



DESIGN AND DEVELOPMENT OF WATERJET CLAMPING BASED ON MACHINING PERFORMANCE

N. Ab Wahab, Teresa SenatiaAnak Sebastian and Abdul Khahar Bin Nordin

Department of Mechanical and Manufacturing Engineering Technology, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya,
 Durian Tunggal, Melaka, Malaysia
 E-Mail: norfariza@utem.edu.my

ABSTRACT

Water-jet cutting machine is commonly used in industry. This kind of machine can be operated in many types of design and material of the product. Generally, there are two types of water-jet machining which is Water-jet Machining (WJM) and Abrasive Water-jet Machining (AWJM). However, several problems occurs to manage the workpiece during the cutting process and the movement of the nozzle. Moreover, the misalignment of the workpiece during the cutting process also one of the issues. The objective of this study is to develop and optimize water-jet clamping. As a conclusion, an improved clamping design for water-jet is proposed to fulfil industry requirements.

Keywords: waterjet, clamping method.

1. INTRODUCTION

Clamping have two function to be considered which is to hold and prevent movement of the work piece. The locators must prevent the first cutting forces that are produce during operation.

The clamps are not primary to resist the cutting forces. The function of clamps is to ensure the workpieces position are not move towards the locators and in the same time the secondary cutting forces can be resisted. For example in drilling (Laporte *et al.* 2015) the first cutting forces are directed down about the drill axis. The forces that lift up the part when the drill move in opposite direction is define as secondary force. Therefore, the chosen clamps must be capable to hold the work piece and prevent the secondary cutting forces.

The other considered factor would be the vibration and stress that will generated during operation. Cam clamp is one of the clamping device that are not suitable for serious vibration machining as excessive vibration can reduce the strength of clamping forces. Another alternative to be considered will be adding a safety guide to determine the forces that act on a clamp (Parus *et al.*).

The other factor that must be considered while choosing the clamp is to avoid the workpiece to get damage. The critical damage would be main part distortion and marring. The excessive force of clamping can bend the workpiece. The clamps with rotating contact pads or with softer contact material can be to avoid surface damage. The best clamp for an application is one that can adequately hold the workpiece without surface damage.

The clamp's speed is also essential to ensure the efficiency of work holder. For example like screw clamp often eliminates any profit potential of the work holder. (Yang *et al.* 2015) More importantly the speed of loading and unloading time are the key factors to keep it minimum as we could. The main goal for this study is to develop a waterjet clamping that is suitable for water-jet machining in Universiti Teknikal Malaysia Melaka.



Figure-1. Waterjet machine.

2. RESEARCH METHODOLOGY

A. Material

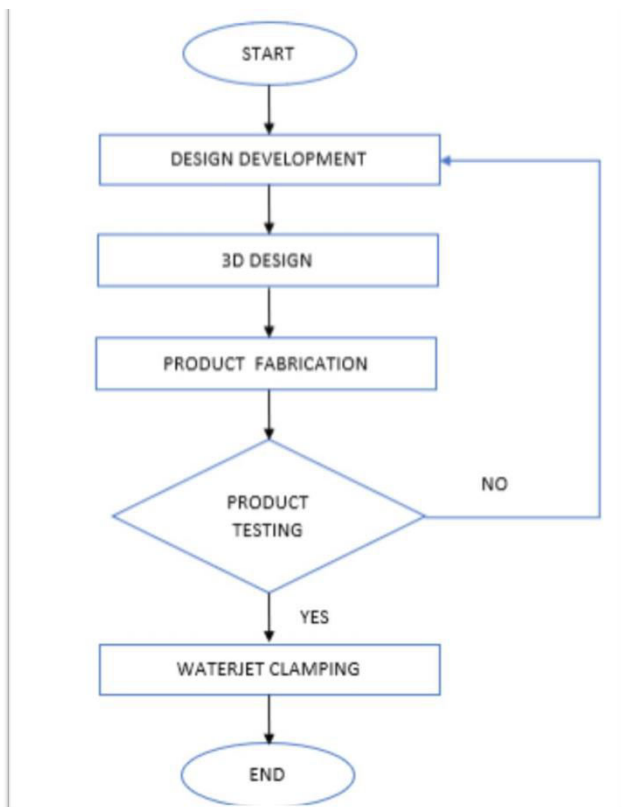
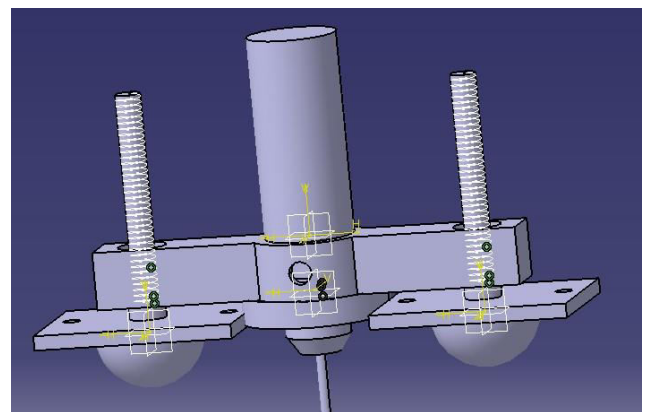
**Table-1.** Quotation of the roller press clamping.

Part	Part name	Material	Actual size (mm)	Quantity
1.	Flexible pillar	Aluminum (Shaft)	$\text{Ø} 13.46 \times 7$ $\text{Ø} 10.16 \times 4$	2
		Steel (Cylinder)	Inner Diameter: $\text{Ø} 13.7$ mm Outer Diameter: $\text{Ø} 16$ mm Length: 26 mm	2
2.	Clamp bar	Aluminum	$150 \times 20 \times 20$	1
3.	Wheel	Polyurethane	$\text{Ø} 38$	2
4.	Spring	Steel	Diameter: 13.5 mm Length: 13 mm	2
5.	Bolt	High strength low alloy steel	$\text{Ø} 5$ mm	2
6.	Nut	High strength low alloy steel	$\text{Ø} 5$ mm	2
7.	Socket screw	High strength low alloy steel	$\text{Ø} 8$ mm	2

- Quotation for the magnetic clamping was made to identify the material cost that required developing the roller press clamping.
- Material that suitable use to develop is the aluminium due to its anti-rust properties.

B. Roller Press clamping

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

**Figure-2.** Flow chart.**Figure-3.** Roller Press clamping in 3D model.

C. Process

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

D. Fabrication

- Clamp bar

a) Raw material cut into dimension around $200 \times 50 \times 100$ mm with quantity of two using the bend saw.



Figure-4. Cutting process on the raw material.

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

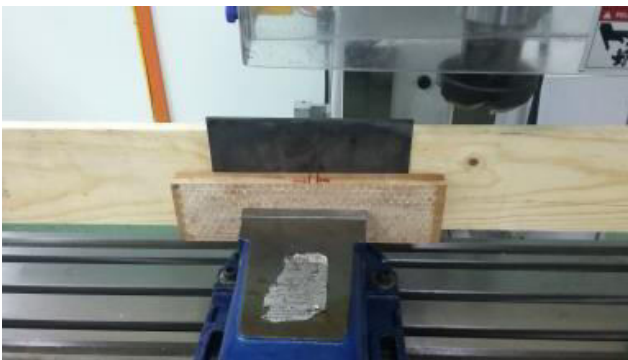


Figure-5. Squaring process on the raw material.

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

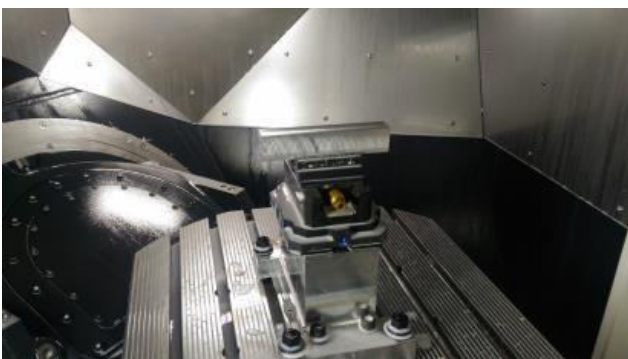


Figure-6. CNC machining.

d) 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.

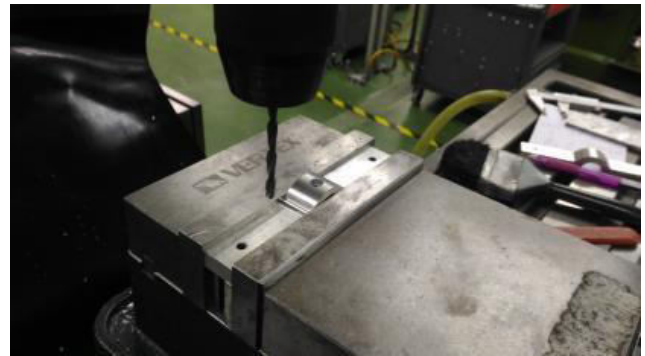


Figure-7. Drilling process.

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

E. Assembly

a) Attach roller platform together with platform holder onto nozzle Figure-8.



Figure-8. Clamp bar attach at nozzle.

b) Place the one of the pillar and wheel at the slot of the clamp bar as show in Figure-9.



Figure-9. Wheel and pillar place at the slot.

c) Place another wheel and pillar at another slot as show in Figure-10.

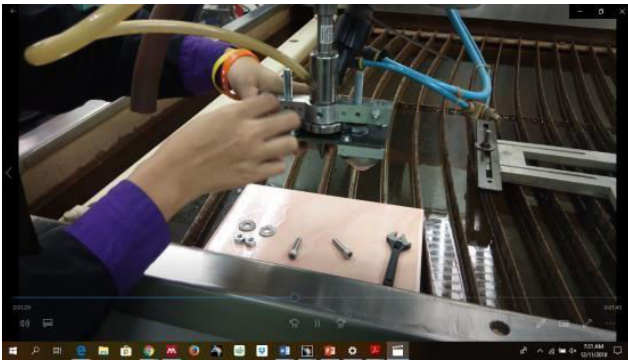


Figure-10. Another wheel and pillar are place at the slot.

d) Hold the clamp bar with one hand tightly and then tight the clamp bar by using the bolt and nut as show in Figure-11.

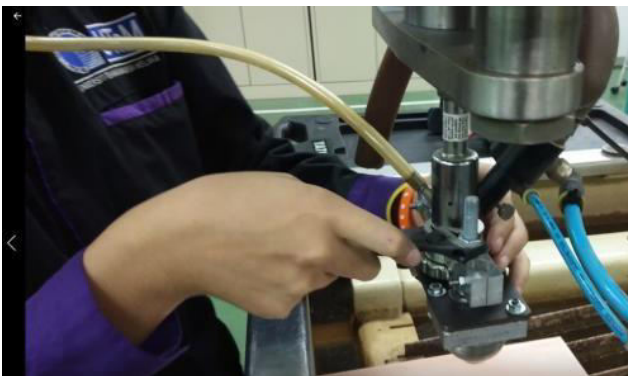


Figure-11. The clamp bar is tighten.

e) Then, lock the movement of the clamp by using the screw and take another screw to lock another side as shown in Figure-12 and 13. Figure-14 shows the assemble process is finish and ready in use.



Figure-12. The movement is lock.

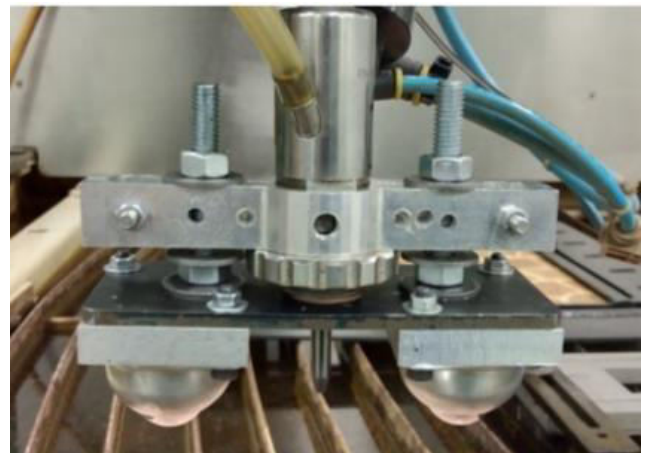


Figure-13. Assemble process is done.

3. RESULTS AND DISCUSSIONS

The cutting with waterjet clamp is more near the reference number which is 100mm with small difference, 0.7mm. Meanwhile for cutting without waterjet clamping show big difference with 11mm due to no loader hold the workpiece during cutting operation and the water will rise and misalignment of workpiece is occurred. This means the dimension of workpiece with waterjet clamping is more accurate than without waterjet clamping.



Figure-14. Dimension of straight cut.

4. CONCLUSIONS

The main goal for this study was to develop a waterjet clamping that is suitable for water-jet machining. As discussed in literature, several problems occurs to manage the workpiece during the cutting process and the movement of the nozzle. The best clamp for an application is one that can adequately hold the workpiece without surface damage. We proposed an improved clamping design for water-jet is to fulfil industry requirements

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