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Stamping Disability Analysis on Material SPC 270 E

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ABSTRACT

Good production results will be a benchmark for a company to compete in today's free market era. To improve good quality is determined by several factors, including: raw material factors, production processes, labor, the state of the engine or dies and the environment. Basically, the production results are not all good, because there are several factors that influence it, as noted above. To overcome this, a company sets a quality requirement because it is very useful for good and quality production results. In determining good quality, it is necessary to conduct a research on the raw material at the SPC 270 E foot step by means of the testing method that will be carried out. The testing methods carried out consist of: tensile testing, hardness testing, metallographic testing, chemical composition testing, and dye penetrant testing. From the results of the research that has been done, it can be seen that the thinning material has an average tensile strength of 307.41 N/mm^2, the standard used by the company is 270 - 323 N/mm^2 and is still in accordance with the tolerance value. Whereas the material with a lump has an average Vickers hardness value of 124.24 HV, the standard used by the company is 135 HV and still fits the tolerance value.

INTRODUCTION

The automotive industry has grown rapidly, along with the increasing public demand for vehicles. With the many production of trucks from various brands, there will be quite a tight competition. In order for the resulting products to compete in the market, the automotive industry must try to maintain product quality and produce at the maximum possible cost. Failure to maintain product quality standards will result in an increase in production costs and also reduce consumer confidence. In order to obtain good quality, we need a well-organized quality control and always analyze deviations that occur by selecting the right method [1-3].

Steel is an alloy (alloy) of iron (Fe) and carbon (C) with a carbon content of not more than 2%. Steel contains other alloying elements that can affect the properties of steel. These elements are intentionally added to obtain certain properties or are inherits that are difficult to remove in the steel making process. The desired properties of steel can be adjusted by adjusting its chemical composition, especially its carbon content [4-7].
Steel is classified into various categories, depending on [8-9]:

a. Composition, such as carbon steel, low alloy steel and stainless steel.
b. Manufacturing methods such as open hearth, basic oxygen or electric furnace.
c. Finish methods, such as hot or cold rolling.
d. Shape of the product, such as rod, plate, sheet or structure shape.
e. De-oxidation processes, such as killed, semi killed or rimmed steel.
f. Microstructure, such as ferrite, pearlite or martensite steel.
g. Strength level, as rated in ASTM standard.
h. Heat treatment, such as annealing, quenching and tempering or thermo mechanics.
i. Quality description, such as forging quality or commercial quality.

The American Iron and Steel Institute defines carbon steel as follows: steel is categorized as carbon steel if there is no minimum content of elements such as chromium, cobalt, colombium (niobium), molybdenum, nickel, titanium, tungsten, vanadium or zirconium, or any other element present. added will result in an alloying effect, if the content of copper is not more than 0.4% or if the maximum content of the following elements does not exceed the following percentages: manganese 1.65%, silicon 0.6% and copper 0.6% [10] .

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In general, carbon steel contains alloying elements and according to its carbon content it can be classified into 4 categories, namely:
1. Low carbon steel
This steel has a carbon content of up to 0.3%. With a low carbon content steel has good formability and is commonly used for the automotive industry, such as for car bodies.
2. Medium carbon steel
Medium carbon steel has a carbon content of 0.3% - 0.6% and manganese 0.6% - 1.65%. This steel is commonly used for clutch shafts, crankshafts and gears.
3. High carbon steel
This steel is commonly used for springs and this high strength wire has a carbon content of between 0.6% - 1%. And the Mn content is around 0.3% - 0.9%.
4. Very high carbon steel
This steel contains carbon content of 1.25% - 2%. Processed by thermo mechanics to obtain certain mechanical properties.

Static fractures can be classified into two parts, namely brittle fractures and ductile fractures. The form of fracture is generally caused by material factors that are brittle and ductile. Analysis of the form of the fracture that occurs can easily find the reason or cause of the fracture. For example, observing the shape of the fracture can give an indication of fracture due to static, that is, the possible cause is an overload or an over tensile load. Over tensile load is caused by these components exceeding the yield stress limit [11-12].

a. The presence of micro cracks (micro crack)
b. The existence of precipitation (precipitation)
c. Necking (stress concentration / reduction)

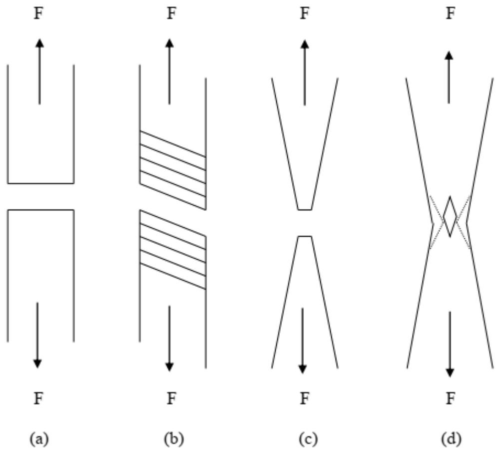

Fig. 1. Types of Fracture in Metal: (a) Single crystal and polycrystalline brittle fracture; (b) The shear fracture of the wild single crystal; (c) Perfect clay fracture in a polycrystalline; (d) Brittle fracture in polycrystals [4]

The purpose of this study was to determine and analyze the mechanical properties and microstructure of the defective stamping plant process.

EXPERIMENTAL METHOD

The research flowchart is done as in Figure 2.

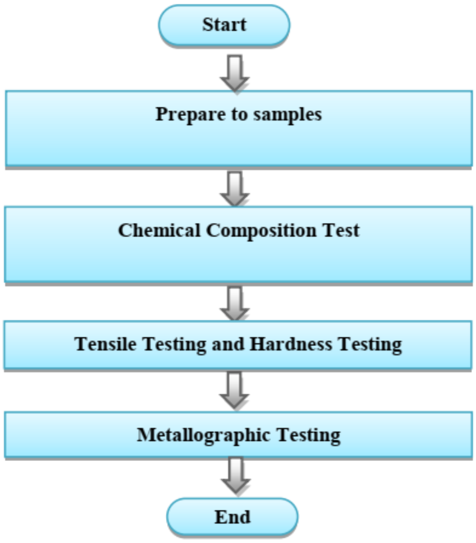

Fig. 2. Flowchart of this research

Based on the Figure 2 the research flow shows the path through which are:

a. Literature studies were conducted in relation to the research topic
b. Preparation of Samples with material low carbon steel plate sheets (SPC-270E)
c. Conducted several testing are: Chemical Composition Test, Tensile Testing, Hardness Testing, and Metallographic Testing.
d. Analyze data after testing's
e. Taking conclusions from the research that has been done.

RESULTS AND DISCUSSION

The object being tested is in the form of a plate that has undergone a stamping process.

Chemical Composition Test Results Data

From the results of observations made at the laboratory, especially the elements contained in low carbon steel plate sheets (SPC-270E), as in Table 1.

Table 1. Chemical Composition Testing Results Data

Specimen	C (%)	Si (%)	S (%)	P (%)	Mn (%)	N (%)	Cr (%)
SPC 270 E	0.001	0.000	0.001	0.008	0.094	0.041	0.042
	Mo (%)	**V (%)**	**Cu (%)**	**Sn (%)**	**Ti (%)**	**Al (%)**	**Fe (%)**
	0.000	0.000	0.019	0.000	0.026	0.032	99.73

Tensile Testing Results Data

In this test, the SPC 270 E specimen is depleted, because the gap in the clearance is too tight or too tenuous. Specimen no 4 is taken from PT. XYZ which has no defects.

Table 2. Tensile Test Result Data

Specimen (no)	Thickness (mm)	Width (mm)	Area (mm^2)	Yield Stress N / mm^2	Tensile Stress N / mm^2	Elongation (%)
1	0.96	9.80	9.41	260.54	312.65	16.80
2	0.99	9.90	9.80	225.16	310.22	11.40
3	0.99	9.50	9.50	232.27	299.37	15.40
4	1.19	25.20	20.16	166.71	323.63	44.30

a. Tensile Strength is obtained based on the following:

$$\sigma u = \frac{Pu}{Ao} \quad (1)$$

Specimen 1. $\sigma u_1 = \frac{Pu}{Ao} = \frac{300\ Kg}{9.41\ mm^2} = 31.88\ Kg / mm^2 = 312.65\ N / mm^2$

b. Yield Strength is obtained based on the following calculations:

$$\sigma y = \frac{Py}{Ao} \quad (2)$$

Specimen 1. $\sigma y_1 = \frac{Py}{Ao} = \frac{250\ Kg}{9.41\ mm^2} = 26.56\ Kg / mm^2 = 260.54\ N / mm^2$

c. Elongation is the ratio between the increases in length after fracture to the initial length.

$$e = \frac{L_1 - L_o}{L_o} \times 100\% \quad (3)$$

Specimen 1. $e_1 = \frac{58.40 - 50}{50} \times 100 = 16.80\ \%$

Hardness Testing Results Data

In this specimen there is a lump defect, because it is still within tolerance limits and can be repaired.

Table 3. Hardness Test Result Data (Vickers)

Specimen	I	II	III	IV	V	Average
1	125.1	126.7	122.9	125.4	127.8	**125.58**
2	127	126.3	125.3	120.3	122.8	**124.34**
3	114	116.8	114.4	112.3	112.7	**114.04**
4	135	135	135	135	135	**135**

Metallographic Testing Results Data

Micro-structure examination is carried out as a support for discussion. Microstructure examination was used to determine the uniformity and structure of ferrite and ferrite. In this microstructure examination using the ASTM E 9 - 95 standard, 800X magnification.

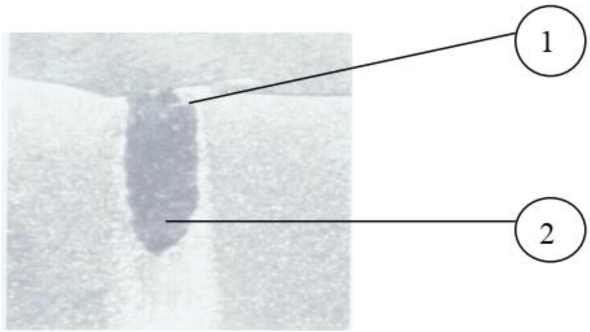

Fig. 2. Magnification Micro Structure Photo for 9X

Based on Figure 2 on 9 X magnifier macro structure photo is:
1. Number 1 is to test the microstructure under the broken area.
2. In number 1 is to test the micro structure that is below the area away from the broken area.

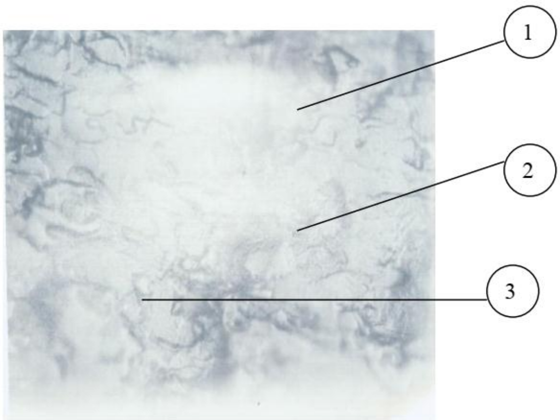

Fig. 3. Photo of Micro Structure 800X Enlargement (In Area No.1 With 3% Nital Solution)

Based on Figure 3. The 800X magnification microstructure photo is:
1. At number 1 is the microstructure of the ferrite phase.
2. In number 2 is the microstructure of the pearlite phase.
3. In number 3 is a microstructure in the form of colored lines

Black or white, these lines are called grain boundaries. Whereas in the dark areas are carbides, and in these areas grain boundaries clumping occurs.

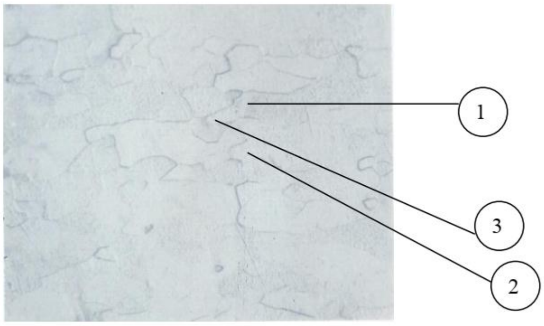

Fig. 4. Photo of Micro Structure 800X Enlargement (In Area No.2 With 3% Nital Solution)

Based on Figure 4. The 800X magnification microstructure photo is:
1. At number 1 is the microstructure of the ferrite phase.
2. In number 2 is the microstructure of the pearlite phase.
3. In number 3 is a microstructure in the form of colored lines

Black or white, these lines are called grain boundaries. Whereas in dark areas is carbide.

Dye Penetrant Testing Results Data

This specimen has a crack defect, because the clearance is too tight.

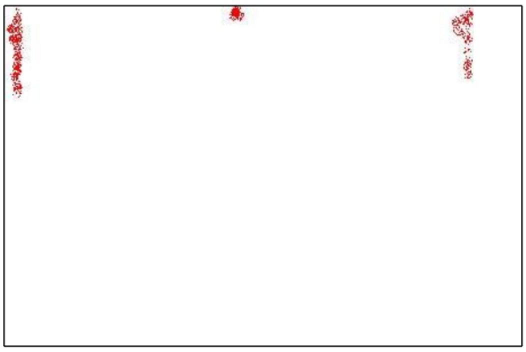

Fig. 5. Dye Penetrant Test Result

CONCLUSION

As the end of the description of the specimen testing from the foot step by step, the specimen has undergone a stamping process, the following will describe the conclusions based on discussions about the testing that has been carried out.
1. Observation results of the chemical composition of the specimens with breakage defects for the low

carbon type (SPC 270 E) used had a carbon content (C) of 0.001%. This indicates that the carbon content in the stamping specimen has reduced its carbon content.
2. Tensile test results on specimens that have thinning defects for low carbon species (SPC 270 E) which have yield strength, tensile strength, fracture strength and elongation with the average value of the three specimen magnitudes.

a. Yield stress is 239.32 N/mm^2.
b. Tensile stress is 307.41 N/mm^2.
c. Elongation is 14.53%.

In specimens that have depleted the carbon content is still very good enough so that it can still be used.
3 The results of hardness testing on specimens with lump defects for the type of carbon (SPC 270 E) which have an average Vickers hardness value:

a. Sample A is: 125.58 N/mm^2
b. Sample B is: 124.34 N/mm^2
c. Sample C is: 114.04 N/mm^2

And the tracking load is 1 kg. In this case, the strength and hardness of the steel plate is very good so that this type of steel plate is able to withstand pressure.
4. The test results of the metallographic structure of the specimens with breakage defects for the carbon type (SPC 270 E). In the bright areas, the ferrite phase for the black or white line is the grain boundary which is often referred to as the pearlite phase, while in the dark areas are carbides whose function is to stabilize the ferrite phase so that it will increase the strength and hardness of the ferrite phase itself without compromising its tenacity.
5. The test results of the dye penetrant on the specimen with crack defects for the carbon type (SPC 270 E) had non-longitudinal cracks.

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