
Study Leaf Spring for Punch in Press Tools

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Abstract: The equipment of cutting tools is developed very rapidly now days, they can be seen from the many uses of metal materials, especially in the mass production industry with certain specifications, such as stainless steel, high carbon steel, and tool steel. Home industries such as the manufacture of rings, pans, bottle caps, stove components and others often use these materials as materials to make tools called press tools. In this press tool, high carbon steel or tool steel is mostly used as a punch, but as the cost and difficulty of these materials make home industries suffer big losses for the manufacture of production tools. For this reason, through this study the authors conducted experiments in the laboratory on recycle leaf spring materials. The experiment was carried out in four stages of testing, namely composition test, tensile test, hardness test, and microstructure test. The composition of elements of the recycle leaf spring are 0.67% Carbon (C), 0.73% Manganese (Mn), 0.02% Sulfur (S), 0.03% Phosphorus (P). The tensile strength of recycle leaf springs is 1382.5 kg/mm². The hardness is carried out with the Rockwell C hardness test, the result of the test is 53.5 HRC. So, the elements of martensitic and austenite in the microstructure test. The results of the laboratory experiments were compared with the data in the literature, so the recycle leaf spring material could be used as a substitute for cutting blades in press tools or the cutting tools of turning machine.

Keywords: metal, press tools, punch, steel, leaf spring

1. Introduction

Nowadays, many industries are engaged in mass production using metal materials derived from steel with certain specifications such as tool steel, stainless steel, and high carbon steel. For material selection, it can be done by looking at the properties possessed by the material, such as operational excellence. Therefore, it is necessary to develop a material as a way to determine whether the structure and properties of the material are optimum in order to achieve maximum durability [1].

Home industries such as the manufacture of rings, pans, bottle caps, stove components, and others, many use production tools called press tools [1]. There are two important parts in press tool, namely the punch and the die [2].

All processes that occur in the press tools involve two important components, namely: the punch and die. Punch is

the part that moves downwards to transmit the force from the power source so that the product material is pressed down, the shape of the cutting edge is adjusted to the desired final shape of the finished object process, the location of the punch in figure 1 is above the product material, the position of the cutting edge actually not always above depending on the type of foundation used [3].

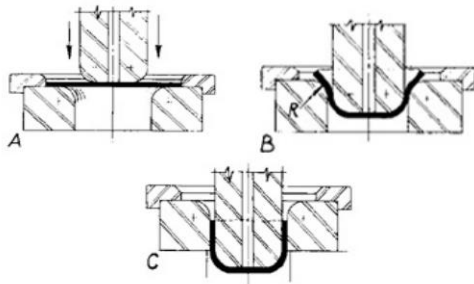


Figure 1. The caption of the figure [3]

The cutting-edge material must be sufficiently hard, also have ductility and resistance to the effects of friction during shaping, and commonly used materials such as amutite. The base is the main component that plays a role in determining the final shape of the workpiece, its shape and size varies according to the desired final shape, the foundation construction must be able to withstand movement, shear forces and cutting-edge forces. On the base there is a certain radius that serves to facilitate the reduction of objects during the direct process, furthermore, with the radius, it is hoped that there will be no tearing of the product material to be formed.

According to its chemical composition, carbon steel can be classified into three namely; Low carbon steel with a carbon content of 0.05% - 0.30% C, is malleable and easy to work with in the machining process. Its use for compositions of 0.05% - 0.20% C is usually for car bodies, buildings, pipes, chains, rivets, screws, nails and carbon compositions 0.20% - 0.30% C are used for gears, shafts, bolt, bridge, building.

Medium carbon steel with a carbon content of 0.30% - 0.60%, its strength is higher than low carbon steel. It is difficult to bend, weld, cut. Use for carbon content of 0.30% - 0.40% for connecting rods in automotive parts. For carbon content 0.40% - 0.50% used for car frames, crankshafts, rails, boilers and screwdrivers. For carbon content 0.50% - 0.60% is used for hammers and sleds on machines [4].

High carbon steel is for the manufacture of tool steel. It is difficult to bend, weld and cut. Content of 0.60% - 1.50% C, use for making screwdrivers, forging hammers, knife tables, vise jaws, drill bits, cutting tools, saw blades. Alloy steels classified according to their carbon content are divided into: low-alloy steel if the alloying element is d" 2.5%, medium-alloy steel if the alloying element is 2.5-10%, high-alloy steel if the alloying element is >10%. In addition, alloy steel is divided into two groups, namely special alloy steel and high speed steel (HSS) that is use for cutting tool in the machining processing [5].

Special Alloy Steel, namely this type of steel contains one or more metals such as nickel, chromium, manganese, molybdenum, tungsten and vanadium. By adding even these metals into steel, the alloy steel will change its mechanical and chemical properties such as becoming harder, stronger and more ductile when compared to carbon steel [5-6].

HSS (Self Hardening Steel) is steel with a carbon content of 0.70% - 1.50%. The use of this steel is to make cutting tools such as drill bits, lathe chisels, and milling chisels. Called HSS because cutting tools made with this material can be operated

twice as fast as carbon steel. Meanwhile, the price of HSS is two to four times that of carbon [4, 7].

Tool Steel and the properties that must be possessed by tool steel are wear resistance, sharp or easy to sharpen, heat resistance, strong and ductile.

Tool steels and high carbon steels are materials that are widely used for punch making. In terms of quality, tool steel and high carbon steel are very good for punch making. but the price is very expensive and difficult to obtain in the market. Therefore, business people are looking for substitute materials that are cheap and have properties that are almost the same as tool steel [8-9].

One of the most important things for the selection of this replacement material is to review the structure and properties of the optimum material so that it is wear-resistant and can be applied to various operational conditions, for that the authors chose and tested used leaf springs as a replacement material. cutting tools, because this material is cheap, easy to obtain and no less important is the reuse of materials that are no longer useful into materials of high economic value.

The test of recycle leaf spring material is carried out to determine whether this leaf spring material is feasible to be a substitute for tool steel in mass production tools, both in terms of the micro structure, as well as from the mechanical properties of this used leaf spring material.

The objectives of this test are to determine the microstructure changes that occur in each treatment cycle on the used leaf spring material and determine the mechanical properties of this material and make comparisons to decide that this used leaf spring material is indeed suitable to be used as a substitute for tool steel.

There are several things that can be the formulation of the problem, namely Is this recycle leaf spring feasible as an alternative material for cutting tools in mass production tools or not, for that it is necessary to do a composition test, tensile test, hardness test to find out the spring material Which type of steel does the leaf belong to?

This study is expected to be used as a reference material in the selection of tool steel replacement materials at a low cost and have specifications and quality that are almost the same as standard materials, so that they can help the world of home industry without affecting the quality and quantity of the product.

2. Research Methodology

2.1. Material and Equipment

The material used was recycle leaf springs found in the market, namely the used goods market in Palembang. To find out the composition of used leaf springs, a composition test was carried out and the same literature was searched which explained the types of materials similar to recycle leaf springs.

The equipment and materials are used:

1. Samples of recycle leaf springs on the market
2. X-Ray Spectograph (composition test equipment)
3. WP 310 Universal-Werkstoff-Prufgerat 50 kN (tensile test)

4. Universal Hardness Tester
5. Microstructure test microscope of metal material
6. Sanding and polishing tools
7. Chemicals used by DP
8. Spray and etching solution (Oxalid acid)

2.2. Specimen Preparation

- a. Preparation of the test specimens for the composition test. The composition test was carried out on used leaf springs, namely by cutting the material purchased on the market with a length of 40 mm and a width of 40 mm as shown in Figure 2. Then the specimen being tested was smoothed.
- b. Preparation of specimens for the tensile test of the material as shown in Figure 3.
- c. Preparation of specimens for hardness tests Hardness test objects are taken from the material directly from the test material.
- d. Preparation of specimens for microstructure testing, in the manufacture of this microstructure test specimen, is should be cut by taking into keep the temperature, so the microstructure in the test object does not change at the time of cutting. After that, the specimen is dipped into the prepared etching solution

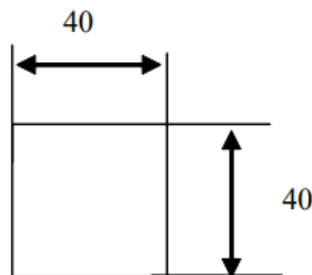


Figure 2. The dimension of harness Test Specimen [10]

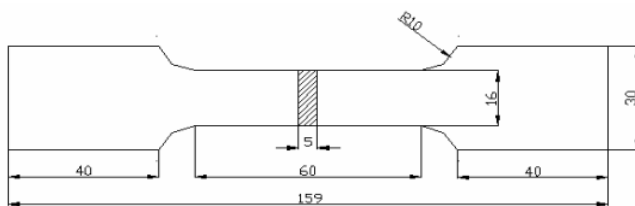


Figure 3. Tensile Test Specimen [11]

3. Result and Discussion

3.1. Composition Result Test

Composition testing is carried out to determine the content of chemical elements contained in the object/test material. In this test the tool used is Thermo ARL (Applied Research Laboratories) Type 3560 Dec. The results obtained from material testing can be seen in the table 1.

Table 1. Composition Result Test

Element	Specimen		Total	Average
	I	II		
C	0.6650	0.6649	1.3299	0.66495
Mn	0.7452	0.7255	1.4607	0.7304
P	0.0273	0.0262	0.0515	0.0257
S	0.0262	0.0238	0.0480	0.0240
Cu	0.0964	0.0985	0.1929	0.0964
Ni	0.0399	0.0406	0.0813	0.0401
Mo	0.0014	0.0026	0.0026	0.0013
Fe	97.3947	97.4202	194.815	97.4075

Based on the tests in table 1, the composition of the recycle leaf spring material that has been tested when compared with existing standards, belongs to the AISI 1064 steel according to American standards (ASTM) [10-13], namely high carbon steel.

3.2. Tensile Test Result

Tensile testing was carried out twice. The experimental results are shown in table 2. It can be seen the average tensile is 1334.89 N/mm².

Table 2. Tensile Result Test

	Specimen		Average
	1	2	
Tensile (N/mm ²)	1316.99	1358.55	1334.89

3.3. Hardness Test Result

In this test using one test specimen, the test is carried out at 8 points. This hardness test uses the Rockwell C test. The result of calculation can be seen in table 3.

The level of hardness of the material based on the Rockwell test is ranges from 48.8-56.8 HRC.

Table 3. Hardness Result Test

No.	Level of Hardness (kg/mm ²)	Indenter	Time (s)	Load (kg)
1	48.8	Diamond cone	15	100
2	56.0	Diamond cone	15	100
3	56.8	Diamond cone	15	100
4	55.3	Diamond cone	15	100

3.4. Metallography Test Result

This test was carried out to see the microstructure of the used leaf spring metal. It is clear that there are elements of martensitic and austenite that make these used leaf springs hard and tough in Figure 8.

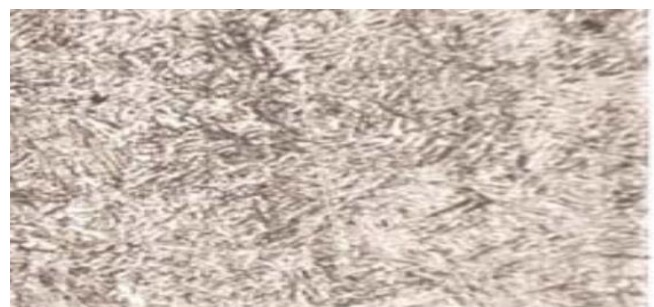


Figure 8. Recycle Leaf Spring Microstructure at 500X Magnification

4. Conclusion

This study has investigated the possibility of recycle leaf spring to replace the material of punch for press tools. The result can be concluded that the recycle leaf spring material available in the market has a composition of 0.66% Carbon (C), 0.73% Manganese (Mn), 0.02% Sulfur (S), 0.03% Phosphorus (P), and this steel is a high carbon steel if according to ASTM it is AISI 1064 with a tensile strength of 1332.5 N/mm^2 . From the hardness test, it was found that this material has a Rockwell hardness level of 48.8 – 56.8 HRC. Based on the microstructure of the leaf spring material, it contains martensitic and austenite. So, it can be recommended as a replacement material for cutting blades especially such as machine.

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