

# SHEET METAL PROCESS MACHINES

<sup>1</sup>Choo Chi Sien, <sup>2</sup>Sanggitha a/p V.Marimuthu, <sup>3</sup>Boo Lee Wen,  
<sup>4</sup>Puspaloshni a/p Pusphparajoo, <sup>5</sup>M F Rajemi

College of Business, Technology Management Building,  
University Utara Malaysia, 06010, Sintok, Kedah, Malaysia  
Email: <sup>1</sup>205806@uum.edu.my

## ABSTRACT

*Any metals can be formed into flat or thin pieces of varying thickness and geometry. The shaping of the sheet metals is grouped in the sheet metal process. The shaping of selected metal washers is being discussed comprehensively. This research reveals the basic process of metal stamping which include the mechanism of shearing operation. The benefits and drawback of sheet metal process are also being discussed. This research gave a better understanding to the readers on the basic concept of sheet metal process.*

### Keywords

*Washer, blanking, punching, sheet metal*

## 1.0 INTRODUCTION

Sheet metal process can be defined as any metal that can be formed into flat or thin pieces of varying thicknesses (Wikipedia, 2013). There are 3 major category of sheet metal forming process such as cutting, bending and drawing (Sheet metal, 2013). In this research, we will select washer as the main product. Washer is a thin plate with a hole that is normally distributes the load of threaded fastener (Washer, 2013). It is involve punching then blanking process. The research objectives are to determine:

- ✓ Material handling of mild steel coil
- ✓ Stamping process of washer
- ✓ Storage system of completed washer

The reason we select washer because it is a vital components in fastening and assembly operations, it is also provide some sort of insulation such as electrical while installed it on machine.

## 2.0 LITERATURE REVIEW

The literature review will be discussing about the production and process of washers from all aspects.

### 2.1 Material handling

Material handling can be handling in 2 situations such as internal logistics and external logistics. Steel coil carrier wagon and roll store system is use in external logistics. Steel coil carrier wagon use to transport the steel coil at the outside of facility whereas, roll store system that help to prevent the coil dropped at road halfway during delivering. It is able to maximum flexibility and safety while on the way transporting the steel coil.

It is also can be used to stabilize the coil in warehouse (Lankhorst Mouldings, 2013). Lift truck is used to carry the mild steel coil within the facility in order to load and unload it during the production and tote box is required to collect the completed stamping washer.

### 2.2 Automated production line

To produce a washer, the firm first has to go through the process of installation. Stock coils, straighteners, feeders, part handling as well as scrap removal systems are known as press auxiliary equipment. The production starts using some metal coils. Stamping press (Wikipedia, Wikipedia the Free Encyclopedia, 2012) punches and forms small sheet parts from a long coil.

The stamping process starts with the installation of mild steel coil to reel (Wikipedia, Reel, 2013). The reel supports the coil stock around and flexible for it to rotate. Based on this research, the most suitable mild steel coil for coil stock is produce by Tianjin, China (Tianjin Xinhai Runda Steel Trade Co., 2011). After prepared the resources the production went through the stamping process.

The rolls in stock straightener (INC., 2012) will compressed the steel coil before enter to the stamping process. After straightener process, the roll feed will spin and push the coil stock toward the stamping press. Then the coil stocks are sent to the punch (Shan, 2011) which is a large block of clamped metal while the die stays stationary. In this process the metal sheet be cut into shapes that

required by deforming it with a die (Hassan, 2010). Die and punch are usually made by steel or carbide (Custom Part Net, 2013).

In order to produce the washer, we need 2 types of puncher which are piercing punch and blanking punch. The piercing punch cuts a hole of 13/32" internal diameter in the stock. The blanking punch (Andersson, 2009) blanks out an external diameter of 13/16" onto a portion of the metal in which a hole had been pierced at a previous station. A finished washer is produced after the 2 stroke of the press on the stock.

After the stamping process, the washer goes through mechanism of shearing operations. There are three phases in this operations which is elastic phase, plastic phase and fracture phase. This phases will compressed sheet metal, penetrate by punch into material to a certain depth and Strain in the material reaches the fracture limit, micro cracks appear which turn into macro cracks, and separation of the parts of work piece occurs.

The quality and accuracy of shearing operations can be affected by clearance between the punch and the die, punch force, mechanical properties of the sheet metal, speed of the punch and the thickness of the sheet. The purpose of calculate the clearance is to determining by its shape and quality of the blanked and punched edge (Education Reference). Quality and accuracy are measured through punch force at a small distance. This causes the sheet metal to rotate and deformation to penetrate into the clearance between the cutting edges.

Lastly, washer will go through the packaging process. Workers will collect the finished washer in the container. The complete part will be gathered in a tote box on the output side of the press. Finished tote box and coils are always will be replaced occasionally.

### 2.3 Storage system

Storage system is a must to every factory to store materials for a period of time and permit retrieval when required. Storage system act as distribution centers, dealerships, retail stores and warehouses. The performance of storage system is determined based on the storage capacity, storage density, accessibility, system throughput, and utilization and availability. In order to store mild steel coil effectively, a top running bridge crane should be built in the warehouse (Harold Potter, 2013).

It is able to lift the desire coil efficiently. It can be move in either x or y-axis along the length of the factory. After the crane operator lift the steel coil it

will move the crane towards the lift truck. Finally, the lift truck will transport the steel coil to the production line to further processing become a product and the worker will carry the full box of completed washer to the warehouse or carry by 4-wheel trucks to transport it to warehouse.

## 3.0 METHODOLOGY

This chapter discusses the methodology methods that use to explain in this research. In this study, this research conducted study on washer in sheet metal process machines. The analysis is done by journal, books, magazines, reference book at library and resources from the internet.

## 4.0 FINDINGS

### 4.1 Mechanism of shearing operation

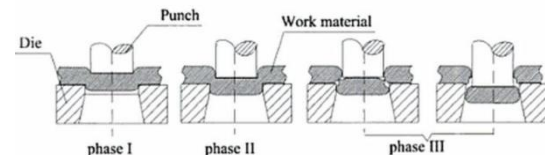


Figure 1: Phases of shearing operation

#### Phase 1: Elastic phase

Sheet metal is compressed across and slightly deformed between the punch and die, the stress and deformation in the material do not exceed the elastic limits. (Metal Stamping Articles, 2013)

#### Phase 2: Plastic phase

Punch will penetrate into the material to a certain depth, pressing it into the hollow of the cutting plate with bending and stretching of material in the clearance region. The deformation of the material becomes permanent and the stress exceeds the yield strength of the work material. The material resists fracture at the end of this phase. (Metal Stamping Articles, 2013)

#### Phase 3: Fracture phase

Strain in the material reaches the fracture limit, microcracks appear which turn into macrocracks, and separation of the parts of workpiece occurs. The cracks in the material start from the cutting edges and propagate along the slip planes until complete separation of the part from the sheet occurs. The punch advances further, pushing the separated part through the bore of the cutting plate. (Metal Stamping Articles, 2013)

### 4.2 Factors affect shearing operation

Punch force,  $F$ ; the speed of the punch; the surface condition and materials of the punch and die; the

condition of the blade edge of the punch and die; the type of lubricant; and the amount of clearances will affect the shearing operation. In this research, we will only discuss the clearances.

#### 4.2.1 Clearances

Clearance region is located between the edge of the punch and the die. The purpose of calculate the clearance is to determining the shape and quality of the blanked and punched edge.

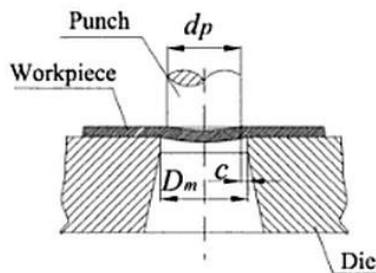


Figure 2: Formula of clearance

$$c = \frac{D_m - d_p}{2}$$

- ✓ If the clearance is too small, the initial crack stops forming and shearing continues, resulting in a second sheared face.
- ✓ If the clearance is small, the cracks from both upper punch and lower die cutting edges spread considerably but the cracks do not converge at the same points, resulting in tongue-shaped protrusion on the face which will drop off.
- ✓ When the clearance is adequate, the cracks extending from the cutting edges will converge at a point. It will permit a clean break below the burnish zone because the upper and lower fractures will extend toward one another. The width of burnish zone is an indication of the hardness of material. The softer the sheet metal, the wider the burnish zone. Hard metals required large clearance.
- ✓ In the case of excessive clearance, the cracks do not meet and will rupture the face cross-section. The face has very poor squareness and considerable penetration and burring. (Boljanovic, 2013)

## 5.0 DISCUSSION

Based on the information that we get, we found that there are some benefits and drawbacks of sheet metal process.

### 5.1 Benefits

#### 5.1.1 Longest lifespan of raw material

Generally, when the stamping die stamping parts to make sure accuracy of the size and shape, it would

not damage the surface quality of stamping and the die life is generally longer, so the stamping quality and interchangeability, with “identical” features. (Groover, 2008)

#### 5.1.2 Changeable die and punch

Stamping press machine can punch out the large size and complex shape of part. Besides that, stamping of material hardening effect of cold deformation, strength and punching stiffness are high. (Groover, 2008)

#### 5.1.3 Labor fees reduced

The fully automated system capable to produced washers without any worker except periodically to load and unload parts. This helps company to save cost of the labor. (Groover, 2008)

#### 5.1.4 Higher production rate

Automated system will increase the production rate. They can process much more product than humans. (Groover, 2008)

## 5.2 Drawbacks

#### 5.2.1 Large investment

Investment in tooling, gear, maintenance expenses can be high. (Groover, 2008)

#### 5.2.2 Noise

Punching noise and vibration generated when the two hazards and the operator’s safety accidents have occurred. However, these problems are not entirely due to stamping process and die to bring their own, but mainly due to traditional stamping equipment and outdated manual caused. (Groover, 2008)

## 6.0 CONCLUSION

Conventional stamping machine were performed on a manual punch press. But now, we can use computer numerical controlled (CNC) punch presses which are most common nowadays in market. It can be hydraulically, pneumatically, or electrically powered and deliver around 600 punches per minute. Hence this method can increase the productivity for the industries.

## REFERENCES

- Andersson, M. (2009, February 05). Method and a device for the manufacturing of washers and washer for a locking system. Retrieved March 20, 2013, from patentdocs: <http://www.faqs.org/patents/app/20090036224>
- Boljanovic, V. (2013, April 3). Sheet metal forming process and die design. Madison Avenue, New York.
- CustomPartNet. (2013). Sheet Metal Cutting (Shearing). Retrieved March 20, 2013, from CustomPart.net: <http://www.custompartnet.com/wu/sheet-metal-shearing>
- Docstoc. (2011). Retrieved april 21, 2013, from automated assembly: <http://www.docstoc.com/docs/129188555/automated-assembly---PowerPoint>
- Education Reference, R. T. (n.d.). Reference Notes, Resource, Tutorials: Blanking Die Design and Metal Stamping. Retrieved March 20, 2013, from suwaprecision.com: [http://www.suwaprecision.com/Metal\\_Stamping\\_Articles/blanking.html](http://www.suwaprecision.com/Metal_Stamping_Articles/blanking.html)
- Gohil, B. (2013). Machine Vision Plus. Retrieved march 17, 2013, from ECVV.com: <http://www.ecvv.com/product/1364453.html>
- Groover, M. P. (2008). Automation, production systems, and computer integrated manufacturing. Upper Saddle River, New Jersey, United States of America: Pearson Prentice Hall.
- Hassan. (2010). Blogger. Retrieved March 20, 2013, from Mechanical Engineering: <http://engineeringhut.blogspot.com/2010/11/dies-and-its-types.html>
- Harold Potter . (2013). Retrieved april 21, 2013, from Bridge Crane: [http://www.haroldpotter.co.uk/crane-types-bridge-crane-c-106\\_111.html](http://www.haroldpotter.co.uk/crane-types-bridge-crane-c-106_111.html)
- INC., P. I. (2012). PA. Retrieved March 20, 2013, from FLIP-TOP STOCK STRAIGHTENER: <http://www.pa.com/products/detail.aspx?catid=41>
- Lankhorst Mouldings. (2013). Retrieved april 24, 2013, from Coil storage: <http://www.coilstorage.com/en/steel-coil-racks>
- Metal Stamping Articles*. (2013, April 10). Retrieved from Suwaprecision: [http://www.suwaprecision.com/Metal\\_Stamping\\_Articles/blanking.html](http://www.suwaprecision.com/Metal_Stamping_Articles/blanking.html)
- Shan, P. H. (2011). Manufacturing Processes - I. Retrieved March 20, 2013, from National Programme on Technology Enhanced Learning: <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-ROORKEE/MANUFACTURING-PROCESSES/Metal%20Forming%20&%20Powder%20metallurgy/lecture8/lecture8.htm>
- Sheet metal*. (2013, April 23). Retrieved from Sheet metal ITI: <http://www.sheetmetal-iti.org/>
- Tianjin Xinhai Runda Steel Trade Co., L. (2011). Made-In-China.com. Retrieved March 20, 2013, from S235jr/Ss400/Q235 Mild Steel Coil & Plates: <http://xhrdsteel.en.made-in-china.com/product/YeKnoyHxYvpQ/China-S235jr-Ss400-Q235-Mild-Steel-Coil.html>
- Washer*. (2013, April 10). Retrieved from Wikipedia: [http://en.wikipedia.org/wiki/Washer\\_\(hardware\)](http://en.wikipedia.org/wiki/Washer_(hardware))
- Wikipedia. (2013, May 1). *Sheet metal*. Retrieved from Wikipedia: [http://en.wikipedia.org/wiki/Sheet\\_metal](http://en.wikipedia.org/wiki/Sheet_metal)
- Wikipedia. (2013). Wikipedia The Free Encyclopedia. Retrieved March 21, 2013, from Machine Vision: [http://en.wikipedia.org/wiki/Machine\\_vision](http://en.wikipedia.org/wiki/Machine_vision)
- Wikipedia. (2013, March 15). Wikipedia The Free Encyclopedia. Retrieved March 21, 2013, from Inductive Sensor: [http://en.wikipedia.org/wiki/Inductive\\_sensor](http://en.wikipedia.org/wiki/Inductive_sensor)
- Wikipedia. (2012, December 6). Wikipedia The Free Encyclopedia. Retrieved March 20, 2013, from Stamping press: [http://en.wikipedia.org/wiki/Stamping\\_press](http://en.wikipedia.org/wiki/Stamping_press)
- Wikipedia. (2013, February 28). Retrieved March 20, 2013, from Reel: <http://en.wikipedia.org/wiki/Reel>
- (n.d.). Retrieved april 23, 2013, from process planning and cost estimation: <http://books.google.com.my/books?id=IZsclp3DQXAC&printsec=frontcover#v=onepage&q&f=true>