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Cost Analysis of Concrete by Partial Replacement of Cement with Pozzolanic Material

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Abstract: ***The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming.***
The search for any such material, which can be used as an alternative or as a supplementary for cement so we had taken a research for partial replacement of cement by combine mixing of GGBS,FLY-ASH & SILICA FUME in a constant percentage and studying the effect of special material on concrete as well as cost analysis of concrete.

I. INTRODUCTION

Concrete has basic naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. After the water, cement is second most used material in the world. But this rapid production of cement creates two big environmental problems for which we have to find out civil engineering solutions. First environmental problem is emission of CO2 in the production process of the cement. We know thatCO2 emission is very harmful which creates lots of environmental changes whatsoever. Ground Granulated Blast furnace slag (GGBS) is a by-product for manufacture of pig iron and obtained through rapid cooling by water or quenching molten slag. Here the molten slag is produced which is instantaneously tapped and quenched by water. This rapid quenching of molten slag facilitates formation of "Granulated slag". Ground Granulated Blast furnace Slag (GGBS) is processed from Granulated slag. Fly ash is one of the residues created during the combustion of coalincoal-fired power plants. Fine particles rise with flue gasses and are collected with filter bags or electrostatic precipitators. Silica Fume is a finely-divided mineral admixture, available in both un compact and compacted forms. This ultra-fine material will better fill voids between cement particles and result in a very dense concrete with higher compressive strengths and extremely low permeability.

II. METHODOLOGY

The study work is to analyses strength properties of partially replaced by GGBS, FLY-ASH, and SILIKAFUME concrete. The tests of concretes are carried out as per IS code for this proposed investigation work.

Steps for Trial…Introduction

↓

Collection of Materials

↓

Test conducted on Materials

↓

Trail mix design

↓

Casting of specimen

↓

Testing of specimen

↓

Results and observations

↓

Conclusion

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III. PROPERTIES OFINGREDIENTS

A. Cement

The cements used in this experimental works are ordinary Portland cement. All properties of cement are tested by referring IS Specification for Ordinary Portland cement. Test results are presented in Table

SR.NO.	DISCRIPTION OFTEST	RESULT
01	Fineness of test	1%
02	Specific gravity	3.15
03	Standard consistency of cement	35%
04	Setting time of cement a) Initial setting time b) Final setting time	 90minute3 60minute
05	Soundness test of cement(with le –	1.5mm

Table 3.1. Physical Properties of Cement(Confirming to IS 12269-1987)

IV. TESTING OF MIX DESIGN

Result Of Trail Mix (observations and test Results)

1) Workability targeted (in mm)
2) Workability observed (in mm)
3) Remarks
4) Corrections
5) Cohesiveness: Remarks
6) Compressive Strength (Average of Three Test Cubes)
a) 3 day (kg/ cm^2) 26.216 N/MM^2
b) 7 day (kg/ cm^2) 32.148 N/MM
c) 28 day (kg/ cm^2) 36.26 N/MM^2

A. Hence This Give Result Of Mix Design For Control Concrete

Ratio (1: 1.47: 1.9) With 28 Days Strength 36.26n/Mm^2

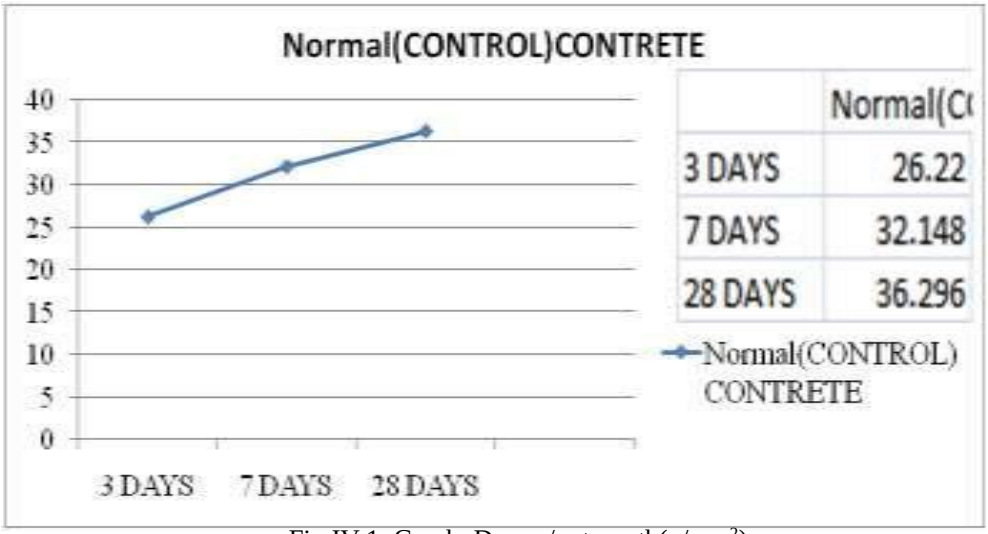


Fig.IV.1: Graph. Days v/s strength(n/mm^2)

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V. FLEXURAL STRENGTH TEST.

The arrangement for flexural strength test is shown in Figure. Automatic universal testing machine was used for this test according to BS1881-118 [12] Beam samples measuring 500×100×100mm were moulded and stored in water for 28days before test for flexural strength. Three similar samples were prepared for each mix proportion. The casting was made by filling Each mould with freshly mixed concrete in three layers. Each layer was compacted manually using a 25mm diameter steel tamping rod to give 150 strokes on a layer.

The hardened beam was placed on the universal testing machine simply supported over a span 3times the beam depth on a pair of supporting rollers. Two additional loading rollers were placed on top the beam. The load was applied without shock at a rate of 200m/s. The flexural strength was then calculated using.

The formula below

$$F_{cl} = \frac{PL}{D_1 D_2}$$

Where,

P = breaking load (in N);

D_1 and D_2 = lateral dimensions of the cross sections (In mm);

L = distance between the supporting rollers (In mm)

1: 1.47 : 1.9 mix	Water/ cement ratio =0.4	Flexural strength	Average						
	p	L	A=PL	D_1 MM	D_2 MM	D_2^2 MM	B = $D_2*D^2_2$	A/B	Avg.
1:1.47 : 1.9 mix	7926.5	400	3170600	100	100	10000	1000000	3.17	3.28
	8473.5	400	3389400	100	100	10000	1000000	3.39	
	6926.5	400	2770600	100	100	10000	1000000	2.77	2.88
	7473.5	400	2989400	100	100	10000	1000000	2.99	

Table V.I

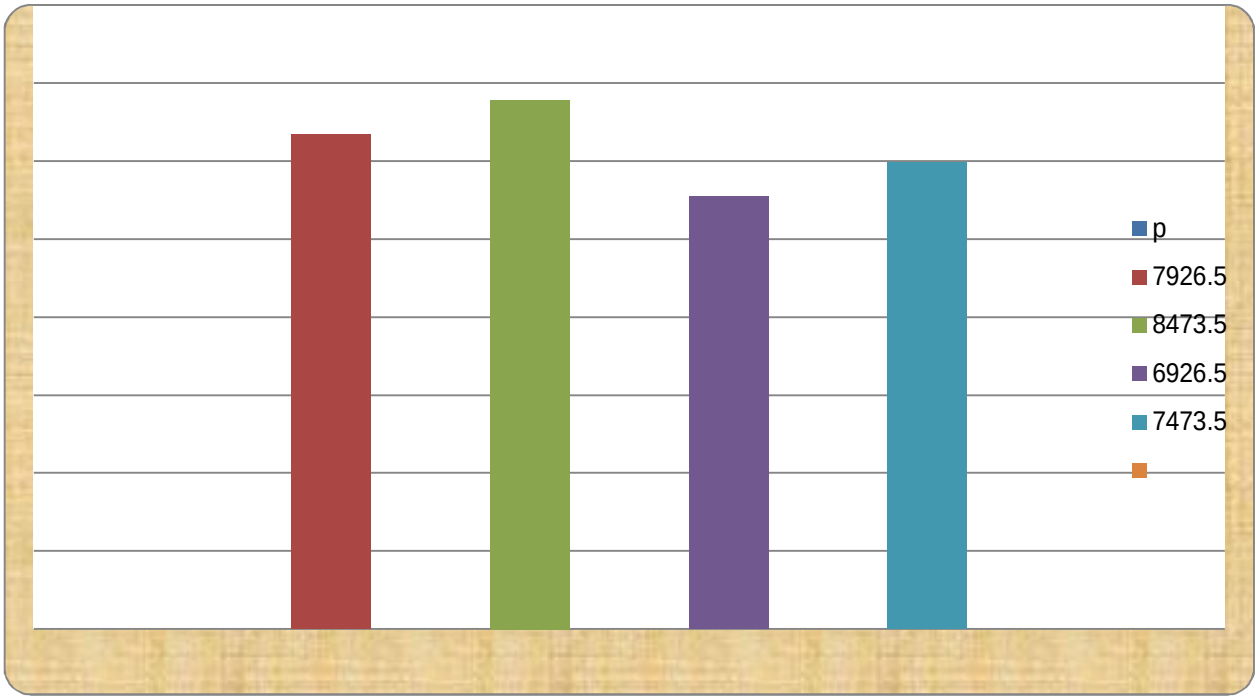


Fig V.2: Graph. load (P) v/s flexural strength(n/mm^2)

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A. Strength of Concrete Having Cement Constant Ie 50%

Comparison of control concrete strength with constant cement (50%) replacement strength

Table2.1 Strength of control concrete with replacement of constant cement

DAYS / STRENGTH(Mpa)	SLUMP(MM)	3DAYS	7 DAYS	28 DAYS
NORMAL CONCRETE(CONTROL CONCRETE (1:1.47:1.9)	75	26.22Mpa	32.148Mpa	36.296Mpa
Cement replacement(30:10:10) CEMENT 50%	65	14.22Mpa	24.59Mpa	29.8Mpa
Cement replacement (10:30:10) CEMENT 50%	80	17.77Mpa	20.00Mpa	29.55Mpa
Cement replacement (10:10:30) CEMENT 50%	75	12.00Mpa	20.11Mpa	29.5Mpa

B. Cement replacement with 50% give optimum result at (30%g:10%f:10%si) replacement i.e. 29.8mpa

COST OF INGREDIENTS PER KG AS PER MARKET RATE IN ASANGAON

G.G.B.S - 2.90 RS / KG

FLY-ASH - 2.75 RS/ KG

SILICA - FUME - 25 RS/ KG

CEMENT - 8.00 RS/ KG

as silica –fume is too much costly hence avoid the maximum replacement of silica-fume

C. Strength of concrete having cement constant ie. 60%

Comparison of control concrete strength with constant cement (60%) replacement strength

Table 4.3. Strength of control concrete with replacement of constant cement

DAYS / STRENGTH(Mpa)	SLUMP(MM)	3 DAYS	7DAYS	28 DAYS
NORMAL CONCRETE (CONTROL CONCRETE (1:1.47:1.9)	75	26.22 Mpa	32.148Mpa	36.296Mpa
Cement replacement(20:10:10) CEMENT 60%	70	22.88Mpa	29.77Mpa	34.00Mpa
Cement replacement(10:20:10) CEMENT 60%	65	14.66Mpa	20.00Mpa	33.33Mpa
Cement replacement(10:10:20) CEMENT 60%	75	13.688Mpa	19.11Mpa	30.33Mpa

D. Cement Replacement with 60% give optimum result at (20%G:10%F:10%Si) Replacement i.e. 34.51mpa

Cost of Ingredients Per kg as per Market Rate in Asangaon

G.G.B.S - 2.90 RS / KG

FLY-ASH - 2.75 RS/ KG

SILICA - FUME - 25 RS/ KG

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CEMENT - 8.00 RS/ KG
AS SILIKA –FUME IS TOO MUCH COSTLY HENCE AVOID THE MAXIMUM REPLACEME OF SILICA-FUME

E. Comparison of control concrete strength with constant cement (70%) replacement strength

Table 4.Strength of control concrete with replacement of constant cement.

DAYS / STRENGTH (Mpa)	SLUMP(MM)	3 DAYS	7DAYS	28 DAYS
NORMAL CONCRETE (CONTROL CONCRETE (1:1.47:1.9)	75	26.22 Mpa	32.148Mpa	36.296Mpa
Cement replacement (10:10:10) CEMENT 70%	70	17.185Mpa	32.07Mpa	34.00Mpa
Cement replacement (10:10:10) CEMENT 70%	70	17.085Mpa	24.07Mpa	34.00Mpa
Cement replacement (10:10:10) CEMENT 70%	70	17.19Mpa	20.11Mpa	34.00Mpa

F.

Cement replacement with 70% give optimum result at (10%G:10%F:10%Si) replacement ie 34.00mpa

Cost of Ingredients Per kg as per Market Rate in ASANGAON
G.G.B.S - 2.90 RS / KG
FLY-ASH - 2.75 RS/ KG
SILICA - FUME - 25 RS/ KG
CEMENT - 8.00 RS/ KG
AS SILIKA –FUME IS TOO MUCH COSTLY HENCE AVOID THE MAXIMUM REPLACEME OF SILICA-FUME

1) Quantity & cost for nine (09) cube for the testing(20g:10f:10si) ie 60% constant cement

Total quantity = 0.0513 m^3
CEMENT IN KG = 16.77 KG
SAND IN KG = 24.65 KG
AGGRIGATE IN KG = 15.93 KG(M1)
15.93 KG(M2)
TOTAL AGGRIGATE =31.86KG
COST FOR THE SAND = 24.65 X 1.32= 32.53 Rs. Ie 33.00 Rs
COST FOR THE AGGRIGATE = 31.86 X 1.1 = 35.046 Rs. Ie 36 Rs.
COST FOR CEMENT IN (20:10:10) CASE ie 60%constant cement.
Total weight of cement =16.77 kg
But 60% cement =0.6x16.77 = 10.062 kg
Hence cost of cement (20:10:10) = 10.062 x 8 = 80.496 Rsie 81.00 Rs.
REMAINING 40% HAVE (20% GGBS, 10% FLY-ASH, 10% SILIKA- FUME)
20% GGBS = 0.2 X16.77 = 3.354 KG
COST FOR GGBS = 3.354 x 2.90 = 9.7266 Rs.
10% FLY-ASH = 0.1 X 16.77= 1.677 KG

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COST FOR FKY- ASH = 1.677 X 2.75 = 4.611Rs.
10% SILIKA- FUME = 0.1 X 16.77 = 1.677 KG
COST FOR SILIKA- FUME = 1.677 X 25 = 41.92 Rs.
Hence total cost for material for (20:10:10) replacement
= 33+36.00+ 81.00 + 9.7266 + 4.611 + 41.92
= 206.2626Rs. (for 20:10:10)
Hence total cost / m^3
4020.66 Rs. / m^3

2) Quantity & Cost For Nine (09) Cube For The Testing (10g:10f:10si) Ie70% Constant Cement.
TOTAL QUANTITY = 0.0513 M^3
CEMENT IN KG = 16.77 KG
SAND IN KG = 24.65 KG
AGGRIGATE IN KG = 15.93 KG(M1)
15.93 KG(M2)
TOTAL AGGRIGATE =31.86KG
COST FOR THE SAND = 24.65 X 1.32= 32.53 Rs. Ie 33.00 Rs
COST FOR THE AGGRIGATE = 31.86 X 1.1 = 35.046 Rs. Ie 36 Rs.
COST FOR CEMENT IN (20:10:10) CASE ie 70%constant cement
Total weight of cement =16.77 kg
But 70% cement =0.7x16.77 = 11.739 kg
Hence cost of cement (10:10:10) = 11.739 x 8 = 93.912 Rsie 94.00 Rs.
REMAINING 30% HAVE (10% GGBS, 10% FLY-ASH, 10% SILIKA- FUME)
10% GGBS = 0.1 X16.77 = 1.677 KG
COST FOR GGBS = 1.677 x 2.90 = 4.8633 Rs.
10% FLY-ASH = 0.1 X 16.77= 1.677 KG
COST FOR FKY- ASH = 1.677 X 2.75 = 4.611Rs.
10% SILIKA- FUME = 0.1 X 16.77 = 1.677 KG
COST FOR SILIKA- FUME = 1.677 X 25 = 41.92 Rs.
Hence total cost for material for (10:10:10) replacement
= 33.00 +36.00 + 94 + 4.8633 + 4.611 + 41.92
= 214.3943Rs.
Hence total cost / m^3
4179.22 Rs./ m^3

VI. RESULT

Sr. no.	Description of sample	Grade of concrete	Slump (mm)	Compressive Strength at 28 days	Tensile strength (N/mm^2)	Flexural strength (N/mm^2)	Cost (Rs.)/m^3
01	60% constant cement Remaining 40% Have (20% Ggbs, 10% Fly-Ash, 10% Silica- Fume) (60% constant cement) (20%G : 10%F : 10%Si)	M30	70mm	34.00 Mpa	2.053 (N/mm^2)	3.28 (N/mm^2)	4020.66 Rs./ m^3

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02	70% constant cement Remaining 40% Have (10% Ggbs, 10% Fly-Ash, 10% Silica- Fume) (70% constant cement) (10%G : 10%F : 10%Si)	M30	70 mm	34.00 Mpa	2.92 (N/mm^2)	2.88 (N/mm^2)	4179.22 Rs./ m^3

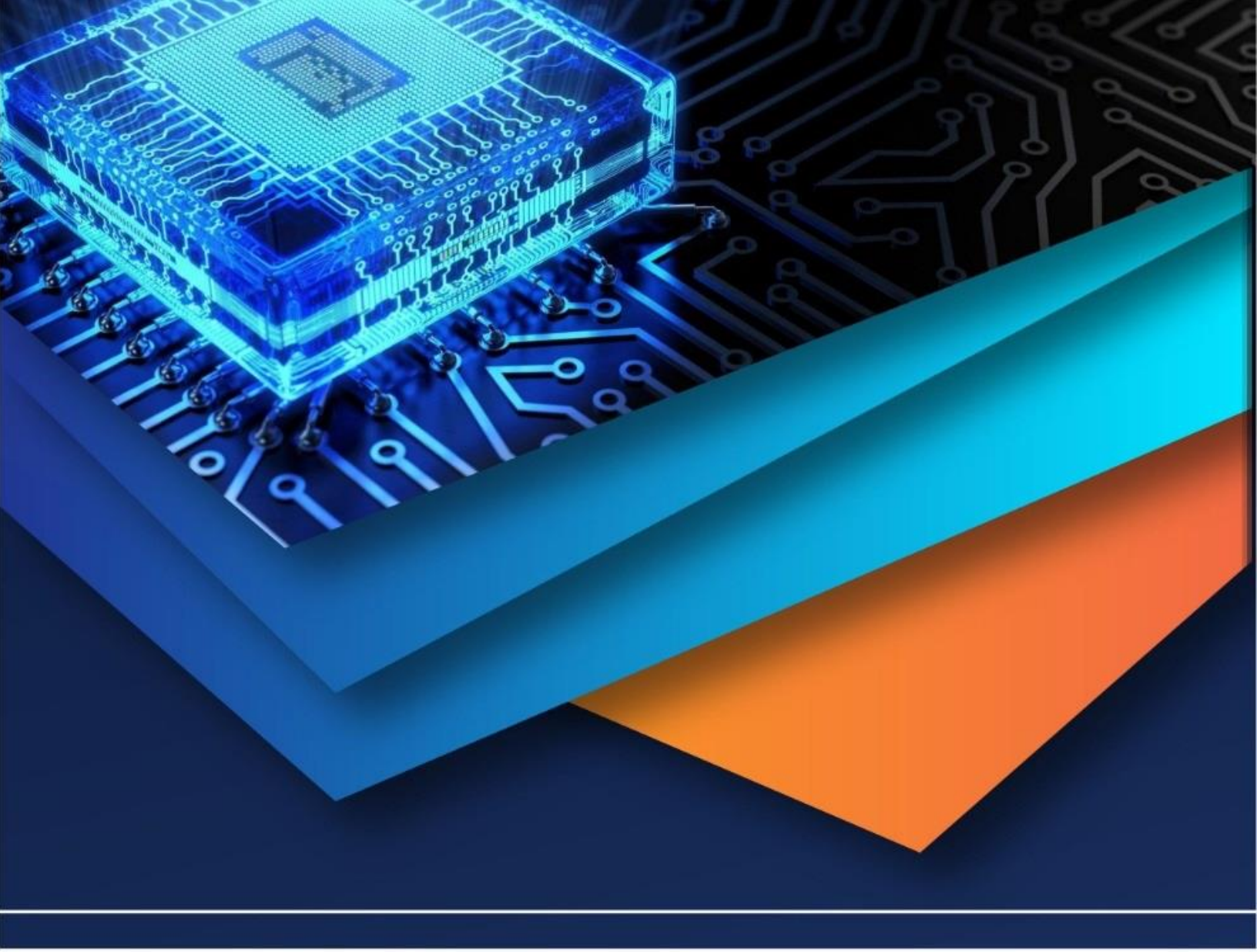
Comparing Both (20G:10F:10Si) & (10G:10F:10Si) the Replacement cost and strength.

a) Hence Preferably (20%Ggbs : 10%Fly-Ash : 10%Silica-Fume) are accepted.
b) Having 60% Constant Cement Replacement In The Presence Of GGBS, Fly-Ash And Silica-Fume Is Optimum.
c) Since The Cost Is Less And Strength Is Very much acceptable, Also cost saving of158.56 Rs / M^3

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