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Vibrational analysis of carbon fiber steering wheel

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ABSTRACT

The most transport truck directing the course of action is to turn the front wheels utilizing a hand worked controlling wheel which is situated before the Driver. The directing segment, which contains an all-inclusive joint which is a piece of the collapsible controlling section which is intended to enable it to veer off from a straight line as indicated by the Roadmap. In 4 wheel controlling with three mode activity, three guiding modes can be changed as required which helps with stopping at substantial traffic conditions when arranging territories where short turning sweep is required and in rough terrain Driving. For reducing the weight of steering wheel carbon fiber used. The 3D model of the steering wheel will be made with the assistance of CATIA V5 Software. The Model Analysis will be carried out using ANSYS19.2. The experimental Impact Hammer testing will be carried out. A comparative analysis will be carried out between Analysis results and experimental results. Result and Conclusion will be discussed and suitable future scope will be suggested.

Keywords— *Steering, Vibration, FEA, ANSYS*

1. INTRODUCTION

In conventional vehicle steering wheel is the most important part for controlling the vehicle. It is a sort of steering control in vehicles. Presently guiding wheels are utilized in current land vehicles, including all large scale manufacturing autos, just as transports, light and overwhelming trucks, and tractors. Directing wheel is the piece of that is controlled by the driver; the remainder of the guiding framework reacts to such driver inputs. Execution of direct mechanical contact as in recycling ball or rack and pinion guiding riggings, without or with the help of pressure driven power controlling, HPS, or as in some cutting edge creation autos with the help of PC controlled engines, known as Electric Power Steering.

Controlling wheels for Transport truck are commonly roundabout and are mounted to the guiding section by a center associated with the external ring of the directing wheel by one or various spokes (discussed single wheels being a somewhat uncommon exemption). Different kinds of vehicles may have a plan of the round shape, a butterfly shape, or some unique shape. In the vast majority of nations where vehicles must drive on the left half of the street, the directing wheel is normally on the correct side of the vehicle (right-hand drive or RHD); the opposite oversees in nations where autos drive on the correct side of the street (left-hand drive or LHD). In consideration of its utilization in directing, the controlling wheel is the standard area for a catch to actuate the vehicle's horn. Transport truck has different controls framework, such like sound framework, journey control, and phone controls, likewise of oar shifters, made into the guiding wheel to limit the degree to which the truck driver must take their hands off the wheel.

2. LITERATURE REVIEW

Rohit B Pawar [1] Wheel and upright assembly is an important part of the vehicle suspension system. Upright is also called as a knuckle. Hub and upright assembly are supported to the vertical weight of the vehicle. Hub is an important part of the wheel assembly system. It is used to transfer the motion vehicle into the wheel. Maximum Speed for the sports car. The Designer keeps as the key factor. Design the vehicle of the minimum weight and maximum stresses ability. Weight and Mass reduction can be reduced by such a method of material selection, Optimum design analysis system. Hub is Transfer the whole weight of the vehicle into the wheel. Hub is usually attached to the motor by closely sliding over and locking into engagement with their shaft, transferring torque from the motor, through hub and wheel.

Prashanth. An et al. [2] the car suspension is viewed as one of the noteworthy structures of a vehicle. It is typically comprised of steel outline, which holds the body and engine of a car vehicle. All the more correctly, vehicle case is a skeletal casing on which different mechanical parts like motor, tires, hub gatherings, brakes, guiding and so forth, are mounted. It provides strength and flexibility to vehicle. Generally, steel is used for making chassis. In this, we have considered a composite material like E-Glass Epoxy for chassis. When we compare steel and E-Glass Epoxy the weight reduction is 75% to 85%. On the basis of results, it was observed that E-Glass Skeleton has predominant quality, the decline in miss-happening, ordinary pressure, weight and fuel utilization contrasted with auxiliary steel. In this manner, E-Glass Epoxy is most preferable for making chassis.

Mageshwaran Subramani [3] In this work, the function frequencies and mode states of numerous cantilever Glass Fiber

Reinforced Polymer Composites (GFRPCs) and carbon fiber fortified polymer composites (CFRPCs) are numerically gotten utilizing the commercial enterprise restricted thing exam programming (ANSYS).The covers under examination incorporate 8 handle cantilevered plates having a plate angle proportion of 2 and fiber volume parts of 0.3, 0.4, 0.5, and 0.6. The limited component examination methodology is depicted. The regular frequencies and mode shapes determined to utilize ANSYS are first approved with the outcomes got from past writing. The understanding between the two outcomes is found to be brilliant. The impact of progress in the framework material, hybridization, and cover stacking succession on the regular frequencies and mode shapes are likewise explored. It is discovered that hybridization and direction of the furthest layer has an increasingly noteworthy impact on the normal frequencies of the overlaid composite plates contrasted with fiber volume portion and change in the grid material.

Jamir Shekh [4] the most traditional and general directing course of action is to turn the front wheels utilizing a hand – worked controlling wheel which is situated before the Driver. The directing section, which contains an all-inclusive joint which is a piece of the collapsible guiding segment which is intended to enable it to veer off from a straight line as per the Roadmap. In convertible four-wheel directing with three mode task three controlling modes can be changed as required which helps with stopping at substantial traffic conditions, when arranging zones where short turning span is required furthermore, in rough terrain Driving.

Shweta Dhargawe [5] the main aim of using active steering control is to increase safety and to reduce both accidents and drivers work load. The target of this undertaking is to plan and build up a steering control framework for the way following of self-sufficient vehicle and to understand the stability of the vehicles on a curved road. A self-reliant vehicle that can force itself to a goal without its driving force wants to perceive the using Environment. In this paper, a steerage manage framework for the way following of impartial cars is depicted. The steerage controller controls the guiding actuator to pursue an appropriate guiding facet. A servo engine is brought to govern the controlling manage. GPS shows the geographical coordinates which specify any given location on the earth surface as latitude and longitude. The ultrasonic sensor used for detecting the obstacles. A magnetometer compass shows the quadrants. Arduino UNO board is used as a mother board in this project.

Akash Sood [6] Car suspension is the most fundamental part that offers quality and strength to the vehicle when it is exposed to various conditions. Skeleton is the supporting casing of any vehicle on which motor body, axles, control train and suspension framework are held together. Tie bars are utilized as a clasp to tie all the vehicle parts [1]. Stepping stool case is considered to be one of the most established styles of the car body. As the stepping stool undercarriage gangs unrivaled burden conveying limit, they are utilized in the greater part of the SUVs just as in overwhelming business vehicles. Higher burden conveying limit of the suspension gives great driving elements and high ride comfort. Subsequently, stepping stool suspension is broadly favored over unibody and spine outlines.

3. OBJECTIVES

- To prepare CAD design using CATIA V5.
- To design the steering wheel of an automobile vehicle.
- To perform modal analysis of steering wheel
- To perform an impact hammer test for vibration analysis.
- To reduce the weight of a conventional steering wheel using carbon fiber material.
- To make a comparative analysis between FEA and Experimental Results.
- Result and Conclusion.

4. METHODOLOGY

Step 1: I began crafted by this undertaking with writing review. I assembled many research papers which are applicable to this theme. In the wake of experiencing these papers, I found out about Structural and vibration optimization of metal automotive fender (Mudguard) using FEA and experimental technique.

Step 2: After that, the parts which are required for my venture are chosen.

Step 3: In the wake of choosing the segments, the 3 D Model and drafting will be finished with the assistance of CATIA programming.

Step 4: The Modal and Harmonic Analysis of the component will be done with the help of ANSYS using FEA.

Step 5: The trial perceptions will be taken on FFT Analyzer.

Step 6: A comparative analysis will be made between simulation and experimental results and then Results and conclusions will be drawn.

4.1 Hand lay-up strategy

Hand lay-up approach is the quiet smooth method of composite processing. The infrastructural affiliation for this approach is likewise minimum. The processing steps are very simple. First of all, a launch gel or wax is sprayed on the molding floor to avoid the sticking of carbon fiber to the surface. Thin plastic sheets are used on the top and backside of the mildew plate to get a desirable surface finish of the product. Reinforcement inside the form of woven mats or chopped strand mats is reduced as in step with the mold size and placed at the ground of mould after Perspex sheet. Then polymer cloth in liquid form is mixed thoroughly in suitable percent with a prescribed hardener (curing agent) and poured onto the floor of mat already placed inside the mold. The polymer material is uniformly spread with the help of a brush. The second layer of carbon fiber is positioned on the polymer surface and a curler is moved with moderate stress on the carbon fiber layer to take away any air trapped as well as the more polymer gift. The system is repeated for every layer of polymer and mat until the specified layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner floor of the top mildew plate that is then saved at the stacked layers and the pressure is carried out. After curing both at room temperature and at a few precise temperatures, mould is opened and the developed composite detail is taken out and in addition, processed.

Fig. 1: Steering wheel by Hand lay-up technique

5. FEA and MODAL VALIDATION– STEERING WHEEL ANALYSIS

The Finite component technique (FEM), is a numerical strategy for tackling issues of building and scientific material science. Ordinary issue regions of intrigue incorporate basic investigation, heat exchange, liquid stream, mass transport, and electromagnetic potential. The expository arrangement of these issues, for the most part, require the answer for limit esteem issues for incomplete differential conditions. The limited component technique detailing of the issue results in an arrangement of logarithmic conditions. The technique yields estimated estimations of the questions at a discrete number of focuses over the area. To tackle the issue, it subdivides an enormous issue into littler, easier parts that are called limited components.

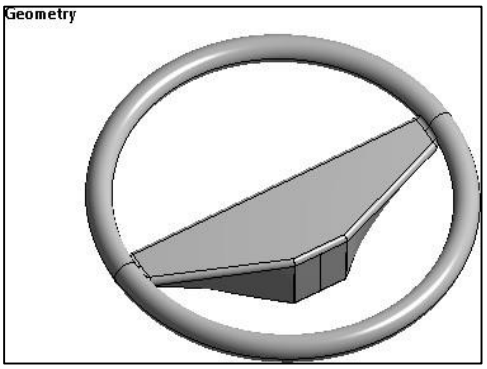


Fig. 2: CATIA Model steering wheel

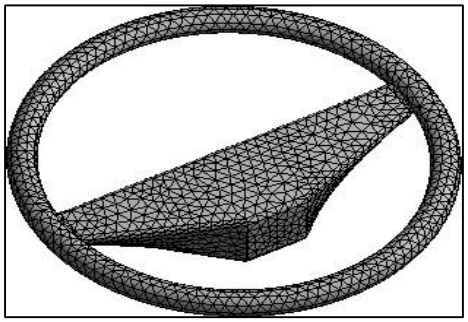
5.1 Regular Steering Wheel Material properties

Table 1: Material properties of polypropylene material

Properties of Outline Row 4: POLYPROPELENE

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	946	kg m^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulu...	
6	Young's Modulus	1325	MPa
7	Poisson's Ratio	0.3	
8	Bulk Modulus	1104.2	MPa
9	Shear Modulus	509.62	MPa

5.1.1 Mesh



Statistics	
Nodes	27823
Elements	16338

Fig. 3: Meshing of the regular steering wheel

5.1.2 Boundary condition

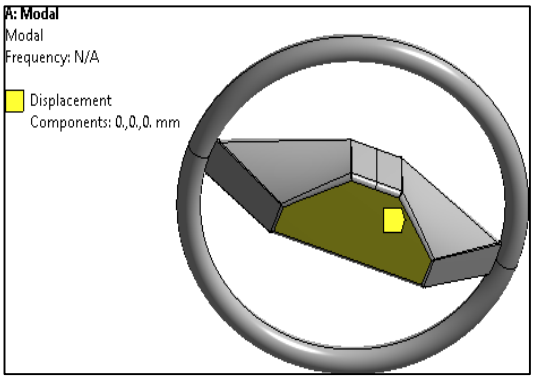


Fig. 4: Boundary condition of the regular steering wheel

5.1.3 Total deformation

The total deformation and directional deformation are general terms in finite element methods irrespective of software being used. Directional deformation can be put as the displacement of the system in a particular axis or user-defined direction. Total deformation is the vector sum all directional displacements of the systems.

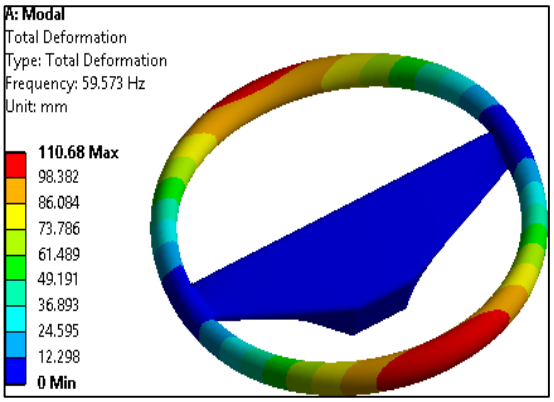


Fig. 5: Total deformation of regular steering wheel mode 1

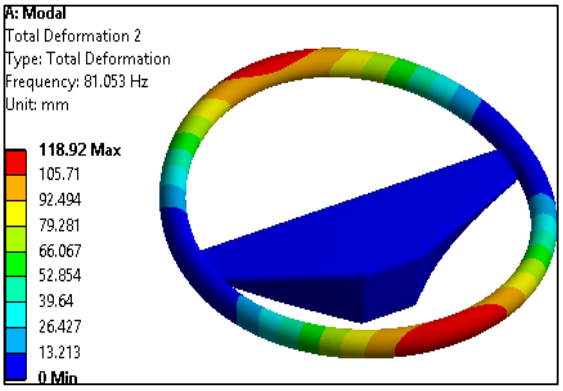


Fig. 6: Total deformation of regular steering wheel mode 2

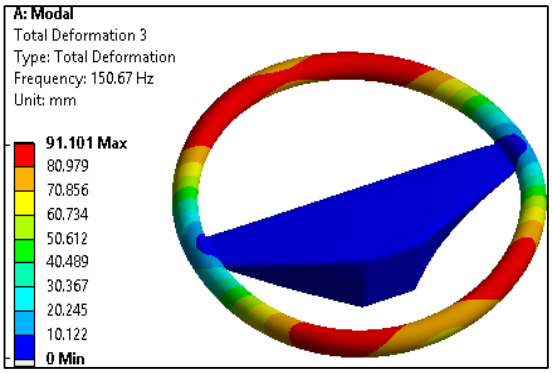


Fig. 7: Total deformation of regular steering wheel mode 3

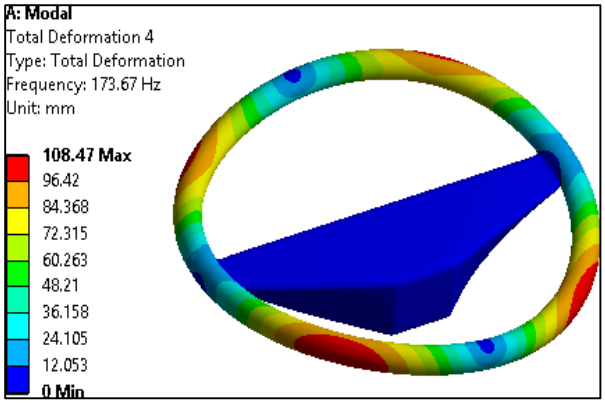


Fig. 8: Total Deformation of regular steering wheel mode 4

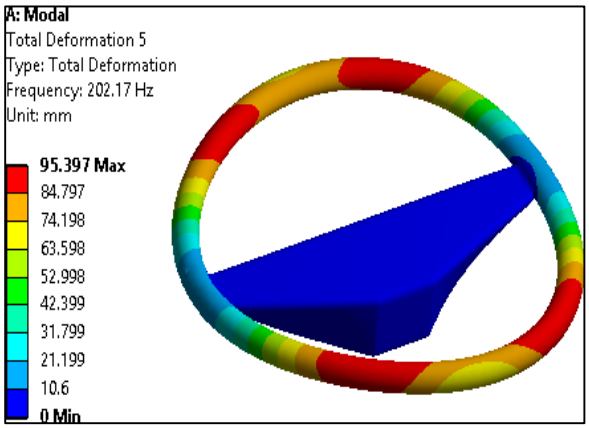


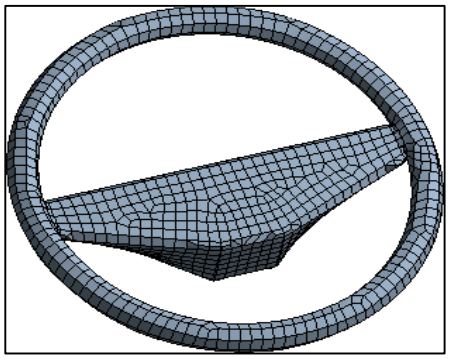
Fig. 9: Total Deformation of regular steering wheel mode 5

5.2 Carbon fiber steering wheel material properties

Table 2: Material properties carbon fiber

Properties of Outline Row 3: Epoxy Carbon UD (395 GPa) Prepreg

	A	B	C
1	Property	Value	Unit
2	Density	1.54E-09	mm^-3 t
3	Orthotropic Secant Coefficient of Thermal Expansion		
8	Orthotropic Elasticity		
9	Young's Modulus X direction	2.09E+05	MPa
10	Young's Modulus Y direction	9450	MPa
11	Young's Modulus Z direction	9450	MPa
12	Poisson's Ratio XY	0.27	
13	Poisson's Ratio YZ	0.4	
14	Poisson's Ratio XZ	0.27	
15	Shear Modulus XY	5500	MPa
16	Shear Modulus YZ	3900	MPa
17	Shear Modulus XZ	5500	MPa



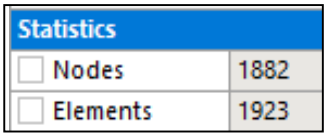


Fig. 10: Meshing of regular steering wheel carbon fiber steering wheel

5.3 Final FEA Result

Table 3: Frequency Comparison of regular and carbon fiber steering wheel

Mode no.	Regular Steering Wheel	Carbon fiber Steering Wheel
1	59.573	174.56
2	81.053	330.06
3	150.67	419.16
4	173.67	572.22
5	202.17	601.08

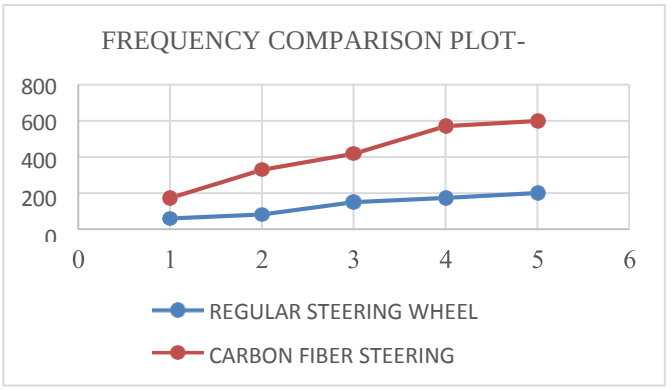


Fig. 11: Frequency Comparison graph of regular and carbon fibre steering wheel

6. FFT ANALYSIS

FFT is one principal property in any grouping being utilized by and large. To discover this property of FFT for some random arrangement, many changes are being utilized. The serious issues to be seen in discovering this property are the time and memory of the board. Two distinct calculations are composed for figuring FFT and Autocorrelation of some random grouping. Correlation is done between the two calculations as for the memory and time administrations and the better one is pointed. Correlation is between the two calculations composed, thinking about the time and memory as the main primary imperatives. Time taken by the two changes in finding the major recurrence is taken. In the mean- time the memory devoured while utilizing the two calculations is likewise checked. In light of these perspectives, it is chosen which calculation is to be utilized for better outcomes

6.1 DEWE-43 universal data acquisition instrument

Fig. 12: Regular Steering Wheel

When connected to the excessive-pace USB 2.0 interface of any computer the DEWE-forty three becomes a powerful dimension tool for analog, virtual, counter and CAN- bus information seize. Eight simultaneous analog inputs sample data at as much as 204.8 KS/s and in mixture with DEWETRON Modular Smart Interface Modules (MSI) an extensive scope of sensors are strengthened Voltage, Acceleration, Pressure, Force,

Temperature, Sound, Position, RPM, Torque Frequency, Velocity and extra. The covered DEWE Soft software programming includes remarkable estimation and exam capacity, reworking the DEWE-43 right into a committed recorder, degree or an FFT analyzer.

Fig. 13: Carbon Fiber Steering Wheel

6.2 FFT test results

6.2.1 For regular steering wheel

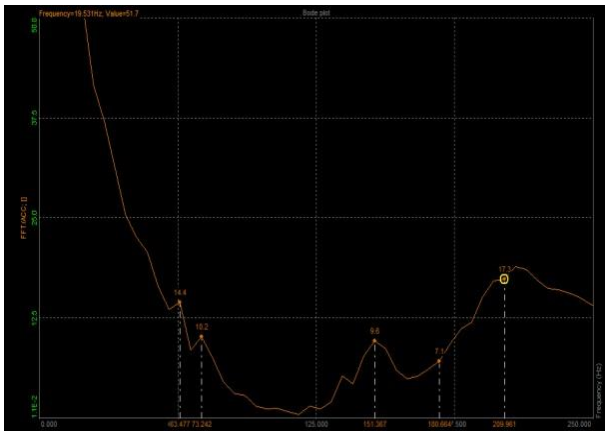


Fig. 14: Regular Steering Wheel

Table 4: Comparison of the regular steering wheel

Mode no	Regular steering wheel(fea)	Regular steering wheel (test)
1	59.573	63.47
2	81.053	73.24
3	150.67	151.36
4	173.67	180.66
5	202.17	209.96

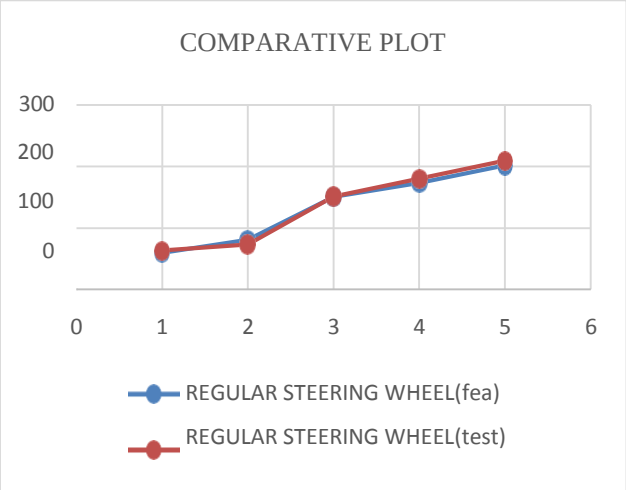


Fig. 15: Comparison graph of the regular steering wheel

6.2.2 Carbon Fiber Steering Wheel

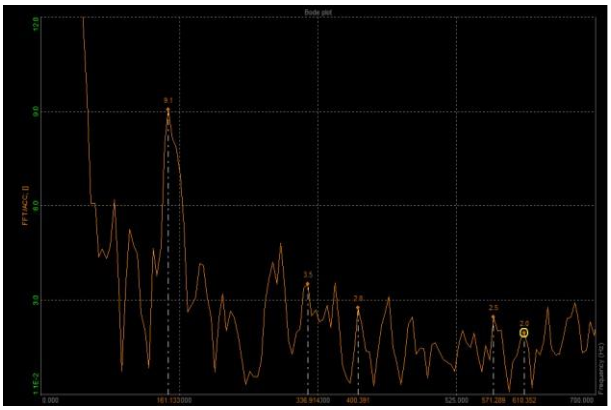


Fig. 16: Carbon fibre steering wheel

Table 5: Comparison of Carbon Fiber Steering Wheel

Mode no	Carbon fiber steering Wheel(fea)	Carbon fiber steering Wheel(test)
1	174.56	161.13
2	330.06	336.91
3	419.16	400.39
4	572.22	571.28
5	601.08	610.35

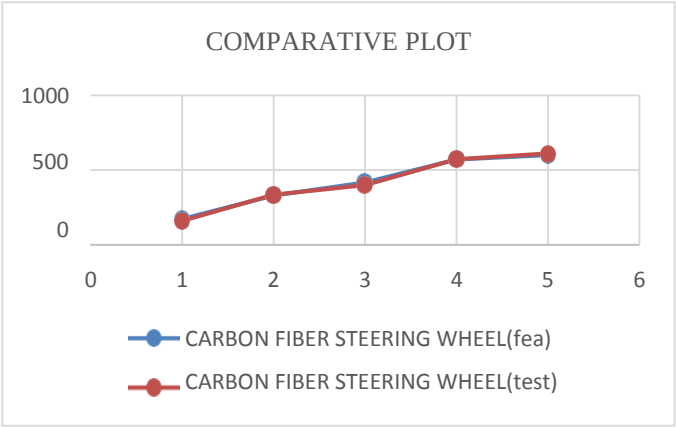


Fig. 17: Comparison graph of Carbon Fiber Steering Wheel

From table5 and graph5 we can see there is a good relation in FEA results and FFT testing results since the FEA test results are very close.

7. CONCLUSION

As per Table no.5 FEA and test results are quite nearer so it maintained validatory relation with the natural frequency.

Due to the use of carbon fiber material weight of steering wheel reduce to 490gm from 1229.5gm i.e., by 60% of the original weight.

The natural frequency of the Carbon Fiber steering wheel is maximum than Regular Steering Wheel so the stiffness of Carbon Fiber Steering increases.

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