

Drilling studies on particle board composite using HSS twist drill and spade drill

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Abstract. Composites materials are finding increased application in different engineering fields due to its favorable properties such as light weight, high strength, stiffness, etc. Among the composites, wood based composites are natural composites in which particle board (PB) and medium density fiberboard (MDF), etc., are extensively used in domestic and commercial purposes mainly in wood based furniture. Among different machining processes, drilling is the most generally used machining process in wood working industry for assembly operations and also affects the surface quality, aesthetic appearance and performance of the final product. Delamination at entry and exit sides of a hole, edge chipping, surface damage, etc are the major damages occurs during drilling of PB composites. The surface defects and delamination damages are significantly influenced by different machining particularly drilling parameters and machining environment. Therefore, study of effect of drilling parameters and machining environment on PB composite is an important area and it needs a detailed analysis. Twist drill is a most commonly used drill bit for drilling all materials however spade drill is specially used in drilling PB composite with lower thrust force and torque and spade drills is commonly used drill bit for rough drilling of particle board composite [5].

1. Methodology

In the present study, drilling of PB composite using HSS twist drill and spade drill of Ø10 mm is investigated. Drilling experiments were conducted using a Mitsui seiki of Japan make Jig boring machine, with model no of A12207. Process parameters considered are spindle speed (rpm), feed (mm/rev) and cutting environment. Drilling experiments are performed based on L₉ orthogonal array using HSS twist drill and spade drill with the total of 18 experiments. Fig. 1 shows the photographic view of drilled particle board of 10 mm thickness.

2. Experimentation



Surface roughness of drilled hole surface was measured with the help of Mtiutoyo SJ-210 roughness tester for all holes at three different orientations. Average surface roughness "Ra" was measured using cutoff of length (λ_c) of 0.8 mm and number of sample as five. The arrangement used for measurement of surface roughness is shown in Fig. 3.

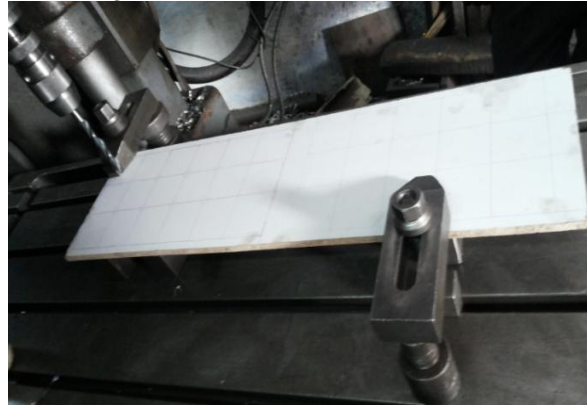


Figure 1. Drilling setup

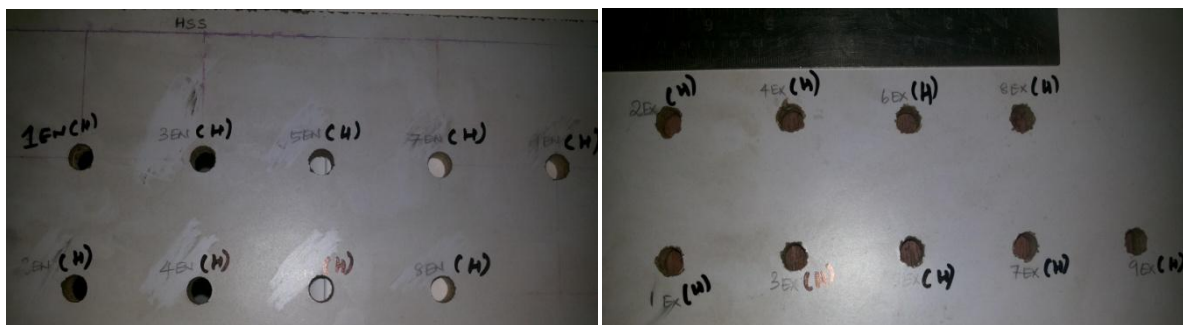


Figure 2. Photographic view of drilled holes: (a) Twist drill-Entry (b) Twist drill-Exit

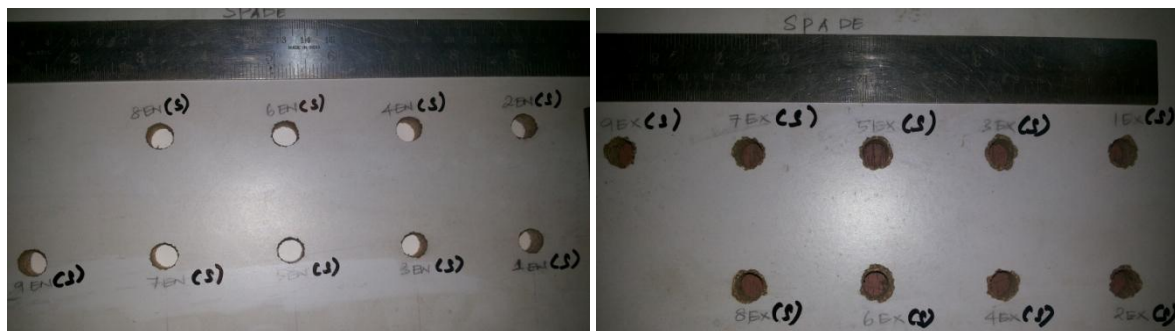
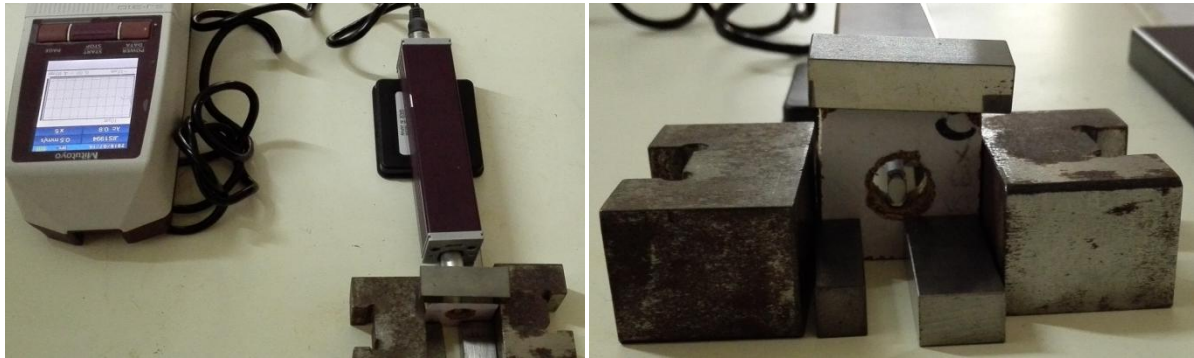


Figure 3. Photographic view of drilled holes: (a) Spade drill-Entry (b) Spade drill-Exit



Figure 4. Drill bits of Ø 10 mm (a) Twist drill (b) Spade drill

**Figure 5.** Surface roughness measurement arrangement

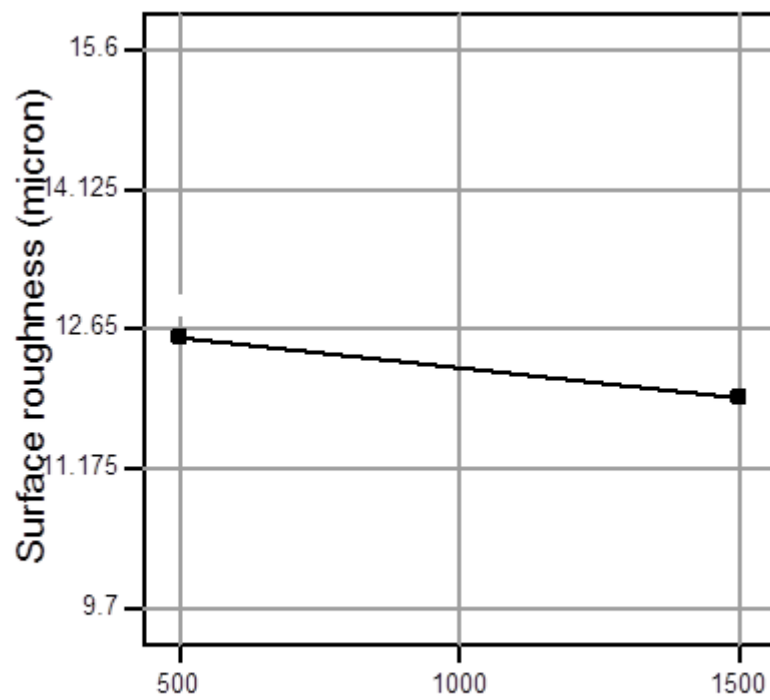
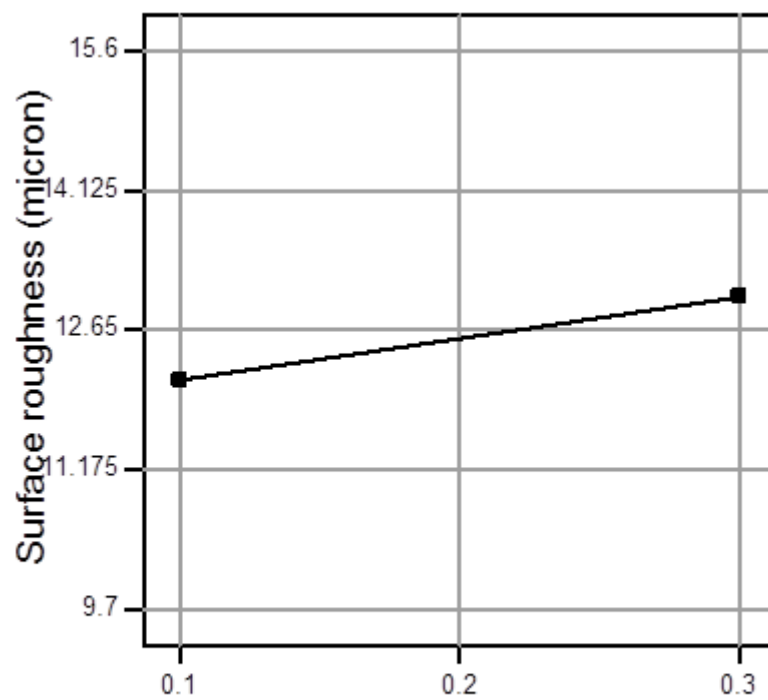
3. Results and Discussion

Table 1. Measured response

				Machining Time: MT(sec)	Average Roughness: Ra (μm)		
Sl No	Speed(S) (RPM)	Feed (f) (mm/rev)	Cutting fluid (C.F)	HSS twist drill	HSS Spade	HSS twist drill	HSS Spade
1	500	0.1	Dry	11.81	18.54	10.561	10.083
2	500	0.2	Coolant	7.3	12.96	12.880	10.653
3	500	0.3	Kerosene	5.31	7.87	11.712	11.619
4	1000	0.1	Dry	6.09	10.3	12.604	12.733
5	1000	0.2	Coolant	4.76	5.77	12.126	14.047
6	1000	0.3	Kerosene	3.33	4.01	12.880	15.300
7	1500	0.1	Dry	4.55	7.44	9.711	12.566
8	1500	0.2	Coolant	3.33	4.55	15.593	13.053
9	1500	0.3	Kerosene	2.03	2.97	12.077	13.310
Average				5.39	8.27	12.24	12.6

3.1 Effect of speed, feed and cutting fluids on Surface roughness

Figure 6 (a-c) shows the effect of process parameters on surface finish for the HSS twist drill. The graphs are taken from Design Expert 7 software from the experimental results. The same trend was observed for spade drill also.

**A: A: Speed****B: B Feed**

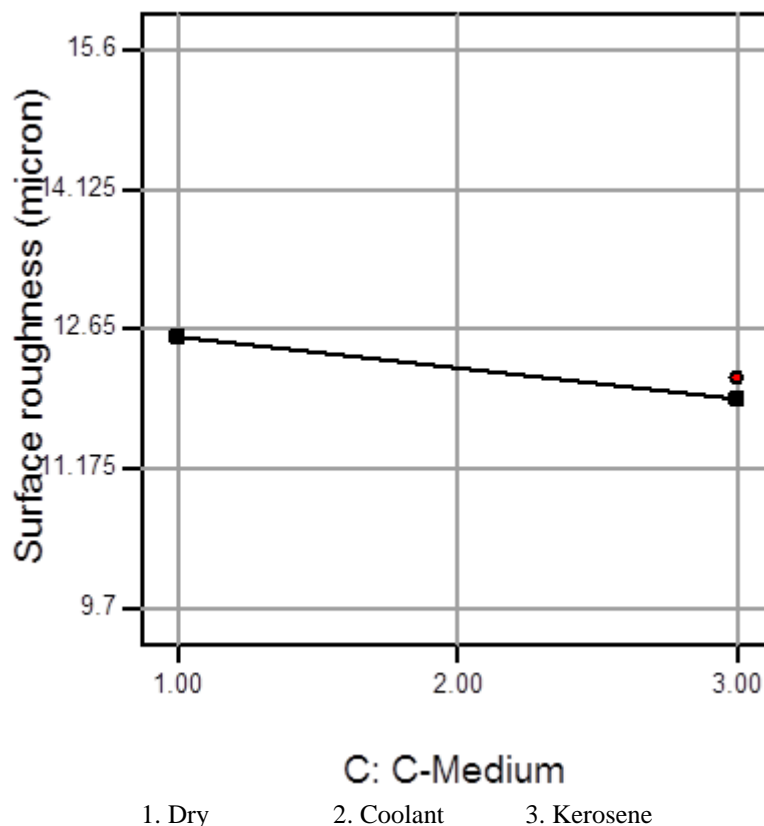


Figure 6. Response graph: (a) S Vs Ra (b) f Vs Ra (c) C.F Vs Ra

From Fig. 6 (a-b), surface roughness increases with increase in feed and decrease in speed. This is due to the fact that the large amount of material removal in a short duration results in poor surface finish with more declamation [2].

From Fig. 6.c, the surface roughness value is low for kerosene as a cutting compared to flood coolant and dry machining because the viscosity of kerosene (1.64 cP) is more than water (1 cP) which favors easy flow of cutting fluid in all interior area of the drilled hole. This also enables the reduction of friction between the tool and PB composite thus caused easy removal of chips and improved the surface finish than other coolant.

Overall, compared to spade drill, twist drill gives lower surface roughness value for the change in the process parameter. Compared to spade drill, twist drill has helical spiral which aids easy removal of chips for one revolution and allows coolant easily to hole.

3.2 Effect of speed, feed and cutting fluids on machining time

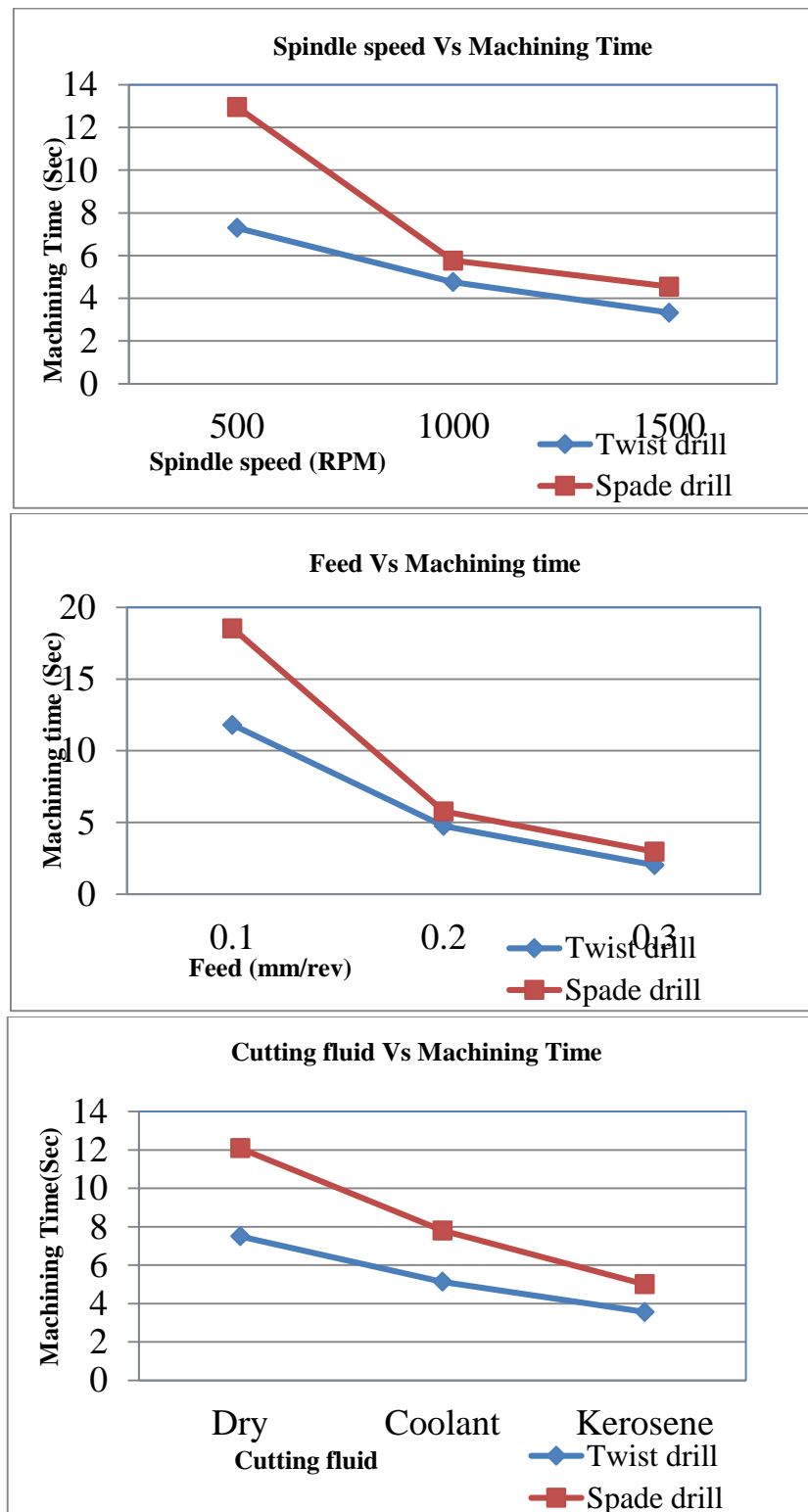


Figure 7. Response graph: (a) S Vs Ra (b) f Vs Ra (c) C.F Vs Ra

From Fig. 7(a-b) it is found that increase in drill rotational speed and feed decreased the machining time with faster removal of chips from the drilled hole and tool interface. Machining time was observed as low in kerosene compared to flood coolant and dry condition (Fig. 7.c). This is due easy flow of kerosene inside the hole due to its higher viscosity along with good lubrication which

washed the chips in faster rate. In case of flood coolant, due to its lower viscosity, it sparkled out without removing chips during machining before reaching to the full depth of the hole.

Overall, compared to spade drill, twist drill gives lower machining time for the change in speed, feed and coolant. This reason is that, twist drill has point angle and 2 flute or cutting edge with helical grooves which helps to remove the material faster than spade drill.

4. Conclusions

The drilling experiments are conducted on PB composite as per L9 orthogonal array to analyze the effect of spindle speed, feed and cutting fluid on machining time and surface roughness. Based on the experimental results the following conclusions are obtained:

- The increase of spindle speed and feed decreases the machining time, whereas the use of kerosene decreased the machining time compared to dry and flood coolant.
- Surface roughness value was decreased for increase in spindle speed at the same time Ra value was obtained as high for lower cutting feed value. Kerosene gave good surface finish than other coolant.
- HSS twist drill gave better performance than spade drill in terms of machining time and surface roughness for given process parameter.

5. References

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