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Vibration and Experimental Analysis of an Automobile Fender and its Optimization

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Abstract: In today's scenario, most of the Automobile Industries focus is on strength enhancement of automobile parts & reduction in the weight of the body parts of the vehicle. Normally Fender is used to avoid mud, sand, liquids and rocks and other road sprays from rotating tire that are thrown into the air. Fenders of heavy automobiles are manufactured from sheet metal which is having thickness less than 6 mm & are often subjected to vibratory loads which leads to Structural Failures. The 3D model of fender was made in the CATIA Software with the help of various tools. The Modal and Harmonic Analysis was carried out using ANSYS19.2. In Modal Analysis various mode shapes indicating minimum to maximum deformation with images were obtained and also Natural frequencies were known, In Harmonic Analysis it was seen whether the plane sheet fender or sheet with parallel ribs or sheet with cross ribs performs better. The experimental Fast Fourier Transform was carried out. Comparative analysis was carried out between Analysis results and experimental results for frequencies. FEA of Original Fender and Original Fender with Parallel vertical ribs was carried out. In result, output acceleration for sheet with vertical parallel ribs was found to be optimized.
Keywords: Automobile Fender, Vibratory loads, Structural Failure, Modal analysis, Vibrational Analysis

I. INTRODUCTION

The fender's component used for the wheel wells will be always larger than the diameter of the tire, that's why, they do not move with the consequently and tire suspension must be broad enough to allow the full range of tire motion on the suspension avoiding the touch of the interior of the wheel well. The streamlined 1949 Nash 600 and Ambassador design was first to feature fenders that were used for the front wheels. More elaborate designs include fender skirts for encasing the external edge of the wheel well, and stylized pontoon fenders for exposed fenders. The panel which covers along with bolts on the wheel of dual rear and frontal wheel pickup trucks also heavy load trucks and other vehicles is called as a fender. An automotive truck with a different bed but excluding bolt on fenders has a bedside, which will be acting as if it is doing work of a fender. When the side bed of truck is attached by welding to the cab, as with the Cadillac's Escalade model and Chevrolet's Avalanche model, it is called a quarter panel. The automotive industry is determined to make the lightweight designs to get the cost and weight advantages along with customer delight. So main priority is given on how less thick the of frame or body panels that is its minimum thickness and utilization of substitute materials.

II. LITERATURE SURVEY

S.M. Chavan and Dr. R.B. Hiremath did their research on Simulation analysis and dynamic dent research in which say, In automotive industry there is an changing and increasing demand for higher quality external panels. Will better function i.e. will have better functional properties and also have lower weights. The wants for weight minimization has led to thinner sheets, shifting the use of high strength steels and a change from steel material to aluminum grades. This thickness minimization, which causes decrement in the dent resistance, inspired examination of the dent resistance against static and dynamic concentrated loads. This paper gives an idea of an investigation of how suitable is the explicit dynamic Finite Element Analysis as a way to obtain and understand the dynamic dent properties of the panel. This test performance is carried out on the body's external panel of utility kind of vehicle and covers two parts, in initial experimental test and analysis is done on developed test rig, this is interfaced and attached with the computer.[1]

Pankaj K. Bhoyar, C. M. Sedani and Monika S. Agarwal carried out their research on Superplastibility FEA ,in which they say excessively plastic forming is a near net-shape forming process which gives many advantages and perks over conventional forming activities including very low forming pressure under low die cast, low flow stress, more design flexibility, and the ability to shape hard metals to form complex shapes. However, low production rate due to slow forming process and less predictive capabilities provides a smaller number of accurate constitutive models for super plastic deformation, treated as a hurdle to the widespread

utilization of SPF. Late headways in finite element tools have shown while analyzing the complex super plastic forming performance. These tools can be utilized skillfully in order to develop optimized super plastic forming techniques to build up the future materials.[2] Mehmet Calisken and Vahdet Ucar in their work in Structural optimization with CADO states that, the aim here in this study and objective is to increase power to weight ratio of an alloy of a steel vehicle body without any structural weakness and to use an integrated engineering solution of ‘‘computer-aided design, engineering & optimization (CADO)’’. In this optimization study, firstly the body’s ‘‘computer-aided design (CAD)’’ parametric model has been made first for some static analyses are necessary for the design study. In the next step, some critical dimensions of the structure’s parts have been defined as design parameters. The aim of the optimization study is a depreciation as much as possible of critical equivalent stress value is under the yield limit. In addition, study of sensitivity has to be studied on the model body with stress measures for a deep and clear analysis. In variety of steps, Pro/Engineer CAD and Pro/Mechanica computer aided engineering (CAE) software has been utilized.[3]
Sathish.K, Justin Dhiraviyam, Baskaran.s in their research study on Design and the fabrication of two-wheeler mudguard with Sisal natural fibre states that, In the todays context scenario automobile industries are enthusiastically focusing on enhancing the strength of a body and reducing its weight of body parts. In two wheelers mudguards are provided to prevent and to be protected from the dirt’s particle and sand particles in tire from entering and ruining and damaging other parts. Now a days most of which are made from ABS/Polypropylene plastics. They are of high cost already and not completely degradable that’s the disadvantage. In their work an attempt has been made to use strong and abundantly and amply available sisal plant fibers as reinforcement in epoxy resin to make low-cost, higher strengths and less weight substitute for mudguards.[4]
Gujja Sunil Kumar, B. Naresh, Ch. Sunil in their research study on Fabrication using carbon fibre for bike mudguard state that, Carbon fiber composites are moving into the main stream for the automobile industry, and also in aircraft industries, they are even finding more places to discover themselves and to be used in other various industries. Basically, Carbon fibers are the man-made materials and are artificial fibers. These fibers have high strength to weight ratio when compared to that of Natural fibers and also some artificially made fibers such as Glass, Kevlar and Aramid etc. In this research project carbon fiber is embedded and mixed in a biopolymer matrix system (epoxy), the work of which is to hold the fibers with each other, this gives and stabilizes the shape of the composite structure and transmits the shear forces mechanically in between the high-quality fibers, and safeguards them against radiation and other aggressive and hazardous media and the specimen preparation is done. The components conditions are fixed and are prepared for testing and tensile test and bending tests are done and compared to the existing part.[5]
Sanjay Kumar S.M, D.P. Girish in their study on Design and Fender analysis states that, Fender is a front and rear outer sider member of a car situated on wheels, which covers the wheel side. It has so many small features with crests and troughs. The surface binding is not a planer one in this case. This is because to decrease the draw depth and it has two rows of draw beads. It looks to be non easy to form because of their small radius fillets. In this analysis, there is a need to find out the forming feasibility of this component and if impossible in single stage then we have to modify and change the die design with very much low numbers of modification and need to optimize the draw bead profile and draw radius in such a way that we can get the good component in a single stage only. For thin and very big forming dies, we have to do gravity analysis. If our die face is profiled one, then we may have to do binder wrap analysis. The binder wrap analysis results are taken to the forming analysis. After this is done, if trimming is there means just before trimming the analysis we must have do mesh coarsening. Then the coarsened mesh and its results are taken for trimming analysis. The results obtained out of the trimming analysis are given to the spring back analysis. From the results of the spring back analysis, next we can cross check the spring back of the real component. The analysis results obtained is used in sheet metal industry for metal forming process.[6]

III. PROBLEM STATEMENT

Mudguards are subjected to vibratory loads which lead to structural failures. Hence, achieving the optimum design through FEA helps in reduction of structural failures which increases the life span of mudguard or a Fender**.**

IV. OBJECTIVES

A. To Optimize the Fender by modification in design.
B. Finite Element Analysis.
1) Obtaining natural frequencies and mode shapes for the fender plates with plane sheet, sheet with parallel vertical ribs and plate with cross ribs.
2) With base excitation of 5g, obtaining the frequency responses for the plane sheet fender, Fender plate with vertical parallel ribs and fender plate with cross ribs.

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3) Observing the output acceleration for all 3 plates, and to find out optimum result from FEA.

C. To perform Experimental Validation for optimum design, which we have obtained using FEA, and maintaining error between the frequencies below 10%.

V. SCOPE

A. The present system of dissertation work represents correlation between the results of theoretical analysis and experimental analysis of an automobile Fender.

B. Theoretical results have been validated with the experimental results. Finite element modeling, Modal shapes and Harmonic analysis of an Flat plate fender and Fender plate with parallel ribs and cross ribs has been completed in ANSYS Workbench.

C. Simulation results are used for result verification in colored visual manner.

VI. METHODOLOGY

A. Literature survey was done with the help of research papers relevant to the fender optimization. From that the importance of the FEA and structural analysis, Importance of Mode Shapes and Vibration Analysis was noted and according to that some basic concepts were considered.

B. After that the components which are required were decided.

C. After deciding the components, the drafting and 3 D Model is obtained with the help of CATIA software.

D. The Modal & Harmonic Analysis of the component are done with the help of ANSYS using FEA.

E. The experimental observations are taken on FFT Analyzer.

F. Comparative analysis is made between simulation and experimental results and then Results and conclusions will be drawn.

VII. FENDER OPTIMIZATION- PLANE SHEET

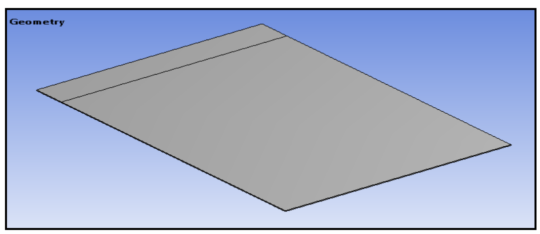
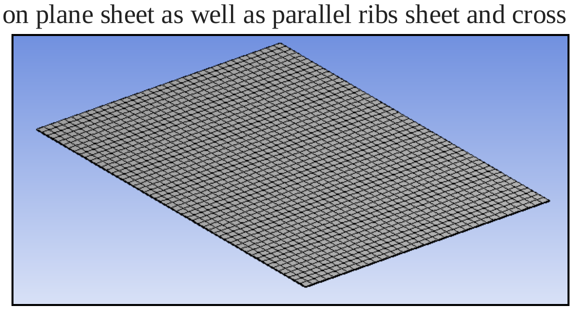


Fig.No.1 Geometry of fender with plane sheet

A. Mesh

ANSYS Meshing is an intelligent, automated for very high performance, general-purpose, intelligent, product. It gives out the most appropriate meshes for defect-free, accurate, very efficient Multiphysics solutions. A mesh which will be suiting for a specific analysis can be obtained with an ease with a single mouse click on ANSYS for all parts in a model. Full controls over the options that which can be modified, are used to generate the mesh and that are available for the experts in industry who wants to use it on full tune. The feature of parallel processing is automatically used to decrease the time when operate, and if not, you have to wait for mesh generation. Hex meshing is done on plane sheet as well as parallel ribs sheet and cross ribs sheet.



Statistics	
Nodes	19935
Elements	3500

Fig.No.2 Meshing of fender with plane sheet.

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B. Boundary Condition

A boundary condition for the model is the setting of a known value for a displacement or an associated load. For a particular node you can set either the load or the displacement but not both. The main types of loading available in FEA include force, pressure and temperature. These can be applied to nodes, edges, elements, points and surfaces or remotely offset from a feature.

A Fixed support is provided at one end and another end is set free.

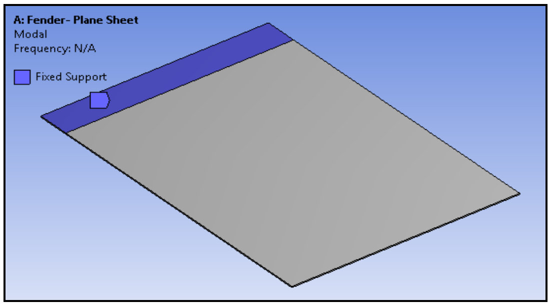
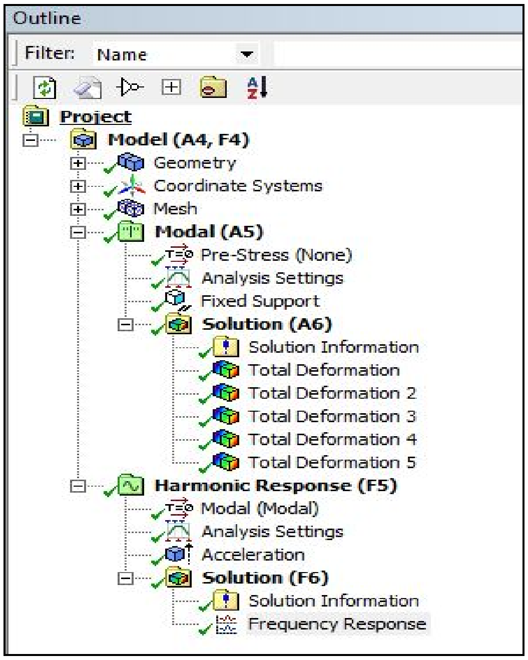


Fig.No.3 boundary condition of fender with plane sheet

C. Analysis Procedure



D. Total Deformation

The total deformation & 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 and total deformation is the vector sum of all directional displacements of the systems.

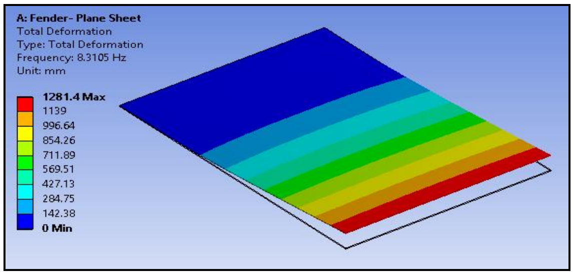


Fig.No.4: Total deformation of mode 1 fender with plane sheet.

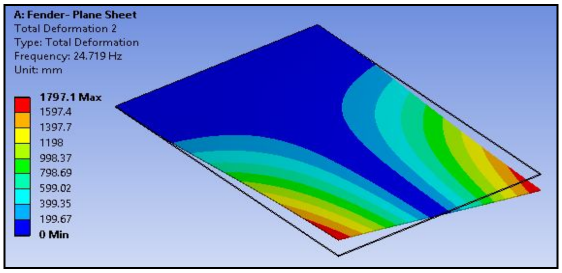


Fig.No.5: Total deformation of mode 2 fender with plane sheet.

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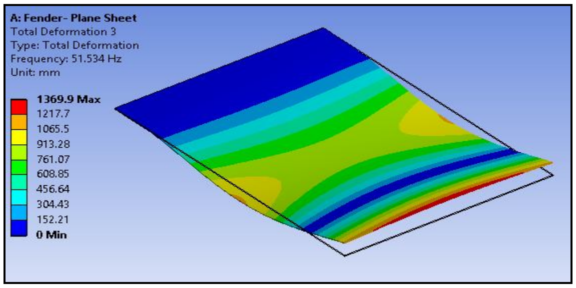

Fig.No.6: Total deformation of mode 3 fender with plane sheet

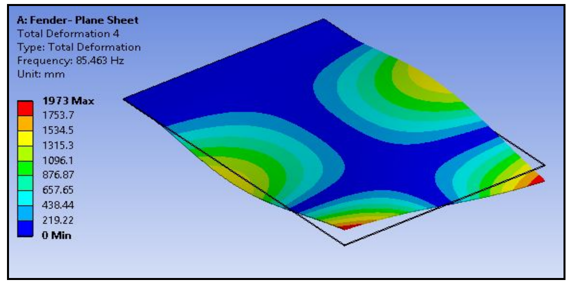

Fig.No.7: Total deformation of mode 4 fender with plane sheet

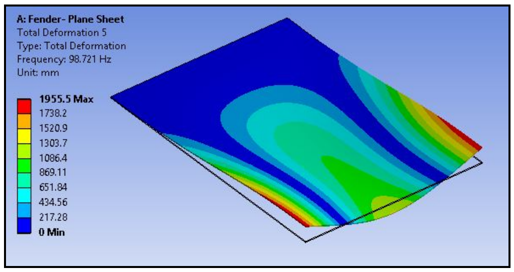

Fig.No.8: Total deformation of mode 5 fender with plane sheet

VIII. FENDER OPTIMIZATION OF SHEET WITH PARALLEL RIBS

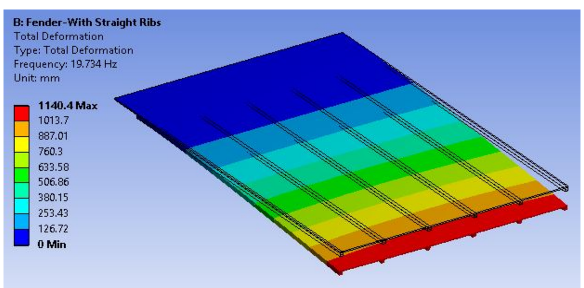

Fig no.9: Total deformation 1 of sheet with straight parallel ribs.

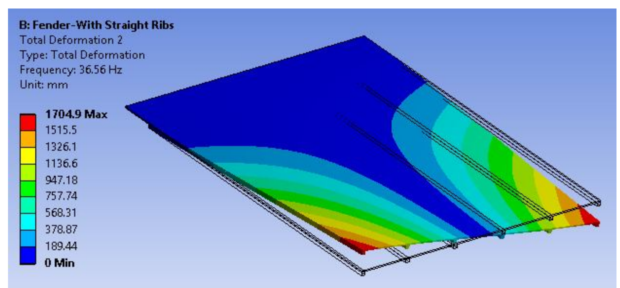

Fig no.10: Total deformation 2 of sheet with straight parallel ribs

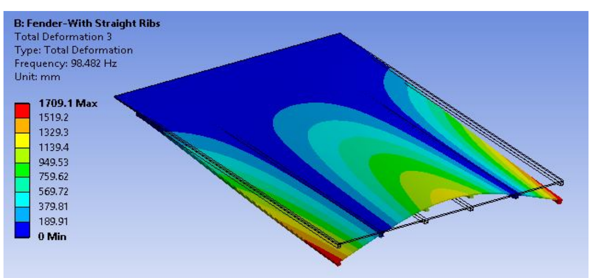

Fig no.11: Total deformation 3 of sheet with straight parallel ribs

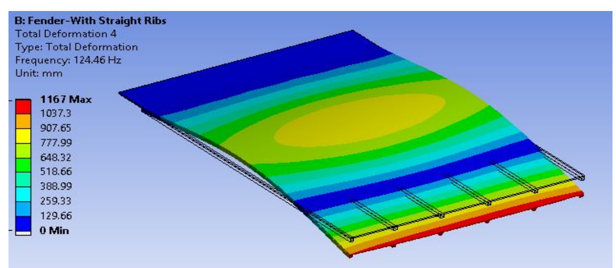

Fig no.12: Total deformation 4 of sheet with straight parallel ribs

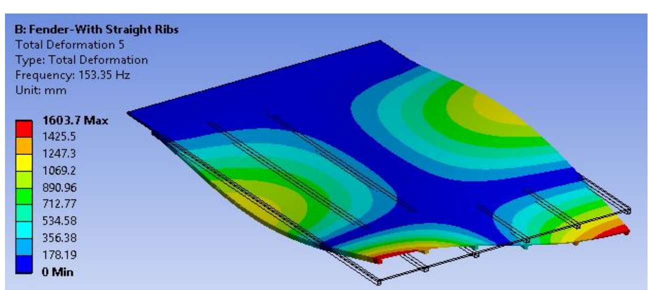

Fig no.13: Total deformation 5 of sheet with straight parallel ribs

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IX. HARMONIC ANALYSIS OF FENDER WITH PLANE SHEET

We are using plane sheet for the purpose of the harmonic analysis here in the first case, here for doing harmonic analysis we are giving excitation in the terms of acceleration of 5g at the fix end. It will give frequency response at the free end at different nodes, which will be analysed for plane sheet as well as with parallel ribs and cross ribs sheet.

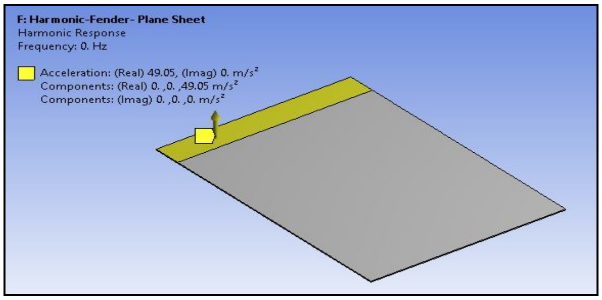

Fig no.14 Base Excitation- 5g acceleration

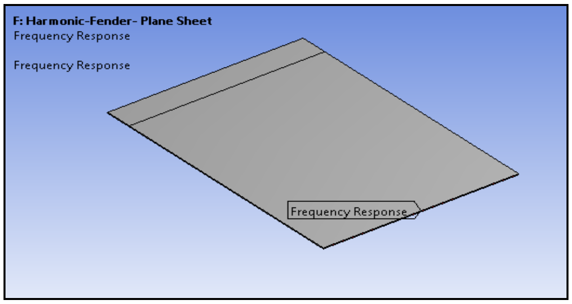

Fig No.15: Frequency Response

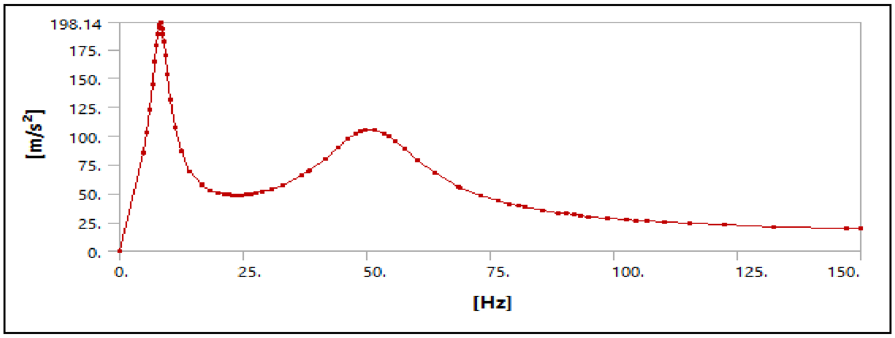

Fig No. 16: Acceleration Vs Frequency Response

X. HARMONIC ANALYSIS OF FENDER SHEET WITH PARALLEL RIBS

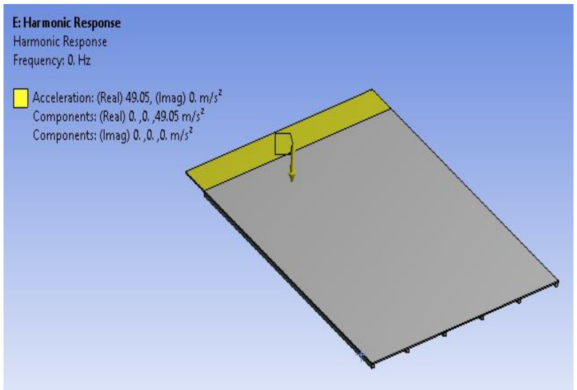

Fig no. 17 Basic Excitation 5g

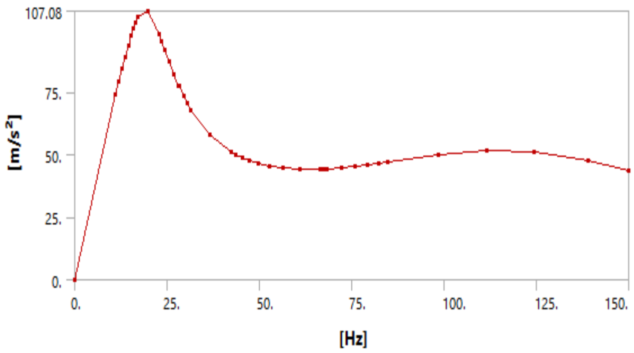

Fig No. 18 Acceleration Vs Frequency Curve

Table No. 1 : Natural Frequencies Result table

Mode no	Natural Frequency Plane sheet (Hz)	Natural Frequency Vertical ribs (Hz)	Natural Frequency Cross ribs (Hz)
1	8.3105	19.734	17.154
2	24.719	36.56	55.654
3	51.534	98.482	104.98
4	85.463	124.46	182.27
5	98.721	153.35	191.76

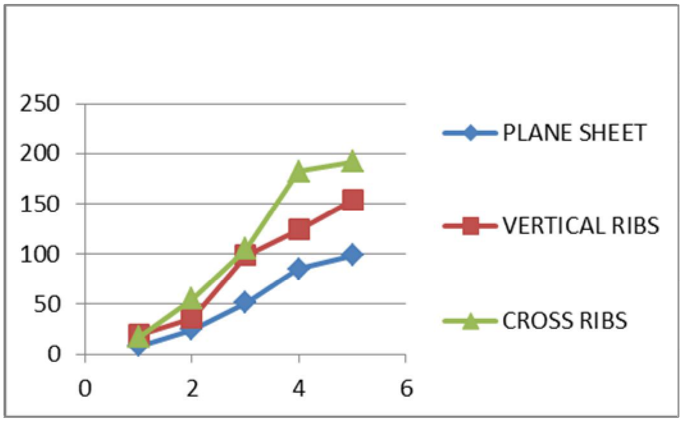

Table No. 2: Harmonic analysis result table

Sr.No	Characteristics	Plane Sheet	Vertical Rib	Cross Rib
1	Nodes	19935	23223	34750
2	Elements	3500	3770	17289
3	Acceleration(m/s^2)	198.14	107.08	194.31

XI. FFT ANALYSIS

FFT is one main characteristic in any sequence being utilized in general. To discover this property of FFT for any given sequence, many transforms are being utilized. The serious issues to be noticed in discovering this property are the time and memory management. Two unique algorithms are written for calculating FFT and Autocorrelation of some random arrangements. In between the two algorithms correlation is carried out with respect to the memory and time managements and the better one is obtained. Examination is done in between the two algorithms and is written, considering the time and memory as the only main primary requirements. Time taken by the two changes in obtaining the fundamental frequency is noted. In the meantime, the memory absorbed while using the two algorithms is also verified. Based on these aspects it is decided which algorithm is to be used for better results.

A. DEWE-43 Universal Data Acquisition Instrument

When connected to the high speed USB 2.0 interface of any computer the DEWE-43 becomes an amazing measurement instrument for data obtaining of analog, digital, counter and CAN-bus. Eight immediate analog inputs sample data at up to 204.8 kS/s and in combination with DEWETRON Modular Smart Interface modules (MSI) a wide scope of sensors are upheld Voltage Acceleration Pressure Force Temperature Sound Position RPM Torque Frequency Velocity And more The included DEWESoft application software adds incredible measurement and analysis capability, turning the DEWE-43 into a good and powerful recorder, scope or FFT analyser.

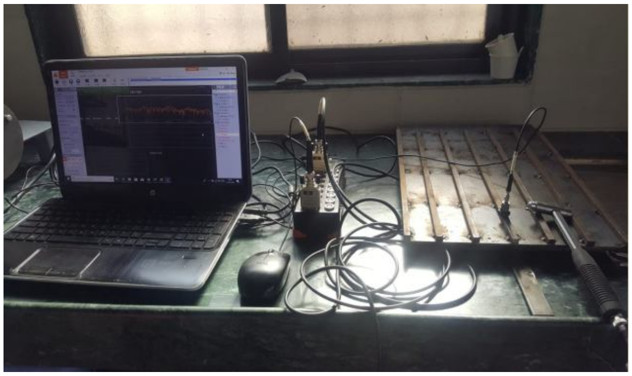

Fig.No.19 Experimental setup of FFT

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XII. TEST FFT RESULTS

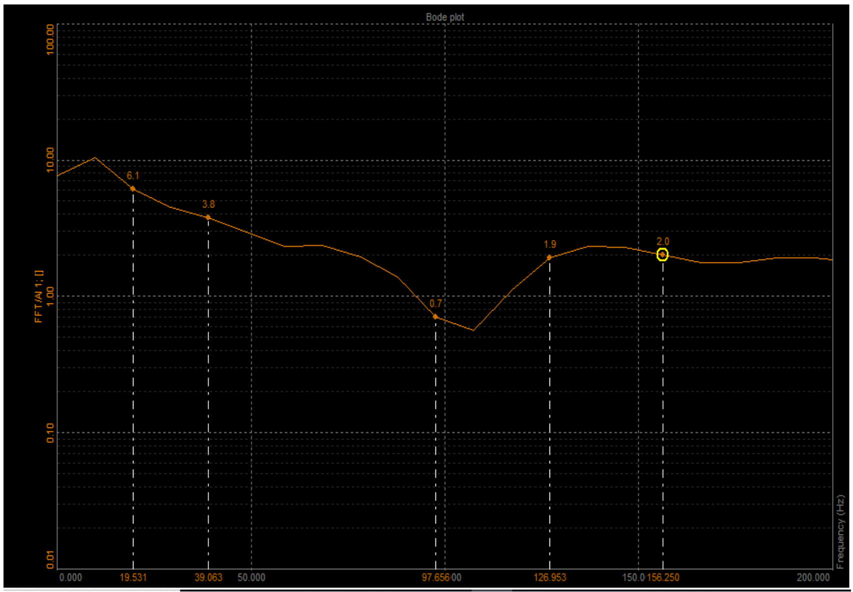

Fig.No.20 Testing result of Fender harmonic analysis

XIII. RESULT -TEST AND FEA COMPARISON

Table No.3: Result- Test and FEA Comparison

Mode No	Natural Frequency of vertical parallel ribs (FEA) (Hz)	Natural Frequency of vertical parallel ribs (FFT Test) (Hz)
1	19.734	19.53
2	36.56	39.06
3	98.482	97.65
4	124.46	126.95
5	153.35	156.25

XIV. CONCLUSION

A. The output acceleration for fender sheet with parallel ribs was least, Hence giving maximum stiffness.

B. Performing Finite Element Analysis on plane fender sheet, Fender sheet with vertical parallel ribs and fender sheet with cross ribs, following conclusions can be made.

1) Mode shapes and frequencies for all 3 fender sheets were noted and in FEA it is seen that maximum natural frequencies were given by sheet with cross ribs. Also Angular model and Angular ribbed optimized Fender's frequencies were noted and maximum frequencies were given by Angular model fender with optimized design. (With vertical parallel ribs).

2) With base excitation of 5g, maximum output accelerations for plane sheet, sheet with parallel ribs and cross ribs sheet were observed. And least output acceleration was observed for sheet with vertical parallel ribs.

C. For sheet with Vertical Parallel Ribs, the FFT testing was done and frequencies obtained from both analytical and experimental results were found matching with less than 10% error.

XV. ACKNOWLEDGMENT

The author would like to take the opportunity to thank who gave us their indebted assistance. I wish to extend my cordial gratitude with profound thanks to our internal guide Prof. G. L. Suryawanshi. I am also thankful to Prof. S. M. Jadhav, PG Co-ordinator for his overwhelming support and invaluable guidance. My sincere thanks and deep gratitude to Head of Department, Prof. D. H. Burande and other faculty members. At last but not least I express my sincere thanks to the Institute's Principal Dr. Y. P. Reddy**,** for providing us infrastructure and technical environment.

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REFERENCES

[1] Baskaran.S, Justin Dhiraviyam, Sathish. K, "Design and Fabrication of Two Wheeler Mudguard using Sisal Natural Fiber", SSRG-International Journal of Mechanical Engineering, Volume 4, Issue 1, January 2017, pp. 1-4.

[2] Jesús M. Blancoa, Aiert Buruagaa, Eduardo Rojib, Jesus Cuadrado, Belinda Pelaz, "Energy assessment and optimization of perforated metal sheet doubleskin fac¸ades through Design Builder", ELSEVIER, Energy and Buildings, Volume 111, 2016, pp. 326-336.

[3] Sanjay Kumar S.M, D.P.Girish, "Design and formability analysis of fender component", International Research Journal of Engineering and Technology, volume 5, Issue 4, 2016, pp. 330-332.

[4] Gujja Sunil Kumar, B. Naresh, Ch. Sunil, "Fabrication of Carbon Fibre Bike Mudguard", International Journal of Innovative Science Engineering and Technology, Volume 2 , Issue 11, Nov 2015, pp 776-782.

[5] Muhammad Asyraf Bin Abdul Jalil, "Evaluation and Sensitivity Analysis for Selecting the Best Design of Automotive Fender Using Analytic Hierarchy Process (ahp)", Technical University of Malaysia, Melaka, 2014-15, pp. 1-9.

[6] Vikas Palve, Gyanendra Roy, "Vibration Fatigue Analysis of Sheet Metal Fender Mounting Bracket & It's Subsequent Replacement with Plastic", Altaire Technology Conference, 2015, pp.1-9.

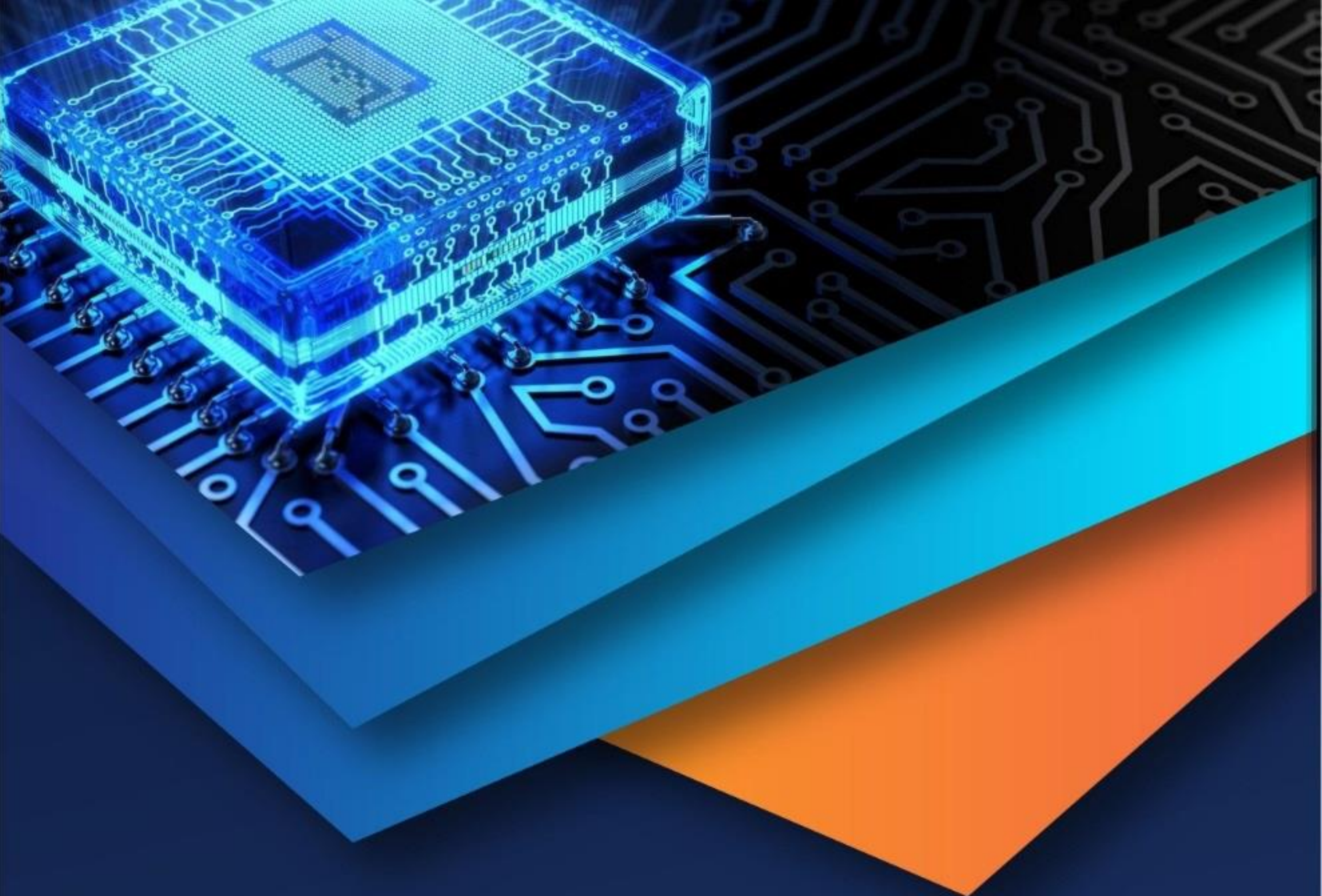
[7] Pankaj K. Bhoyar, C.M. Sedani , Monika S. Agrawal "FEA of Superplastically formed Front Fender Car Panel", International Journal for Mathematical Modelling and Computing, Advanced materials Manufacturing & characterization, Volume 3, Issue 1, 2013, pp. 237-242.

[8] S.M.Chavan, Dr.R.B.Hiremath "Simulation Analysis of Dynamic Dent Resistance on Auto Body Panel", International Journal of Engineering Research and Applications, ISSN: 2248-9622, volume 2, Issue 5, Sept-Oct 2012, pp.1453-1457.

[9] Zhiyu Jiang, Mintong Gu, "Optimization of a fender structure for the crashworthiness design", ELSEVIER, Material and Design, volume 31, 2010, pp.1085-1095.

[10] Ines Ribeiro, Paulo Pec, Arlindo Silva, Elsa Henriques, "Life cycle engineering methodology applied to material selection, a fender case study", ELSEVIER, Journal of Cleaner Production volume 16, 2008, pp.1887-1899.

[11] Xiao-yun Zhang, Xian-long Jin, Wen-guo Qi, Yi-zhi Guo, " Vehicle crash accident reconstruction based on analysis of 3D deformation of the auto-body, Advances in Engineering Software, volume 39, 2008, pp. 459-465.



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