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EFFECT ON MECHANICAL PROPERTIES DUE TO ALLOYING ELEMENTS

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Abstract— The present study pertains to changes in mechanical properties of Plain carbon & Alloy steel. An experimental study has been made on Plain carbon and Alloy steel. Two main studies have been carried out. In the first study, Plain carbon steel was prepared in Electric Arc Furnace and subjected to all the heat treatment operation like Annealing, Hardening, Tempering and Stress-relieving. Later on the hardness was also listed for the specimen prepared which was found to be 203 BHN in cast 1 & 207 BHN in T.P. The mechanical properties were also listed and found yield strength 41.99 TSI, 53.85 UTS, 24% Elongation and Impact 70, 71, 72 Ft .Lb. And 5 different readings have been taken on different cast from 1 to 5 to know the exact value. In the second study, alloying elements were added to 5 castings and Heat Treatment process operation were carried out like Normalizing, Hardening, Tempering, and stress-relieving operation for Test piece sample. After that checked the hardness of Cast was found their Cast no 1A 314 BHN and T.P. 320 BHN. Mechanical properties were also checked and the cast no 1A - 87.92 Y.S., 112.4 kgf/mm sq UTS, 22%E, and Impact property 8.56, 8.77, 8.77 mm Kgf in alloy steel. And same procedure was carried out for five heat cast heat samples.

Key Words: - *Ultimate Tensile Strength, Yield Strength &Hardness.*

Introduction

Steel is an alloy of iron and one or more of other elements like carbon, chromium, silicon, vanadium, tungsten, molybdenum and so on with definite percentage of carbon ranges from 0.15-1.5% [1], plain carbon steels are those containing 0.1-0.25% [2]. There are two main reasons for the popular use of steel: (1) It is abundant in the earth's crust in form of Fe_2O_3 and little energy is required to convert it to Fe. (2) It can be made to exhibit great variety of microstructures and thus a wide range of mechanical properties. If one or more elements, other than carbon, are added to steel to ensure specific properties, such as better mechanical strength ductility, electrical properties, magnetic properties and so on. Alloy steels are also broadly divided into three different types. Low-alloy steels: total alloying content is less than about 5%. Medium-alloy steels: total alloying content is in the range of 5-10%. High-alloy steels: total alloying content is above 10%. The main constituents of plain carbon steel are iron and carbon. The properties of carbon steels are directly related to the percentage of carbon present. In addition to carbon, plain carbon steels also contain other elements such as, manganese, silicon, sulphur and phosphorus in the amounts shown above

Table 1.1 Composition Range Of Carbon Steels

Sr. No.	Elements	Percent By Weight
1	Carbon	0.04 to 1.20/1.70
2	Manganese	0.30 to 1.00/1.70
3	Silicon	0 to 0.30
4	Sulphur	0.04 MAX.
5	Phosphorus	0.05 MAX.
6	Iron	BALANCE

Steel can be hardened to resist cutting action and prevent abrasion .the rate of cooling and the manner of cooling are the controlling factor in heat treatment process .heat treatment not only increases

the hardness but also increases the tensile strength and toughness. Hardness is an important mechanical property of the machinery components. Higher hardness material has higher wear and abrasion resistance .hardening process increases the hardness but it affects the other mechanical properties, like fatigue strength (or fatigue life), impact strength, ultimate tensile strength (UTS) etc.[3].In hardening, the steel or its alloy is heated to a temperature high enough to promote the formation of austenite, held at that temperature until the desired amount of carbon has been dissolved and then quench in oil or water at a suitable rate [4].

There are various heat treatment processes Heat Treatment process operation which we have adopted for testing like Normalizing, Hardening and stress-relieving operation. There are many tests to measure mechanical properties, but we shall discuss some of the important and common tests, such as hardness test, tensile test and impact test.

1.1 Effect of Alloying Elements

Alloying elements affect the constitution, characteristics, and behavior of carbon steels in many ways. Some of the major effects of alloying elements are, strengthening of ferrite, formation of special carbides and compounds, shifting of critical temperatures and compositions, and lowering of critical cooling rate.

2. Experimental Procedure:

In the study of mechanical properties and their testing there are certain things which are considered basic or fundamental. A test almost universally employed to express mechanical properties and supply the most useful fundamental information regarding behaviour of materials is the tensile test. In practically tensile testing machine consists essentially of two parts: (1) the unit for applying a load to the specimen, and (2) the measuring device for the measurement of the load on the specimen. The material to be tested is machined to standard dimension and attached to the jaws of tensile testing machine. Before commencing the test two gauge marks are made on the specimen longitudinally usually 50mm or 200 mm apart according to the size of the test piece. Take the specimen for this test may be either round or flat.

In a tensile test, the round or rectangular specimen is deformed by the action of a smoothly increasing load up to the point of rupture. The amount of elongation in the test piece caused by the load is measured accurately by a mechanical, electrical or optical device called extensometer. As the loading of the test piece progresses, load and deformation readings are recorded simultaneously. The readings are made to obtain data for plotting a tensile test diagram. Such a diagram shows the relation between the force applied to the specimen and its resulting deformation. On the diagram the values of the applied load are plotted as ordinates and the absolute elongation corresponding to each load is plotted as an abscissa. Since both the stress and strain are obtained by dividing the load and elongation by constant factors, the load elongation curve will get the same shape as engineering stress-strain curve. The two curves are frequently used interchangeably

The shape and magnitude of a stress-strain curve of a material will depend on its composition, heat treatment, prior history of plastic deformation and strain rate, temperature, and the state of stress imposed during the testing. The parameters which are used to describe the stress-strain curve of a material are the elastic limit, proportional limit, yield strength or yield point, tensile or ultimate strength, percent elongation and reduction of area

Table 2.1 Chemical Composition and Mechanical Testing Properties of M. C. Steel on different cast

CAST NO	C% MAX.	Si% MAX.	Mn% MAX.	S% MAX.	P% MAX.	Y, S. 65%TSI	UTS 40MIN	E% 20MM	IMPACT 20MM	CAS 179-229	T.B. 179-229
Specific VALUES	0.33	0.50	1.70	0.040	0.040	OF UTS	TSI		FT.LB	HARDNESS	HARDNESS
CAST NO 1	0.19	0.467	1.408	0.0121	0.023	41.99	53.85	24	70,71,72	203	207BHN
CAST NO2	0.24	0.376	1.35	0.006	0.022	33.20	42.57	24	62.64,64	210	207BHN
CAST NO 3	0.32	0.47	1.13	0.009	0.019	39.5	47.35	24	67,67,68	201	207BHN
CAST NO 4	0.19	0.42	1.30	0.0061	0.021	36.64	46.98	30	67,63,70	201	217BHN
CAST NO 5	0.24	0.43	1.045	0.009	0.018	36.05	46	24	65,67.60	203	207BHN

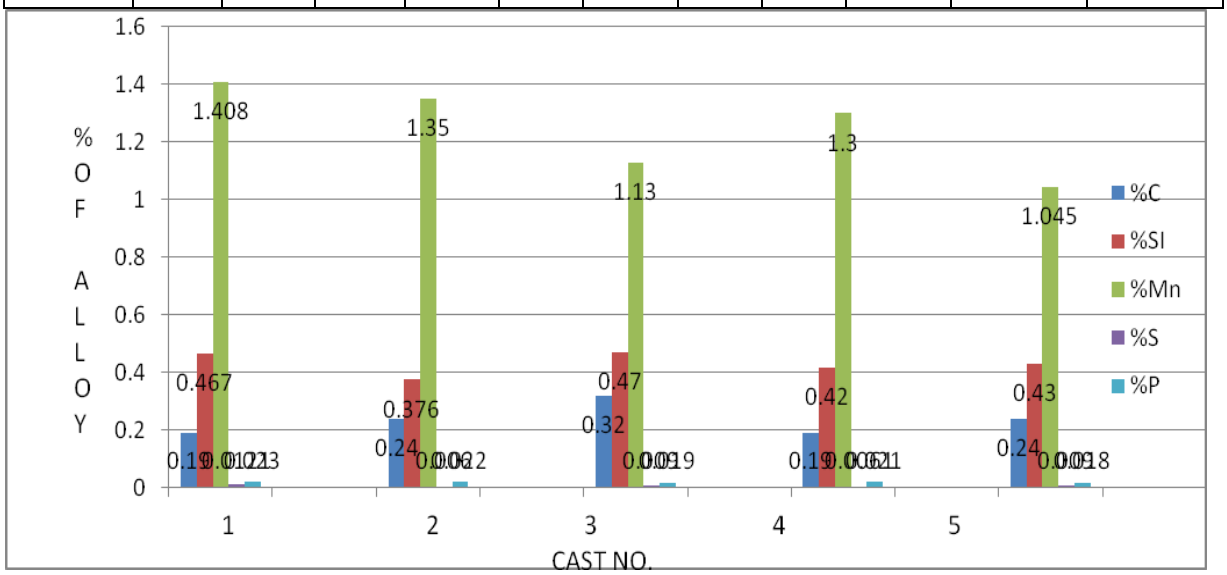

Fig.1.1 Graph of mild carbon steel of the alloying elements on five different cast

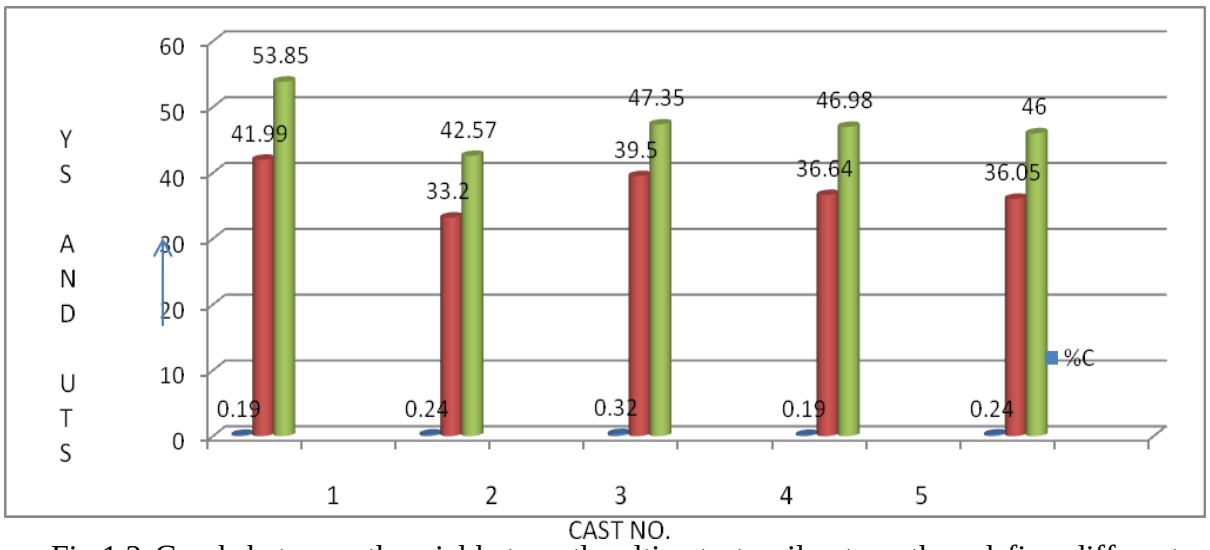

Fig.1.2 Graph between the yield-strength, ultimate tensile strength and five different casts after mix up with add alloying elements during the process of making steel.

Table 2.2 Chemical and Mechanical Properties of Alloy Steels on different cast

CAST NO	C %	Si%	Mn %	S%	P%	Ni%	Cr %	Mo %	Y.S	UTS	E %	IMPACT	CAST	T.P.
Specified Values	0.28 0.33	0.30 MAX	1.30 1.50	0.030 MAX.	0.030 MAX.	0.75 to 1.25	0.60 to 1.00	0.35 to 0.55	85Kgf/mmsq	100Kgf/mmsq		30mm Kgf	300-340 BHN	300-340 BHN
Cast No 1A	0.28	0.29	1.39	0.015	0.027	0.75	0.60	0.40	87.92	112.46	*22*	8.56,8.77 ,8.77	314	320
CAST NO 2A	0.30	0.27	1.44	0.007	0.27	0.78	0.63	0.37	98.65	126.47	20	7.54,7.75 ,7.95	308	320
CAST NO 3A	0.32	0.15	1.31	0.10	0.020	0.75	0.65	0.43	87.82	111.89	16	7.54,7.75 ,7.95	308	320
CAST NO 4A	0.31	0.26	1.40	0.009	0.017	0.87	0.66	0.37	87.23	109.42	16	7.24,7.34 ,7.54	308	320
CAST NO 5A	0.29	0.20	1.30	0.011	0.021	0.80	0.67	0.37	85	112.31	20	7.95,8.15 ,7.90	333	320

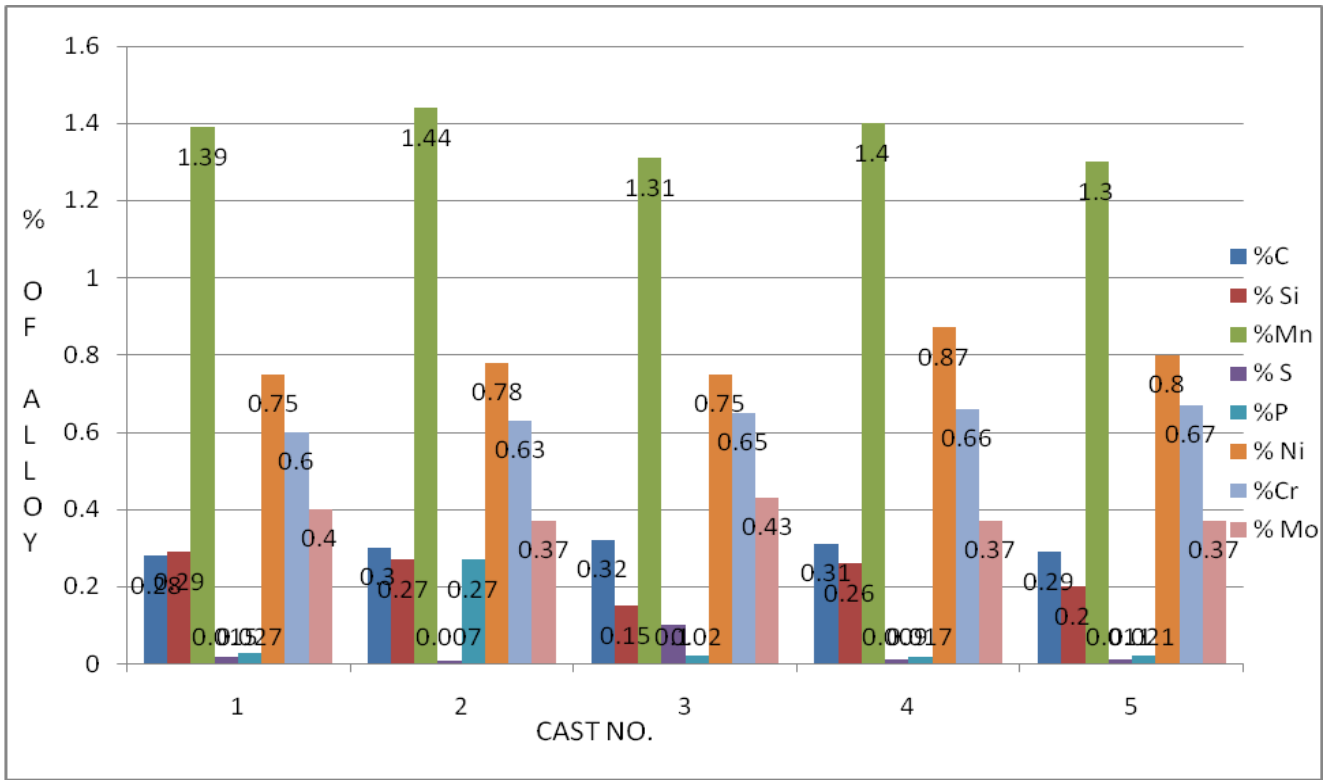

Fig.1.3 Graph of alloy carbon steel of the alloying elements on five different cast

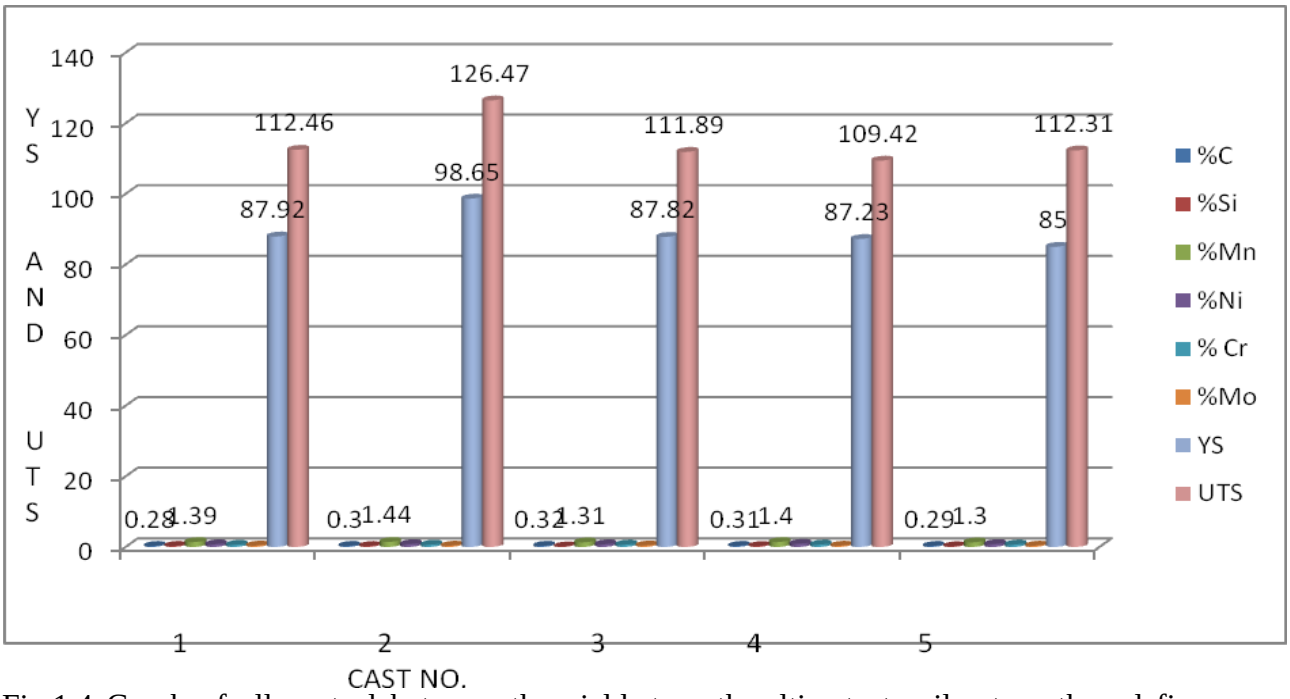

Fig.1.4 Graph of alloy steel between the yield-strength, ultimate tensile strength and five different casts after mix up with add alloying elements during the process of making steel.

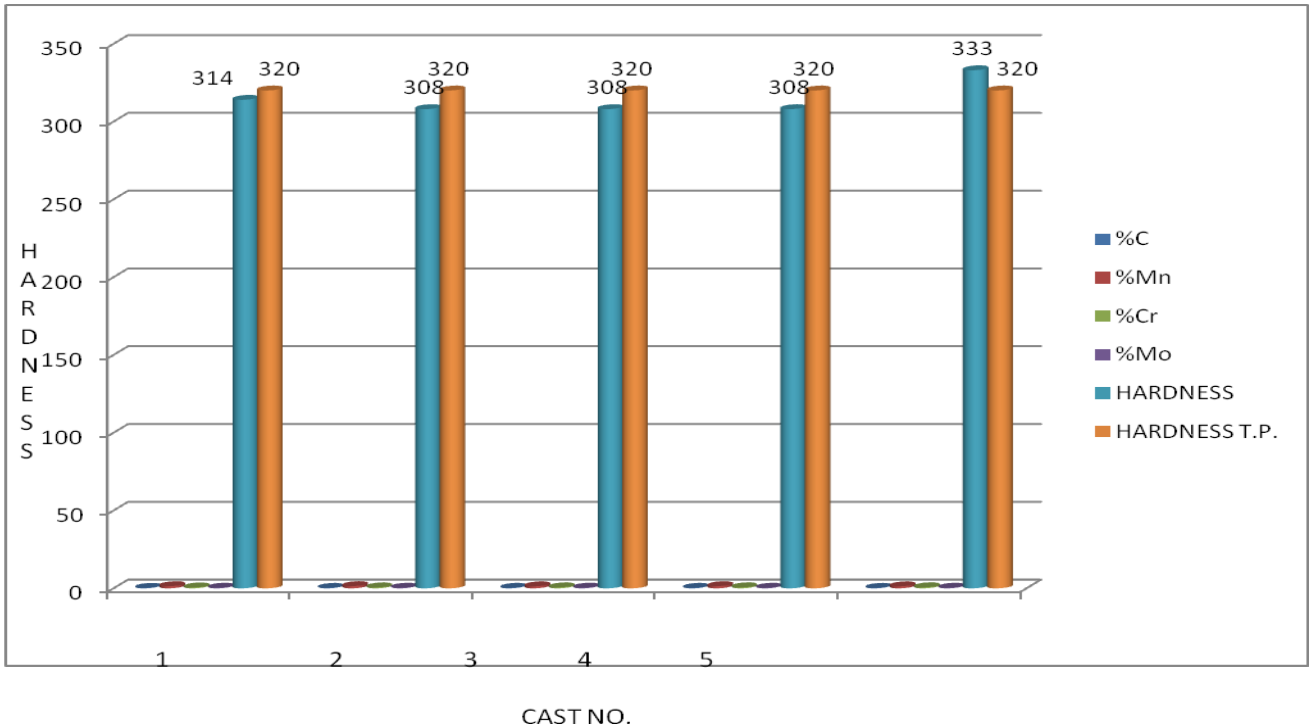

Fig.1.5 Graph of alloy steel with increases alloying elements between the hardness on different casts

CONCLUSION

1. Based on the analysis of result of this investigation and interpretations the following main conclusions are drawn:-

R. NO.	PLAIN CARBON STEEL	Y.L./LOAD (KN).	UTL/LOAD (KN.)	HARDNESS T.P (BHN)	CAST/HAR. (BHN)	BAR/ELONG (MM)/F.L.-OL.
CAST1	P.C.	104.44	133.90	207	203	62-50=12
CAST2	P.C.	82.68	106.00	207	210	62-50=12
CAST3	P.C.	91.96	117.90	207	201	62-50=12
CAST4	P.C.	91.26	117.00	217	201	65-50=15
CAST5	P.C	100.77	129.20	207	203	62-50=12

2. Based on the tested result shown in the given chart YS and UTS sample loads found more as compared to plain carbon steel. And sample was tested normalized, hardened and tempered condition.

3.On the basis of above investigated results it is observed that alloy steel gets more mechanical properties like yield-strength, ultimate tensile-strength and hardness also. All results are shown in both the above charts.

4. On the analysis of both above steel results it is found that mechanical properties has increased if you add alloying elements during the process of making steel.

5. When alloy elements added to steel, perform different functions depending upon their characteristic, amounts and the subsequent heat treatment. Some important functions and application of different alloying elements properties is shown in chart and results.

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