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EXPERIMENTAL INVESTIGATION ON SPROCKET DEVELOPMENT USING NX CAD AND CAE BY REVERSE ENGINEERING

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Abstract:

This project is about the application of reverse engineering, reverse engineering helps in obtaining the geometry of part or products which are not available otherwise. Its application makes it possible to reconstruct the original component with its drawing and manufacturing process. In this proposed work a sprocket will be produced by reverse engineering. The procedure includes various stages which involves the different phases of reverse engineering. The process starts with the understanding the reverse engineering procedure.

The part geometry is going to obtain with the help of different measuring instruments. Then NX CAD software will be used for drawing and drafting, further the ANSYS software will be used for analysis of sprocket. Duplex stainless steel will be used for the manufacturing of sprocket. Because of its composition it will provide more strength and toughness to the sprocket. In this project report existing motorcycle sprocket is compared with the sprocket of duplex steel material. With different properties of mild steel, cast iron, duplex steel. Stress and deformation of sprocket is compared. This work can be useful for further development of sprockets.

***Keywords*- REVERSE ENGINEERING, NX CAD, ANSYS, DUPLEX STEEL, DURABILITY.**

I. INTRODUCTION:

SPROCKET

The name 'sprocket' applies generally to any wheel upon which are radial projections that engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth. Sprockets can be supplied in various materials and styles, depending upon the application and severity of service requirements. The selection of material used for the manufacturing of sprocket depends upon the strength and service conditions like wear and noise etc. also involves the cost as well as the material performance required. The sprockets maybe manufactured from metallic non-metallic materials. The steel is widely used for the manufacturing of sprocket due to its go wearing properties, excellent machinability and case of producing complicated shapes by machining .Sprockets can also be supplied in various cast materials as Standard Carbon Steel (with or without hardened teeth), Stainless Steel, Special materials such as alloy steel, bronze etc ,the non metallic materials like wood, compressed paper and plastics like Nylon, Acrylic and Polycarbonate etc. are used for gears, especially for reducing weight and noise.

The sprocket is a very vital component in the transmission of power and motion in most motorcycle; there is always a pair (rear and front) in a motorcycle. The front sprocket drives the rear sprocket via chain connection. They exist in various dimensions, teeth number and are made of different materials.

Generally sprockets are made of mild steel and cast iron . A sprocket-wheel or sprocket is a profiled wheel with teeth, cogs that mesh with a Chain. The name 'sprocket' is applies generally to any wheel upon which radial projections engages a chain passing over it. May be the mostly recognized type of sprocket might be found in the bike which drives a chain which thus ,drives a little sprocket on the pivot of the back wheel.

II. REVERSE ENGINEERING:

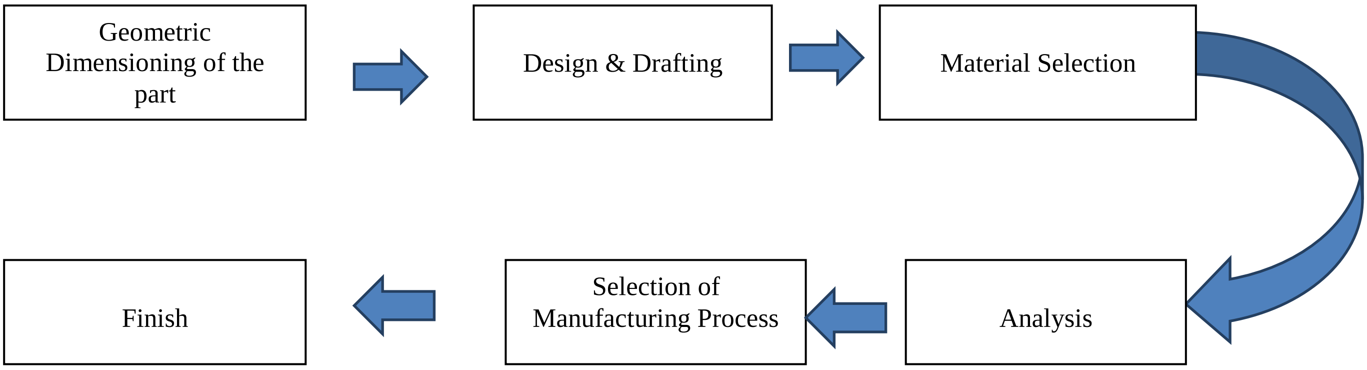
When a product is manufactured using a conventional engineering process, data will accompany it. Depending on the complexity or intended use of the product, the documentation available can include a full set of drawings, analysis results, specifications and standards, materials, test results, as well as manufacture and assembly information etc. The method of duplicating an existing component, subassembly, or product, without the aid of documentation, drawings or computer models is known as reverse engineering. Thus reverse engineering is the process of extracting information about the product from the product itself.

This is a common practice in industry and an important part of the product development cycle .There are numerous applications of reverse engineering; it is often used in computing technologies for abstraction and redesign of software as well as being used on electrical components. It is defined for use in this thesis however, to reverse engineer a mechanical component by analyzing the existing objects physical dimensions, features, material and physical properties.

- There are number of reasons why one would reverse engineer a component.
- The original manufacturer no longer produces the product but the customer need a replacement component .
- There is existing documentation for a product ,but components have been modified for use, thus existing documentation is no longer relevant.
- To understand competitors products and develop superior products.

REVERSE ENGINEERING PROCESS:

Reverse engineering a product does not follow a sequence of procedure .There are a number of options to consider when recreating a component .Generally the aim of reverse engineering is to create a three dimensional geometric model from a physical part. Once the cad model is obtained it can be used to directly manufacture the component (or) used to improve the existing design.



The model can be used for computer-aided engineering (CAE) applications such as finite element analysis (FEA). Ansys can be used to predict stresses on mechanical components as well as deformation and safety factors. The use of FEA is preferable when the original material specification for a component is not available, otherwise an incorrect material could be chosen for manufacture and lead to component failure. Once a simulated material has been tested, it can either be selected for manufacture, if it is suitable, or if it is not, then another material must be selected or the CAD model must be altered.

Computer-aided manufacture (CAM) refers to the use of software for the control of machine tools and other machinery in the manufacture of parts. Traditional manufacturing methods such as a Computerised Numerical Control (CNC) milling machine can then be used to produce the component.

STEPS INVOLVED IN REVERSE ENGINEERING:

- Geometric Dimensioning of the part
- Design and drafting
- Material selection
- Analysis
- Selection of manufacturing process
- Finishing

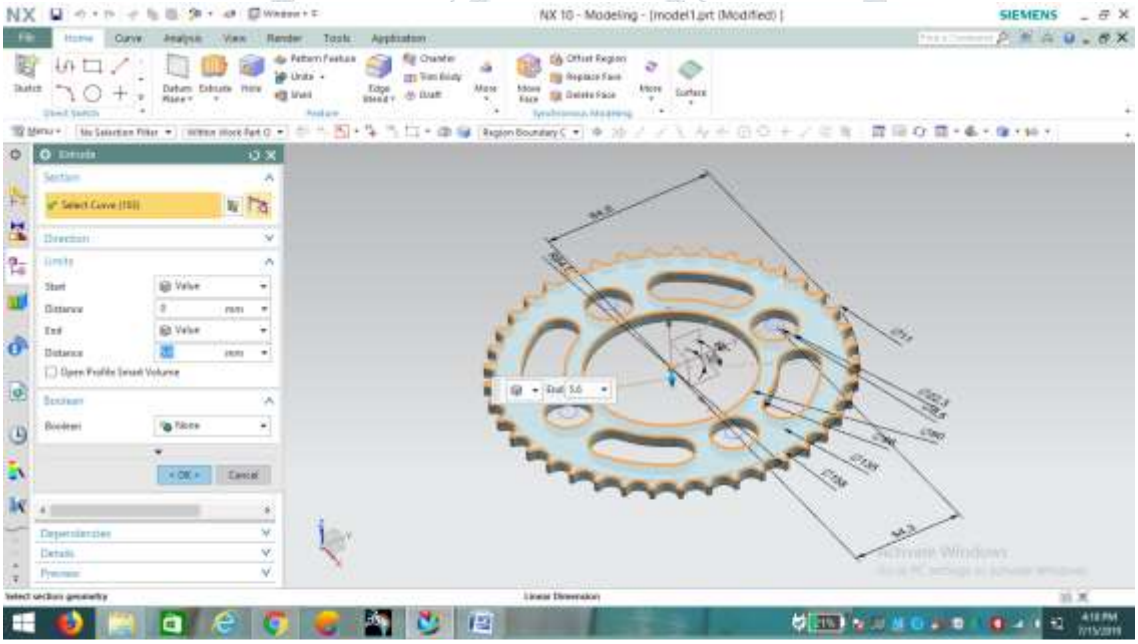
GEOMETRIC DIMENSIONING:

In order for a component to be digitized and made into a workable CAD model, its features and dimensions must be measured someway. There is a variety of techniques available to achieve this. An object can be measured manually or measured by the use of systems such as measuring machines or scanners.

In this proposed work we use manual geometry collection method, which is a method of gathering measurement data from a part with the use of conventional tools .These include digital venire calipers, rules.

DESIGN AND DRAFTING:

NX CAD software is used for both two dimension (2-d) and three dimension (3d) drawings.



MATERIAL SELECTION:

Selecting the right material for the sprocket involves many factors, including the cost as well as the material performance required. Duplex steel of grade 2205 (1.4462) is selected for sprocket manufacturing. Duplex steel is a combination of austenitic and ferrite grades of approximately equal proportions.

Duplex steels are called “duplex” because they have a two phase micro structure consisting of grains of ferritic and austenitic stainless steel. When the duplex steel is melted it solidifies from the liquid phase to a completely ferritic structure. as the material cools down to room temperature, about half of the ferritic grains transform to austenitic grains. the result is a microstructure of roughly 50% austenitic and 50% ferrite.

MECHANICAL PROPERTIES:

Strength: duplex stainless steels are about twice as strong as regular austenitic or ferritic stainless steels.

Toughness and ductility: Duplex stainless steels have significantly better toughness and ductility thanferritic grades; however they do not reach the values of austenitic grades.

Stress corrosion and cracking resistance: duplex steels show very good stress corrosion cracking resistance, a property they have “inherited” from the ferrite side

Structural properties:

Young's Modulus, (E) =20.9×104 MPa

Poisson's Ratio (V) = 0.31

Density (ρ) = 8690 kg/m3

Yield stress (σ) =500MPa

Ultimate tensile stress (σ) =950MPa

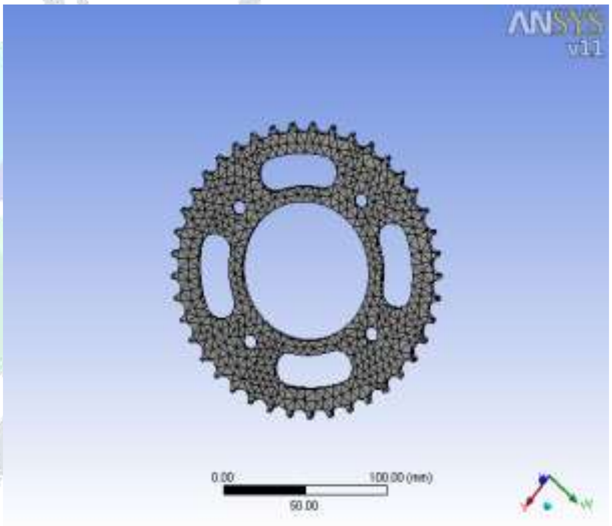
CHEMICAL COMPOSITION:

Industrial Material		Elements (wt. %)										
		C	Si	Mn	Ni	Cr	Mo	Cu	N	Co	S *	PREn
Austenitic	304L	0.02	0.49	0.60	11.12	18.29	0.21	0.31	0.03	0.00	9	19.46
	316L	0.01	0.49	0.73	11.08	16.89	2.17	0.48	0.03	0.25	10	24.53
Ferritic	430	0.01	0.31	0.30	0.29	16.16	0.05	0.10	0.03	0.02	5	16.80
	434	0.03	0.39	0.39	0.45	16.17	0.92	0.12	0.05	0.03	23	20.01
Duplex	1.4362	0.02	0.41	1.09	4.02	22.30	0.28	0.30	0.15	0.13	4	25.62
	1.4462	0.02	0.4	1.61	5.45	22.91	2.78	0.22	0.15	0.07	3	34.48

Table 1
:ion of stainless
ITECH. *Sppm

ANALYSIS:

For structural analysis (stress and displacement) of the sprocket ANSYS V11 software is used.



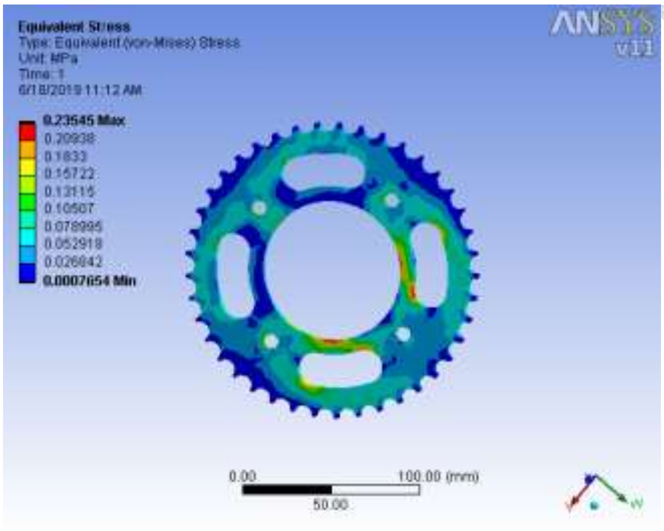
Statistics	
Nodes	7749
Elements	3657

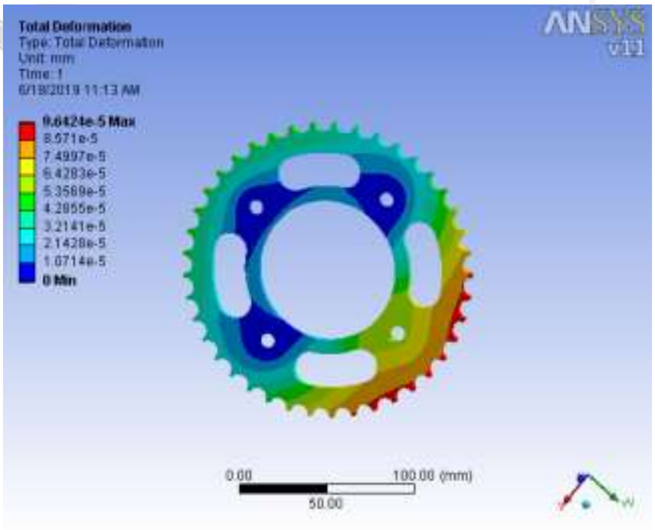
STRUCTURAL ANALYSIS:

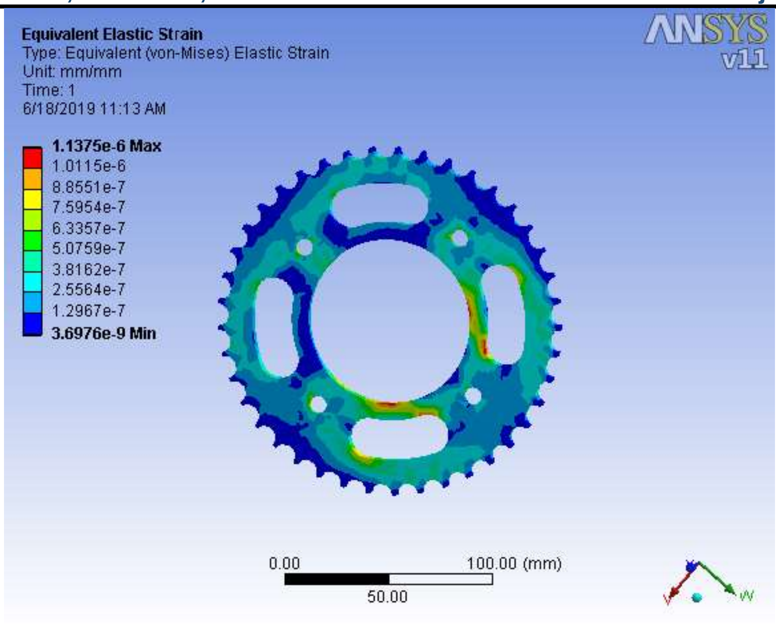
MATERIAL PROPERTIES

MS

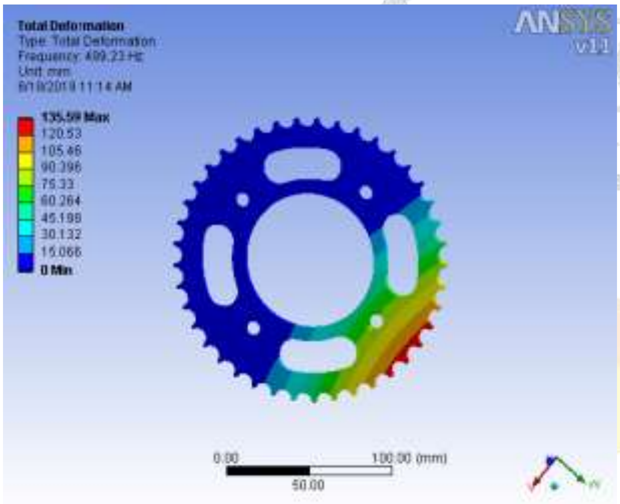
Structural	Add/Remove Properties
Young's Modulus	2.07e+005 MPa
Poisson's Ratio	0.303
Density	7.85e-006 kg/mm³
Thermal Expansion	0. 1/°C
Thermal	Add/Remove Properties
Thermal Conductivity	0. W/mm·°C
Specific Heat	0. J/kg·°C
Electromagnetics	Add/Remove Properties
Relative Permeability	0.
Resistivity	0. Ohm·mm

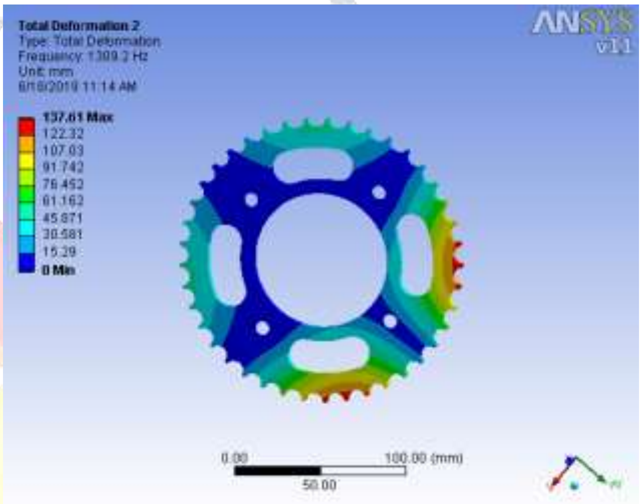


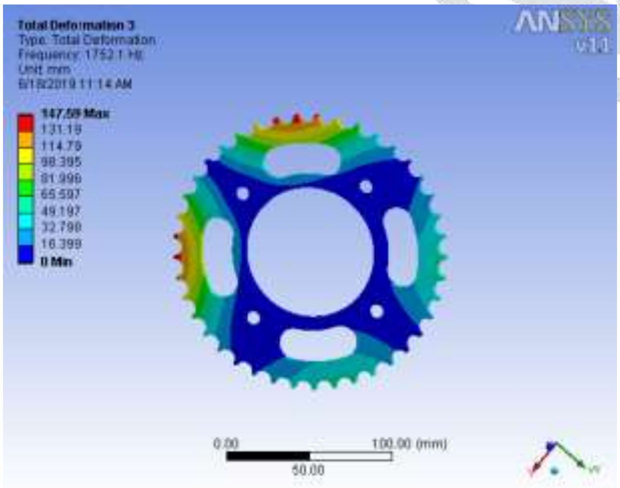


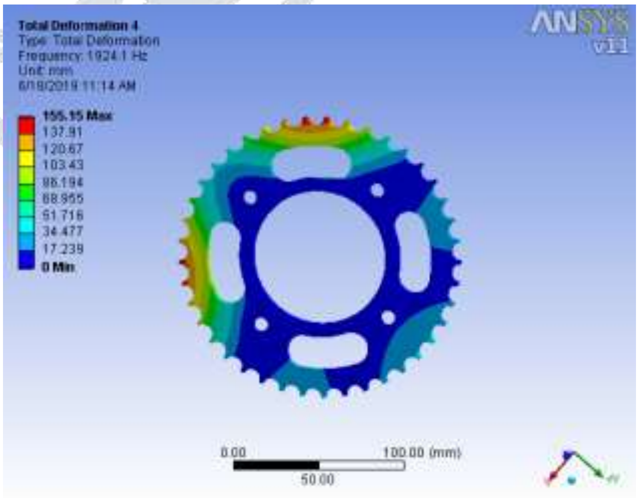


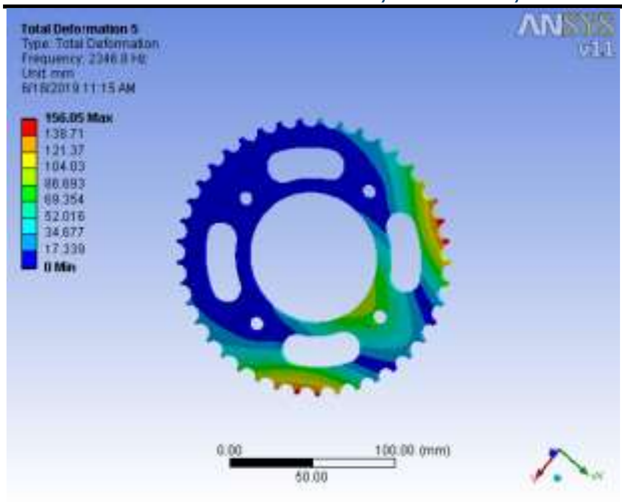
MODEL ANALYSIS:

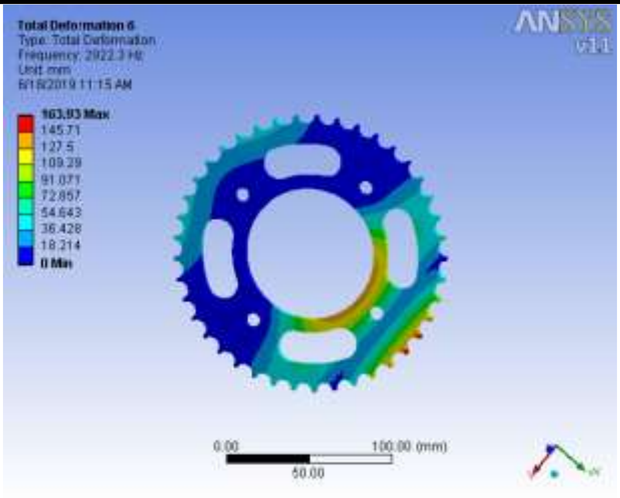












Structural Analysis

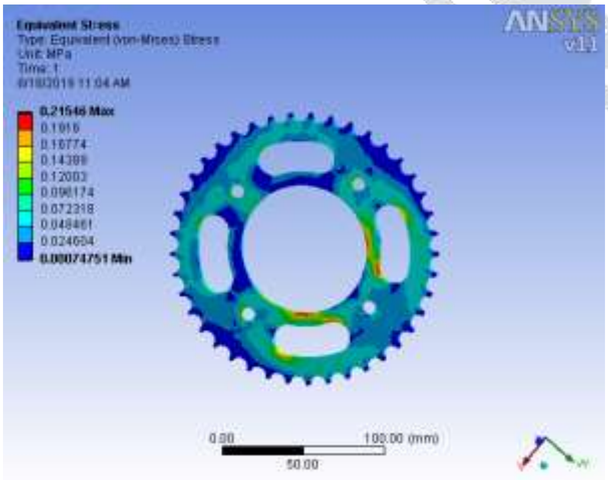
Cast Iron

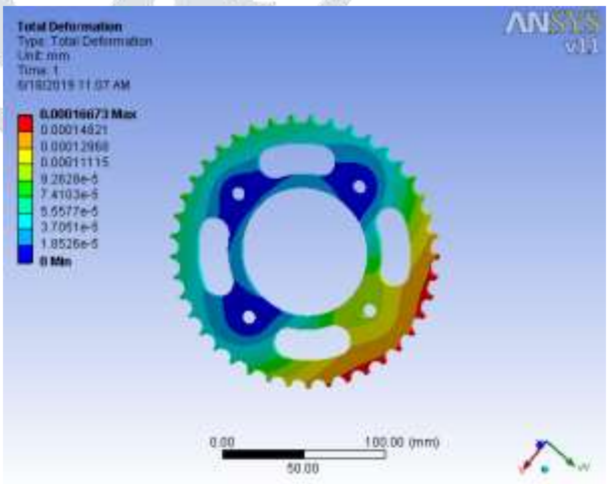
Structural Add/Remove Properties

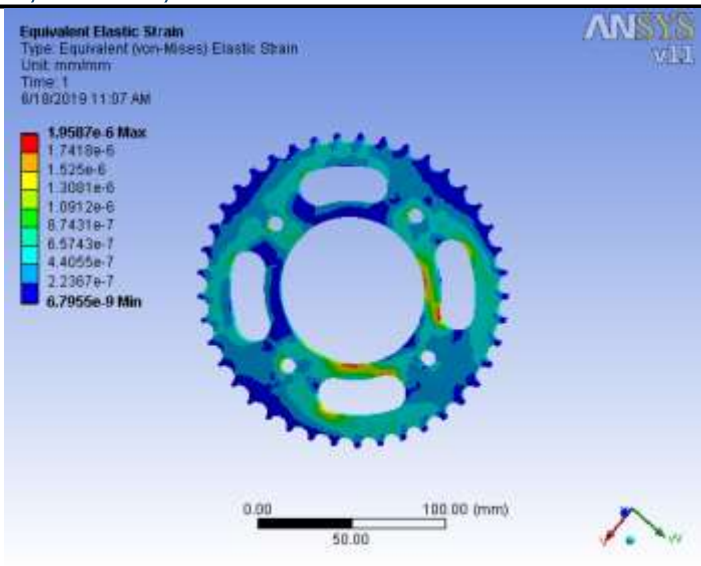
Young's Modulus	1.1e+005 MPa
Poisson's Ratio	0.28
Density	7.2e-006 kg/mm³
Thermal Expansion	1.1e-005 1/°C
Tensile Yield Strength	0. MPa
Compressive Yield Strength	0. MPa
Tensile Ultimate Strength	240. MPa
Compressive Ultimate Strength	820. MPa

Thermal Add/Remove Properties

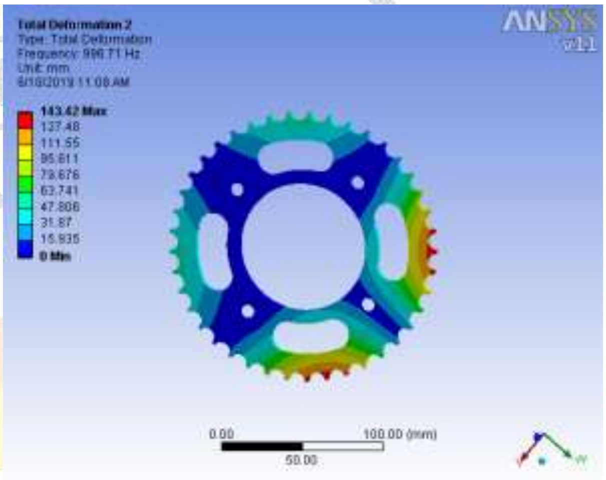
Thermal Conductivity	5.2e-002 W/mm·°C
Specific Heat	447. J/kg·°C

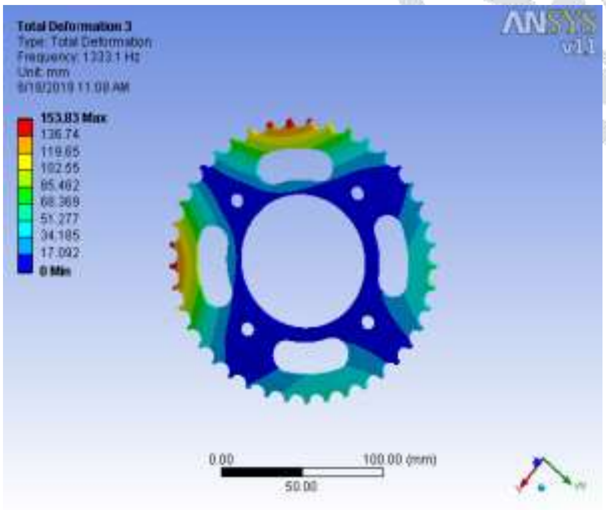


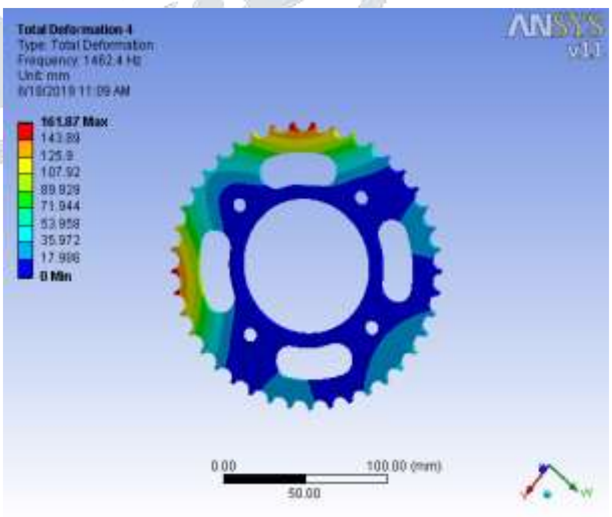


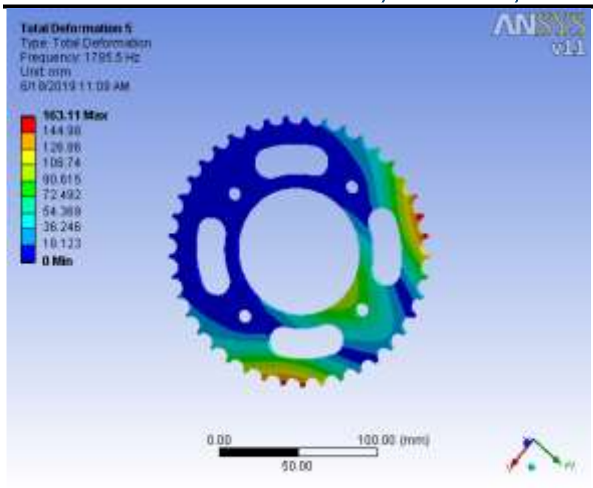


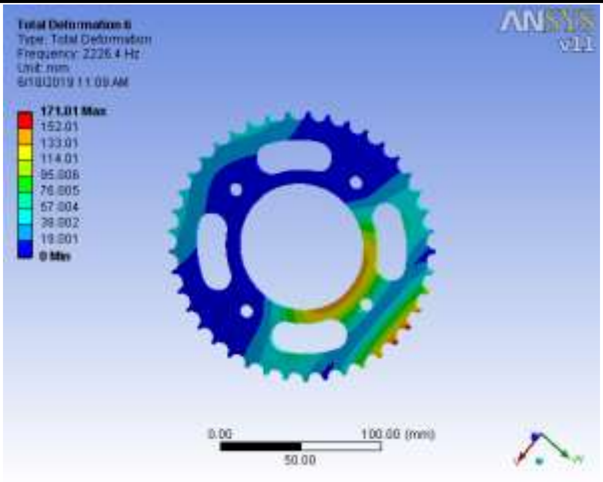
MODEL ANALYSIS







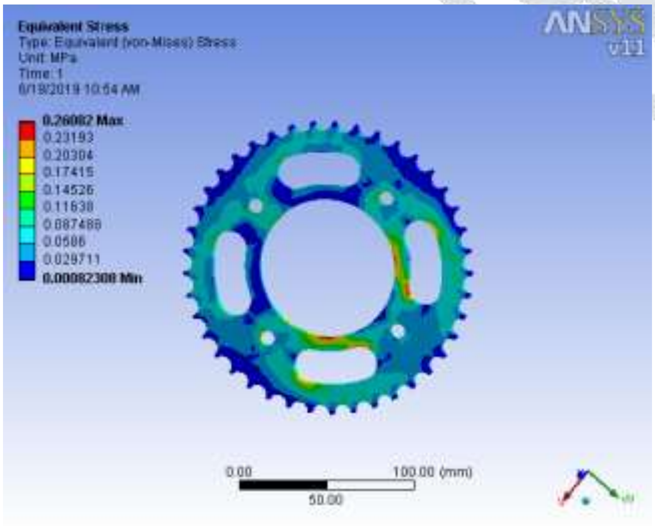


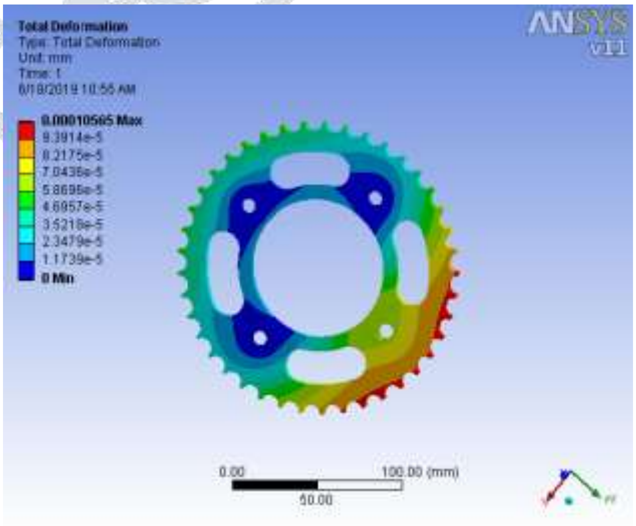


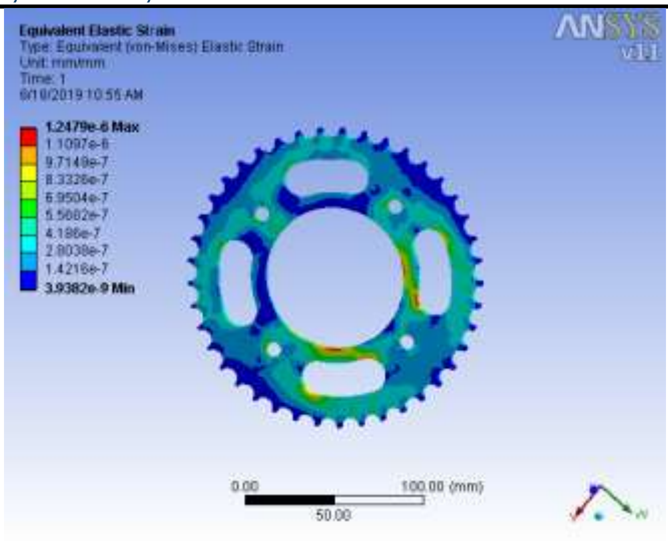
MATERIAL PROPERTIES: DUPLEX STEEL

Structural	Add/Remove Properties
Young's Modulus	2.09e+005 MPa
Poisson's Ratio	0.31
Density	8.69e-006 kg/mm³
Thermal Expansion	1.7e-005 1/°C
Tensile Yield Strength	500. MPa
Compressive Yield Strength	207. MPa
Tensile Ultimate Strength	950. MPa
Compressive Ultimate Strength	0. MPa
Thermal	Add/Remove Properties
Thermal Conductivity	1.51e-002 W/mm·°C
Specific Heat	480. J/kg·°C
Electromagnetics	Add/Remove Properties
Relative Permeability	10000
Resistivity	7.7e-004 Ohm·mm

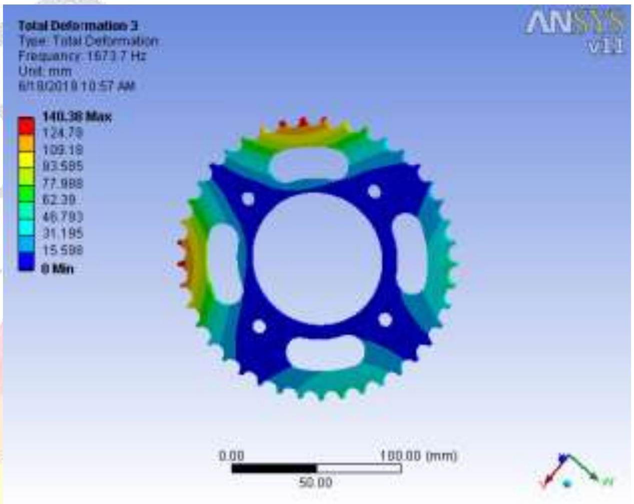
STRUCTURAL ANALYSIS

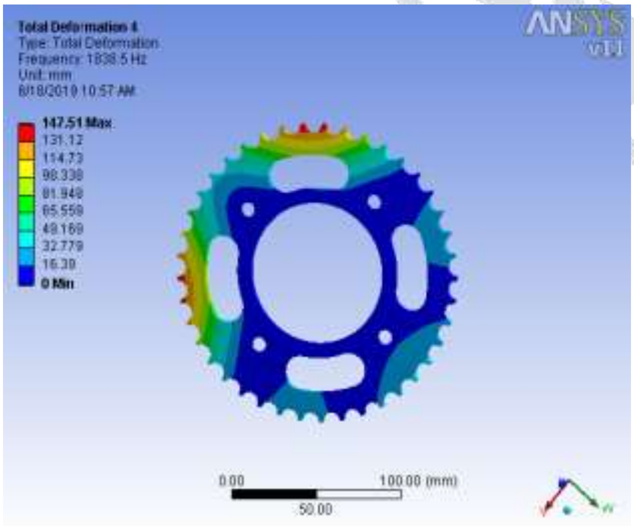


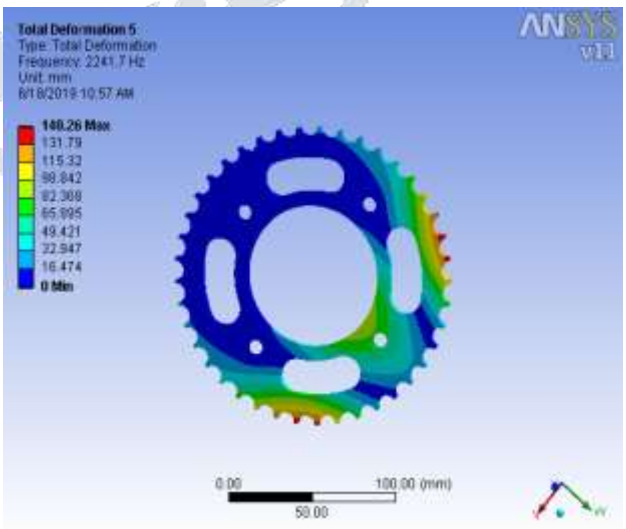


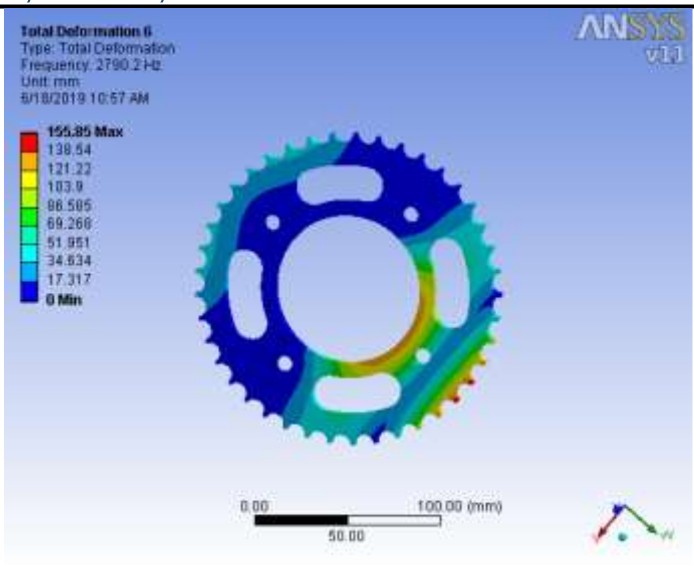


MODEL ANALYSIS









SELECTION OF MANUFACTURING PROCESS:

In this work we used vertical CNC milling machine and lathe material. There are several methods that could be used to manufacture the sprocket. The methods include milling, hobbing, powder metallurgy sintering and steel casting in most cases manufacturing process to be used greatly lies on the facility available. In this work vertical CNC milling is used.

FINAL PRODUCT:

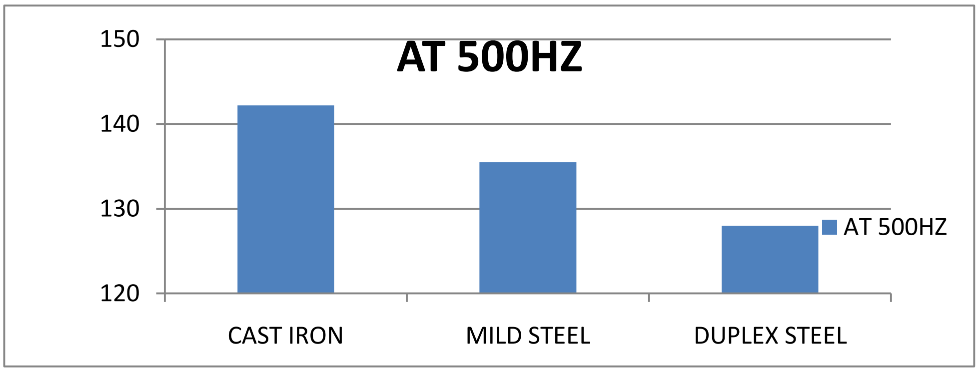
III. RESULTS:

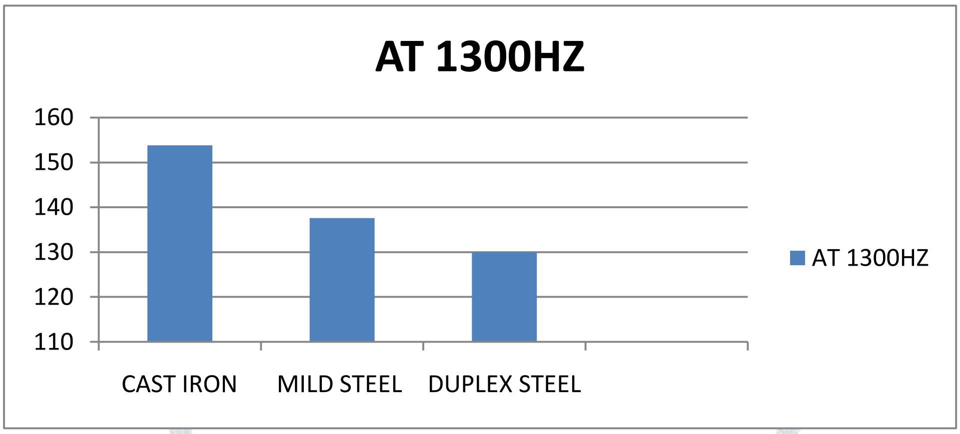
STRUCTURAL ANALYSIS: From the comparison of result values of different materials analysed, duplex steel material shows the least value of max. stress, max. strain and deformation .

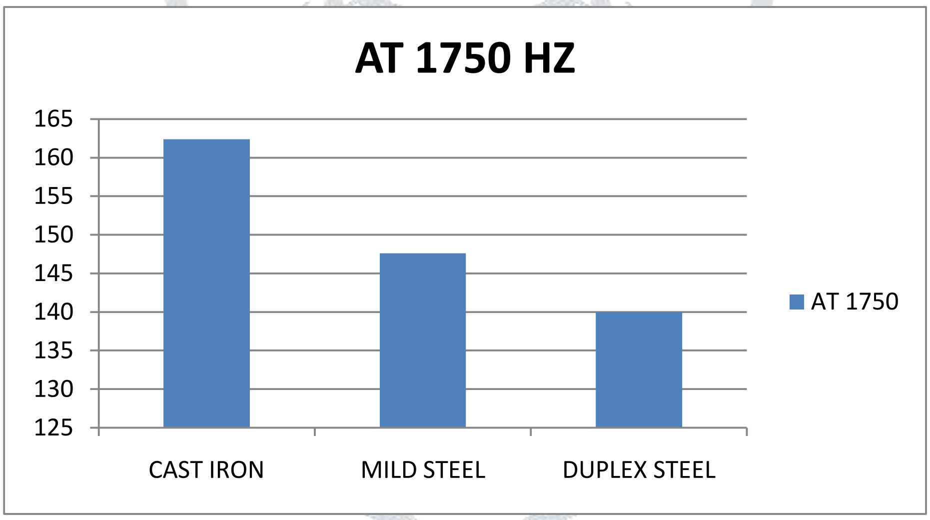
Because of the high chromium and molybdenum percentage present in the duplex steel it shows greater resistance to corrosion and have more strength and toughness than other materials used in the analysis.

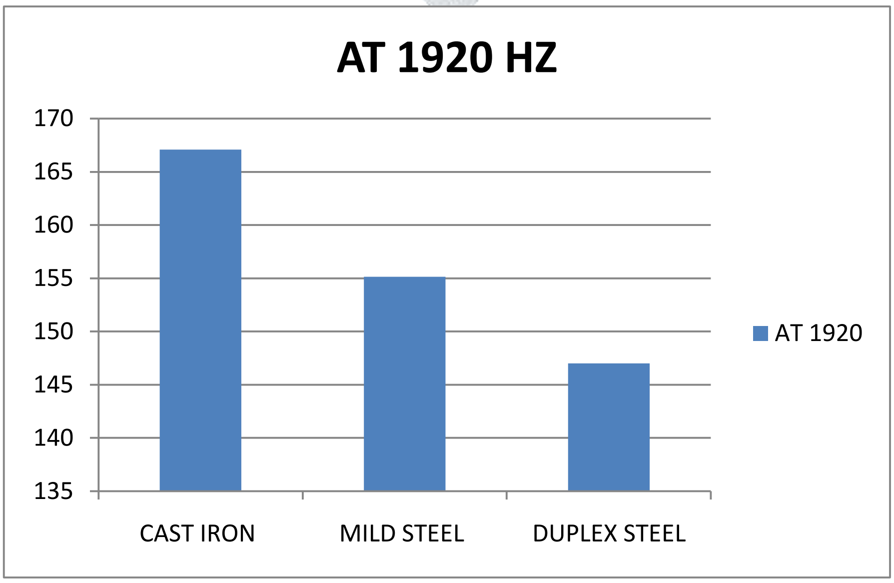
MODEL ANALYSIS:

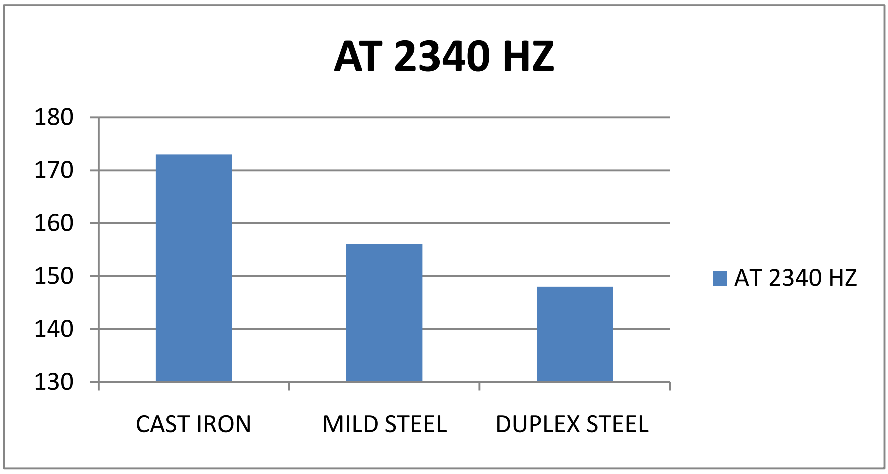
Vibration analysis values noted at different frequency values are shown below

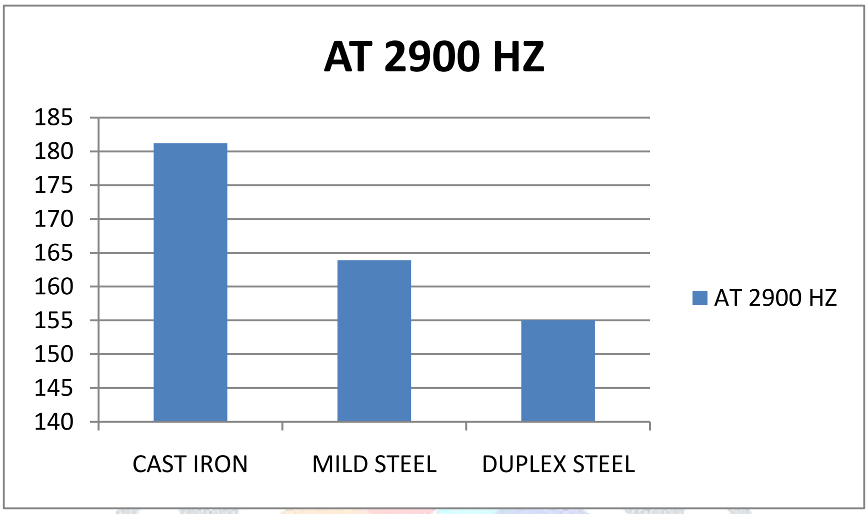

AT 500HZ
150
140
130
120
AT 500HZ
CAST IRON
MILD STEEL
DUPLEX STEEL


AT 1300HZ
160
150
140
130
120
110
AT 1300HZ
CAST IRON
MILD STEEL
DUPLEX STEEL


AT 1750 HZ
165
160
155
150
145
140
135
130
125
AT 1750
CAST IRON
MILD STEEL
DUPLEX STEEL


AT 1920 HZ
170
165
160
155
150
145
140
135
AT 1920
CAST IRON
MILD STEEL
DUPLEX STEEL





IV. CONCLUSION:

- From the results of the finite element analysis (FEA), it is observed that stresses are maximum at joint locations. It is also observed that all the materials used have stress values less than their respective permissible yield stress values, hence the design is safe.
- From the comparison of ANSYS results and the properties of all the materials, it is found that duplex steel is the material which is having the least value of maximum stress, maximum strain and maximum deformation among the materials used here for analysis .
- Subsequently it is the most appropriate substitute material for sprocket and is relied upon to perform better with satisfying amount of weight reduction.
- According to the surveys after approximately 20,000 kms of motor cycle drive chain sprocket assembly needs to be replaced.

But the use of duplex steel chain sprocket can run longer than the conventional mild steel and cast iron sprockets. Researchers are also searching for more alternative materials to replace the conventional mild steel. Cost of the material is the another factor which restricts the use of alternative materials in place of existing materials for sprocket manufacturing for motor cycles, so these can be used for further development of chain sprocket and more efficiency can be achieved during power transmission.

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