Comparison between import and local product of Koma material for hardness and microstructure

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Abstract. Koma material is one of the wire cutting machine part from PT. X in Indonesia, which has a function as a wire straightening device that will be processed or cut. This material is made from white cast iron and is obtained from imports. Never tried to make the local product. The aim of the research is making Koma material from white cast iron. The method is used to make Koma material which has a quality similar to imported products. The prepared material later will be tested using hardness testing and optical microscope measurement for observing its microstructure. The results are compared with Koma imported products show that Koma material of imported products has a higher hardness than local products, due to the differences content in chemical elements in the white cast iron.

1. Introduction
Manufacturing developments need for wire raw materials especially for household products is quite high. While small-scale companies every day need 150 kg of raw material for a wire. One of the processes of wire raw materials is the straightening process using a wire straightening machine [1]. Wire straightening machine (Figure 1) is a machine used to straighten wires (generally made of iron) that have diameters ranging from (2 - 20) mm. Iron wire is initially in the form of a roll (roll coil) then straightened according to the use of it needs [2].

Figure 1. Wire straightening machine.

In small and medium scale companies they do have wire straightening machines but the capacity of products produced from these machines cannot meet the size of consumer demand. While one of the
materials used to straighten a wire called Koma material (Figure 2), is one part of a wire cutting machine. Koma material functions as a wire straightening device to be processed or cut so this Koma material must be strong and resistant to wear. The work system is a comma material by spinning at high speed so that it can produce wire streaks that are more straightforward and of good quality [3].

![Figure 2. Koma material.](image)

The problem that arises is Koma material made from white cast iron is still imported so far, not yet produced from domestic products. Therefore, it causes high production costs [4]. The purpose of this study was to make a Koma material from white cast iron local products, then the results were compared with imported products.

2. Method

Procedure of method research is prepare of Koma material from local product and import product. Koma material made of white cast iron (local cast iron). The composition of both was observed using a spectrometer device. Then the hardness test was carried out and the microstructure was observed by using an optic microscope. Clearly shown in flow chart, Figure 3. Koma material results are shown in Figure 4(a) as for local product and 3(b) as import product.

![Figure 3. Flow chart of research.](image)
3. Results and discussion

3.1. White cast iron composition test results

Testing the composition to determine the elemental content contained in local cast white iron products and imported products using a spectrometer machine. The results obtained are shown in Table 1 and Table 2. Table 1 composition of white cast iron while imported products Table 2 shows white cast iron of local products. Table 1 and Table 2 show the content of koma material elements made of white cast iron. The standard composition of the composition of white cast iron is carbon (C) between 1.8 - 3.6%, manganese (Mn) between 0.25 - 0.80%, phosphorus (P) between 0.06 - 0.2%, sulfur (S) between 0.06 - 0.2%, chrome (Cr) 1%, silicon (Si) 1.3%, nickel + copper (Ni + Cu) 1.5%, and moliuben (Mo) 0.5% [5]. It appears that the white cast iron content of imported products mostly meets the standards of Koma material, whereas for local products only carbon and copper content is available, even though the carbon content is not in accordance with the standard.

The next step is to look at the composition of the white cast iron of imported products and local products, then testing the hardness of the two products. The final results will be seen micro structure using Optical Microscope (MO) magnification of 100x and 500x. The absence of phosphorus and sulfur elements in local products causes reduced flow for iron liquids which reduces the ability to cast.

**Table 1.** The composition of white cast iron imported products.

|     | Fe2  | C   | Si  | Mn1 | P   | S   | Cr1 | Mo  | Ni1 | Al  | B   | As  |
|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| ST 1# | 97.84 | 0.105 | 0.152 | 1.47 | 0.011 | 0.012 | 0.04 | 0.00< | 0.01 | 0.007 | 0.00< | 0.0024 |
| ST 2 | 92.63 | 5.51> | 1.26 | 0.276 | 0.033 | 0.012 | 0.013 | 0.00< | 0.00< | 0.006 | 0.00< | 0.0000< |
| AVG  | 95.24 | 2.81  | 0.708 | 0.873 | 0.022 | 0.012 | 0.027 | 0   | 0.005 | 0.007 | 0   | 0.0012 |

**Table 2.** The composition of white cast iron local products.

|     | Fe2  | C   | Co  | Cu  | Mg  | Nb  | Pb  | Sn  | Ti  | V   | W   |
|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| ST 1# | 90.32 | 0.05 | 0.008 | 0.02 | 0.00< | 0.0405 | 0.0098 | 0   | 0.005 | 0.018 | 0.047 |
| ST 2#> | 93.76 | 3.21> | 0.003 | 0.00< | 0.00< | 0.00< | 0.00< | 0.031 | 0.014 | 0.013 |
| AVG  | 92.04 | 1.63 | 0.006 | 0.01 | 0   | 0.0202 | 0.0049 | 0   | 0.018 | 0.016 | 0.03 |

3.2. Hardness test results

The results of the hardness test for coma material of imported products and local products are shown in Table 3 and Table 4. The hardness value of the Koma material of imported products is far greater than local products. Its value is almost twice the local product. This condition occurs because the standard content of the coma material elements of imported products are all in imported products. The
content of Mo and Ni causes the coma material of local products to have high hardness and wear resistance. The hardness value of imported products of 543 BHN meets the standards for white cast iron, namely between (400 - 600) Brinell Hardness Number (BHN) [6].

Table 3. Koma material of import product.

| Sample | Test | Hardness Test (HRc) (Rockwell) |
|--------|------|-------------------------------|
|        | 1    | 57.5                          |
|        | 2    | 51.2                          |
| Koma   | 3    | 54.2                          |
| Import | 4    | 56.4                          |
|        | 5    | 52.2                          |
|        |      | Average HRc 54.3 543 BHN      |

Table 4. Koma material of local product.

| Sample | Test | Hardness Test (HRc) (Rockwell) |
|--------|------|-------------------------------|
|        | 1    | 41.0                          |
|        | 2    | 38.7                          |
| Koma   | 3    | 35.7                          |
| Local  | 4    | 36.0                          |
|        | 5    | 37.6                          |
|        |      | Average HRc 37.8 353 BHN      |

3.3. Results of micro structure observations

Microstructure observations for comma material for local products and import products at 100x and 500x magnifications are shown in Figure 5 and Figure 6 respectively.
Figure 5. Koma material of local product (a) Magnifications 100 x, (b) Magnifications 500 x, (c) Carbide (Fe₃C).

Figure 6. Koma material of import product (a) Magnifications 100 x, (b) Magnifications 500 x, (c) Pearlite.

Almost the microstructure of Koma material in local products is contained of white carbide (Fe₃C) which is formed from very fast cooling (quenching) to form carbides (about 30% by volume) [7,8]. The carbides formed are meta stable, and they are very hard but brittle [9]. Micro structure of imported products is formed carbide and pearlite (dark color) as austenite’s are also hard but more resilient than carbides [10]. Finally when tested for hardness, the imported product Koma material is harder than the local product.

4. Conclusion
Koma material for imported products are still superiors to the value of hardness and has an elemental composition that is in accordance with the standards of white cast iron. The micro structure formed shows the austenite phase with hard and tough pearlite granules.

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