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Mechanical Properties Evaluation of Cast Al-Zn Alloy

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Abstract

Al-Zn Alloys are characterized by low density, high thermal & electrical conductivities, and good corrosion resistant characteristics. The great limitation of these alloys is their low melting point (660^{o}C),which restricts their use at elevated temperatures. The mixture of Al and 1o% Zn is casted. The mechanical properties like hardness, tensile strength are evaluated. The ultimate tensile strength and total elongation of Al-10%Zn sample were found to be 107.472 MPa and 2.482% respectively the yield strength calculated be 49.413MPa fracture load is found to be 12.18 kN. The ultimate compression strength and maximum displacement for the sample of Al-10%Zn were found to be 118.982MPa and 3.04mm respectively, the maximum load used is 114.52 and the average hardness value under Rockwell B-scale is 21.3HR

Keywords: Al-Zn alloys, Casting, Tensile strength

Introduction

Aluminium alloys are characterized by low density, high thermal & electrical conductivities, and good corrosion resistant characteristics. Al has FCC crystal structure; these alloys are ductile even at low temperatures and can be formed easily [1]. However, the great limitation of these alloys is their low melting point, which restricts their use at elevated temperatures. Common applications of Al alloys include: beverage cans, automotive parts, bus bodies, aircraft structures, etc. Some of the Al alloys are capable of strengthening by precipitation, while others have to be strengthened by cold work or solid solution methods [2].Omar Fajardo, etalexamine and observe the microstructure of aluminium zinc and their alloys. They investigated on the mechanical properties of sand cast Permanent mold, zinc aluminium alloys, chemical specifications of zinc aluminium alloys[3]. García-Villarreala etal, investigated on the addition of silicon nanoparticles into Al-Zn alloys to form metallic matrix Nanocomposites by mechanical alloying process. The study includes the results showed that during mechanical milling Si is added to the Al–Zn matrix achieving a uniform and homogeneous dispersion. After

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solidification, it forms small particles of AlZnSi with blocky morphology in inter dendritic regions. The nanoindentation profiles showed that the elastic modulus and hardness properties increase with increasing milling time. However, a high concentration of Si(>1.2wt.%) results in a saturation of Si in the Al–Zn matrix, which adversely affects the mechanical properties.[4]

EXPERIMENTAL PROCEDURE

The alloy of Al-Zn required composition is prepared by melting at elevated temperature and casted. The cast alloy of Al-Zn tested at room temperature to determine the mechanical properties. Different techniques like optical emission spectroscopy, tensile test, compression test, hardness test are done to determine the chemical composition and some mechanical properties of the alloy.

Preparation of Al-Zn Cast alloy

In this process sand casting is used for casting of Al-Zn alloy. For sand casting required, cope and drag are taken and patterns for which castings are to be prepared are placed in the cope and the cope is filled with required amount of black sand. The black sand is rammed using rammer to avoid mould from breaking. Same process is followed with the drag, cope and drag are fixed. The molten metal is poured in to the mould cavity through sprue after a reasonable amount of time (half an hour) the castings are separated from the mould cavity and quenched in water. The castings formed are further grinded for even surface and better appearance.

Results and Discussions

Different tests like compositional analysis, tensile test, compression test, hardness test was carried out on Al-Zn alloy. The results obtained from these tests are reported, analysed and discussed further in this section. The following table 1 shows the weight percentage of different elements present in the prepared Al-Zn alloy sample.

Table 1: Weight percentage of different elements present in the Al-Zn sample after casting

Elements	Cu	Mg	Si	Fe	Mn	Zn	Pb	Ti	Al
Wt%	1.206	0.002	4.554	1.038	0.164	9.802	0.344	0.040	82.71

The weight percentage of zinc in Al-10%Zn is founded to be 9.802% which is very close to 10%. The change in composition of aluminium results change in its microstructure and mechanical behaviour under loads. Microstructures obtained from the computerised optical

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microscope are shown in fig 2a and 2b. From Figures 2a & 2b shows an optical micrograph of Al-10%Zn alloy at 100x and 200x magnification respectively. The microstructure consists of β-phase AlZnSi needle particles (grey) with distribution of AlCuFe in the matrix of Al solid solution.

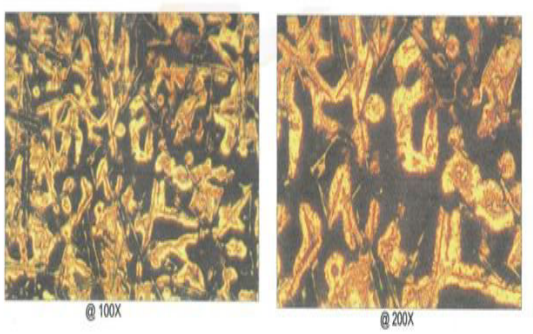

Fig 2a Microstructure of Al-10%Zn alloy at 100X from optical microscope

Fig 2b Microstructure of Al-10%Zn alloy at 200X from optical microscope

From the load and elongation values obtained from the universal testing machine, corresponding engineering stress and engineering strain were calculated and plotted to get stress vs strain curve for Al-10%Zn alloy as shown in figure 3. The ultimate tensile strength and total elongation of Al-10%zn sample were found to be 107.472 MPa and 2.482% respectively the yield strength calculated be 49.413MPa fracture load is found to be 12.18 kN. From the load and elongation values obtained from the universal testing machine, corresponding engineering stresss and engineering strain were calculated and ploted to get stress vs strain curve for Al-10%Zn alloy**.** The ultimate compression strength and maximum displacement for the sample of Al-10%Zn were found to be 118.982MPa and 3.04mm respectively, the maximum load used is 114.52. The hardness test of the Al-Zn sample were conducted using a Rockwell hardness testing machine with a minor load of 10 kgf and major load 100kgf using a ball Indenter. Five indentations were taken and average value is reported. From the results obtained the average hardness value under Rockwell B-scaleis 21.3HRB as shown in Table 2. The Rockwell hardness values for Al-10%Zn is found to be 21.3 HRB. This shows that the hardness values of the Al-10%Zn alloy is less when compared to base metal Al has ahardness value above 33.0HRB.

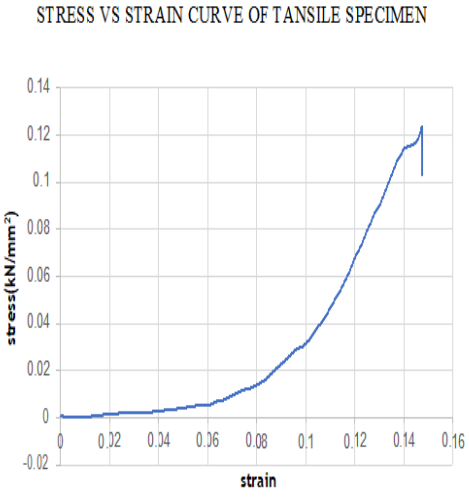

Fig 3 Stress vs Strain curve for tensile test sample

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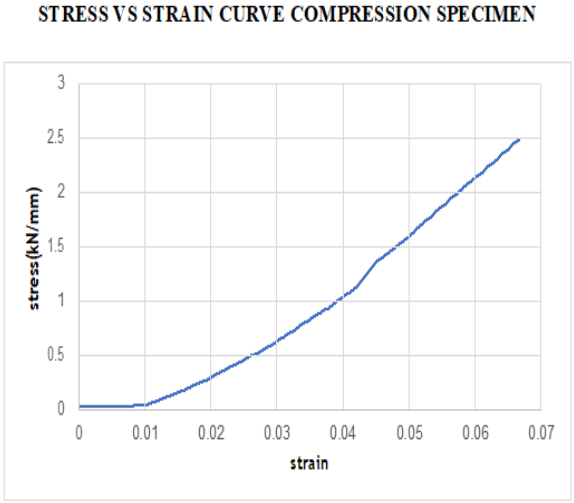

Fig 4 Stress vs Strain curve for compression test sample

Table 2 Hardness values of the Al-Zn alloy in Rockwell B-Scal

S.no	Hardness values in B scale
1	20.5 HRB
2	18.6 HRB
3	23.7HRB
4	17.8HRB
5	27.3HRB
Average hardness	**21.3HRB**

Conclusions

The conclusion drawn from the conducted investigations are as follows:

- The prepared Al-Zn sample alloy have homogenous distribution of zinc throughout the cast.
- Yield strength and ultimate tensile strength are very less due to brittle in nature
- The tensile strength of the Al-Zn alloy is low when compared with the tensile strength of the base Al metal.
- Hardness of Al-Zn alloy decreases when compared with the hardness values of baseAl metal.
- The total percentage of elongation of Al-Zn alloy decreases when compared to the percentage of elongation of base metal.

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