EXPERIMENTAL STUDY ON USE OF VARIOUS PROPORTIONS OF FOUNDRY SLAG AND ALCCOFINE IN CEMENT CONCRETE

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ABSTRACT

The objective of this study is to study on effect of High Strength Concrete containing cementitious materials such as foundry slag and Alccofine. High Strength Concrete is generally good which is to be mould in any shape and size, in this context the constituents of concrete is unlikely to get replaced by other material on account of its produce variability, uniformity, workability and economy. The Alccofine which is used of 0,10,20,30,40 and 20% and foundry slag content0,10,20,30,40,50,60 and 50% constant mix. Concrete sample of M80 grade using water/binder ratio 0.238, with various percentage of foundry slag and with optimum percentage of alccofine (15%) were casted and tested for compressive strength (CS), tensile strength (TS). And flexural strength (FS) development at the age of 7,28,56, days. In addition to find out the optimum content of Alccofine and foundry slag from mix proportion. Replacement of fine aggregates with upto50% of foundry slag showed an increase in compressive strength, tensile strength and flexural strength at all ages but showed a decrease in these properties with 50% of FD. Alccofine and foundry slag have highr compressive strength and Alccofine enhanced the durability of concrete is dispersion. Resulted suggested that reasonably high strength concrete can be designed by substituting fine aggregates with 10% to 50% of foundry slag and partial replacement of cement with 20% of Alccofine.

Keyword: - *Foundry Slag, Compressive Strength, Flexural Strength, Alccofine, Split Tensile Strength, Workability*

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1. INTRODUCTION

Production of cement stone of the reason which results in global warming due to CO_2 emission. Approximate 1.35 billion tons of greenhouse gas is contributes by global cement industry annually. Cement is utilized for construction at present time because of its need. Also if we drop the waste materials to the environment directly, it can cause environmental challenge to sort out the problem. So it needs to be attention that waste material should be utilized as per requirement as possible. Waste materials can be used to produce new products and also this waste can be used as admixtures. So that our natural resources can be used more efficiently and we can save environment from waste deposits. Concrete is hard, durable, and economically used in the field of civil engineering.

Thousands of kilo tons of waste from industry that is foundry slag (FD) is engendered every year in India and more than 95 % of which left unutilized. The unutilized waste slag is disposed in the form of landfills posing a harm to our environment. This may lead to the quandary of dumping waste of industry slag. Withal slag engendered from the smelting of scrap steel such as old cars contain toxins and dioxins, which becomes hazardous to our environment as well as the human health. Albeit industrial slag has some properties which makes it perfect for salutary use. The felicitous and maximum utilization of industrial waste foundry slag affects economical and environmental condition. The main constituents of Waste foundry slag are silicates, calcium alumina silicates and alumino silicates which makes a product that can be reused as an aggregate in concrete and can be superseded by natural conventional aggregate.

2. MATERIAL

2.1 CEMENT

Cement is a fine grey powder which is the best binding material for construction work. It is mixed with water and materials such as sand, gravel, and crushed stone to make a strong bond. Cement and water form a paste that binds the materials together and forms hard concrete. The ordinary cement contains two basic ingredients argillaceous and calcareous. The property of the argillaceous material is that here clay predominates and in calcareous materials, calcium carbonate predominates. Portland cement is manufactured by grinding together calcareous materials (limestone, chalk, marl, etc.) and argillaceous (shale or clay) materials in approximate proportion of 2:1 and other silica, alumina or iron oxide bearing materials together OPC is classified into three grades, namely 33 Grade, 43 Grade, 53 Grade depending upon the strength of 28 days. The grade indicates the compressive strength of cement at 28 days tested according to IS: 4031- part IV (Methods of physical tests for hydraulic cement)

Portland Pozzolana cement (fly ash based) procured from Grill-Infrastructure Ltd, Solan. Confirming to BIS-1489 is used. Physical Properties of Portland Pozzolana Cement are given in Figure-

Figure-1 Cement (OPC 35)

2.2 FINE AGGREGATES

The material which passes through 4.75 mm sieve is termed as a fine aggregate (IS 383-1970)

2.3 COARSE AGGREGATE

Normally, aggregates occupy 70% to 80% of the volume of concrete and have an important role in its properties. They are granular materials, derived for the most part from natural rock, crushed stone, or natural gravels and sands. In order to obtain the best concrete quality, aggregates should be hard and strong, free from impurities, and chemically stable. Broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in the present work.

Characteristics	**Value**
Colour	Grey
Shape	Angular
Maximum Size	20 mm
Specific Gravity	2.68
Fineness modulus	6.656

Table-1: **Properties of Aggregates**

2.4 FOUNDRY SLAG

Molding sand is foundry sand. First sand is moistened & compressed then oiled and heated and pack the soil normally and maintain its required shape. Foundry sand is also keep to casting of sand for preparing of mould cavity In this experimental study foundry slag used from the steel industry of Chambaghat Solan (Himachal Pradesh). As per BIS maximum size was taken as 4.75 mm & minimum will be 150 microns.

Fig -2 : Foundry Slag

2.5 ALCCOFINE

Alccofine 1203 is a slag based SCM contains high glass content with high reactivity and ultra- fineness from Ambuja Cement ltd. Specific gravity of alccofine1203 is 2.93. Alccofine 1203 used in this research conforms to ASTM C989-99. Physical and chemical properties of Alccofine are given in the tables 2 and 3.

Table -2 : Physical Parameters of Alccofine 1203

Specific gravity	Bulk Density (kg/m^3)	Particle size distribution (μ)		
		d 10	d 50	d90
2.8	600-700	1-2.1	4-5.5	8-10

Table -3 : Chemical Parameters of Alccofine 1203

CaO	Al_2o_3	SIO_2	Glass content
30-33 %z	22-25 %	32-35 %	>93%

3. MIX DESIGN

The mix design of concrete is generally defined by its particular compressive strength with desired workability as compressive strength is considered to be the index of quality of concrete. Workability is required to mix, place and compact the concrete properly. The proportions of various components of high strength concrete mix were calculated according to BIS: 10262-1982, 2009. As the IS code is silent about the mix proportioning of high strength concrete, some trials have been carried out along with use of IS codes to determine the mix proportioning of ingredients of high strength concrete.

In the present study, Mix Design for M80 (28 days characteristic compressive strength) grade concrete is prepared as per IS specification BIS: 10262-1982, 2009 with trial.

4. EXPRIMENTAL PROCESS

4.1 SLUMP TEST

The slump test was conducted in order to determine the workability obtained for RAC in comparison with the conventional concrete. The slump value was used as an indication of mix water/cement ratio and all the mixes were designed for 80-100mm slump value.

Figure-3: **Slump Test**

Table-4 : Slump variation with varying % age of FD

Foundry Slag Content FD(%)	Slump (mm)
CTR	189
F10	196
F20	193
F30	206
F40	202
F50	221
F55	229

4.2 COMPRESSIVE STTRNGTH

The compressive strength test results including some correction between yearly strength increases and the addition of silica fume. The compressive strength is affected by both the aggregate properties. The potential strength of concrete is related to mix proportioning such as cement content, water/cement ratio and choice of suitable aggregate, and proper curing when chemical bonding develops. The w/c ratio and curing give proper compaction, affect the development of concrete microstructure, and also affects the amount, distribution and size of pores. The bond that is developed in concrete becomes hard due to aggregate-paste bond, which is both physical and chemical. The main important parameter is that recycled aggregate concrete develops a weaker chemical bond with cement paste, and the chemical composition of the aggregate is different from commonly used natural aggregates. The re-bonding of some elements in cement paste residue can take place. The main important parameter of the aggregate affecting compressive strength is its shape, texture, maximum size and the strength of coarse aggregate.

Table-5: Variation of Compressive strength with variation of FD content (%) and age

Foundry slag content	Curing Age of Specimen in Days		
FD (%)	7 days	28 days	56 days
CTR	71.21	102.16	105.08
F10	72.59	102.72	106.20
F20	72.85	103.36	106.56
F30	75.69	103.72	107.27
F40	76.45	104.16	107.39
F50	80.24	108.27	110.92
F55	76.78	103.65	107.56

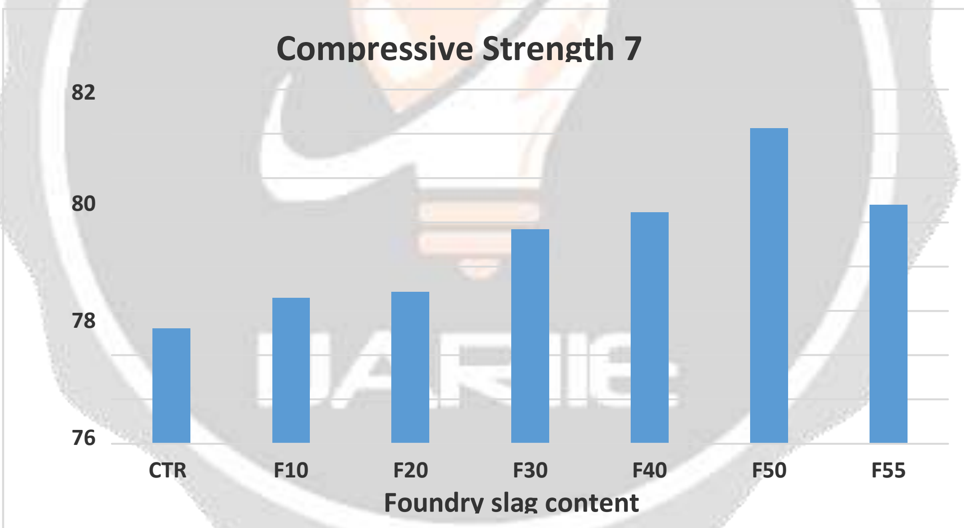

Figure-4: **Variation of CS with variation of FD content (%) after 7 Days**

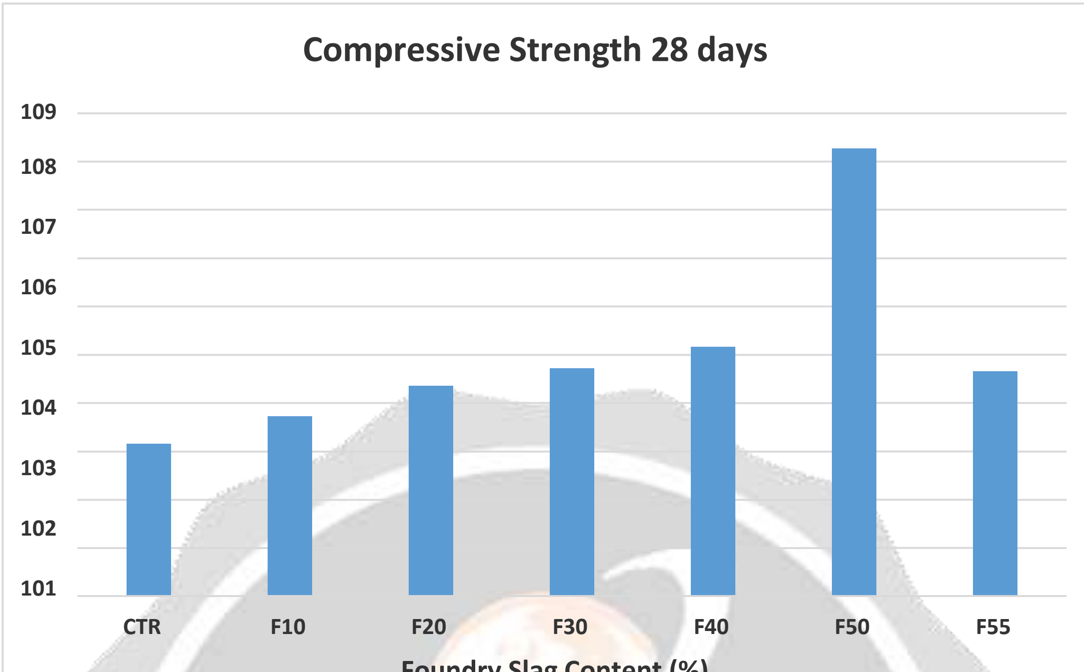

Figure-5: **Variation of CS with variation of FD content (%) after 28 Days**

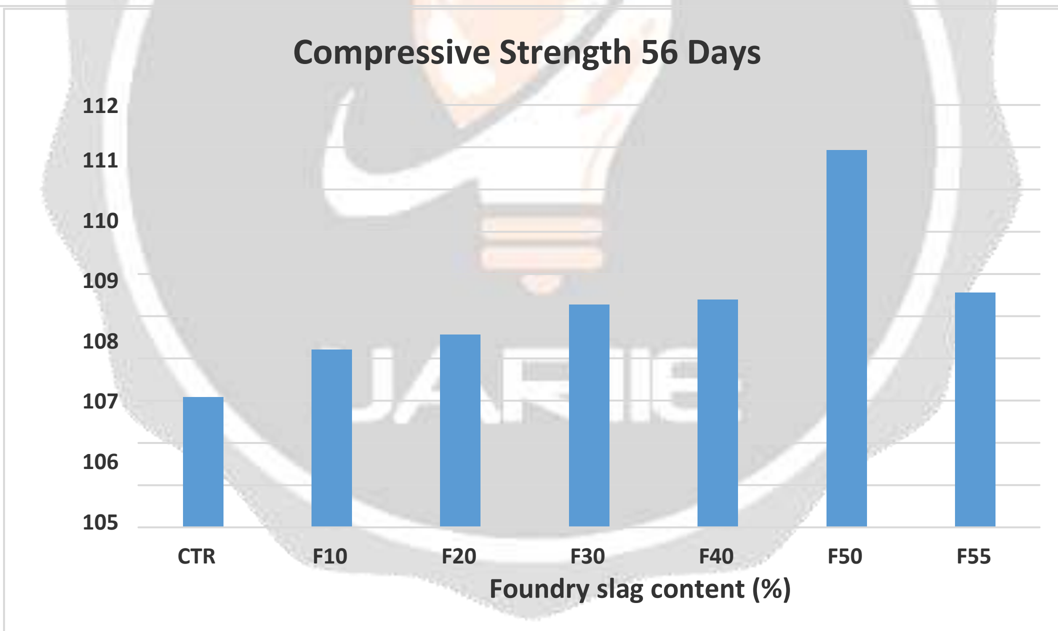

Figure-6: **Variation of CS with variation of FD content (%) after 56 Days**

4.3 SPILT TENSILE STRENGTH TEST

The test specimen results which are obtained from the split tensile test were carried out on 100 mm x 200 mm cylindrical samples for determining tensile strength which indicated that specimens F10-F55 exhibited more TS than CTR. Outcome of tensile strength (TS) test is same as that of compressive strength (CS).

Table 4.5: Variation of Split Tensile Strength with Variation of FD content (%)

Foundry slag content Slag (%)	Curing Age of Specimen in Days		
	7 days	28 days	56 days
CTR	5.64	7.28	8.27
F10	5.75	7.33	8.285
F20	5.78	7.39	8.295
F30	5.80	7.42	8.320
F40	5.82	7.46	8.340
F50	5.89	7.50	8.345
F55	5.79	7.38	8.290

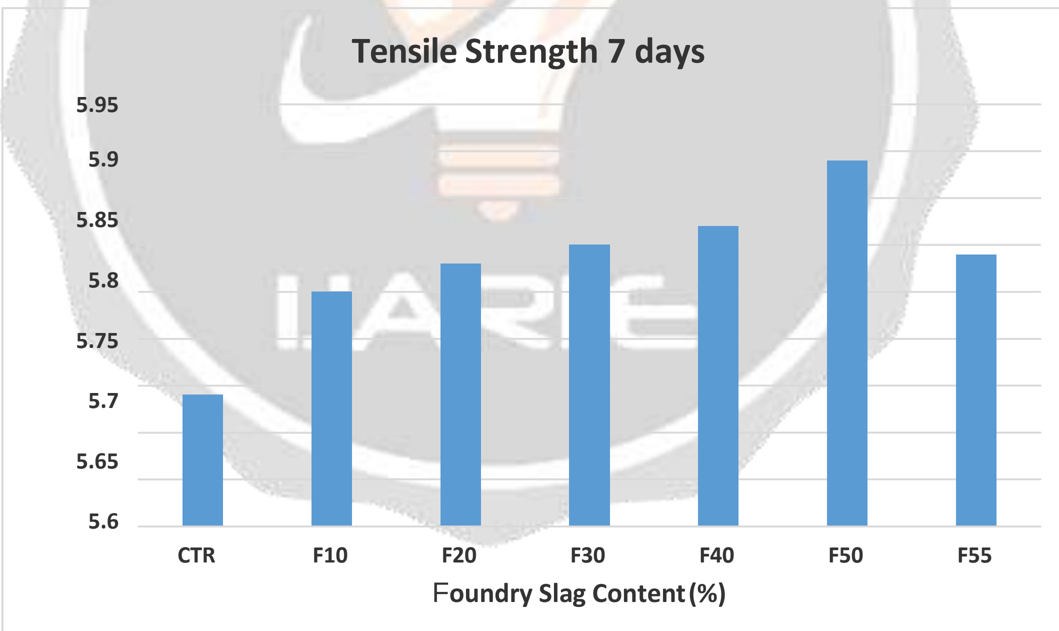

Figure7 : Variation of TS with Variation of FD content (%) after 7 Days

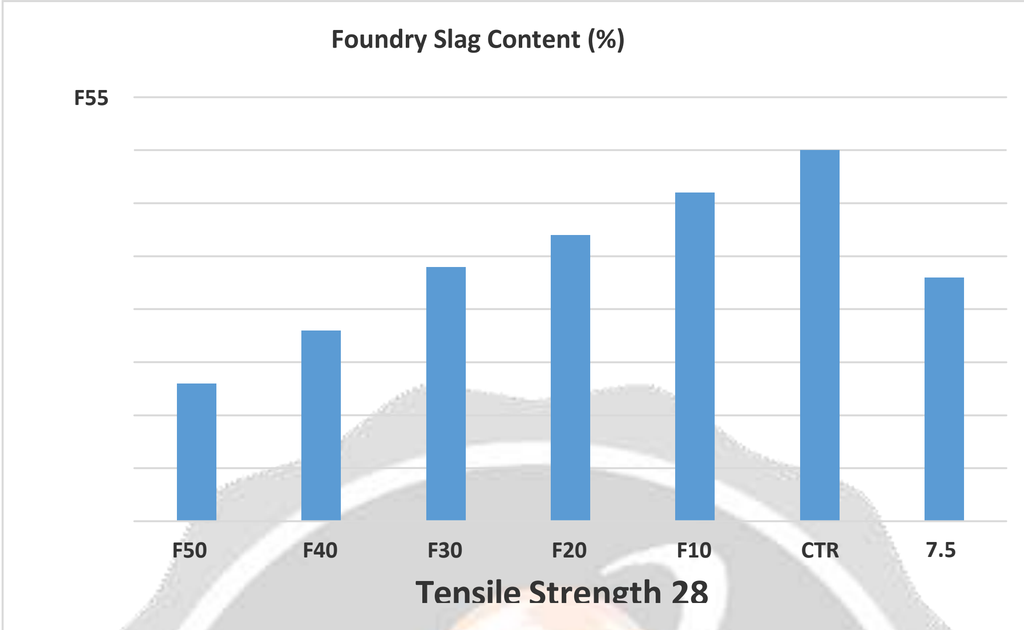

Figure 8: Variation of TS with Variation of FD content (%) after 28 Days

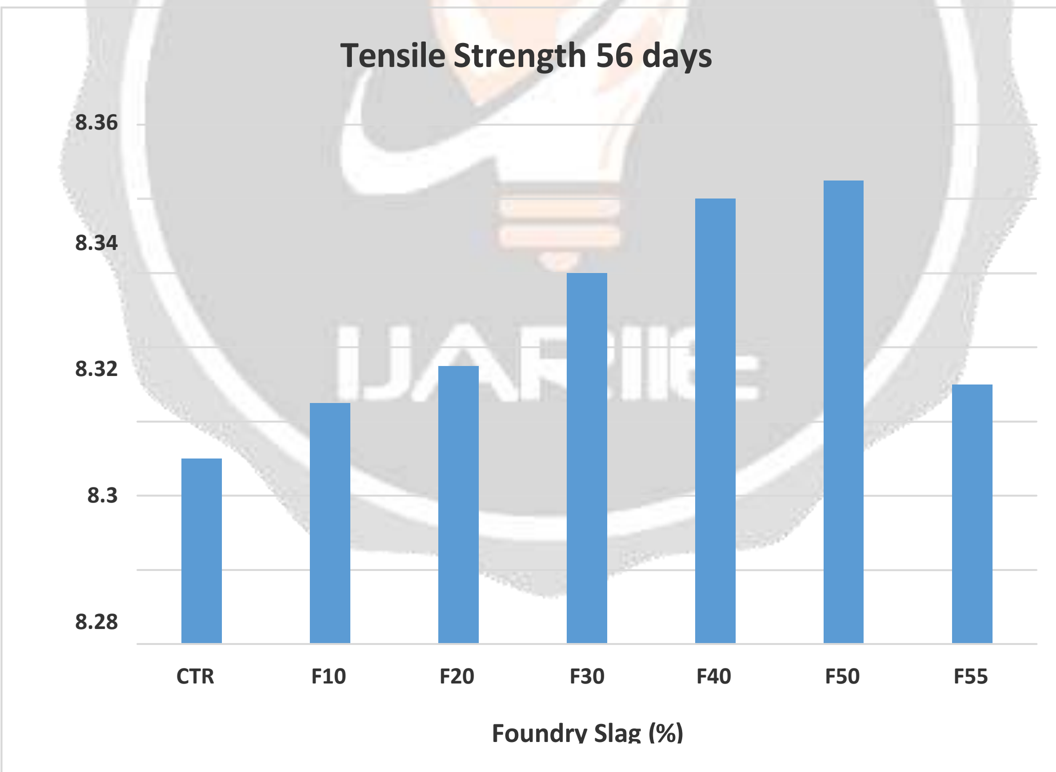

Figure 9: Variation of TS with Variation of FD content (%) after 56 Days

Table4.6: Variation of Flexural Strength with Variation of FD content (%) and Age

Foundry slag content	Curing Age of Specimen in Days		
FD (%)	7 days	28 days	56 days
CTR	8.92	10.37	11.198
F10	8.97	10.74	11.375
F20	9.15	11.590	11.376
F30	9.19	12.365	12.459
F40	9.45	12.366	12.60
F50	9.62	12.498	12.80
F55	9.12	11.038	10.328

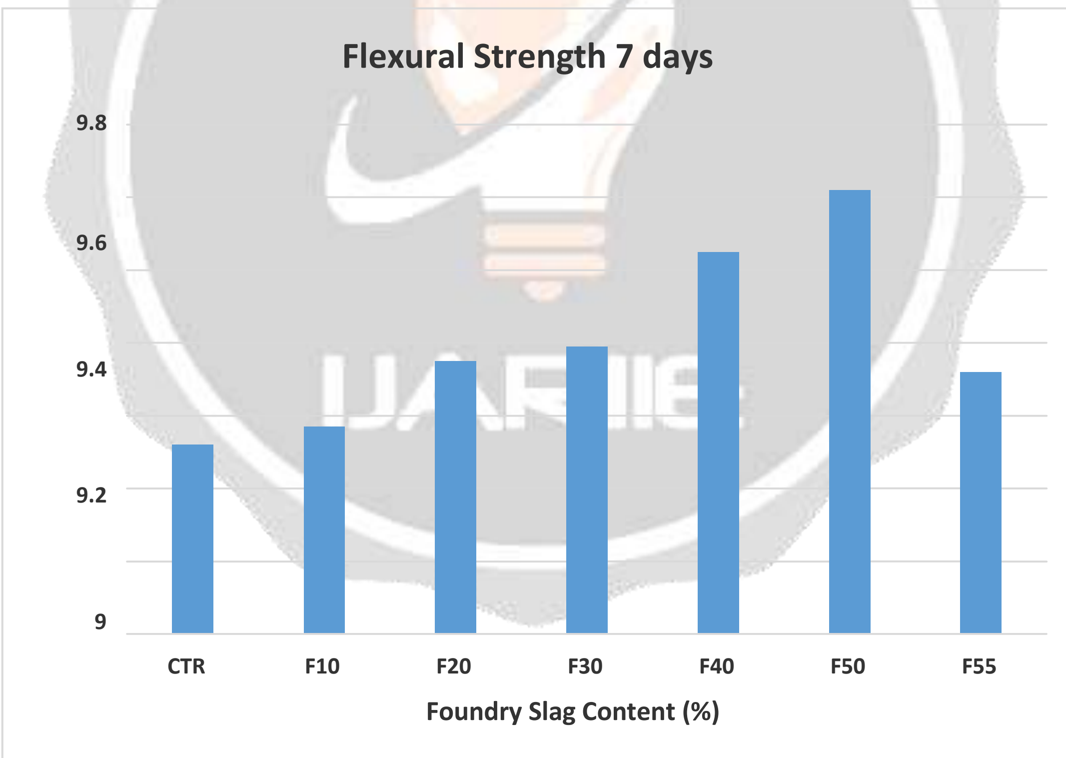

Figure 10: Variation of FS with Variation of FD content (%) after 7 Days

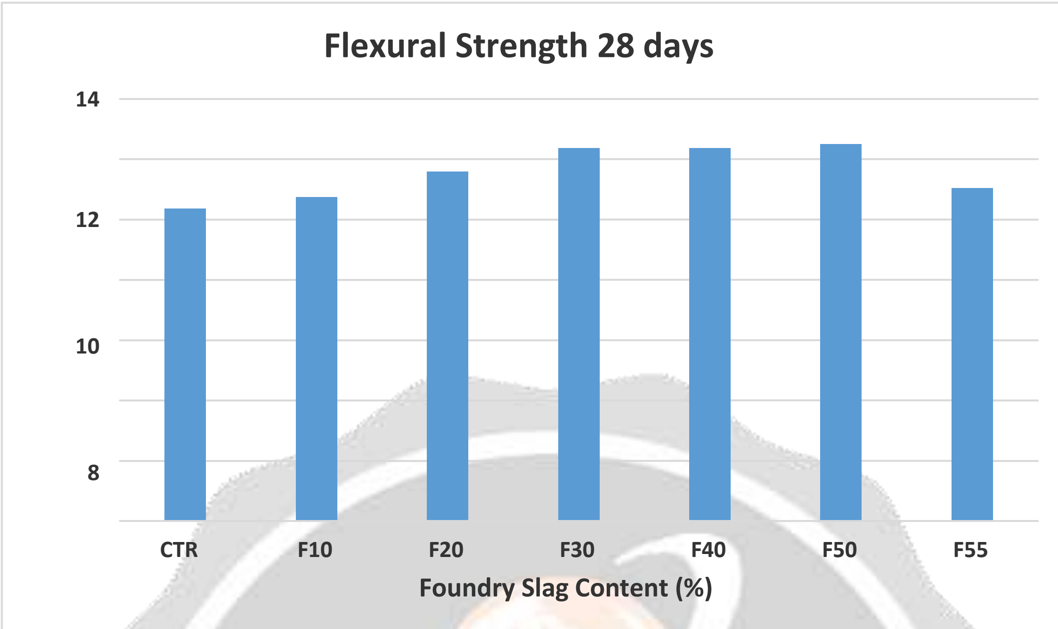

Figure 11: Variation of FS with Variation of FD content (%) after 28 Days

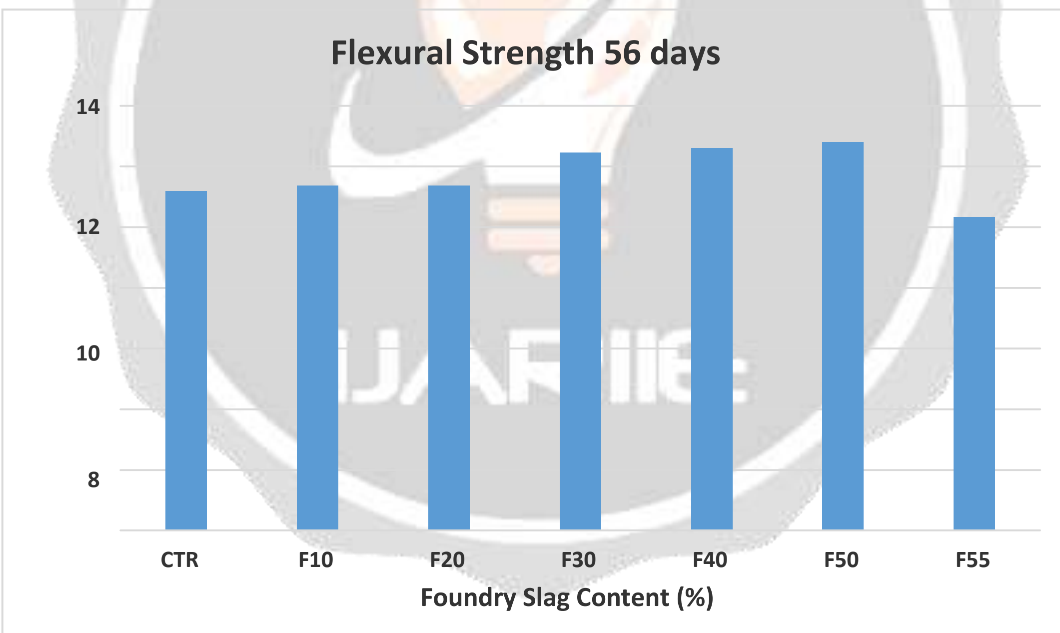

Figure 12: Variation of FS with Variation of FD content (%) after 56 Days

4. CONCLUSIONS

- Test results reported that there is rise in compressive strength, splitting tensile strength, flexural strength and impact strength for M80 grade of concrete mix with inclusion of waste foundry slag (FD) up to 50% replacement and 20% Alccofine in addition to PPC.
- CS, TS, FS of all experimental concrete mixes shown in normal consistence in strength with increase when we will increase curing age which signifies that there was no adverse effect of substituting FA with FD.
- Reduction in strength values of concrete at 55% replacement label was recorded but it can still be used.
- Failure pattern of specimens was found to be dumb-bell shaped with sound like blast. It has been found that specimens can take load even after fracture. Due to this property of high strength concrete made with foundry slag and Alccofine, this type of concrete can be used in earth prone areas and life can be saved at the time of earth quake, because time of full collapse of buildings will be increased.
- Results also showed increase in strength properties at 20% replacement of cement by Alccofine and 50% replacement of sand with waste foundry slag

5. REFERENCES

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