STRENGTH ANALYSIS OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT BY FLYASH AND SAND BY GBFS

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ABSTRACT: Concrete is especially labeled into 3 sorts based totally at the density. Concrete containing herbal sand and gravel or beaten- rock aggregate and water, when positioned within the skeleton of form and allowed to treatment, becomes difficult like stone. Generally weighing approximately 2400kg/m^3 is known as “regular-weight concrete” and it's far the most commonly used concrete for structural purposes. For packages wherein a higher strength-to-weight ratio is desired, it is viable to lessen the unit weight of concrete via the use of natural mixture with decrease bulk density. The time period light-weight concrete is usedfor concrete that weightless than 1800 kg/m^3. Heavy weight concrete used for radiation shielding, is a concrete produced from high density aggregate andusually weigh more than 3200kg/m^3. Our goal it is to study the residences of concrete by using in part changingcement by means of fly ash and fine aggregate (sand) by using Granulated Blast Furnace Slag (GBFS). On this look at, cement was partially replaced by way of fly ash and best mixtures were in part changed by means of GBFS in concrete. A combination layout became executed for M20 grade of concrete by using is technique. Three grades of Ordinary Portland Cement (OPC) particularly: 33, 43 and 53 as labeled by means of Bureau of Indian Standard (BIS) are commonly utilized in production industry. Now in this mission most effective 53 grade of cement is used. This paper reports comparative have a look at on consequences of concrete residences by using in part alternative of OPC of 53 grades with fly ash and sand had been partially changed by way of blast furnace slag. The principle variable investigated in the take a look at of version of fly ash dosage of 10% and slag dosage of 10%, 20%, 30% fly ash dosage of 20% and slag dosage of 10%, 20%, 30% fly ash dosage of 30% and slag dosage of 10%, 20% and 30%. The compressive power and split tensile strength & acid assault of concrete were specially studied. Test outcomes indicate that, inclusion of fly ash and GBFS commonly improves the concrete houses up-to positive percentage of substitute in 53 Grade of cement.

KEYWORDS: Cement, Fly ash, GBFS, Sieve analysis, Normal consistency Test, Initial setting & Final setting time, Soundness, Workability, Compressive strength, Split tensile strength.

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1. INTRODUCTION

Concrete is a widely used construction fabric for various sorts of systems due to its structural stability and strength. The everyday Portland cement (OPC) is one of the main components used for the manufacturing of concrete and has no alternative in the civil creation industry. Sadly, manufacturing of cement entails emission of big quantities of carbon dioxide gasoline into the ecosystem, a main contributor for inexperienced residence impact and the worldwide warming. Hence, it's far inevitable either to search for another fabric or in part placed againit by means of some different fabric.

In this paper, the extraordinary admixtures had been used to examine their sole and combined effects at the resistance of concrete further to their consequences on mechanical and balance properties by way of the replacement ofcement via 10% fly ash and sand replacement 10%, 20%, 30% of slag, cement byusing 20% fly ash and sand substitute 10%, 20, 30% of slag, cement substitute of 30% fly ash and sand substitute 10%, 20%, 30% of slag.

The secondary materials utilized in our undertaking are pozzolanic substances. The time period pozzolana is a siliceous or a siliceous and aluminous material which itself possesses no cementitious price but in presence of water, chemically react with calcium hydroxide to shape compounds possessing cementitious residences. The fabric which having the pozzolanic belongings called pozzolanic cloth. The pozzolanic substances which might be utilized in our challenge are

1.1 Fly ash

Fly ash also called flue-ash is one of the residues generated incombustion coal and incorporates the high-quality particles that upward push with the flue gases. Ash which does not upward push is termed backside ash. In a commercial context, fly ash usually refers to ash produced in the course of combustion of coal. Fly ash is normally captured with the aid of electrostatic precipitators or other particle filtration gadget before the flue gases reach the chimneys of coal-fired energy plants and together with bottom ash removed from the lowest of the furnace is in this situation together referred to as coal ash. Depending upon the supply and makeup of the coal being burned, the additives offly ash vary appreciably, however all fly ash consists of good sized quantities of silicon dioxide (SiO_2) and calcium oxide (CaO).

1.2 Granulated Blast Furnace Slag (GBFS)

Granulated Blast Furnace Slag (GBFS) is a by-product of the metal enterprise. Granulated Blast Furnace Slag (GBFS) is described as “the non-metal product consisting basically of calcium silicates and other bases that is advanced in a molten situation Concurrently with iron in a blast furnace”. Within the manufacturing of iron, blast furnaces are loaded with iron ore, fluxing dealers, and coke. Whilst the iron ore, which is made from iron oxides, silica, and alumina, comes collectively with the fluxing dealers, molten slag and iron are produced. The molten slag then goes through a specific procedure depending on what form of slag it becomes. Air-cooled slag has a hard end and large floor location while compared to aggregates of that quantity which allows it to bind well with Portland cements as well as asphalt mixtures. GBFS is produced while molten slag is quenched unexpectedly using water jets, which produces a granular glassy mixture. This glassy mixture with little fines used as sand replacement within the present investigation.

1.3 SCOPE AND OBJECTIVES

- To study normal consistency, initial and final setting times, soundness andfineness of cement.
- To study specific gravity, water absorption of coarse aggregate.
- To study specific gravity, water absorption of fine aggregate of river sandand slag.

2. REVIEW OF LITERATURE

Rathish Kumar P [1] has demonstrated the optimal size of the cinder to be used in the GBFS concrete and study the strength and sorptivity characteristics of concrete prepared with cinder-based light weight aggregates at the end of 3, 7 and28 days for medium grade concretes with different sizes of aggregate. It was concluded that with 12.5mm size aggregate and 30% fly ash replacement have mechanical properties which were superior in 20Mpa, while 10 mm size aggregate with a 30% fly ash replacement improved the properties of 30Mpa concrete.

Clarke (1993) [2] Demonstrates that, when we are considering the cracking and failures of concrete it is necessary to have the knowledge regarding its tensile strength values. It is also noted that, GBFS shows a flexural and tensile splitting strength slightly lower to that of normal weight concrete of the same compressivestrength.

Bryan (1989) [3] Natural lightweight aggregates may be defined as inherently low density natural mineral materials. The primary user is the construction industry where weight reduction equates to cost savings. Principal products in which natural lightweight aggregate is utilized because of its lower density include lightweight Portland cement concrete and lightweight concrete masonry units. In addition, due to location, some natural lightweight aggregates compete with normal weight constructions aggregates for uses such as road base and common backfill material.

Seabrooks (1988) [4] Demonstrates the results of the 162 trial mixtures of the second phase of a three-phase programme, using aggregates from the threesources such as, two chemical admixture systems, three levels of fly ash replacement, and three levels of silica fume replacement. It is resulted those 91 days compressive strengths of the order of 65 MPa are attainable light weight concrete, although this is the threshold level of the aggregates. Further, it is concluded that a nominal increase in strength occurs with type fly ash replacement and addition of the silica fume.

3. RESULTS

Concrete is the most generally utilized made material in the development business. It's the most critical property is solidness which relates the execution of the material to its administration life under different natural conditions. The capacity of cement to withstand and tastefully and for long stretches the impacts of load, time, and condition depends particularly on how the building properties of the material are constituted at first and how they are permitted to create with age.

3.1 Slump Cone Test:

Slump test is the most ordinarily strategy for measuring the consistency ofsolid which can be utilized either in research facility or at site of work. The inner surface of the form is altogether cleaned and liberated from dampness and adherence of any old set cement before initiating the test. The shape is put on a smooth, flat, unbending and non-permeable surface. The form is then filled in four layers, each roughly ¼ of the stature of the shape. Each layer is packed 25 times by the packing bar taking consideration to disseminate the strokes equally finished the cross segment. After the best layer has been rodded, the solid is hit off level with a trowel and packing bar. The shape is expelled from the solid instantly by raising it gradually and deliberately in a vertical bearing. This enables the solid to die down. This subsidence is alluded as 'droop' of cement. The distinction in level between the tallness of the form and that of the most noteworthy purpose of the died down cement is measured. The distinction in stature in 'mm' is taken as drop of cement.

Test results

- Slump in terms of millimeters to the nearest 5 mm = 49.5mm
- Shape of the slump: SHEAR
- Referring to the selection of data, we have a slump value within the Range (60 – 180 mm).

Fig: 1 Slump Cone Apparatus

Fig: 2. Measuring Slump Fall

Table 1: Workability of concrete with replacement of fly ash and slag

S.NO	Details of Material	Slump in mm
1	90% cement + 10% FA and 90% sand +10% slag	45
2	90% cement + 10% FA and 80% sand + 20% slag	47
3	90% cement + 10% FA and 70% sand + 30% slag	50
4	80% cement + 20% FA and 90% sand + 10% slag	53
5	80% cement + 20% FA and 80% sand + 20% slag	56
6	80% cement + 20% FA and 70% sand + 30% slag	58
7	70% cement + 30% FA and 90% sand + 10% slag	54
8	70% cement + 30% FA and 80% sand + 20% slag	57
9	70% cement + 30% FA and 70% sand + 30% slag	59

3.2 SOUNDNESS TEST

The extension of bond example was under 10 mm indicated by IS 4031(Part 3)1988. This affirmed the concrete is a decent added substance material. Table 4.9 demonstrates the qualities for soundness of 100% OPC.

Table 2: Soundness of Ordinary Portland Cement

Test for Physical Requirement	Zuari O.P.C 53 Grade	IS 4031-1988
Lechatlier Method (mm)	1	<10

Soundness of cement with 10% replacement of fly ash:

Table 3: soundness of cement with 10% replacement of Fly Ash

Test of Physical requirement	ZUARI O.P.C 53 Grade	IS 4032(part 3) :1987
Le-Chatlier method (mm)	2	<10mm

Soundness of cement with 20% replacement of fly ash:

Table 4: Soundness of cement with 20% replacement of Fly Ash

Test of Physical requirement	ZUARI O.P.C 53 Grade Cement	IS 4032 (part 3) :1987
Le-Chatelier method (mm)	1	<10mm

Soundness of cement with 30% replacement of fly ash:

Table 5: soundness of cement with 30% replacement of Fly Ash

Test of Physical requirement	ZUARI O.P.C 53 Grade Cement	IS 4032 (part 3) :1987
Le-Chatlier method (mm)	2	<10mm

3.3 TESTS ON CEMENT

3.3.1 Specific Gravity of CementProcedure:

Particular gravity of bond is characterized as, the proportion of dry weightof concrete to the heaviness of equivalent volume of lamp fuel included. This testis led by Le-Chatliers mechanical assembly this property imperative in the blend plan. Note down the heaviness of discharge thickness bottle (w1). Take a 33% of bond in bottle and measure the container (w2) at that point fill the jug with lamp fuel completely and measure the jug with concrete and lamp oil (w3). At that point clean the container and fill the lamp fuel in the jug and measure the jug with lamp fuel (w4).

Note down the readings and decide the particular gravity of bond.

Particular Gravity of bond = (W2-W1)/((W2-W1)- (W3-W4))

Observations and Calculations

Type of cement : OPC 53 Grade

Liquid used : Kerosene

Density of liquid : 0.79 gm/cc

Weight of cement : 10g

Table 6: Specific gravity of cement

S.No.	Specifications	Sample-1	Sample-2
1	Weight of empty gravity bottle (W_1)	28	25
2	Weight of empty bottle + cement (W_2)	38	35
3	Weight of empty bottle + cement + Kerosene (W_3)	73	74.5
4	Weight of bottle + Kerosene (W_4)	66.2	67.9

Specific gravity of Sample-1 = $(W_2-W_1)/((W_2-W_1)-(W_3-W_4))$

= 10/ (10)-(6.8)

= 3.12

Specific gravity of sample-2 = $(W_2-W_1)/ ((W_2-W_1) - (W_3-W_4))$

= 10/ (10)-(6.6)

= 2.94

Specific Gravity of cement = (3.12+2.94)/2

=3.0

3.3.2 Standard Consistency of Cement

Theory: Standard consistency is characterized as that rate water necessity of the concrete glue, the thickness of which will be with the end goal that the Vicat's plunger infiltrates up to a direct 5 toward 7 mm from the base of the Vicat's form.The question of leading this test is to discover the measure of water to be addedto the bond to get a glue of ordinary consistency i.e. a glue of certain standard.

Table 7: Normal Consistency of Cement

S.No	percentage of water to be added	Depth not penetrated(mm)
1	28%	37
2	30%	33
3	32%	12
4	34%	5

Initial reading is the indicator reading when the lower and of the plunger touchesthe bottom non-porous paste.

Standard consistency of cement = 34%

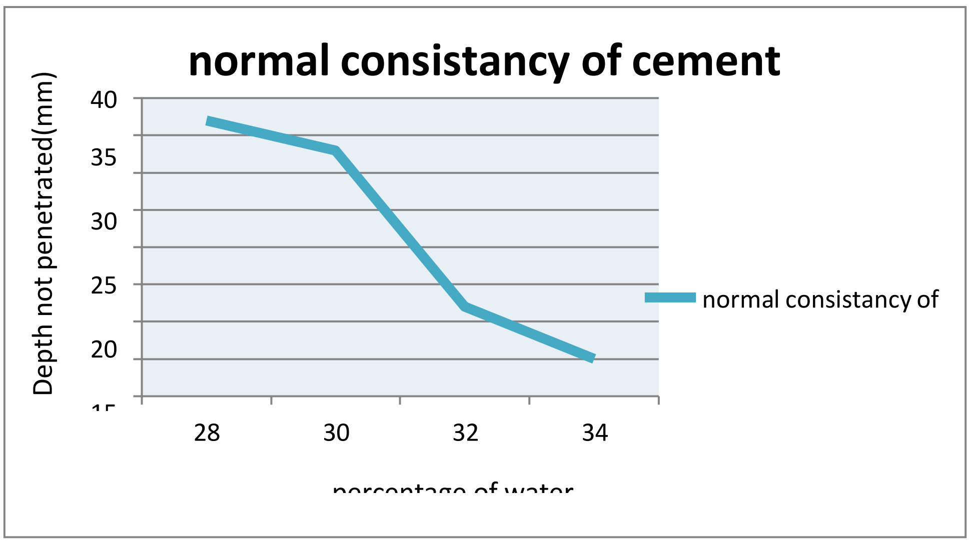

Figure 3: Shows the normal consistency of cement

3.3.3 Standard Consistency of Cement with Replacement of 10% Fly Ash

Theory: Typical consistency is characterized as that rate water necessity of theconcrete glue with substitution of 10% fly powder, the thickness of which will beto such an extent that the Vicat's plunger enters up to a guide 5 toward 7 mmfrom the base of the Vicat's form. The protest of directing this test is to discover the measure of water to be added to the bond with the substitution of 10% fly cinder to get a glue of typical.

Table 8: Normal Consistency of Cement 10% replacement of cement

S.NO.	Percentage of water to be added	Depth not penetrated (mm)
1	30%	29
2	32%	21
3	33%	15
4	34%	6

Initial reading is the indicator reading when the lower and of the plunger touchesthe bottom non-porous paste.

Standard consistency of cement = 34%

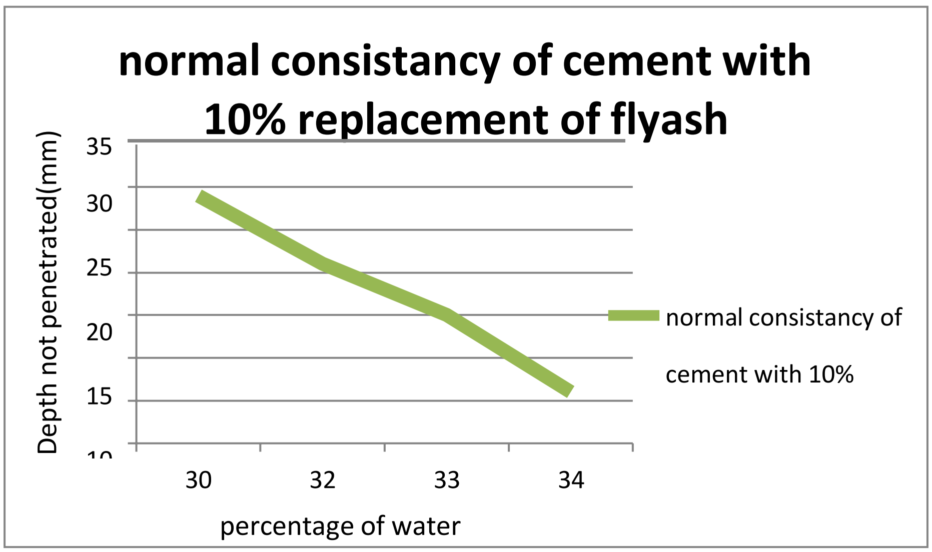

Figure 4: Shows the normal consistency of cement with 10% replacementof Fly Ash

3.3.4 Standard Consistency of Cement with Replacement of 20% Fly Ash

Theory: Ordinary consistency is characterized as that rate water necessity of the concrete glue, the thickness of which will be with the end goal that the Vicat's plunger infiltrates up to a guide 5 toward 7 mm from the base of the Vicat's shape. The protest of directing this test is to discover the measure of water to be added to the bond with substitution 20% of fly fiery remains a glue of ordinary consistency.

Table 9: Normal Consistency of Cement with 20% replacement of fly ash

S.NO.	Percentage of water to be added	Depth not penetrated(mm)
1	30%	30
2	32%	23
3	33%	13
4	34%	5

Initial reading is the indicator reading when the lower and of the plunger touchesthe bottom non-porous paste.

Standard consistency of cement = 34%

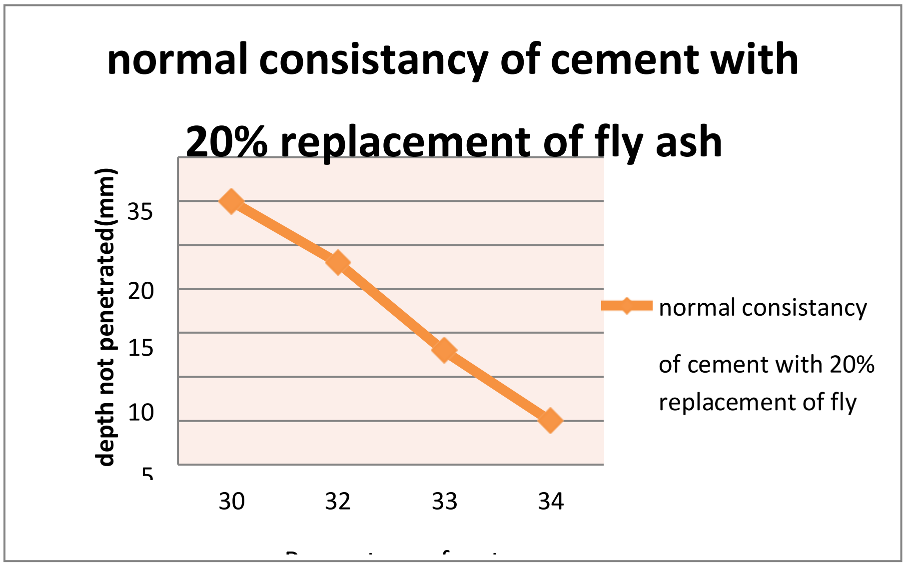

Figure 5: Shows the normal consistency of cement with replacement of 20%Fly Ash

3.3.5 Standard Consistency of Cement with Replacement of 30% of FlyAsh

Theory: Normal consistency is described as that percent water requirement of thecement with replacement of 30% fly ash paste, the viscosity of in order to be suchthat the vicat's plunger penetrates up to a point five to 7 mm from the bottom of sure general.

Table 10: Normal Consistency of Cement with replacement of 30% fly ash

S.NO.	Percentage of water to be added	Depth not penetrated (mm)
1	30%	33
2	32%	21
3	33%	17
4	34%	12
5	35%	5

Initial reading is the indicator reading when the lower and of the plunger touchesthe bottom non-porous paste.

Standard consistency of cement = 35%

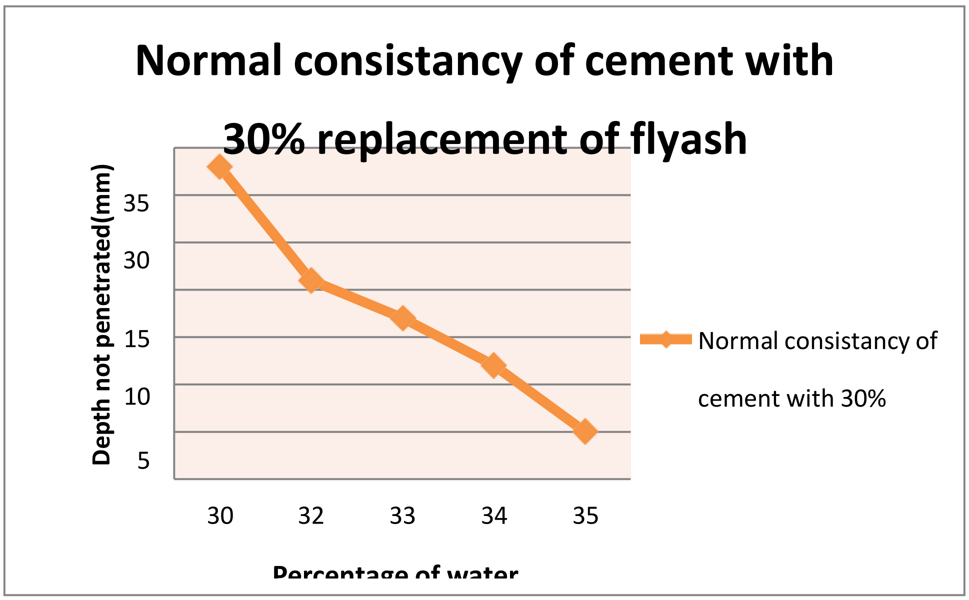

Figure 6: Shows the normal consistency of cement with 30% replacement offly ash

3.3.6 Initial and Final Setting Time:

Bond glue was set up by blending concrete with 0.85 times proper blending water required to give a glue of standard consistency. The stop watch was begun at the moment the blending water was added to the concrete. After a large portion of a-minute, the glue was completely blended with fingers for one moment. The form lying on a nonporous plate was filled totally with concrete glue and the surface of filled glue was leveled smooth with the highest point of the shape. The test was directed at room temperature of 27±2^{0}C at a relative stickiness of 60%. The form with the concrete glue was set in the Vicat's contraption and the needle was brought tenderly down to reach the test squareand was then immediately discharged. The needle in this way enters the piece andthe perusing on the graduated size of Vicat's device was recorded. The systemwas rehashed until the point that the needle neglects to puncture the piece by around 5 to 7 mm measured from the base of the shape. The stop catch of stop watch was pushed down and the time was recorded which give the underlying setting time. The bond glue was considered at last set when after applying the needle tenderly to the surface of test obstruct, the needle makes a submersion, yetneglects to infiltrate and the time was noted which gives the last setting time. Theneedle was cleaned after each redundancy and furthermore mind was taken with the end goal that there couldn't any vibrations.

3.3.7 NORMAL CONCTRETE INITIAL AND FINAL SETTING TIMES:

Weight of cement = 400gms

Amount of water added = 0.85*P*Weight of cement

= 0.85*0.34*400

= 115.6 ml

Table 11: Shows the Initial setting time of normal cement

S. No.	Time (min)	Depth not penetrated (mm)
1	30	2
2	35	3
3	40	5
4	42	5

Initial setting time =40 min
Final setting time =380 min

AS PER IS12269-1987

Initial setting time >30 min

Final setting time <600 min

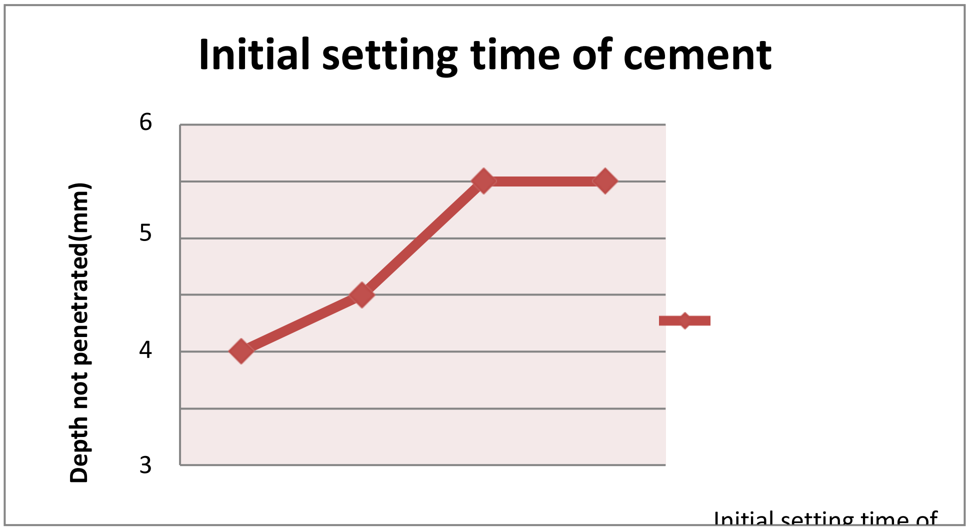

Figure 7: Shows the initial setting time of cement

3.3.8 INITIAL AND FINAL SETTING TIMES OF CEMENT WITH 10% REPLACEMENT OF FLY ASH:

Weight of cement = 400gms

Amount of water added = 0.85*P*Weight of cement

= 0.85*0.34*400

= 115.6 ml

Table 12: Shows the Initial setting time of cement with replacement of 10%fly ash

S. No.	Time(min)	Depth not penetrated(mm)
1	32	2
2	36	3
3	40	3
4	45	3.5
5	60	6

Initial setting time =60 minFinal setting time =300 min
AS PER IS12269-1987

Initial setting time >30 min Final setting time <600 min

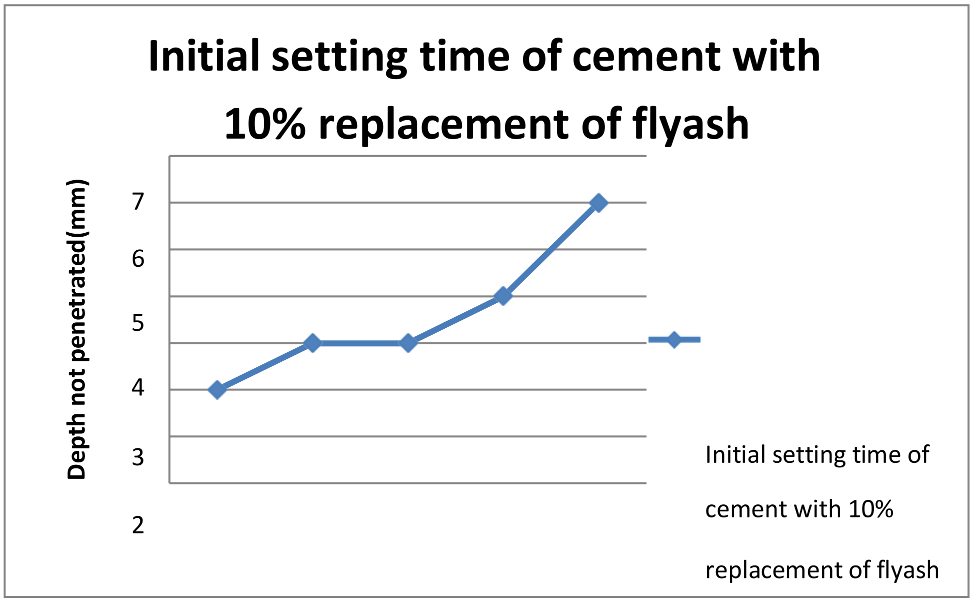

Figure 8: Shows the initial setting time of cement with 10% replacement ofFly Ash

4. CONCLUSIONS

Fly Ash and GBFS is utilized as a part of generation of solid 3D shapes and chambers substitution concrete by fly fiery remains measurement of 10% at substitution sand by slag dose of 10%, 20%, 30%, substitution bond by fly powder dose of 20% at substitution of sang by slag dose of 10%, 20, 30%, substitution of bond by fly cinder dose of 30% at substitution of sand by slag dose of 10%, 20%,30%.These 3D squares and barrels were curedand tried for compressive quality and split elasticity for 3days, 7days, 14days, 28days, 56days, 90days and comes about were noted. In view of exploratory examination directed after conclusions are made.

- With expanding of fly powder and slag rates in solid then the workability ought to beexpanded slowly when contrasted with ordinary cement.
- By utilizing of fly fiery debris and slag in concrete the water ingestion amount oughtto be expanded step by step on account of slag consumed greater amount of water.
- The most intriguing finding was that fly ash impedes the underlying setting andquickens the last setting of solid mortar.
- The exploratory outcomes demonstrate that the pozzolanic movement of fly cinderand slag squander increments with increment of time.
- The physical properties of bond with the substitution of fly fiery debris and slag wereobserved to be increment with the expanding of the rates of admixtures.
- Although the soundness of bond was observed to be increment after substitution of

admixtures.

- The compressive for
- 100% bond + 0% substitution mineral admixtures at 3 days, 7 days, 14 days, 28 days,56 days and 90 days were 15.82 N/mm^2, 18.74 N/mm^2, 23.54 N/mm^2, 29.25 N/mm^2, 35.47 N/mm^2 and 37.54 N/mm^2.
- 10% FA+10% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 20.66 N/mm^2, 32.6 N/mm^2, 33.33 N/mm^2, 36.88 N/mm^2, 39.77 N/mm^2, 42.55 N/mm^2, 10% FA+20% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 20.88 N/mm^2, 23.55 N/mm^2, 24.22 N/mm^2, 25.99 N/mm^2, 32.22 N/mm^2, 35.55 N/mm^2.
- 10% FA+30% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 19.33 N/mm^2, 20.66 N/mm^2, 20.44 N/mm^2, 22.88 N/mm^2, 25.15 N/mm^2, 28.66 N/mm^2.
- 20% FA+10% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 23.77 N/mm^2, 26.22 N/mm^2, 26.22 N/mm^2, 31.22 N/mm^2, 33.11 N/mm^2, 35.11 N/mm^2, 20% FA+20% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 18.88 N/mm^2, 20.44 N/mm^2, 23.77 N/mm^2, 29.99 N/mm^2, 31.11 N/mm^2, 32.66 N/mm^2.
- 20% FA+30% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were14.22 N/mm^2, 19.11 N/mm^2, 21.77 N/mm^2, 24.88 N/mm^2, 26.21 N/mm^2, 27.22 N/mm^2.
- 30% FA+10% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 14.44 N/mm^2, 20.66 N/mm^2, 21.11 N/mm^2, 23.33 N/mm^2, 28.22 N/mm^2, 30.22 N/mm^2, 30% FA+20% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 13.77 N/mm^2, 19.77 N/mm^2, 20.55 N/mm^2, 21.33 N/mm^2, 27.55 N/mm^2, 29.33 N/mm$^{2.}$
- 30% FA+30% GBFS at 3 days, 7 days, 14 days, 28 days, 56 days and 90 days were 111.77 N/mm^2, 17.22 N/mm^2, 18.22 N/mm^2, 18.99 N/mm^2, 23.55 N/mm^2, 27.66 N/mm^2.
- The Compressive quality of cement for 10% FA and 10% GBFS is more contrastedwith that for 10% FA and 20% GBFS and 10% FA and 30% GBFS
- The Compressive quality of cement for 20% FA and 10% GBFS is more contrastedwith that for 20% FA and 20% GBFS and 20% FA and 30% GBFS.
- The Compressive quality of cement for 30% FA and 10% GBFS is more contrastedwith that for 30% FA and 20% GBFS and 30% FA and 30% GBFS.
- The greatest quality had accomplished 39.59% expanded at 10 % FA and 10% GBFS substitution when contrasted with controlled cement.
- The split elasticity esteems were observed to be bit by bit diminished while the mix ofrate substitution of admixtures is expanded.

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