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Structural Analysis of Traction Gear using Different Composite Materials

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Abstract: Gear is a toothed wheel that works with others to alter the relation between the speed of a driving mechanism and the speed of the driven parts. Geared devices can change the speed, torque, and direction of a power source. The most common situation is for a gear to mesh with another gear. This paper presents a detailed and fabrication of a high strength and low cost Traction gear. First The Traction gear is modelled in CATIA V5 and imported to ANSYS for structural analysis and modal analysis to determine the natural frequencies and mode shapes. Analysis is done by the different materials for gears like Cast iron, carbon steel, and composite materials like Aluminium Silicon carbide results are compared the withstand limits emphasized on the comparative performance of Traction gear having different load conditions by determining the errors generated and structural stress developed in the Traction gear for load.

Keywords: CATIA V5, Ansys, Routing, Catia.

I. INTRODUCTION

Rigging is a basic segment in numerous machine parts; its application differs from little outfitted engine to and convoluted aviation extras. Human has been natural about the possibility that the continued twisting of wood or metal forward and backward with high sufficiency could break it. He found that the rehashed pressure can create crack with worry inside versatile farthest point of material. The weakness examination for structure outlining depends on approach which has been advanced in the course of the most recent 100 years or something like that. The specific first exhaustion investigation has been finished by German mining engineer, W.A.S. Albert who performed number of continued stacking test on press chain. Weakness is the most imperative disappointment mode to be considered in a mechanical plan. Weariness is the procedure of consistent restricted lasting auxiliary change showing up in a material subjected to fluctuating pressure conditions. On the off chance that as far as possible does not surpass as far as possible, the body will recapture its unique state. Fashioner ought to have a decent information of logical and experimental systems to get powerful outcomes in deflecting disappointment. Mechanical disappointment is watched essentially because of weakness configuration in this way weariness turns into a conspicuous plan, thought for some structure, for example, air ship, railcars, car suspension, Vehicle edge and extensions. In typical conditions, contact weariness is a standout amongst the most widely recognized disappointment modes for equips tooth surfaces. Apparatus tooth connection causes glue wear for the duration of the life of rigging drive. Under intermittent burdens, most materials will break when submitted to occasional loads over countless. There are two noticeable methods of weariness harm that is root bowing pressure and contact pressure.

The tooth harm is generally a direct result of most extreme bowing pressure. Mining machine utilizes footing gear confines transmission framework. It comprises of single pinion and apparatus setup and these riggings are otherwise called speed reducer, outfit head, adapt reducer and so forth which comprises of orientation and set of rigging shafts. Apparatus investigation was performed utilizing systematic techniques approach however these days PCs have turned out to be more created and use for numerical models to foresee weariness conduct. Rigging is a fundamental part in numerous machines. They are utilized as a part of numerous fast applications. The principle point of this investigation is to foresee contact weakness break commencement coming about because of high anxieties or strains amid the cross section process. These contact stresses are for the most part at their most astounding at some separation under the surface, where introductory breaks are destined to show up. Keeping in mind the end goal to build the twisting weakness quality at the tooth root filet of riggings, gears with high weight point and positive addendum alteration factor are for the most part embraced. Bharat Gupta has considered contact pressure, the central factor to decide the required measurement of apparatuses. Intensive investigations of contact pressure created between the diverse mating gears are generally essential for adapt outline. Scientific techniques for ascertaining gear contact stresses utilize Hertz's conditions, which were initially determined for contact between two barrels. Riggings are normally produced using metal, plastic, and wood. In spite of the fact that apparatus cutting is a considerable industry, numerous metal and plastic riggings are made without cutting, by procedures, for example, kick the bucket throwing or infusion shaping. Some metal riggings made with powder metallurgy require ensuing machining, while others are finished subsequent to sintering. Similarly, metal or plastic apparatuses made with added substance assembling might require wrapping up by cutting, contingent upon application.

II.LITERATURE REVIEW

V. Siva Prasad [1] this paper depicts plan and examination of footing rigging and it is proposed to substitute the metallic apparatuses of sugarcane juice machine with polymer apparatuses to lessen the weight and commotion. A virtual model of footing gear was made in PRO-E; Model is foreign in ANSYS 10.0 for investigation by applying ordinary load condition. The principle motivation behind this paper to examination the distinctive polymer equips specifically nylon, polycarbonate and their practicality checked with partner metallic rigging like as cast press. Finishing up the investigation utilizing the FEA philosophy, it can be demonstrated that the composite riggings, if all around planned and broke down, will give the valuable properties like as a minimal effort, commotion, Weight, vibration and play out its task like the metallic apparatuses. In view of the static investigation N ylon intend are appropriate for the utilization of sugarcane juice machine under constrained load condition in examination with cast press goad gears.

Vivek Karaveer [2] this paper exhibits the pressure investigation of mating teeth of the footing apparatus to discover greatest contact worry in the rigging tooth. The outcomes got from limited component investigation are contrasted and hypothetical Hertz condition esteems. The footing gear are displayed and amassed in ANSYS DESIGN MODELER and stress examination of footing gear tooth is finished by the ANSYS 14.5 programming. It was discovered that the outcomes from both Hertz condition and Finite Element Analysis are practically identical. From the distortion example of steel and dim cast press, it could be reasoned that distinction between the most extreme estimations of steel and dim CI adapt mishapening is less.

MahebubVohra [3] in this paper, Metallic material Cast iron and Non Metallic material Nylon are researched. The pressure investigations of the machine headstock adapt box are dissected by limited component examination. Diagnostic bowing pressure is figured by two recipe Lewis equation and AGMA recipe. Explanatory outcomes are contrasted and the limited component strategy result for approval. Finishing up the examination, we watched that limited component strategy programming ANSYS have estimations of stress dispersion were in great concurrence with the hypothetical outcomes. Other than non-metallic material can be utilized rather than metallic material in light of the fact that non-metallic material gives additional advantages like as less cost, self-greasing up, low clamour, low vibration and simple assembling.

III.EXISTING SYSTEM:

The principle issue in riggings will be at tooth. When we apply rehashed weight on equip, rehashed pressure can deliver break with worry inside versatile farthest point of material. Exhaustion is the most critical disappointment mode to be considered in a mechanical design.Mechanical disappointment is watched for the most part because of weakness configuration thusly weariness turns into a conspicuous outline. While changing force or movement because of greatest pressure the tooth will break in actuality driving it to harm early and diminish the life of the apparatus. Because of more load it will break soon, so there is an unmistakable need to enhance the quality of apparatus

IV. PROPOSED SYSTEM

The fundamental point of this work is to enhance the quality of footing gear. For that we are utilizing diverse composite materials and contrasting it and ordinary material demonstrating that composite material will help in enhancing the quality of apparatus. The footing gear is demonstrated in "CATIA V5" and imported to "ANSYS" for basic investigation and modular examination. Basic examination is performed to decide the twisting and Von-mises stresses. Modular investigation is performed to decide the characteristic frequencies and mode shapes.

A. Design of Traction Gear Using Catia

CATIA offers an answer for shape configuration, styling, surfacing work process and perception to make, change, and approve complex inventive shapes from modern outline to Class-A surfacing with the ICEM surfacing advancements. CATIA bolsters various phases of item plan whether began starting with no outside help or from 2D outlines. CATIA can read and create STEP organize records for figuring out and surface reuse.

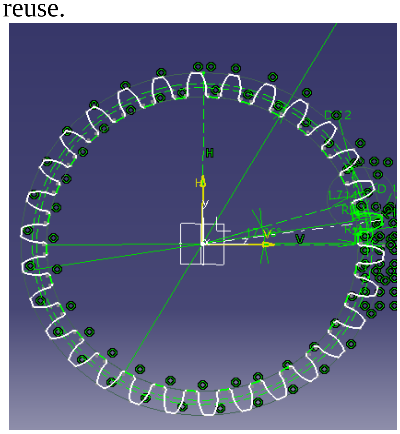

Fig1. Traction Gear sketch Design.

B. Applying the pad to the sketch:

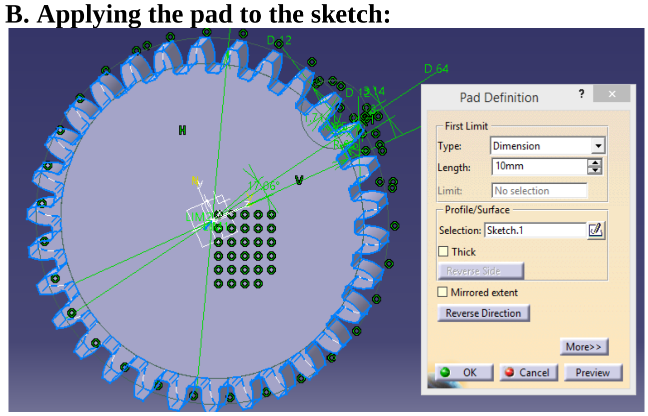

Fig2. Traction Gear convert to 3D.

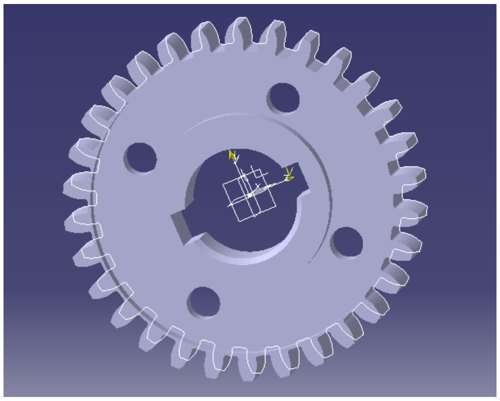

Fig3. Traction Gear complete 3D model.

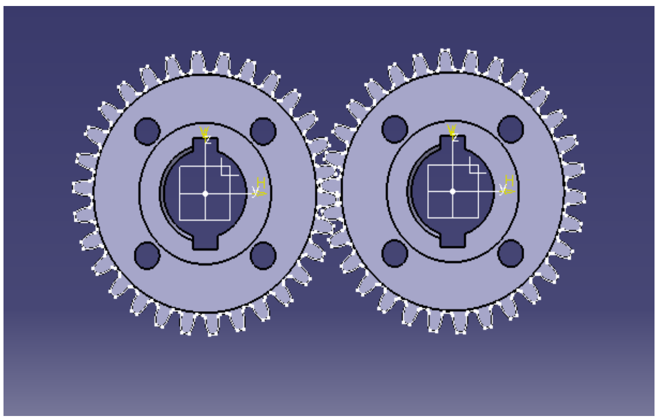

Fig4. Assembly of Gears.

C. Drafting Views

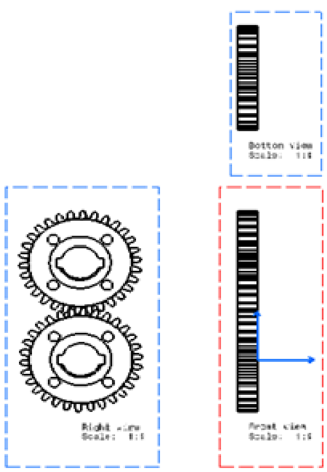

Fig5. Drafting Views of Traction Gear.

D. Analysis Of Traction Gear Using Ansys:

Structural Analysis- Basic examination is presumably the most widely recognized use of the limited component strategy as it suggests extensions and structures, maritime, aeronautical, and mechanical structures, for example, dispatch frames, airplane bodies, and machine lodgings, and in addition mechanical segments, for example, cylinders, machine parts, and apparatuses.

Static Analysis - Used to decide relocations, stresses, and so on under static stacking conditions. ANSYS can process both direct and nonlinear static examinations. Nonlinearities can incorporate versatility, stretch solidifying, huge redirection, substantial strain, hyper flexibility, contact surfaces, and crawl.

Transient Dynamic Analysis - Used to decide the reaction of a structure to subjectively time-shifting burdens. All nonlinearities said under Static Analysis above are permitted.

Buckling Analysis - Used to compute the clasping loads and decide the clasping mode shape. Both direct (Eigen esteem) clasping and nonlinear clasping examinations are conceivable.

Notwithstanding the above investigation writes, a few unique reason highlights are accessible, for example, Fracture mechanics, Composite material examination, Fatigue, and both p-Method and Beam.

IV.RESULTS AND DISCUSSION

In this section, the outcomes acquired for the examination of footing gear for the first profile Also, transient auxiliary investigation are talked about. And furthermore clarified the charts plotted looking at those outcomes.

A. Material Data

Gray Cast Iron

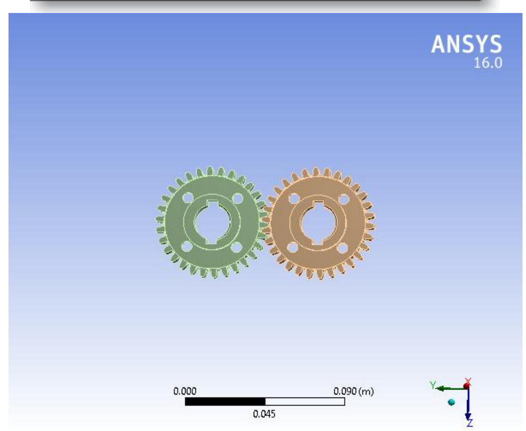

Fig6. Geometry

TABLE 1. Model (A4) > Geometry

Object Name	Geometry
	Fully Defined
Definition	
Source	E:\catia\cadcam\machine design\traction gear\assembly modifed gears.igs
Type	Iges
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	1.e-002 m
Length Y	0.12404 m
Length Z	6.4442e-002 m
Properties	

Volume	2.9763e-005 m³
Mass	0.21429 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	45542
Elements	23982
Mesh Metric	None

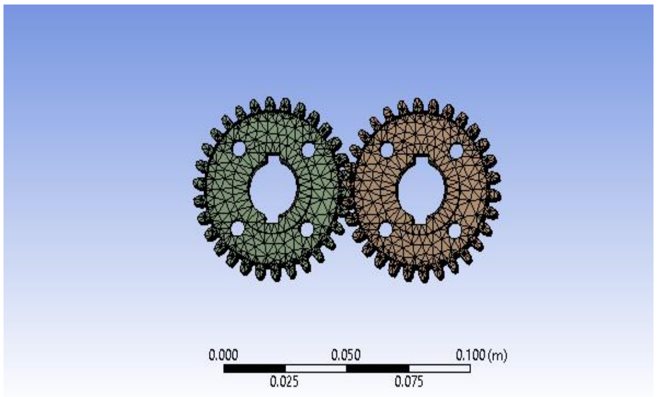

Fig7. Mesh.

TABLE2. Model (A4) > Mesh

Object Name	Mesh
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Solver Preference	Mechanical APDL
Relevance	0
Sizing	
Use Advanced Size Function	Off
Relevance Center	Medium

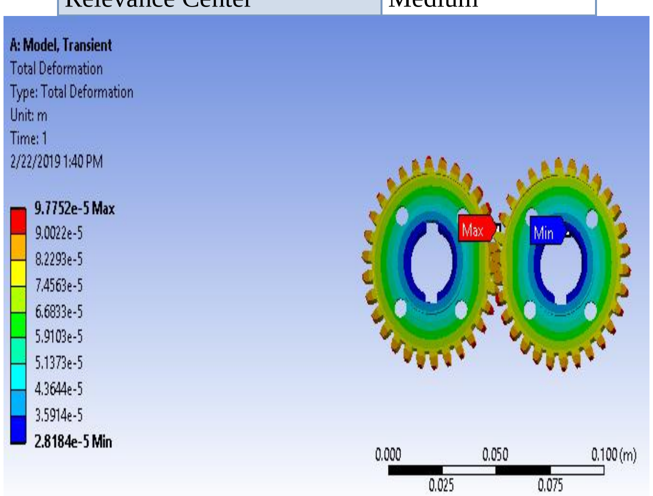

Fig8. Model (A4) > Transient (A5) > Solution (A6) > Total Deformation.

TABLE 3. Model (A4) > Transient (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [m]	Maximum [m]
1.	2.8184e-005	9.7752e-005

Material Data:

Alluminium selicon carbaid

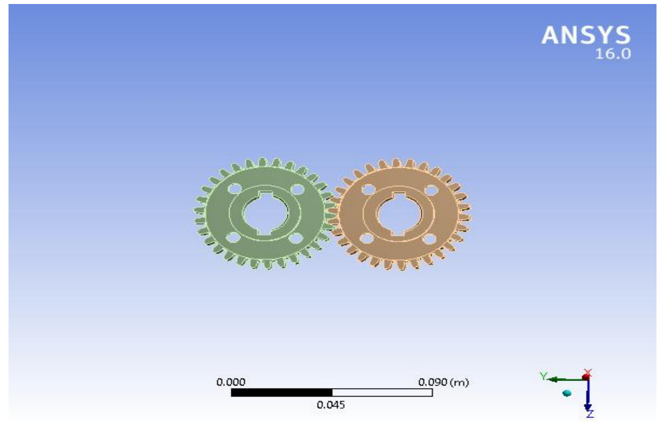

Fig9. Geometry.

TABLE 4. Model (A4) > Geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	E:\catia\cadcam\machine design\traction gear\assembly modifed gears.igs
Type	Iges
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	1.e-002 m
Length Y	0.12404 m
Length Z	6.4442e-002 m
Properties	
Volume	2.9763e-005 m³
Mass	8.3633e-002 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	45542
Elements	23982
Mesh Metric	None

TABLE 5. Model (A4) > Mesh

Object Name	Mesh
State	Solved
Display	
Display Style	Body Color

Defaults	
Physics Preference	Mechanical
Solver Preference	Mechanical APDL
Relevance	0
Sizing	
Use Advanced Size Function	Off
Relevance Center	Medium
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Minimum Edge Length	8.2281e-004 m
Statistics	
Nodes	45542
Elements	23982
Mesh Metric	None

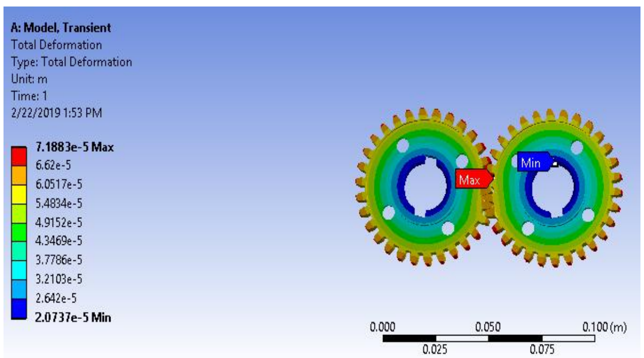

Fig10. Model (A4) > Transient (A5) > Solution (A6) > Total Deformation.

TABLE 6. Model (A4) > Transient (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [m]	Maximum [m]
1.	2.0737e-005	7.1883e-005

Material Data:
carbon epoxy

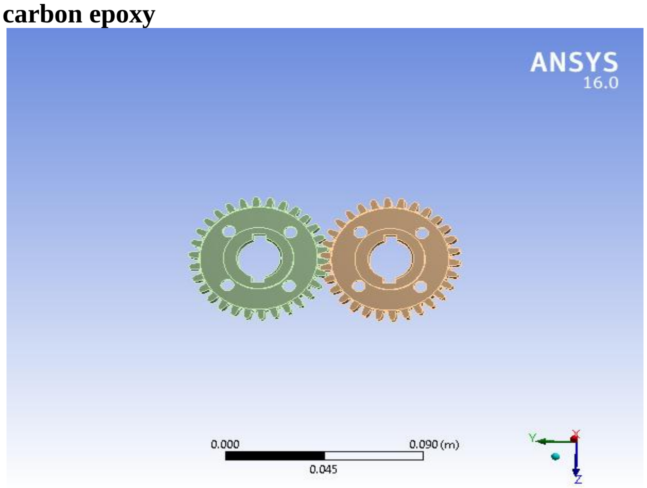

Fig10. Model (A4) Geometry

TABLE 7. Model (A4) > Geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	E:\catia\cadcam\machine design\traction gear\assembly modifed gears.igs
Type	Iges
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	1.e-002 m
Length Y	0.12404 m
Length Z	6.4442e-002 m
Properties	
Volume	2.9763e-005 m³
Mass	5.3573e-002 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	45542
Elements	23982
Mesh Metric	None

TABLE 8. Model (A4) > Mesh

Object Name	Mesh
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Solver Preference	Mechanical APDL
Relevance	0
Sizing	
Use Advanced Size Function	Off
Relevance Center	Medium
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Minimum Edge Length	8.2281e-004 m
Statistics	
Nodes	45542
Elements	23982
Mesh Metric	None

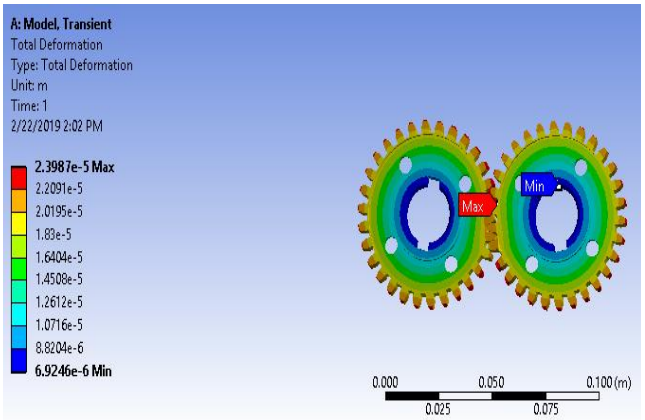

Fig11. Model (A4) > Transient (A5) > Solution (A6) > Total Deformation

TABLE 9. Model (A4) > Transient (A5) > Solution (A6) > Total Deformation

Time [s]	Minimum [m]	Maximum [m]
1.	6.9246e-006	2.3987e-005

Material Data:
Gray Cast Iron

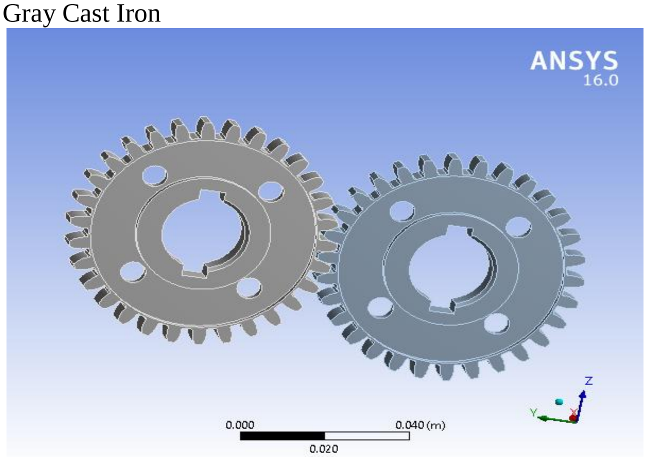

Fig11. Contents.

Material Data:
Gray Cast Iron
Model (A4) Geometry

TABLE 10. Model (A4) > Geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	E:\catia\cadcam\machine design\traction gear\assembly modifed gears.igs
Type	Iges
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	1.e-002 m
Length Y	0.12404 m
Length Z	6.4442e-002 m
Properties	
Volume	2.9763e-005 m³
Mass	0.21429 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	58550
Elements	31354
Mesh Metric	None

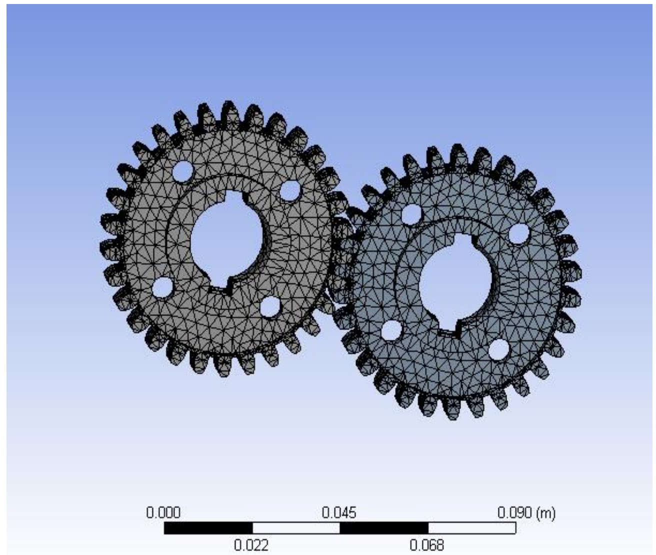

Fig12. Mesh.

TABLE 11. Model (A4) > Mesh

Object Name	Mesh
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Relevance	0
Sizing	
Use Advanced Size Function	Off
Relevance Center	Fine
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Minimum Edge Length	8.2281e-004 m
Statistics	
Nodes	58550
Elements	31354
Mesh Metric	None

VI. CONCLUSION

When the human kind started using wheels they found the requirement of a typical wheel which can reduce or increase the rotational speed so the gear was invented. Most of the power transmission equipment's consist of gear assemblies; many times gears play an important role. In this study, to understand the behaviour of gear materials with respect to stresses Finite Element Analyses were carried out.

- On the basis of that study, the analysis of aluminium silicon carbide, Carbon epoxy, cast iron is analyzed in the application of gear box which is used in transmission system.
- It was found that Carbon epoxy have got good resistance characteristics as compared to other materials,
- So from these analysis results, we conclude that, the stress induced, carbon epoxy deformation of traction gear is less as compared to the other material gear.
- In model analysis carbon epoxy material gave good vibration resistance comparing to other two materials

VII. FUTURE SCOPE

In the present project, structural and model analysis of traction gear is done by different materials and carbon epoxy gave best results. There is scope of using other type of composite materials other than mentioned materials and better results can be achieved, can increase the strength and hence increase the life of gears and can be used in other industries for better results.

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