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DRILL BIT SELECTION USING DESIGN OF EXPERIMENTS (DoE) METHOD

(PEMILIHAN MATA PAHAT BOR MENGGUNAKAN METODE DESIGN OF EXPERIMENTS (DoE))

Rieza Zulrian Aldio[1*], Zainol Mustafa[2]
[1]*Department Of Mechanical Engineering Universitas Islam Riau*
[2]*Department of Mathematical Sciences Universiti Kebangsaan Malaysia*
*Corresponding author : 10aldio@gmail.com

ABSTRACT

Drilling process is one of the most common machning process in industrial sector. More than half of the metal-cutting processes are conducted by the drilling process. Drill bit has influenced the results of the drilling process. Therefore, selection of the suitable drill bit becomes a critical factor in the drilling process. This is because the use of the suitable drill bit could fulfill the determined specification value of the hole. Six Sigma and Failure Mode Effect Analysis (FMEA) methods are used to identify factors that have influenced the results of the drilling process. Then by using the Design of Experiment, selection of the best drill bit could be done. In this study, 2 factors that influenced the result are the drill bit type and the drill point angle. Significance test using nested design through MINITAB 14 application has shown that both factors have significant influence over the hole diameter size.. Then by using the plot from the MINITAB 14 application, HPMT 1 became the best drill bit because it could fulfill the specification value. As for the best point angle in this study is 139.72º. Process capability calculation of HPMT 1 has shown that the process is in control. The conclusion is that drill bit HPMT 1 with point angle 139.72º became the best option in this study.

Keyword : Drill bit, Design of Experiment, Drill bit point angle, Nested design

INTRODUCTION

In machining process, cutting tools has important roles on finished products. It is extremely important in designing and determining the cutting tools geometries. As a quality control and assurance in general, those tools will be subjected to several tests for making sure that they met the manufacturer's specifications. These test not only serve as a mean to determine the quality, but also the performance of the cutting tools. Thus it is very important in determining the suitable cutting tools to used in certain machining process.

By using the Design of Experiment (DoE) method, selecting the best cutting tool to used is possible. DoE could also helps as a tool for improving the productivity and quality. Since DoE is a method for designing an experiment and its purpose is to analyse the data into a conclusion that

fulfill the objectives of the experiment (Sunil, 2014).

Drilling process is one important machining process, as it is the last machining process done in the aerospace manufacturing (Sharman, 2008). Aerospace manufacturing require more than 100,000 holes for small engines, mainly for fasteners. The cutting tools used in drilling are the drill bits. Drill bit's geometries will define the quality of the drilling process. The most common drill bit angle used are between 118 to 135 degree and for the clearance angle is 7 to 15 degree (Kalpakjian & Schmid, 2006). Abrao (2008) found that carbide drill bit point angle that has 150 degree or more, combined with high cutting speed will produce better surface finish than the smaller value of point angle. Parameter of machining also affect the process, Lin (2002) found that bigger feed value on vary speed will result bigger surface hardness.

The purpose of this experiment is to found out which drill bit is the best. Another purpose is to determine whether the drill bit type and point angle used in the experiment affect the hole diameter or not.

METHODOLOGY

Each drill bit will be tested up to 800 holes on the S45C carbon steel. There are 4 types of carbide drill bit used, with each type having two different value of point angle (130.4º and 139.72º). Thus, there are 8 different type geometries used for this experiment. After the drilling, the holes diameter will be measured and these values will be calculated into data analysis by using Minitab program.

Figure 1 below shows the design of this experiment. Using 8 combination of tools with 4 repetitions for each combination.

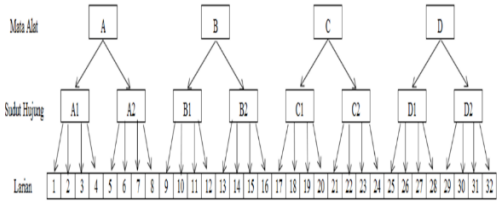

Figure 1 Nested design of drill bit combination

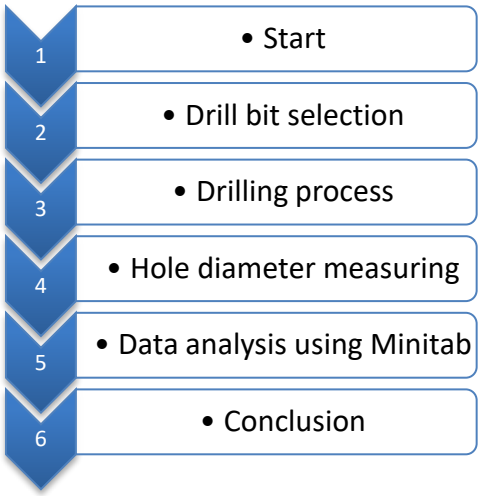

Figure 2 Experimental Procedure

Equipment

1. CNC Machine Makino S33

Figure 3 Makino S33

2. MAHR Vernier Caliper

Figure 4 Vernier Caliper

3. 8 type of Carbide Drill Bits

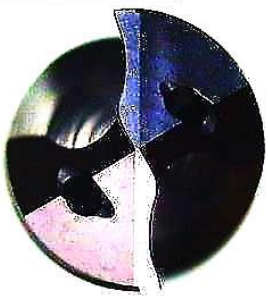

Figure 5 HPMT 1

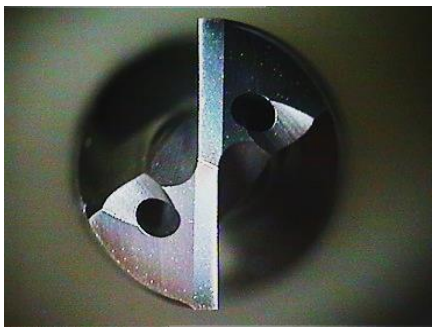

Figure 6 HPMT 2

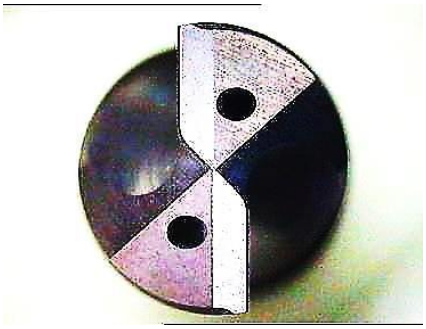

Figure 7 MT

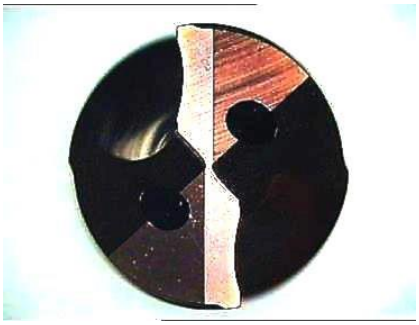

Figure 8 WT

4. S45C Carbon Steel

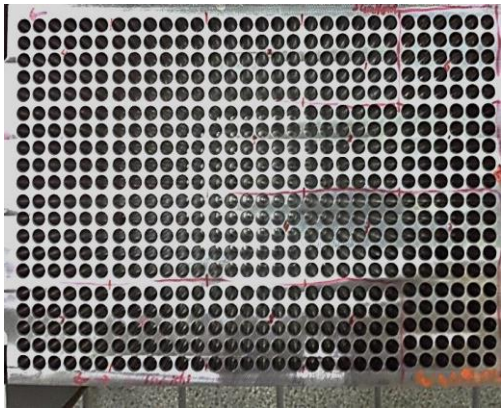

Figure 9 Carbon steel

RESULT & DISCUSSION

Statistical descriptive's result shows that the minimum and maximum diameter of the drilling process are

between 10.204 and 10.311 mm. The average value of the diameter of hole is 10.2568 mm. For the minimum value, it is obtained from using the MT tool with point angle 130.4º. as for the maximum value, is obtained from using the HPMT 2 also with point angle 130.4º. Table 1 below shows the result of the diameter of the hole.

Table 1 Result of the hole diameter

No	Drill Bit	Point Angle (º)	Hole Diameter (mm)			
			1	2	3	4
1	A	A1	10.255	10.252	10.248	10.258
		A2	10.240	10.245	10.232	10.234
2	B	B1	10.311	10.290	10.307	10.288
		B2	10.265	10.269	10.260	10.271
3	C	C1	10.204	10.207	10.215	10.213
		C2	10.259	10.262	10.255	10.248
4	D	D1	10.274	10.277	10.280	10.279
		D2	10.272	10.254	10.248	10.244

Figure 10 shows the normality of the data. It plotted the normality of the data of the experiments.

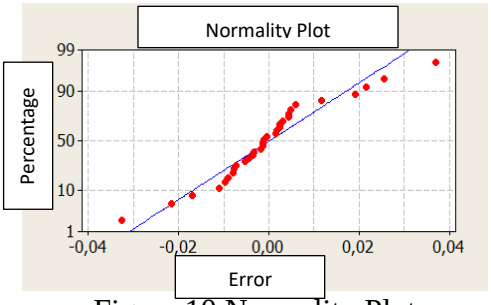

Figure 10 Normality Plot

Table 2 shows p-value on each factor, drill bit type and point angle. First hypothesis state that drill bit type didn't affect the diameter's value, this hypothesis can be rejected because the p-value is smaller than the significance level, with the p-value at 0.025, smaller than the significance level used (α=0.05). Then, it can be known that the drill bit did affect the diameter's value and had significant influence on it.

Then table 2 also shows that the point angle also affect the diameter's value. This is due to the p-value obtained is again, smaller than the significance level (p-value = 0.000). Point angle on the drill bit also affect the diameter's value significantly.

Table 2 ANAVA table

Puncaperubahan	Degree of Freedom	Sum of Square	Min of Square	*P*-value
Drill bit (A)	3	0.0116132	0.0038711	0.025
Point angle {B(A)}	4	0.0079618	0.0019904	0.000
Error	24	0.0013090	0.0000545	

Sum	31	0.020 8840

CONCLUSION

Based on the results, it can be concluded that both drill bit type and point angle used did had impact on the hole diameter. Since both aspects had lower p-value than the significance level used for the experiment (α=0.05). HPMT 1 became the best choice for this experiment, since both point angle (130.4º and 139.72º) produce more accurate hole diameter.

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