Surface Hardening Characterization of Camshaft of Original Equipment Manufacture for Automatic Motorcycle 125 cc

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Abstract—Camshaft is one of main components in the combustion engine system, which controls the combustion timing process, with respect to the opening and closing of the suction valve. The camshaft receives compressive and friction loads on the cam/lobe surface twisting loads on the central shaft which requires the harder surface and the ductile inner side. This study aims to characterize the surface hardening layer: material composition, hardness and the microstructure of camshaft of original equipment manufacture for automatic motorcycle 125 cc. The research methodology uses experimental method: spectrometer composistion test, Rockwell hardness test on the two directions of the cros-sectional surfaces of the cam lobe as a distance function from the surface and microstructure observation to determine the phase using an optical microscope. The results show that of surface hardening layer is around 4-10 mm form the outer surface with the hardness of 57 – 61 HRC with the martensite microstructure whlist the inner side of the cam is around 30 HRC with the bainite microstructure. The chemical composition results some of the alloys: 0.2% of carbon, 1.22% of 1.12 chromium and 0.82 of mangan which indicates the low alloy steel.

Index Terms— Automatic Motorcycle, Chamshaft, Material Characterization, Surface Hardening.

1 Introduction

The automotive industry is increasingly stretching the Indonesian market, seen various kinds of vehicle brands and types that appear every month. This resulted in the need for spare parts for two-wheeled and four-wheeled vehicles is very high, this is due to the impact of increasing the number of vehicles each year.

The camshaft is one of the main automotive components in the piston motor combustion that functions as an opening and closing the suction and exhaust valve when the combustion process takes place [1]. In principle, the camshaft will rub against the tappets connected to the rocker arm so that the possibility of wear on the camshaft causes an imperfect cycle of the flap and suction valve opening and closing. There are two types of camshafts, DOHC and SOHC [1]. Both types of camshafts require a combination of wear and resistance to the cam surface, which results from the hardening process. Materials used in making camshafts are gray cast iron and carbon steel [2]. Figure 1 depicts the SOHC valve system which includes camshaft, rocker arm and teh valve spring to control the combustion.

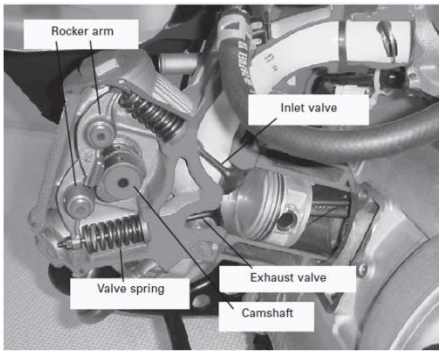

Fig. 1. SOHC type valve system [1].

2 Research Methodology

2.1. Material Composition Test

Figure 2 shows the camshaft of original equipment manufacture (OEM) for automatic motorcycle 125 cc. This type of motorcycle is selected due to the highest population of the motorcycle in Indonesian market.

Fig. 2. Camshaft for automatic motor cycle 125 cc used in this research.

The chemical composition test was conducted at the metal materials laboratory using Optical Emission Spectroscopy Switzerland QTH-127. This test aims to determine the chemical composition of the composition contained in camshaft specimens.

2.2. Hardness Test

The hardness testing study was conducted by using the Afri 206 RT hardness tester, using the Rockwell (HRC) method. The test is carried out on 2 different directions as described in Fig 3, where the cross-sectional test direction (A, B, C, D) covers the top surface (edge), the transition area and the middle/center area.

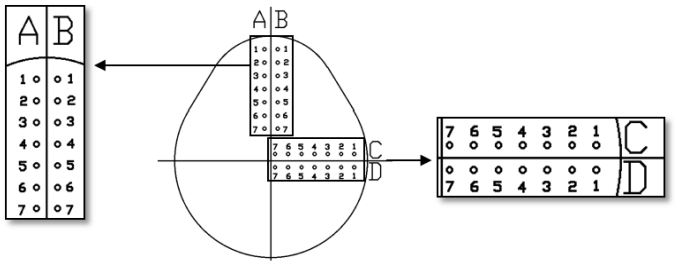

Fig. 3. The direction method of hardness test

2.3. Microstructure Analysis

To find out what structures and phases are contained in the material, a microstructure test is carried out with the following procedure :

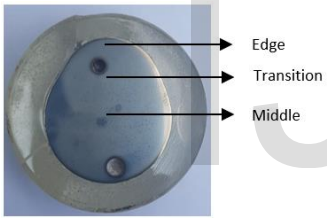

Fig. 4. The point of microstructure observation

Observation of the microstructure is carried out at three points as shown in Fig. 4. From the photo of the microstructure then we can interpret a conclusion the properties and characteristics of the camshaft material.

3 Results

3.1 . Material Composition

TABLE 1

Material Composition of OEM Chamshaft

Elements	Fe	C	Si	Cr	Mo	Mn	P	S	Ni
Contents (%)	97.46	0.213	0.194	1.122	0.044	0.818	0.021	0.02	0.02

In table 1 obtained results Fe content of 97.46%, and C content of 0.213%, with Mn content of 0.818%, Cr of 1.122%, and Mo of 0.044%, it can be concluded that OEM camshafts made from carbon steel can be compared with HQ705 / AISI 4340 / VCN150 steel [4].

3.2 Hardness

TABLE 2

Hardness of OEM Chamshaft

No	Depth (mm)	Hardness (HRC)			
		A	B	C	D
1	2	61	61	57	57
2	4	60	60	53	37
3	6	59	59	33	35
4	8	55	43	32	33
5	10	33	42	31	32
6	12	31	32	31	31
7	14	30	30	30	30

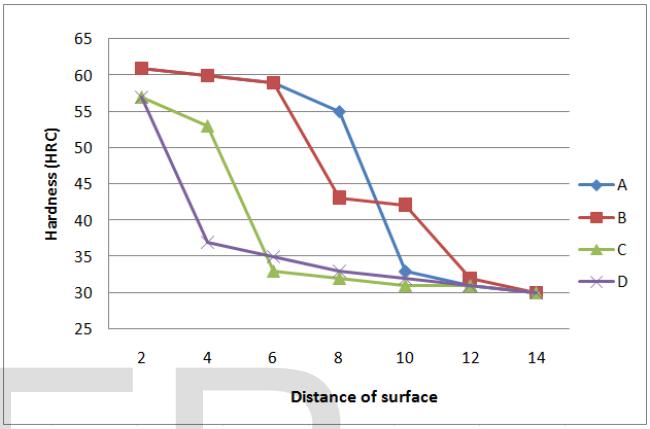

Fig. 5. Chart of the OEM chamshaft hardness

Hardness of OEM camshaft is known, the value of hardness decreases with changes of the distance into the cam. The highest hardness is on the cam edge, at 61 HRC and the lowest hardness is in the middle of the cam, at 14 HRC. Thus the cam surface is hard while the inside of the cam is ductile.

3.3 Microstructure

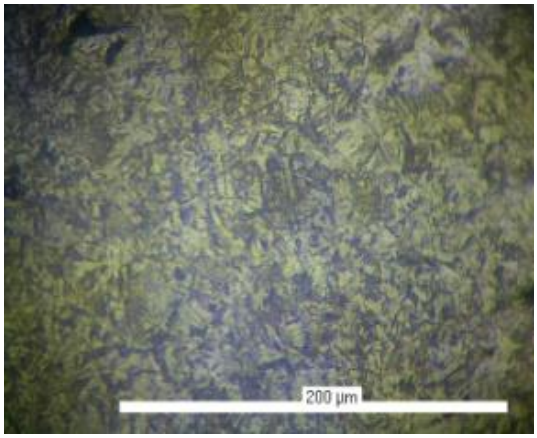

Fig. 6. Microstructure at the edge of the OEM Chamshaft

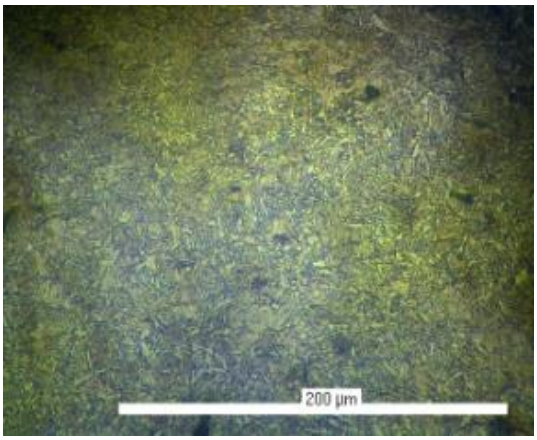

Fig. 7. Microstructure at the transition of the OEM Chamshaft

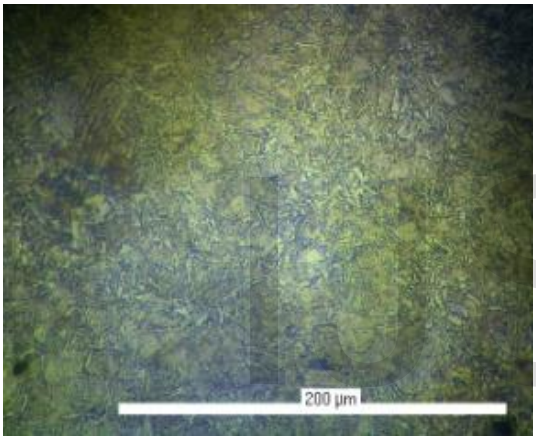

Fig. 8. Microstructure at the middle of the OEM Chamshaft

Fig. 6, fig. 7, and fig. 8 are photos of microstructure observations on camshaft at the edge, at the transition, and the middle point, reference to fig. 4.

4. Conclusion

According to Yamagata [1], material and composition content commonly used in making camshaft shown at Table 3. From the Table 1 and Table 3, the material composition of OEM chamshaft closes with JIS-SCM420. From the Table 2 the camshaft hardness layer test results obtained the depth of hardness reaches 4-10 mm on the nose point and on the base circle points. This is followin research conducted by Michalski [5] where hardening thickness ranges around 3-4 mm. The microstructure of the surface camshaft is martensite while the inside section is dominated with bainite.

TABLE 3

Compotition of camshaft material (%) [1]

Material	C	Si	Mn	Cr	Mo	Cu	V	W	Fe
High-Cr Cast Iron	3.2	2.0	0.8	0.8	0.2	-	-	-	Balance
Hardenable Cast Iron	3.2	2.0	0.8	1.2	0.6	-	-	-	Balance
Cr-Mo Steel JIS-SCM420	0.2	0.3	0.8	1.0	0.2	-	-	-	Balance
Sintered Metal for cam lobe	0.9	0.2	0.4	4.5	5.0	3.0	2.0	6.0	Balance

Acknowledgment

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