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Experimental Study of Fly Ash Concrete with Steel Fiber

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Abstract—**The main objective of this paper is to analyse the situation and behavior of M20 grade concrete with mis design 1:1.5:3 and with 0.48 water cement ratio. Here cement was partially replaced by 10% ,20%, 30% of fly ash of F- class by weight.also addition of steel fiber of hook type in percentage of 0.5%,1%,1.5% was used to produce M20 grade concrete. aspect ratio of steel was used as 50. Compression strength test, flexural strength test, split tensile test were performed according to guildlines of BIS. The test were co related with results of normal concrete. Due to addition of steel fiber Compression strength, flexural strength , split tensile strength has increased. Especially flexural strength has increased very high. The high results were obtained at a percentage of 10% flyash with 1.5% of steel fiber.**

Keywords— **Flyash, steel fiber,workability test, flexural strength test, split tensile strength test, compression strength test, absorption test.**

I. INTRODUCTION

The impact of crushed stone aggregates, extraction of the source that are formed in many parts of the country and has created a lot of problems in the environment. it included the loss of forests, noise,dust blasting, vibration and pollution hazards . In India 70% of electricity generated from thermal power plants.environmental threats include Air pollution, water pollution and particularly shortage of land for the dumping that fly ash. in India there is the worst conclusion for dumping coal.the outcome of Air that comes from coal and lignite that are used in power plants, as the result being light becomes airborne the scores help Problem. the important here is that when it reaches in the atmosphere cause depletion of Ozone layer now to overcome from this problem the best choice the waste material has to be use it if limited.

In India as we know there is problem of dumping area and majority of electricity is generated from thermal power full supply generation is estimated to be 154 million tonnes in 2001 to 2012 . To work on this problem, although flyash is used as landfills but now flyash is used as replacement material for cement, also in payments, base blocks. if we have to use flyash in large quantities like embankment fills, replacement aggregate should be considered. in India their the artificial aggregate is not used widely reason is cost is very high and easy availability of natural resources .

The composition of flyash depends upon the different proportions of cement and formation of light weight concrete. it is so much influence is using directly as concrete, in construction industry. the design and construction due to flyash is very much economic as it reduce the weight of concrete and there is the reduction of weight of the structures due to fly ash, so that Idea is not an addition of structures.while we're taking concrete into consideration we have flyash that has less and it as coarse aggregate concrete. its density of concrete is between two 2200 to 2600 kg /mm. so, it is way it is very high as compared to fly ash that makes it an economic instructional material. In other words concrete produces density that is required for self weight of structure and nonstructural members are reduced it. so it is very much easier While We're taking flyash instead of concrete as economy is achieved in design that support structure element that leads with the lightweight concrete when we are taking conventional concrete and changing its production of completion method, that is because this is known as light weight concrete.

Role of fibre reinforced fly ash concrete:- the cement concrete which is uniformly dispersed, shortcrete and randomly oriented for various fibrous elements that increase the structural integrity is known as fibre reinforced concrete. and the addition of fibre is added to concrete mix than their percentage measured is the total volume of compound when we divide fiber length L by diameter d, it gives aspect ratio of the fibre. the mixture which is component by the addition of cement, flyash, aggregate and fibre is known as flyash fibre reinforced concrete. The fiber used in the cement mixture also act as crack arester, that helps in the prevention of cracks through large under load. the chemical and mechanical property of flyash abounded its data to access the material parameters. the replacement of cement with flyash different percentage presented by Goplasrhnam 2001 besides is the use of flyash concrete and fibre concrete components. As the cement is replaced evenly workability starts increasing bhat compressive strength, split tensile strength, flexural strength goes on decreasing and No effect was noted on the behaviour of plain concrete

How flash protects concrete:- the important effect of durability of concrete is its permeability it will reduce the amount of water needed to produce a given slump and fly ash concrete is less permeable. in pozzolanic activity, it will make more durable CSH as it will fill capillaries and bleed, water channels which are accompanied by the water soluble lime. it will also improve corrosive protection. by decreasing concrete permeability flyash can read use the rate of Ingress of water, corrosive chemical and oxygen. these do this basis it will protect Steel renforcement from dust and its subsequent expensive result. it will also increase the resistance of sulphate and decrease alkali silica reactivity. at this point a difference between class C and class F need to be made. it will both improve their permeability and general durability of concrete, the chemistry of class F was has proved to be more effective in mitigating sulphate and alkali silica expension and deterioration in concrete. Same of class C could be used to mitigate is reactions, but it will be used at the largest rate of cement replacement. fly ash in concrete will reduce sulphate attack in the two additional ways.

1). it will reduce calcium hydroxide, which combine with sulfate to produce gypsum. Gypsum is the material that has large volume then calcium hydroxide and sulfates which combined to form it, cause and damaging expansion.

2) in the cement aluminates also combine with sulfate to form expensive compounds.

Replacing of cement, the total density of available aluminate is reduced, therefore through this process it will decrease the potential for this type of expensive reaction. by reducing the alkali silica the reactivity, of flyash has the ability to react with the alkali hydroxide in Portland cement paste makes them and unavailable for action with reactive silica in certain aggregates.

More studies suggest that larger than 30% of Replacement with flyash for cement as a dramatic effect in combining this expansive reaction.

II. LITERATURE STUDY

In previous research 1983 Gaze and Nixon has studied how the effect of fly ash on the expanded of bars of motar bars which contains Beltane Opal, a highest reactive aggregative, stored at 38c. 10, 20 or 30% 0f fly ash 0f 1 series of specimen were made using of low alkali cement. In order to eliminate of effect of dilution of the alkalis potassium sulphate was added to kept alkali level constant at 12% equivalent Na2o.

As even when the alkali content was kept constant the fly ash reduced the expansion of the mortar, with every little expansion for the 20% and 30 % fly ash motars was varied from 0.9- 1.2% by adding potassium sulphate in order to stimulate the effect of diluting a high – alkali cement with up to 30% fly ash. They also found that dilution of the alkalis may also reduced expansions, but by less than was achieved by the substitution of fly ash for the part of the cement. When the alkali content was kept constant. Thus the effect of fly ash on the expansion due to alkali- silica reaction cannot be attributed to dilution alone. Thomas Etal in 1991 examined concrete specimens of equivalent 28- day strength and workability but was made with difficult levels of fly ash. Prisms 75x75x200mm were stored at 100% R.H at either 20c or 38c. Length changes were monitored for two years, after which they were placed at an outdoor exposure site for seven years. The deration of engineering properties the specimens containing either no fly ash or 5%fly ash suffered significant expansion and cracking due to a alkali – silica reaction. However, specimens with 20% or 30% of a high- alkali fly ash substituted for the cement exhibited lillte expansion and no cracking. Petrographic examination of these specimens showed no evidence of damaging alkali- silica reaction. Alkali- silica gel was found in isolated locations not associated with cracking. The authors have pointed out that if the fly ash were acting only as an inert diluent of the cement alkalis, one would expect a reduction in alkali – silica reaction. It has also seen that the results of effect of fly ash are more than simply the dilution of alkalis. In concretes having similar cement contents and equal quantizes of reactive sand, the concrete with 20% fly ash – suffered no damage while the concrete without fly ash experienced considerable expansion and cracking. Using a fly ash with a high total alkali content. In 1985 Nixon Etal found that an early ages the fly ash made a net contributed to the alkali content of the pore solution. After 28 days, however the fly ash has reduced the alkalinity of the pore solution below that produced by dilution with an inert material. However the fly ash has reduced the alkalinity of the pore solution below that produced by dilution with an inert material. However, with very low alkali cements, the fly ash contributed to the alkanity at ages up to one year. In the year 1978 Bhatty and Greeing has studied that the ability of calcium silicate hydrates to retain different types of alkalis. They found that hydrates having low Cao/Sio2 ratios are more effective in binding alkalis. E.g.

The hydrate with a Cao/ Sio2 ratio of o.97 retained the twice amount of alkali as the hydrate with a Cao/ Sio2 ratio of 1.25.

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They also found that calcium silicate hydrate in equilibrium with 1N NaOH solution has a maximum Cao/Sio2 ratio between 1.25 and 1.32, while the Cao/Sio2 ratio of calcium silicate hydrate formed on the hydration of cement is about 1.5. The addition of a Pozzolan to the cement reduces the Cao/Sio2 ratio, thus reducing the solution alkali. After that Bhatty in 1985 extended and modified this works using C3S and finely ground opal as the reactants in water or 1N NAOH solution. By comparing the alkali concentration in the original solution with the filtrates obtained after different reaction times, Bhatty was also able to determine the amount of alkali retained by the hydrates. He concluded that the amount of Sio2 needed to prevent deleterious expansions due alkali – aggregate reaction should be such that the Cao/Sio2 ratio does not exceed about 1.5. Some of the silica may be supplied by the aggregate itself. The effect of fly ash on the pore structure of concrete may also help to reduce expansions due to alkali- silica reaction. The silica in fly ash reacts with the calcium hydroxide produced by the hydration of the cement to form calcium silicate. The reaction results in a finer, less continuous pore system when calcium silicate hydrate ay consider three mechanisms by which fly ash controls takes up more space than the calcium hydroxide it replaces. In field exposures, where water and additional alkalis may enter the concrete from the environment this tightening of the pore structure limits their availability to participate in the generation and swelling of alkali- silica reaction thus one may consider three mechanisms by which fly ash controls expansion:-

1. By binding them into the low cao/ sio2 remove some of the alkalis from the pore solution.
2. Due to pozolanic reaction of the fly ash with calcium hydroxide produced by the hydration of the cement reduce of concrete permeability and diffusivity.
3. Atleast a lower avalaible alkali content or dilution of the cement alkalis by a fly ash with a lower alkali content.

The first mechanism does not apply if the cement content is not reduced. However the other two also still plays a role. This test program examines the effectiveness of these two mechanisms in, controlling expansion due to alkali- silica reaction.

III. OBJECTIVES

The experiment was carried out to overcome the problems created due to huge requirement of the raw material for manufacturing of conventional building material and also to minimize hazards caused by Industrial waste on the environment.

A. To investigate the effect of fly ash & steel fiber in concrete by determining its

(1) Workability
(2) Flexural Strength
(3) Compressive Strength
(4) Split Tensile Strength
(5) Absorption Test

B. To determine the optimum content of the fly ash & steel fiber to be used as replacement in concrete to improve the

(1) Flexural Strength
(2) Compressive Strength
(3) Split Tensile Strength

IV. METHODOLOGY

A. Ordinary Portland cement (OPC)

Most of the investigation on SCC is being made using ordinary Portland cement. Though all cement conforming to various IS codes are suitable, selection of cement should be based on their compressive strength, fineness and compatibility with other ingredient. Here OPC 43 grade is used.

The cement used in this experimental work is 43 grades Ordinary Portland Cement. All properties of cement are tested by referring IS 12269 - 1987 Specification for 43 Grade Ordinary Portland cement. The specific gravity of the cement is 3.15. The initial and final setting times were found as 90minutes and 180 minutes respectively. Standard consistency of cement was 31.25%.

B. Aggregates

The aggregates are normally divided into two categories, namely fine and coarse. Fine aggregate normally consists of natural, crushed, or manufactured sand. Coarse aggregates can be made of natural gravel or crushed stone. In the present study the sand confirm to zone II as per Indian standards. The crushed aggregate used were 12.5mm.A maximum size of 10mm to 14 mm is usually selected as coarse aggregates up to 20 mm may be used in SCC.

Fine aggregate :

Locally available sand passed through 4.75mm IS sieve is used. The specific gravity of 2.84 and ineness modulus of 3.895 are used as fine aggregate. The loose and compacted bulk density values of sand are 1094and 1162 kg/m3 respectively, the water absorption of 1.491%.

Coarse Aggregate

Crushed aggregate available from local sources has been used. The coarse aggregates with a maximum size of 20mm having the specific gravity value of 2.958 and fineness modulus of 7.136 are used as coarse aggregate. The loose and compacted bulk density values of coarse aggregates are 1467 and 1629kg/m3 respectively, the water absorption of 1.30%. 10MSA:-Crushed aggregate available from local sources has been used. The coarse aggregates with a maximum size of 10mm having the specific gravity value of 3.016and fineness modulus of 5.829 are used as coarse aggregate. The loose and compacted bulk density values of coarse aggregates are 1531 and 1726kg/m3 respectively, the water absorption of 1.835%.

C. Fly ash

Fly ash a by-product of the combustion of pulverizes coal in thermal power plants. Fly ash is used in developing SCC to make up the demand for higher powder content. Fly ash is ranging in diameter from less than1µm up to 150µm. they are use full in enhancing the deformability and stability of the fresh SCC. Class F- normally produced from bituminous coal has been used.

S.No	Property	Formula	% content
1.	Silicon Dioxide	Sio2	59.04
2.	Aluminum Oxide	Al2O3	34.08
3.	Iron Oxide	Fe2O3	2.0
4.	Lime	Cao	0.22
5.	Sulphur Trioxide	SO3	0.05
6.	Magnesium Oxide	Mgo	0.43
7.	Alakalies	NA2O	0.5
8.	Alakalies	K2O	0.76
9.	Loss of ignition	LOI	0.63

D. Steel fiber

The inclusion of fibre especially steel fibers in SCC significantly enhances the flexural strength, ductility and toughness. Because of its non-flexibility it gives more strength. The most important thing describing a fiber is its aspect ratio. Aspect ratio is the length of fibre divided by an equivalent diameter of fibre, where equivalent is the diameter of the circle with an area equal to the cross sectional area of fibre. Steel fiber having aspect ratio 50 with geometry of cylindrical hooked ends used.

E. Viscosity modifying agent

Viscosity modifying agent is mostly used in the he self-compacting concrete; it was used for the workability and stability of the concrete. The viscosity modifying agent mostly was in liquid from, powder type or combination of two.

V. RESULTS

Replacement % Used	**Strength in N/mm^2**		
	7th Day	**14th Day**	**28th Day**
0% GP	15.5	17.3	20.06
10% & 0.5%	18.43	21.25	28.04
10% & 1%	19.4	22.3	28.56
10% & 1.5%	24.06	28.08	34.53
20% & 0.5%	17.28	20.6	27.05
20% & 1%	17.68	22.3	27.4
20% & 1.5%	18.64	24.93	31.20
30% & 0.5%	14.90	17.83	26.61
30% & 1%	15.3	18.4	25.08
30% & 1.5%	13.3	14.53	22.05

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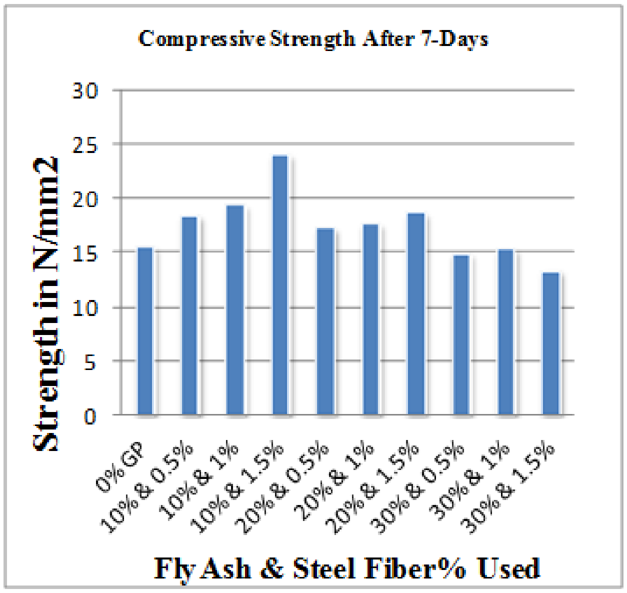

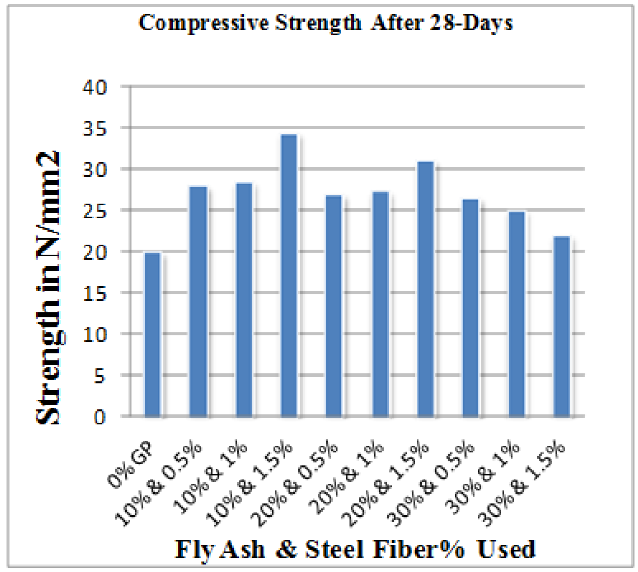

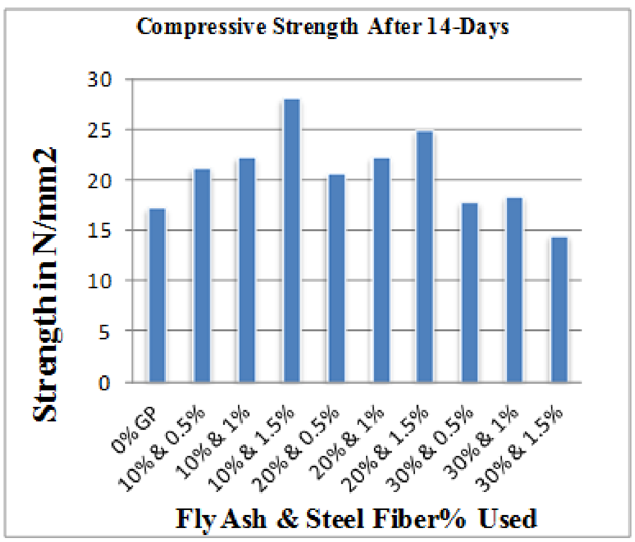

Replacement % Used	Strength in N/mm2		
	7th Day	14th Day	28th Day
0% GP	3.67	4.32	5.4
10% & 0.5%	3.45	4.64	5.76
10% & 1%	4.32	5.31	6.43
10% & 1.5%	6.02	6.24	6.64
20% & 0.5%	2.95	3.64	5.53
20% & 1%	4.06	4.98	6.20
20% & 1.5%	5.3	6.1	6.73
30% & 0.5%	2.87	4.05	5.32
30% & 1%	4.06	4.93	6.05
30% & 1.5%	4.24	6.02	7.75

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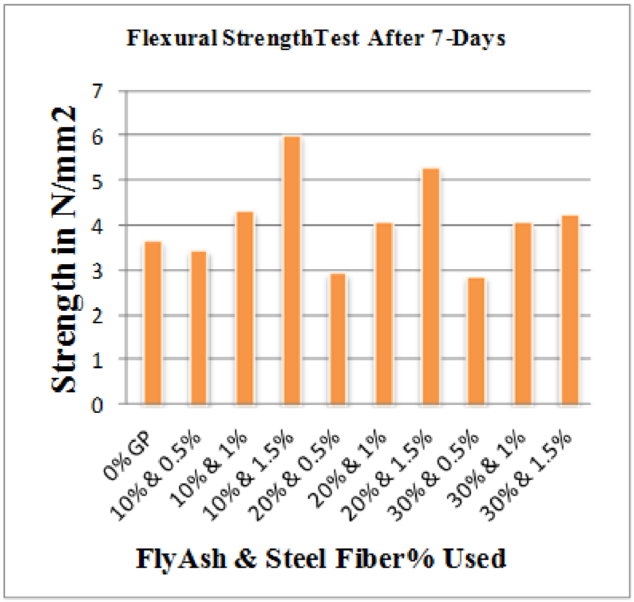
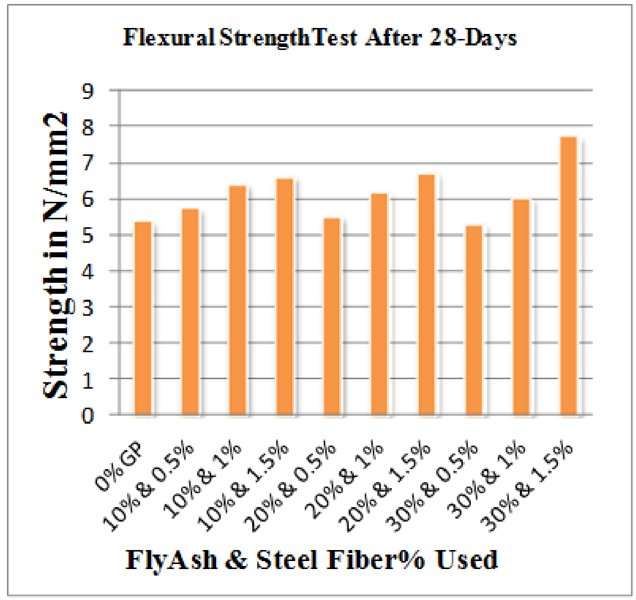
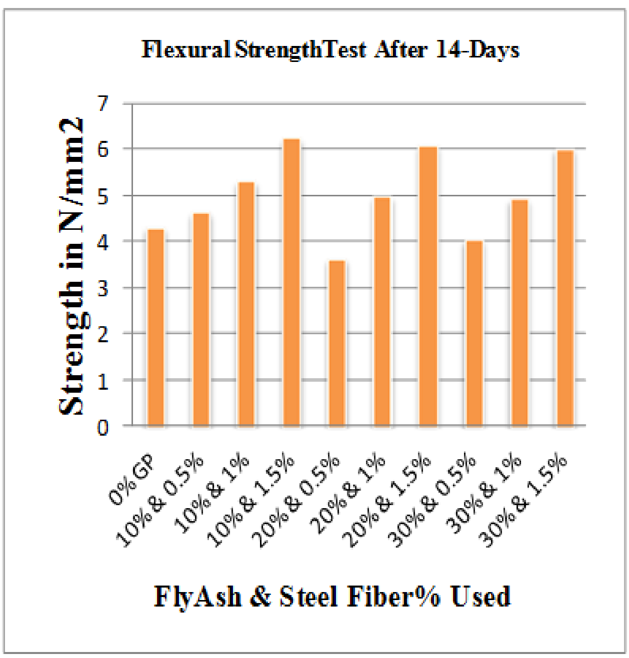
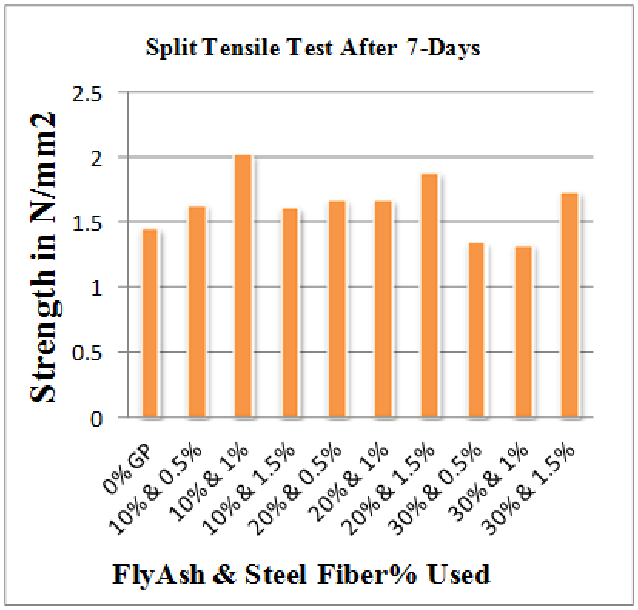
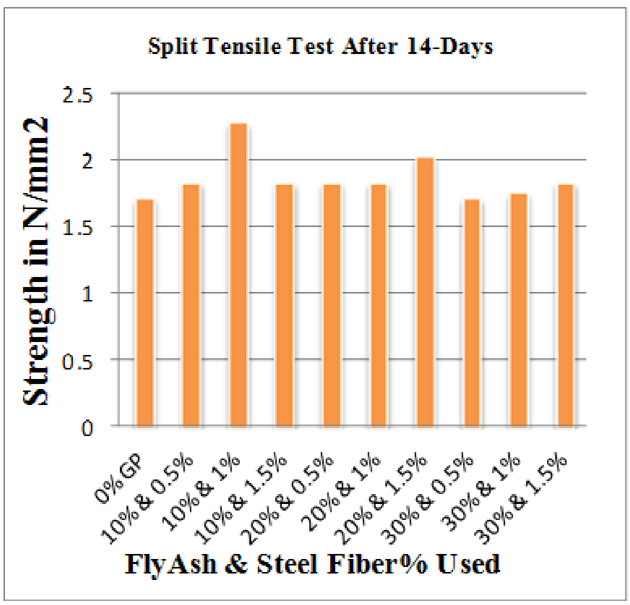


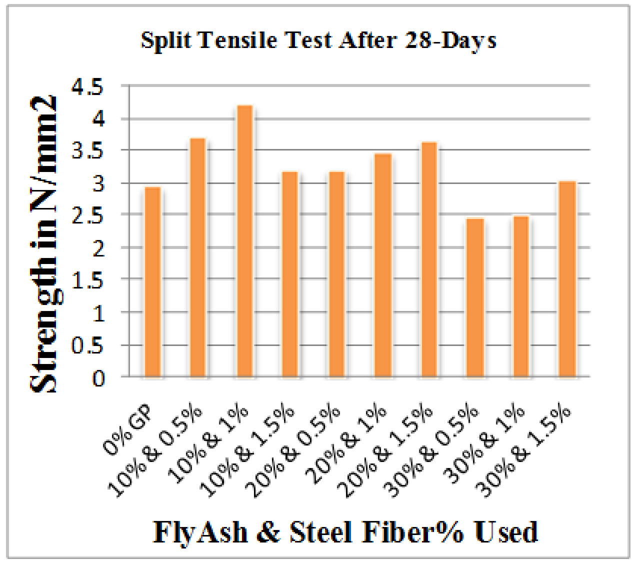




Replacement % Used	Strength in N/mm2		
	7th Day	14th Day	28th Day
0% GP	1.46	1.72	2.94
10% & 0.5%	1.64	1.84	3.70
10% & 1%	2.03	2.29	4.21
10% & 1.5%	1.62	1.84	3.2
20% & 0.5%	1.68	1.84	3.2
20% & 1%	1.68	1.84	3.46
20% & 1.5%	1.89	2.03	3.64
30% & 0.5%	1.35	1.72	2.45
30% & 1%	1.33	1.76	2.5
30% & 1.5%	1.74	1.84	3.03







Slump Test	
Replacement % of Cement by flyash and steel fiber	Overall Slump in mm
0%	42
5%	46
10%	53
15%	61
20%	72
25%	85
30%	98

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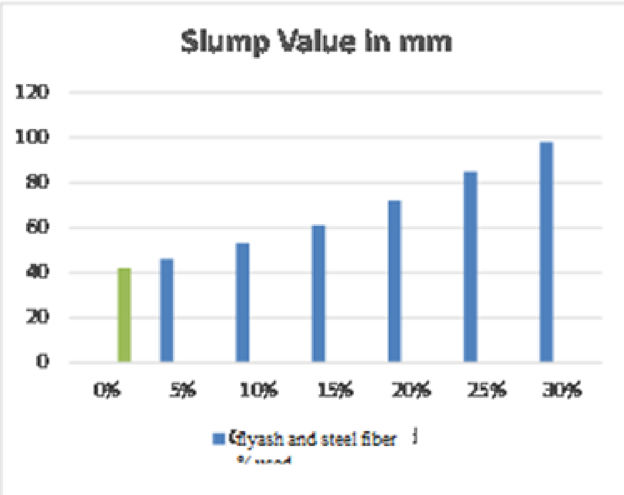
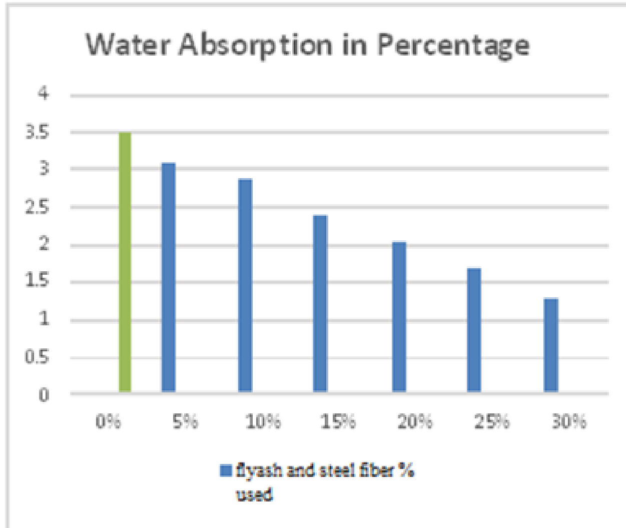


Water Absorption Test	
Replacement % of Cement by flyash and steel fiber	Overall Absorption %
0%	3.48
5%	3.08
10%	2.86
15%	2.38
20%	2.02
25%	1.67
30%	1.26



VI. CONCLUSION

By the above experimentation we conclude that,

1) When the percentage of 10% of fly ash with 1% of steel fiber is used there is increase in the strength that is in compression test, flexural test and split tensile strength.
2) Workability goes on increasing constwhen there is increase in the amount of steel fiber and fly ash.
3) Absorption deceases with the increase in the percentage of steel fiber and fly ash.

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