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Performance of Sustainable Concrete Containing Fly-ash and Iron-slag

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Abstract

Concrete is the world's most consumable man-made construction material. Next to water, concrete is the most used material that needed massive quantities of Ordinary Portland cement. Ordinary Portland cement production is that the second after to the automobile the major generator of the carbon-dioxide compound, that impure the atmosphere. Additionally, to it, a great amount of energy was additionally consumed for the cement production. Hence, it's inevitable to seek out a different material to the existing most expensive, most resource intense Portland Cement. Fly- Ash, a by-product of coal obtained from the thermal power plant is lots accessible worldwide. Fly-ash is wealthy in silicon dioxide and alumina reacted with Ordinary Portland Cement particles and form a gel that acted the binding material for the concrete. Also, GGBS is added which is also a by-product of iron industries and have good cementing properties. It is formed in abundance as waste material, therefore it may be used in construction purpose to overcome its harmful effects on environment. In the current study, Fly-ash is used as partial replacement of cement where-as Iron Slag is used as partial replacement of fine aggregate (sand). Cement was replaced by following percentages of fly-ash 6%, 12% and 18%, and fine aggregate was replaced by following percentages of iron-slag 15%, 30% and 45%. The tests like compression test, split tensile test and flexural test was done on hard concrete and workability (slump) test was also done fresh concrete.

CHAPTER _ 1
INTRODUCTION
1.1 GENERAL

The popular well-known construction substance on this planet & is one of having significant insurgencies ever is Concrete. Numerous surprising landmarks were manufactured utilizing concrete. It contains cement (binder), fine aggregate (void filler) and coarse aggregate (quality imparter).

A strong mass that can be effortlessly shaped into a wanted mould could be framed as blending the fixings in some extents. After some time a strong lattice-shaped by bond ties whatever remains of the fixings together into a solitary hard (inflexible) solid material with numerous utilization, for example, structures, asphalts and so forth., The innovation of utilizing concrete was received before on a substantial scale by the antiquated Romans, and the real piece of solid innovation was very consumed in the Roman Kingdom. Colosseum in Rome were built majorly by of concrete, also the Pantheon Arch is the Planet's biggest un-reinforced bond structure. when the Roman Kingdom in the mid 18 century, this innovation were re-introduced by utilizing cement become turned out to be uncommon. Today, the broadly utilized man-made material is concrete in terms of tonnage.

Now a day in the present situation the natural resources are being depleted to fabricate the solid wilderness. Before natural resources are totally exhausted, it is smarter to pick other alternative resources

for cement, fine aggregate and coarse aggregate. There are numerous alternative resources like fly ash, marble powder, waste ceramic tiles and so forth, in this context, it's smarter to pick the locally accessible materials for substitution.

However, the generation of cement has reduced the limestone holds on the planet and requires an extraordinary utilization of energy. River sand has been the most well-known decision for the fine aggregate part of concrete previously, however abuse of the material has prompted natural concerns, the draining of securable stream sand stores and an attendant cost increment in the material. In this way, it is attractive to acquire modestly, ecologically inviting substitutes for cement and river sand that are preferably by-products.

1.2 HISTORICAL BACKGROUND

The date when concrete were created is depended upon the one's interpretation of the expression 'Concrete'. Early substances was unrefined cement formed by pounding & consuming limestone or gypsum. Lime is referred also as crushed, smashed, consumed Limestone. Whenever water & fine aggregate is subjected to this cement, it become paste, this paste substance was used to hold other materials like bricks, stones with each other. After a decade, that substances were enhanced, joined to different substances at last, transformed as current Concrete.

Now a days concrete were formed by utilising OPC, Fine Aggregates & Coarse Aggregates and Water. Chemicals called admixtures were also mixed with it, to enhance it's properties during normal temperature, also used during harsh climatic conditions like high temperature, low temperature, acidic conditions, etc.

First concrete resembles building was build by the Nabataea who lived and having a chain of watering site and developing a kingdom in the areas of south Syria and north Jordan in approximately 6500 BC. At that time they subsequent discover the benefits of lime i.e., the cement which gets solid shape upon curing & in 700 BC, they start making kilns to distribute mortar to the constructing of stone-wall, floorings, houses and under-ground water-proof reservoir.

1.3 GREEN CONCRETE

Green concrete is absolutely a new advanced topic in the record of concrete and comes in the world by Dr. W.G In 1998.

Concrete that is formed by utilising the wastes which do not have any harmful impact to environment is referred to 'Green concrete'. Green Concrete may be given much consideration at the time of mix design and when placed in moulds to have good quality and have low maintaince and which is energy saving. Also it should release low quantity of CO2 and it should not waste water.

CHAPTER - 2
LITRATURE REVIEW

The literature review is written on the basis of various researches done by the different researchers. The various industrial wastes used by different researchers are as follows:

Merien Senani, Noureddine Ferhoune [1] replaces fine aggregate (sand) by iron slag in ordinary concrete partially or completely and the mechanical properties of concrete were tested and compared with ordinary concrete. The result shows great impact on the mechanical properties of concrete and it is suggested to use iron slag for the production of concrete.

Ahmad S. Ouda, Hamdy A. Abdel-Gawwad [2] study the effect of iron slag on replacing sand from ordinary cement mortar. The percentages of replacement of sand are as 0%, 40%, 80% and 100% by

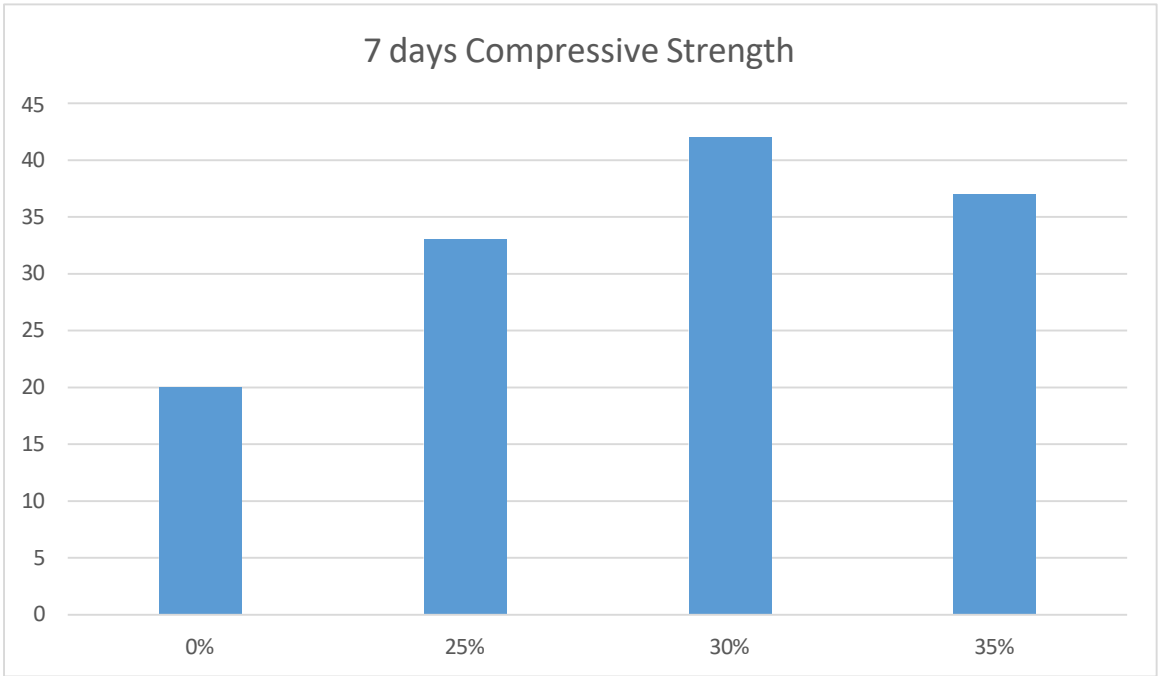
weight by iron slag. The result show increment in strength properties.

Gurpreet Singh, Rafat Siddique [3] study the effect of iron slag on various properties of self-compacting concrete (SCC) like compressive strength, rapid chloride permeability, water absorption resistance to sulphate attack up to 365 days. Fine aggregate was replaced at following percentages of iron slag 0, 10, 25 and 40 %. Results shows concrete gives better strength and iron slag is suitable to be used in concrete in place of sand.

Isa Yuksel [4] suggests the use of iron slag in concrete because of the better workability and high strength as compared to normal concrete. Up to 50% iron slag can be used in concrete and the early strength of concrete is low if we compare it normal concrete but the results after 28 days or more are much higher than the normal concrete.

Erdogan Ozbay, Mustafa Erdemir and Halil Ibrahim [5] make a review on the usage of iron slag (GGBFS) in concrete and mortar. For that they have reviewed about 100 papers, and suggests that the use of iron slag in concrete increases its workability and enhancing the long term compressive strength. Also the unit cost of concrete is decreased, improved abrasion resistance and increase in flexural strength.

Anil Singh, Arjun Kumar [6] study on the partially replacement of fine aggregate (sand) by iron slag in concrete at the various percentages like 25% and 30%. The concrete casted were
tested after 28 days. The compressive and split tensile strength were increased by 4kn and 2kn respectively at the percentage of 30%.



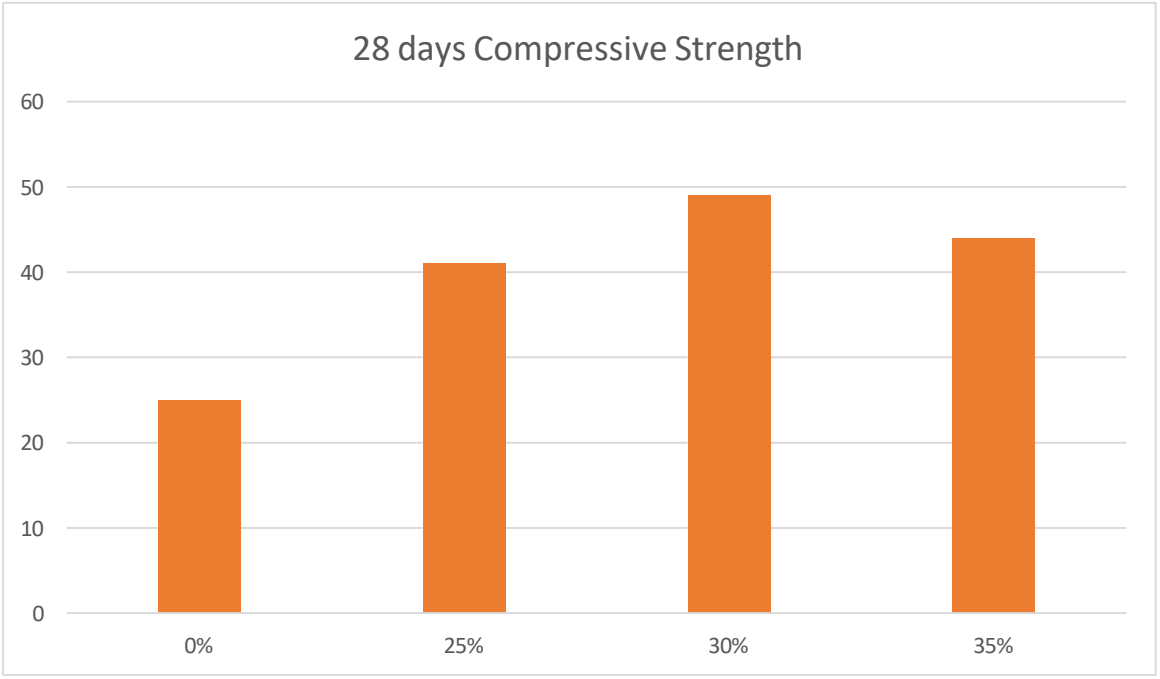


Chart no. 01

Rafat Siddique [7] study the performance characteristics of class F fly-ash in concrete. Normally utilisation of fly-ash in concrete is 10 to 15% but he does experimental investigation on further increment of percentages. For this cement was replaced at different percentages like 40%, 45% and 50%. The casted concrete was tested by different tests like compressive test, split tensile test, flexural test, air content and abrasion resistance. The results shows decrease of strength at 28 days tests but after 91 days the strength increase up to 365 days.

A.Oner, S. Akyuz and R. Yildiz [8] make a study on the concrete containing fly-ash and find the optimum usage of fly-ash in it. Cement was replaced partially by fly-ash at following percentages 15%, 25%, 33%, 42%, 50% and 58%. All casted cubes were tested after 28 and 180 days and the optimum usage of fly-ash was obtained which is 40% by using Bolomey and Feret strength equations.

Harun Mallisa and Gidion Turuallo [9] investigates the maximum fly-ash percentage to replace cement for the formation of high strength concrete. The water-cement ratio taken in this study is 0.30. The cement was partially replaced by following percentages 0, 10, 15, 20, 25 and 30% and super plasticizer used was Naptha 511P. Best result (compressive strength) was obtained at 25% replacement of cement by fly-ash.

Dr. K. Ganesh Babu and G. Siva Nageswara Rao [10] make an effort to understand the efficiency of fly-ash in concrete, in consideration of water-cement ratio, age and replacement percentage. The efficiency of fly-ash were evaluated after 7, 28 and 90 days were found to be 0.3, 0.5 and 0.6 respectively.

CHAPTER - 3
SCOPE AND OBJECTIVE OF STUDY
3.1 SCOPE OF STUDY

The current study deals with the usage of fly-ash and iron-slag in concrete in place of cement and fine aggregate respectively for the formation of sustainable concrete. As we know now-a-days there is need of

alternative for cement as its production produces green-house gases which effects our environment drastically. As a civil engineer it's our responsibility to find a better alternative for it, and fly-ash is better option as it is available in abundance and is a waste material which is of no use. Researches have been done from years to find its best percentage up to which cement can be replaced from concrete. In this study, the cement was replaced by fly-ash at three percentages.

Also fine aggregate was replaced by iron-slag at three percentages, in order to find the optimum value for its usage in concrete. As the natural sand is depleting day-by-day, so here is need to find an alternative to sand and iron-slag as a waste material is better option for that.

The cement industry doesn't work the up to date image of a property industry as a result of it consumes raw matter and energy that are not reversible, got its raw matter by mining and making a object that are not able to be recycled. Through the utilizing waste products of thermal power plants, chemical units and steel factory, energy employed in the assembly is significantly reduced. By doing this the prices of raw matter, energy billing and moreover greenhouse gas quantity gets reduced. In the method, it will take out the wastes, like fly-ash and iron-slag into valuable concrete product.

3.2 OBJECTIVES OF STUDY

- To check the effect on strength properties of concrete by the substitution of fly-ash and iron-slag in it.
- To find the best percentage of fly-ash and iron-slag for their use in concrete.
- To find an alternative to OPC and fine aggregate.
- To decrease production of carbon dioxide, make eco-friendly binder.
- To utilise wastes materials as much as possible in order to protect environment from damage.

CHAPTER - 4
MATERIALS AND PROPERTIES

The present study focuses on maximum usage industrial wastes like fly-ash (F A) and iron-slag (G G B F S).

4.1 SELECTION OF MATERIAL

Concrete is comprised of three fundamental parts: water, aggregate and O P C. O P C is usually in the form of powder and is solely responsible for binding other aggregates in presence of water.

4.1.1 CEMENT

Cement used in this project was 43 grade OPC. Cement which is the main bonding agent which solidifies along with the mixed ingredients in presence of water and is also the most powerful building matter. It is usually in powdered form and is consumed to bind bricks or stones or tiles etc.

4.1.2 WATER

Water as important for our life, is also essential for the concrete. Without water we are not able to make such huge buildings and so on. When water is mixed with aggregate and cement a reaction takes place known as hydration, so then it solidifies to the desired matter and moulds. All concrete strength and durability properties and directly and indirectly controlled by amount water such as compressive, shrinkage, workability, etc.

So water is as important for concrete also for service life of it.

4.1.3 AGGREGATES

It is necessary to consume the good and best aggregates in concrete matrix as nearly about 75% volume is occupied by the aggregates present in matrix. It also have great influence on the distinct properties of concrete, and on the both fresh & hard properties of matrix. Hence they should be selected carefully.

4.1.3.1 Fine Aggregate

This type of aggregate is mainly consists of natural sand like river sand or crushed sand made by crushing of rocks with particle size lesser than 5mm.
Itz chemical composition is as:

Table no. 01

Constituents	Percentage (%)
Lime	67
Silica	25
Alumina	8
Iron Oxide	6
Magnesia	4
Sulphur Trioxide	3

Whenever cement and water comes in contact, hydration reaction takes place and then a paste is formed which solidifies and form the hard matter.

4.1.2 WATER

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Itz chemical composition is as

Table no. 02

Chemical Composition	Percentage (%)
Loss on Ignition	43.83
SiO_2	0.77
Al_2O_3	0.11
Fe_2O_3	0.36
CaO	54.71
MgO	0.21
SO_3	Nil

4.1.3.2 Coarse Aggregate

It usually consists particles of size larger than 5mm upto 40mm, made up of rocks or gravel. Rocks, boulders, furnace slag, etc are grinding in the needed sized particles. It comprises about 65% volume of total concrete matrix.

For this project 10mm and 20mm size coarse aggregates were used.

4.2 DIFFERENT ALTERNATIVE MATERIALS

A lot of alternate waste materials were produced by many manufacturing industries may become a potential source of being an alternative to the cement, fine aggregate, and coarse aggregate.

In this project, cement is partially replaced by fly-ash and fine aggregate is partially replaced by iron-slag.

4.2.1 FLY ASH

The fly-ash used in this project is class F fly-ash and was collected from local Ready Mix Plant and its colour was Grey.

F A the foremost extensively consumed external building matter in concrete & is a by-product on ignition of fine coal in electrical power creating plants. When ignited within the chamber, most of the matter and carbon present in coal are burned off. While combustion, the impurities present in the coal fuses with the suspension chamber and are then taken away by gases. Through this method way the fused matter cools and hardens to become spherical particles called as flyash. The F A is at lost gathered from that chamber by bag filters.

F A seems to be powdered form and matching with OPC in form but is finer than it, mostly itz particles are spherical in shape. Their size may vary from 1nm - 100µm with the standard particle size measurement underneath 20µm. Class F are typically low-Ca F A with C content lesser 5 percent. Class C usually have higher Ca F A with carbon contents lesser 2 percent.

Figure no. 01

4.2.1.1 PHYSICAL PROPERTIES OF FLY-ASH

Table no. 03

Parameters	**Fly Ash**
Density	2.17g/cm^3
Bulk density	1.26g/cm^3
Moisture content	2%
Particle Shape	Spherical/Irregular
Colour	Grey

pH	6 – 10
Specific gravity	1.66 – 2.55
Grain size distribution	Sandy silt to silty loan
Porosity	45 – 55%
Water holding capacity	45 – 60%

4.2.1.2 CHEMICAL PROPERTIES OF FLY-ASH

Table no. 04

Contents	**Percentage by mass**
Calcium oxide	5.6
Silicon dioxide	55.3
Aluminium oxide	25.70
Iron oxide	5.3
Magnesium oxide	2.1
Sulphur trioxide	1.4
Potassium oxide	0.6
Titanium dioxide	1.3

4.2.2 IRON-SLAG

Iron-slag used in this project was collected from local Iron and Steel Rolling Mills, Mandi Gobindgarh, Punjab. It was black in colour.

G G B F S, also called iron-slag, is built by iron blast-furnace slag. It is not metallic binder usually contains majorly of silicates & alumina-silicates of Ca build in a liquid state at the same time accompanied during a kiln. The liquefied dross at high temperature regarding 1500°C, & apace cooled by ending by water to create a glass sand like coarse matter. The coarse matter, then is gridding to smaller sized 45 microns, having fineness of about 400 - 600 m2/kg. The denseness (s g) for gridding coarse kiln dross is within the variety of two 0.85 to 2.95. The bulk density of ground granulated blast furnace slag ranges from 1050 - 1375 kg/m3.

Figure no. 02

4.2.2.1 PHYSICAL PROPERTIES OF IRON-SLAG

Table no. 05

Parameters	**Iron-Slag (GBBFS)**
Physical form	grey powder
Bluk density (kg/m^3)	1200
Specific gravity	2.89

4.2.2.2 CHEMICAL PROPERTIES OF IRON-SLAG

Table no. 06

Contents	**Percentage by mass**
SiO_2	6.98
Al_2O_3	2.94
Fe_2O_3	68.88
CaO	0.8

CHAPTER - 5
RESEARCH METHODOLOGY

In this study various tests will be done on the materials like fly-ash, GGBFS, fine aggregate and coarse aggregate to determine the various properties of material, and to determine whether they should be used in this project work, mix design and concrete casting.

5.1 CEMENT

5.1.1 Specific Gravity Test Apparatus Required

Le Chaterlier"s flask, Weighing balance, Diesel oil and Weighing Balance

Figure no. 03

Method for Specific Gravity

- The flask is allowed to dry utterly and created free from liquid and wetness. the load of the empty flask is taken as W1.
- The bottle is stuffed with cement to its 0.5 (Around 50gm of cement) and closed with a stopper. The arrangement is weighed with stopper and brought as W2.
- To the present diesel oil is another to the highest of the bottle. The mixture is mixed totally and air bubbles are removed. The flask with diesel oil, cement with stopper is weighed and brought as W3.
- Next, the flask is empty and stuffed with diesel oil to the highest. The arrangement is weighed and brought as W4.

Calculations:

W1 = 111gm, W2 = 161gm, W3 = 358.8gm and W4 = 357.9gm

Specific Gravity of Cement Sg is given by the formula,

= (W2-W1)/((W2-W1)-(W3-W4)*0.829)

= (161-111)/((161-111)-(399-358.8)*0.87)

= 3.15

5.1.2 Fineness Test Method for Fineness test:-

- First of all take a cement sample of 100g weight.
- Now we sieve this cement sample by using 90 micron sieve.
- We sieve it for 20 minutes and then weight of retained sample.
- The retained weight should be less than 10% of weight.

Table no. 07

Work	Result
Weight of sample before sieve	100g
Weight retained	5g
Percentage retained	<10%

5.3 Consistency Test:-

order to find initial setting time, final setting time, soundness and strength of cement, a rameter is used called as “Vicat Plunger”. The diameter of needle and height is 10mm and mm respectively. This is used to find the water content needed to make a cement paste of ndard consistency.

ethod for Consistency test:-

- Take a cement sample of 250gm.
- Add 28% of water as first trail.
- Remove all air voids from the sample.
- Now, release the plunger and measure the depth of perimeter from bottom.

Table no. 08

Sample	Water	Depth
28% of 250g	70ml	23.8mm
30% of 250g	75ml	18.9mm
32% of 250g	80ml	12.3mm
34% of 250g	85ml	7.8mm

Therefore the consistency of cement is 34%.

5.1.4 Initial Setting Time test:-

Initial setting time is that time measurement from adding water to cement upto it loses its plasticity.

Method for Initial Setting Time test:-

- Take sample of weight 500g.
- After finding is consistency, now see the penetration of needle from 33mm to 35mm, from the top.
- This time of penetration is known as initial setting time.

Table no. 09

10 Min Gap Time	Penetration
0 to 10	3mm
10 to 20	4.7mm
20 to 30	6mm

Therefore the initial setting time of cement is 30 minutes.

5.2 AGGREGATE

5.2.1 Fine Aggregate

Fine aggregate is one of the most important part of concrete mixture. This also called as sand and is obtained mostly from marine.

5.2.1.1 Specific Gravity Test

Specific Gravity is that a quantitative relation of weight of a given vol. of aggregates / weight of equal vol. of water. Itz utilised to know the strength and quality of the current matter. Aggregate which shows low relative density area unit typically weaker than those with higher relative density values.

Apparatus Required

- A estimate of capability concerning 3kg, to weight correct 0.5g, and in a sort and form on allow

advisement of the taken matter instrumentality once hanged in water.

- A thermostatically controlled kitchen appliance to keep up temp. at 100-110° C.
- A perforated drum of pores size less than 6.3 mm perforated instrumentality of agreeable size with skinny wire hanged to support it in one position.
- An instrumentality for pouring water and hanging the drum.
- A vacuum having no air instrumentality having capability just like of used drum.
- A empty not too deep receptacle and 2 absorble garments, min. size of 75x45cm.

Method

- Immediately when immersed the present air is off the trail with the raising the drum of twenty five millimetre on top of the bottom of the chamber and allowing it to move down at the speed of only one drop per second. drum and mixture allowed to rest fully immersed in water for a amount of twenty four hour after.
- The drum and therefore the trial are weighted whereas hanged in water at a temp. of 32°C. the load whereas hanged in water were written as = W1.
- The drum and aggregate are taken off from water and permited to empty for a number of min., when that aggregate are placed to the dry absorbable garments. The empty drum were came to the vessel of water tampered twenty five times and weight is taken in water as= W2.
- The agg. rested on absorbable garments having upper face dry until no additional wetness can be taken off by that fabric. Then these agg. were referred to the 2nd dried fabric unfold in one layer and permitted to dry for a minimum of ten minutes till the agg. are fully surface dried. The face dried mixture is now weighted as= W3.
- The agg. were rested during a exceedingly low deep receptacle and unbroken in an kitchen appliance controlled at a temp. of 110° C for twenty-four hrs. it's now off from the kitchen appliance, cooled down in an vacuum instrumentality and weighted as=W4.

Table no. 10

Weight	Sample	Quantity
W1	Wt. of pycnometer	645gm
W2	Pycnometer+sand +water	1845gm
W3	Pycnometer+water	1510gm
W4	After 24 hrs.	550

Formulae

- S G = **W4**/ (**W4**– (**W2**– **W3**))

= 550/(550-(1845-1510))

= 2.59

5.2.1.2 Sieve Analysis

It is done to come know the particulate size dispersal of aggregates. Its is performed as per IS 2386 part 1- 1963, during it we have a tendency to use completely distinct sieves as per IS code book and allow the various aggregates to move via them & therefore gathered at distinct sized sieves.

Apparatus Required

Group of IS Sieves of sizes – 80, 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10, 6.3, 4.75, 3.35, 2.36, 1.18mm, 600, 300, 150 and 75µm.

- 0.1 % is allowed for the accuracy of the load of the check trial.

Figure no. 04

Method

- The check trail is dry to a continuing weigh at a temp. of 110 + 5^0 C & weighted.
- Now trail is sieved by employing a set of IS Sieves.
- When the sieving is done the matter on each sieve retained is weighted.
- Now all weight moved via every sieve is estimated as a proportion of the entire trail weigh.
- F M were estimated by adding entire proportion of aggregate maintained on every sieve and division the total by 100

In tabular form we have:

Table no. 11

Sieve size	Wt. retained (gm)	% retained	Cumulative wt. retained	Cumulative % retained
4.75	1	0.059	-	-
2.36	1	0.06	1	0.06
1.18	1.45	0.80	2	12
600 micron meter	1	0.061	17	0.921
300mm	1	0.061	17.9	0.97
180 mm	641	33	19	1.1
90mm	845	43	660	33.1

75 mm	491	25	1510	75.6
			1999	100.04
				211.8

Calculations:

Fine modulus = 211.8/100

= 2.118

5.2.2 Coarse Aggregate

In this project here 10mm and 20mm aggregates were used.

5.2.2.1 Specific Gravity:-Method

- Calculate the weight of basket in air/ water.
- Weight of basket and aggregate In water.
- Weight of aggregates after 24hr.

Table no. 12

Weight	Sample	Quantity
W1	Basket in water	3320gm
W2	Basket in air/water	845gm
W3	Wt. before oven dried	3986gm
W4	Wt, after 24 hrs.	3982gm

Calculation:

Specific gravity = W3/(W4-9W1-W2))

= 3986/(3982-(3320-845)

= 2.64

5.3 MIX DESIGN

M25 grade of concrete is used for this project work and the design of M25 grade is as follows:

1. Target strength for mix proportions: Fck = fck + 1.65*S

Where, **S = 4.0,** is Standard deviation for **M25**, from table no. 1 of **IS:10262:2009, fck = 25,** is the grade of concrete.

Therefore, Fck = 25 + 1.65*4.0

= 31.6N/mm^2

Is the target strength of M25 grade.

2. Selection of Water/Cement ratio:

From table no. 5 of **IS:456**, Maximum Water/Cement ratio = 0.50, for exposure considered as moderate.

From graph no. 1 of **IS:10262:1982**, water/cement ratio taken for work = 0.44 Therefore **W/C = 0.44**

3. Selection of Water Content:

From table no. 2 of **IS:10262:2009,** maximum water content for maximum aggregate size 20mm = 186 kg.

Slump 50 – 75mm and departure = +- 3,

Therefore estimated water content = 186 + ((3/100)*186)

= **191.58kg/m^3**

4. **Calculation of cement Content:** Water/ Cement ratio + 0.44 Cement Content = 191.58/ 0.44

= 435.409kg/m^3 Therefore cement content **= 435.409Kg/m^3**

From table no. of **IS:456**, minimum cement content for moderate exposure condition = 300kg/m^3

Since, 435.409 Kg/m^3 > 300 Kg/m^3 ..ok

5. **Estimation of Mix Ingredients:**

a) Volume of concrete = **1m^3**

b) Volume of cement = **0.139m^3** [after calculations]

c) Volume of water = **0. 192 m^3** [after calculations]

d) Volume of all aggregates = a – (b + c)

= 1 – (0.139 + 0.192)

= 0.66m^3

6. **Mass of Fine Aggregates:**

Mass of fine aggregates = d * Vol. of fine aggregate * specific gravity of fine aggregate * 1000

= 0.669 * 0.37 * 2.59 * 100

= **641.1 kg**

7. **Mass of Coarse Aggregates:**

Mass of coarse aggregates = d * Vol. of Coarse aggregate * specific gravity of coarse aggregate * 1000

= 0.669 * 0.063 * 2.64 * 1000

= 1112.6 kg

8. **Mix Proportions:**

Table no. 13

Cement (kg)	Water (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)
435.409	191.58	641.1	1112.6
1	0.44	1.472	2.555

CHAPTER - 6
RESULT AND DISCUSSION
6.1 FRESH CONCRETE (grade M25)

Following test will be done on Fresh concrete:

1. Slump Test

Slump Test / Workability Test:

Slump check is employed to see the workability of recent concrete. Slump check as per IS: 1199 – 1959 is performed. The equipment utilised in order to do slump check are Slump cone and rod.

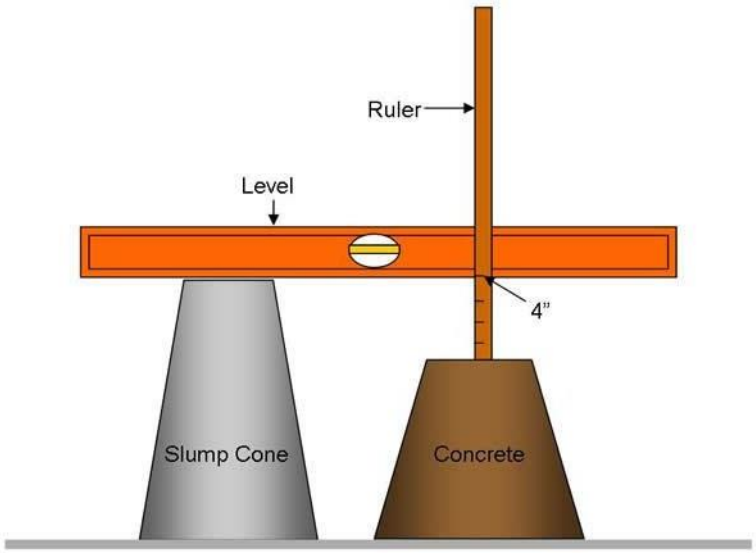


Figure no. 05

Method

- The inside all over of the mould is totally cleaned and a light-weight coat of oil is done.
- Now this container were rested on a smooth, plane and non-absorptive flooring.
- The cast is now poured in 4 levels with new concrete.
- Every single covering is compacted twenty five times by the rod end of the tamping rod equally via out area.
- Once the top covering is tamped, the concrete is stricken off the extent by trowel.
- The cast is off from the concrete right away by hanging it slowly in the upward direction.
- The distinction in between the upper most of cast and the top face of concrete in height in mm is slump of that matter.

Table no. 14

Serial No.	W/C ratio	Percentages of FlyAsh	Percentages of IronSlag	Slump Values
1	0.44	0%	0%	108
2	0.44	6%	15%	115
3	0.44	12%	30%	110
4	0.44	18%	45%	96

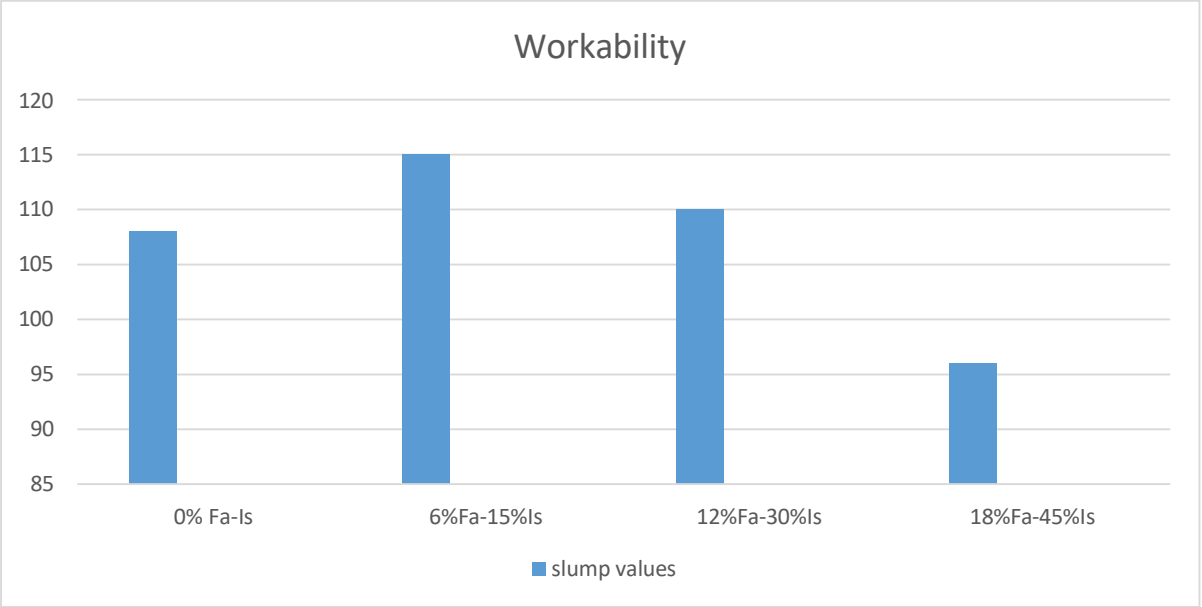


Chart no. 02

Figure no. 06

Result:-

Slump values of varies percentages of Fly-ash and Iron-slag are in following table:

Density of Cubes:- The cubes used in the project work are of size 150mm*150mm*150mm. The weight of cubes were taken for finding density.

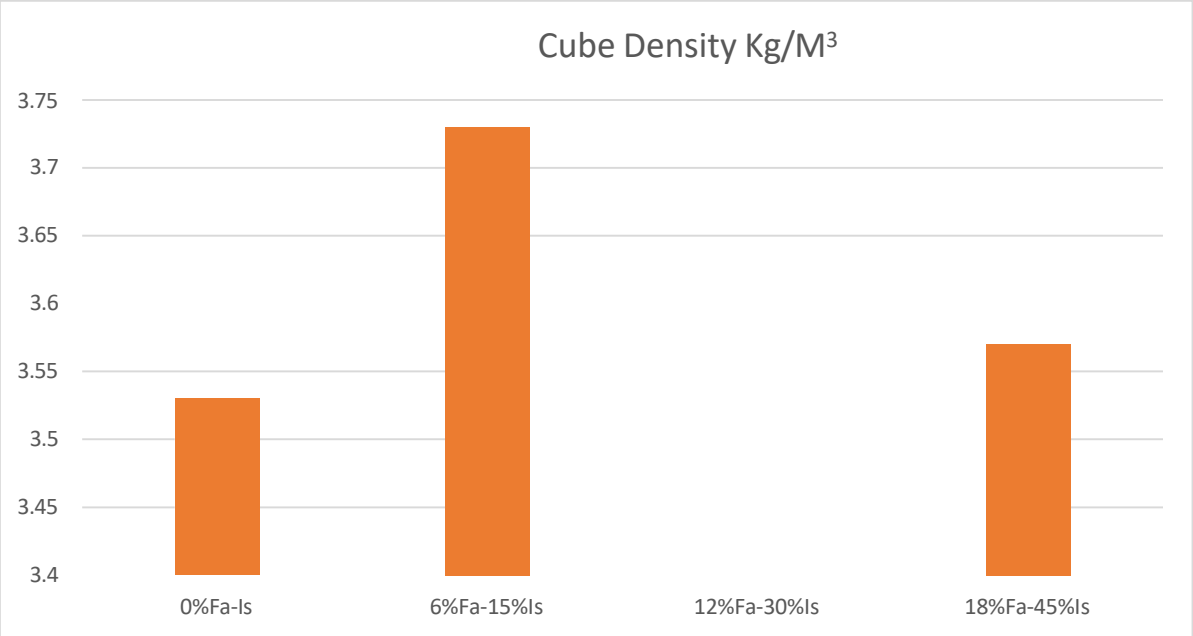


Table no. 15

Serial no.	Flyash %	Ironslag %	28days Density
1	0%	0%	3.53kg/M^3
2	6%	15%	3.73kg/M^3
3	12%	30%	3.6 kg/M^3
4	18%	45%	3.57 kg/M^3

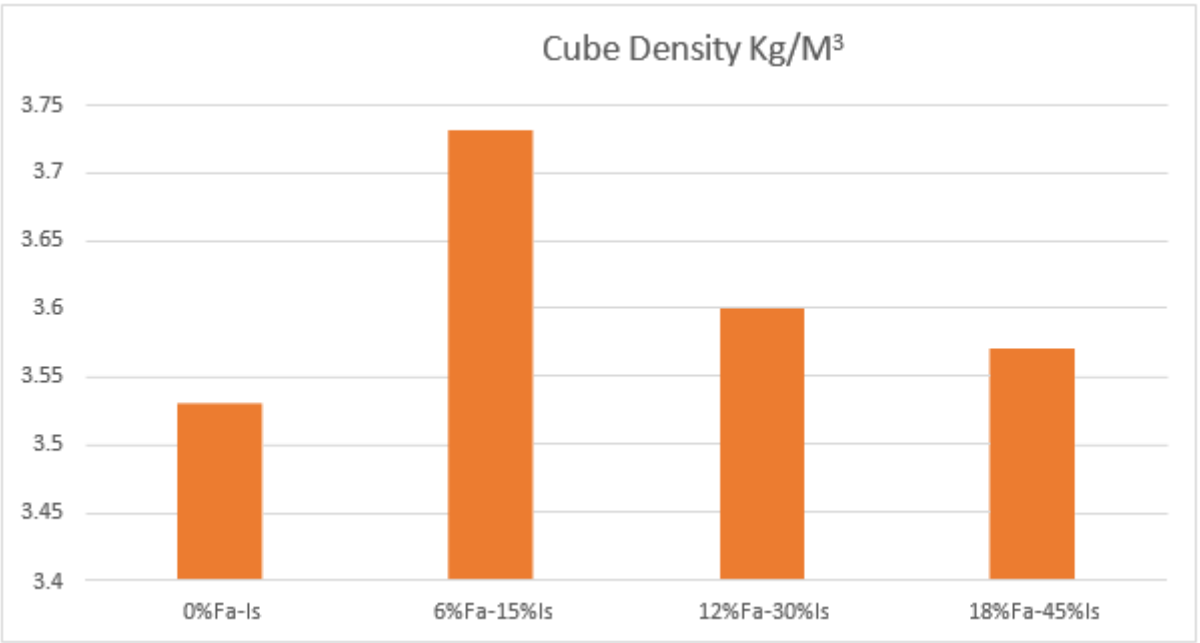


Chart no. 03

6.2 HARD CONCRETE (grade M25)

Following tests will be done on Hard concrete:

1. C S T
2. S T S T
3. F S T

6.2.1. Compressive Strength Test:

Compressive Strength = Applied Load / Cross-sectional Area

Apparatus Required

- Compression Testing Machine

Method

For cube check 2 kinds of trails of 15 X 15 X 15cm or 10 X 10 x 10cm depends on the dimensions of agg. are consumed. Mostly for many tasks, cubic trail of size 15 x 15c x 15cm are normally practiced. The concrete is poured in these trails and after 24 hrs they are rested in water for curing, also it is noted that there should be min. no. of voids.

Figure no. 07

Now after curing time span they are check by using CTM and load is calculated.

Result:-

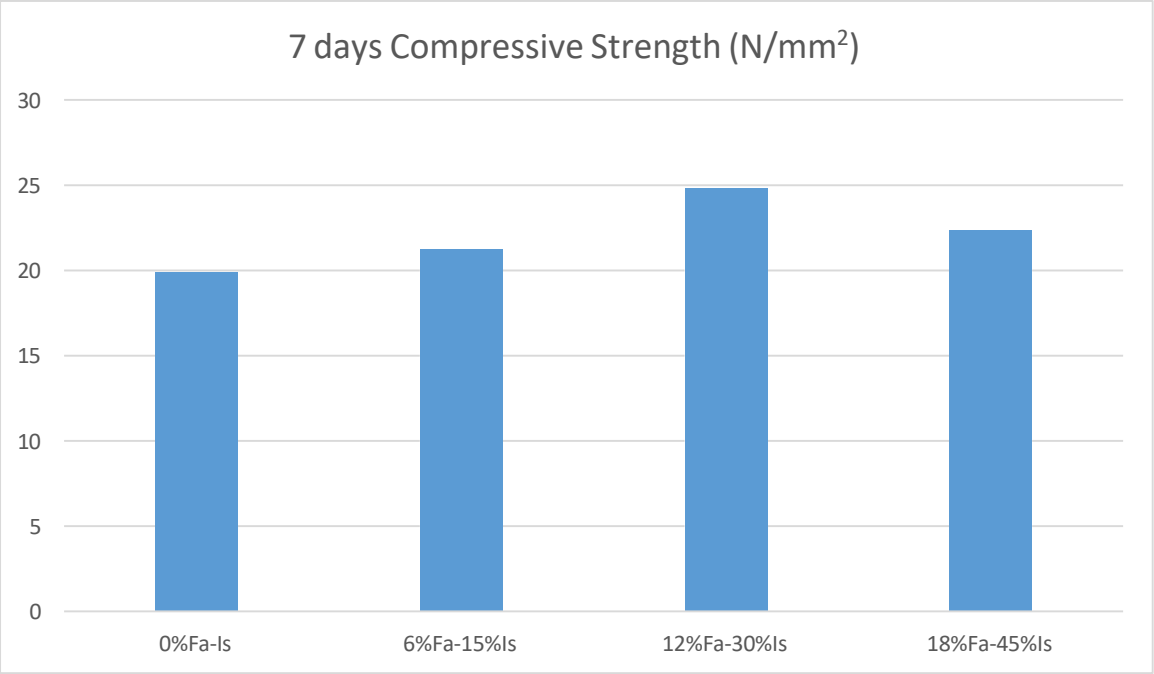
The cubes used in the project work are of size 150mm*150mm*150mm. The compressive strength values of cubes containing different percentages of flyash and ironslag are given in the following table:

Table no. 16

Serial no.	% of flyash	% of ironslag	M25 Grade - Compressive strength N/mm^2			
			7 days	Avg. 7 days	28 days	Avg. 28 days
1	0	0	19	19.9	29	30.03
			20		30.3	
			20.7		30.8	
2	6	15	20	21.26	30.1	31.16
			21.2		31	
			22.6		32.4	

3	12	30	26	24.83	35	36.5
			24		37.6	
			24.5		36.9	
4	18	45	23	22.36	34	33.26
			21.8		33.8	
			22.3		32	

Chart no. 04



From the above table, it demonstrates a positive increment in the compressive quality up to 12% of flyash and 30% of ironslag in concrete. But there is little reduction in compressive quality at 18% of flyash and 45% of ironslag in concrete.

6.2.2. Split Tensile Strength Test:

The S T S of concrete is one among the fundamental & necessary properties that greatly have an effect on the limit of cracking in moulds.

Split Tensile Strength = 2P / pi L D

Figure no. 08

Apparatus Required

- Compression Testing Machine

Method

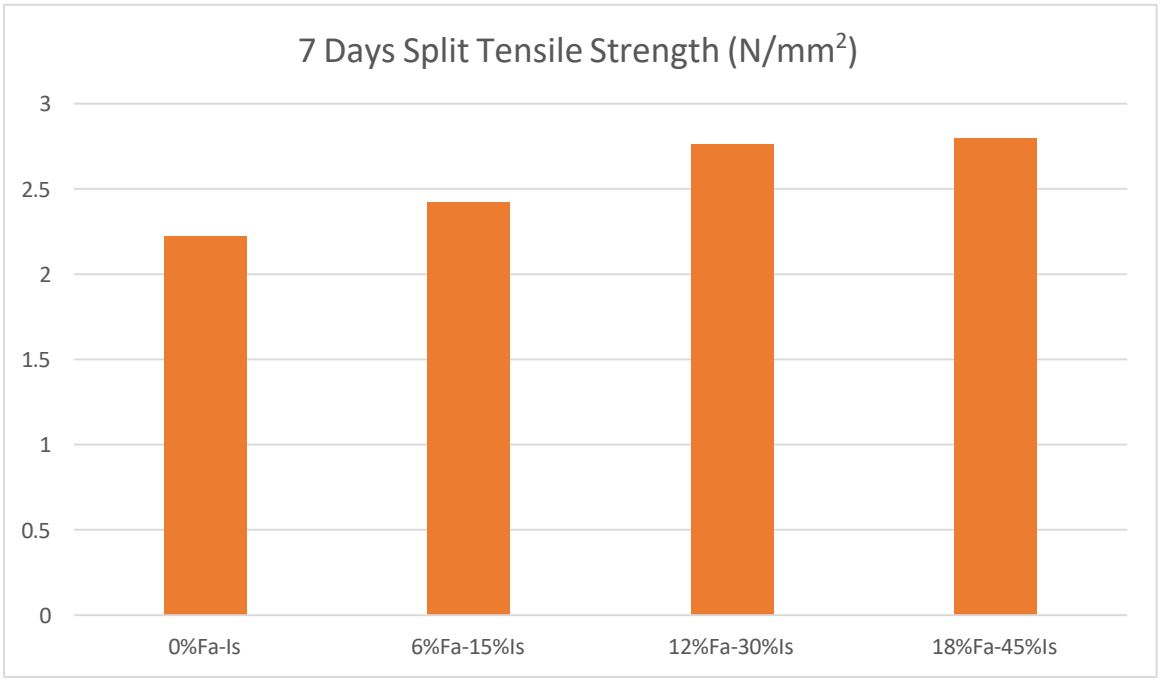
- First of all get a trail cube from the water after desired time span to which you have calculate strength.
- Now the adsorbed water is wiped off from all faces of trail.
- Now 2 lines are drawn of faces so that they are constant to its central axis.
- Now note down the dimensions of trail.
- Setting the CTN at a desired range.
- Rest plywood pieces on bottom and top of trail.
- Place straight the trail on CTM.
- Now make sure that upper part of CTM is down.
- Now on the CTM and note down the load at which it breaks.

Result:-

The cylinders used in the project work are of size 300mm*150mm. The split tensile strength values of cubes containing different percentages of flyash and ironslag are given in the following table:

Table no. 17

Serial no.	% of flyash	% of ironslag	M25 Grade - Split Tensile strength(N/mm^2)			
			7 days	Avg. 7 days	28 days	Avg. 28 days
1	0	0	2.11	2.22	3.2	3.21
			2.10		3.12	
			2.45		3.33	
2	6	15	2.22	2.42	3.11	3.19
			2.54		.3	
			2.51		3.46	
3	12	30	2.76	2.76	4.53	4.31
			2.62		4.3	
			2.9		4.1	
4	18	45	2.43	2.39	3.35	3.46
			2.5		3.6	
			2.26		3.44	



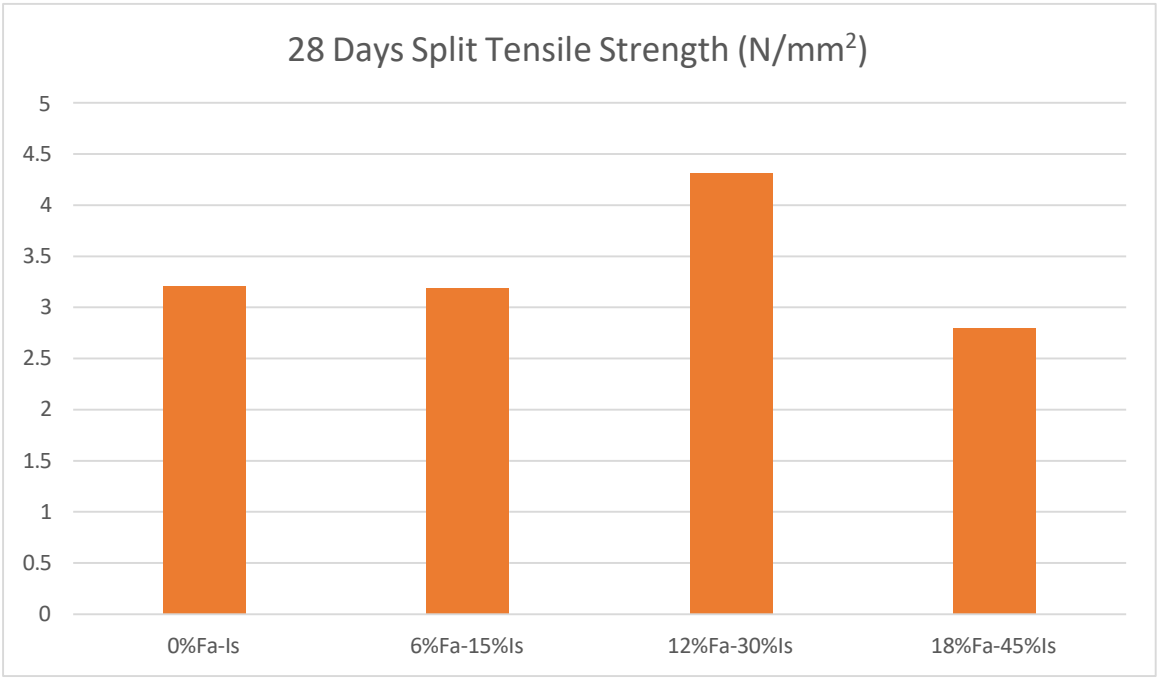


Chart no. 05

From the above table, it was observed that the split tensile strength gets increased up to 12% of flyash and 30% of ironslag. But afterwards it shows decrement in property at 18% flyash and 45% of ironslag.

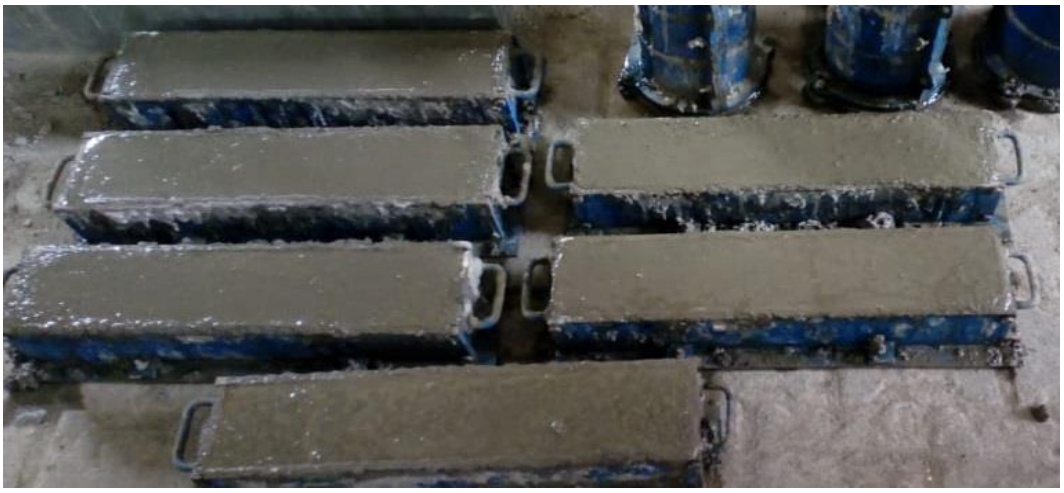
6.2.3. Flexural Strength Test:

Flexural strength measures the bending property of concrete beam upon loading.

Flexural strength = PL/bd^2 or $3Pa/bd^2$

Apparatus Required

- Compression Testing Machine



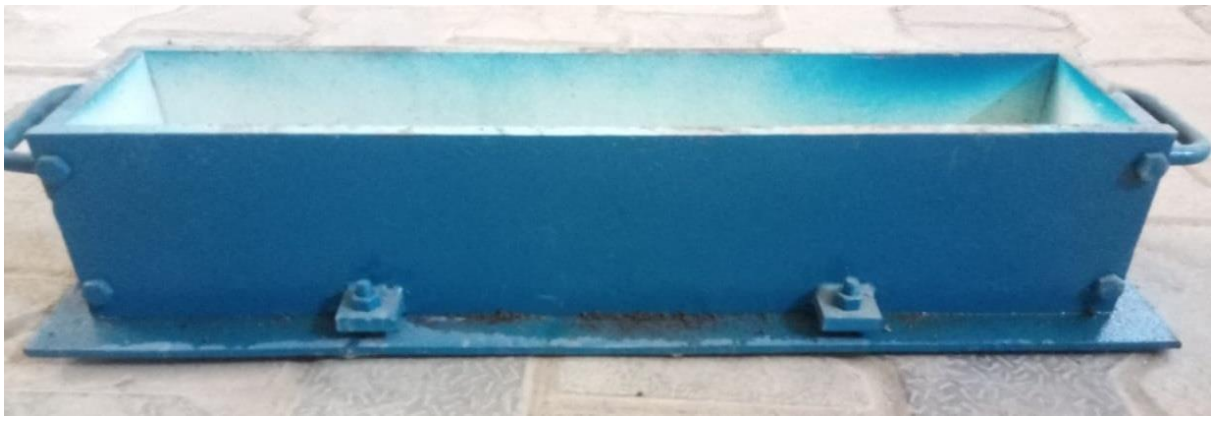


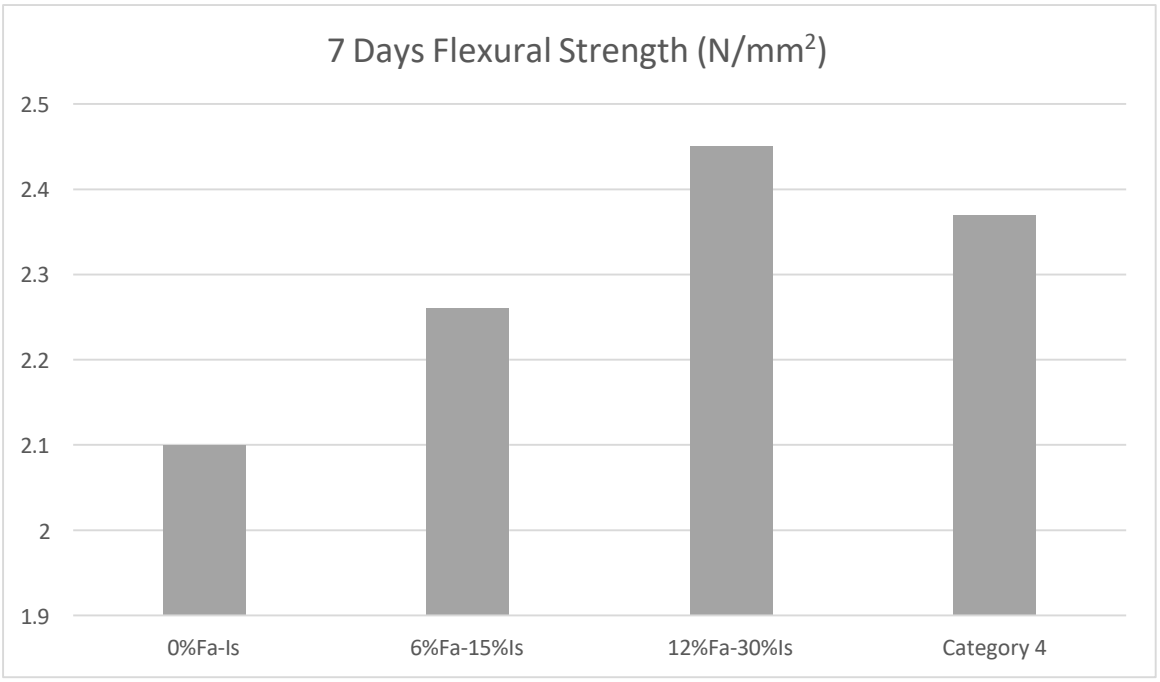
Figure no. 09

Result:-

The beams used in the project work are of size 100mm*100mm*500mm. The Flexural strength values of cubes containing different percentages of flyash and ironslag are given in the following table:

Table no. 18

Serial no.	% of flyash	% of ironslag	M25 Grade - Flexural strength			
			7 days	Avg. 7 days	28 days	Avg. 28 days
1	0	0	2.01	2.10	3.71	3.50
			2.3		3.2	
			2		3.6	
2	6	15	2	2.26	3.1	3.52
			2.3		3.56	
			2.5		3.9	
3	12	30	2.24	2.45	4	4.44
			2.6		4.74	
			2.51		4.58	
4	18	45	2.33	2.37	3.37	3.6
			1.99		3.81	
			2.8		3.62	



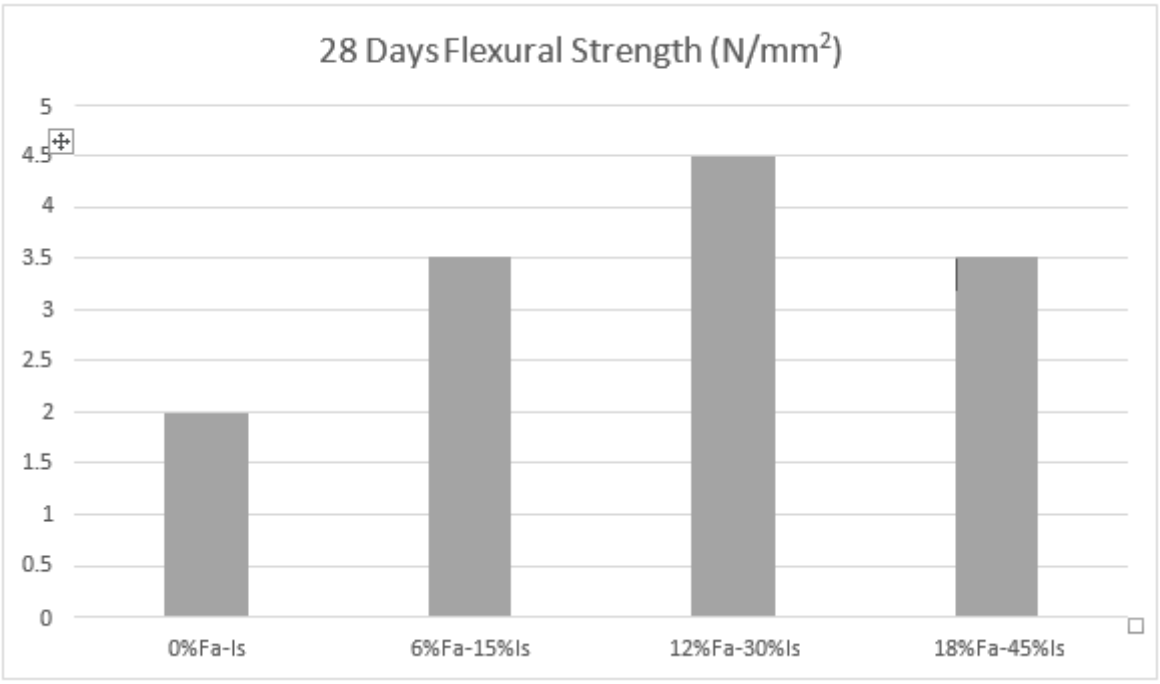


Chart no. 06

From the above table it was investigated, that there is positive increment of flexural strength of concrete at 12% of flyash and 30% of ironslag. But afterwards it was observed that there is reduction in strength at 18% of flyash and 45% of ironslag.

CHAPTER – 7 CONCLUSION

Following conclusions may be drawn based on experimental work:

1. The workability of concrete increases on the substitution of flyash in concrete along ironslag up to the percentages of 6% and 15% respectively.

2. The compressive strength gets increased up to the percentages of 12% of flyash and 30% of ironslag in concrete, but afterwards there is slight decrement in strength.
3. The split tensile strength gets increased up to the usage of 12% of flyash and 30% of ironslag in concrete, but after then there is slight decrement in strength.
4. The flexural strength of concrete gets increased up to 12% of flyash and 30% of ironslag, but after then there is slightly less strength of concrete.
5. After all abservations and calculations, it may be demonstrated that up to 12% fly-ash is usable in concrete and at the same time 30% of iron-slag is also usable. As we can see that this combination gives us best results.

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