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STUDY OF POLYETHYLENE TEREPHTHALATE PET PLASTIC BOTTLES FIBER IN FLY ASH CONCRETE WITH PARTIAL REPLACEMENT OF FINE AGGREGATES BY IRON SLAG

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ABSTRACT

In present day plastic waste is increase day by day. Waste plastic bottles are major causes of solid waste disposal problems. This induced an environmental issue as waste plastic bottle are difficult to biodegrade and involves process either to recycle or reuse. Hence an attempt has been made to understand whether it can be successfully used in concrete to improve some of the mechanical properties and strength of concrete. Iron slag is one of the industrial by-products from the iron and steel making industries. Iron slag is an industrialwaste by-product of steel industry These Iron slag are materials which does not have a higher scrap value and are considered waste. This industrial waste demolition is dumped and they cannot be recycled. They even pollute the atmosphere and are hard to dispose. In this study the study of polyethylene terephthalate PET plastic bottles fiber in fly ash concrete with partially replacement of fine aggregate (sand) by Iron Slag. Iron slag as partially replacement of fine aggregate in different percentage 10%, 20%, and 30% in fly ash concrete. The PET plastic bottles are cut in the form of fiber. The length of fiber was kept 2.5cm and breadth was 0.5cm.Then molds in the form cubes, cylinders and beams were casted in the laboratory, cured and tested (i.e. compressive strength, flexural strength split and tensile strength) has observed. To investigate the fresh concrete properties, the slump test was conducted for every batch of various percentage of waste iron slag. While for hardened concrete properties, compressive strength test, splitting tensile strength test and flexural strength test were conducted. The results indicate that the concrete with added of waste PET bottle fiber reduce the workability and compressive strength of concrete and the mechanical properties and durability properties of concrete by adding Iron Slag by partially replacement of sand in various percentage. However, for splitting tensile strength test and flexural strength test, it showed a strength development of concrete when added of waste PET bottle fiber and Iron slag.

Keywords: *Iron Slag: Polyethylene terephthalate PET plastic bottles fiber: fly ash concrete; M25 concrete: Compressive strength: Split tensile strength: Flexural strength and Durability.*

I. INTRODUCTION

Concrete A composite material that consists essentially of a binding medium, such as a mixture of Portland cement and water, within which are embedded particles or fragments of aggregate, usually a combination of fine and coarse aggregate. Concrete is by far the most versatile and most widely used construction material worldwide.

Cement forms is a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. Concrete is used in large quantities almost everywhere mankind has a need for infrastructure. The amount of concrete used worldwide ton for ton is twice that of steel, wood, plastics and aluminum combined. Concrete usage in the modern world is exceeded only by that of naturally occurring water.

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Cement =Powder
Cement + Water =Cement Paste
Cement Paste + Fine Aggregate (FA) = Mortar
Mortar + Coarse Aggregate (CA) = Concrete

Iron Slag refers to the type of metal manufacturing slag that is generated during the process of manufacturing iron and steel products. The term "slag" originally referred to slag produced by metal manufacturing processes, however it is now also used to describe slag that originates from molten waste material when trash and other substances are disposed of at an incinerator facility.

The Iron and steel industry is one of the most important industries in India. During 2014 through 2015, India was the third largest product of raw steel and the largest producer of sponge iron in the world. In India the industry produced 91.46 million tons of total finished steel and 9.7 million ton of pig iron. Most of iron and steel in India is produced from the iron ore.

Concrete Properties

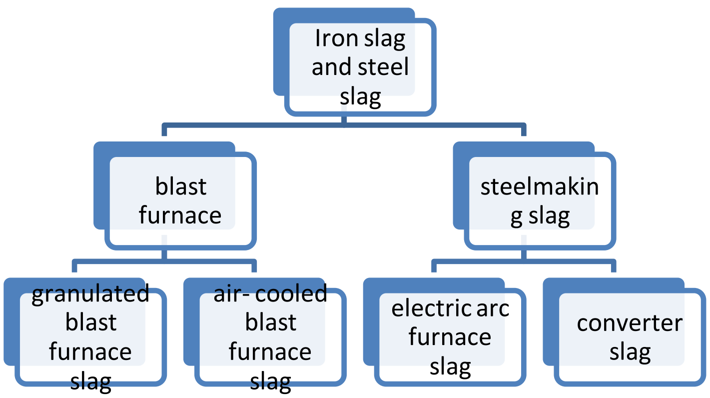
The properties of concrete are its characteristics or basic qualities. There are four properties of concrete.

1. WORKABILITY
2. COHESIVENESS
3. STRENGTH
4. DURABILITY

SUPPLEMENTARY CEMENTITIOUS MATERIAL More recently, strict environmental – pollution controls and regulations have produced an increase in the industrial wastes and sub graded byproducts which can be used as SCMs such as fly ash, silica fume, ground granulated blast furnace slag etc. The use of SCMs in concrete constructions not only prevents these materials to check the pollution but also to enhance the properties of concrete in fresh and hydrated states.

IRON SLAG refers to the type of metal manufacturing slag that is generated during the process of manufacturing iron and steel products. The term "slag" originally referred to slag produced by metal manufacturing processes, however it is now also used to describe slag that originates from molten waste material when trash and other substances are disposed of at an incinerator facility.

Type of iron and steel slag



Fly ash is comprised of the non-combustible mineral portion of coal. When coal is consumed in a power plant, it is first ground to the fineness of powder. The fly ash was prepared to identify problems and research opportunities concerning the characterization of fly ash for its use with OPC cement in concrete.

Plastic Fiber is an inexpensive type of fiber and generally lower quality than glass optical fiber. Attenuation is generally higher with plastic fiber. The primary use of plastic fiber is in the automotive and medical industries. Plastic fiber attenuation over short distances is not a major problem and therefore is becoming popular in more popular especially where there are budget concerns.

II. LITERETURE REVIEW

(1) ZiadBayasi (1993) in his research "**Properties of Polypropylene Fiber Reinforced Concrete"** the fresh and hardened material properties of fibrillated polypropylene fiber reinforced concrete is reported. Fiber lengths were X and % in. and volume fractions were 0. I, 0.3, and 0.5%. Fiber effects on concrete properties were assessed. Properties studied were slump, inverted slump cone time, air content, compressive and flexural behaviors, impact resistance and rapid chloride permeability, and volume percent of permeable voids. An innovative method of characterizing the flexural behavior of fibrillated polypropylene fiber concrete was proposed.

1. Fibrillated polypropylene fibers have no detectable effect on the workability **and** air content of fresh concrete at volumes below 0.3 percent. An adverse effect on workability and an increase in air content of concrete resulted from the application of polypropylene fibers at 0.5 percent volume.
2. Fibrillated polypropylene fibers tended to increase the permeability of concrete. With l/2-in.-long fibers, the increase was relatively mild. With 3/4-in.-long fibers, the increase was significant.

(2) Ahmed S. Ouda(2015) in his research "**The effect of replacing sand by iron slag on physical, mechanical and radiological properties of cement mortar**" bulk density and gamma ray radiation shielding propertiesof mortar have been investigated. Cement mortar of mix proportion 1:3 including various percentagesof iron slag was designed. The percentages of replacement were 0%, 40%, 80% and 100%by weight of fine aggregate. Mortar mixes were prepared with water cement ratio of 0.44 and cured in potable water for 90 days.

1. The incorporation of the basic-oxygen furnace slag (BOFS) in cementations mortars at 40%, 80% and 100% replacement improves the physico-mechanical characteristics for mixes than normal mortar made of sand.
2. Mortar sample of full sand replacement exhibited the highest compressive strength among all mixes, as it had 32%, 31%, 39%, 40% and 38% higher values compared to the control mix.
3. Based on this study, it is concluded that percentage iron slag can fully replace sand in cement mortar.

(3) SushovanDutta, M. B. Nadafin their research (**the Use of Waste Plastic Bottles and Fly Ash),** Two different type plastic water bottles, having different diameter and tensile stiffness, were chosen to prepare perforated cells of different heights wrapped with jute geotextile from inner side so that fine infill materials cannot escape from the perforations. Laboratory strain controlled compression tests were carried out on the cells rested over a rigid base and filled with compacted fly ash or stone aggregates. Test results showed significant load carrying capacity of the composite cells with fly ash as infill material. Though fine fly ash appeared to be an effective infill material, use of coarse stone aggregates as infill material produced better load carrying capacity of the composite cells.

1. Water bottles can be available with different diameters. Different sizes of encasements can be prepared by cutting them in required sizes.
2. The study shows an easy way of recycling the waste plastic water bottles as reinforcement materials in the field of Geotechnical engineering.

III. OBJECTIVE OF THE STUDY

The main objective of the present study is to compare the strength characteristics of M25 concrete by using of iron slag with partially replacement of fine aggregate and a percentage of plastic fiber in fly ash concrete, and also comparison is made between there cost. So it is up to us that how effectively we make use of these materials so that these materials can be used in service mankind. . So the usage of these wastes materials helping in dual role by minimizing the usage of raw material of concrete and by using the waste materials that are affecting the environment. To achieve this objective following step are to be followed:

1) Design of M25 concrete mix to obtain the ratio of different components of concrete.
2) The Iron Slag is used in different percentage 10% by weight of fine aggregate 20% by weight of fine aggregate 30% by weight of fine aggregate.
3) Fly ash is used 30% by weight of cement to increase the strength of concrete and reduces the corrosion in concrete.
4) 0.5% of Polyethylene terephthalate PET plastic bottles fiber is used of by total weight of concrete which give more strength when compared to control concrete.
5) The plastic bottles pieces are in a concrete as a plastic fiber to improve the properties of concrete.
6) This investigates the mechanical behavior of the components by using fibers.
7) Use of fly ash is environmental friendly that waste material from industries is effectively being used to create quality building material.

Different tests are conducted during the study

- Compressive strength
- Split tensile strength
- Flexural strength
- workability

There are some other important properties of concrete will also be under consideration such as workability, compaction, bleeding and segregation of concrete.

IV. SCOPE OF THE STUDY

Concrete is the most widely used man made material in construction industry. Due to the limited availability of its raw materials and their bad effects on the environment, researchers are now moving their focus on other raw materials. The first preference of today's engineering is to minimize the adverse effects of whatever they build on environment. To achieve these objectives researchers focused their study on cement that was causing most adverse effect on the environment by emitting CO_2 and by usage of fossil fuels during burning process. To minimize these researchers focused on the usage of waste materials that were also adversely affecting the environment. Some of these are already in use such as fly ash; silica fume etc. and many others are under research. So the usage of these wastes materials helping in dual role by minimizing the usage of raw material of concrete and by using the waste materials that are affecting the environment. The other advantage of using these waste materials is that they are helping in improving the properties of concrete.

Iron slag is a byproduct of iron and steel production by the metallurgical industries. Annually, million tons of iron slag is produced in the industries. Most of iron slag is landfilled, which represents a significant economic loss and a waste of valuable land space. Iron slag has great potential for the construction of concrete.

Fly ash increases the strength of concrete, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate resistance, and it reduces alkali-aggregate reaction. However, it also improves the performance of concrete and quality of concrete. Fly ash affects the plastic properties of concrete by improving its workability, fly ash also reducing water demand, reducing segregation and bleeding in concrete, and lowering heat of hydration.
Polyethylene terephthalate PET plastic bottles fiber addition in concrete is called fiber reinforced concrete. The fires added in the concrete can be plastic material i.e. Synthetic fibers such as polypropylene fibers.

- It increases the flexure strength of concrete.
- It increases compression strength of concrete when plastic bottle fiber can be used as core part of concrete.

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V. EXPERIMENT PROGRAM

Materials used in research

- Ordinary Portland cement of 53 grade confirming to IS 8112-1995.
- Fine Aggregates: Natural River Sand confirming to Zone III of IS 383-1970.
- Coarse Aggregates: Natural crushed stone of size between 10-20mm confirming to IS 383-1970.
- Fly Ash confirming to IS 15388-2003.
- Iron Slag.
- Polyethylene Terephthalate PET Plastic Bottles Fiber.
- Water: normal tap water

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, and crushed stone to make concrete. The cement and water form a paste that binds the other materials together as the concrete hardens. The function of cement is to bund the sand and stone together and second to fill up the voids in between sand and stone particles to form a compact mass. Portland cement referred as (ordinary Portland cement) is the most important type of cement and a fine powder produced by grinding Portland cement clinker. The cement is classified into three grades (i.e. 33 Grade, 43 Grade, and 53 Grade) depending upon the strength of 28 days.

Figure(1) OPC 53 Grade Cement

Fine aggregate

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The most common constituent of sand, in inland continental settings and non-tropical coastal settings, is silica (silicon dioxide, or SiO_2), usually in the form of quartz which, because of its chemical inertness and considerable hardness, is the most common mineral resistant to weathering. It is used as fine aggregate in concrete.

Figure(2) fine Aggregate (sand)

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Water

Generally, water that is suitable for drinking is satisfactory for use in concrete. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is necessary. When it is suspected that water may contain sewage, mine water, or wastes from industrial plants or canneries, it should not be used in concrete unless tests indicate that it is satisfactory. Water from such sources should be avoided since the quality of the water could change due to low water or by intermittent tap water is used for casting.

Iron slag

Steel slag is the residue of steel production process and composed of silicates and oxides of unwanted elements in steel chemical composition. Fifty million tons per year of LD slag were produced as a residue from Basic Oxygen Process (BOP) in the world.

In order to use these slags in cement, its hydraulic properties should be known. Chemical composition is one of the important parameters determining the hydraulic properties of the slags. In general, it is assumed that the higher the alkalinity, the higher the hydraulic properties. If alkalinity is> 1.8, it should be considered as cementations material.

Figure(3) Iron Slag

Fly ash

Fly ash, which is largely made up of silicon dioxide and calcium oxide, can be used as a substitute for Portland cement, or as a supplement to it. The materials which make up fly ash are pozzolanic, meaning that they can be used to bind cement materials together. Pozzolanic materials, including fly ash cement, add durability and strength to concrete.

Fly ash cement is also known as green concrete. It binds the toxic chemicals that are present in the fly ash in a way that should prevent them from contaminating natural resources. Using fly ash cement in place of or in addition to Portland cement uses less energy, requires less invasive mining, and reduces both resource consumption and CO2 emissions.

Plastic Bottles Fiber

PET fiber is a waste material which is obtained from industry. We collect the PET bottles from the restaurants and marriage halls. They were used after removing the top and bottom of the bottle. The length of fiber was kept 2.5cm and breadth was 0.5cm.

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Figure (4) Plastic Bottles Fiber

Working procedure in methodology

Concrete is prepared with PET plastic bottles fiber in fly ash concrete with partial replacement of fine aggregate by iron slag. Determination of strength of concrete of mix proportion by using fly ash with OPC cement as binder mix, Iron Slag as fine aggregate and coarse aggregate of 10mm and 20mm. In this phase concrete of mix proportion will be prepared by using OPC cement + Fly ash as binder mix with different proportion of plastic fiber, Iron slag as fine aggregate and coarse aggregate. The concrete mixes will be tested for following strengths.

- Compressive strength
- Split tensile strength
- Flexural strength

1. Material should be collected for the research work from different parts.
2. Iron slag is collect from the Kashmir steel rolling mills PVT Ltd, Bari Brahmana Jammu.
3. Fly ash is collect from the
4. Plastic bottles are collected from local marriage halls and local Restaurants. And then cut in the form of plastic fiber by hand and kept 2.5cm length and 0.5cm breadth.
5. Cement: - OPC cement of 53grade was used for the investigation. The cement was fresh and without lamps. Test was performed to determine various physical property of cement. Setting time: - the setting time of cement were tested by the Vical apparatus method described in IS: 4031-1968 shall conform to the following requirement.

   Initial setting time in minutes: - not less than 30 min.
   Final setting time in minutes: - not more than 600min.

6. Fine aggregate (sand):-The natural river sand is collect from the local area crusher (Choudhary stone crusher Nanak Chak Samba). This was the cheapest source of sand. Fine aggregate (natural river sand) falling under the zone-3 (IS: 385).
7. Coarse aggregate:-These are the crushed gravel or stone obtained by crushing of gravel or hard stone in angular form from the local area crusher Choudhary stone crusher. The size of coarse aggregate is 10mm and 20mm is locally available. The aggregate were washed to remove dust and dirt and then were dried to surface dry condition.
8. Water: - which is suitable for drinking is satisfactory for use in concrete for the mixing and curing of concrete. Water should be clean portable, fresh and free from the bacteria which affect the concrete and desire matter confirming to IS: 2025-1964 is used for the mixing. Water is the main component and a key ingredient in the manufacturing of concrete.

Concrete mix design

Characteristics cube strength M25
Type of cement: - OPC 53Grade
Fine Aggregate: - natural river sand

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Zone III (IS: 383)
Coarse Aggregate: - crushed (angular) 20mm maximum size (IS 383)

Table (1) Specific gravity

Cement	3.15
Coarse aggregate	3.56
Fine aggregate	3.52

Target mean strength
F_{CK}=fck +T×S
Where F_{CK} = Target mean compressive strength at 28 days,
fck= characteristic compressive strength at 28 days.
S= standard derivation i.e. 6.3,
T= a statistic, depending upon the accepted proportion of low result and the number of tests.
F_{CK} = 25+1.65×6.5
=35.395
W/c = 0.48
Air content = 2%

Water content & fine to total aggregate ratio
For nominal maximum size of 20mm aggregates concrete grade below M35 the water and sand content obtained are 186 kg/m^3 and 35% (of total aggregates volume) respectively.

Correction of water = 0
Correction of sand = 1.5%

Final water content =180kg/m^3
Sand content 35-1.5 = 33.5%

Determination on cement content
Water content =180kg/m^3
Cement content =180/0.48 =375kg/m^3

Determination of fine and coarse aggregate
Fine aggregates**:** The value of fine aggregates is solved by volumetric formula.

Total volume in m3 = [weight of water/ specific gravity of water + weight of cement/specific gravity of cement + Fa / (% of fine aggregates×3.52)] ×1/1000

0.98^3= [180+(375/3.15)+(Fa/0.333×3.52)] ×1/1000
Fa= 802.97kg

Coarse aggregates: The value of coarse aggregates:–
0.98= [180+(375/3.15) + (Ca/1-0.335) ×3.56] ×1/1000
Ca = 1612.09kg

W/C ratio = 0.43 which is reduced to =0.4
Water content = 186kg
Adjustment of water = 0

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Adjustment of sand = 35%
Cement content =186/0.4 =465 kg

Cement increase by 10%
465 +10% = 511.5kg

Now
Fine aggregate
Fa=[0.98×1000-180-511.5/3.14] ×0.35×3.52
Fa = 784.9kg

Coarse aggregate
Ca [0.98×1000-180-511.5/3.14] ×0.05×3.56
Ca = 1474.353

***Table (2) total quantities of ingredients and the Mix proportion*:**

water	cement	Sand (F.A)	Coarse aggregate (C.A)
186	511.5	784.9kg	1474.35
0.4	1×10%	1.53	2.88
Mix design of M25 0.4	1	1	2

Experimental procedure for the mixing of concrete
Machine mixing may be done in the experiment program.

1. First arrange and stake all required tools and material such as concrete ingredients, (i.e. OPC cement, aggregates fine and coarse, water) bucket shovel trowel, head pans (trays) etc.
2. Measure the weight of ingredient according to the mix design M25.
3. Keep a drum of water near to the mixture.
4. Measure the weight of water according to the mix design in the bucket.
5. Clean the excessive dust from the aggregate with water.
6. Cuts the plastic bottles in fiber form. The length of fiber was kept 2.5cm and breadth was 0.5cm.
7. Dry mixing of aggregate is done for 2min for the proper mixing of aggregates used for the casting of cubes, cylinders and beams.

Figure (5) concrete Mix Proportion

Cubes of size 150mm x 150mm x 150mm was used in this experiment.

1. Clean all the cube moulds.
2. After cleaning moulds apply oil on the inner side of moulds.
3. Fill the concrete in the mould in 2 or 3 layers approximate 5-8cm thick.

4. Compact each layer with not less than 35 strokes per layer using tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at the lower end).
5. Level the top surface and smoothen it with a trowel.
6. All the cast specimen were de-moulded after 24 hours.
7. Placed all the specimens in the curing tank for the curing of specimen of 7days,14days, and 28days.
8. After curing the test were perform compressive stress, split tensile stress, and flexural test.
9. Record the test value and date of test and also note any unusual features in the type of failure.

The quantity measured of ingredient according to the mix design was.

1. Coarse aggregate
    a. 10mm 40% = 22.2kg
    b. 20mm 60% = 33.4kg

2. Fine aggregate = 28.8kg
3. Iron slag = 10%, 20%, 30% replacing of fine aggregate.
4. Fly ash = 6kg.
5. OPC cement = 14kg.
6. Water = 7.2 kg.

30% of fly ash is used by the replacing the cement
10%, 20%, and 30%.of iron slag is used by the replacing of fine aggregate (sand).

Figure (6) cubes Casting

Casting of cylindrical moulds:
The size of cylinder is 150mm diameter and 300mm height. The same process of mixing and measurement of materials in cube experiment is done in this experiment of casting of cylindrical moulds. the amount of quantity of material used in the experiment for the casting of cylinders moulds is same as in the casting of cube. Dry mix in the mixture for 2min after that the liquid Component of the mixture was then added to the dry materials and the mixing continued for further about 4 minutes to manufacture the fresh concrete.

Figure (7) casting of cylinder moulds

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Casting of Beam moulds:

According to ASTA the size of the specimen is 150mm width, 150mm depth, and the length should not be least three times the depth of the specimen. Beam mould of size 150mm x 150mm x 700mm is used in the experiment. Beam mould are Fill the in two approximately equal layers with the second layer slightly overfilling the mold. Tamp each layer with the tamping rod using the Rounded end. Rod each layer throughout its depth, taking care to not forcibly strike the Bottom of the mould when compact the first layer. After rodding each layer, strike the mold 10 to 15 times with the mallet and spade along the sides and end using a trowel. Strike off to a flat surface using a float or trowel. Finishing of beam may done by making the surface smooth by using the trowel.

VI. RESULTS AND DISCUSSION

Compressive strength of concrete: Overall strength of a structure such as flexural resistance and abrasion directly depend upon the compressive strength of concrete. Compressive strength of concrete is defined as the characteristic strength of 150mm size concrete cubes tested at 28 days.The resistance to failure under the action of compressive force. Compressive strength is an important parameter to determine the performance of the material during service conditions.

At the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. The compressive strength of the cube specimen is calculated using the following formula:

Compressive Strength, fc = P/A N/mm^2

Where P = Load at failure in N

A = Area subjected to compression in mm^2

- Compressive strength of cubes after 7 days

  First weight of cube mould i.e. weight before compaction = 8.13 kg

  Load = 548KN

  =548/150 x150mm^2

  = 24.35 N/mm^2

Figure (8) Compressive testing machines

Table (3) Result of Compressive strength of concrete(cubes)

S. NO	Grade of concrete	Percentage of Iron slag Replacing sand	Avg. Compressive strength of cubes after 7days (N/mm^2)	Avg. compressive strength of cubes after 14days (N/mm^2)	Avg. compressive strength of cubes after 28days (N/mm^2)
1	M25	0%	24.35	32.21	37.45
2	M25	10%	26.35	33.5	38.68
3	M25	20%	27.56	34.5	39.56
4	M25	30%	28.67	35.68	40.21

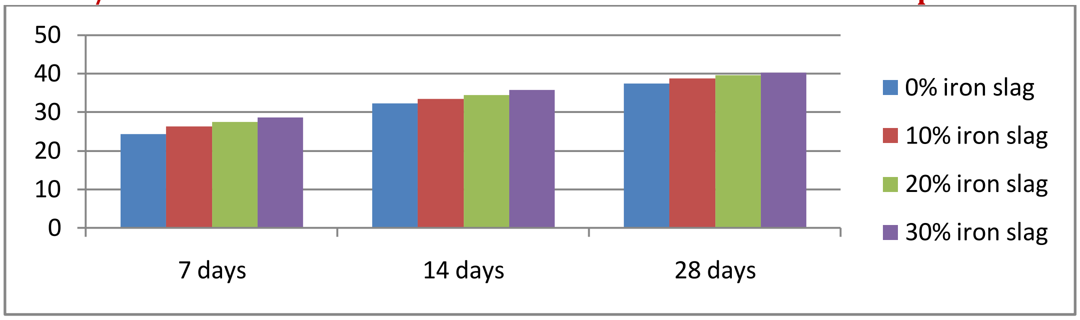

Figure (9) Compressive strength bar chart

Split tensile stress

Tensile strength is an important property of concrete because concrete structure is highly vulnerable to tensile cracking due to the various kinds and applied loading itself. However tensile stress of concrete is very low in compared to its compressive strength, Due to difficulty in applying uniaxial tension to a concrete specimen, the tensile strength of concrete is determined by indirect test method i.e. split cylinder test.It is the standard test, to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS: 5816-1970.

It can be calculated by f_t= 2P/Π DL
Where
P = compressive load at failure
L = length of cylinder
D = diameter of cylinder

Figure (10) Tensile Strength Testing Machines

Table (4) Result of split tensile strength of cylinder moulds

S. NO.	Grade of concrete	Percentage of Iron Slag	Avg. Tensile strength of cylinder after 7days (N/mm^2)	Avg. tensile strength of cylinder after 14days (N/mm^2)	Avg. tensile strength of cylinder after 28 days (N/mm^2)
1	M25	0%	2.01	3.14	4.02
2	M25	10%	2.33	3.34	4.24
3	M25	20%	2.84	3.56	4.56
4	M25	30%	3.01	3.84	4.7

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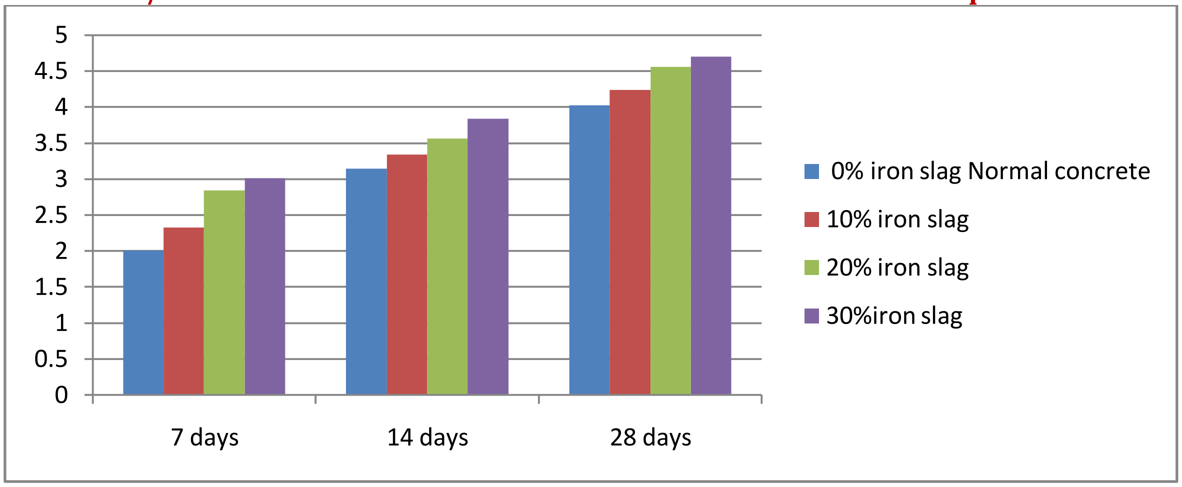

Figure (11) Tensile Strength Bar Chart

Flexural strength test

Ability of the concrete to resist its bending is determined by its flexural strength. It is also an indirect method to determine tensile strength of concrete. To determine the flexural strength of concrete which comes into play when a road slab inadequate sub-grade support is subjected to wheel loads and / or there are volume changes due to temperature.

The flexure strength is determined by the given equation.
Modulus of rapture = PL/Bd^2
Where P = maximum load at which specimen fails.
L = length of specimen.
B = width of specimen.
d = depth of specimen.

Table (5) Result of Flexural strength of beam

S. NO.	Grade of Concrete	Percentage of Iron Slag	Avg. flexure strength of beams after 7days (N/mm^2)	Avg. flexure strength of beam after 14days(N/mm^2)	Avg. flexure strength of beams after 28days (N/mm^2)
1	M25	0%	4.1	4.4	5.25
2	M25	10%	4.23	4.52	5.33
3	M25	20%	4.33	4.6	5.54
4	M25	30%	4.39	4.65	5.58

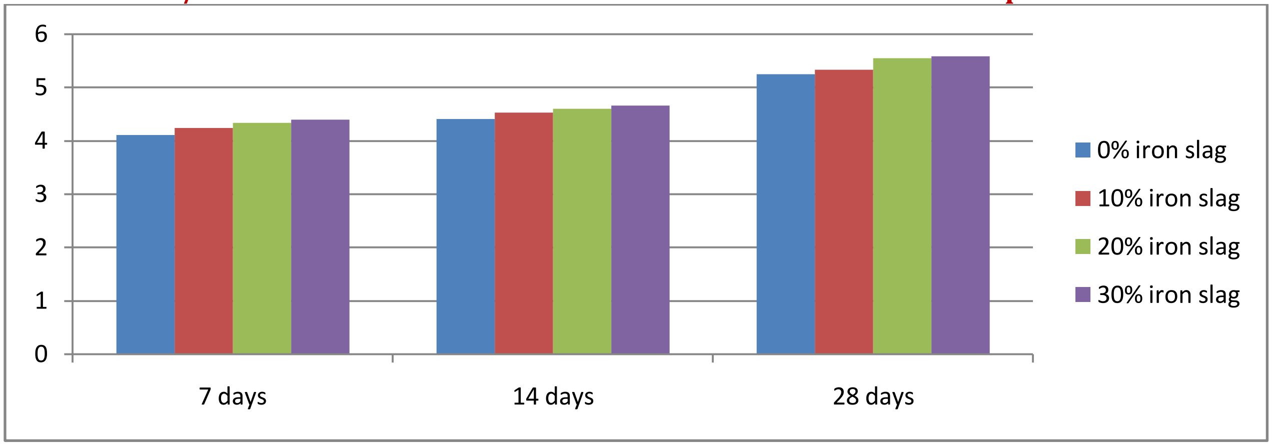

Figure (12) flexure strength bar chart

VII. CONCLUSION

1. The utilization of Iron slag in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of Iron slag in fine aggregate and cement reduces the cost of making concrete.
2. The initial and final setting time of Iron slag admixed concrete is higher than control concrete.
3. Utilization of Iron slag as fine aggregate in concrete and as a cement raw material has the dual benefit of eliminating the costs of disposal and lowering the cost of the concrete
4. It was observed that, the Iron slag replacement for sand is more effective than cement.
5. Iron slag when combined with limestone aggregates by different ratios on improving the mechanical properties of hardened concrete.
6. It also improves the performance of concrete and quality of concrete. Fly ash affects the plastic properties of concrete by improving its workability, fly ash also reducing water demand, reducing segregation and bleeding in concrete, and lowering heat of hydration. Fly ash reaches its maximum strength more slowly than concrete made with OPC cement.
7. The compressive strength increase with increase in the percentage of iron slag

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