ISSN No: - 2456 – 2165

Study of High Strength Concrete With and Without Plastic Fibers

Author:

Khzeema Hussain

Faisal Hamza

Muzaffar Hussain

ISSN No: - 2456 – 2165

ABSTRACT

Concrete is the construction material being used extensively in the world next to water. the impact of environment factors on concrete reduces the desired strength ,life, durability etc. as an alternative high strength concrete has being researched upon to improve the desired mechanical properties for meeting the structural performance of the concrete

High strength concrete (HSC) is a product of high quality ingredients with high percentage cement ,aggregates, low water cement ratio, silica fume, super plasticizer etc.

In this thesis the experimental set up is made to study the mechanical properties of HSC with and without plastic fibers. similarly the effect of silica fume on HSC by varying its percentage by 0% 5% 10% in the mix studied. for all mixes 25% extra fly ash has been added for cement and sand. In this experiment, comparison for compressive strength is shown between cubes made of gravel stone of (10mm) with and without fiber.

The aim of this project is to observe the compressive strength with and without using plastic fibers.

ISSN No: - 2456 – 2165

INTRODUCTION

High Strength Concrete:- is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The term 'High Strength' is somewhat pretentious because the essential feature of this concrete is that it's ingredients and proportions are specifically chosen so as to have particularly appropriate properties for the expected use of the structure such as high strength and low permeability. Hence High Strength concrete is not a special type of concrete. It comprises of the same materials as that of the conventional cement concrete. The use of some mineral and chemical admixtures like Silica fume and Super plasticizer enhance the strength, durability and workability qualities to a very high extend.

High Strength concrete works out to be economical, even though it's initial cost is higher than that of conventional concrete because the use of High Strength concrete in construction enhances the service life of the structure and the structure suffers less damage which would reduce overall costs. Concrete is a durable and versatile construction material. It is not only Strong, economical and takes the shape of the form in which it is placed, but it is also aesthetically satisfying. However experience has shown that concrete is vulnerable to deterioration, unless precautionary measures are taken during the design and production. For this we need to understand the influence of components on the behavior of concrete and to produce a concrete mix within closely controlled tolerances. The conventional Portland cement concrete is found deficient in respect of :

- Durability in severe environs (shorter service life and frequent maintenance)
- Time of construction (slower gain of strength)
- Energy absorption capacity (for earthquake resistant structures)

• Repair and retrofitting jobs. Hence it has been increasingly realized that besides strength, there are other equally important criteria such as durability, workability and toughness. And hence we talk about 'High Strength concrete' where performance requirements can be different than high strength and can vary from application to application. High Strength Concrete can be designed to give optimized performance characteristics for a given set of load, usage and exposure conditions consistent with the requirements of cost, service life and durability. The high strength concrete does not require special ingredients or special equipments except careful design and production. High Strength concrete has several advantages like improved durability characteristics and much lesser micro cracking than normal strength concrete. Any concrete which satisfies certain criteria proposed to overcome limitations of conventional concretes may be called High Strength Concrete. It may include concrete, which provides either substantially improved resistance to environmental influences or substantially increased structural capacity while maintaining adequate durability. It may also include concrete, which significantly reduces construction time to permit rapid opening or reopening of roads to traffic, without compromising long-term serviceability. Therefore it is not possible to provide a unique definition of High Strength Concrete without considering the performance requirements of the intended use of the concrete.

ISSN No: - 2456 – 2165

EXPERIMENTAL ANALYSIS

Since the scope and the objectives of the study has been mentioned earlier, there are procedures should be followed to perform a specific function in this chapter. All the tests and the results shall be shown from appropriate table and graph that can be prepared simultaneously. At this stage, the main function is to show the various steps and systems that lead to the results of testing materials selected. Once the characteristic of the materials selected has been performed through appropriate testing, the comparisons between the materials should be analyzed comprehensivelyto produce a good results as well as good conclusions.

MIX DESIGN PROPORTION

In this thesis a mix design has been made using Erntroy and Shaklock's Empirical Graphs and got 1:0.92:1.38:0.33

MATERIAL FOR TESTING.

The concrete mixes were prepared with material available atHyderabad, except silica fume and fly ash was imported from Bombay and Ramagundam. The cementation material was a combination of cement (Ultra Tech cement Grade 53), fine sand, fly ash, granite screenings,10mm gravel chips, silica fume(SF), and super plasticizer.

3.4 DESIGN MIX FOR HIGH STRENGTH CONCRETE

28 days cube strength =60 N/mm^2

Very good quality control

Control factor 0.8(Experimental value)

Degree of workability - very low

Type of cement - Ordinary Portland Cement

Type of Coarse aggregate - gravel(construction aggregate) maximum size 10mm

Type of fine aggregate - Natural sand

Specific gravity *of* cement = 3.15 Sand = 2.60(Experimental value)

Coarse aggregate = 2.50

Free surface moisture: Fine aggregate-5%, coarse aggregate-1%

Mix design

Average strength (a) = Strength /Control factor=60/0.8=7.5 N/mm2

Reference number = 10

Water /Cement ratio = 0.33 Aggregate/ Cement ratio =2.3

(10mm C.A; very low workability)

Fine aggregate/Total aggregate =40

By weight 1:2.3x0.4:2.3x0.6 w/c=0.33

I= $C/3.15x10^3$ + $0.92C/2.6x10^3$ + $1.38C/2.5x10^3$ + 0.32C/10' (If C is the mass of cement required per m^3 of concrete)

I= $(3.175x10^{-4}$ + 3.538x10-4 + $5.52x10^{-4}$ + $3.2)(10^{-4})$ C

I= $(15.433x10^{-4})$ C

C=641.96

Cement = 641.96; Fine aggregate = 591.125Kg; Coarse Aggregate = 887.185kg

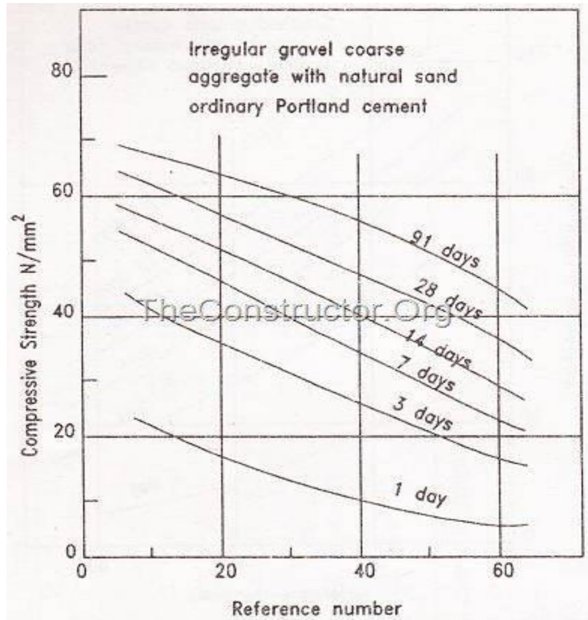
5% F.A = 5/100x 596.125 = 29.806Kg

1% C.A = 1/100x894.185 = 8.942Kg

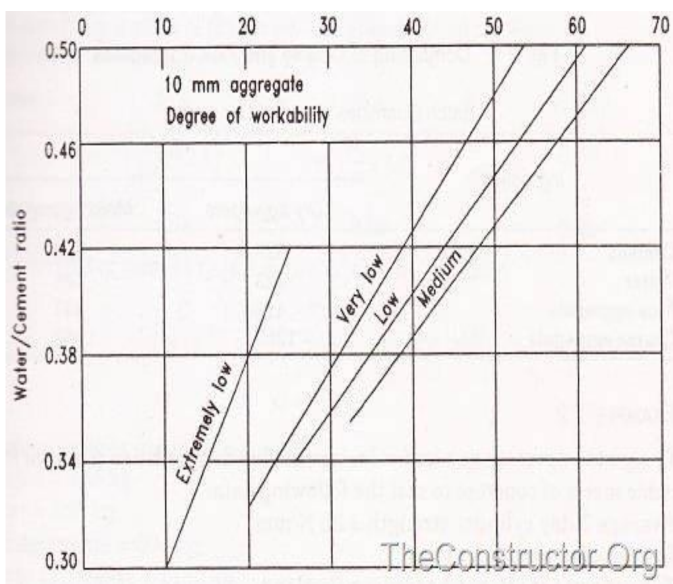
Total volume for 9 cubes per batch

$0.1x0.1x0.1=1x10^{-3}$ (100x100 mm cube dimension)

$9x1x10^{-3}=0.009m^3$ (volume for 9 cubes)



Relation between compressive strength and reference number for mixes containing gravel as coarse aggregate, natural sand and ordinary Portland cement.



Relation between water/cement ratio and reference number for 10mm size aggregates

Type of coarse aggregate*	Irregular gravel								Crushed granite							
Maximum size of aggregate	20 mm				10 mm				20 mm				10mm			
Degree of workability**	EL	VL	L	M	EL	VL	L	M	EL	VL	L	M	EL	VL	L	M
Water / cement ratio by weight																
0.30	3.0	–	–	–	2.4	–	–	–	3.3	–	–	–	2.9	–	–	–
0.32	3.8	2.5	–	–	3.2	–	–	–	4.0	2.6	–	–	3.6	2.3	–	–
0.34	4.5	3.0	2.5	–	3.9	2.6	–	–	4.6	3.2	2.6	–	4.2	2.8	2.3	–
0.36	5.2	3.5	3.0	2.5	4.6	3.1	2.6	–	5.2	3.6	3.1	2.6	4.7	3.2	2.7	2.3
0.38	–	4.0	3.4	2.9	5.2	3.5	3.0	2.5	–	4.1	3.5	2.9	5.2	3.6	3.0	2.6
0.40	–	4.4	3.8	3.2	–	3.9	3.3	2.7	–	4.5	3.8	3.2	–	4.0	3.3	2.9
0.42	–	4.9	4.1	3.5	–	4.3	3.6	3.0	–	4.9	4.2	3.5	–	4.4	3.6	3.1
0.44	–	5.3	4.5	3.8	–	4.7	3.9	3.3	–	5.3	4.5	3.7	–	4.8	3.9	3.3
0.46	–	–	4.8	4.0	–	5.1	4.2	3.6	–	–	4.8	4.0	–	5.1	4.2	3.6
0.48	–	–	5.2	4.4	–	5.4	4.5	3.8	–	–	5.1	4.2	–	5.5	4.5	3.8
0.50	–	–	5.5	4.7	–	–	4.8	4.0	–	–	5.4	4.5	–	–	4.7	4.0

*Natural sand used in combination with both types of coarse aggregate

**EL = extremely low

VL = very low

L = low

M = medium

Aggregate/cement ratio required to give four degree of workability with different water/cement ratio using ordinary Portland cement.

3.7 TESTS FOR COMPRESSIVE STRENGTH OF CONCRETE SPECIMEN

This cause deals with the procedure for determining the strength of concrete specimens.

Apparatus

Testing Machine — The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible error shall be not greater than ± 2 percent of the maximum load. The testing machine shall be equipped with two steel bearing platens with hardened faces. One of the Platens (preferably the one that normally will bear on the upper surface of the specimen) shall be fitted with a ball seating in the form of apportion of a sphere, the centre of which coincides with the central point of the face of the platen. The other compression platen shall be plain rigid bearing block. The bearing faces of both platens shall be at least as large as, and preferably larger than the nominal size of the specimen to which the load is applied. The bearing surface of the platens, when new, shall not depart from a plane by more than 0.01 mm at any point, and they shall be maintained with a permissible variation limit of 0.02 mm .The movable portion of the spherically seated compression platen shall be held on the spherical seat, but the design shall be such that the bearing face can be rotated freely and tilted through small angles in any direction.

AGE AT TEST

Test shall be made at recognized age of the test specimens, the most usual being 7 and 28 days. ages of 13 weeks and 1 year are recommended if test at greater ages are required. where it may be necessary to obtain the early strengths, test may be made at the age of 24 hrs ± 1/2 hrs and 72 hrs ± 2 hrs. the ages shall be calculated from the time of the addition of water to the dry ingredients.

NUMBER OF SPECIMENS

At least three specimens, preferably from different batches, shall be made for testing at each selected age.

NOTE: When a full investigation is being carried out, it is advisable for three separate batches to be made for each given variable. an equal number of specimens for each variable should be made.

PROCEDURE

Specimens stored in water shall be tested immediately on removal from the water and while they are still in thawed condition. surface water and grit shall be wiped off the specimens and any projecting fins removed. specimen when received dry shall be kept in water for 24 hrs before they are taken for testing. the dimensions of the specimens to the nearest 0.2mm and their weight shall be noted before testing.

Placing the specimen in the Testing Machine

The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen, which are to be in contact with the compression platens. In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom. The axis of the specimen shall be carefully aligned with the centre of thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine. As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maxim load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

Calculation

The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross-sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest kg per sq cm. Average of three values shall be taken as the representative of the batch provided the individual variation is not more than + 15% of the average. otherwise repeat test shall be made.

Report

The following information shall be included in the report On each test specimen:

- Identification mark,
- Date of test,
- Age of specimen,
- Curing conditions, including date of manufacture of specimen in the field,
- Weight of specimen,
- Dimensions of specimen,
- Cross-sectional area,
- Maximum load,
- Compressive strength

ISSN No: - 2456 – 2165

Mix Proportion of HSC

sample	Q m^3	Opc kg	Fly ash kg	Silica fume %	Sand kg	Aggregate kg	Water lit	Super plasticizer	Type	Plastic fibers g
P1	0.009	5.8	2.7	0	5.3	8	2.8	211	10MM gravel & plastic fiber	210
P2	0.009	5.5	2.7	5	5.3	8	2.8	210	10MM gravel & plastic fiber	208
P3	0.009	5	2.7	10	5.3	8	2.7	206	10MM gravel & plastic fiber	205
P4	0.009	5.8	2.7	0	5.3	8	2.8	211	10MM gravel	
P5	0.009	5.5	2.7	5	5.3	8	2.8	210	10MM gravel	
P6	0.009	5	2.7	10	5.3	8	2.7	206	10MM gravel	

RESULTS AND ANALYSIS

TABLE 4.1: DOSAGE OF SUPER PLASTIZER TO BE ADDED FOR THE MIX

TABLE NO:4.1.1: 25ml per kilogram of cement

NO OF DAYS	COMPRESSIVE STRENGTH(N/MM^2)
7	38.55
14	46.42
28	58.31

TABLE NO 4.2:COMPRESSIVE STRENGTH WITH PLASTIC FIBERS

TABLE NO 4.2.1:10 MM GRAVEL STONE 0% SILICA FUME

NO OF DAYS	COMPRESSIVE STRENGHT(N/MM^2)
7	32.46
14	48.38
28	54.21

TABLE NO 4.2.2: 10 MM GRAVEL STONE 5% SILICA FUME

NO OF DAYS	COMPRESSIVE STRENGHT(N/MM^2)
7	33.16
14	49.65
28	56.11

ISSN No: - 2456 – 2165

TABLE NO 4.2.3:10 MM GRAVEL STONE 10% SILICA FUME

NO OF DAYS	COMPRESSIVE STRENGHT(N/MM^2)
7	34.89
14	49.64
28	57.55

TABLE NO 4.3:COMPRESSIVE STRENGTH WITHOUT PLASTIC FIBERS

TABLE NO 4.3.1:10 MM GRAVEL STONE 0% SILICA FUME

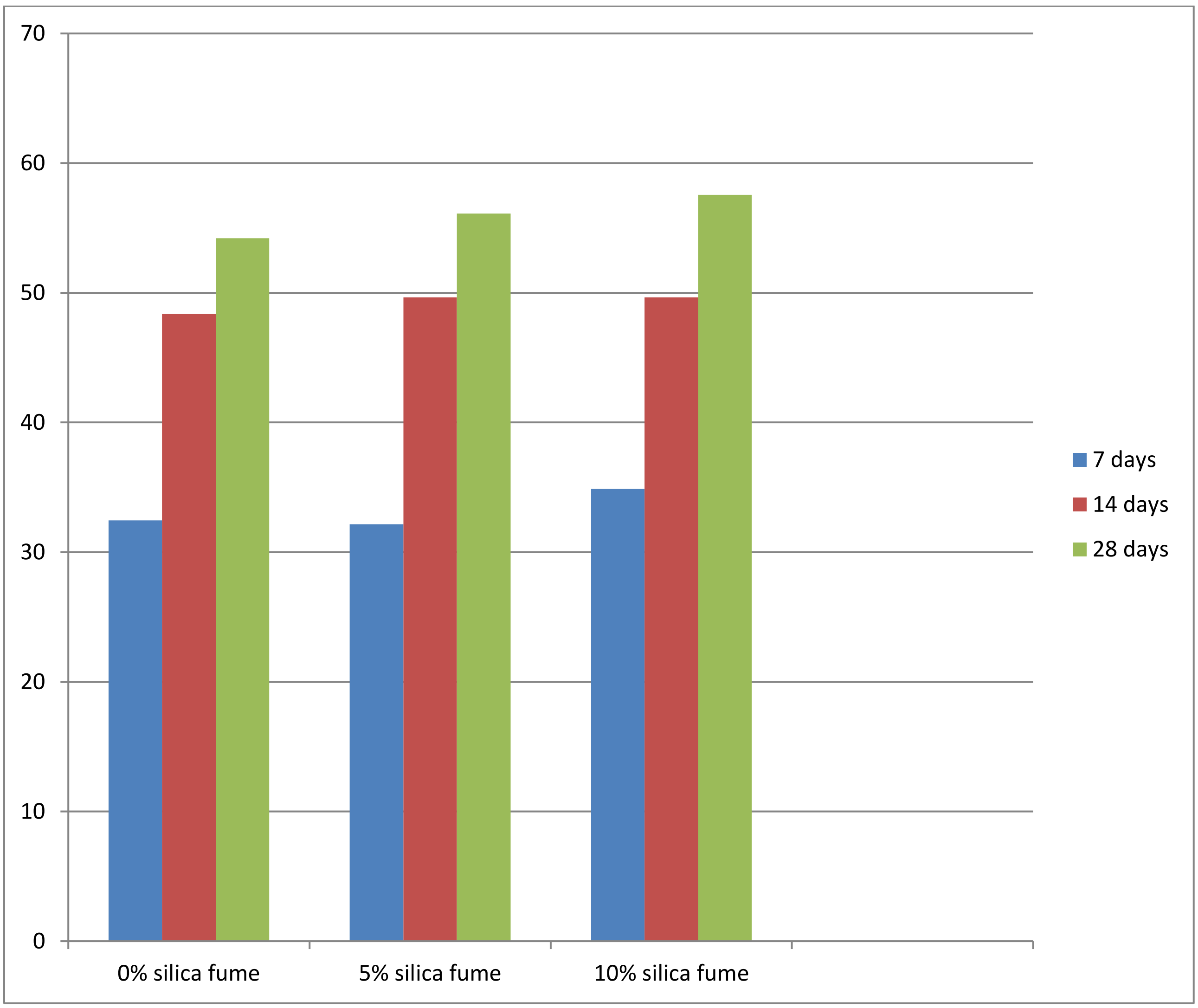
NO OF DAYS	COMPRESSIVE STRENGHT(N/MM^2)
7	32.56
14	53.76
28	64.56

TABLE NO 4.3.2:10 MM GRAVEL STONE 5% SILICA FUME

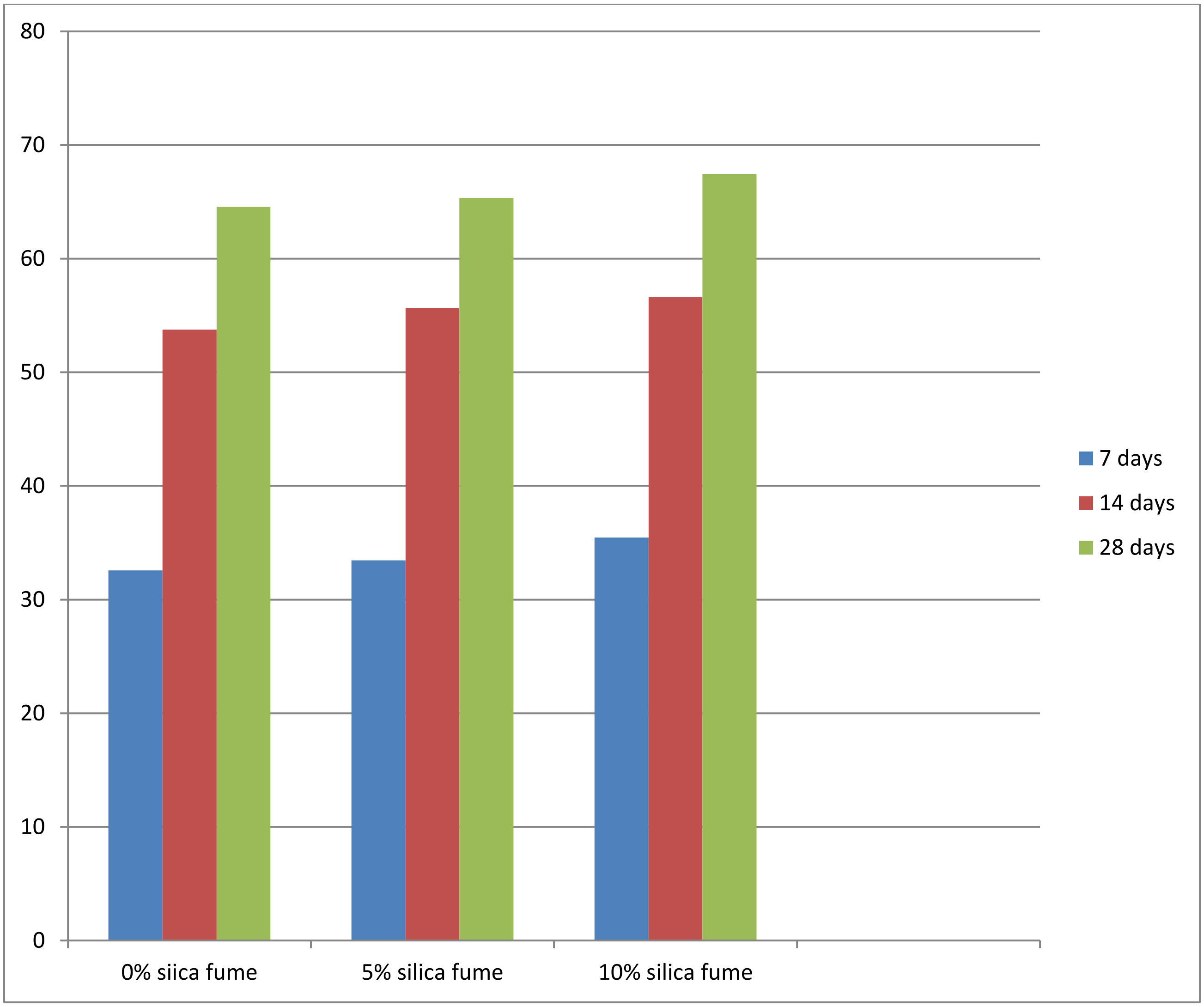
NO OF DAYS	COMPRESSIVE STRENGHT(N/MM^2)
7	33.45
14	55.65
28	65.34

TABLE NO 4.3.3:10 MM GRAVEL STONE 10% SILICA FUME

NO OF DAYS	COMPRESSIVE STRENGHT(N/MM^2)
7	35.46
14	56.61
28	67.44



COMPRESSIVE STRENGTH WITH 10 MM GRAVEL WITH PLASTIC FIBER AND TAKING SILICA FUME OF PERCENTAGE 0%,5%,10



COMPRESSIVE STRENGHT WITH 10MM GRAVEL WITHOUT PLASTIC FIBER TAKING PERCENTAGE OF SILICA FUME 0%,5%,10%

ISSN No: - 2456 – 2165

CONCLUSIONS-AND RECOMMENDATION

- Concrete with smaller size aggregates (10mm) exhibited highercompressive strengths. This could be attributed to the improved bond and more homogenous behavior of concrete.

- By trial and error method the dosage of super plasticizer of

- 25ml per kilogram of cement has given good result.

- It was observed that by use of plastic fibers there was deduction in the strength of concrete.

- By adding 10% of silica fume, it has given good compressive strength result when compared to 5% of silica fume

RECOMMENDATIONS

There are various recommendations suggested for future works are as follows:

- Other studies like creep, shrinkage, permeability should be investigated
- The study can be done by replacing the fly ash instead of adding it to cement and sand
- 10mm size of aggregate has given good result in terms of strength and the same can be further investigated
- Mix design of M60 has been done and further study on 10mm size aggregate can be done on other heavy mixes

ISSN No: - 2456 – 2165

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