INVESTIGATION ON EFFECT OF CASTING MOULDS ON MECHANICAL PROPERTIES OF ALUMINIUM ALLOYS

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5. Keywords:
Aluminium alloy; Cooling moulds ; Vickers Hardness Test (VHN), Wear, Microstructure

6. Introduction:

Aluminium alloys are widely used in various industrial sectors, such as aerospace, automotive, construction, and packaging, due to their unique properties, including high strength-to-weight ratio, corrosion resistance, and durability. One of the most common methods used for manufacturing aluminium alloys is casting, which involves pouring the molten metal into a mould to obtain a desired shape. However, the mechanical properties of the final product are significantly influenced by the casting process, particularly the type of casting mould used. The mechanical properties of an aluminium alloy, such as tensile strength, ductility, and hardness, are primarily determined by the alloy's microstructure, which can be influenced by the casting mould material and casting conditions. Thus, understanding the effect of casting moulds on the mechanical properties of aluminium alloys is crucial for producing high-quality products with consistent properties. In this research project, a systematic study on the influence of casting moulds on the mechanical properties of aluminium alloy using Copper, Mild steel, Aluminium and sand moulds are used. The results of this study contribute to knowledge on the optimal selection of casting moulds for obtaining aluminium alloy with desired mechanical properties.

7. Objectives:

1. To investigate the effect of casting moulds (Aluminium, Mild steel, Copper and Sand) on microstructural behaviour of Al alloy.
2. To study the effect of casting moulds (Aluminium, Mild steel, Copper and Sand) on mechanical properties Al alloy (Hardness).
3. To access the tribological (wear) properties (Coefficient of friction, Frictional force, Weight loss) of Al alloy cooled in metallic moulds (Aluminium, Mild steel, Copper) and Sand mould.
4. To understand the role of casting mould in controlling the microstructure of Al alloy
5. To suggest the selection of best casting mould for Al alloy to improve the mechanical properties.

8. Methodology:

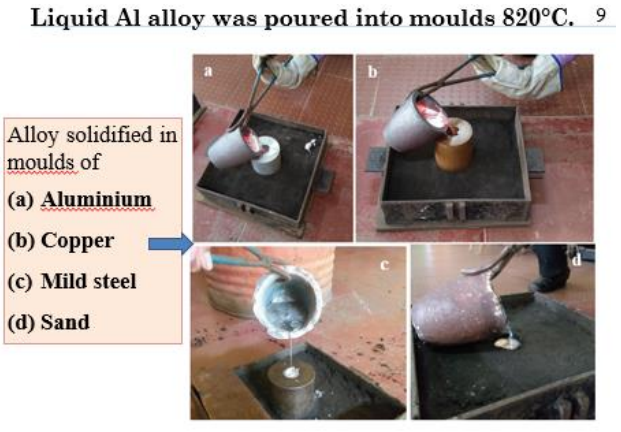
The methodology of our proposed model is as follows:

Aluminium alloy block (90mm, l × 90mm h× 60mm, w) was purchased from Lordwin Hydraulics, Andheri, Mumbai. The composition of Al alloy is in mentioned in Table 1.

Table 1 : Aluminium Alloy composition

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	V	Zr	Al
0.950	0.16	0.030	0.550	0.77	0.010	0.009	0.020	0.001	0.001	97.49

To prepare cylindrical metallic moulds, ingots of aluminium, mild steel, copper material was purchased from Hi–Tech shop, Mangalore and machined to required dimensions (Inner diameter 30 mm, outer diameter 87 mm and length 120 mm). Sand mould was prepared at Foundry and Forging lab, AIET lab with the help of cope and drag as per the same dimensions of other metallic moulds. An electrical resistance furnace was used to prepare the melt. The melt was held in the 3 kg capacity sand crucible. The Al alloy has been kept in the sand crucible and subjected to melting. The alloy composition was melted in the electric arc furnace (Heatron) by maintain temperature of 840°C. Then the melt has been poured into the different types of metallic moulds such as Aluminium, Mild steel, copper as well as Sand mould. The liquid alloy was allowed to solidify in the moulds and the cast parts were removed from the mould. The standard specimens were tested on Vickers hardness testing machine (Model: - VM 50) at MT lab, RYME College, Ballari . The experiment was conducted to investigate the hardness properties for all specimens prepared under the different specimen. In this Vickers hardness test machine, we have tested our specimen with 98.06N for the duration of 15sec for each trail. In this Micro Vickers Hardness Testers are capable of accurate measurement of hardness numbers using state-of-the-art image processing technology.machine (Model: - Hvd-1000) at MT lab, RYME College, Ballari .The experiment was conducted to investigate the hardness properties for all specimens prepared under the different specimen. In this Vickers hardness test machine, we have tested our specimen with 100grms for the duration of 10sec for each trail. Microstructure of the alloy cooled different moulds were captured using Leica Metallurgical Microscope.



9. Results and conclusion:

Microstructure is the very small scale structure of a material, defined as the structure of a prepared surface of material as revealed by a microscope above 25× magnification. The microstructure of a material (such as metals, alloys) can strongly influence physical properties such as strength, toughness, ductility, hardness, corrosion resistance, high/low temperature behaviour or wear resistance. These properties in turn govern the application of these materials in industrial practice. Here microstructures of standard specimens after mirror polished were shown below and they etched with Keller's reagent which is a mixture of nitric acid, hydrochloric acid and hydrofluoric acid.

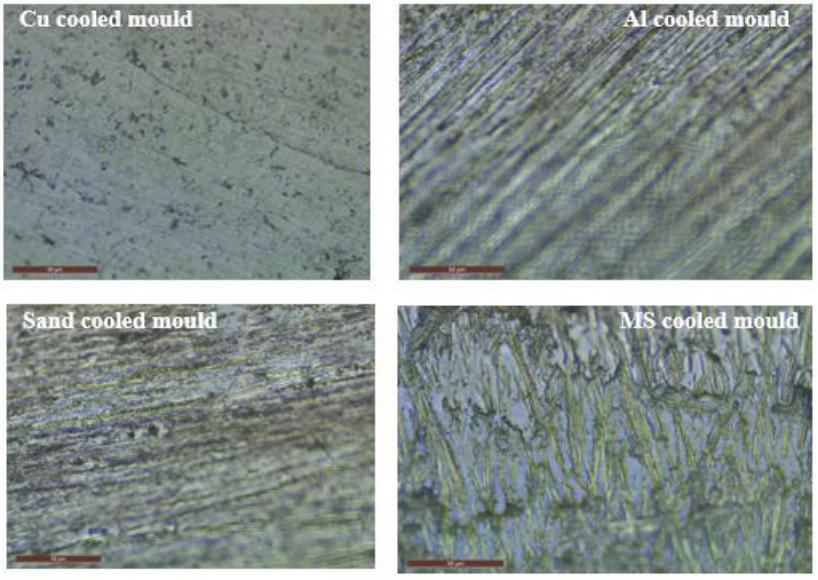


Fig : Microstructures of specimen cooled in different modes

Micro-Vickers hardness test was conducted to determine the mechanical properties such as harness in this test load applied is 100gf and mean wise readings were obtained. Vickers hardness test was conducted to determine the mechanical properties such as harness in this test load applied is 10Kgf and mean wise readings were obtained. The wear testing was carried out for all the specimens cooled in different moulds.. The specimen surfaces are subjected to micro structural study. During wear testing, wear rate and frictional force for all specimens were noted. In order to determine the load and speed for wear testing, the following wear calculations are adopted.

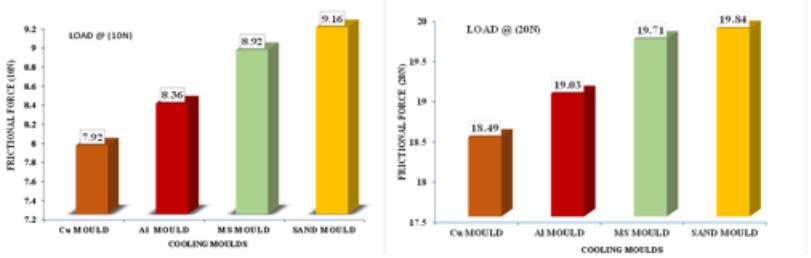


Fig : Frictional Force vs. Cooling moulds

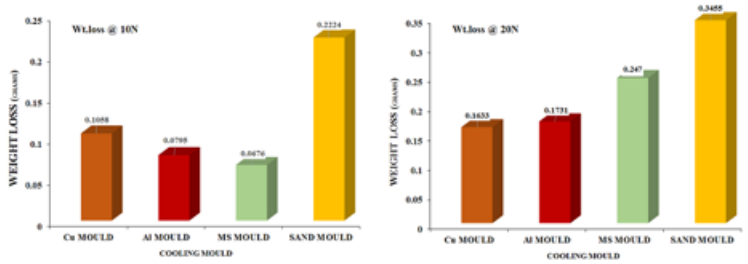


Fig : Weight Loss vs. Cooling moulds

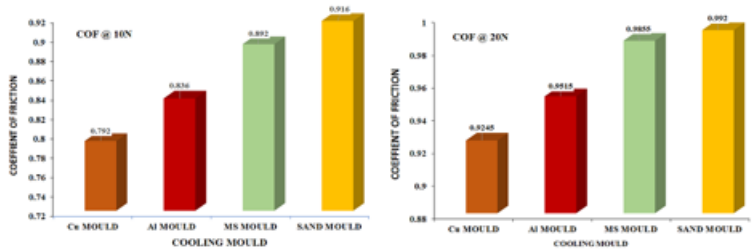


Fig : Moulds vs Weight Loss

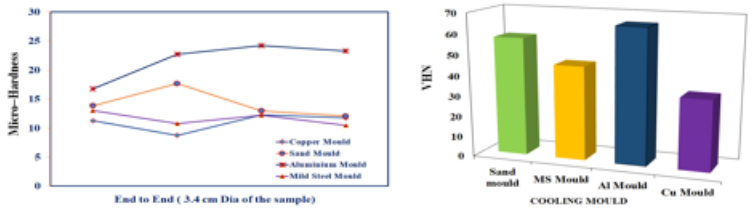


Fig : Moulds vs VHN and Micro Vickers hardness

1. Aluminium and Sand moulds exhbhited higher micro−hardness (end to end) compared to alloy cooled in copper and mild steel moulds. However, not much in higher hardness values was observed for the alloy cooled in mild steel and copper.
2. Average VHN (randomly taken) for Al alloy cooled in Aluminium mould showed higher Vickers Hardness Number (VHN)
3. Al alloy solidified in sand mould exhbhited higher Frictional Force (N) as well as higher Coefficient of Friction at loads 10N and 20N.
4. Weight loss for alloy solidified in Al mould exhibited least and Cu as well as Al showed intermediate behivour.

10. Scope for future work:

1. To produce controlled homogenous and refined microstructure by addition of ternary alloying elements in the immiscible Aluminium alloy.
2. To produce uniform microstructure of immiscible Aluminium alloy by explosive compaction.
3. Influence of ternary alloying addition on the microstructure and tribological properties of Aluminium alloy.