face, more than two pairs of gears mesh at the same time. Thus it could bear much loading. Moreover, its teeth do not mesh on the full length. Instead of that, one end of the teeth would steer towards the other end steadily, so the gear boasts the advantages of smooth works, little noise and vibration facilitating the fact that the gear could be used in cars, tractors, machine tools and other dynamic and motion-transmission devices. Its mechanical behavior and working performance play an important role in the whole machine.

II. Literature Review

JIHUI L. et al. 2013, discussed the mechanical properties of spiral bevel gear which have significant influence on the whole mechanical structure and play an important role in the system optimization, strength check, fault diagnosis and fault prediction, and gear tooth meshing-dynamic load is an important issue in the gear research field. Three-dimensional models of spiral bevel gears are created by SOLIDWORKS and then converted to ADAMS by means of data exchange interface between SOLIDWORKS and ADAMS. By the contact algorithm theory of multi-body dynamics and ADAMS, the dynamic simulation of the spiral bevel gears mesh is specified. The curves of angular speed, torque and meshing force on the spiral bevel gears are obtained by simulation calculation, which provide references to research on dynamic characteristics of gear driving device.

Xiang T. et al. 2015, tried to obtain the spiral bevel gear wheel natural frequencies and mode shapes in the unconstrained state for the purpose of dynamic characteristics study, the spiral bevel gear wheel three-dimensional solid model of a mini-bus main reducer. The finite element model of spiral bevel gear wheel which consists of 32351 nodes, 18436 solid187 tetrahedrons finite element method elements is established by using free grid meshing method in this paper.

III. Model And Analysis

This gear set is designed using Solidworks software. Fig. 1shows this gear set.

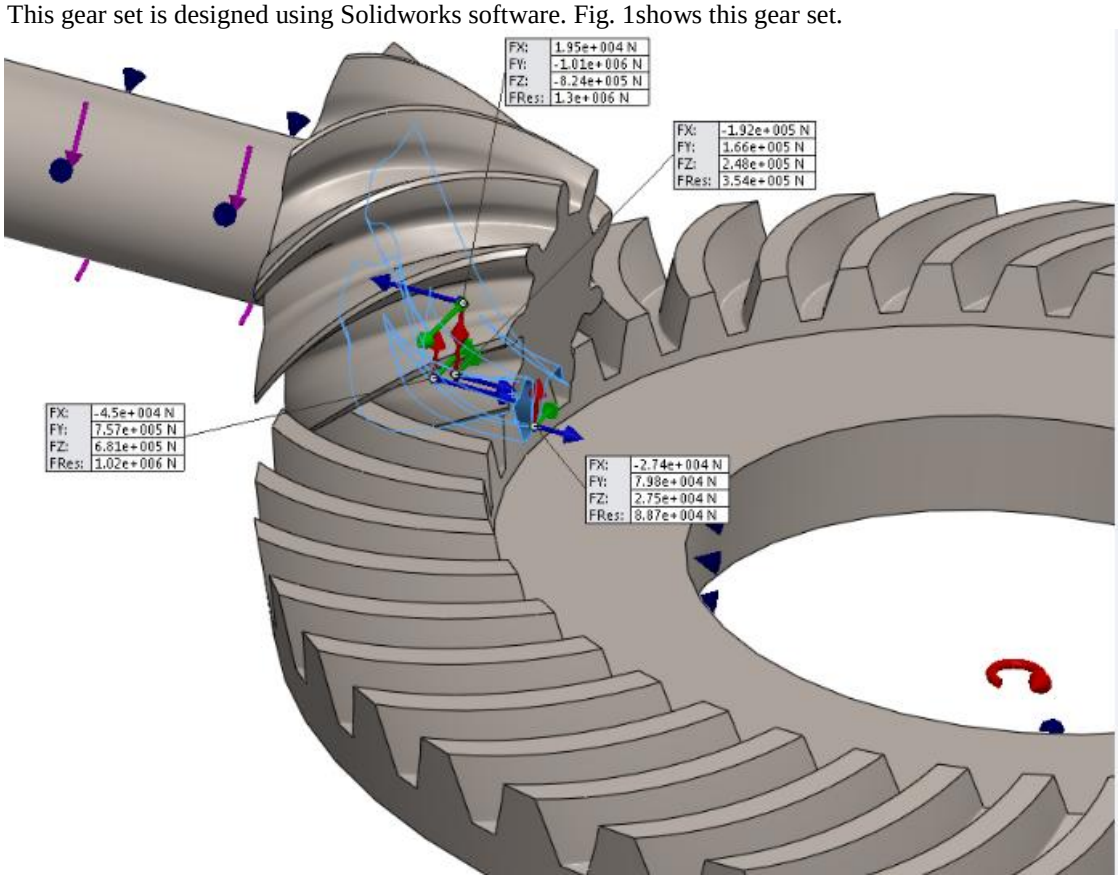

Fig.1 Bevel gear set

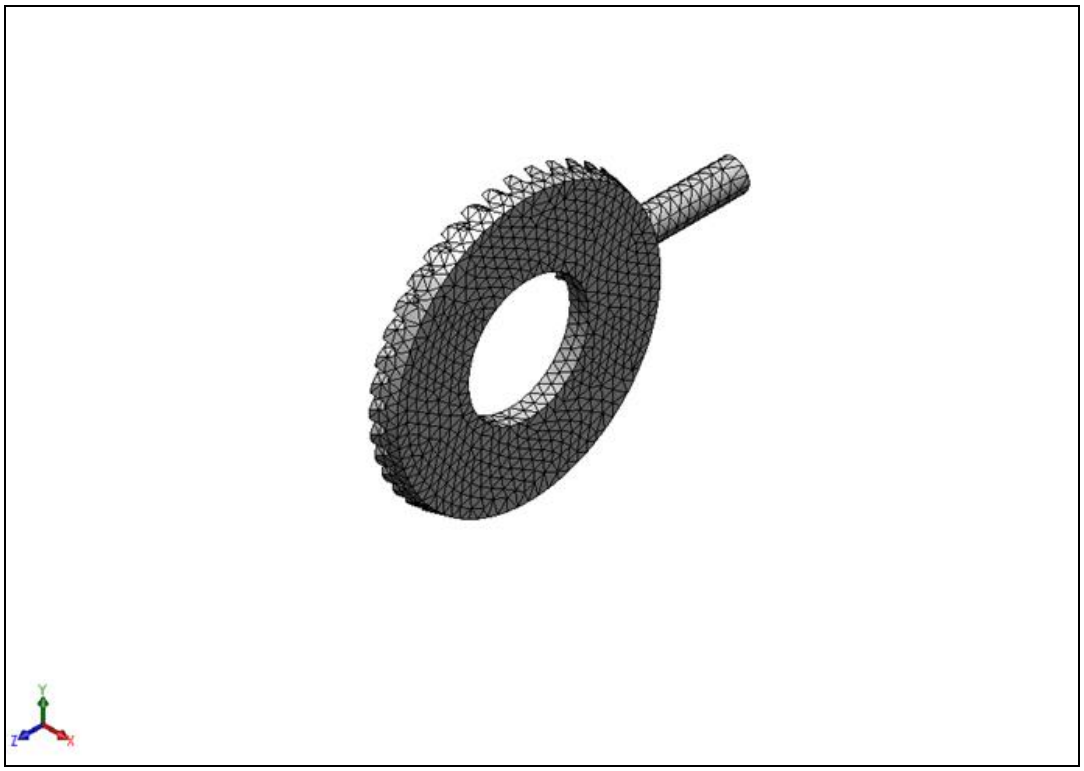

Fig.2 bevel gear set meshing

IV. Results and Discussion

-Static analysis

Fig.3 shows the Von-Mises stress distribution on the bevel gear combination the maximum and minimum values are shown.

Name	Type	Min	Max
Stress1	VON: von Mises Stress	26379.1 N/m^2 Node: 12660	3.03215e+010 N/m^2 Node: 15931

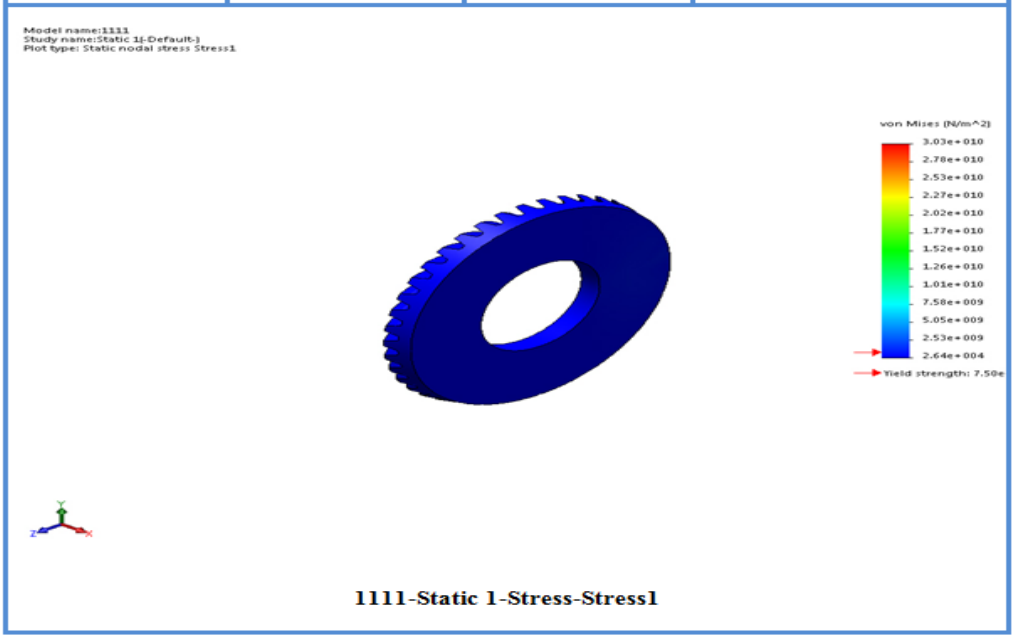

Fig.3 Von-Mises stress distribution of the bevel gear

Fig. 4 shows the displacement of the bevel gear the minimum value is 0.159271 mm and the maximum is 62.7209 mm.

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.159271 mm Node: 1649	62.7209 mm Node: 926

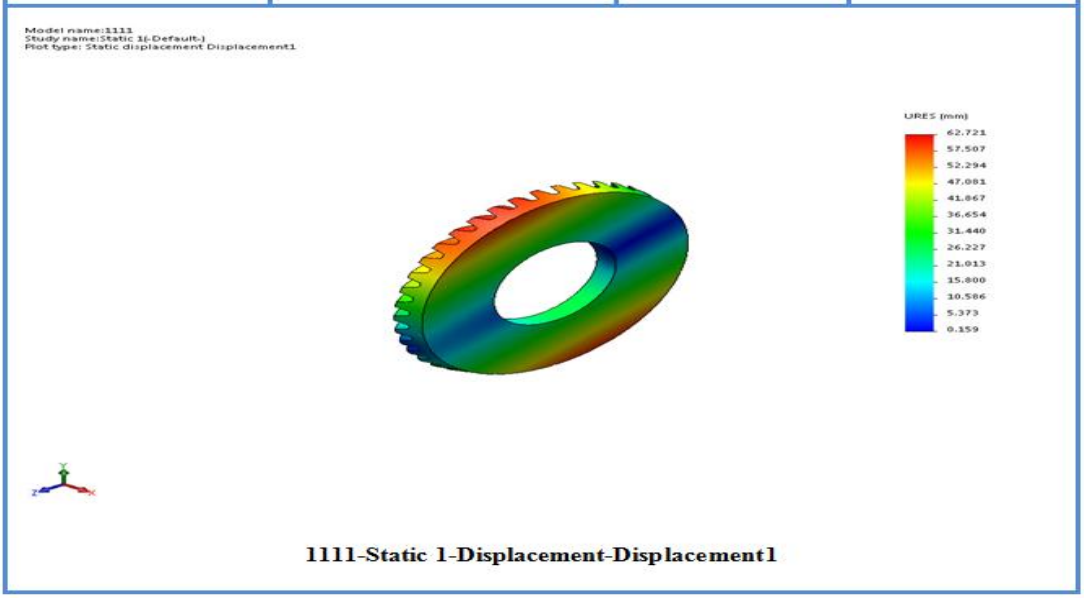

Fig.4 Displacement of bevel gear

Fig.5 shows the strain of the bevel gear, the maximum value is 0.07733. while the minimum is about $2x10^{-7}$.

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	2.1078e-007 Element: 2543	0.0773348 Element: 9607

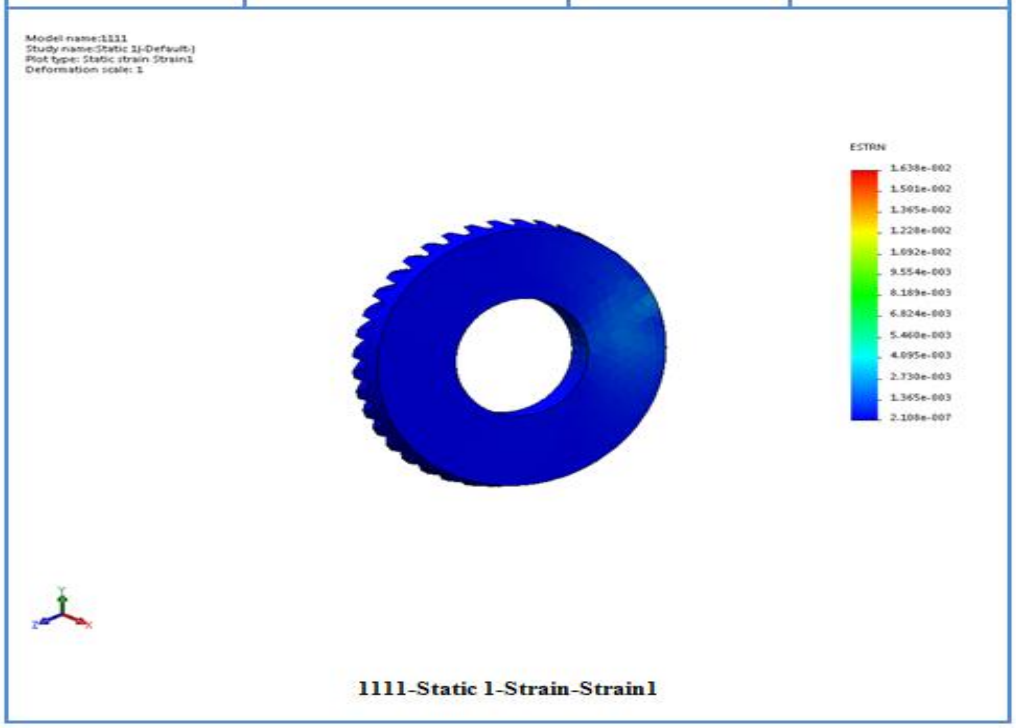

Fig.5 strain of bevel gear

Fig.6 shows more detail for stress distribution of the bevel gears combination.

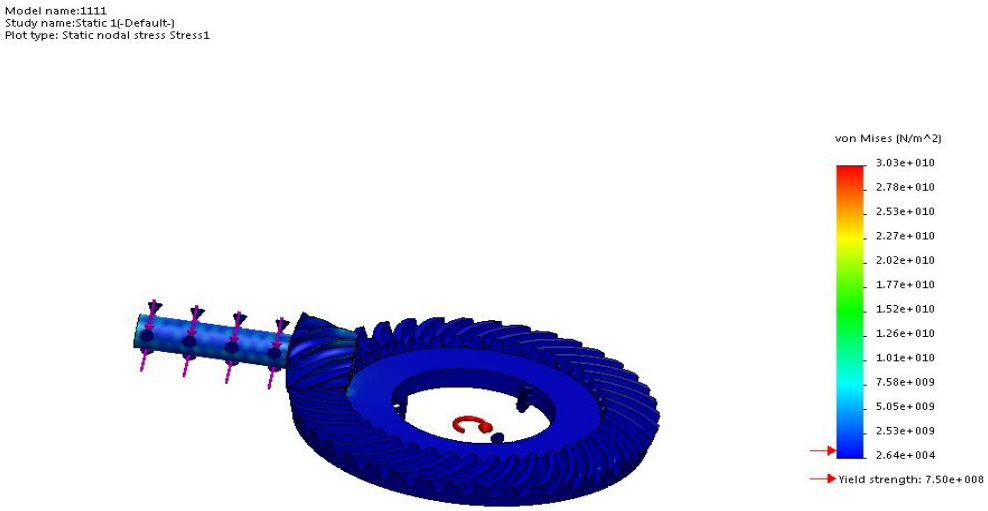

Fig.6 Stress distribution of the bevel gears combination

Fig.7 and fig.8 show the displacement and strain values occurred in bevel gears during mesh.

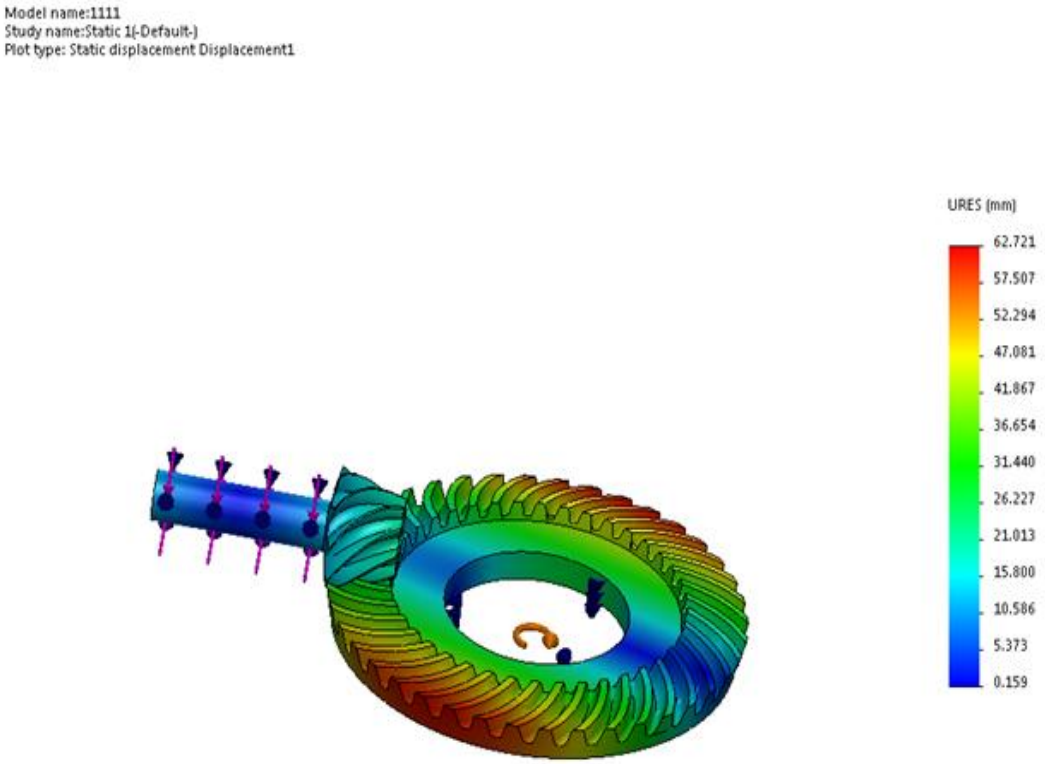

Fig.7 Displacement values of bevel gears during mesh

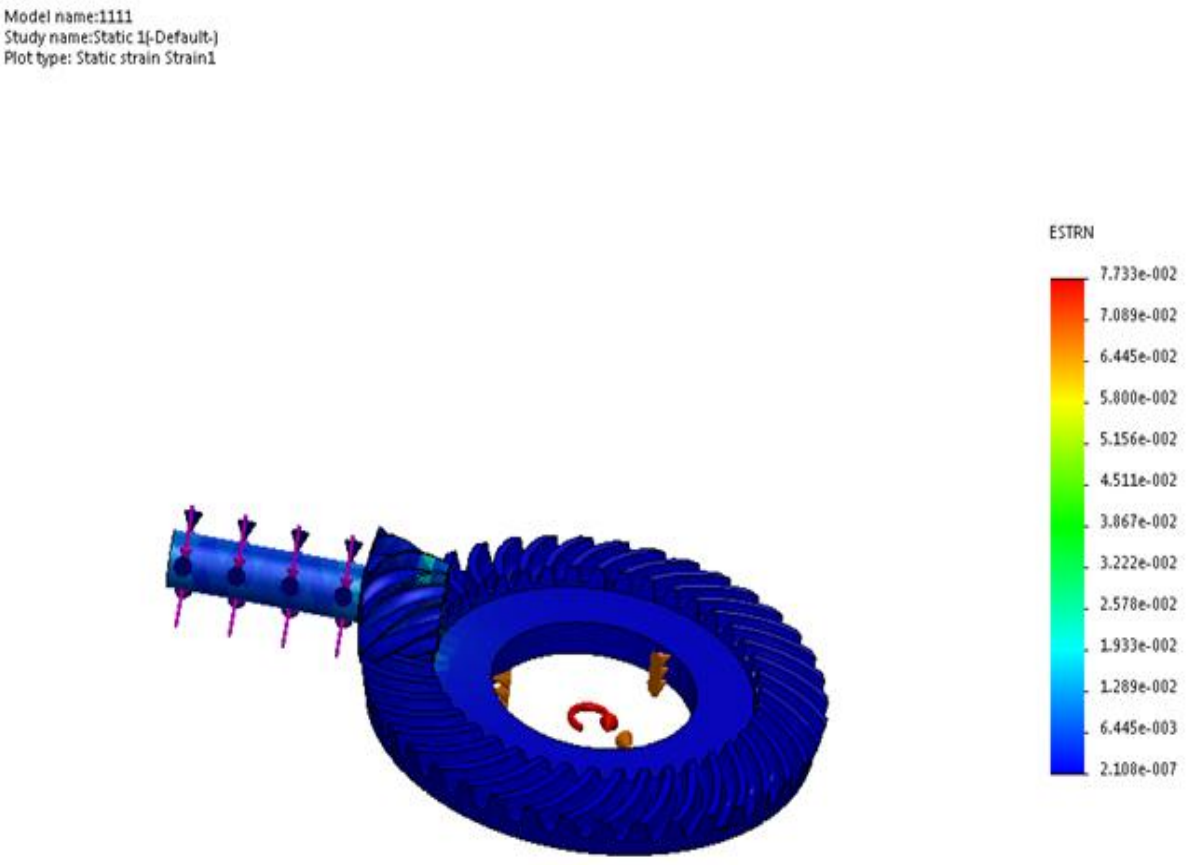

Fig.8 Bevel gears strain values during mesh.

-dynamic analysis of the bevel gear system

Fig. 10 shows the change of angular velocity of bevel gear with time.

Fig.9 shows the values of factor of safety on different areas of the bevel gear system.

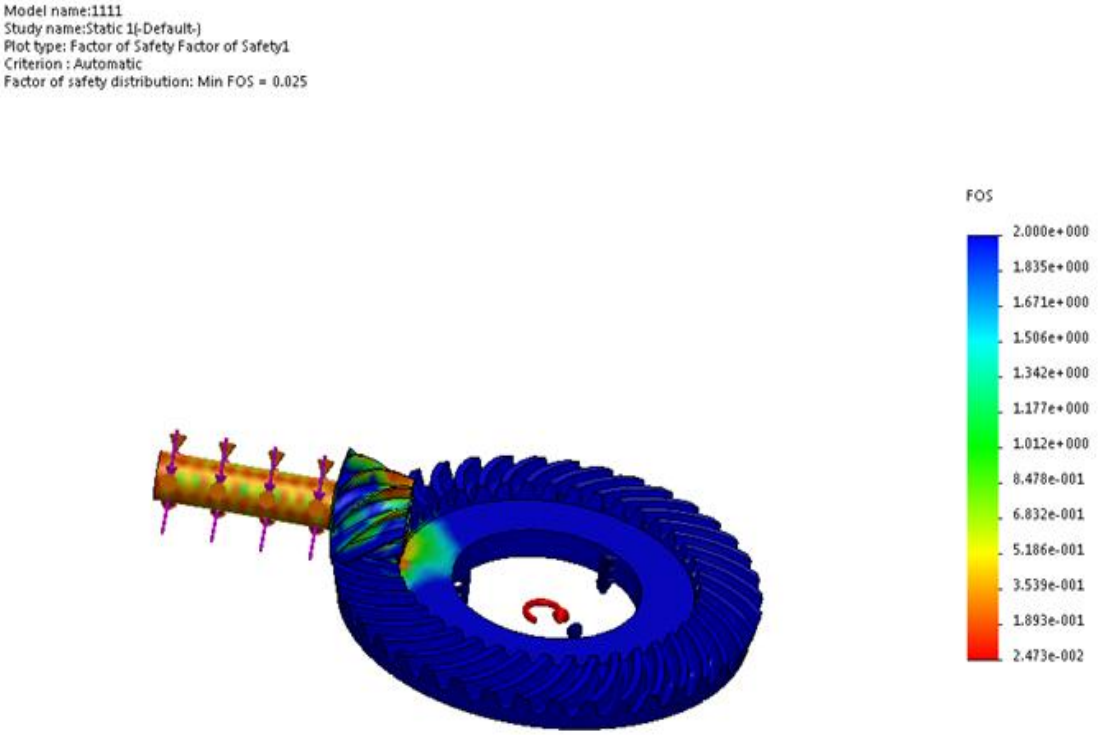

Fig.9 Factor of safety of the bevel gear system

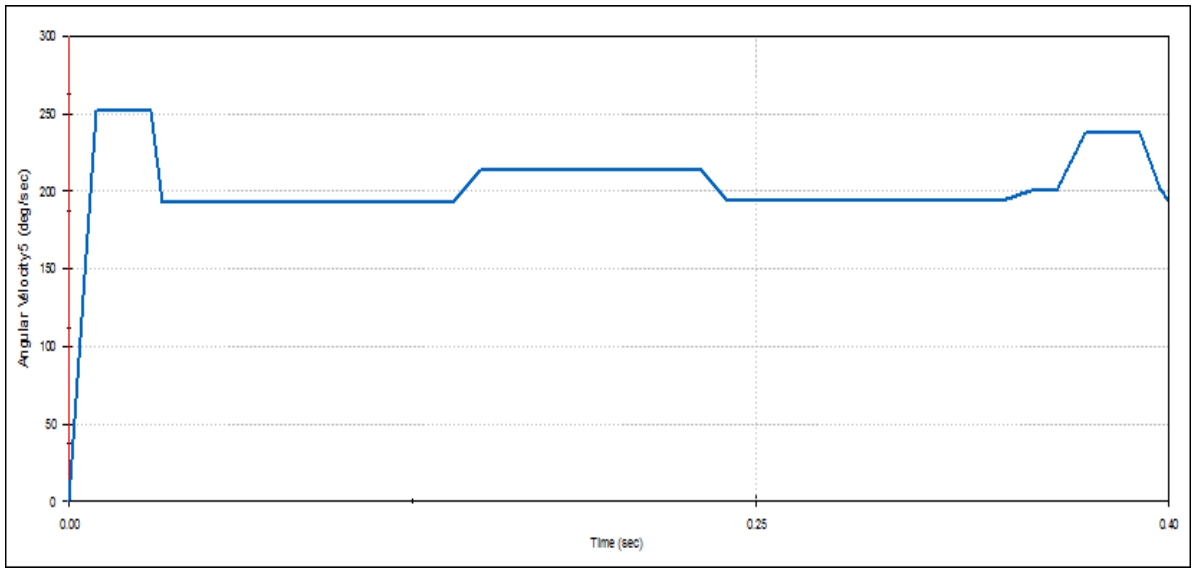

Fig. 10 Angular velocity change with time for bevel gear system.

Fig. 11 shows the motor torque change with time, it has a steady state value about $1.57x10^7$ N.mm.

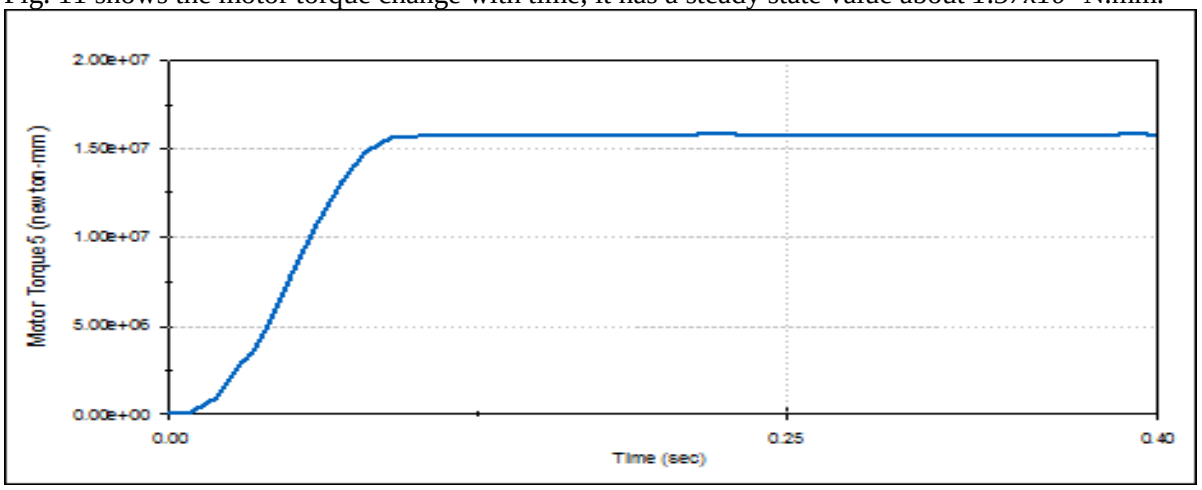

Fig.11 motor torque change with time.'

V. Conclusion

This paper presented two types of analysis of the bevel gear system: static and dynamic analysis, in static analysis stress, strain, and displacement values are calculated during meshing of the bevel gear and pinion, also the dynamic analysis shows the variation of angular velocity with time during mesh. The motor torque (required to operate the system) changes with time is calculated also. The values of such quantities strictly depend on dimensions and materials of the bevel gear. The change in angular velocity and torque applied also change the values of stress, strain, and displacement of the bevel gear.

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