EFFECTS OF ANNEALING ON PUNCHES HEAD AND THE REPURCUSSION ON THE PRODUCT LIFECYCLE AND COST (UTeM)

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This report is submitted
in fulfilment of the requirement for the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

DECLARATION

I declare that this project report entitled “Effects of Annealing on Punches Head and the Repercussion on Product Lifecycle and Cost” is the result of my own work except as cited in the references

Signature : ....

Name : ....

Date : ....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature	: ....
Name of Supervisor	: ....
Date	: ....

DEDICATION

To beloved mother and father, family and friends.

ABSTRACT

Punches are still a main tool used all around in the metalworking industry. They are mainly used for punching sheet metal to form small form products such as rivet sockets and various complex forms. The punches are disposable tool most often thrown away after fracturing. This, in large amount, could potentially harm the environment in the long-term period.

Annealing is a heating process conducted on metal workpiece to reduce the hardness and stabilise the workpiece. The application of induction heating annealing could aid the punches head in reducing its hardness thus allowing it to sustain more impact forces before wearing out. Applying this process, the number of punches needed for a typical stamping and blanking process could be reduced significantly.

This study case intends to investigate whether annealing would reduce the number of punches needed for a typical blanking or punching situation and to determine whether annealing the punches head would reduce the overall cost and reduce the metal scraps from production.

ABSTRAK

Punches masih merupakan peralatan utama yang masih digunakan dalam industry pembuatan besi. Punches kerap digunakan untuk menumbuk lubang pada kepingan besi untuk menghasilkan soket rivet dan pelbagai bentuk lubang yang kompleks. Punches ialah satu peralatan yang sering dibuang selepas ia retak atau rosak. Keadaan ini, dalam kuantiti yang besar, berpotensi besar untuk merosakkan alam sekitar pada jangka masa panjang.

Annealing ialah proses pemanasan yang digunakan atas alat kerja besi untuk mengurangkan kekerasan dan menstabilkan alat kerja tersebut. Applikasi seperti induction heating boleh membantu kepala punches dengan mengurangkan kekerasan pada kepalanya supaya punches tersebut boleh mengekalkan keupayaan untuk diketuk sebelum patah dengan lebih lama. Mengaplikasikan proses ini, jumlah punches yang diperlukan untuk proses stamping dan blanking boleh dikurangkan dengan nilai yang banyak.

Kes kajian ini turut berhasrat untuk mengkaji sama ada annealing akan mengurangkan jumlah punches yang diperlukan dalam proses tipikal blanking atau punching dan menentukan sama ada annealing kepala punches turut mengurangkan kos keseluruhan produksi dan mengurangkan pembaziran besi dari aspek produksi.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to everyone who gave me their guidance and co-operation throughout the whole year of this Final Year Project; those who are involved has made this final year project very significant and memorable to my approach to handling a project. I also would like to dedicate a special thanks to my supervisor, Dr. Siti Nurhaida – whom has taught me a great deal regarding on how to approach and tackle a project from scratch and how to implement an engineer-like mindset all the while providing me with her insights on the matter at hand.

This knowledge will be appreciated and be put into good use in the future if I get the opportunity to apply it. Special appreciation to my parents who supported me morally and financially throughout this past year. Lastly, I would also like to thank all who gave their assistance and guidance to me in order to complete this final year project.

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INTRODUCTION

1.1 Background

Metal Shear Forming has been a long-time production process used to fabricate product through process such as shearing, stamping, parting, blanking and punching. In this study, punching is the focus. Punching is a process where a sheet of metal is inserted between an upper shoe and lower shoe which comprises of other components; punches being the main component here. The punches come into contact with these sheet metal and is applied force on the shank shearing the sheet metal to the shape of the punch – be it round, ellipse or custom shapes.

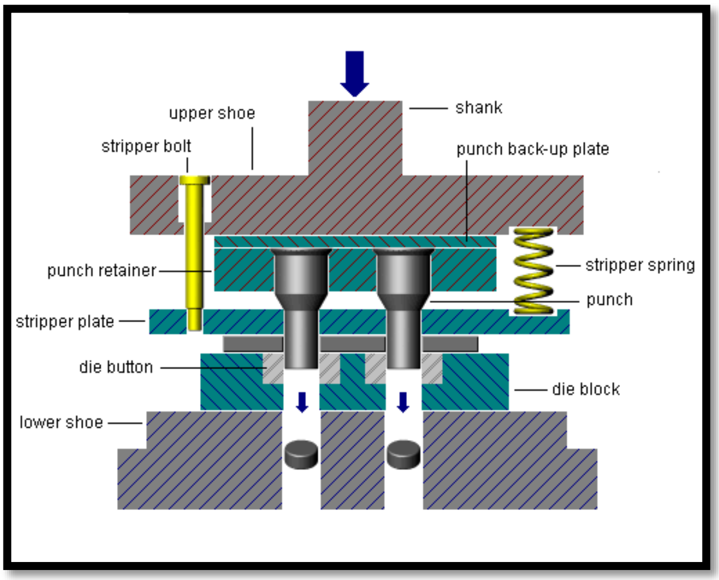

Figure 1.1.1 - Hole Punching Diagram Example

The punch is often replaced when it is broken and often it is ordered in a factory in large quantity to keep as reserved. There are two types of punches – standard and custom. More often than not, these punches are custom-made to meet with the unique dimensions of product to be produced. The punches often fail at the head as it is subjected to large amount of force from the shank through extensive usage of the punch; wear-and-tear is unavoidable and the same is applied to punches. There are multiple ways to prolong the lifespan of the punches – one of it being “annealing”.

Annealing is a stress-relief process used to alter the mechanical property, hardness of a material and alter the physical properties by increasing the ductility. The process is essentially heating to high temperature and air cooling. There’s a wide group of heat treatment processes and is executed mainly for homogenization, recrystallisation or relief of residual stress in typical cold worked or welded components. There is various method of annealing such as full annealing (conventional annealing), induction heating, isothermal annealing etc.

Mechanical properties affected by annealing in punches head is hardness as aforementioned. The decrease in hardness at the head of the punches will allow the punches to be subjected to force for longer usage before breaking thus extending the punches lifespan. This could lead to decrease of maintenance cost and reduces the waste of scrap materials.

1.2 Problem Statement

Punching is a manufacturing process that have been around since the Industrial Revolution in 1760 at Great Britain. Punching is also known as metal forming. The punches formed through manual production method such as lathing, grinding, surfacing etc. The mechanical properties of these punches are usually very similar to the raw material used to form aforementioned punches. Annealing the head of the punches reduces the hardness of punches head in which theory should prolong the lifespan of the punches; at an extra production cost. The problem is to determine the difference of cost between non-annealed punch and annealed punch and which is more cost-efficient and the effects towards the environment.

1.3 Objective

The objectives of this project are as follows:

1. To investigate the correlation of annealing on punches head to the number of cyclic loads attainable by the punches being subjected to a force and comparing the difference of standard and annealed punches in terms of cyclic loads.
2. To determine the performance difference of non-annealed and annealed punch and the worth of annealing to a punch's performance to cost ratio.
3. To estimate the increase of production cost when annealing punches.

1.4 Scope of Project

The scopes of this project are:

1. Only hardness will be considered as the manipulative variable in the simulation of the study regarding the difference of annealed punch and standard punch. The hardness will correlate to the failure of the punch.
2. Only one type of punch design will be used for the testing.

1.5 General Methodology

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Literature review

   Journals, articles, or any materials regarding the project will be reviewed.
2. Prerequisite for Machine Testing

   Data required for testing shall be obtained before the main test.
3. Testing

   A machine testing designed to emulate the real life working condition of the punching or stamping process will be conducted on the punches. The data will be related to real-life price of the punches and cost will be calculated between annealed punches and standard punches.
4. Report writing

   A report on this study will be written at the end of the project.

The methodology of this study is summarized in the flow chart as shown in Figure 1.5.

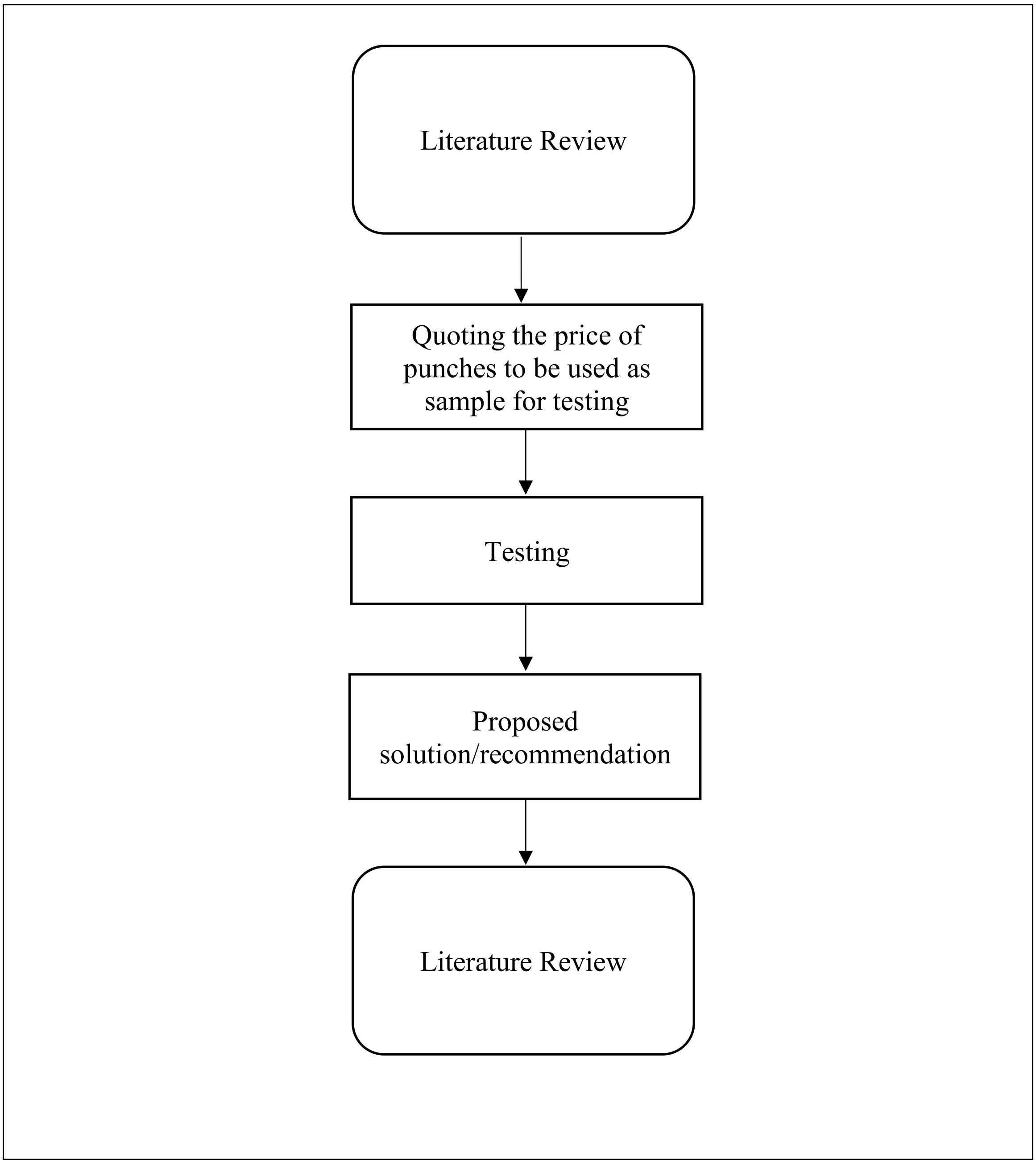

Figure 1.5.1 - Flow chart of the methodology

2 Chapter 2

LITERATURE REVIEW

2.1 Metal Working Manufacturing

Metal working is also known as metal forming which involves mechanical working of metal workpieces. Metal working operations are often executed to either create a new shape or to enhance the properties of the metal. Forming the solid workpiece are divided into two categories, non-cutting and cutting. Non-cutting forming involves process such as forging, rolling and pressing and cutting forming involves machining operations performed on various machine tools. The main objective of metal working is to shape the workpiece into desired shape and size while catering to the provided dimensions and specifications under the action of externally applied forces.

Metal workpiece are commonly worked by plastic deformation because the workpiece would benefit from the mechanical properties imparted onto it. The necessary deformation in a metal workpiece can be achieved by application of mechanical force only or by heating the metal and then applying a small force. The impurities present in the metal are then elongated with the grains and in the process, get broken and dispersed throughout the metal. This also decreases the harmful effect of the impurities and improves the mechanical strength. This plastic deformation of a metal takes place when the stress caused in the metal, due to the applied forces reaches the yield point. The two common phenomena governing this plastic deformation of a metal are (*a*) deformation by slip and (*b*) deformation by twin formation. In the former case it is considered that each grain of a metal is made of a number of unit cells arranged in a number of planes, and the slip or deformation of metal takes place along that slip plane which is subjected to the greatest shearing stress on account of the applied forces. In the latter case, deformation occurs along two parallel planes, which move diagonally across the unit cells. These parallel planes are called twinning planes and the portion of the grains covered between them is known as twinned region. On the macroscopic scale, when plastic deformation occurs, the metal appears to flow in the solid state along specific directions, which are dependent on the processing and the direction of applied forces. The crystals or grains of the metal get elongated in the direction of metal flow. However, this flow of metal can be easily being seen under microscope after polishing and suitable etching of the metal surface. The visible lines are called fibre flow lines. The above deformations may be carried out at room temperature or higher temperatures. At higher temperatures the deformation is faster because the bond between atoms of the metal grains is reduced. Plasticity, ductility and malleability are the properties of a material, which retains the deformation produced under applied forces permanently and hence these metal properties are important for metal working processes. (Singh, 2006)

As mentioned before, there are two types of forming; non-cutting and cutting. Non-cutting is when a sheet metal undergoes a process to change the overall shape of the metal sheet yet the quantity after the process is still one sheet metal just deformed or bent to desired shape and dimension. Forming operations covers bending, drawing and squeezing.

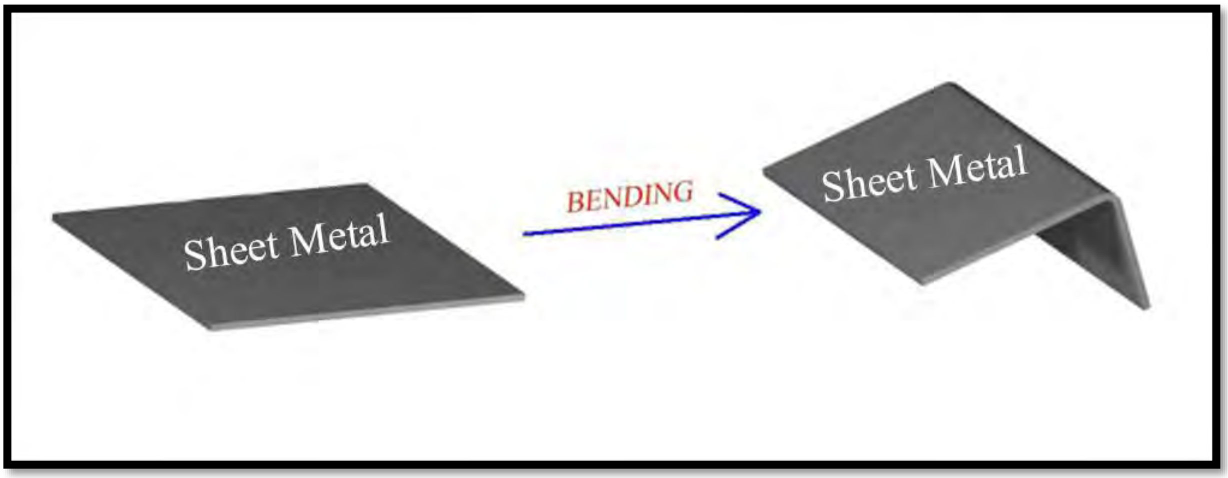

Figure 2.1.1 – Metal Sheet Bending Process

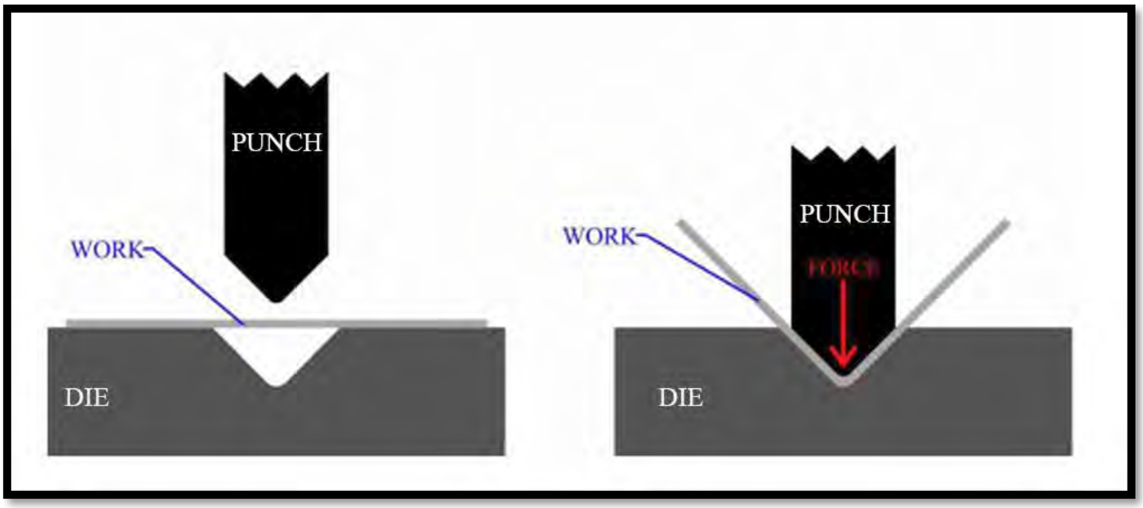

Figure 2.1.2 – Punching Process Example 1

Cutting forming, on the other hand, is when a piece of metal sheet metal subjected to a cutting process to form multiple pieces of smaller sheet metals. It does not necessarily require symmetrical cut, it could be any shape and the excess sheet metal is thrown away or recycled as waste material. This cutting process encompasses blanking, notching, perforating, trimming, shaving, slitting, lancing, nibbling and punching.

Figure 2.1.3 – Metal Sheet Cutting

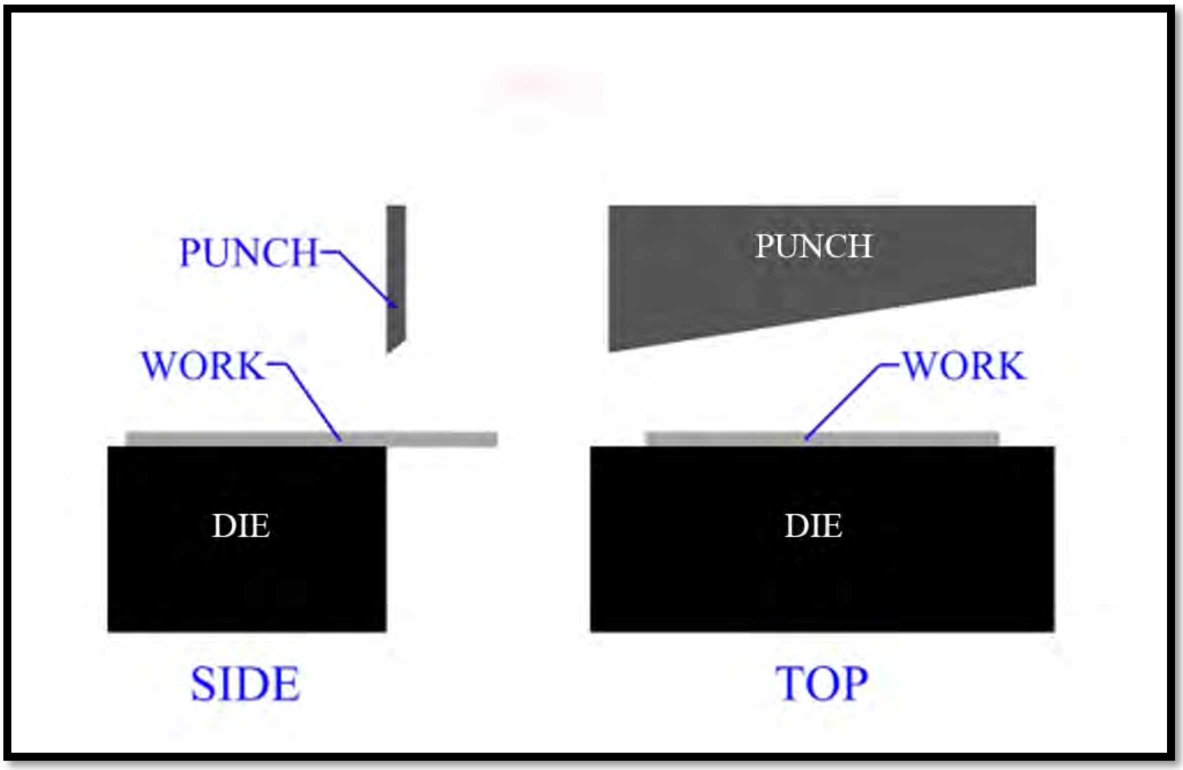

Figure 2.1.4 – Punching Process Example 2

In this case study, we will be focusing partly on punching process.

2.2 Punching (Shearing)

Punches are essentially a metalworking manufacturing technique that falls under cold working method specifically called cold extrusion. It is a cutting operation that require specific tools and tolerance for certain material; often a punch and a set of die. The punch will be piercing the material while the die limits the depth of the punch. This method of manufacturing is mainly used to make small components from ductile materials.

Impact extrusion of material is accomplished where the work blank is placed in position over the die opening the punch forces the blank through the die opening causing the material to flow plastically around the punch. (Singh, 2006)

Impact extrusion is a type of specialty cold forming used for larger parts with hollowed cores and think wall thickness; such as pins. The impact extrusion process begins with a tightly controlled metal blank that is placed in a die that is located on a vertical mechanical or hydraulic press. A punch being driven into a die by the force of the press causes the metal blank to flow (extrude) in a forward or backward manner. The process of impact extrusion means to pierce a metal blank at such force that it changes the metal into a plastic state that allows the metal to actually flow in to a die shape and around the punch. The challenges with impact extrusion are for the engineer to design a process for the impact extrusion shape with the minimum number of process steps. (St. Clair, 2017)

These punches are usually made up of hard metal but may be subjected to different materials such as Titanium Nitride (TiN); completely dependent on the material to be extruded. The material is dependent on the material that will be sheared or punched. If the blank metal sheets are made up of aluminium, for example, the hardness of the punch would not be so high as it would be an overkill and a wasted tooling used since the higher the hardness of the punch, the higher the price of the punch. Naturally, the punches would be higher in hardness than the material otherwise the blank metal sheets would not be able to be punched (sheared) because the plastic deformation of the metal sheets could not be achieved.

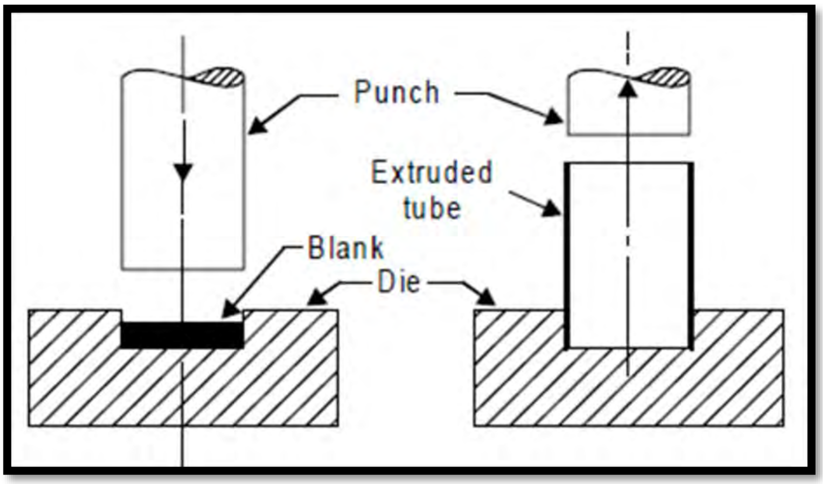

Figure 2.2.1 – Punching Process Cross-section

This process is can also fall under the category of metal shearing since the material to be "punched" are subjected to shearing force for the blank to be formed as shown in Figure 2.2.2

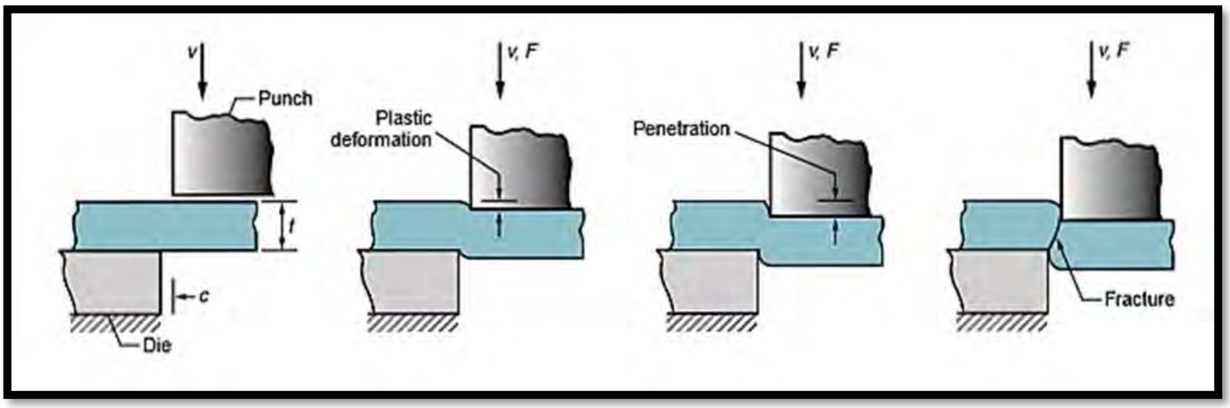

Figure 2.2.2 – Punching Process Shearing

Punches usually fail at the joint between the head of the punch and the bottom part of the punch (the part that is in contact with the working material). Punch head breakage can lead to serious problem mainly in heavy punching and fast speed punching because of the compression that occurs during cutting working condition. Rapid strain rates that occur in high speed stamping may increase the punching load from normal shear strength to the ultimate tensile strength which could lead to deformation. The crack or breakage at this part will lead to failure because the punch will no longer be able to withstand the heavy punching and fast speed punching as the force no longer can transverse through the body of the punch. Failed punches are normal and unavoidable, but if the lifespan is increased, it would bring down manufacturing cost and decrease waste product from tooling. (Hedrik, 2018)

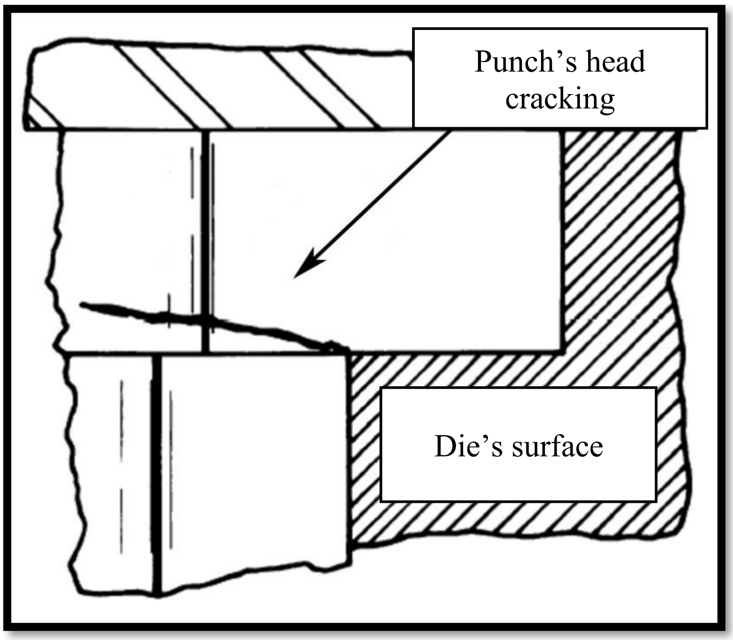

Figure 2.2.3 – Punch Failure Cross-section

Punches fail after extensive usage as they are subjected to impulsive force multiple times and the lifespan varies depending on the working material it is used with to form blanks. The higher the hardness of the punch material, the worse it will be when a crack forms. Higher hardness may allow the punch to shear the blank metal sheet better but the