

# Casting Defects And Mechanical Properties of Al-Si Alloy with Bangkalan Local Clay as Sand Casting Binder

Candi Galih Syaifullah<sup>3</sup>, Ayik Bela Saputra<sup>3</sup>, and Shabrina Ruhyatul F<sup>4</sup>, Putut Murdanto<sup>1,2</sup>

<sup>1</sup> Center of Nano Research and Advanced Materials, Universitas Negeri Malang

<sup>2</sup> Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Malang

<sup>3</sup> Bachelor Program, Mechanical Engineering Department, Universitas Negeri Malang

<sup>4</sup> Bachelor Program, Chemistry, Science Department, Universitas Negeri Malang

\*putut.murdanto.fi@um.ac.id

## ABSTRACT

This research is aimed to know the defect of casting, tensile strength, and hardness of Al-Si alloy to the variation of binder. The research method used is descriptive quantitative research method. This because the data is expressed in the form of numbers. This research uses pre-experimental research design using one-shot case study model. Based on the results of the study, it was found that most pinhole defects were owned by specimens using 90% bentonite binder that is 59 defects. Whereas the pinhole defect which is at least owned by the specimens using bangkalan local clay binder 9% that is 31 defects. The most common open grain structure defect is owned by metal casting specimens using a 9% bentonite binder, which is 81 defects. Whereas the defect of open grain structure is at least owned by the specimen result of casting of metal clad with bangkalan local clay 3% which amounted to 40 defects. The result of the research using bangkalan local clay binder of 9% has higher tensile strength than other binder. This is because the characteristic of bangkalan local clay which has a high content of calcium (Ca) is 92,81%. The value of the tensile strength of the bangkalan local clay is 12,8712 (kg/mm<sup>2</sup>), whereas the bentonite which is said to be the ideal binder for the mold has a tensile strength of 10,1612 (kg/mm<sup>2</sup>). The highest hardness value is owned by Al-Si alloy casting specimen with bend mixture variation of bangkalan local clay 9% that is 128,033 HV. While the lowest hardness value is owned by Al-Si alloy casting foundry with 9% bentonite binder 114,4 HV

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## I. Introduction

Science and technology of the world today is increasingly advanced and growing rapidly. Demanding the world of industry to be able to apply and develop technology in order to produce quality products. Especially in the world of metal casting. The process of metal casting is the process of manufacturing a product that starts from pouring molten metal into a mold cavity and then left for a while for clotting process [1].

Metal casting is a path taken when machining and metal formation cannot be done with machining or bench work (forging). Metal casting indicator is a complicated shape and requires a high level of accuracy. Bronze casting was first performed in Mesopotamia approximately 3,000 BC, then this technique was passed on to Central Asia, China and India [1].

For mass-produced prints does not use sand prints whereas for complicated products and not in bulk products then sand molds are used. Wet sand mold is sand mold which still has 5% water content, while dry sand mold has no water content [2]. Wet sand molds generally use clay binders for cheaper reasons.

The use of bentonites in sand mold mixture is not more than 9% due to the difficulty of removing castings from sand mold [2]. Usually the sand used in making molds for casting process is mixed with water and clay. The typical volume of the mixture can be 89% sand, 7% binder, and 4% water [5]. Examples of casting product results are numerous, just like in car parts such as; cylinder block, brake pads, crank house, cylinder sheets and so on. For casting results on machine tool components, such as machine bed, machine table and handle.



## II. Research method

Research method used is descriptive quantitative research method. This is because the data is expressed in figures. This study uses pre-experimental research design by using a one-shot case study model. This research model is intended to know a group of subjects that are subject to treatment and then to measure the group. The strength of castings has been determined to be incorporated into dependent variables, ie castings, tensile strength, and Al-Si alloys. While it is said that the experimental quantitative is due to the results of the research described by researchers based on the manipulation of free variables (in the form of bentonite variants), Molasses drops, local clay clays and all three mixtures and control variables (9% binder content and 5% water content).

Materials used for this study are bentonite, molasses, bangkalan local clay, silica sand and used pistons. The tools used to support the implementation of this research are tensile test engines, vickers hardness test tools, DSLR camera. In this research, the process is a macro photo of castings and conducts a real test using metal tensile test tool and vickers test tool. Before making macro photos and real testing many things to prepare, such as performing XRF testing, XRD testing, and testing of mechanical properties of printed sand, designing predetermined patterns, molding, smelting and pouring of Al-Si metal, as well as making specimens in accordance with defined standards. The characteristic to know is the mechanical properties and permeability of sand printing with local clays and the composition of the local elemental composition of clays. The data can be obtained from the results of previous similar studies.

Once the test specimen is made according to the standard and the standard of the test is determined, then the test process can be applied. The results of this testing process can be a tensile strength value, the Al-Si alloy hardness value and the number of defects present in the castings.

## III. Results and discussion

### A. Defects of Metal Casting

Checking the quality of casting can be done in various ways, one of them with visual inspection and macro photographs done by sight. In this study investigated is the appearance of the surface of the casting, various defects and how many the number of defects that occur on the surface of the castings.

Based on Figure 1, can be seen that the pinhole defect and the open grain structure defect for bentonite percentage of 9% of the needle needle defect as much as 14 and the defect of the grain structure of the opening 17 defects. Local clay bangkalan 9% has 12 pinhole defects and defects of open grain structure 13 defects. As for the third mix of 3% each have defects of the pinhole as much as 6 defects and defects the grain structure of the opening 26 defects. The defects of open grain structures are caused by low cooling speeds, which extend in thick slices, looking like skin pores on a surface that has been worked with the machine [1]. An effort to prevent the defect of other open grain structures is to increase the cooling speed of using bangkalan local clay binder as a binder or as an additive. Limestone affecting the process of cooling the results of Al-Si metal casting [4].

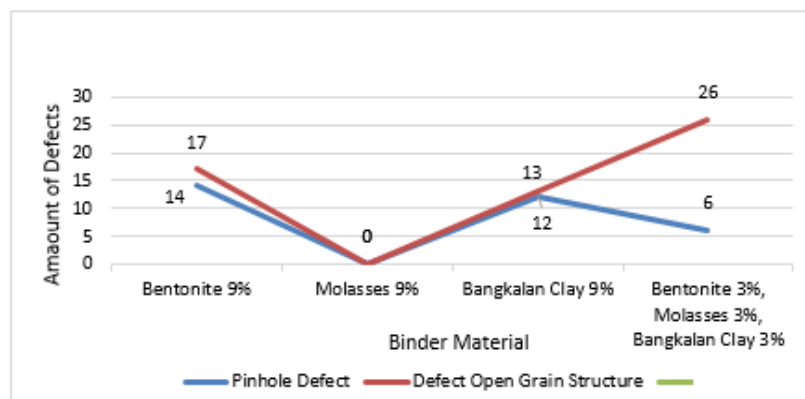


Fig. 1. Average Diagram Of Alloy Defects Al-Si

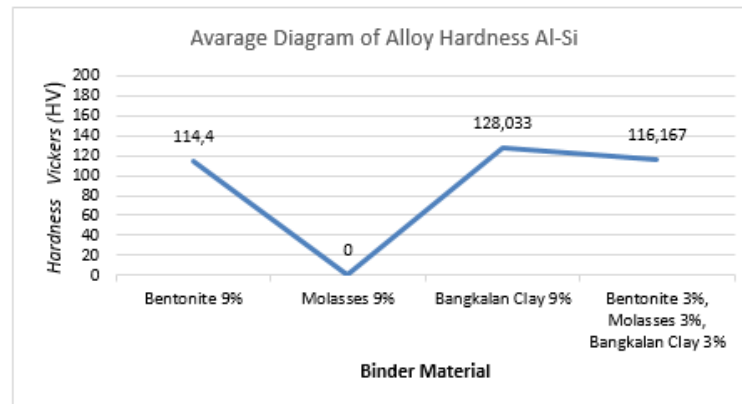


Fig. 2. Diagram Vickers Hardness Test Results Al-Si Metal Alloys

### B. Hardness Of Al-Si Alloys

Surface hardness is a term that expresses the strength of the material or its material and its resistance to wear and tear. Violence testing is done with the scale used is HV (Hardness Vickers) with diamond pyramid penetration, with style 200 grams and dwell for 10 seconds. Hardness tests were performed at 3 different point on the specimens surface.

Based on Figure 2, can be seen that the hardness value in each specimen is different. Where the highest hardness is owned by Al-Si alloy casting specimens with local bending mixture variation bangkalan 9% that is 128,033HV. While the lowest hardness value is owned by Al-Si alloy casting foundry with 9% bentonite binder, 114,4 HV. This occurs due to the characteristics of bangkalan local clay which has a high content of calcium is 92,81%. The element of calcium is usually present in limestone, and it can increase the hardness of Al-Si metals.

Examined the analysis of castor defects, tensile strength, and hardness of Al-Si foundry with the percentage of bangkalan local clay [7]. Where the result of Al-Si metallic leaching research using bangkalan local clay 12% with the addition of 0,5% bentonite which has the highest hardness value of 131,9 HV compared with Al-Si metal casting result using bangkalan local clay 9% with the addition of bentonite 0,5% of 118,467 HV and 6% with the addition of 0,5% bentonite of 114,2 HV. Examines the influence of limestone mixture as a material on the poor sand against the fluidity, hardness and quality of Al-Si metal casting [4]. Explained that the hardness produced using rockwell hardness tester hardness with 7% limestone composite got the highest hardness value with 52,8 HRC compared with 3% composition with hardness 47,89 HRC and 5% with hardness 52,26 HRC. Bangkalan local clay own included in natural limestone.

In addition, the value of hardness is also influenced by permeability, good permeability capable of channeling the air in the print cavity to exit [6]. The speed of the cooling process in a sand mold is strongly influenced by the value of the permeability of the mold, therefore the higher the permeability value of a sand mold increases the speed of the hot metal cooling process contained in the sand mold [3]. Permeability not only affects the hardness of the cast, the air is trapped inside the print cavity, but also affects the surface smoothness of the cast [6]. In addition to Calcium content that can affect the hardness of magnesium content on the bangkalan local clay of also affect the value of hardness of castings. The addition of magnesium in small amounts will have an impact on the increase in small hardness as well.

## IV. Conclusion

Most pinhole defects are owned by Al-Si alloy casting specimens with bangkalan local clay ninding variant 9% that amounted to 31 defects. While the most open grain structure defect is owned by Al-Si alloy casting specimens with 9% bentonite binder variation, which is 81 defects. Whereas the defect of open grain structure is at least owned by Al-Si Alloy casting specimens with 3% Bangkalan local clay binder variant, which is 40 defects. The result of the research using bangkalan local clay binder of 9% has higher tensile strength than other binder. This is because the characteristic of bangkalan local clay which has a high content of calcium (Ca) is 92,81%. The value

of the tensile strength of the bangkalan local clay is 12,8712 ( $\text{kg/mm}^2$ ), whereas the bentonite which is said to be the ideal binder for the mold has a tensile strength of 10,1612 ( $\text{kg/mm}^2$ ). The highest hardness value is owned by Al-Si alloy casting specimens with bangkalan local clay mixture variation of 9% that is 128,033 HV. While the lowest hardness value is owned by Al-Si alloy casting foundry with 9% bentonite binder 114,4 HV. This suggests that the Ca and Mg content of the bangkalan local clay affects the defects of castings, tensile strength and hardness of Al-Si alloy metals.

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