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COMPARATIVE ANALYSIS AND STUDY OF HIGH STRENGTH CONCRETE AND COST EFFECTIVENESS

DARLA GNANESWAR KUMAR [#1] , T S D PHANINDRANATH [#2], P. LAVANYA [#3]

[#1] M.Tech Scholar,Department Of Structural Engineering(Civil),
Chaitanya Engineering College,
Kommadi, Visakhapatnam -530 041.

[#2] Asst.Prof, Department of Structural Engineering(Civil),
JNTUV, AP, India.

[#3] Asst.Prof, Department of Structural Engineering(Civil),
Sai Ganapathi College of Engineering, AP, India.

ABSTRACT

Concrete is one kind of a composite material that is formed of fine and rough or harsh in texture bonded together with one kind of cement paste to get harden over time. There are various types of concretes used for constructing walls like lime-based concrete which forms by portland cement and some of them are formed by hydraulic cements like calcium aluminate cements. Although there are various types of composite materials, one among the most commonly used composite is asphalt concrete, mostly used for constructing the road surfaces formed by a material like bitumen. The main role of concrete is development of infrastructure i.e. for buildings and highways. If we look at the other side of the concrete usage, cost plays a vital role in choosing the best and accurate composition. In order to achieve the efficient mixture, there was a high strength concrete which is formed by a fresh water to give smooth states. In this paper we mainly focus on effective utilization of mineral admixture i.e. replacing fly in the place of cement & also adding a super plasticizer CONPLAST SP 430 as Mineral Admixture to obtained High Strength Concrete. By using the fly-ash in the composition we can able to reduce a lot of excess water usage during the construction.

Key Words:
Portland cement, Calcium Aluminate, Plasticizer, Admixture.

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1. INTRODUCTION

As we all know that concrete has been a major material for providing a stable and reliable infrastructure for constructing buildings, walls or floors. Concrete with compressive strengths of 20-40N/mm² have been traditionally used in construction projects. With the demand for more sophisticated structural forms along with deterioration, long term poor performance of a conventional concrete led to accelerated research for development of concrete which would score on all the aspects that a new material is evaluated upon i.e. workability, durability, affordability and thus enable the construction of sustainable and economic buildings with an extra ordinary slim designs besides providing material that will have long term better performance and reduced maintenance.

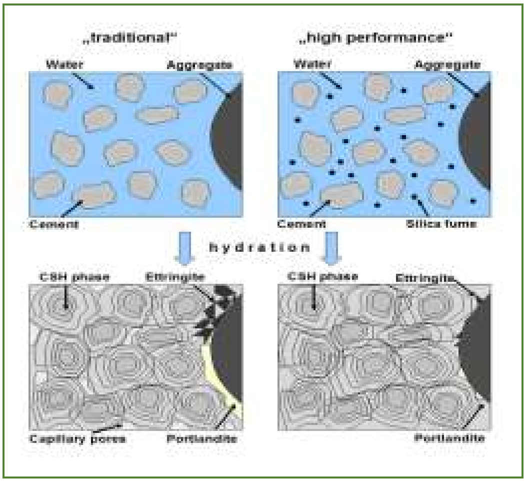

Figure.1. Represents the Difference between Traditional and High Strength Concrete (HSC)

The development of High Strength Concrete has been a great breakthrough in Concrete Technology. High strength concrete (HSC) may be defined as concrete with a specified characteristic cube strength between 40 and 100 N/mm², although higher strengths have been achieved and used. Strength levels of 80 to 100 N/mm² and even higher are being used for both precast and in-situ works.

From the above figure 1, we can clearly find out the differences between the traditional and high strength concrete, where the traditional concrete contains cement along with water. In that we can find the capillary pores inside the concrete. But if we look into the high strength concrete, we can find cement, water along with additional substance like silica fume. By using this silica fume inside the concrete, there will be no presence of capillary pores seen inside the concrete.

2. BACKGROUND WORK

In this section we will find the background work that was analyzed and studied in order to implement this current proposed project. This section will describe the work that is related to the study the cost effectiveness of designing structures with High Performance Concrete by giving a cost comparison between concrete M20 and M60 using a concrete mix achieved in the laboratory. Also here we can see the several researches that were done on the primitive concrete types. Now let us discuss about those in detail as follows:

A) MAIN MOTIVATION

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Some of the earlier researches on the effectiveness in designing of structures like high rise buildings with High Strength Concrete are as follows:

a) **J.HEGGER** (Aachen University of Technology, Institute of Concrete Structures, 52056 Aachen, Germany) studied the economical and constructional advantages of High Strength Concrete for a 186 m high rise building in Frankfurt, Germany concluded that, for columns designed for 20KN with 85MPa concrete more than 50% of the reinforcement can be saved when compared to 45MPa concrete.Inspite of the approximately 60% higher concrete cost the total cost of the building can be reduced by about 15%.

b) According to a study by **MORENO**, the use of 41MPa compressive strength concrete in the lower columns of a 23-storey commercial building requires a 865 mm^2 column whereas the use of 83MPa concrete allows a reduction in column size to 610 mm^2.In addition to the reduction in the initial cost, a smaller column size results in less intrusion in the lower stories of commercial space and, thereby more rentable floor space. Also studies have been conducted regarding the method for obtaining HSC as regards to the constituents required, mix design parameters, effect of various chemical and mineral admixtures on the strength of concrete. Whilst a number of studies have considered the development of a rational or standardizes method of concrete mix for HSC no widely accepted method is currently available.

3. A NOVEL PROPOSED STUDY OF HIGH STRENGTH CONCRETE AND COST EFFECTIVENESS

In this section, we mainly describe the proposed **High Strength Concrete and Cost Effectiveness** for High Strength Concrete is based on the water-binder ratio.

A) PRELIMINARY KNOWLEDGE

The use of Fly-ash as a partial replacement of cement on the Workability and compressive strength of High-strength concrete will be investigated. The mixing procedure for the High-strength concrete will be as per IS 10262-2009 & IS 456-2000.The experimental work planned in this investigation consisted of mix proportioning of M60 grade High-strength concrete with Fly ash as cementations material. The methodology adopted for the experimental work includes

1) Mix proportioning for High-strength concrete to achieve desired early initial strength without segregation and bleeding using chemical admixture.
2) Fly ash as cementatious material will be used, in different dosages to study the flow ability and strength of the mix proportion.
3) Slump Flow and compaction factor Tests will be conducted to find out the workability and segregation resistance of High-strength concrete.

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4) Compressive strength test will be conducted to determine the strength characteristics of High-strength concrete.

5) Finally the strength results are compared at 3days, 7 days and 28 days for the precast mix with different dosages of Fly-ash.

B) MATERIAL PROPERTIES

The materials used for the experimental programmed are cement, river sand, coarse aggregate, fly ash, super plasticizer and water were locally available at the institute vide the construction agencies working in the institute. The succeeding subsections describes in detail about the materials used.

i) CEMENT

The Cement used was Jaypee Ordinary Portland Cement (OPC) of grade 43 conforming to IS: 8112-1989. The various laboratory tests confirming to IS: 4031-1996 (PART 1 to 15) specification was carried out and the physical properties were found as such:

TABLE 1: Physical Properties of CEMENT

Sl.No	Physical Properties	Observed Value for Cement
1.	Specific Gravity	3.14
2.	Initial Setting	30 Min
3.	Final Setting(Minutes)	600 Min
4.	Consistency (%)	30 %
5.	Fineness(m2/kg)	225 m2/kg

B) FINE AGGREGATE

The shape and surface texture of fine aggregate has a greater influence on water demand of concrete because fine aggregates contain a much higher surface area for a given weight. Rounded and smooth fine aggregate particles are better from the view point workability than sharp and rough particles.

Sieve size	Weight retained,Kg	Cumulative weight retained,Kg	Cumulative percentage retained	Cumulative percentage passing
4.75 mm	0	0	0	100
2.36 mm	0.001	0.001	0.2	99.8
1.18 mm	0.001	0.002	0.4	99.6
600 mm	0.06	0.008	1.6	98.4
425 mm	0.110	0.118	23.6	76.4
300 µ	0.210	0.328	65.6	34.4
150 µ	0.152	0.480	96.0	4
<150 µ	0.20	0.5	100	-
Total	0.5	0.5	287.4	-

Table 2: Gradation of Fine Aggregate

Fineness modulus = 287.4/100

= 2.87

C) CHEMICAL ADMIXTURE

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The main component that is required for achieving the HSC is Water-Cement ratio. As water reductions and is seen in content the strength of water content increases the strength considerably. This can be achieved by using water reducing admixture or super plasticizer. The use of super plasticizer generally reduces the amount of water required by 15%-40%.Super plasticizers are usually the chemical compounds like Sulphonated Melamine Formaldehyde(SMF),Sulphonated Naphthalene Formaldehyde(SNF) and Modified Lignosulphonates.

The admixture used is a super plasticizer **CONPLAST SP 430.**

Figure 2. Represents the Sample of CONPLAST SP 430

DESCRIPTION ABOUT THE CONPLAST SP 430:

CONPLAST SP 430 is supplied as a brown liquid instantly dispersible in water. It has been specially formulated to give high range water reductions upto 25% without loss of workability or to produce high quality concrete of reduced permeability.

4. RATE OR COST ANALYSIS OF M-60 GRADE CONCRETE

Here we can see the rate analysis of M-60 Grade Concrete which is formed by various factors. Now let us discuss about that in detail.Rate analysis or coast analysis is the estimation of total expenditure or the rates of the individual items used in the construction project. It also gives an idea of total quantity of material and the total coast of the project. The Purpose of Analysis of Rates is as follows.

From the below table 2 and 3 it can be seen that for M60 grade concrete mix the total cost of materials used is 7985.22/- and that of M60 Fly ash induced concrete is 7812.16/- respectively which is less with a difference of **173.06**/- rupees. Therefore it can be concluded that usage of fly ash in concrete is recommended as it results in cost-effective concrete.

5. EVALUATION RESULTS

In this section we try to show the evaluation test results for our proposed High Strength Concrete. For this we took 4 controls mixes with partial replacement of cement with Fly Ash were prepared. For all the mixes the dosage of chemical admixture is maintained constant i.e. 0.1 by weight of cement to obtained High Strength Concrete of desired initial strength.

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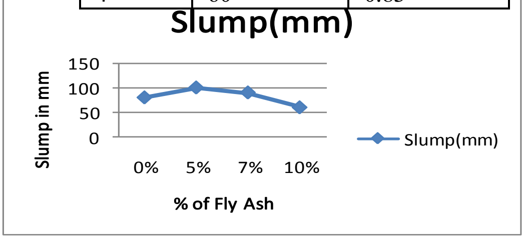
WORKABILITY TEST RESULTS:

Workability is defined as the ease with which concrete can be mixed, placed, consolidated and finished. A concrete is said to be workable if it is easily transported, placed, compacted and finished without any segregation. The results of the slump & Compaction Factor tests are presented in table 6 and comparative study with varying percentage of quarry dust is shown graphically.

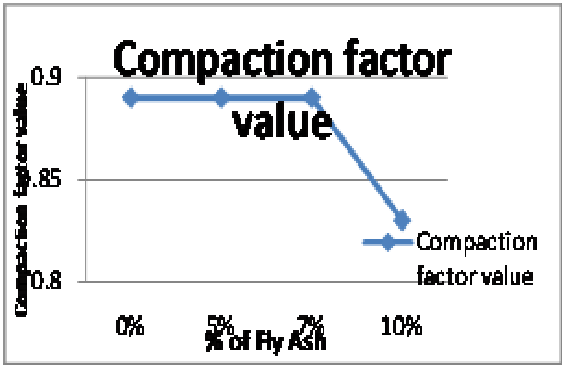
6.1. WORKABILITY:

Mix	*Slump(mm)*	*Compaction Factor*
1	80	0.89
2	100	0.89
3	90	0.89
4	60	0.83

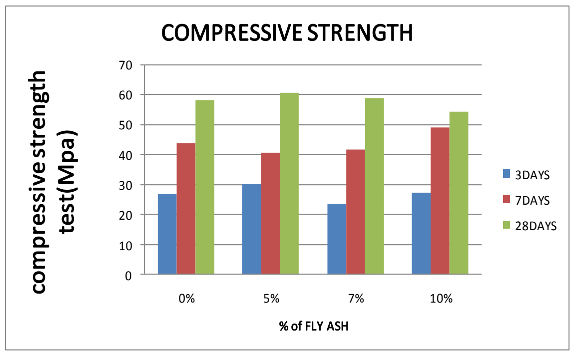


ANALYSIS OF RESULTS

Graph 1.Represents the Graph indicates % of FLY-ASH vs SLUMP Values



Graph 2.Represents the Graph indicates % of FLY-ASH (VS) COMPACTION FACTOR



Graph 3.Represents the Graph indicates % of FLY-ASH (VS) COMPRESSIVE STRENGTH

TABLE 3.Rate Analysis for Design Mix M-60 Grade Concrete

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Rate Analysis For Design Mix (5% Fly ash) M-60 Grade Concrete					
Providing and laying cement concrete in retaining walls, return walls (any thickness) including attached pilasters, columns, piers, abutmets, pillars, posts, struts,buttresses, plain window sills, fillets etc upto floor five level, excluding the cost of centring,string or lacing courses, parapets, coping bed blocks, anchor blocks,shuttering and finishing:					
S.NO	**DESCRIPTION**	**UNIT**	**QUANTITY**	**RATE**	**AMOUNT**
	Details of cost for 1 cum.				
	Materials:				
1	Stone aggregate 20mm	tonne	0.815	1365	1112.47
2	Stone aggregate 12.5 mm	tonne	0.349	1097	382.85
3	ırriage of agg. 20mm &12.5 n	tonne	1.165	113.6	132.34
4	Coarse sand	tonne	0.509	594	302.35
5	Carriage of coarse sand	tonne	0.509	106.49	54.2
6	Cement	tonne	0.469	6000	2814
7	Carriage of cement	tonne	0.469	94.65	44.39
8	ıd-Mixture (Conplast SP 43(	Lts	4.98	55	273.9
9	Fly ash	tonne 0.025	0.025	72	1.8
	Labour:				
1	Beldar	Day	0.9	500	450
2		Day	0.78	500	390
3		Day	0.7	510	357
4		Day	0.06	600	36
5		Day	0.06	590	35.4
	Mixer	Day	0.07	800	56
	Vibrator	Day	0.07	350	24.5
	Scaffolding	L.S.	114.4	2.6	297.44
	Sundries	L.S.	14.3	30	429
	(Extra labour for lifting.material upto floor level) Coolie 0.75x2.50)	Day	1.88	329	618.52
				Total	**7812.16 /-**

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TABLE 4: RATE ANALYSIS FOR DESIGN MIX (5 % FLY-ASH) M-60 GRADE CONCRETE

Rate Analysis For Design Mix (5% Fly ash) M-60 Grade Concrete

Providing and laying cement concrete in retaining walls, return walls (any thickness) including attached pilasters, columns, piers, abutmets, pillars, posts, struts,buttresses, plain window sills, fillets etc upto floor five level, excluding the cost of centring,string or lacing courses, parapets, coping bed blocks, anchor blocks,shuttering and finishing:

S.NO	Descripition	Unit	Quantity	Rate	Amount
	Details of cost for 1 cum				
	Materials:				
1	Stone aggregate 20mm	tonne	0.815	1365.00	1112.47
2	Stone aggregate 12.5 mm	tonne	0.349	1097.00	382.85
3	Carriage of agg. 20mm &12.5 mm	tonne	1.165	113.60	132.34
4	Coarse sand	tonne	0.509	594.00	302.35
5	Carriage of coarse sand	tonne	0.509	106.49	54.20
6	Cement	tonne	0.469	6000.00	2814.00
7	Carriage of cement	tonne	0.469	94.65	44.39
8	Ad-Mixture (Conplast SP 430)	Lts	4.980	55.00	273.90
9	Fly ash	tonne	0.025	72.00	1.800
	Labour:				
1	Beldar	Day	0.900	500.00	450.00
2	Coolie	Day	0.780	500.00	390.00
3	Bhishti	Day	0.700	510.00	357.00
4	Mason 1st class	Day	0.060	600.00	36.00
5	Mason IInd class	Day	0.060	590.00	35.40
	Mixer	Day	0.070	800.00	56.00
	Vibrator	Day	0.070	350.00	24.50
	Scaffolding	L.S.	114.400	2.60	297.44
	Sundries	L.S.	14.300	30.00	429.00
	(Extra labour for lifting material upto floor level) Coolie (0.75x2.50)	Day	1.88	329.00	618.52
				TOTAL	7812.16 /-

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SOME OF THE EXPERMENTAL PHOTOGRAPHS

Figure 3 . Represents the Slump cone for Trial mix containing 0% fly ash and 1.0% SP 430

Figure.4. Represents the Slump cone of trial mix i.e. mix with 7.0% fly ash and 1% SP430

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Figure 5.Represents the Concrete specimen of grade M60 with 5% fly ash and 1.0% SP430

COMPRESSIVE STRENGTHS

The specimens were tested for compressive strength on compression testing machine provided with two steel bearings applied without shock and is increased continuously at a rate 140/cm2/min (approx) until the specimen breaks. The measured compressive strength is calculated by dividing the maximum compressive load by the cross-section area calculated from the mean dimension of the specimen is clearly seen in the table 5.

Table 5.Represents the Compressive Strength Test Results

Mix no	% Fly Ash	Compressive strength(Mpa)		
		3days	7days	28days
1	0	26.72	43.49	57.94
2	5	29.80	40.36	60.66
3	7	23.29	41.37	58.90
4	10	27.08	48.75	54.27

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6. CONCLUSION

In this paper, we for the first time From the present investigation and limited observations reported, on the effect of partial replacement of cement with Fly Ash in High Strength Concrete mixes, following conclusion like the compressive strengths of concrete may vary with the change in percentage of fly-ash. Also the value of slump is increased with the decrease in the content.

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8. ABOUT THE AUTHORS

DARLA GNANESWAR KUMAR is currently pursuing his 2 years M.Tech in Department of CIVIL Engineering with Structural Engineering as Branch Specialization at Chaitanya Engineering College, Kommadi,Visakhapatnam, AP, India. His area of interest includes Structures.

T S D PHANINDRANATH is currently working as an Assistant Professor in Department of Structural Engineering(Civil),JNTUV, AP, India. He has almost 2 years of teaching experience.His research interest includes seismic zone.

P. LAVANYA is currently working as an Assistant Professor in Department of Structural Engineering(Civil) at Sai Ganapathi College of Engineering College, AP, India.She has more than 3 years of teaching experience.Her Research interest includes Structures.