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Finite Element Analysis of Hypereutectic Aluminium Silicon Alloys

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Abstract

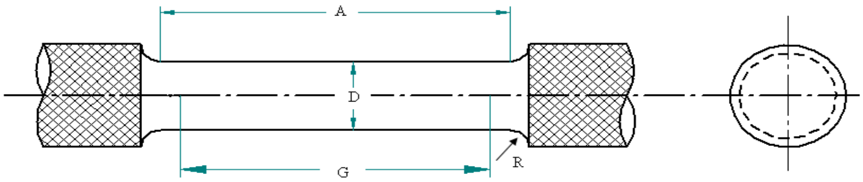
In the present work attempt has been made to compare the experimental and finite element analysis results of tensile behavior of as cast hypereutectic Aluminium–Silicon alloys. Parameters like deflection, tensile strength are estimated subject to given boundary conditions. Analysis is carried out using ANSYS 13 and experiments are carried out using computerized UTM TUFUN -100.Numerical results reveal that there is a deviation of 10-15% from the experimental results. It may be therefore reported that FEA results may be sufficient for industrial applications as the deviation is within the limit and further experimentation can be avoided.

1.0 Introduction.

Hypereutectic Al-Si alloys are finding widespread applications in the field of automotive and aircraft industries. Hence a large volume of work has been reported to investigate the mechanical properties of hypereutectic Al-Si alloys [1–11].The very main objective of the present study is to avoid the necessity of casting and experimentations for obtaining the mechanical properties.

2.0 Methodology

Hypereutectic Al-Si alloys are prepared by foundry technique. Calculated quantities of commercial purity aluminum (99.7 Wt % purity) and Al-20 Si master alloy are melted in a resistance furnace under a cover flux (45% NaCl+45% KCl+10% NaF) upto 720 ^{0}C±5 ^{0}C and as cast hypereutectic Al-Si alloy specimens are prepared after degassing the melt with solid hexachloroethane (C_2Cl_6) and the melt is poured into cylindrical graphite mould (25 mm diameter and 100 mm height) surrounded by fire clay brick with its top open for pouring. From the casted specimens tensile specimens are prepared according to ASTM E8M-04 standards as shown in Fig.1.



A= 54, R=08, D=9.0 ± 0.1, G=45.0 ±0.1

Fig.1 Tensile test specimen prepared as per ASTM E8M-04 standards.

Tensile test on Al-13, 14, 15, 17 and 20% Si alloys is carried out using Computerized Universal Testing Machine (TUFUN 100, FIME Ltd., Miraj).

2.1 Modeling and boundary conditions.

Finite element analysis is a tool for analyzing the experimental results and almost replacing the experimental testing procedures. Once the compatibility of the results is achieved with minimum deviations, we can completely eliminate the experimental testing, and thereby saving the cost of destructive experimental testing. The specimens are modeled in ANSYS and the solid tetrahedron elements are used for meshing using free mapping and convergence is achieved using mesh convergence. The boundary condition used is fixed displacement in x, y and z direction at one end of the specimen similar to the experimental boundary conditions. Loading is carried out at the other end. The analysis is carried out for the peak load indicated in the experimental results.

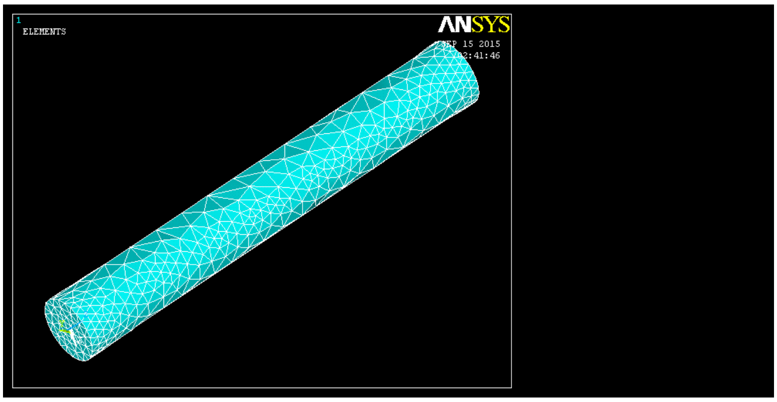


Fig 2.Modeling and boundary conditions applied over Hypereutectic Al-Si alloy.

3.0 Results and Discussions

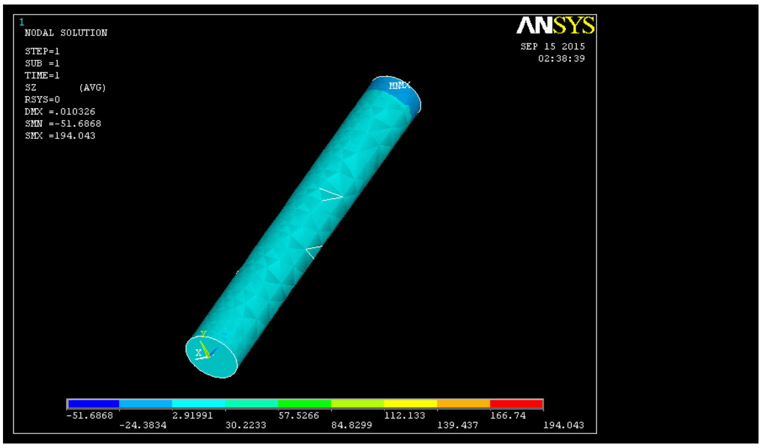


Fig.3 FEA results of UTS of hypereutectic Al-13 Si alloy.

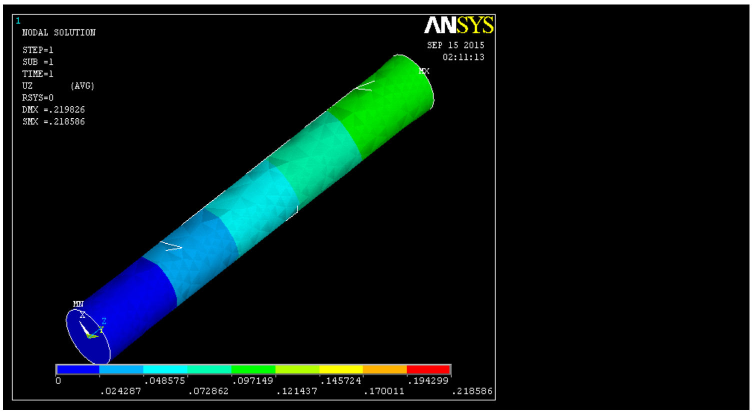


Fig.4 FEA results of deflection of hypereutectic Al-13 Si alloy.

From Fig. 5 it is clear that tensile strength and % of elongation of hypereutectic Al-Si alloys decreases with increase in Si content in hypereutectic Al-Si alloys. This may be due to the fact that mechanical properties of hypereutectic Al-Si alloys are greatly influenced by shape and size of primary silicon particles [12]. Figure 3 shows FEA results of tensile strength of Al-13 Si alloy and Fig 4 shows FEA results of deflection of Al-13 Si alloy. Experimental result of Al-13 Si shows UTS of 190.2 MPa and deflection of 0.2408 where as numerical FEA study shows UTS of 194.043 MPa and deflection of 0.2185 indicating deviation of 1.99% for UTS and 0.9 % for deflection. Comparison of Numerical and Experimental values are done for Al-13, 14, 15, 17 and 20 Si alloys results revel that there is deviation of 5-10% with the experimental values.

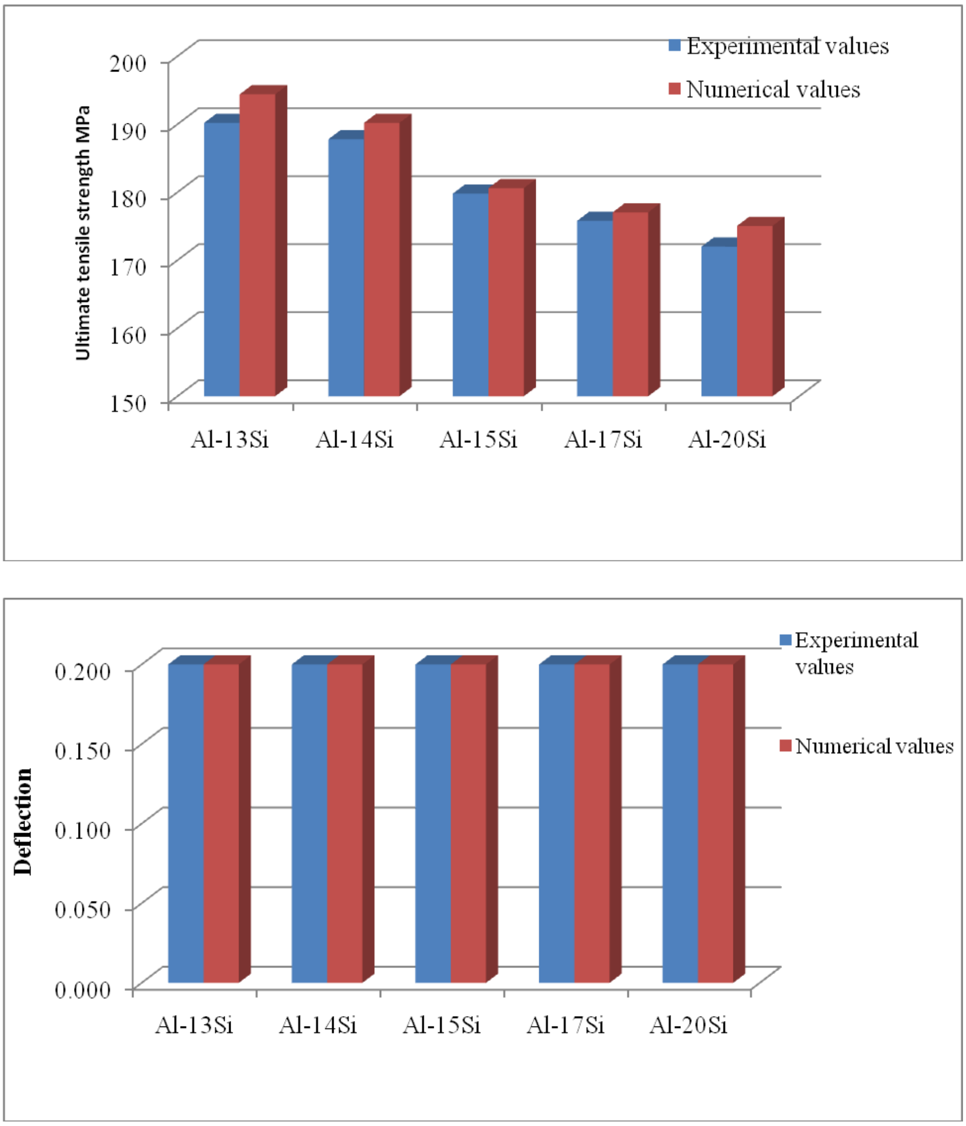


Fig.5 Comparison of Experimental and Numerical results of UTS and deflection of hypereutectic Al-Si alloys.

4.0 Conclusions

Comparison of the experimental and FEA analysis of tensile behavior of as cast hypereutectic Aluminium–Silicon alloys are discussed in the present study. Numerical results indicated a deviation of only 5-10% as compared to experimental results which is within the limit, thus avoiding the need and necessity of casting and further experimentations for the study of tensile properties of hypereutectic Al-Si alloys.

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