R.E.M. (Rekayasa Energi Manufaktur) Jurnal | Vol.9 No.2/2024
ISSN online (2528-3723)
http://doi.org/10.21070/rem.v9i2.1714

The Effect of Motorcycle Wheels (Original Equipment Manufacturer) Reconditioning Process on Mechanical Properties and Microstructure

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Article history: Received: 15 Agustus 2024 | Revised: 7 November 2024 | Accepted: 9 November 2024

Abstract. *Wheels are an essential component of a vehicle. Material damage or failure on casting wheel-type wheels is primarily because these wheels receive a reasonably hard impact load due to uneven road conditions or potholes. This condition makes the wheels unable to function normally, and components must be replaced. Given the relatively high cost of replacing wheels, several options are offered to vehicle owners (consumers) to have their wheels reconditioned. This study aims to analyze the effect of the reconditioning process on the mechanical properties and microstructure of the casting wheel material. The sample material is taken from the Original Equipment Manufacturer (OEM) wheel casting wheel in the Disk section for impact testing, Rim for hardness, and microstructure tests. The results are that the reconditioning process affects the mechanical properties and microstructure of the original equipment manufacturer (OEM) alloy wheel material. The decrease in hardness value was 68.86 HBW to 61.59 HBW from the conditions before and after reconditioning. The impact test results where the impact energy absorption is greater after reconditioning is 29.24 J, and the average impact value for wheel specimens after reconditioning is 0.2902 J/mm2. The impact energy value before reconditioning is 7.87 J, and the average impact value is 0.0973 J/mm2. The microstructure obtained is hypereutectic, and the reconditioning process has little effect on the dendritic structure.*

Keywords - *Casting wheels; hardness test; impact test; aluminium; microstructure*

INTRODUCTION

Motorcycles are still a popular means of transportation for people in Indonesia [1]. This is because motorcycles can easily and quickly reach the desired destination for their users. However, motorcycles are considered unsafe in some circles and still have shortcomings regarding driver safety, which can lead to a relatively large chance of traffic accidents. Other factors causing traffic accidents are poor road conditions and potholes. This not only has an impact on traffic accidents but also has an impact on damage to motorcycle components such as wheels.

Wheels are an important component of a vehicle [2, 3]. Wheels are part of the wheel that functions to receive weight and all loads (forces) caused by road conditions and the load of the vehicle [4]. So, the wheels must have strong and sturdy materials to support the loads in every condition [5]. Based on the raw materials, wheels are divided into two types, namely steel wheels (spoke wheels) and aluminum wheels (cast wheels) [6, 7]. Casting wheel Original Equipment Manufacturer (OEM) type wheels are in great demand by consumers compared to spoke wheels, so the automotive industry always prioritizes technological advances by releasing the latest models of casting wheels [8]. This is because casting wheels have several advantages over previous types of wheels made of steel material [9]. The benefits of casting wheels include lighter weight and a variety of design shapes [10].

Based on the field analysis, many damages or material failures were found on casting wheels, which caused the wheels to change shape (bend). This change in shape is due to the wheel receiving a reasonably hard impact load due to uneven road conditions or roads with holes [11]. This condition makes the wheel unable to function normally, and components must be replaced. Considering the cost of replacing the wheel is quite large. Usually, technicians or mechanics in the field will provide several options to vehicle owners (consumers) so that their vehicle wheels are reconditioned. Reconditioning is pressing the damaged (bent) wheel to operate generally at a reasonably affordable cost. The reconditioning process is implemented in two steps. The first is by pushing or pressing in the opposite direction from the bend of the wheel. The second process is heating the wheel to a specific temperature to become soft and make it easier to return the bent wheel to its original position [12].

Therefore, by observing the process applied to the casting wheels, which impacts changes in mechanical properties and other properties, this study aims to analyze the mechanical properties and microstructure of the casting wheels material before and after the reconditioning process.

METHODS

The materials used are two parts that come from the Original Equipment Manufacturer (OEM) casting wheels from Honda Beat motorcycles. The first material is a material that is still good ("before reconditioning") and the second material is the material "after reconditioning" from the Original Equipment Manufacturer (OEM) casting wheels. The sample materials taken from the casting wheels were the Disc part for impact testing, Rim for hardness, and microstructure testing, as shown in Figure 1. The cut samples were prepared for impact, hardness, and microstructure testing. Before testing, the entire surface of the specimen was polished with #1200-grit abrasive paper and cleaned with ethanol. Hardness testing was carried out using a portable hardness tester (AR936, China) according to ASTM E10-18 standards [13], while impact testing followed ASTM E23-02 standards [14]. For changes in microstructure observed under an optical microscope (Olympus BX53M, JAPAN), samples for microstructure were cut from the cross-section and lateral positions.

Table 1. Chemical composition of original equipment manufacturer (OEM) casting wheels

Chemical composition Wt%										
Cu	Si	Mg	Fe	Mn	Ni	Ti	Cr	Sn	Pb	Al
0.60	14.5	0.28	0.40	0.20	0.60	0.10	0.01	0.20	0.30	Bal.

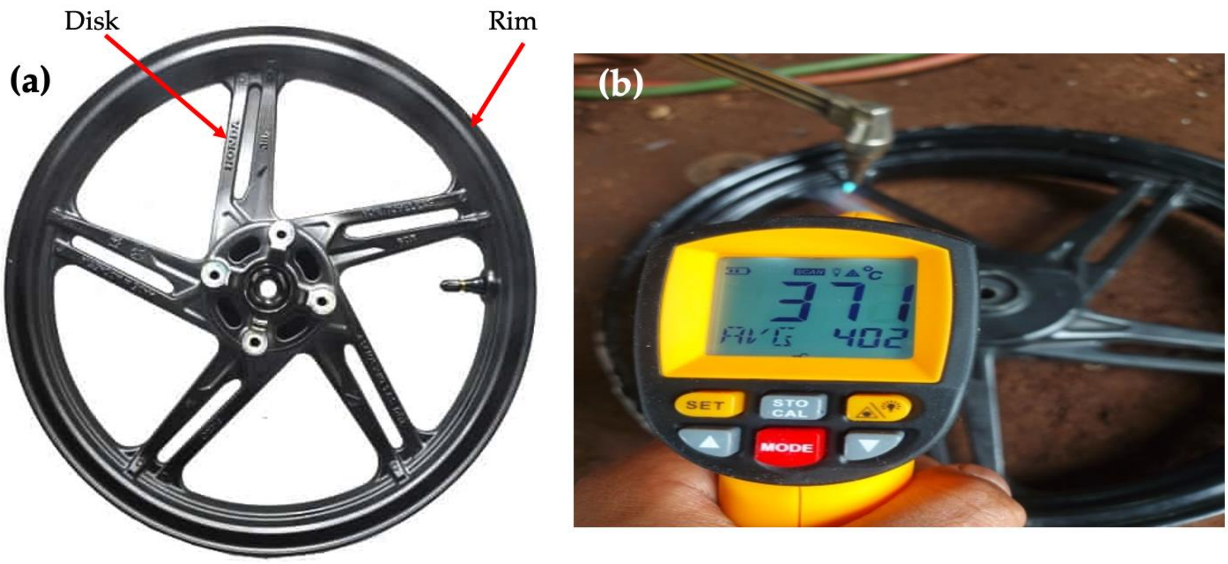

Figure 1. (a) Original equipment manufacturer (OEM) casting wheels, (b) wheels reconditioning heating temperature measurement process

RESULTS AND DISCUSSION

Based on the chemical composition in Table 1, the Al element content is 82.8% Wt. This type of aluminum alloy is categorized into an aluminum alloy through a casting process (Casting Alloy) with a serial number approaching 3xx.x. The presence of alloying elements such as silicon (Si) and magnesium (Mg) in aluminum alloys can improve aluminum materials' mechanical and physical properties. This aluminum alloy, with the addition of manganese (Mn) ranging from 0.05 to 1.8% alloy, has good formability and is suitable for use at high temperatures. Meanwhile, based on research by Ahn, S.S. et al., adding elements Al–Si–Cu–Fe–Mg can improve the mechanical properties of the alloy with various processing parameters [15].

Table 2. Hardness test results of wheel specimens before and after the reconditioning process

Specimen	Before Reconditioning (HBW)	After Reconditioning (HBW)
1	68.07	64.63
2	68.97	59.81
3	69.55	60.34
Average	**68.86**	**61.59**

The hardness test results were carried out before and after reconditioning, where the test result data is shown in Table 2. The hardness value of the OEM wheel's base material (before reconditioning) is relatively the same; the average hardness value is 68.86 HBW. At the same time, the average hardness value of the OEM wheel's material that has been reconditioned decreased slightly to 61.59 HBW. Suppose seen, where the decrease in hardness value before and after reconditioning is not too significant. Based on the measurements, the temperature and time during reconditioning on the OEM wheel's material is an average of 400 ^{O}C for 60 seconds. From the research of A. N. Aliyah and A. Anawati on the Effect of Heat Treatment on Microstructure and mechanical hardness of aluminum alloy AA7075 [16], it was stated that for heat treatment at a temperature of 400 ^{O}C there was a significant decrease in hardness. According to him, this decrease in hardness is suspected to be due to the presence of deposits that form compounds from the elements Mg, Zn, and Fe which are alloying elements in the aluminum.

Table 3. Impact test results of wheel's specimens before and after the reconditioning process

Specimen	Impact Energy Before Reconditioning (Joule)	Impact Toughness Before Reconditioning (J/mm^2)	Impact Energy After Reconditioning (Joule)	Impact Toughness After Reconditioning (J/mm^2)
1	-	-	39.20	0.3563
2	7.89	0.0982	18.81	0.2093
3	7.84	0.0963	29.72	0.3049
Average	7.87	0.0973	29.24	0.2902

The impact energy value and impact price are presented in Table 3 for the wheel's specimen before and after the reconditioning process. The impact energy value of the specimen before reconditioning is an average of 7.87 J, while the impact price is an average of 0.0973 J/mm^2. After reconditioning, the impact energy value on the wheel's specimen increases up to 3.7 times, which is 29.24 J. For the impact price of the wheels specimen after the reconditioning process, the average is 0.2902 J/mm^2. This means that the impact price has increased almost three times from the value of the base material. In impact testing, heat impacts the material's impact strength, where the material that has undergone reconditioning looks more ductile than the base material (material before reconditioning). Figure 2 shows the fracture surface of the impact test results on the material before and after reconditioning. Figure 2(a) shows a brittle fracture surface, while Figure 2(b) shows a slightly fibrous fracture surface.

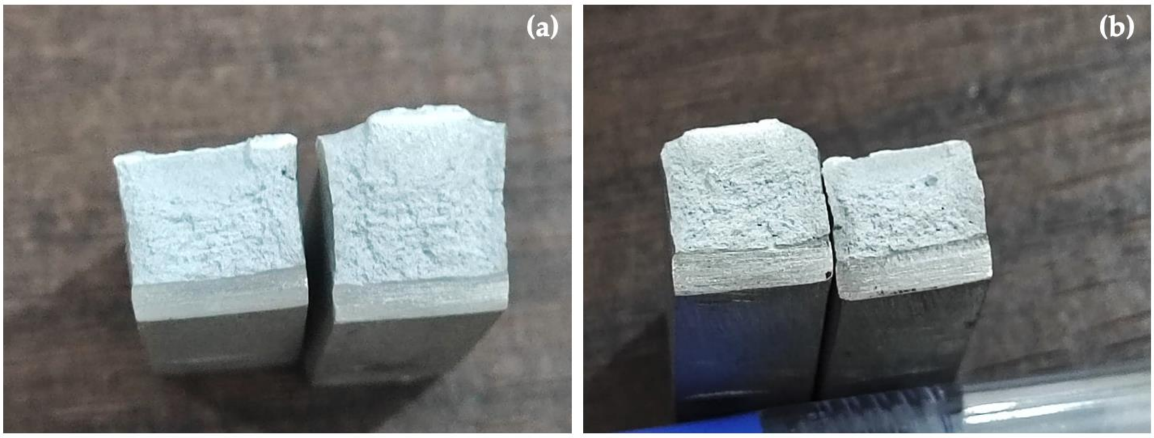

Figure 2. (a) Impact test fracture shape before reconditioning, (b) Impact test fracture shape after reconditioning

There is no significant difference based on observations of the microstructure images of the wheel's material specimens before and after the reconditioning process. Where the structure of the material before and after the reconditioning process is seen as a dendritic structure. If observed from the chemical composition table 1, where the silicon content is obtained at 14.5%, then the type of this structure is classified as hypereutectic. Ahn, SS, et al. also mentioned the same thing, where the silicon content in their study was (Si-14 wt.%) called hypereutectic [15]. There was no significant change when observing the microstructure of the wheel's material specimens before and after the reconditioning process. The wheel's material specimen before reconditioning is image 3(a) for the cross-section direction and 3(b) for the lateral direction. Meanwhile, images 3(c) are for the cross-section direction, and 3(d) are for the lateral direction of the rim material specimen after reconditioning. If viewed carefully, only a slight enlargement is formed in the hypereutectic structure on the wheel's material specimen that has been reconditioned.

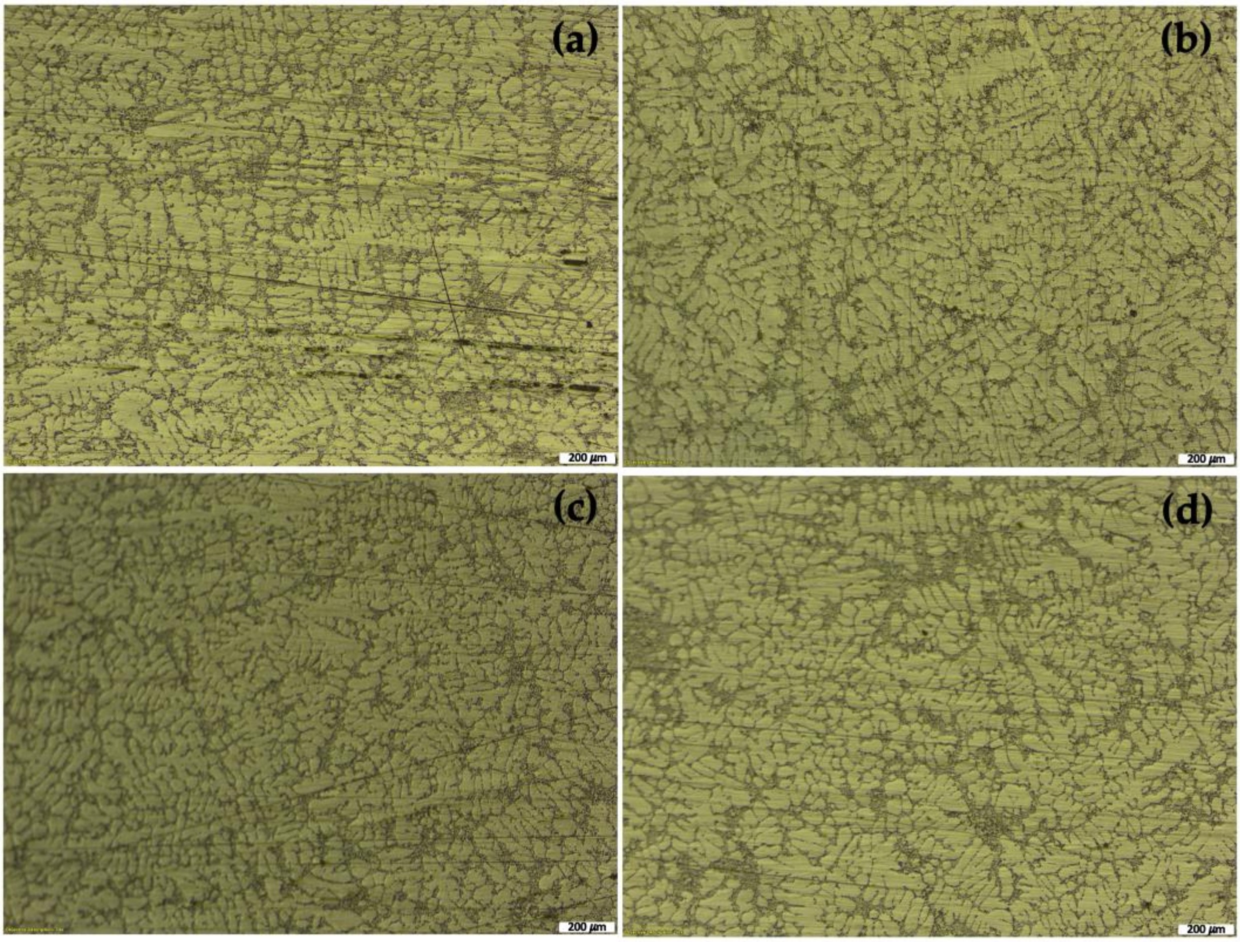

Figure 3. (a) Microstructure before reconditioning in the cross-sectional direction (50X), (b) Microstructure before reconditioning in the lateral direction (50X), (c) Microstructure after reconditioning in the cross-sectional direction (50X), (d) Microstructure after reconditioning in the lateral direction (50X).

CONCLUSION

The reconditioning process affects the mechanical properties and microstructure of the wheel's material's original equipment manufacturer (OEM). The decrease in hardness value is 68.86 HBW to 61.59 HBW from the conditions before and after reconditioning. This is not the case for the impact test results where the absorption of impact energy is more excellent after reconditioning, which is 29.24 J from the value before reconditioning of 7.87 J. Meanwhile, the microstructure obtained is a hypereutectic structure, and the reconditioning process only slightly affects its dendritic structure.

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