Design and Development of New Clamping Method for Waterjet Machine (JetCLAMP) based on machining performances

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***Abstract*— Water-jet machine is commonly used in industry. This kind of machine can be operates in many types of design and material of product. Generally, there are two types of water-jet machining which is Water-jet Machining (WJM) and Abrasive Water-jet Machining (AWJM). The objective of this study is to develop a new method water-jet clamping for water jet machine. This work is focused on to produce and design a new clamping method for waterjet machine. Moreover, we proceed to choose suitable material can be uses to produce waterjet clamping. Furthermore, we have to analyze the efficiency of the clamp to hold the workpiece. Finally, to determine the capability of the clamp to hold various of thickness and the size of the workpiece. It is expected that the water-jet clamping can afford to clamp the workpiece in various of thickness and size of the workpiece. In conclusion, through this project we have to produce a new clamping method for water-jet which is to fulfill industry requirement.**

Index Term— waterjet, new clamping method,

I. INTRODUCTION

Clamps serve two primary functions. First, they must hold the workpiece against its locators. Second, the clamps must prevent movement of the workpiece. The locators, not the clamps, should resist the primary cutting forces generated by the operation.

Holding the workpiece against locators. Clamps are not intended to resist the primary cutting forces. The only purpose of clamps is to maintain the position of the workpiece against the locators and resist the secondary cutting forces. The secondary cutting forces are those generated as the cutter leaves the workpiece. In drilling, for example, the primary cutting forces are usually directed down and radially about the axis of the drill. The secondary forces are the forces that tend to lift the part as the drill breaks through the opposite side of the part. So, the clamps selected for an application need only be strong enough to hold the workpiece against the locators and resist the secondary cutting forces.

Holding securely under vibration, loading, and stress. The next factors in selecting a clamp are the vibration and stress expected in the operation. Cam clamps, for example, although good for some operations, are not the best choice when excessive vibration can loosen them. It is also a good idea to add a safety margin to the estimated forces acting on a clamp.

Preventing damage to the workpiece. The clamp chosen must also be one that does not damage the workpiece. Damage occurs in many ways. The main concerns are part distortion and marring. Too much clamping force can warp or bend the workpiece. Surface damage is often caused by clamps with hardened or non-rotating contact surfaces. Use clamps with rotating contact pads or with softer contact material to reduce this problem. The best clamp for an application is one that can adequately hold the workpiece without surface damage.

Improving load/unload speed. The speed of the clamps is also important to the work holder's efficiency. A clamp with a slow clamping action, such as a screw clamp, sometimes eliminates any profit potential of the work holder. The speed of clamping and unclamping is usually the most-important factor in keeping loading/unloading time to a minimum.

The main goal of this project is to development a new waterjet clamping that suitable for water-jet machining uses in JTKP Laboratory. The design of this product is depending on the learning purpose and to make it has a good potential in commercialize it to the industry sector. This product is one the requirement from JTKP Machining Technology Laboratory to increase the quality in using the waterjet machining.

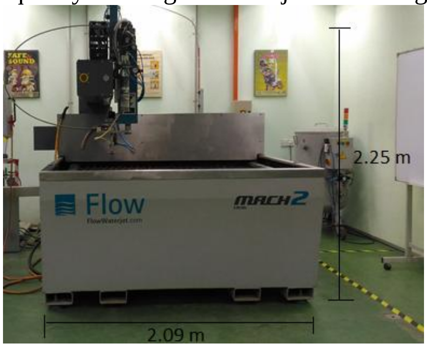

Fig. 1. Waterjet machine

II. RESEARCH METHODOLOGY

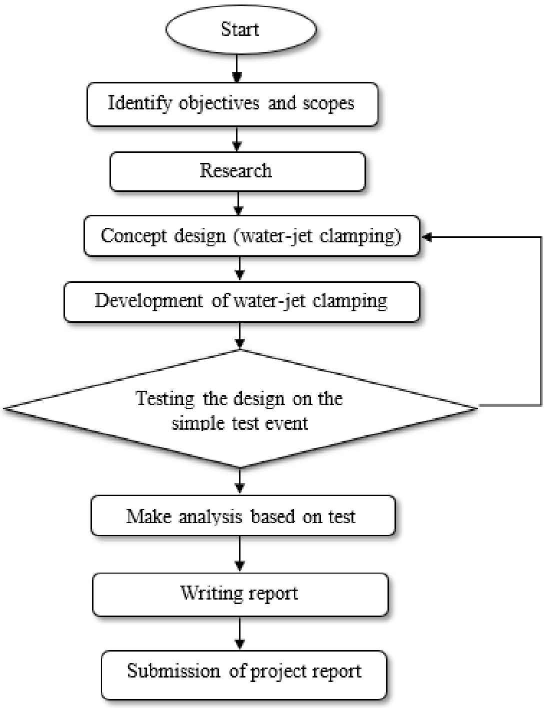

Fig. 2. Flow chart

A. *Roller Press clamping*

- In this stage, the roller press clamping is design based on the nozzle that available in the laboratory and few design in the industry market.
- By using Solidwork software, the modal of roller press clamping is drawn as Figure 3.

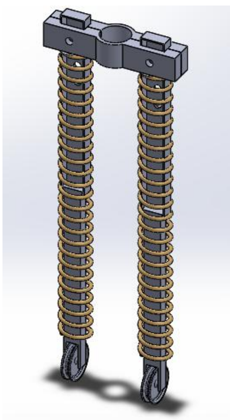

Fig. 3. Roller Press clamping in 3D model

B. *Material*

- Quatation for the magnetic clamping was made for to identify the matertial cost that required to develop the roller press clamping.
- Material that suitable use to develop is the aluminum due to its is anti rust properties.

Table I
Quotation of the roller press clamping

Part	Part name	Material	Actual size (mm)	Quantity
1.	Flexible pillar	Aluminum (Shaft)	Ø 13.46 × 7 Ø10.16 × 4	2
		Steel (Cylinder)	Inner Diameter: Ø13.7 mm Outer Diameter: Ø16 mm Length: 26 mm	2
2.	Clamp bar	Aluminum	150 × 20 × 20	1
3.	Wheel	Polyurethane	Ø38	2
4.	Spring	Steel	Diameter: 13.5 mm Length: 13 mm	2
5.	Bolt	High strength low alloy steel	Ø 5 mm	2
6.	Nut	High strength low alloy steel	Ø 5mm	2
7.	Socket screw	High strength low alloy steel	Ø 8 mm	2

C. *Process*

- Conventional and Computer Numerical Control (CNC) machine will be used in the process develop this roller press clamping.
- CNC machine, milling machine and welding machine is used.

D. Changes in design

- There are few changes design from the earlier design due to the mechanism and location to attach the roller press clamp.
- Figure 4 show the new design in 3D model.

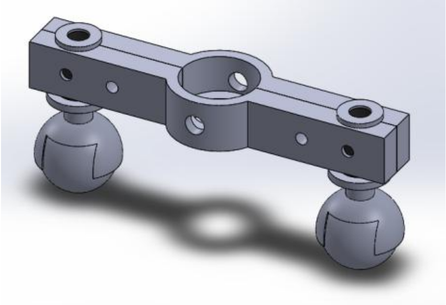

Fig. 5. New design in 3d model.

E. Fabrication

- Clamp bar

1. Raw material cut into dimension around 200 × 50 × 100 mm with quantity of two using the bend saw.

Fig. 6. Cutting process on the raw material

2. The raw material is proceed with squaring process on the milling machine to make stock for CNC machining.

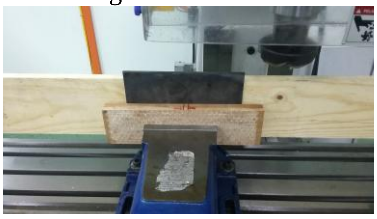

Fig. 5. Squaring process on the raw material

3. Proceed to the CNC machining process to create the two piece clamp bar.

Fig. 6. CNC machining

4. Then, six holes is drill for both clamp bar. Two holes at the center of clamp bar with diameter 8 mm and four holes with diameter 5 mm by using the milling machine.

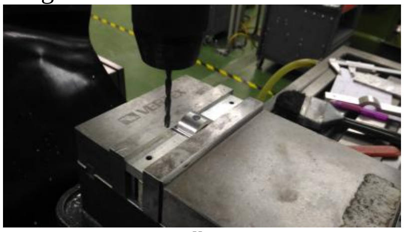

Fig. 7. Drilling process

5. The both center holes is proceed to tapping process to make the inner screw thread by using the tapping tools.

Fig. 8. Tapping process

- Flexible Pillar

a) Shaft

1. Raw material cut into dimension around diameter 20 mm and length 20 mm with two quantity using the bend saw.
2. The aluminum rod goes to lathe to cut it according to the design.

Fig. 9. Turning process

3. The aluminum rod that had been cut is also drill using the lathe machine.
4. Then, the shaft proceed tapping process to attach the wheel by using tapping tools.

b) Cylinder

1. The steel hollow rod is cut to get length 26 mm.
2. The end of the hollow rod is hit by the hammer to reduce the diameter with Ø 10 mm.

c) Shaft and cylinder assemble

1. The shaft and the spring is insert into the cylinder.
2. The top of cylinder is close with washer by using MIG welding machine.
3. After that, the wheel is assemble by using the spanner.

F. Assembly

1. Attach clamp bar on the nozzle and then take one pillar and wheel and place on the slot of the clamp bar as show in Figure 10.

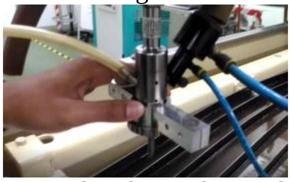

Fig. 10. Clamp bar attach at nozzle

2. Place the one of the pillar and wheel at the slot of the clamp bar as show in Figure 11.

Fig. 11. Wheel and pillar place at the slot.

3. Place the another wheel and pillar at the another slot as show in Figure 12.

Fig. 12. Another wheel and pillar are place at the slot.

4. Hold the clamp bar with one hand tightly and then tight the clamp bar by using the bolt and nut as show in Figure 13.

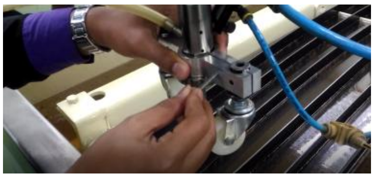

Fig 13. The clamp bar is tighten

5. Then, lock the movement of the clamp by using the screw and take another screw to lock another side as show in Figure 14 and 15. Figure 16 is show the assemble process is finish and ready in use .

Fig. 14. The movement is lock.

Fig. 15. Both side is lock by using screw.

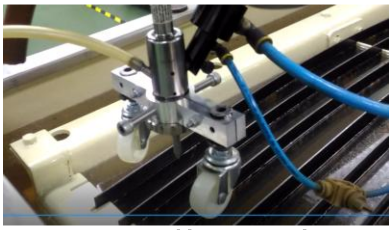

Fig. 16. Assemble process is done.

III. RESULT AND DISCUSSION

Fig. 17. Final product of the clamping

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1. *Mechanism of the roller press clamping*

Roller press clamping is controlled mechanically by adjusting the height of the nozzle. The spring placed inside the flexible pillar that always in under expand position. When the nozzle is moving downward according to the height that had been set in computer, the spring is compress and the spring force is exerted at workpiece in downward direction. This mechanism will help the clamp to hold the workpiece on the platform.

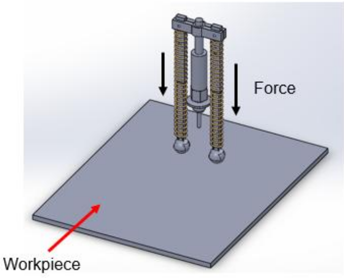

Fig. 18. Mechanism used in roller press clamp

2. Operation

Since the roller press clamping move downward and hit toward the workpiece, the spring will be reflect the force apply to it because the spring is in compression mode. From this phenomenon, the spring force is press workpiece that create holding force. The shorter the gap between the roller press clamp and workpiece, the higher the clamping force will apply to the workpiece.

3. Result

The result of surface roughness by using both clamping method were obtained as show in the Table II below:

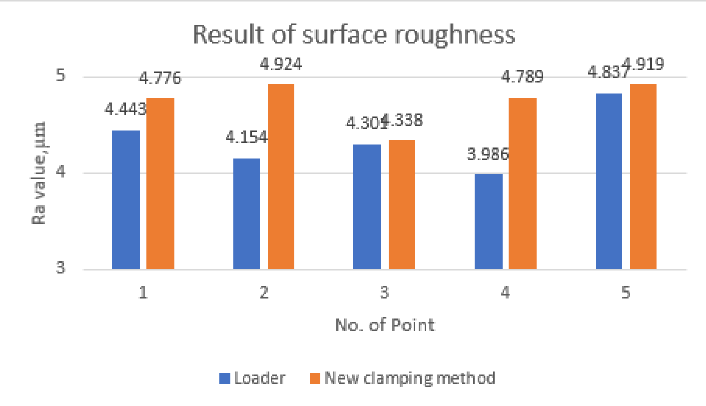

Fig. 48. Surface roughness graph

Based on the graph, we can see the different value pattern between both clamping. The New Clamping Method was more precise than the Loader. To determine whether the objective of this experiment is achieve or not, the mean value of surface roughness, R_a and standard deviation were calculated. Those value are show at the table VII below:

Table II

Result of surface roughness, R_a

No. of point	Surface Roughness of R_a, µm	
	Clamping method	
	Loader (Sample A)	New clamping method (Sample B)
1	4.443	4.776
2	4.154	4.924
3	4.301	4.338
4	3.986	4.789
5	4.837	4.919
Mean	4.3442	4.7492
Standard Deviation	0.323637	0.240195

Based on the calculation that had been made, the mean value for Sample A is 4.3442 and Sample B is 4.7492. This shows that mostly R_a value for Sample B was more closest to the its average value. In additional, for the standard deviation value, Sample B has lower value than Sample A which mean the R_a value for Sample B has less variation compared to Sample A. Hence, the Sample B is more precise than Sample A.

IV. CONCLUSIONS

As conclusion, this thesis indicates the design and the development stage of a roller press clamping for the waterjet machine. This study shows the fabrication of a roller press clamping and determine the functional of the roller press clamping. The main goal of this study is to produce a new method of clamping for the student to explore and produce more creative and innovative clamping product instead understand the mechanism that should be applied on the clamping to make its works.

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