IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

STATIC STRUCTURAL AND MODAL ANALYSIS OF MECHANICAL COMPONENT USING FEA APPROACH

[1]Vivek Rameshrao Yawale, [2]Namrata Nivrutti Naik,

[1]BTech Student at VIIT,
[1]Department of Mechanical Engineering,
[1]Vishwakarma Institute Of information Technology, Pune, India

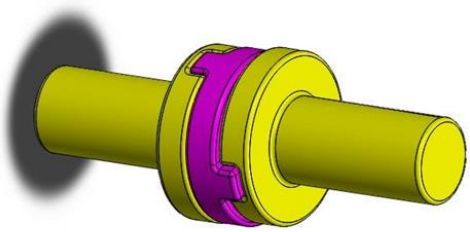
Abstract: Structural analysis software solutions that enable engineers of all levels and backgrounds to solve complex structural engineering problems faster and more efficiently. This is one of the important tools you need in order to determine if a component is safe or not. The purpose of modal analysis is Define the natural frequencies and mode shapes of the system. To check the connections between components if there are rigid modes in the system. This study compares the performance of tetrahedral elements and hexahedral elements in various structural problems. The problems selected demonstrate different types of behaviour namely: bending, shear, torsional and axial deformations and frequencies. It was observed that in Oldham coupling the tetrahedral element is convenient and in spur gear analysis the results obtained with tetrahedral elements and hexahedral elements were equivalent in terms of accuracy. The comparison is done for static structural and modal analysis for tetrahedral and hexahedral element analysis.

Index Terms **- FEM, Oldham coupling, stress analysis, deformation, Spur gear, Modal analysis, frequency.**

Finite **E**lement **A**nalysis:

FEA is referred as the Finite Element Method, or FEM. It is a simulation of a physical phenomenon using a numerical mathematic technique. This method is the core of mechanical engineering, as well as variety of other disciplines. It also is one of the key principles used in development of simulation software. FEM is use by the engineer to reduce the number of physical prototypes & run virtual experiment to optimize their designs. Complex mathematics is required in order to understand the physical phenomena that occur all around us. These include things like fluid dynamics, wave propagation, and thermal analysis. In complex situations where multiple highly variable equations are needed, Finite Element Analysis is the leading mathematical technique.

- **O**LDHAM **C**OUPLING



I. INTRODUCTION

The main function of coupling is transmitting torque from one shaft to the other shaft. These is classified in two groups 1) Rigid coupling 2) Flexible coupling. When the load transfer takes place at very low speed then the rigid connection is used. When torque is transfers between the two axes, while allowing some misalignment between two axes then the flexible coupling is used. Couplings are often the cheapest part of a system, but they protect the most expensive and most valuable components when they are designed to break before the harmful forces pass through the system.

II. WORKING PRINCIPLE OF OLDHAM COUPLING

Oldham coupling is consist three disc, one is coupled with the input shaft, second is coupled with output shaft & third disc is the centre disc joined each disc. The tongue and a slot has one side is perpendicular to other side of tongue and slot. This coupling is specially used to reduce the coupling backlash in mechanism. The centre disc is slides on the surface of other disc for every rotation with the help of tongue and slot of discs, during the torque and power transmission through one drive to other, the sliding motion also include small amount of angular and axial motion.

III. Methodology

- **M**aterial: Structural steel is one of the other widely used materials. It is mainly used as a reinforcement material to counter concrete's low tensile strength and ductility. Ductility is an important property of structural steel because it provides a warning signal before actual failure, thus making the failure less catastrophic. It allows for the redistribution of stresses in continuous members and at points of high local stresses, such as at holes or other discontinuities. Although structural steel is always used below its yield point (in the elastic region), Structural steel is 100% recyclable and one of the most reused materials in the world.

Properties	**Value**	**Units**
Density	7850	Kg/m^3
Young Modulus	2,07E+11	Pa
Poisson's Ratio	0.3	
Shear Modulus	7.9615E+10	Pa
Bulk Modulus	1.725E+11	Pa
Tensile yield strength	2.5E+08	Pa
Tensile ultimate strength	2.5E+08	Pa
Limit rupture in traction	4.6E+08	Pa

- **C**ATIA **M**odeling: Solid modelling is done in CATIA. It has different features which are 3D parametric and works with 2D tools also includes design to manufacturing process. It also generates auxiliary, orthographic sections, isometric or detailed 2D drawing views. The modelling of spur gear is done using CATIA V5

- **Ansys Analysis:** Ansys provides different types of analysis methods. Structural analysis software from ansys provides linear static analysis which gives stresses or deformations and modal analysis software studies the vibration characteristics, dynamic effects and complex behaviour of component.

Here the static structural analysis of Oldham coupling by applying a Tetrahedral and Hexahedral mesh and for this we have followed these steps:

1) Applying the mesh.

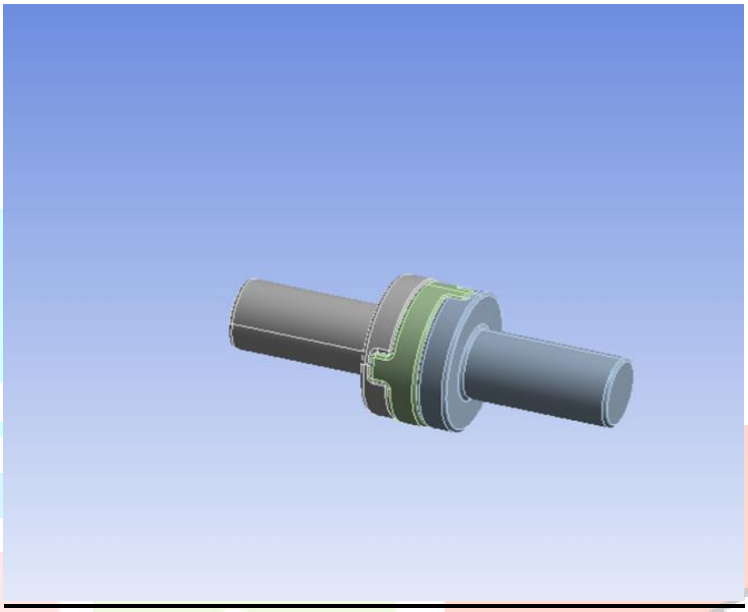
2) Giving Boundary Conditions such as Force, Fixed support.

3) Addition of required results and then we have calculated the Total deformation, Stress for different mesh similarly, we have done for Modal analysis of Spur Gear and calculated the frequencies for each mesh.

- **D**imensions :
  1) Shaft diameter = 50 mm
  2) Shaft length = 60 mm
  3) Flange diameter = 100 mm
  4) Flange thickness = 10 mm
  5) Centre part
     Diameter = 100
     Extended part = 5 mm

IV. RESULT AND DISCUSSION

A. Geometry Of Oldham Coupling :



B. Tetrahedral meshing :

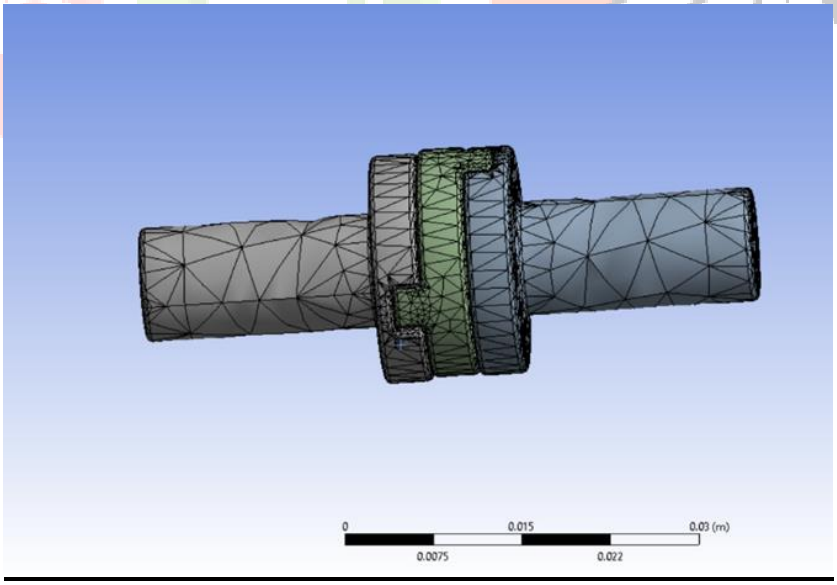


Fig 1. Meshing with Relevance size

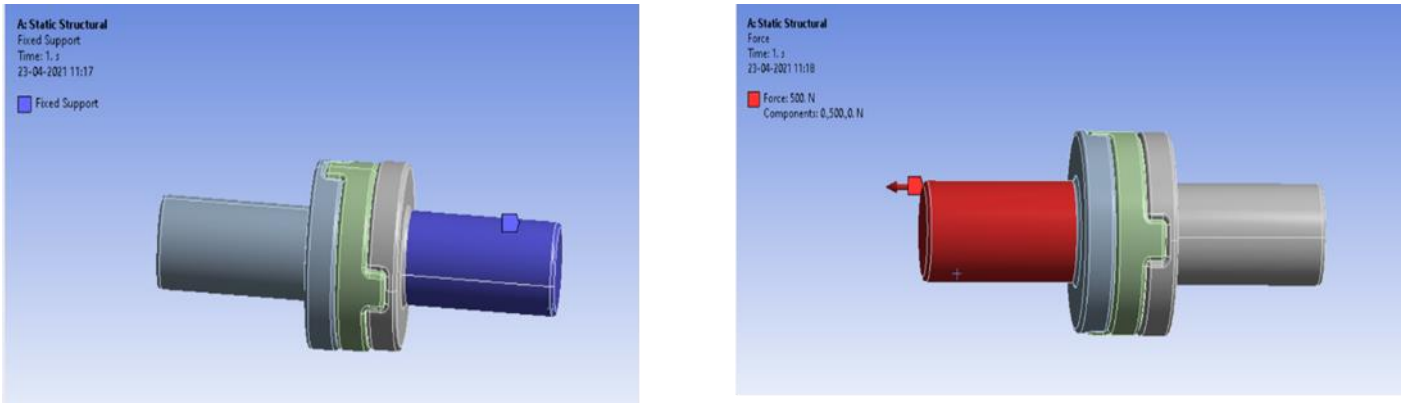


Fig 2. Boundary Conditions

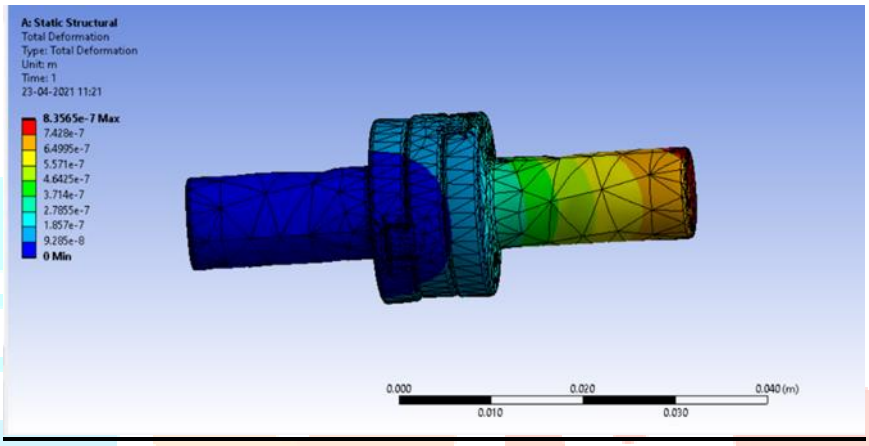


Fig 3. Total Deformation

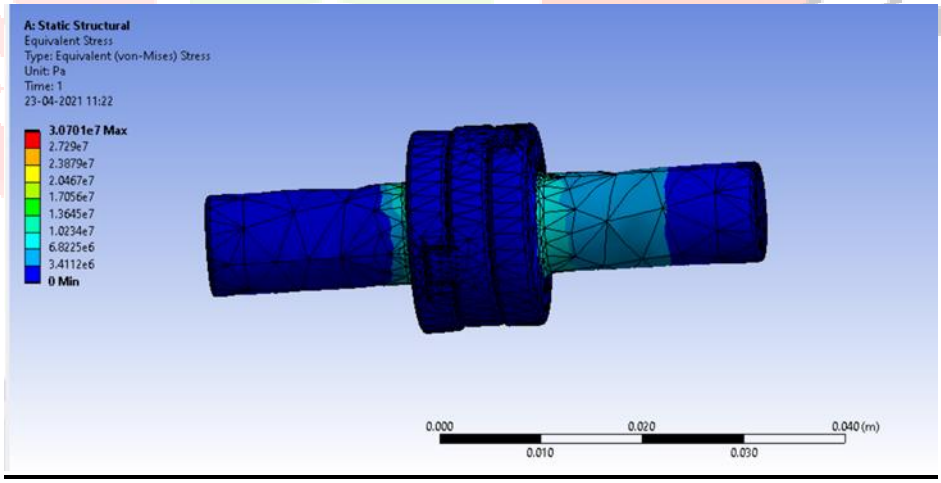


Fig 4. Maximum Stress

C. Hexahedral Meshing :

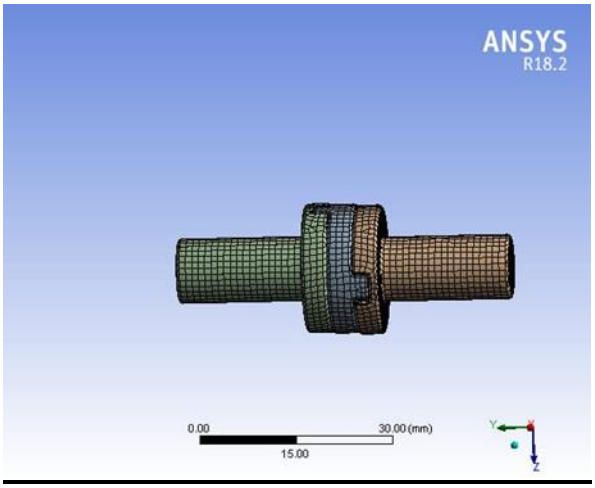


Fig 1. Meshing with Relevance size

Fig 2. Boundary Condition

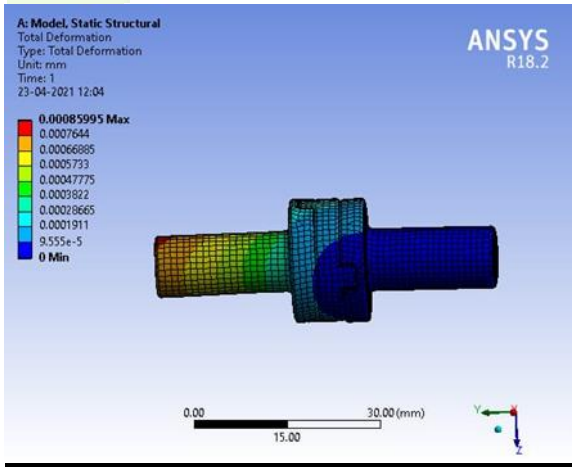


Fig 3. Total Deformation

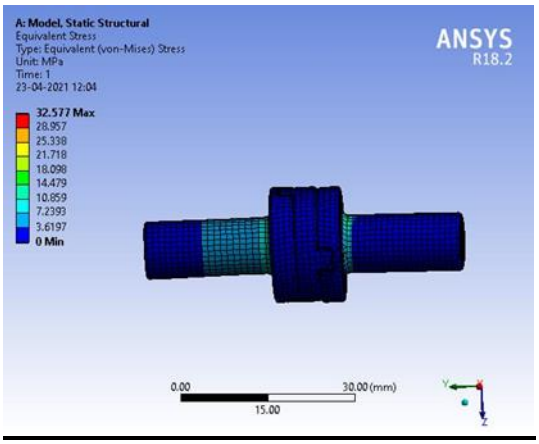
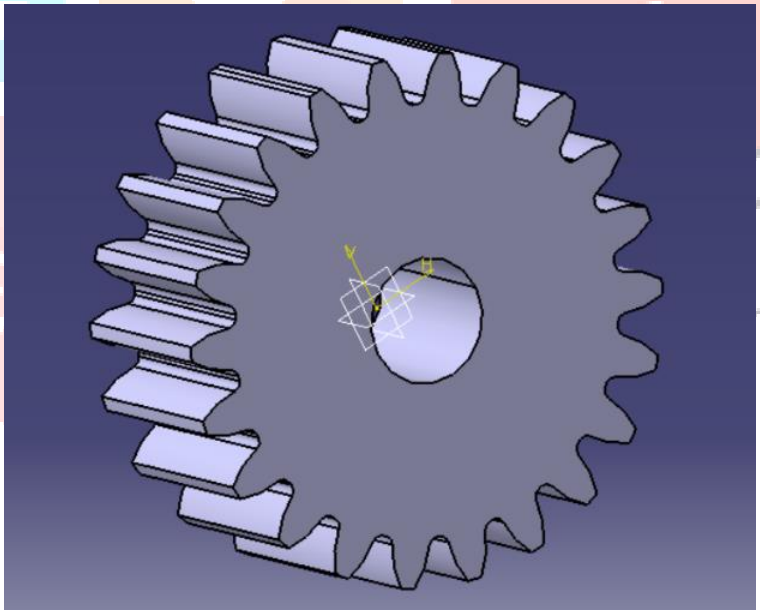


Fig 4. Maximum Stress

- **C**omparison Of **R**esult
  a. The total maximum deformation by using tetrahedral meshing is 8.3565e7 m & the maximum stress is 3.0701e7 N/m^2.
  b. By using Hexahedral Meshing the total maximum deformation is 8.5995e4 m & the maximum stress is 32.577 N/m^2.

- **SPUR GEAR**



I. INTRODUCTION

Spur gears are most common and simple. They are mounted on parallel shafts and have straight teeth. These gears are together used for large gear reduction.

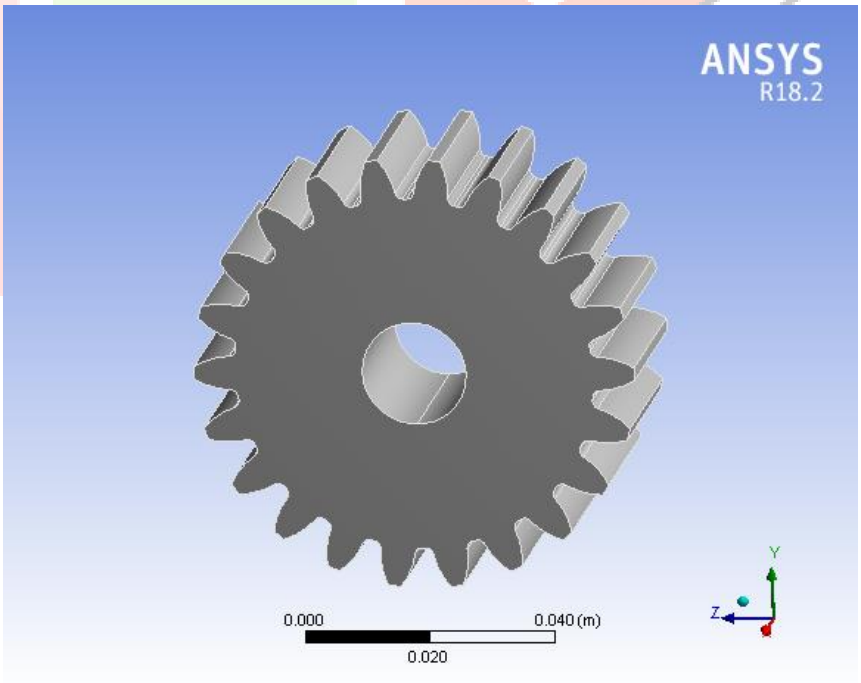
It provides constant and positive speed drive. Materials which are used to make spur gears are steel, nylon, aluminium, bronze, cast iron Bakelite and nowadays plastic also. This material can decide the amount of vibration takes place in gear. These all depend on natural frequencies and it is studied by ansys. Applications of spur gears are metal cutting machines, gear motors and gear pumps, power plants, marine engines, washing machines, rolling mills, steel mills and automobile gear boxes etc. It has good characteristics of its strength to density and hardness to density also.

II. MODELING OF THE SPUR GEAR

Description	Symbol	Values
Number of teeth	N	22
Pressure Angle (degree)	α	20
Module	m	3
Pitch circle diameter (mm)	D	66
Face width (mm)	W	28
Input Speed(rpm)	Ni	140

III. RESULT AND DISCUSSION

A. Geometry Of Spur Gear :



B. Tetrahedral meshing :

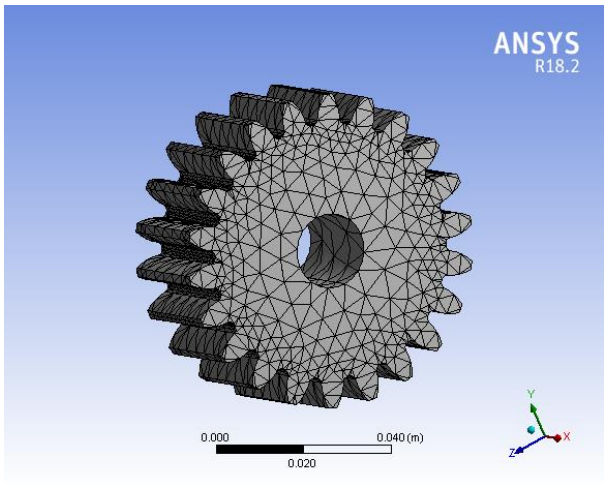


Fig 1. Meshing with Relevance size

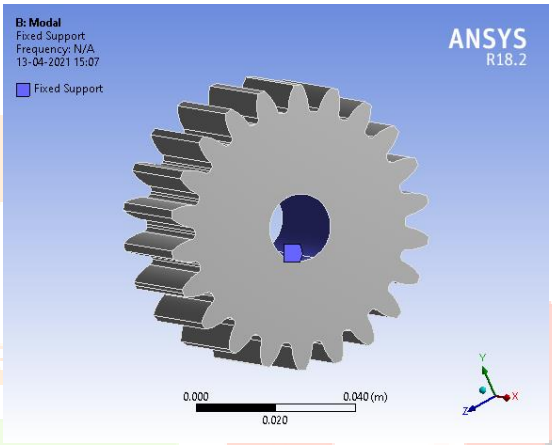


Fig 2. Boundary Conditions

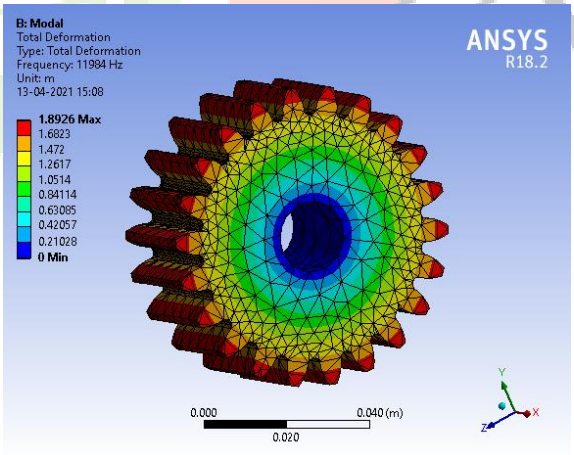


Fig 3. Total Deformation

C. Hexahedral Meshing :

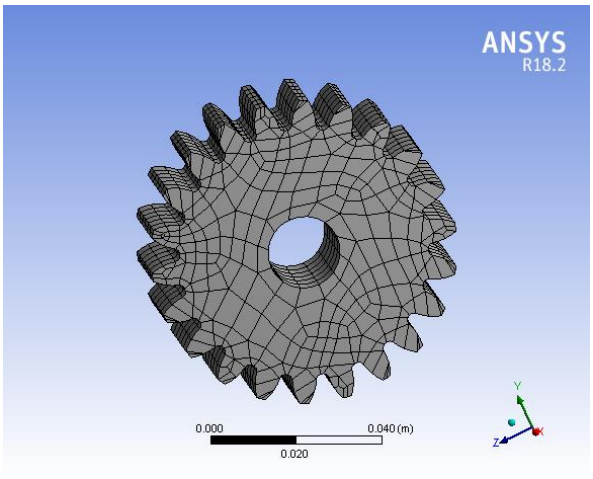


Fig 1. Meshing with Relevance size

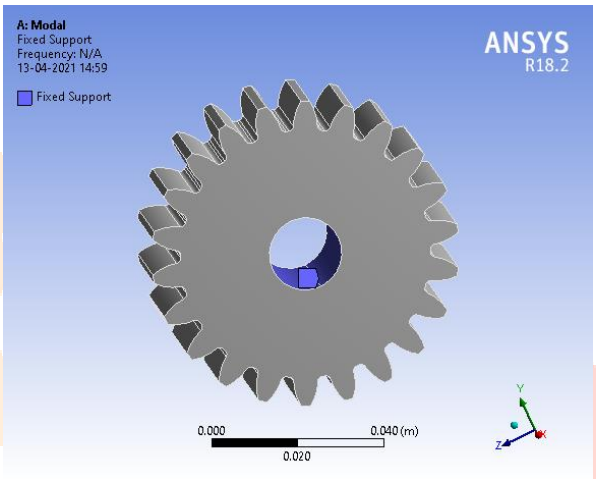


Fig 2. Boundary Conditions

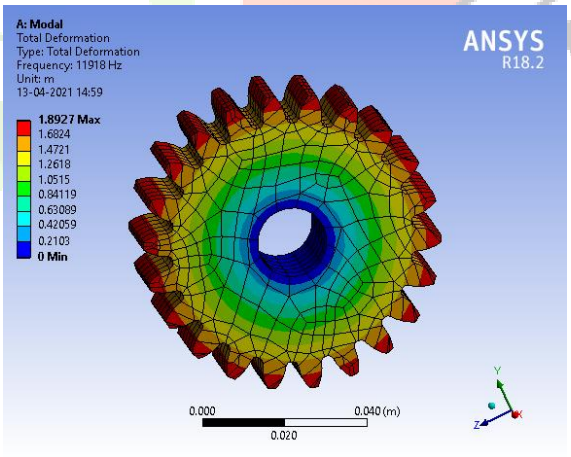


Fig 3. Total Deformation

- Comparison Of Result :

a.

Tetrahedral

Mode	Frequency
1.	11984
2.	17454
3.	17463
4.	19389
5.	23687
6.	23691

Hexahedral

Mode	Frequency
1.	11918
2.	17375
3.	17384
4.	19319
5.	23600
6.	23606

b. The total maximum deformation by using tetrahedral meshing is 1.8926 m
And the total maximum deformation by using hexahedral meshing is 1.8927 m

CONCLUSION

- During the static structural analysis of Oldham coupling it has been observed that tetrahedral mesh is more convenient than hexahedral.
- In the Modal analysis of spur gear results are same with both the tetrahedral and hexahedral meshes are same. So, both are convenient.
- For modal analysis as we increase the number of modes the frequency of modes increases.

REFERENCES

[1] Finite Element Analysis of the Oldham Coupling by using ANSYS Md Asif Arshad1 V. K. Titariya2 1M. Tech. Student 2Assistant Professor 1,2Department Mechanical Engineering 1,2SAMCET, Bhopal, India.

[2] SPUR GEAR MODAL ANALYSIS K Vikas Kumar 1, Prof. T. Eswara Rao2 2Assistant Professor, Department of Mechanical Engg. Gandhi Institute of Engg. and technology, Gunupur, ODISHA.

[3] Impact Of Mesh Quality Parameters On Elements Such As Beam, Shell And 3D Solid In Structural Analysis Padmakar Raut (Department of Mechanical Engineering, Mumbai University, Mumbai-400614).

[4] Desai, Utkarsh M.; Patel, Dhawal A. (2015): Modeling and stress analysis of composite material for spur gear under static loading condition. IJAPME, 1(2), pp. (print) 2394-6202, pp. (online) 2394-6210.