EFFECT OF PERCENTAGE OF SI3N4 ON AL-6061 AND EPOXY RESIN COMPOSITES DURING ITS DRILLING OPERATIONS PROCESS THROUGH MODAL ANALYSIS

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Abstract - *Machining industries face the problem during generation of the perfect cylindrical hole on composite material due to the effect of vibration induced on it the size of the drill bit increases at beginning and tapers at the end an account of distribution of thrust and torque forces are affected by vibration effects. Hence an interesting factor has been cracked down by earlier investigators to minimize vibration during drilling operations by modal analysis. In the present investigation an attempt has been made to know the above effect on AL6061- Si3N4 and Epoxy resin based – Si3N4 composites. Different percentage of Si3N4 and machining parameters are based on Taguchi technique. Through drill tool dynamometer and infrared thermometer are used to record the thrust, torque and temperature liberated during drilling operations simultaneously vibrations are induced are measured with the help of vibrometer. At the end of the experimentation, it has been found that the presence of 10% Si3N4 on both composites has indicated the same value of delamination factor at entry and exit has been found for different diameters of drilled holes on i*

Key Words: Composites, Delamination, modal analysis, etc..

1.INTRODUCTION

In In the past three decades, the dominant new materials are composite materials, plastics and ceramics. The use range and quantity of composite materials have steadily increased, and new markets have been continuously penetrated and conquered. Modern composite materials occupy an important share of the technical resources marketplace. After normal products to complex niche submissions, the mechanical properties of metals at high temperatures, conductive polymers), which has led to new submissions. The tertiary aim is to develop resources by enhanced properties (e corresponds exactly. This actually leads to cost and weight savings. For example: the replacement of engine hoods, curved panels and throats, welded metal parts, cylinders, pipes, pipes, blade fixing bands, etc.,.

1.1 Metal matrix composites

Metal matrix composite in general, consists of a minimum of two elements one is termed the matrix, another is named the reinforcement. In MMC typically metal alloys are used as a matrix but pure metals are rarely used. Matrix and reinforcement combined on exhibits superior properties than the properties of the individual parts on their own. Generally, matrix is chosen on the premise of corrosion and oxidation resistance or different properties.

1.2 Polymer matrix composite

Generally, the hot temperature resistance property of the composites trust within the main on the matrix material rather than the reinforcement. (P-M-Cs) are engulfed with of an spread of short fibers certain on by a compound matrix. The fracture toughness are improved by adding reinforcement with ceramic matrix composite (CMC). The strengthening in an passing P-M-C delivers more-strength and toughness to the component.

1.3. Drilling in PMC and MMC

Different strategies of drilling are in used reminiscent of standard drilling, deep hole drilling and peck drilling. the kind of drilling operation depends on the size, tolerance, quality and range of drills required. Quality of the opening depends on the varied factors like Slicing, geometry, material used, work part material, and so forth the items which require to be controlled throughout drilling are cylindricity, roundness and delamination. For getting more good product excellence and acceptable method performance yield it's so essential to regulate and enhance many drillings parameters.

For this study it has been found that limited investigation has been carried out on different size of drilled holes on MMC and PMC composites In the this work an attempt has been made to soothen out the conical formation of different size of drilled holes on MMC and PMC Composites by using Modal-analysis.

2. EXPERIMENTAL SETUP

2.1 Material Selection

Aluminium (Al6061) based metal matrix composite and Epoxy resin based polymer metal matrix with o%, 6%, 10 % volume fraction of particulate silicon nitride has been selected for the present investigation processed by stir casting process.

Table .2.1 Raw material for A6l01 metal matrix with different percentage of Si_3N_4

Material	Quantity
Al6061 (Matrix)	600cm^3
Si_3N_4 (Reinforcement)	115gms
Beaker and stirrer	3 set
Mould set 100×100×20 mm (W×B×H)	3 set

Table 2.2: Raw material for epoxy with different percentage of Si_3N_4

Material	Quantity
Epoxy resin LY556 (Matrix)	600cm^3
Si_3N_4 (Reinforcement)	115gms
DY070 (Epoxy hardener)	60cm^3
Beaker and stirrer	3 set
Mould set 100×100×20 mm (W×B×H)	3 set

2.2 INSTRUMENTS USED IN THIS WORK

2.2.1 Video measuring machine

Video measuring system are specifically designed for non-touch measuring inspection of small complex capabilities on small or massive parts. These video dimension structures are a herbal step up from measuring microscopes and optical comparator. With granite base creation and metallic levels the machine gives long time accuracy and reliability.. The video measuring machine may be used to measure circularity cylindricity and delamination of numerous components and snapshots of dimension may be obtained. Video measuring machines can be configured with dimension software programs armetrology unique DROs

Figure 2.1 Video measuring machine

2.2.2 Setting machining parameters to drill a hole on material

Experimentation consists of drilling of AL metal matrix reinforced with various percentage of Si3N4 and epoxy resin polymer matrix reinforced with various percentages of Si3N4 composite. Drilling operation is done through automated drilling machine device using high speed steel. The available spindle speed and machine tool specifications are given in table 4.3in all slicing conditions for each drill thrust force, shaking, temperature, circularity and cylindricity are measured using dynamometer, shock pulse absorber, heat spy, Tool makers microscope and Internal micrometer respectively. Dynamometer is fixed below the work table to measure the thrust force. Heat spy is focused to the tool tip interface to measure the temperature of the tool. In drilling method thrust force and torsion are important parameter than cross feed and longitudinal feed force. Mechanical load is measured in terms of thrust force and torque. The test setup for mechanical load will be as shown in the figure 2.3.

Table 2.3 Machining parameters and levels

Machining parameters	Level 1	Level 2	Level 3
% of Si_3N_4	0	6	10
Cutting speed (rpm)	S_1 =360 RPM	S_2 = 490 RPM	S_3 = 680 RPM
Feed Rate (mm/rev)	F_1 = 0.095 mm/rev	F_2 = 0.190 mm/rev	F_3 = 0.285 mm/rev
Dill bit diameter (mm)	D_1 = 6 mm	D_2 = 8 mm	D_3 = 10 mm
Machining time (sec)	30	60	90

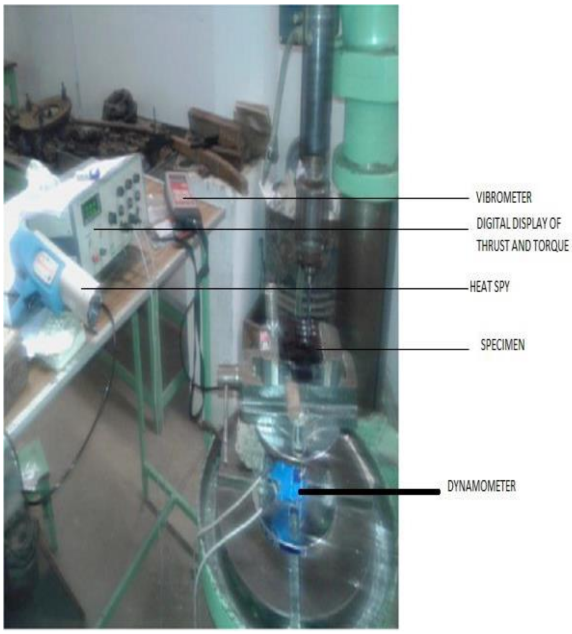

Figure 2.2 Test setup to drill a hole

3.0 EXPERIMENTAL PROCEDURE

3.1 PREPARATTION OF MMC

To prepare the aluminum with different percentage of Si_3N_4 the raw material required are shown in table 3.1

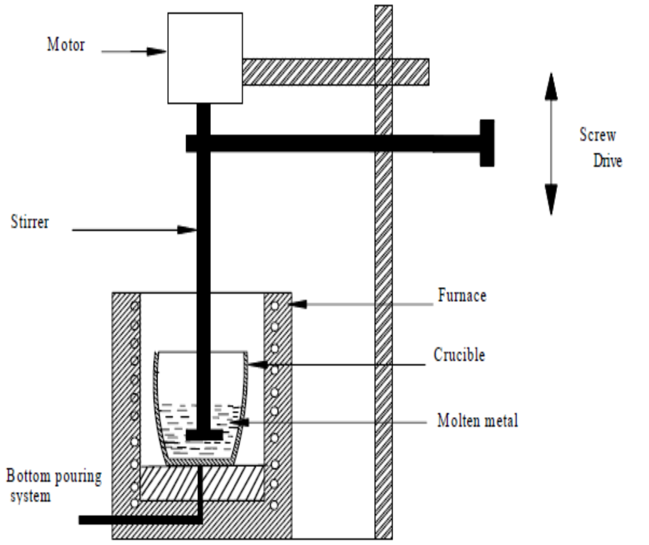

Figure 3.1 Preparation of MMC by stir casting method

The composite specimen is prepared by stir casting method. The required specimen dimension is 100*100*20. The beakers are label for different % of Si_3N_4 and 200cm³ of molten aluminum is poured into the crucible, then 6% and 10% of Si_3N_4 is add into the crucible based on the composition. The mixture is stirred well for 20 minutes to obtain the homogeneous mixture. Then the molten mixture is poured into the moulding set of dimension 100*100*20. Then the prepared specimen is kept at room temperature 24hr for curing. . After hardening the composite is check for any errors.

3.2 PREPARATION OF PMC

To prepare the epoxy with different percentage of Si_3N_4 the raw material required are shown in **table 2.2.** The composite is prepared by stir casting method. The beakers are label for different % of Si_3N_4 and 200cm3 of epoxy resin is poured into each beaker, then 6% and 10% of Si_3N_4 is add into the beaker based on the composition and 20cm3 of epoxy hardener is added to each beaker and stirred for 10 minutes for uniformity, then the solution is poured into the mould set of required dimension. The mould is kept at room temperature for about 24 hour to harden the composites and to avoid adherence the mould is covered by wax. After hardening the composite is check for any errors.

The cured material was chopped gently to cut into required size of 100 x 100 mm width and a thickness of 20 mm. The specimen was kept for heat treatment in the following range of temperature as per ASTM standards.

a) Heated up to 160^{0}C for first 2 hours
b) Heated down 160^{0}C for next 2 hours
c) Cooled to room temperature

Figure 3.2 Heat treatment of a specimen

3.4 Drilling a hole on Al6061-Sin and Epoxy Resin-Sin composites and Measurement of Experimental parameters

Drilling operation is performed on the Al metal matrix reinforced with various volume percentage of silicon nitride and epoxy resin polymer matrix reinforced with various volume percentage of silicon nitride. Various percentage of silicon nitride used are 0%, 6% and 10%. Drilling operation is performed for different machining parameters viz. Feed Rate (mm/rev), Cutting speed (rpm), Dill bit diameter (mm), Machining time (sec) based on the literature survey, experts suggestion, cutting tool catalogue and machine tool manual. Parameters considered for the design of experiment is shown in the table 4.10.the responses such as thrust force, torque, vibration, temperature, surface roughness, cylindricity and tool wear can be analyzed using Taguchi technique. Design of experiment is done using MINITAB software. The experiments were performed based on L27 orthogonal array based on single objective optimization by Taguchi's Technique using 2 level 5 factor experiment design for both metal matrix composite and polymer matrix composite. The designed worksheet is stored

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Table 3.1 Experimental results for Al6061 with different percentage of Si3N4

Runs	% volume of Si_3N_4	Speed (rpm)	Feed rate (mm/rev)	Dia. of drill bit (mm)	m/c time (sec)	Ra (µm)	Cylindricity (mm)	Delamination (mm)	
								Entry	Exit
1.	0	360	0.095	6	30	5.74	0.085	0.89	1.05
2.	0	360	0.095	6	60	4.036	0.1062	1.05	1.05
3.	0	360	0.095	6	90	4.091	0.0669	1.06	1.05
4.	0	490	0.19	8	30	1.865	0.108	1.05	1.03
5.	0	490	0.19	8	60	5.041	0.1353	1.04	1.08
6.	0	490	0.19	8	90	3.001	0.1327	1.04	1.08
7.	0	680	0.285	10	30	7	0.1178	1.06	1.05
8.	0	680	0.285	10	60	6.011	0.1344	1.04	1.07
9.	0	680	0.285	10	90	3.89	0.1398	1.07	1.07
10.	6	360	0.19	10	30	6.349	0.0928	1.05	1.06
11.	6	360	0.19	10	60	3.113	0.1345	1.05	1.06
12.	6	360	0.19	10	90	2.561	0.1290	1.03	1.04
13.	6	490	0.285	6	30	5.12	0.1050	1.05	1.06
14.	6	490	0.285	6	60	3.828	0.1320	1.05	1.07
15.	6	490	0.285	6	90	2.988	0.0710	1.06	1.07
16.	6	680	0.095	8	30	2.933	0.0790	1.05	1.06
17.	6	680	0.095	8	60	3.933	0.1060	1.03	1.07
18.	6	680	0.095	8	90	3.429	0.1259	1.06	1.07
19.	10	360	0.285	8	30	3.001	0.0860	1.05	1.06
20.	10	360	0.285	8	60	2.817	0.1390	1.06	1.06
21.	10	360	0.285	8	90	5.12	0.1300	1.06	1.06
22.	10	490	0.095	10	30	4.459	0.1540	1.02	1.02
23.	10	490	0.095	10	60	3.488	0.1160	1.03	1.03
24.	10	490	0.095	10	90	4.56	0.0638	1.03	1.04
25.	10	680	0.19	6	30	5.713	0.0990	1.05	1.05
26.	10	680	0.19	6	60	7.05	0.1159	1.06	1.06
27.	10	680	0.19	6	90	5.529	0.1031	1.04	1.04

Table 3.2 Experimental results for Al6061 with different percentage of Si3N4

Runs	% volume of Si_3N_4	Speed (rpm)	Feed-rate (mm/rev)	Dia-of drill bit (mm)	m/c-time (sec)	Thrust Force (N)	Torque (N-mm)	Vib. (mm/sec)	Temp. (^{0}C)
1.	0	360	0.095	6	30	40	9.76	0.5	34
2.	0	360	0.095	6	60	49.55	19.42	0.6	35
3.	0	360	0.095	6	90	59.06	19.56	0.8	37
4.	0	490	0.19	8	30	157.88	38.8	1	40
5.	0	490	0.19	8	60	186.98	49.76	1.1	42
6.	0	490	0.19	8	90	236.54	49.24	1.3	42
7.	0	680	0.285	10	30	461.89	128.04	1.6	47
8.	0	680	0.285	10	60	432.23	157.08	2.3	52
9.	0	680	0.285	10	90	363.57	119.24	2.1	57
10.	6	360	0.19	10	30	391.54	57.98	0.9	42
11.	6	360	0.19	10	60	422.09	69.07	1.1	46
12.	6	360	0.19	10	90	341.23	77.78	0.8	45
13.	6	490	0.285	6	30	272.17	28.13	1.7	43
14.	6	490	0.285	6	60	205.66	40.04	1.8	45
15.	6	490	0.285	6	90	194.89	11.81	1.8	46
16.	6	680	0.095	8	30	66.78	29.43	1.2	43

17.	6	680	0.095	8	60	57.01	27.04	1.5	44
18.	6	680	0.095	8	90	40	57.17	2.3	43
19.	10	360	0.285	8	30	57.77	57.66	1	44
20.	10	360	0.285	8	60	58.02	65.17	1.1	42
21.	10	360	0.285	8	90	67.67	50.43	1	49
22.	10	490	0.095	10	30	174.58	28.43	1.1	42
23.	10	490	0.095	10	60	155.06	27.13	1.2	44
24.	10	490	0.095	10	90	145.15	29.43	1.3	44
25.	10	680	0.19	6	30	100.01	38.14	1.6	45
26.	10	680	0.19	6	60	117.96	39.24	1.5	47
27.	10	680	0.19	6	90	175.99	48.75	1.7	48

Table 3.3 Experimental results for Epoxy resin with different percentage of Si3N4

Runs	% volume of Si_3N_4	Speed (rpm)	Feed rate (mm/rev)	Dia. of drill bit (mm)	m/c time (sec)	Ra (μm)	Circularity (mm)	Delamination (mm)	
								Entry	Exit
1.	0	360	0.095	6	30	4.598	0.10	1.05618	1.00594
2.	0	360	0.095	6	60	5.120	0.0725	1.03802	1.08055
3.	0	360	0.095	6	90	4.388	0.0615	1.02824	1.0695
4.	0	490	0.19	8	30	5.061	0.0515	1.03713	1.08932
5.	0	490	0.19	8	60	3.623	0.068	1.06815	1.06812
6.	0	490	0.19	8	90	5.375	0.0895	1.05634	1.09251
7.	0	680	0.285	10	30	3.604	0.2035	1.03277	1.07704
8.	0	680	0.285	10	60	5.342	0.07	1.03674	1.06079
9.	0	680	0.285	10	90	3.529	0.0675	1.03651	1.05681
10.	6	360	0.19	10	30	2.158	0.0885	1.04973	1.09188
11.	6	360	0.19	10	60	2.512	0.0855	1.04384	1.08726
12.	6	360	0.19	10	90	1.723	0.1225	1.00095	1.07532
13.	6	490	0.285	6	30	3.393	0.0675	1.03314	1.12614
14.	6	490	0.285	6	60	6.916	0.0675	1.05993	1.09811
15.	6	490	0.285	6	90	3.767	0.0445	1.03662	1.11226
16.	6	680	0.095	8	30	3.405	0.259	1.02554	1.11463
17.	6	680	0.095	8	60	6.01	0.095	1.04956	1.11856
18.	6	680	0.095	8	90	2.698	0.0715	1.03840	1.08027
19.	10	360	0.285	8	30	3.232	0.0945	1.05500	1.09532
20.	10	360	0.285	8	60	3.691	0.042	1.05913	1.08601
21.	10	360	0.285	8	90	4.652	0.0575	1.08691	1.09466
22.	10	490	0.095	10	30	1.558	0.0745	1.01353	1.07709
23.	10	490	0.095	10	60	1.341	0.095	1.01471	1.06295
24.	10	490	0.095	10	90	5.101	0.0905	1.02626	1.06855
25.	10	680	0.19	6	30	8.001	0.0383	1.08127	1.09337
26.	10	680	0.19	6	60	9.0383	0.0605	1.05078	1.11104
27.	10	680	0.19	6	90	6.401	0.0435	1.04507	1.14499

Table 3.4 Experimental results for Epoxy resin with different percentage of Si3N4

Runs	% volume of Si_3N_4	Speed (rpm)	Feed rate (mm/rev)	Dia. of drill bit (mm)	m/c time (sec)	Vib. (mm/sec)	Temp. (^0C)
1.	0	360	0.095	6	30	0.6	35
2.	0	360	0.095	6	60	0.8	38

3.	0	360	0.095	6	90	0.7	38
4.	0	490	0.19	8	30	1.3	40
5.	0	490	0.19	8	60	1	44
6.	0	490	0.19	8	90	1.7	44
7.	0	680	0.285	10	30	1.6	42
8.	0	680	0.285	10	60	1.5	45
9.	0	680	0.285	10	90	1.5	47
10.	6	360	0.19	10	30	0.6	43
11.	6	360	0.19	10	60	0.8	49
12.	6	360	0.19	10	90	0.8	48
13.	6	490	0.285	6	30	1.2	39
14.	6	490	0.285	6	60	1.2	43
15.	6	490	0.285	6	90	1.2	47
16.	6	680	0.095	8	30	1.3	40
17.	6	680	0.095	8	60	1.8	41
18.	6	680	0.095	8	90	1.7	52
19.	10	360	0.285	8	30	1	44
20.	10	360	0.285	8	60	1.1	44
21.	10	360	0.285	8	90	1.3	49
22.	10	490	0.095	10	30	0.9	48
23.	10	490	0.095	10	60	1.1	50
24.	10	490	0.095	10	90	1.2	47
25.	10	680	0.19	6	30	1.8	46
26.	10	680	0.19	6	60	1.2	43
27.	10	680	0.19	6	90	1.3	42

3.3 Modal analysis for 10%Al-Si3N4

Modal analysis is done for the Al6061 reinforced with different percentage of Si3N4. Model with 100mm×100mm×20mm crossectional area is built in CATIA V5R20. Then the built model is imported to ANSYS workbench 15.0. A default course mesh of 3 nodded triangular elements is developed with 100 relevance. The drill diameter section is meshed with refinement of two. The cad model of the Al6061 reinforced with 0%, 6% and 10 % Si3N4 is as shown in figure 3.4.

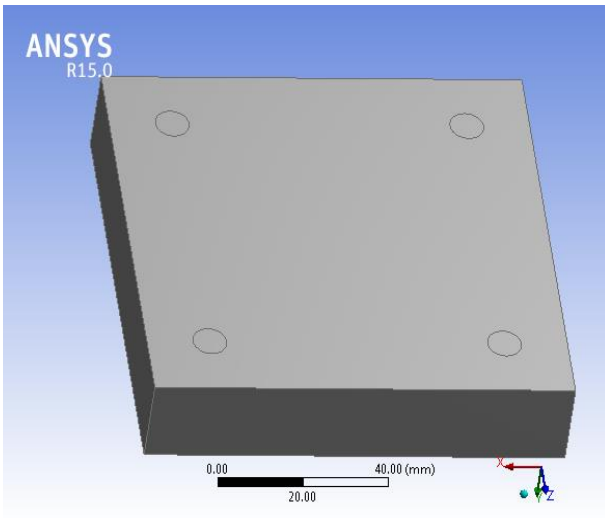
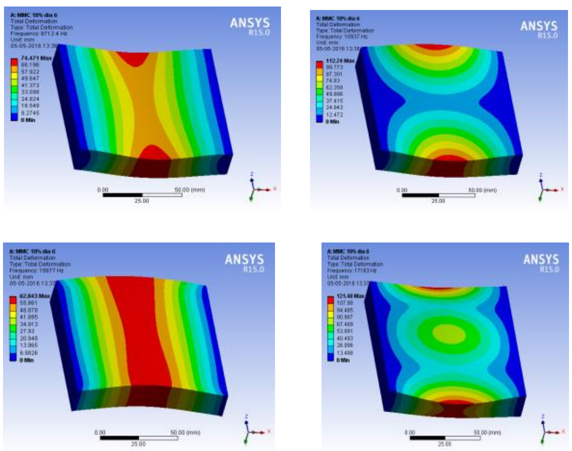


Figure 3.3.1 Cad model of the Al-Si3N4 composite

Table 3.3.1 Analytical natural frequencies of Al-10% Si_3N_4

Mode No	Frequency (Hz)
1	9712.4
2	10937
3	15877
4	17163
5	22107
6	23668



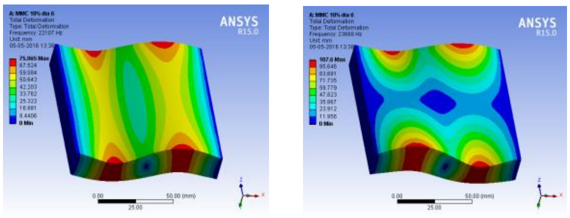


Figure 3.3.2 Six Mode Shapes under Total deformation condition for Al -10% silicon nitride

$$\omega_n = \frac{\beta_{nr}}{l^2}\sqrt{\frac{EI}{m}} \quad 3.1$$

$$I = \frac{bh^3}{12} \text{ or } \frac{b^3 h}{12} \quad 3.2$$

$$f_n = \frac{\omega_n}{2\pi} \quad 3.3$$

Where,
I = Moment of Inertia in mm4
m = Mass of the composite in kg
E =Young's Modulus in Mpa
β_{nr}=Eigen Values for different modes
l = length of the Speciment

Theoretical modal or natural frequencies are calculated for the remaining modes and the resulted frequencies are tabulated as shown in table 3.7. theoretical and analytical natural frequecies are compared and plotted in a graph as shown in figure 3.6. theoretical and analytical natural frequecies are almost coincide with each other.

Table 3.3.2 Theoretical natural frequencies of Al-10% Si3N4

Mode No	Frequency (Hz)
1	8862.647
2	9887.89
3	15819.82
4	17797.3
5	23729.73

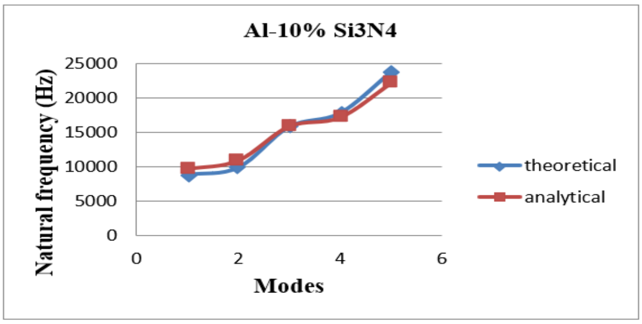


Figure3.3.3 Comparison of theoretical and analytical natural frequencies at different modes of Al- 10 Si3N4%

3.4 Modal analysis of Epoxy resin-Si3N4 (10%)

Modal analysis is done for the Epoxy resin reinforced with different percentage of Si3N4. Model with 100mm*100mm*20mm correctional area is built in CATIA V5R20. Then the built model is imported to ANSYS workbench 15.0. A default course mesh of 3 nodded triangular elements is developed with 100 relevance. The drill diameter section is meshed with refinement of two. The cad model of the Epoxy resin reinforced with 0%, 6% and 10 % Si3N4 s as shown in figure 3.7.

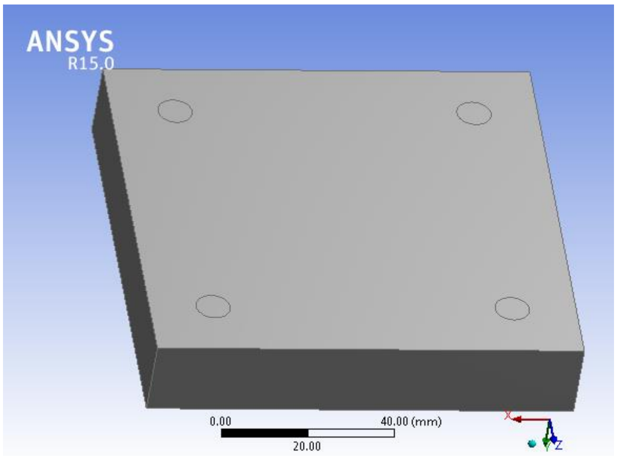


Figure 3.4.1 Cad model of the Epoxy resin-Si3N4(10%) composite

Table 3.4.1 Analytical natural frequencies of Epoxy resin-10% Si3N4

Mode No	Frequency (Hz)
1	8189.8
2	9277.6
3	13563
4	14517
5	18718
6	20103

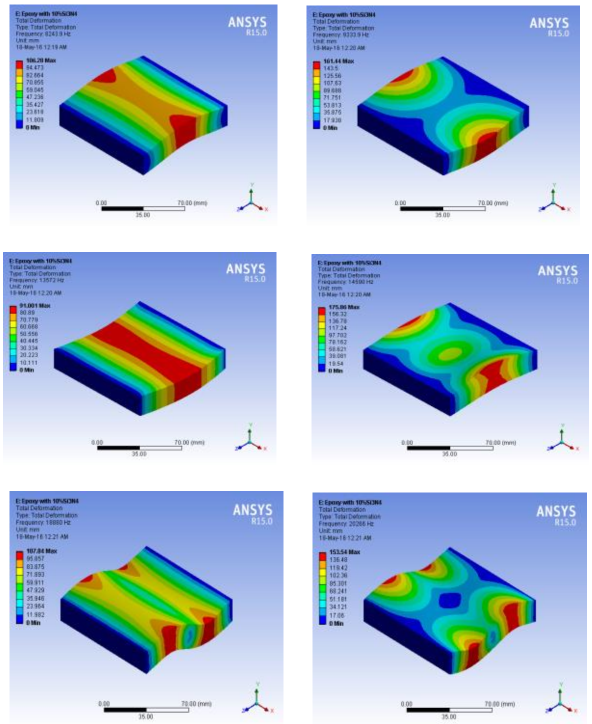


Figure 3.4.2 Six Mode Shapes under Total deformation condition for Epoxy resin -10% silicon nitride

Table 3.4.2 Theoretical natural frequencies of Epoxy resin-10% Si3N4

Mode No	Frequency (Hz)
1	7119.46
2	7943.056
3	12708.24
4	14296.77
5	19062.36

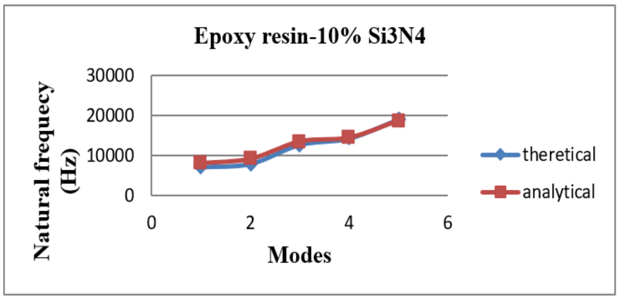


Figure 3.4.3 Comparison of theoretical and analytical natural frequencies at different modes of Epoxy resin-10% Si3N4.

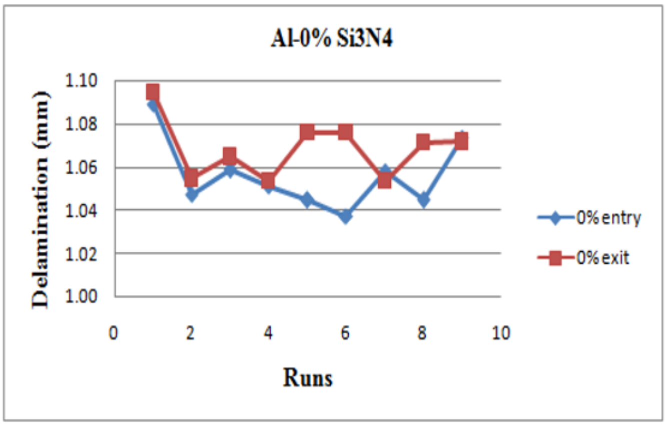
Theoretical modal or natural frequencies are calculated for the remaining modes and the resulted frequencies are tabulated as shown in table 3.9. Theoretical and analytical natural frequecies are compared and plotted in a graph as shown in figure 3.9.theoretical and analytical natural frequecies are almost coincide with each other.

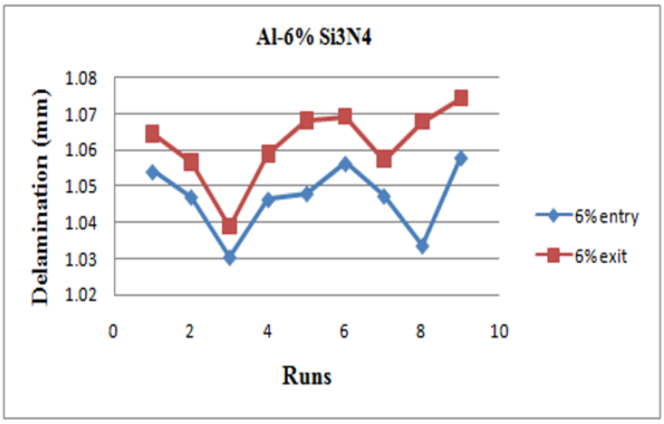
4. RESULTS AND DISCUSSION

From the above experimentation and finite element analysis the results can be discussed as follows Delamination discussion.

4.1 Experimental delamination of Al-Si3N4

Quality of the hole greatly affected by the delamination. Experimental delamination data is as shown in table 4.11.Comparison of the delamination measured during the experiment for different % of Si_3N_4 are discussed as follows





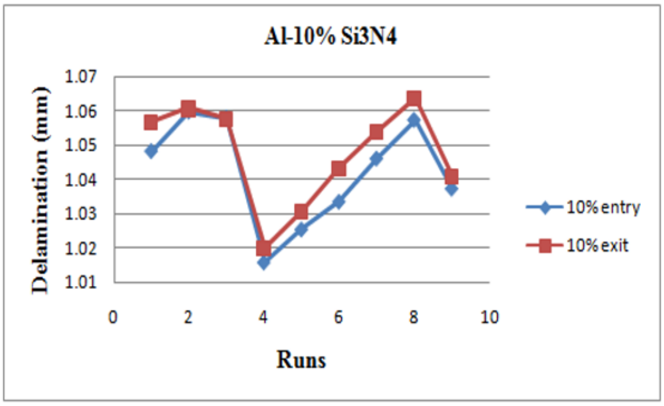
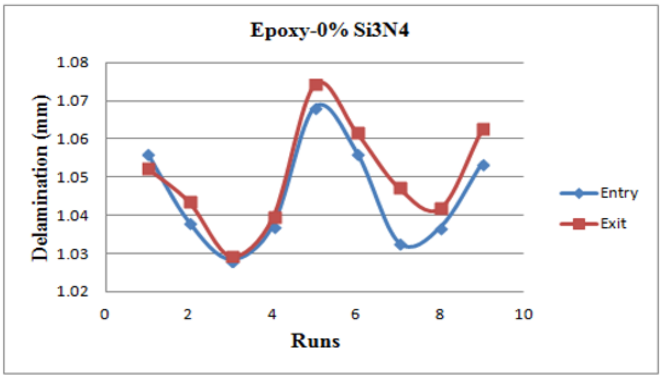
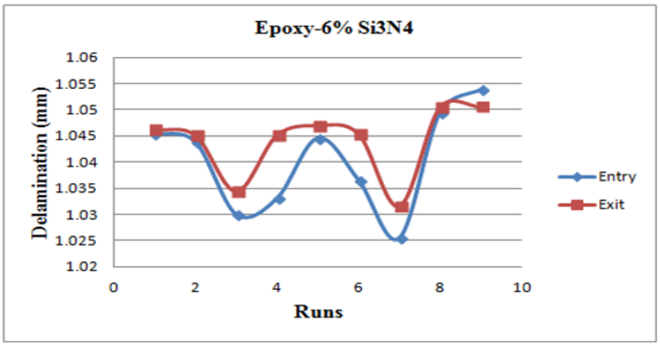


Figure. 4.1: Comparison of the delamination at entry and exit for Al-Si_3N_4(10%)

Above figure shows the comparison of the delamination at the entry and exit of the hole during drilling of Al- 0%, 6% and 10% Si_3N_4 of 6mm, 8mm and 10mm diameter. Delamination at the entry of the hole is more than the exit due the plunging action at the entry of the hole and more thrust force at the exit. Principal stress, von mesas developed in the material and deformation in the direction of cutting increases as the hole depth progressed hence the delamination is more at the exit. Delamination during drilling, decreases with increase in the % Si_3N_4 reinforcement therefore delamination is minimum in the 10% Si_3N_4 thereby quality of the hole is enhanced.

4.2 Experimental delamination of epoxy resin-Si3N4(10%)





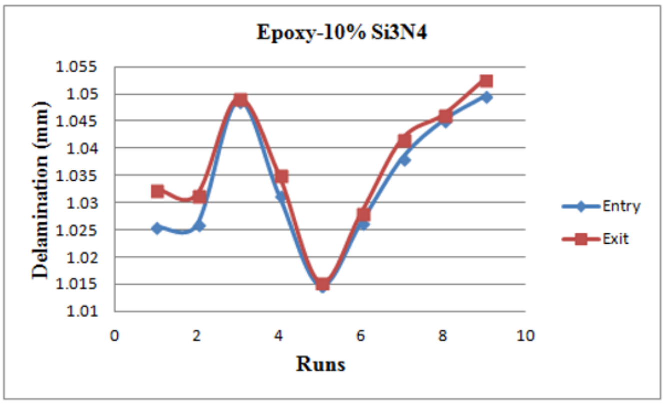


Figure.4.2: Comparison of the delamination at entry and exit for Epoxy resin-Si_3N_4(10%)

Above figure shows the comparison of the delamination at the entry and the exit of the hole during drilling of Epoxy resin- 0%, 6% and 10% Si_3N_4 of 6mm, 8mm and 10mm diameter. Delamination decreases with increase in % of Si_3N_4.hence, the delamination is minimum in 10% Si_3N_4. Delamination is more at the exit than the entry due the increase in the stresses, total deformation and deformation in the direction of cutting. Delamination at the entry of the hole is due to the plunging action of the drill bit and frictional force during drilling. Delamination at the exit is due the higher stresses and deformation.

4.3 Modal analysis

From the above finite element analyzed data following discussion can be made for Al6061 and epoxy resin reinforced with 0%, 6% and 10% Si3N4 of 6mm,8mm and 10mm diameter as shown below

4.3.1 Al-Si3N4(10%)

Modal analysis is done using ANSYS 15.0 workbench, obtained modal or natural frequencies are tabulated as shown in table 3.7. Six mode shapes of the component are shown in figure 3.5. Theoretical natural calculated using the formula 3.1 resulted natural frequencies are tabulated as shown in table 3.6. Theoretical and natural frequencies are compared and plotted as shown in figure 3.6. The graph shows that theoretical and natural frequencies are almost coincide each other.

4.3.2 Epoxy-10% Si3N4

Modal analysis is done using ANSYS 15.0 workbench, obtained modal or natural frequencies are tabulated as shown in table 3.9. Six mode shapes of the component are shown in figure 3.8. Theoretical natural calculated using the formula 3.1; resulted natural frequencies are tabulated as shown in table 3.9. Theoretical and natural frequencies are compared and plotted as shown in figure 3.9. The graph shows that theoretical and natural frequencies are almost coincide each other.

4.4 Inference of the experiment:

The resulted natural frequency shows that the modal or natural frequency of the component increases with increase in the percentage reinforcement of Si3N4. Increased natural frequency reduces the chances of vibration and distortion of drilling operation performed in the component there by increases the life of the component

5. CONCLUSIONS

From the above results and discussion following conclusion can be made

Modal evaluation is carried out to decide the component's vibration characteristics such as natural frequencies and mode shape that helps to avoid the resonant vibration of the component during drilling operation. From the above results and discussion it has been proven that the natural frequencies of both Al6061-Si3N4 and Epoxy resin-Si3N4 composites increases with increase in % of Si3N4 irrespective of the drill diameter. Resonant vibration of the composites decrease with increase in the natural frequencies hence, resonant vibration decreases with increase in the % of Si3N4 in a composite.

Through experimentation it has been validated with the simulation results. i.e.

1.As a speed and feed increases, the thrust force, torque, Machining time, and vibration correspondingly increases for any diameter of drill bit mounted on drill spindle of the drilling machine. The above phenomenon affects the cylindricity of the hole with respect to presence of silicon nitride on metal matrix and polymer composites.

2. Delamination factor substantiate the above conclusion. The value of the factor changes at entry and exit during generation of hole on different percentage of silicon nitride on MMC and PMC composites are different at entry and exit respectively.

3. Irrespective of the size of the drill bit and machining parameters the value of delamination remains same at entry and exit, which in turn helps in increasing the effectiveness of the drilling operation due to the matching of natural frequency with calculated frequency through modal analysis.

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