COMPARISON OF THE VIBRATION PROPERTIES OF MATERIALS AA2124/SiC/25p and ALUMINUM 6061-T6

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Abstract: Vibration characteristics of 2124A/SiC/25P metal matrix composites and aluminum 6061-T6 materials are compared with FEA. These materials, which are widely used in the aircraft industry is different vibration characteristics. These materials are usually subjected to dynamic loadings in aerospace. Vibration analysis that is determined from stress and frequency is important vibration analysis is important. Therefore, in this study, vibration response of two different materials were examined. Vibration analysis using a distributed point and forced damped was performed in the MSC ACTRAN program. Metal matrix composites according to the aluminum alloy were found to be more stable against vibration resistance.

Keywords: Metal Composite, Vibration, Analyses

Introduction

Aluminum and its alloys are used commonly in aerospace and transportation industries because of their low density and high strength to weight ratio. Especially Al-based Metal Matrix Composites (MMC) exhibit high strength, high elastic modulus, and improved resistance to fatigue, creep and wear; which make them promising structural materials for many industries (Kurt, 2011). The high cost of current MMCs compared to aluminum alloys has inhibited production on a large industrial scale (Kevorkijan, 1998). Aluminum 2124 alloy is a high strength wrought alloy generally used in aerospace industry for making structural components. Addition of high wear resistant ceramic particles, such as SiC, Al_2O_3, AlN, B_4C, TiC to the alloy is expected to increase the mechanical properties considerably. These MMCs suffer from the disadvantage of low ductility which is due to different reasons, like brittle interfacial reaction products, poor wettability, particle-matrix deboning or presence of porosity or particle clusters (Bauri, 2011; Uyyuru, 2006).

Composites are much sought after materials for a variety of industrial applications owing to their improved mechanical properties over the conventional alloys and materials. MMCs are the forerunners amongst different classes of composites. Al-based MMCs are well known for their high specific strength, hardness and wear resistance. During sliding against metals and abrasives, many studies have reported that MMCs exhibit better wear resistance than the un-reinforced alloys (Wai, 2000).

Table 1. AA2124/SiC/25p and ALUMINUM 6061-T6 composition

Cu	Mg	Mn	Si	Al
3.86	1.52	0.65	0.17	93.8

The plates used in this study are AA2124-T4 alloy matrix MMC strengthened with 25 % SiC particles (AA2124/SiC/25p-T4). This material was supplied by Aerospace Metal Composite Limited (UK) in form of billet with size of 400 mm × 260 mm × 50 mm. The MMC material was produced by powder metallurgy and mechanical alloying techniques followed by hot forging and tempering to T4 condition (solution heating at about 505 °C for 1 h, quenching in 25 % polymer glycol solution and room temperature aging for >100 h). The ultimate tensile strength of the base AA2124/SiC/25p-T4 MMC is of 454 MPa. The chemical composition of the AA2124/SiC/25p-T4 MMC is shown in Table 1. MMC plates of 130 mm × 50 mm × 3 mm size were cut from this billet by electro-discharge machining (EDM) technique with a feding rate of 2 mm/min. The microstructure of AA2124/SiC/25p MMC is shown in Fig. 1. In the AA2124 alloy matrix consists of an almost uniform distribution of the SiC reinforcement. In the longitudinal and transverse directions, the SiC particle-free regions are observed in AA2124/SiC/25p MMC. These particle-free regions were elongated along the forging direction. The forging process did not induce cracking in the reinforcement or at the interface SiC particles/matrix.

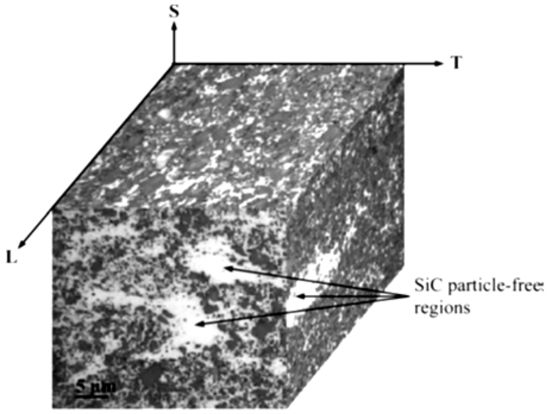

Fig 1. The AA2124/SiC/25p MMC microstructure in the longitudinal (L), transverse (T) and short transverse (S) directions after forging (Donskoy, 1998)

These MMC materials are using in aerospace industrial. The use of composite materials has been increasing consistently in aerospace applications due to their high specific stiffness and strength. However, the mechanical properties of composite materials.

Modal analysis is the most important part of the dynamic analysis. We can investigate natural frequencies and mode Shapes by using this modal analysis. Therefore, Finite Element Analysis (FEA) is commonly used for performing modal analysis. In this study presents a FEA for vibration properties of materials AA2124/SiC/25p and Aluminum 6061-T6.

Acoustic and vibration effect to cause various defects such as cracks, deboning, fatigue, and etc. lead to anomalous high levels of nonlinearity as compared with flawless structures. Actually, as long as the vibration function is known, the degraded image can be simulated with an original image. And by contrast of the theoretical features and the measured features of degraded images' spectrum, reliability of the simulation method can be validated. The Finite element methods and the simulation algorithm can control the degradation parameters accurately and flexibly and provide great convenience to the restoration of the degraded images (Tang, 2011; Wang, 2017; Tester, 2004).

In aerospace design and calculated, researcher have used software for expensive and nonrepeating application. As Circumferential, turbofan and structural geometrics object. ACTRAN is commonly acceptable in acoustic and vibration analyses software. And a lot of aerospace projects have been used for acoustic and vibration analyses (Asghar, 1993; Edward, 1994).

In this paper, using material in aircraft industry compression with new generation material. These results include only Finite element analyses. In future these results according to experimental results.

Materials and Methods

As we know finite element analysis have been used frequently for vibration analysis. Therefore, this study uses MSC.ACTRAN software for vibration properties of two materials which are AA2124/SiC/25p and aluminum 6061-T6. In the finite element modeling procedure, a simply sheet modeling was prepared 130x50x3 mm and meshed in MSC.ACTRAN program. This plate is connected to a single edge as cantilever beams. Applied force point selected random away from connected side (Fig. 3). Selected point used for two materials analyses. Also this analysis used total number of elements is 520 in FEM model. The properties of the materials used were given in Table 2.

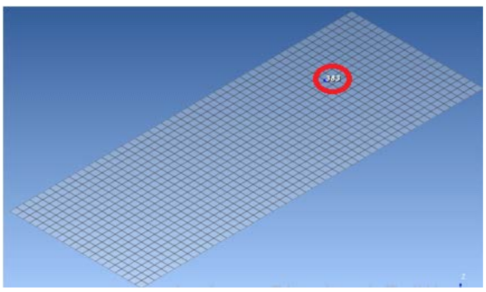

Fig 2. Location of applied frequency

Table 2. Material properties used in the analysis

	Elastic Module [GPa]	Poisson ratio	Density [g/cm3]
2124A/SiC/25p	115	0,3	2,88
Aluminum 6061-T6	69	0,33	2,7

The response of point and distributed forced damped vibrations applied to the plate was measured. Applied frequencies range is 0-5000 Hz.

Results and Discussion

In the analysis, it was detected natural frequency of the two different materials. Natural frequency of the AA2124/SiC/25p material is larger than the aluminum 6061-T6 (Fig. 3.). The material having a high natural frequency is known to be more rigid. This shows us that AA2124/SiC/25p material was later to undergo resonance and strength of the material.

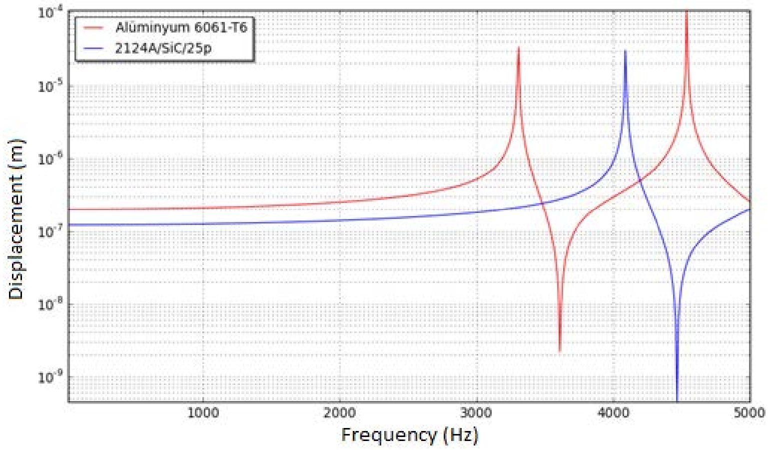

Fig. 3 Response of the plate against Point forced damped vibrations.

Figure 4 shows that when examined, there are two modes aluminum 6061-T6 plate because of applied frequencies range is 0-5000 Hz. But AA2124/SiC/25p material has only a natural frequency. Referring also to Figure 4, the displacements occurring in the material subjected to the same load the remaining two are different from each other. Displacement on MMK plate is considered to be less than aluminum plate.

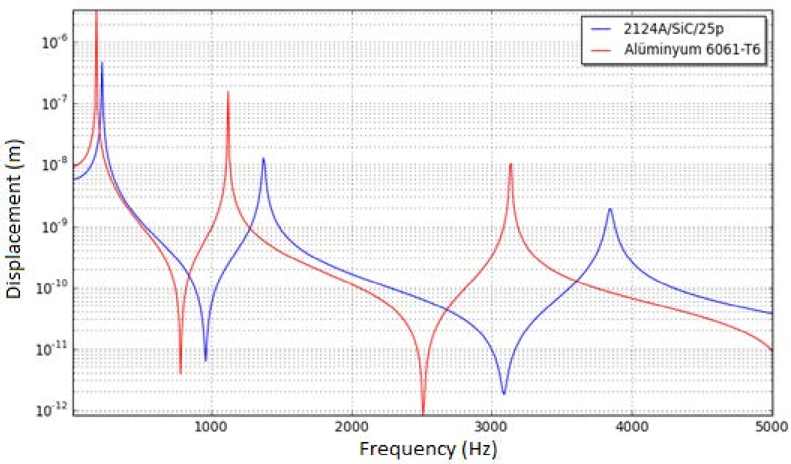

Fig. 4. Response of the plate against distributed forced damped vibrations.

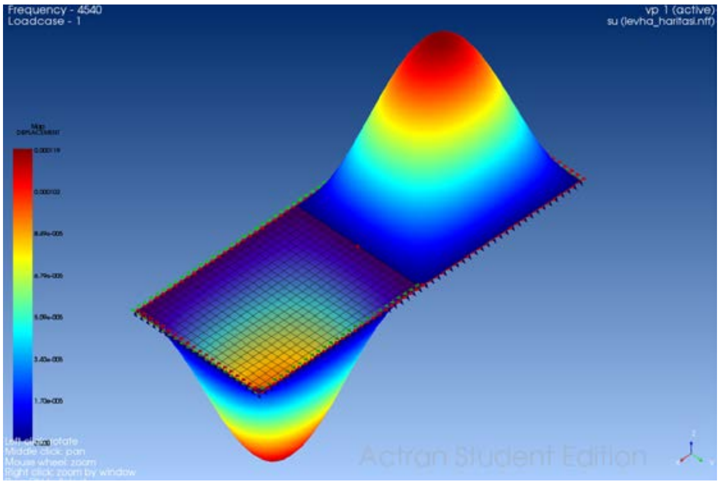

Fig. 5 Modal shape of aluminum 6061-T6 at 4540 Hz

Conclusion

In this study, AA2124/SiC/25p and aluminum 6061-T6 materials used in the aerospace industry have been compared to the vibration behavior. According to the analysis results, natural frequency value of AA2124/SiC/25p material is greater than the aluminum 6061-T6 materials. This shows us that this material is more resistant to dynamic loads. The aluminum 6061-T6 material has been shown to lower frequencies in change mode. Due to the properties owned by the AA2124/SiC/25p material is particularly important in terms of the aluminum 6061-T6 materials used in the aerospace industry.

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