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DAMPING ANALYSIS OF HIGH STRENGTH ALUMINUM A356 ALLOY COMPOSITE

Sowmya K[1], Dr. Maruthi B H[2], Dr. Guruprasad H L[3], Raj Kumar K[4]

1 PG Student, 2 Professor & HOD, 3 Associate Professor, 4 PG Student

Deportment of Mechanical Engineering

East West Institute Of Technology, Bengaluru-91,

Karnataka, India

Abstract- The work is aimed at the study of the effect of vibration characteristics of aluminum alloys of different compositions. The modeling and analysis will be carried out using ANSYS software. A modal analysis will be carried out to understand the vibration behavior i.e., natural frequency and mode shapes, of the material considered. The mode shapes and natural frequency play an important role in the design of dynamic machines. The harmonic analysis will be done to determine frequency characteristics.

Keywords- Finite Element Analysis (FEA), ANSYS, Vibration Behavior, Harmonic Analysis.

I. INTRODUCTION

Materials are so significant in the improvement of human development that the history specialists have recognized early times of progress by the name of most fundamentally utilized material, for example Stone Age, Bronze Age. Materials have influenced and controlling an expansive scope of human exercises through a huge number of decades. Grouping of Engineering Materials when all is said in done the materials are named 1) Metals and Alloys, 2) Ceramics, Glasses, and Glass-earthenware production, 3) Polymers (plastics), Thermoplastics and Thermosets, 4) Semiconductors.

Composites are not only valuable in making things fly. Vehicles of things to come must be more secure, progressively efficient, and all the more earth cordial, and composites could help accomplish every one of the three. Thus there is an incredible requirement for materials with uncommon properties with the development of new innovations. Along these lines, developed another class of designing materials for example composites. A composite material is made out of fortification implanted in a framework. The grid holds the support to frame the ideal shape while the fortification improves the general mechanical properties of the lattice.

A356 compounds are composites where is aluminum (Al) is the significant metal. The unmistakable alloying components are copper, magnesium, manganese, silicon, and zinc. A356 composite surfaces will concoct a white, defensive layer of consumption aluminum oxide if missing unprotected by anodizing and right artistic creation methods. When all is said in done, stiffer and lighter structures can be accomplished with A356 compounds than is conceivable with prepares. In car building, vehicles made of A356 compounds utilize space outlines made of expelled profiles to guarantee unbending nature.

In this current work limited component Geometric Modeling made utilizing catia V5 and 3d model import to ansys workbench 19.2 static basic examination exposed to pressure conditions, strain relocations and dynamic investigation to discover six intial modes and corresponding normal frequency. The coincided model is exposed to certain limit conditions. It is done in three unique advances:

(i) Linear Static Analysis.
(ii) Dynamic investigation
(iii) Life estimation

The displaying and limited component examination will be done utilizing ANSYS workbench 19.2 programming. The static basic and modular investigation will be done to comprehend the vibration conduct.

II. LITERATURE REVIEW

Maher Rehaif Khudhair1 and M. Gopi Krishna Mallarapu took a shot at MMCs are promising materials under steady turn of events and their application in various businesses is expanding. The work introduced in this paper is focused on the investigation of vibration qualities of aluminum A356 with various fortifications. A356 amalgam and Al–20Cu–10Mg combination framework has been researched as lattice and fortifications. Modulus of flexibility of composites was found from pliable test, and the examples are blended through mix throwing method by scattering high quality amalgam particulates (HSAP) rapidly and ceaselessly to the vortex, and ingot into a Cast Iron barrel shaped form.

Shiva Prasad, Shiva Kumar, Ch.Santosh Kumar Reddy took a shot at Aluminum composites are truly outstandingly utilized as a bit of different projects because of their huge burden to quality homes. Numerous investigations works had been done to consider and improve the mechanical places of aluminum blends. The arrangement of alloying portions foresee a central part in picking the properties of a blend. The inevitable consequences of numerical frameworks have been perceived through and monstrous as they enthusiastically encourage with the check works out as expected. In the current assessment a numerical assessment contraption i.E., controlled area assessment (FEA) is utilized.

Jufu Jiang, Guanfei Xiao, ChangjieChe and Ying Wang dealt with the 2024 nanocomposite fortified with Al2O3 nanoparticles were manufactured by the ultrasonic-helped semisolid blending (UASS) strategy and improved into a chamber segment. Microstructure, mechanical properties, and wear conduct of the improved composite parts were explored.

K Logesh, P Hariharasakthisudhan, An Arul Marcel Moshi, B Surya Rajan and Sathickbasha K dealt with In this test research work, the metal framework composites of A356 combination were set up by strengthening contrastingly formed particles Aluminum Nitride (AlN), Multi-Walled Carbon Nano Tube (MWCNT) and graphite (Gr). The principle goal of this examination work was to research the impact of various molded fortification in the microstructure and mechanical conduct of composites.

Khederet. al (2011), utilized fluid state blending procedure for getting ready composite of unadulterated aluminum fortified with SiC, MgO& Al2O3, and in this method, degasser was added to the substance of the composite while blending to limit gas rises at the last cast. It was discovered that the expansion of SiC, MgO& Al2O3 particulates into the lattice expanded the yield quality, a definitive elasticity and the hardness, and diminished extension (pliability) of the composites in examination with those of the framework. Expanding wt% of SiC, MgO& Al2O3 expanded their reinforcing impact yet SiC was the best fortifying particulates, for higher quality, hardness, and grain size decrease however it diminishes pliability and sturdiness.

III. FINITE ELEMENT APPROACH

An assessment of estimated is as yet a procedure where the deliberate repeat reaction limits are dismembered to locate a hypothetical model that practically all nearly resembles the dynamic activities of the structure under test. This specific thing of the modular test remains called exploratory modular assessment, regardless of the truth that this expression is still normally mistakenly utilized for the whole modular test. The method of information investigation proceeds in 2 stages:

Distinguishing the fitting model sort (with gooey and basic damping). This choice remains regularly by and furthermore confined by programming utilized for any modular investigation. Most of programming groups manage one kind of damping and furthermore give no decision to the client.

Deciding fitting subtleties of the chose model. This point, as Weise known as modular subtleties extraction, stays finished by twist fitting on the surveyed repeat response abilities to the hypothetical articulations.

IV. FINITE ELEMENT METHOD

Procedure actions in Fem Modeling

- Description of Continuum
- Selection of suitable interpolation model
- Derivation of the component stiffness matrix
- An assemblage of component formulas to get the equilibrium equations
- Enforcing the boundary condition
- The solution of arrangement situation to locate nodal values of remainsplacement
- Computation of component strains as well as stresses

4.1 GEOMETRY

The process is mostly done with the aid of computers and for applications that are also computer-based. Computer typography and technical drawing are done based on two-dimension problems while computer-aided design (CAD/CAM) is done based on three dimension.

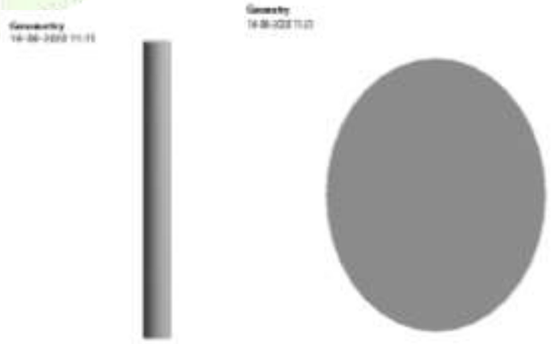

Fig 4.1: isometric view of Aluminium A356 Alloy Composite

4.2 FEM MESHING

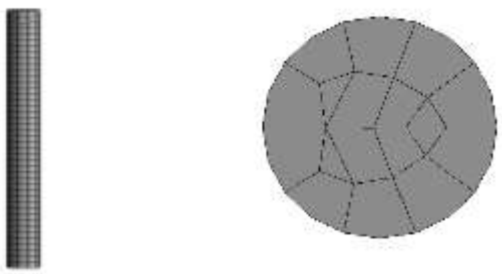

Fig 4.2: Meshing model of Aluminium A356 Alloy

The above figure 4.2 Meshing model of Aluminium A356 Alloy Composite using hex dominant method and the total number of element 34643 and 73643 Nodes.

4.3 MODAL ANALYSIS

Recognizing the proper sort of model, This choice is frequently by and by limited by programming utilized for the modal analysis. Most of the software bundles work with one kind of damping and give no decision to the client.

Deciding fitting boundaries of the picked model. This stage, furthermore called modular boundaries extraction, is done by twist fitting of the deliberate repeat response abilities to the hypothetical articulations.

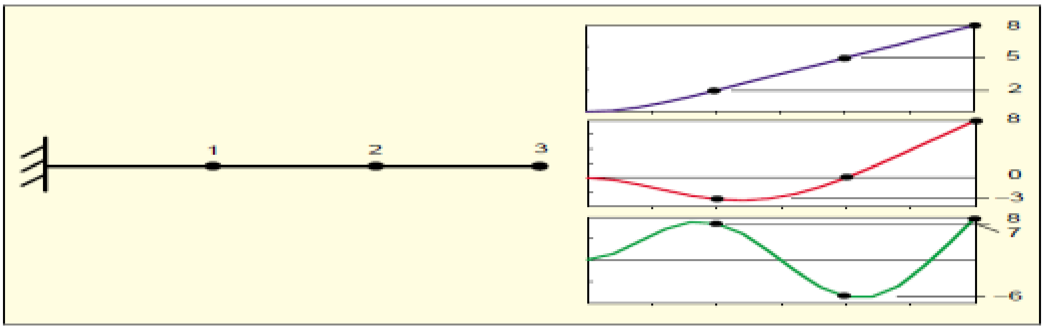

Fig 4.3: A 3 DOF model of a beam.

The above figure 4.3 shows .A 3 DOF model of a beam. One end of cantilever fixed and other end will be free , initial six modes and natural frequency

V. RESULTS AND DISCUSSION

5.1 CASE 1 ALUMINUM ALLOY

TABLE 5.1: different modes and corresponding natural frequency

Sl No.	No Of Modes	Frequency
1	1	131.49
2	2	131.5
3	3	815.85
4	4	815.89
5	5	1940.1
6	6	2223.6

Fig 5.1: First damping mode

The above figure 5.1 shows First damping mode and corresponding natural frequencyis131.49 Hz and mode shape is primary y direction.

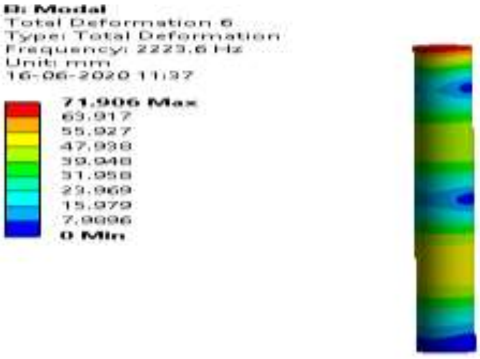

Fig 5.2: sixth damping mode

The above figure 5.2 shows sixth damping mode and corresponding natural frequency is 815.85 Hz and mode change in primary z torsional modes for applied load condition.

5.2 CASE 2: STRUCTURAL STEEL

TABLE 5.2: different modes and corresponding natural frequency

Sl No.	No Of Modes	Frequency
1	1	155.48
2	2	155.68
3	3	968.97
4	4	970.04
5	5	2612.1
6	6	2657.2

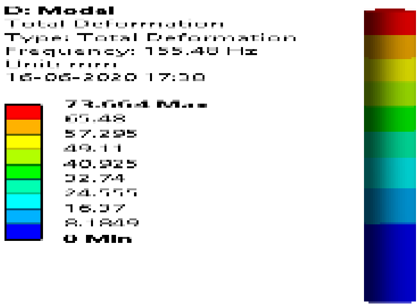

Fig 5.3: First damping mode

The above figure 5.3 shows First damping mode and corresponding natural frequency is 155.48 Hz and mode shape is primary y direction for applied load condition

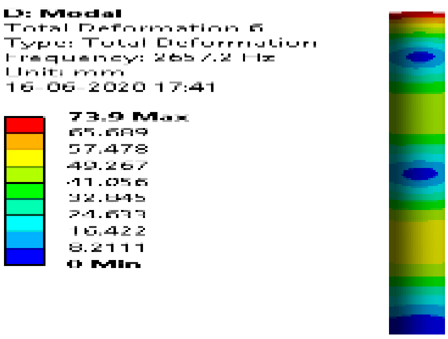

Fig 5.4: Sixth damping mode

The above figure 5.4 shows sixth damping mode and corresponding natural frequency is 2657.2 Hz and mode change in primary z torsional modes for applied load condition

5.3 CASE 3: ALUMINIUM A356 ALLOY COMPOSITE

TABLE 5.3: different modes and corresponding natural frequency

Sl No.	No Of Modes	Frequency
1	1	118.83
2	2	118.84
3	3	735.36
4	4	735.4
5	5	1727.4
6	6	2002.7

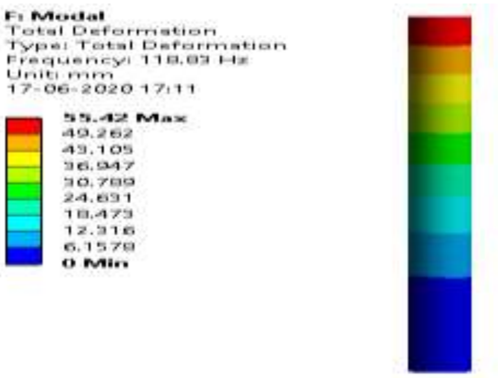

Fig 5.5: First damping mode

The above figure 5.5 shows First damping mode and corresponding natural frequencyis 118.80 Hz , mode shape is primary y direction for applied load condition.

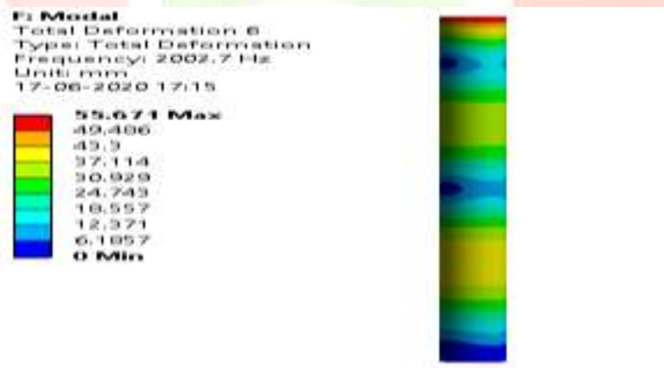

Fig 5.6:Sixth damping mode

The above figure 5.6 shows Sixth damping mode and corresponding natural frequency is 155.48 Hz and mode change in z direction for applied load condition.

Table 5.4: Comparison of damping frequency of Aluminum A356 alloy, structural steel, and aluminum alloy

Sl/no	Aluminium A356 AlloyComposite (Hz)	Aluminum alloy (Hz)	Structural steel (Hz)
1	118.83	131.49	155.48
2	118.84	131.5	155.68
3	735.36	815.85	968.97
4	735.4	815.89	970.04
5	1727.4	1940.1	2612.1
6	2002.7	2223.6	2657.2

VI. FATIGUE ANALYSIS

To aid in predicting the fatigue life of a component, fatigue tests are carried out using coupons to measure the rate of crack growth by applying constant amplitude cyclic loading and averaging the measured growth of a crack over thousands of cycles. However, many special cases need to be considered where the rate of crack growth obtained from these tests needs adjustment. Such as the reduced rate of growth that occurs for small loads near the threshold or after the application of an overload; and the increased rate of crack growth associated with short cracks or after the application of an under load.

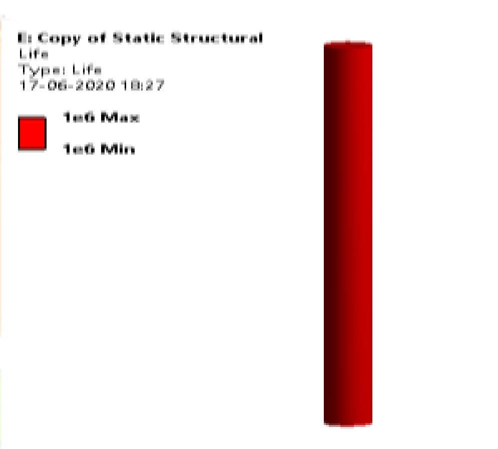

Fig 6.1: fatigue life estimation of Aluminium A356 alloy

The above figure 6.1 Above image explain about fatigue life estimation of Aluminium A356 alloy , it life estimated up to 1000000 cycles for the repeat load condition

Goodman diagram

Mean Stress can be calculated from,

$$\sigma_{mean} = \frac{\sigma_{von}}{2}$$

Where σ_{von} = Equivalent von-Misses Stress

$$\sigma_{mean} = \frac{\sigma_1 + \sigma_2}{2}$$

$$\sigma_{mean} = 16.32 \text{ MPa}$$

Where

σ_1= Maximum Principal Stress

σ_2= Minimum Principal Stress

Number of cycles:

$$N_f = \left\{ \frac{[\sigma_{ult} - \sigma_{ult}(\frac{1}{fos} - \frac{\sigma_a}{\sigma_e})]}{\sigma_a} \right\}^{\frac{1}{0.08}}$$

Where,

Nf=Fatigue life σe=Endurance limit

σutl=Ultimate stress σa=Alternating stress

Fos=Factor of Safety

$$N_f = 0.99 \times 10^6$$

The resulting life of failure obtained by the analytical method is greater than Cycles hence it is high cycle fatigue.

CONCLUSION

Linear static structural analysis has been carried out to estimate the maximum stress, strain, and deformation in Aluminium A356 Alloy Composite. It is found that peak stress of 230 Mpa, total deformation of 0.088329 mm is obtained and compare with aluminium alloy and structural alloy

The initial damping modes and corresponding natural frequency of Aluminium A356 Alloy Composite, structural steel and aluminum is compared damping properties less inAluminium A356 Alloy, for the aluminium alloy131.49 Hz and for the structural steel 155 Hz when compare with all three alloy best result im aluminium A356 which is good use in aircraft domain because of good damping property and less weight

Fatigue of aluminium A356 alloy was carried out for 1000000 cycles of startup and shutdown, the fatigue life results obtained is more than 1000000 cycles, hence the design is safe

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