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Optimization of Process Parameters in Milling of Jute/Coir Hybrid Natural Fiber Reinforcement Polymer Composite Using Taguchi Method

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Abstract:
In present era, day by day new engineering materials are forth coming but among all, the composites, especially epoxy polymer composites have important advantages because of its mechanical properties such as high wear resistance, electrical resistance, high strength to weight ratio, corrosion resistance, and etc. It can replace the traditional materials for manufacturing different components with required properties. Jute or coconut coir hybrid natural fiber reinforced polymer composite materials especially for the major application of automobile industry, aerospace industry, electronic industry and etc. Milling is one of the machining process most widely applied to composite materials but Milling of these composite materials irrespective of the application area can be considered a critical operation, owing to their tendency to delaminate when subjected to mechanical stresses. The objective of the present work is to optimize process parameters namely cuffing speed, feed in milling of hybrid jute/coir natural fiber reinforcement polymer composites. In this work, experiments are conducted by the experimental design of taguchi and an orthogonal array used to optimize the process parameters on whole quality. Analysis of variance (ANOVA) test was conducted to determine the significance of each parameters on Milling. This work is useful in selecting optimum values of various process parameters. That not only minimize the trust force and torque and also reduces the delamination and improve the quality of milling.

Keywords: coir and jute hybrid natural fiber reinforcement polymer composite, milling parameters, taguchi method, optimization, SEM

I INTRODUCTION:

1.1 COMPOSITE MATERIALS

The nature of Composite materials are heterogeneous formed by mixing more components reinforcing fibers or fillers and compactable matrix it replaces traditional materials, as of their advanced properties, as high mechanical strength ,high strength-to-weight ratio and least thermal expansion. The Natural reinforced fiber polymer composites become more attractive due to environment friendliness, high specific strength, biodegradability, and lightweight. Natural fiber combined with synthetic fiber-reinforced polymer composites are finding enlarged applications

Composite materials for engineering, construction and other related applications formed by integrated two or more materials in such a way that constituents of the composite materials are noticeable not fully blended. One of the examples of composite material was concrete uses cement as binding material in mixture and gravel as reinforcement. Concrete uses rebar as second reinforcement makes as three-phase composite as of three fundamentals involved. Superior composites materials are exhibit popular physical and chemical properties are

1. High specific stiffness and strength,
2. Dimension stability,
3. Temperature and chemical resistance,
4. Relatively easy processing,
5. Lightweight,
6. High strength to weight ratio,
7. Good anticorrosion properties.

1.2 MILLING:

End milling is a machining process used in metalworking, woodworking, and other material shaping/removal processes. It is used to cut or shape materials using a rotating end mill. The process is used for a wide range of tasks, including: slotting, contouring, facing, and profiling work pieces. End milling can be used to create a huge range of features on a work piece such as slots, pockets, holes, complex contours, and mixed forms. It is a fundamental process in manufacturing and is employed across all manufacturing sectors to precisely cut and shape: metals, plastics, wood, stone, and composites. The choice of end mill type, size, and cutting parameters depends on the specific machining requirements and the material being worked on. Standard type end mills generate cutting forces in one direction. With a positive helix cutter, this has the tendency to lift the work piece while causing damage to the top edge on the other hand, the compression-style router generates cutting forces into the top and bottom surfaces of the work piece. These forces stabilize the cut while eliminating damage to the work piece edges. Delamination can be reduced by proper selection of cutting tool geometry and cutting configuration. Straight flute cutters and double spiral compression tools are most suitable because they eliminate the axial force component acting normal to the ply. Down milling (climb) is more suitable than up milling (conventional) for reducing delamination and improving surface roughness.

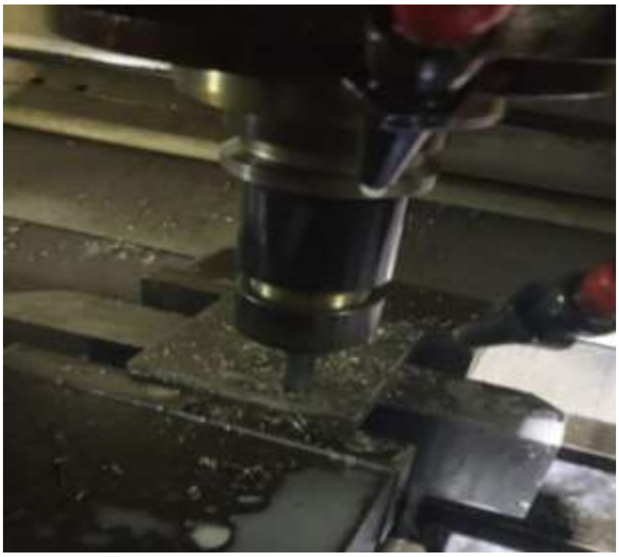
II. EXPERIMENTAL SET UP:

The milling process starts with positioning the work piece on the CNC machine's work surface or holding device. Milling tools are then installed into the machine's spindle. Depending on the programmed requirements from CAD, the milling can proceed in either a horizontal or vertical direction. After securing the work piece, downloading the program, and attaching the tool, the operator initiates the program to commence the milling process. The experiment was conducted on a CNC milling machine of Model No. JV55 Experiments were conducted by choosing different levels of input parameters for cutting speeds, feed rates. Thrust force and torque have been measured by using digital milling tool dynamometer.

Process parameters and levels

milling parameters/ Factors	**Level 1**	**Level 2**	**Level 3**
Speed (rpm)	350	600	800

Feed rate (mm/min)	20	30	40
Depth of cut(mm)	5	8	10



CNC Milling

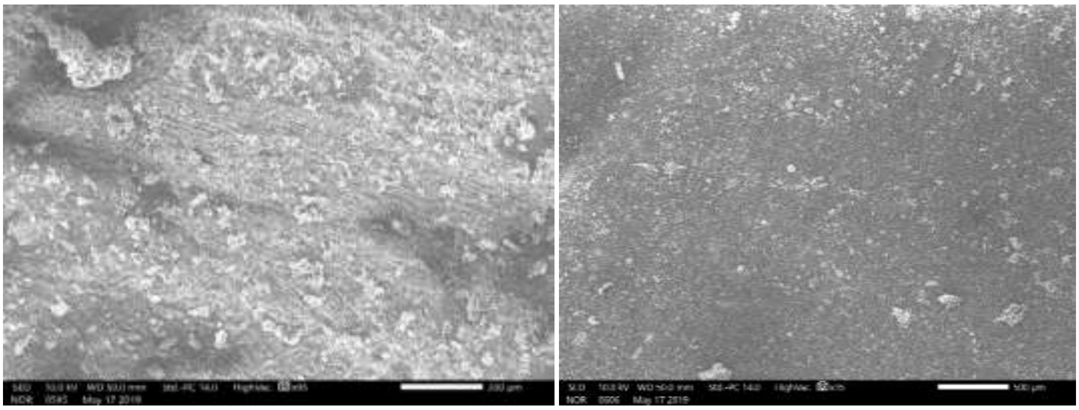
In this working process jute and coir natural fiber reinforcement polymer composite drilled by CNC drilling machine. The number of experiments is planned according to the Taguchi's L9 orthogonal array as shown in Table II which has 9 rows corresponding to number of experiments.

In this working process jute and coir natural fiber reinforcement polymer composite milled by CNC milling machine. The number of experiments is planned according to the Taguchi's L9 orthogonal array as shown in Table which has 9 rows corresponding to number of experiments.

Table 3: ORTHOGONAL L9 ARRAY OF TAGUCHI:

Experiment no.	**Speed (rpm)**	**Feed (mm/min)**	**Depth of cut(mm)**
1	350	20	5
2	350	30	8
3	350	40	10
4	600	20	5
5	600	30	8
6	600	40	10
7	800	20	5
8	800	30	8
9	800	40	10

Scanning Electron Microscope (SEM) is type of Electron microscope. Scans with high energy beam of electrons in raster scan pattern. The electrons interact with atoms make sample produce signals that contain information about samples surface topography. SEM produce very high resolution images of sample surface revealing details less than 2 to 5nm size. Due to less narrow electron beam SEM micrographs have large depth of fielding characteristic three dimensional appearances useful for understanding surface of structure sample. Conventional imaging in SEM specimens be electrically conductive at least surface and electrically grounded to prevent increase of electrostatic charge at the surface.The present work used SEM, model no J S M –I T 500



III. RESULTS :

Input parameters and output values

S. no	Speed (rpm)	Depth of cut (mm)	Feed (mm/min)	Delamination	Torque (N-M)	Thrust force (N)
1	350	5	20	1.175	0.7612	4.28
2	350	8	30	1.341	1.4811	7.34
3	350	10	40	1.426	2.3241	10.8
4	600	5	20	1.037	0.5661	5.59
5	600	8	30	1.100	1.2812	8.94
6	600	10	40	1.107	1.7612	14.41
7	800	5	20	1.025	0.3921	5.94
8	800	8	30	1.026	0.9211	11.21
9	800	10	40	1.029	1.3211	16.12

above shown in the table15. inputs and out puts, in puts are process parameters that are speed, feed and depth of cut and out puts are delamination, torque and thrust forces, to select the optimum values by using the mini tab tool. The results of delamination, torque and thrust forces of each sample are shown in table. The results are transformed into s/n ratio. The s/n ratio values for all responses are presented in table respectively. The main effects of mean and s/n ratio are plotted in figs respectively

Taguchi Design

Design Summary

Taguchi Array	L9(3^3)
Factors:	3
Runs:	9

Columns of L9 (3^4) array: 1 2 3

Output values of s/n ratios, standard deviation and mean

S. no	Speed (rpm)	Feed (Mm/min)	Depth of cut(mm)	delamination	Torque (N-M)	Thrust (N)	SNRA	STDE	MEAN
1	350	20	5	1.175	0.761	4.28	10.156	1.923	2.267
2	350	30	8	1.341	1.481	7.34	12.853	3.423	3.387
3	350	40	10	1.426	2.324	10.8	16.165	5.172	4.850
4	600	20	5	1.037	0.566	5.59	10.366	2.774	2.397
5	600	30	8	1.100	1.281	8.94	14.407	4.475	3.773
6	600	40	10	1.107	1.761	14.41	18.491	7.498	5.759
7	800	20	5	1.025	0.392	5.94	10.850	3.036	2.452
8	800	30	8	1.026	0.921	11.21	16.286	5.910	4.385
9	800	40	10	1.029	1.321	16.12	19.422	8.629	6.156

The table shows the s/n ratio values, standard deviation values, and mean values of the delamintion, torque and thrust force with process of taguchi analysis using mini tab tool.

IV. CONCLUSIONS

In this work presents the optimization of cutting process parameters namely, cutting speed, feed and depth of cut in milling of coir, jute hybrid natural fiber reinforcement polymer composites using the application of taguchi and ANOVA analysis in mini tab tool. The conclusions drawn from this work are as follows:

The optimum process parameters in milling of coir and jute hybrid natural fiber reinforcement polymer composites are:

1. The optimum values of minimum delamination, the process parameters are speed 350rpm, feed 40 mm/min, depth of cut 5mm, and this values maintain the minimum delamination levels.
2. The optimum values of minimum torque , the process parameter are speed 350rpm, feed 40 , depth of cut 5mm this values maintain the minimum torque value.
3. The optimum values of minimum thrust force, the process parameters are speed 800rpm, feed 40, depth of cut 5mm this values maintain the minimum thrust force value
4. The optimum values of the minimum delamination, minimum torque and minimum thrust force levels, the process parameters speed 800rpm, feed 40 and depth of cut 5mm

Damage increased that is delamination, torque and thrust force increased then to increase the cutting speed, feed and decrease the depth of cut that can be decrease the damage.

This work useful in selecting optimum values of speed, feed and depth of cut and minimize the torque and thrust force and also reduces the delamination and improve quality of milling.

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