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New Alloy Of Aluminium, Silicon, Nickel & Study Of Their Mechanical Properties

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Abstract: *Within the last few years there has been a rapid increase in the utilisation of aluminium silicon alloys, particularly in the aerospace structures, automobiles industries and military application, due to their high strength to weight ratio, high wear resistance, low density, and low coefficient of thermal expansions, excellent corrosion & wear resistance and ease of fabrication at reasonable cost. Because of their excellent cast ability it is possible to produce reliable castings, even in complex shapes, in which the minimum mechanical properties obtained in poorly fed sections are higher than in castings made from higher strength but lower cast ability alloys. Silicon is the primary alloying element; it imparts high fluidity and low shrinkage, which result in good cast-ability and weld-ability. The low thermal expansion coefficient is exploited for piston, the high hardness of the silicon particles for wear resistance. Nickel is the secondary alloying element; it helps in increasing heat capacity of the alloy, it also helps in increasing hardness, machinability, due to its lower atomic radii of 149pm, boiling point-2913C, melting point-1455C, and young modulus is 200GPa. The high specific tensile strength of aluminium alloys is very strongly influenced by their composed polyphase microstructure. The structure of the alloys can be hypoeutectic, hypereutectic or eutectic, as can be seen on the equilibrium phase diagram. In this present research work investigation, study focused on mechanical properties and microstructure of the Nickel-Silicon-aluminium alloy. This study aimed to investigate mechanical behaviour of Al-Si-Ni alloy and effect of Nickel addition. Grain size and mechanical properties and non-destructive test of alloys have been studied. And then at last fine fibre's or thin rod like structures are machined out of the samples and then used as reinforcing material in composite fibre sheet material made up using sugar cane bagasse and strong adhesive. The Result Showed that NICKEL addition to aluminium decreases its ultimate tensile strength, Peak load, break load. The addition of nickel in aluminium silicon alloy must be done at temperature greater than 600°C. Below this temperature nickel could coagulate and can be removed along with the slag removal process, giving a vast variation in planned composition and actual spectro report.*
The addition of nickel to hypoeutectic phase to Al –Si alloy the hardness and toughness is considerably reduced, this is due to the formation of some intermetallic compound with silicon wafers in solid solution as seen in the microstructure of that composition. This alloy of sample no. 3 can be used at places where brittle material with high hardness value is required. All the mechanical properties of sample no. 1 are found to be greater than all other properties of the other samples. Sample one is Al-Si alloy at hypereutectic phase. And its grain structure is also very fine so it was found that nickel addition to Al-Si alloy in eutectic and hypoeutectic phase doesn't improve any property of the alloy considerably.

Brief Introduction of preparation of Alloy and Specimen

After very close study of various research papers and books related to aluminium alloys with silicon, and detailed study of material science textbooks I decided to put nickel also in the hyper and hypoeutectic composition of Al-Si alloys. I decided all the four different compositions to make and test to find something new and material behaviour.Sand Mould was prepared with the following constituents-------
Silica sand (SiO_2), Chromite sand ($FeCr_2O$), Zircon sand ($ZrSiO_4$), 75 to 85%, Bentonite (clay), 5 to 11%,Water, 2 to 4%, Inert sludge 3 to 5%, Anthracite (0 to 1%)
At least three set of each casting was carried out for the experiment. A generated code for identification (Silicon % /Type of casting) is given below.

Identification name	Aluminum percentage	Silicon percentage	Nickel percentage	solid solution equilibrium phase
SAMPLE 1	83.2%	16.8%	-----------	HYPEREUTECTIC
SAMPLE 2	93.2%	6.8%	-----------	HYPOEUTECTIC
SAMPLE 3	83.8%	12.6%	3.75%	EUTECTIC
SAMPLE4	89.6%	6.8%	3.75%	HYPOEUTECTIC

Table 4.1 Identification code of Test Specimen

Then we produced all the four casting from Ajeet Metal Industries, India. I used all the components of 99% purity and used very precise casting method to cast these rods.

For the ultrasonic testing the whole machined sample was used, as this testing is also a Non-destructive testing so there is no harm to sample after the testing. Hence the samples were directly used for the ultrasonic testing. Ultrasonic Flaw Detector machine set up is used to detect the flaws if any present in castings produced.

The above aluminium sample numbers 1 to 4 as marked, tested ultrasonically and found complete loss of backwall throughout the circumference, with pinhole defect Indications**.**The entire sample are having larger grain structure and bold microstructure.

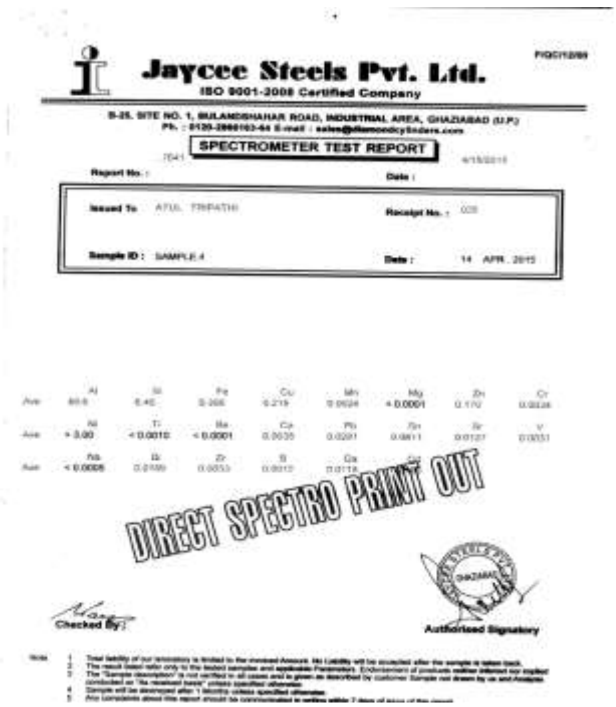
The chemical compositions of the cast alloys were evaluated using optical emission spectrometer (Model: ARL 3460 Metals Analyser, Thermo Electron Corporation Limited, Massachusetts, United States of America). The samples were cylindrical shape of 20 mm diameter and 10 mm height. Here, excitation is done by an arc or a spark and the analysis of the spectrum of frequencies of emitted electromagnetic radiation is done to identify the elements.

Fig 4.7 spectroscopy machine at Jaycee steel industries

After non-destructive test, compositions of the element in the alloys are tested by spectrometer on Jaycee Steel Industries Gzb. A test piece of 35 mm diameter and 10-8 mm of length is to be cut from sample. Then test sample piece is perfectly grinded through the grinding wheel and emery paper of size1/10. Grinded surfaces are keeping on the plate to the machine then it is clamped by the screw controlled leaver and turn on machine then in presence of argon testing machine direct shown the percentage of the element on the display board. Normally machine set all measuring parameter for the calculation for the above said all test piece on machine operate foe 220 AC current and 400 Hz frequency.

Figure4.8 Clamping Platform of Spectro Test Machine

The Result report of spectroscopy test carried out at Jaycee Steel in Ghaziabad of the samples which I ad casted separately while casting the main casting and later the same piece was used to test the hardness.



FIQC/12/09

Jaycee Steels Pvt. Ltd.

ISO 9001-2008 Certified Company

B-25, SITE NO. 1, BULANDSHAHAR ROAD, INDUSTRIAL AREA, GHAZIABAD (U.P.)

SPECTROMETER TEST REPORT

Report No. : 7641 Date : 4/15/2015

Issued To : ATUL TRIPATHI Receipt No. : 008

Sample ID : SAMPLE 4 Date : 14 APR. 2015

	Al	Si	Fe	Cu	Mn	Mg	Zn	Cr
Ave	89.8	8.40	0.266	0.219	0.0024	< 0.0001	0.170	0.0026
	Ni	Ti	Be	Ca	Pb	Sn	Sr	V
Ave	> 3.00	< 0.0010	< 0.0001	0.0035	0.0291	0.0611	0.0127	0.0051
	Na	Bi	Zr	B	Ga	Cd		
Ave	< 0.0008	0.0199	0.0053	0.0012	0.0118	[illegible]		

DIRECT SPECTRO PRINT OUT

Checked By : Authorised Signatory

Note 1–5 [illegible]

In the report of spectroscopy we found that our method of casting all the samples of different composition was correct with some minute loss in % of nickel as it may have been vaporised during melting in crucible. Till now I had done composition designing, casting,ultrasonic testing, and spectroscopy to confirm the percentage of the samples as thought. I had also collected chips of all the samples and their weight for the future non mechanical testing and machinability of the alloys, as we can also tell some of the mechanical behaviour of the material by carefully examining the chips after machining the rods of all the composition were turned and face on lathe machine using single point cutting tool at the chuck speed of 287-298RPM.

These chips will be further used to check corrosion resistance of the alloys.

For the purpose of performing hardness test on each sample of different composition a disc of 10-15 mm thickness is machined out using power hacksaw machine having carbide continuous blades.

This property is quite closely related to the strength of a material. Although it is a basic and very important property of materials, no precise definition of this property has been yet developed or established. However a common way of defining this property is in terms of the capacity or ability of a material to resist permanent indentation, such as on scratching, wear, penetration, abrasion, cutting etc.

The diameter of the disc was same as that of the previous or main cylindrical machined sample of each composition.

Major Load = 100Kgf
Minor Load = 10Kgf

SNo.	Sample no.	Hardness no.
1.	Sample no. 1	20
2.	Sample no. 2	22
3.	Sample no. 3	25
4.	sample no. 4	35

Table 5.7 hardness values of all samples.

Fig 3.10 sample for hardness test preparation

3.6 Preparation of the sample for the computerized optical microscopy.

For computerized optical microscopy the specimen should be small enough to be easily mounted on the microscope bed. For the detailed and clear microstructure kellers reagent is also used with sample. And the surface of the specimen should have mirror like shining surface without any surface defect.

Emery paper is used to make the surface of the specimen smooth and then double disc type polishing machining is used to provide it shining surface, the sample of the previous testing is used for this purpose also.

Fig 3.11 Sample for microscopy and microstructure

Microstructures of the alloy samples were observed under computerized optical microscope (Model: Olympus BX51, Essex, UK). The Al-Si samples of different weight composition were mechanically polished using standard metallographic techniques before the examination. Characterization is done in etched conditions. Etching was done using the Keller's reagent (1 volume part of hydrofluoric acid (48%), 1.5 volume part of hydrochloric acid, 2.5 volume parts of nitric acid and 95 volume parts of water). The micrographs of the samples were obtained.

MICROSTRUCTURE TEST

Grain structure with the help of microstructure is visualized with help of COMPUTERISED OPTICAL MICROSCOPE. The following methods are used for the preparation of the test piece. The samples were polished using with standard metallographic technique of polishing with an emery paper of 1/0, 2/0 3/0 and 4/0 specifications and then followed by a wheel cloth polishing using an emulsion of alumina particle suspended in water. Afterwards, these samples were polished by kerosene oil and brass. Then sample were etched with keller's reagents (composition 1% vol.HF1.5% vol HCl, 2.5% vol. HNO3 and remaining water
The microscopic structures of the sample are as follows.

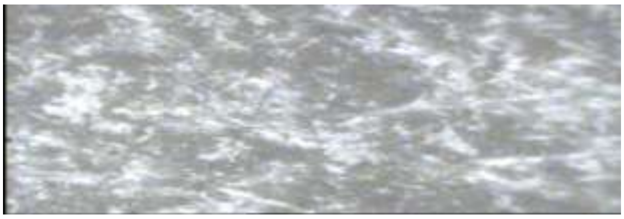


Fig 4.13 microscopic structure of sample

Fig 4.14 experimental set-up for optical microscopy

5.4 MICROSTRUCTURE ANALYSIS.

During microscopic examination or microstructure analysis, the structure of a material is studied under magnification. The properties of a material determine how it will perform under a given application and these properties are dependent on the material's structure. Microstructure analysis at LTI ranges from simple determination of certain parameters such as grain size or coating thickness to full evaluation of failure mechanisms.

Microstructures obtained from computerised optical microscope are shown in fig 5.9 to fig. 5.12 for sample number 1, 2, 3, and 4 respectively.

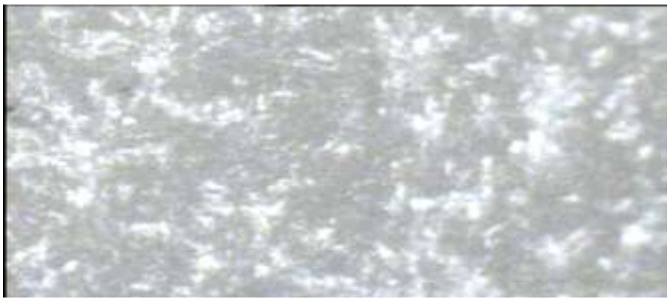


Fig 5.10 microstructure of sample no. 1

Fig 5.11 microstructure of sample no. 2

Fig 5.12 microstructure of sample no. 3

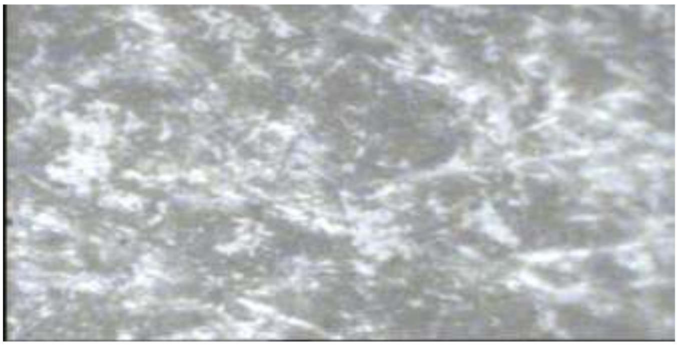


Fig 5.13 microstructure of sample no. 4

Figure 4.1 shows an optical micrograph of Al-7% Si alloy and it may be seen that more-or-less rounded particles of aluminium (light areas, α-solid solution) are crystallized, which are surrounded by fine eutectic silicon (dark areas). Here, silicon has networked structure. The micrograph of Al-12% Si alloy in Fig. 4.2 shows the refinement of the eutectic silicon particles. The silicon has long rod like structure. It may be seen in Fig. 4.3 that the degree of refinement of the eutectic silicon increased as the silicon content of the alloy increased beyond the eutectic composition. Here the primary silicon appears as coarse polyhedral particles. In addition, presence of primary silicon is also observed in the Al-12% Si and Al-14% Si alloys, although the size and volume fraction of the primary silicon is more in Al-14% Si, as compared to Al-12% Si alloys.

3.7 Preparation of the sample for the tensile testing.

Tensile Testing is a very commonly used test, performed to determine different tensile properties, viz., ultimate tensile strength, yield strength, elastic limit, proportional limit, breaking strength, % elongation, % reduction in area etc. on conventional universal testing machine the specimen we need is greater than the sample we have, so after tensile testing there are so more tests to be performed on it, so we have to use small sized specimen to test tensile properties. So we decided to select tensometer for our purpose, as it had collets of smaller diameter.

Fig 3.12 Four cut out parts from the cylindrical rod using power hacksaw.

Fig 3.13 machining of specimen for tensile test and specimen

Fig 3.14 tensometre machine set-up and specimen

The specimen sample were machined on conventional lathe from the four cut out parts of 80mm length using power hacksaw machine. Then these quatrocylindrical parts were machined on lathe to make four samples for each composition means total 16 samples were made.

Tensile properties of the alloys were analysed by carrying out test on the universal tensometer. Electronic Tensometre, Model PC-2000 (Bench Model Horizontal Tensile Testing machine Capacity: 20 KN).

The electronic tensometre is a compact and versatile bench model horizonatal tensile testing machine of capacity 20KN (2000 Kg). This mini universal testing machine is popularly used for tensile, compressive, shear, flexural properties of different materials. The model PC 2000 is top of the range model in series of tensometre, it combines with the state of art computer technology and precision manufacturing techniques to offer unique mini horizontal universal testing machine. The online test graph is displayed on the monitor. The feature in software is the ultimate solution for ever increasing stringent demand of material testing in quality inspection. The instrument is offered with dc servo Motor, Drive, Digital indicating unit and Material testing software.

Tensile tests were carried out with a crosshead speed of 1mm/min, which corresponds to nominal strain rate of 0.001 per second. During the tests, the load elongation data is captured by induced software, whose data is used for further analysis. The figure 3.4 shows the dimensions for the specimen for this test. The numbers shown are the lengths in mm.

Description	**Model PC-2000**
1. Mechanical Frame a. Capacity	20 KN max. (2000 Kg.)
b. Dimensions	H300 x W700 x L1 050mm approx.
c. Weight	60 Kg (Approx.)
2. Motor Drive Unit	Essential
a. Specifications	Motor: Permanent Magnet DC Servo, 3.6 V, 4.8 A, 1600 rpm, 0.16 KW.
b. Speed Variation	Servo Drive, Speed variation through timer belt & pulley arrangement computer control system. (0.2 to 500 mm/min.)
3. Load Measurement	20 KN max. with interchangeable load cells
a. Load cells available	0.2 KN, 2 KN, 5 KN, 10KN&20KN
b. Measuring Unit	Newton & Kg.
4. Displacement Measurement facility	Optical encoder as sensor 0 to 500mm (Excluding grip) (Extra displacement on demand)
5. A. Least count & Load Accuracy	LC. + 0.05% of load Cell Accuracy 1%
b. Displacement	LC : 0.1 mm std. with PC 0.01 Omm software
6. Pre-test data	Available
7. Test Facilities	i Peak test ii Break test iii Preset load iv preset length v Graph analysis through software for various Test results
8. Test Results	All the details regarding test on Computer
9. Graph of the test	On line graph through PC Software on any printer
10. Computer Interface facility	Computer Controlled Machine
11. Memory of Display Unit	Test data saved on PC directly
12. Graph Zooming	With Software zooming possible. (Proof stress, Area under curve)
13. Over load & over Travel Protection	Available

Table 4.2 specification of tensometre

ULTIMATE, YIELD STRESS TEST

Universal testing machine (UTM capacity of 1 ton) was used for testing the physical features of raw materials;

Figure 4.15 Test Specimen of UTM

The gauge length is that length which is under study or observation when the experiment on the specimen is performed. The gauge length of a specimen bears a constant standardized ratio 1:5-1:6 to the cross-sectional dimension. The specimen is placed in the machine between the grips and an Extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held.

Figure4.16 Extensometer tensile Testing Machine

However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips. Once the machine is started it begins to apply an increasing load on specimen.

Throughout the tests the control system and its associated software record the load and extension or compression of the specimen. Load frame usually consisting of two strong supports for the machine. The ultimate tensile strength and yield strength percentage elongation was examined on the UTM

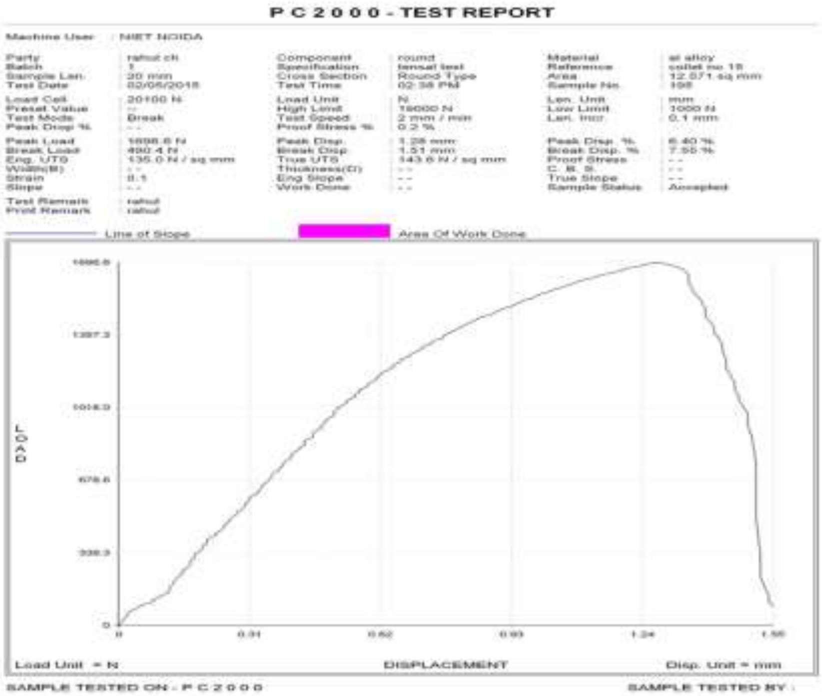
Figure 4.17 Specimen after Testing

Through the physical verification, it was observed that fracture of test specimen is ductile. The ultimate tensile strength, peak load and break load is given in table 5.6.

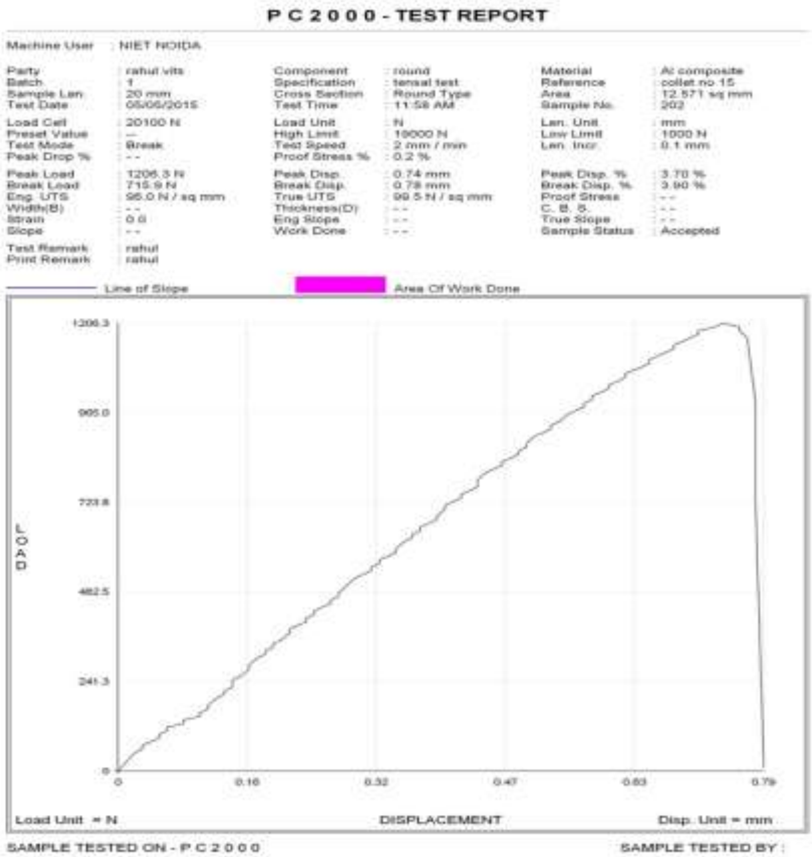
The graphs of the tensile test performed on the electronic computerised 2000 Pc machine are directly shown below all the parameters of the testing are given in the figures of each sample.

There are three specimens machined out from each sample having same composition, it means total of 12 test sample were machined on the lathe, and this done so as to obtain the best average result for each sample.

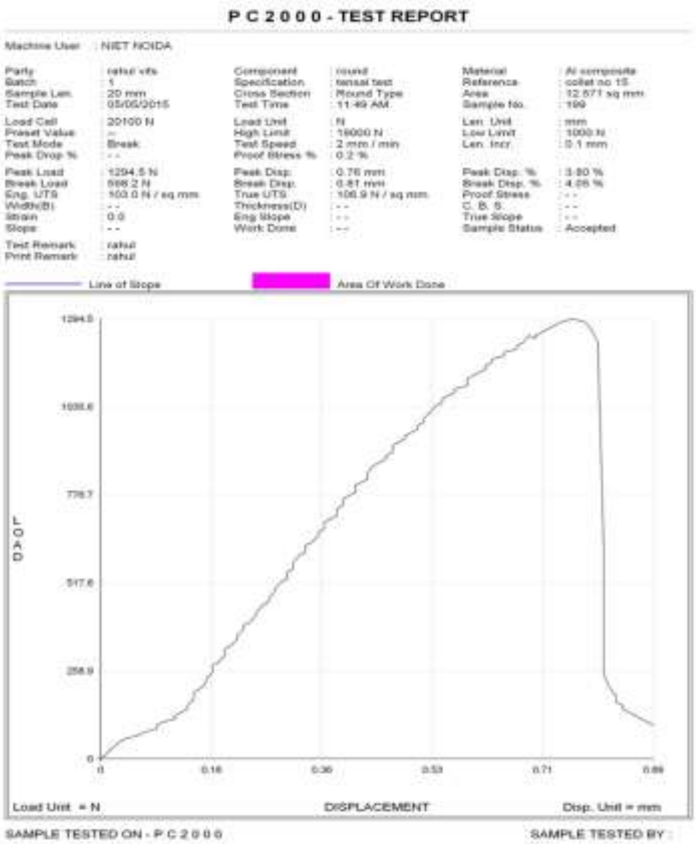
Test report sample 1



Test report sample 2



Test report sample 3



Test report sample 4

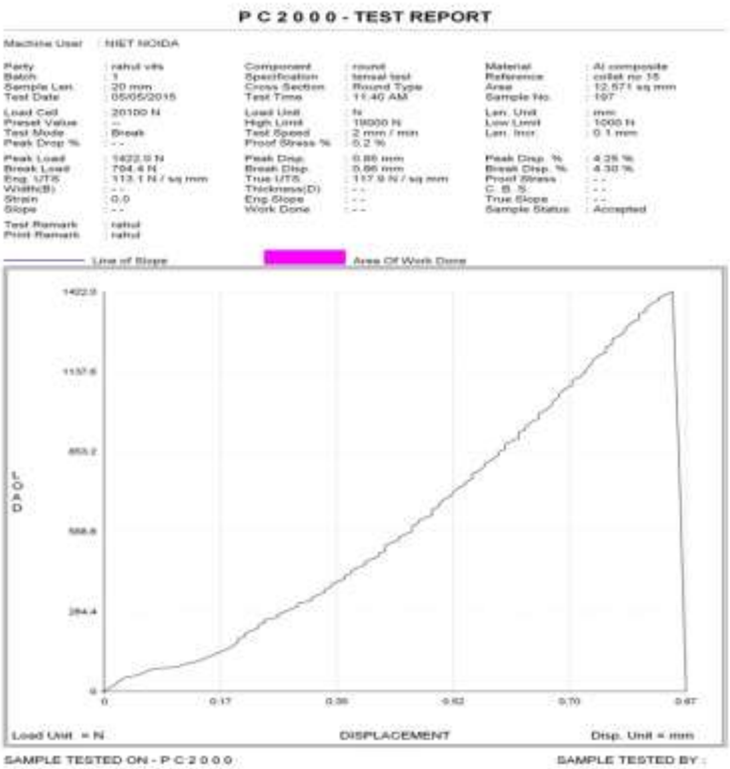


Table 5.3 Comparison of Ultimate Tensile Strength:

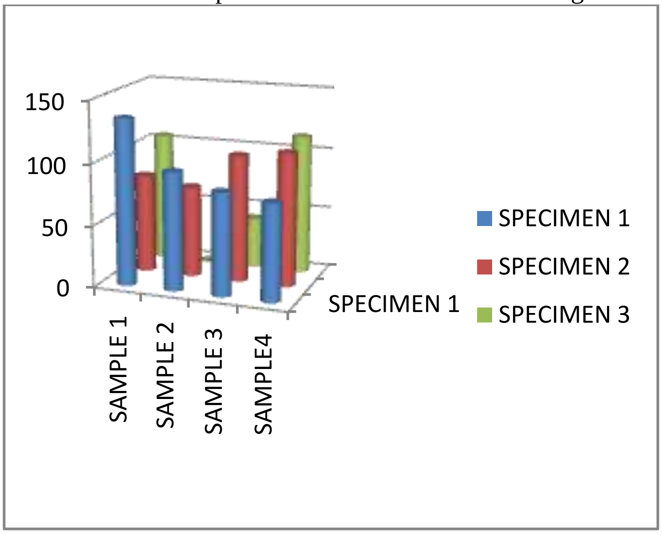


Table 5.4 Comparison of Break Load:

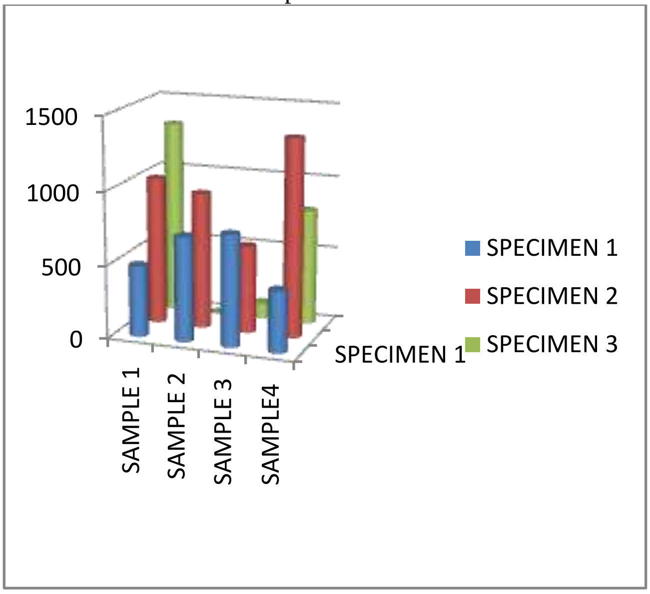


Table 5.5 Comparison of peak load:

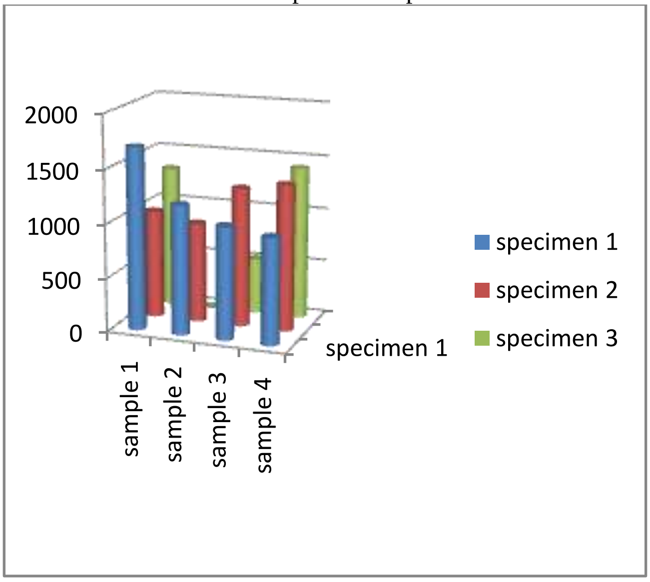
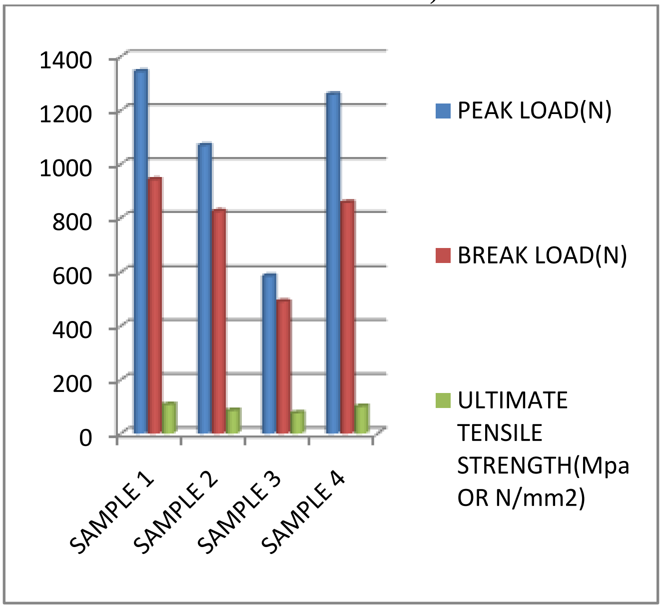


Table 5.6 Comparison of average values of tensile test performed for all specimens. (AVERAGE VALUES OF ALL SPECIMENS)



5.5 d) Discussion:

From Fig. 4.4 to Fig. 4.6, it can be observed that the curves are continuous when transition from elastic to plastic region takes place. Therefore, the yield strengths of the alloys are computed by 0.2% offset method, according to ASTM standard E8M [17]. From Fig. 4.7 and Fig. 4.8, it is observed that ultimate tensile strength and yield strength increases with the increase of weight percentage of silicon; while it is reverse for the total elongation. This may be due to the presence of hard silicon precipitates which increases the hardness of Al-Si alloys.

3.8 Preparation of the sample for the toughness test.

It is the property on account of which a material is able to withstand bending or torsion without fracture and is equal to the work per unit volume needed to fracture the material. In other words we can say that it indicates the amount of energy absorbed by the material before it's actual fracture or fracture occurs. The total are under the stress strain curve diagram from the data obtained through the tensile test is also toughness of the material. It can be used as a measure to cross check the tests.

Fig 3.15 sample for toughness test.

The impact test is done to test the toughness of a material. Toughness is the property which enables the material to be twisted. Bent or stretched under a high stress before rupture.

Toughness takes into account both the strength and ductility of the material. The stresses induced during impact lading are many more times the stress induced during gradual loading.

Impact tests are essentially performed to assess shock absorbing capacity of materials subjected to suddenly applied loads.

Toughness is indicated by the amount of energy that a unit volume of the material could absorb after being stressed up to the point of fracture, it is expressed in Jules. Of all types of impact, the notched bar tests are most extensively used.

The impact test then measures the energy necessary to fracture a standard notch by applying an impulse load. Impact testing machine tales the form of a pendulum which is made to strike a sudden blow against the test specimen. The pendulum swinging down from a specified height hits the test piece and the height to which it rises after striking depends on the energy absorbed un-breaking the test piece. Greater the energy absorbed in breaking, lower is the height to which the pendulum rises.

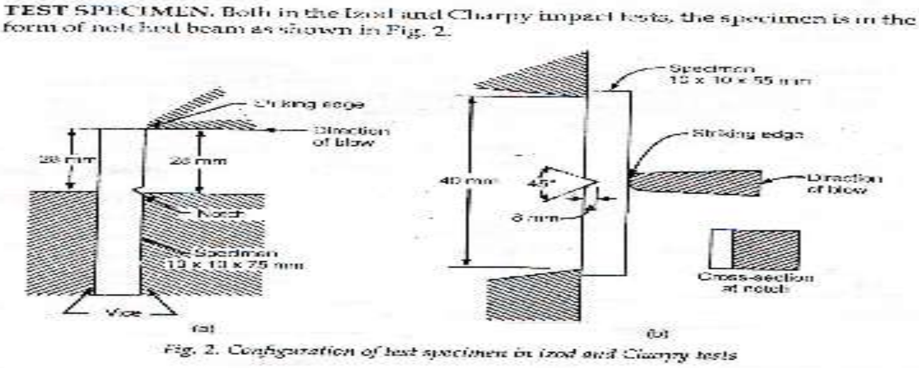


Figure. 4.20 Specimen for Izod Test

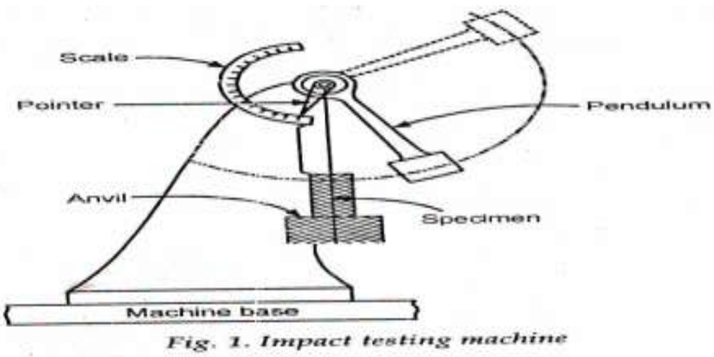


Figure 4.21 Izod Impact Testing M/C

A scale is provided to measure the energy absorbed during the impact test.Izod test, the specimen is kept as cantilever beam while in Charpy test it is placed as simply supported beam. The specimen has V-Shaped of 45 degrees and the depth of notch is generally taken as T/5 to T/3 where t is the thickness of specimen.

The specimen made as per appropriate length (75mm full, 28 mm of free length, 47 mm of Holding length and 10mm of square face), angle of notch 45^0 and its depth 2mm. Bring the striking hammer to its top most position and lock it at that position. Press down the pendulum release lever so that the hammer falls and swings past the bottom most position. Note down the reading (say x) on the dual/ this initial reading is without any specimen and indicates the air and frictional loss in the energy of the hammer. Being the hammer again to its top most position and lock it at that position. Clamp the test specimen in the vice .For Izard test, the notch should face the striking hammer and be half inside and half above the top surface of the vice. The hammer would strike the test specimen and fracture it. The total energy of the hammer will not be absorbed and it will swing to the other side of the specimen. At its topmost height after breaking the specimen, note down the indicator reading.

- Material of Test Piece = Aluminium alloy
- Dimensions of Test Piece = 75*10*10
- Type and Angle of Notch = V-notch, 45- degree
- Depth of Notch = 2 mm
- Reading on Scale = Joule

Observation Table.5.8 Observation of CHARPY Impact Testing

Sno.	Sample no.	Specimen 1	Specimen 2	Specimen 3	Average impact test
1.	Sample 1	10J	10J	6J	8.67J
2.	Sample 2	8J	8J	8J	8J
3.	Sample 3	10J	8J	10J	9.34J
4.	Sample 4	8J	6J	8J	7.34J

4.10CHIPS OF ALLOYS

In this test specimen was hold on the automatic lath and using the constant 1000 rpm ,feed rate of 150 revolution / minutes & depth of cut 1mm to 3mm with same cutting tool then chips which is turn out from the test sample is examined then quality of chips was conformed about the nature of the material.

High % of Silicon has more very small chips than less % of Silicon alloys, this shows that less % of Silicon is more ductile than higher percentage of Silicon. From this test we can also investigate the Machinability of the alloys there the chips are very small in that alloys we can get good surface finish at all elevated temperature

Fig 23 Combined pic of chips of all sample

The following cutting parameter was used for this experiment

- Machine 6 ft. Lathe
- RPM 300 rpm
- Cutting Feed Rate 150 rev/min

Table 5.9 Chips Quantity and other parameters:

Sno.	Sample number	Before machining	After machining	Weight of chips	Wt. loss in chips	Conclusion.
1.	**Sample 1**	**1.100Kg**	**1.007Kg**	**85.59gm**	**7.41gm**	**Discontinuous chips**
2.	**Sample 2**	**1.100Kg**	**1.010Kg**	**88.69gm**	**1.31gm**	**Discontinuous chips**
3.	**Sample 3**	**1.097Kg**	**1.009Kg**	**74.24gm**	**13.76gm**	**Discontinuous chips**
4.	**Sample 4**	**1.132Kg**	**1.028Kg**	**104.62gm**	**-0.62gm**	**Discontinuous chips**

6. FUTURE SCOPE

There are the following future scopes of the research

- Machinability of Alloys
- Wear Testing
- Test for Fatigue, Creep and cyclic loading
- Solidification curve of Alloys
- Microstructure of alloys by SEM Test
- Weldability of the Alloys

- Nickel addition to be increased with silicon
- Magnetic properties should be checked

7. ANNEXURE

7.1 SHRINKAGE ALLOWANCE

Usual Allowance for Each Foot in Length

In large cylinders…………..	3/32 inch
In small cylinders………….	1/16 inch
In beams and girders………	1/16 inch
In thick brass………………	5/32 inch
In thin brass……………….	3/16 inch
In cast-iron pipe…………..	1/8 inch
In steel……………………	1/4 inch
In zinc……………………...	5/16 inch
In lead……………………...	3/16 inch
In tin……………………….	1/4 inch
In copper…………………...	3/16 inch
In bismuth…………………	5/32 inch
In malleable iron…………..	1/8 inch
In aluminium………………	1/5 inch

7.2 TAPER ALLOWANCES FOR MOULDING.

Sand moulding				
Height of pattern mm	Shell Moulding	Metal	Wood	
		Machine drawn	Manual drawn	Machine drawn
Up to 20	0° 45'	1° 30'	3°	3°
20 to 50	0° 30'	1°	1° 30'	1° 30'
100 to 200	0° 20'	0° 30'	0° 45'	0° 45'

7.3 MACHINING ALLOWANCE

Type of metal and alloys	Machining allowance (mm)
Cast Irons	
(i) Large size castings (>1000 mm)	10.0
(ii) Medium size castings (<150 mm)	3.0
Cast Steel	
(i) Large size castings (>1000 mm)	12.0
(ii) Medium size castings (<150 mm)	4.3
Non-Ferrous Materials	
(i) Large size castings (>1000 mm)	5.0
(ii) Medium size castings (<150 mm)	1.5

8. CONCLUSION

The effects of silicon % on mechanical properties of Al 12.99% Si alloy of copper mould casting have been studied. Based on Mechanical testing & examination conducted of the specimen, the following conclusion can be drawn

1. Modification with 0.23 wt. % on silicon & process moderation in casting of alloys gives better grain structure, so it can be used as aluminium based cylinder body piston, bulb sheet, and connecting rod in automobiles sector.
2. Ultimate tensile strength of the alloy improved as compared to LM 6.
3. Ultimate load of the alloys is increase & % Elongation decrease with increase in silicon %
4. Chips of the specimen shows like ductile material.

   The effect of nickel addition on mechanical properties on Al-Si alloy also have been studied and following conclusion can be drawn

1. Addition of Nickel in Eutectic and hypoeutectic Al-Si alloy increases the hardness of the material considerably, so that it is very tough to be cut it down through electrical disc type cutter and carbide tool of power hacksaw.
2. Nickel forms coarse grain structure with the silicon and aluminium in solid solution due to its solubility at elevated temperature and thus it decreases the toughness value on chirpy test.
3. Making of homogeneous alloy of nickel and silicon is very complicated task and needs so much care.
4. Nickel addition decreases the tensile strength of the alloys with respect to hypereutectic aluminium silicon alloy.

References

[1]. Dissertation of Ravi Shankar Raman in year 2011 for "to Study of Microstructure and mechanical properties of lead based silicon Aluminium alloy".

[2]. Jing li, Zhong-ping zhang, Qing sun, Chun-Wang li, and Rong-sui li a modified method to estimate fatigue parameters of wrought aluminium alloys, july 31, 2010).

[3]. A.Kara Karaaslan, I. Kaya and H. Atapek , Effect of aging temperature and of retrogression treatment time on the microstructure and mechanical properties of alloy 7075 , Metal Science and Heat Treatment Vol. 49, Nos. 9 – 10, 2007.

[4]. Kouichi Maruyama, Mayumi Suzuki, and Hiroyuki Sato,Creep strength of magnesium-based alloys, vol. 42, 2008.

[5]. I. N. Fridlyander,1 O. E. Grushko,1 and L. M. Sheveleva1, Heat hardened alloy v1341 for cold pressing of sheets, Vol. 46, Nos. 9 – 10, 2004

[6]. M. M. Krishtal Effect of structure of aluminium-silicon alloys on the process of formation and characteristics of oxide layer in micro arc oxidizing, metallovedenie termicheskaya obrabotka metallov, no. 9, pp. 20 – 25, September, 2004.

[7]. D. Wang2 and R. A. Over felt Oscillating Cup Viscosity Measurements of Aluminium Alloys: A201, A319 and A3561 1 Paper presented at the Fourteenth Symposium on Thermophysical Properties, June 25–30, 2000

[8]. C. Mary T. Le Mogne B. Beaugiraud B. Vacher J.-M. MArtin S. Fouvry, Tribochemistry of a Ti Alloy Under Fretting in Air: Evidence of Titanium Nitride Formation 12 March 2009

[9]. G. S. Makarov, Production of aluminium alloys status and prospects science, technology, industry, Vol. 46, Nos. 11–12, 2002

[10]. V. Nikolaev, G. A. Markov, and B. I. Pshchevitskii, "A new phenomenon in electrolysis," Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, 5(12), 32 (1977).

[11]. A. S. SHATROV, "Technology of Commercial Production of ICE Parts from Aluminium Alloys with Reinforcing the Functional Surfaces by MO," in: Selected Reports of the 2 – 4 Int. Conf. "Problems of Development of Automotive Industry in Russia, Tolyatti, 1996 – 1998 [in Russian], Tolyatti (1999), pp. 162 – 164.

[12]. Y.P.Lim," Evaluation of Al-5Ti-1T and Al-10Sr in LM6 and casting" JAMME Journal volume 34 ISSU-1, May 2009 71-78