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Investigation of Machining Defects on Rolled Steel Plate

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By

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APPROVAL

This thesis submitted to the senate of Universiti Teknikal Malaysia Melaka (UTeM) and has been accepted as fulfillment of the requirement for the degree of Bachelor Manufacturing Engineering (Manufacturing Design). The members of the supervisory committee are as follow:

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DEDICATION

Specially dedicated to My beloved Father, Yaacob bin Abdullah and My Mother, Rohani bt. Hussain who are very concern, understanding, patient and supporting. Thanks for my everything to My supervisor Mr. Sivarao for his constructive guidance, encouragement and patience in fulfilling our inspiration in completing this project. To My Sister, Brother and All My Friends, I also would like to say thanks. The work and Success will be never be achieved without all of you.

ABSTRACT

The aim for this study is to investigate the machining defect on rolled steel plate. In this study, the effects of cutting speed and feed rate and number of holes drilled are investigated. For this purpose, mild steel (AISI 1045) is drilled at dry machining conditions with two different types of workpiece in CNC Haas milling machine. Drilling process was carried out with 10mm and 20mm HSS drill diameter. The point angle of the drills has 118°, which is the recommended value for cutting materials for mild steel were used for the experiment work. Wide ranges of the feed and the cutting speed, including values recommended by general machining handbooks, were tested to find the surface roughness. The Surftest SJ-301 has used to measure the defects at drilled holes. In the experiments, depending on the types of workpiece, lowest surface roughness is found 4.34µm at exp 2. The highest surface roughness is presented at experiment 4 with 8.93µm. The results also obtained that variable cutting speed gives the influence of the surface finish at hole and the lower feed rate gives the high surface roughness value. The best parameter for the both of workpiece were found at 478rpm and feed 15mm/min for 10mm drill diameter and 239rpm and feed 19mm/min for 20mm drill diameter.

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CHAPTER 1

INTRODUCTION

1.1 Project Introduction

The purposes of this study are to show the results of drilling holes on the rolled steel plate and to define the machining defect. The surface finish for the holes were investigates to define the machining defects. The drilling process considered is the hole initiation process, while the hole modification process is either drilling or boring. This chapter will provide an overview of the overall application of rolled steel plate in industry. The rolled steel plate usually used for power plant system, boiler system, pressure vessel system fertilizer drum system and etc.

This paper will describe the suitable parameters for drilling process in rolled steel plate. These suitable parameters can reduce the manufacturing cost when doing the drilling process at the rolled steel plate. Among parameters are drill bits size, speed (rpm), feed rate, type of drill bit and type of rolled steel material. For the experiment section, I will list down the category of function for the machine selection.

Table 1.1: Function for the machine selection

No.	Types of machine	Function
1.	CNC Haas Machine	Drilling process
2.	Surftest Sj-301	Surface roughness measurement

This report will provide an overview of the experiment project titled investigation of machining defect on rolled steel plate. It will include the problem statement, the project objectives, the scope of study, the importance of study and the methodology.

1.2 Drilling Process

Drilling is easily the most common machining process. One estimate is that 75% of all metal-cutting material removed comes from drilling operations. Drilling involves the creation of holes that are right circular cylinders. By using the selection parameters this paper was describe the machining defects in rolled steel plate. Drilling is the process most commonly associated with producing machined holes.

Although many other processes contribute to the production of holes, including boring, reaming, broaching, and internal grinding, and drilling accounts for the majority of holes produced in the machine shop. This is because drilling is a simple, quick, and economical method of hole production. The other methods are used principally for more accurate, smoother, larger holes. They are often used after a drill has already made the pilot hole. Drilling is one of the most complex machining processes. The chief characteristic that distinguishes it from other machining operations is the combined cutting and extrusion of metal at the chisel edge in the center of the drill. The high thrust force caused by the feeding motion first extrudes metal under the chisel edge. Then it tends to shear under the action of a negative rake angle tool. Drilling of a single hole is shown in Figure 1.1 and high production drilling of a plate component is shown in Figure 1.2

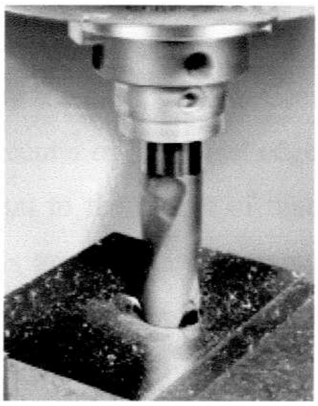


Figure 1.1: Drilling of a single hole

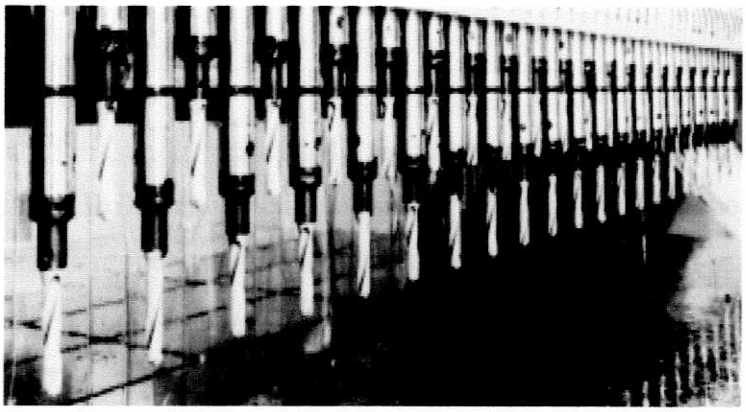


Figure 1.2: High production drilling of a plate component

The cutting action along the lips of the drill is not unlike that in other machining processes. Due to variable rake angle and inclination, however, there are differences in the cutting action at various radii on the cutting edges. This is complicated by the constraint of the whole chip on the chip flow at any single point along the lip. Still, the metal removing action is true cutting, and the problems of variable geometry and constraint are present, but because it is such a small portion of the total drilling operation, it is not a distinguishing characteristic of the process.

For a given set-up, the undeformed chip width is constant in drilling. The feed dimension specified for drilling is the feed per revolution of the spindle. A more fundamental quantity is the feed per lip. For the common two-flute drill, it is half the feed per revolution. The undeformed chip thickness differs from the feed per lip depending on the point angle. The spindle speed is constant for any one operation, while the cutting speed varies all along the cutting edge. Cutting speed is normally computed for the outside diameter. At the center of the chisel edge the cutting speed is zero; at any point on the lip it is proportional to the radius of that point. This variation in cutting speed along the cutting edges is an important characteristic of drilling. Once the drill engages the workpiece, the contact is continuous until the drill breaks through the bottom of the part or is withdrawn from the hole. In this respect, drilling resembles turning and is unlike milling. Continuous cutting means that steady forces and temperatures may be expected shortly after contact between the drill and the workpiece.

1.3 Operating Conditions

The varying conditions, under which drills are used, make it difficult to give set rules for speeds and feeds. Drill manufacturers and a variety of reference texts provide recommendations for proper speeds and feeds for drilling a variety of materials.

1.3.1 Drilling Speed

Cutting speed may be referred to as the rate that a point on a circumference of a drill will travel in 1 minute. It is expressed in surface feet per minute (SFPM). Cutting speed is one of the most important factors that determine the life of a drill. If the cutting speed is too slow, the drill might chip or break. A cutting speed that is too fast rapidly dulls the cutting lips. Cutting speeds depend on the following seven variables:

- The type of material being drilled. The harder the material, the slower the cutting speed.
- The cutting tool material and diameter. The harder the cutting tool material, the faster it can machine the material. The larger the drill, the slower the drill must revolve.
- The types and use of cutting fluids allow an increase in cutting speed.
- The rigidity of the drill press.
- The rigidity of the drill (the shorter the drill, the better).
- The rigidity of the work setup.

• The quality of the hole to be drilled. Each variable should be considered prior to drilling a hole. Each variable is important, but the work material and its cutting speed are the most important factors. To calculate the revolutions per minute (RPM) rate of a drill, the diameter of the drill and the cutting speed of the material must be considered.

1.3.2 Drilling Feed

Once the cutting speed has been selected for a particular workpiece material and condition, the appropriate feed rate must be established. Drilling feed rates are selected to maximize productivity while maintaining chip control. Feed in drilling operations is expressed in inches per revolution, or IPR, which is the distance the drill moves in inches for each revolution of the drill. The feed may also be expressed as the distance traveled by the drill in a single minute, or IPM (inches per minute), which is the product of the RPM and IPR of the drill.

1.4 Types of Drill Bits

1.4.1 Twist Drill

Drill bits are cutting tools used to create cylindrical holes. Bits are held in a tool called a drill, which rotates them and provides axial force to create the hole. The twist drill bit is the type produced in largest quantity today. It can be used to create holes in metal, plastic, wood and stone. The twist drill bit was invented by Steven A. Morse of East Bridgewater, Massachusetts in 1861. He received U.S. Patent 38119 for his invention on 7 April 1863. The original method of manufacture was to cut two grooves in opposite sides of a round bar, then to twist the bar to produce the helical flutes. This gave the tool its name. Nowadays, the drill bit is usually made by rotating the bar while moving it past a grinding wheel to cut the flutes in the same manner as cutting helical gears. Tools recognizable as twist drill bits are currently produced in diameters covering the range at least from 0.05 mm to 100 mm. Lengths up to about 1000 mm are available for use in powered hand tools.

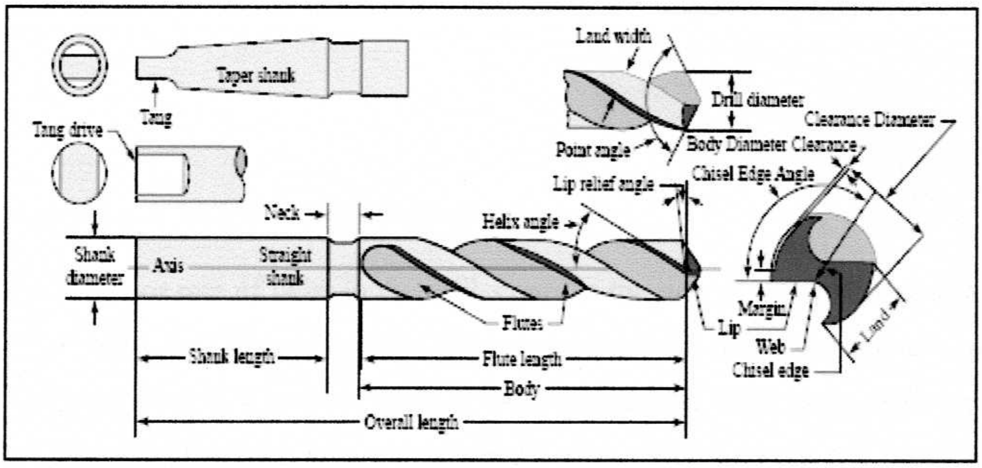


Figure1.3: Nomenclature of a twist drill shown with taper and tang drives.

The geometry and sharpening of the cutting edges is crucial to the performance of the bit. Users often throw away small bits that become blunt, and replace them with new bits, because they are inexpensive and sharpening them well is difficult. For larger bits, special grinding jigs are available. A special tool grinder is available for sharpening or reshaping cutting surfaces on twist drills to optimize the drill for a particular material. Manufacturers can produce special versions of the twist drill bit, varying the geometry and the materials used, to suit particular machinery and particular materials to be cut. Twist drill bits are available in the widest choice of tooling materials. However, even for industrial users, most holes are still drilled with a conventional bit of high speed steel.

The most common twist drill (the one sold in general hardware stores) has a point of 118° degrees. This is a suitable angle for a wide array of tasks, and will not cause the uninitiated operator undue stress by walking or digging in. A more aggressive (pointy) angle, such as 90° degrees, is suited for very soft plastics and other materials. The bit will generally be self-starting and cut very quickly. A shallower angle, such as 150° degrees, is suited for drilling steels and other tougher materials. This style bit requires a starter hole, but will not bind or suffer premature wear when a proper feed rate is set.

Drills with no point angle are used in situations where a blind, flat-bottomed hole is required. These style drills are very sensitive to changes in lip angle, and even a slight change can result in an inappropriately fast cutting drill bit that will suffer premature wear.

The tool geometry is broken down into several areas:

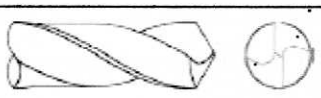
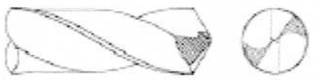
- The helix, or rate of twist in the drill, controls the rate of chip removal in a drill. A low helix drill is used in high feed rate applications under low spindle speeds, where removal of a large volume of swarf is required. High helix drills are used in cutting applications where traditionally high cutting speeds are used and the material has a tendency to gall on the drill or otherwise clog the hole, such as aluminum or copper.
- Point angle is determined by the material the drill will be operating in. Harder materials require a larger point angle, and softer materials require a more pointed angle. The correct point angle for the hardness of the material controls wandering, chatter, hole shape, wear rate, and a wide array of other characteristics.
- Lip angle determines the amount of support provided to the cutting edge. A greater lip angle will cause the drill to cut more aggressively under the same amount of point pressure as a drill with a smaller lip angle. Both conditions can cause binding, wear, and eventual catastrophic failure of the tool. The proper amount of lip clearance is determined by the point angle. A very acute point angle has more web surface area presented to the work at any one time, requiring an aggressive lip angle, where a flat drill is extremely sensitive to small changes in lip angle due to the small surface area supporting the cutting edges.

1.4.2 118° and 135° Point Angle

118° point angles are used primarily in softer materials such as mild steels and cast irons. The advantages of a 118° point in these materials include control over chips, which are wide and thin. 135° split points should be engaged to cut harder steel materials and especially in deep holes over 4 times drill diameter. A 135° point cutting harder materials will produce thicker chips, thus minimizing work hardening of the cavity. The length of the lips on a 135° point measured from the axis to the outer corners is relativity short and thus penetrates much quicker into the work piece reducing thrust and abrasion along the cutting edges.

1.4.3 Drill Point Characteristics

Table 1.2: Drill Point Characteristics

Type	Performance Benefits*	Comments
 Conventional Point (118°)	• General purpose • Widely available • Acceptable drill life • Best suited in mild steel and aluminum	• Not self-centering; "walking" can occur on hard surfaces • May produce burs on breakthrough
 Split Point (118° and 135°)	• Self centering • Excellent for portable drilling • Longer drill life • Good for drilling on curved surfaces • Improved penetration rates • Requires less effort	• Difficult to regrind

	• Breaks up chips • Best suited in alloy steels	

1.4.4 Coated Drill Bit

1.4.4.1 HSS - High Speed Steel

Since its introduction at the end of the 19th century high speed steel has become one of the most important materials used for the manufacture of cutting tools. High speed steel Cutting Tools exhibit Tools exhibit hardness, toughness and wear resistance characteristics which make them suitable for a wide range of applications. High speed steel (HSS) is a material usually used in the manufacture of machine tool bits and other cutters. It is often used in power saw blades and drill bits. It is superior to the older high carbon steel tools, which were used extensively through the 1940's, in that it can withstand higher temperatures without losing its temper (hardness). This property allows HSS to cut faster than high carbon steel, hence the name (high speed steel). At room temperature HSS and high carbon steel have an equivalent hardness; only at elevated temperatures does HSS become advantageous.

High speed steel is the most highly allowed of the tool steels. They can be hardened to various depth, have good resistance to fracture, high speed steel are especially suitable for high positive rake-angle tools (those with small include angles), for interrupted cuts, and for machine tools stiffness that are subject to vibration and chatter. High speed steel tools are available is wrought, cast and sintered (powder metallurgy) forms. They can be coated for improved performance. High Speed steel may also be subjected to surface treatments, such as case hardening for improved hardness and wear resistance or steam treatment at elevated temperatures to develop a black oxide layer for improved performance, to reduce built-up edge formation.