

# Retrofitting of RC Beams using Self Curing Self Compacting Concrete



Abilash C S, Sunil Kumar Tengali

**Abstract:** The disposal of wastes from thermal, steel industries and from demolition of building is causing severe land pollution. About 5% of Global warming is caused due to production of cement and by using pozzalonic materials such as Fly Ash, GGBS, Silica fume, Metakaolin and Alcoffine, by using such kind of mineral admixtures. These materials possess the cementitious property when mixed with water. In congested reinforcement conditions it is difficult to compact the concrete with a vibrator, hence self compacting concrete is used. Concrete is the most used material after water, but water is the most important ingredient for the production of concrete, due to the scarcity of water self curing compound is used for the production of concrete by replacing M-sand in place of natural river sand conforming EFNARC Codal provisions. This study mainly focuses on the partial replacement of Cement by Fly ash and alcoffine at varied proportions by weight of Cementitious material for producing Self curing self Compacting Concrete. Mechanical properties at 3,7,28,56 and 90days will be done by casting. Validation of the test results will be obtained using Neural network and Mat labs To produce concrete with appreciative strength using different pozzalonic material and to Further experimental investigation is to study the deflection and crack behavior of RC Beam with Fly ash and Alcoffine will be done by casting number of beams of size 2800\*150\*300. Two methods of retrofitting methods such as CFRP Jacketing and Concrete jacketing will be done for the cracked beam and the ultimate load carrying capacity of CFRP Jacketing and Concrete Jacketing will be observed. To study the different retrofitting methods and comparing the values of CFRP and Concrete Jacketing.

**Keywords :** Alcoffine, Retrofitting, Jacketing, Self curing.

## I. INTRODUCTION

In recent days the problem in India is the disposal of waste lands directly cause seivour Environmental pollution, mainly from Thermal and Steel Industry. These waste products can be efficiently used to produce innovative substance which can be used as efficient filler material in concrete upto a greater extent in place of cement . This substance may result in the cost saving by using Industrial wastes. In congested Reinforcement it is difficult to consolidate the concrete with a vibrating machine; improper consolidation may lead to deterioration of concrete due to unfilled voids and pores in concrete. In this study cement is used as primary cementitious

material and Fly ash is used as secondary cementitious material and Alcoffine as filler material in concrete blast furnace slag as ternary cementitious material. The motivation for developing this concrete is reduction in number of skilled labour and to shorten the construction period. Here in this study the behaviour of Self Curing self compacting concrete beams was studied for both conventional concrete and replacement concrete for different types of retrofitting methods under different loading conditions

## II. OBJECTIVES OF THE STUDY

- A. The present objective is to produce concrete with appreciative strength and durability properties using admixtures in partial to cement.
- B. Use of Fly ash and alcoffine as a partial replacement to cement.
- C. To find out the properties of concrete such as strength properties and durability properties etc and comparing it with the conventional concrete and concrete with different Fly ash percentage replacement and alcoffine in it and also to find the carbon reduction.
- D. Is to reduce land pollution by adopting different retrofitting methods such as concrete jacketing and CFRP wrapping and comparing the load carrying capacity of different retrofitted beams.

## III. METHODOLOGY

### A. Binder selection

Mostly used OPC (Ordinary Portland Cement) and then only few have used PPC (Portland pozzolana cement) for their research because of its durability, high strength (more than 80-85 % strengt is achieved within 28 days as compare to that of PPC which only achieves 70-75 % maximum within 28 days. For the present experimental study, Ordinary Portland Cement (OPC) of 53grade conforming to IS: 12269 - 1987 is used. The physical properties of the cement obtained after conducting the tests as per IS: 269 and IS: 4831 satisfying the requirements as per IS: 12269 - 1987 are given in Table I

**Table I : Physical properties of Cement**

Sl.No	Properties	Results	Requirement as per IS 11269-187
1	Setting Time		
	Initial	40min	Not Less Than 30 Min
	Final	60min	Not Less Than 600 Min
2	Normal Consistency	34%	-----
3	Fineness	5%	-----
4	Specific Gravity	3.15	-----

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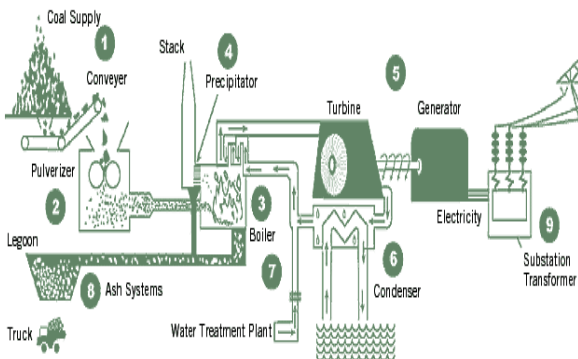
## B. Additive selection

Mostly there are two types of additive, these are mineral admixture and chemical admixture and research has been performed by different researcher over all additive for their properties of performance and influence when mix with Portland cement. As per demand of high strength, high performance, durability, workability and anti corrosive concrete. A mineral admixture which performs in superior manner than that of all other admixture found/use in India is Alcoffine and Fly ash and chemical admixture is Glenium B233 and water proofing compounds in Table II

**Table II:- Physical Properties of Fly Ash**

Sl No	Test Conducted [as per IS1727 – 1967]	Results	Requirements as per IS:3812(Part 1):2003 (RA 2007)
1	Specific Gravity	2.2	-
2	Fineness-Specific surface in m <sup>2</sup> /kg by Blaine's Air-Permeability method, min .	328.0	320.0
3	Lime Reactivity-Average Compressive Strength in N/mm <sup>2</sup> ,min	4.6	4.5
4	Compressive Strength at 28 days, N/mm <sup>2</sup> ,(Min)	42.53	Not less than 80% of the strength corresponding to plain cement mortar cubes
5	Soundness by Autoclave Test Expansion of Specimens, percent,(Max)	0.045	0.8
6	Residue on 45 micron sieve, percent,(max)	22.5	34

Components of a coal-fired thermal plant



**Fig 1 : Flow chart of Thermal power plant operation**

## C. Fine Aggregate

There are four grading zone for fine aggregate as per IS383:1970 and these are Grading Zones I, II, III & IV. These grading zone classified as per percentage passing material from various sieves and there are mainly four zones and they all have different passing percentage limit for different sieves but there is only one sieve(600 micron) which is almost common to all Zone specification .

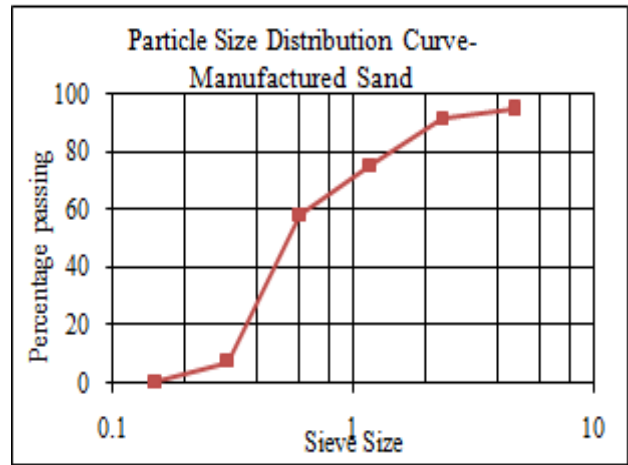
**Table III: Sieve Analysis of Manufactured Sand**

Weight of sample =1000gms

Sieve Size	Mass retained in gms	% of mass retained	Cumulative mass retained in gms	% finer
4.75mm	48.52	4.852	4.852	95.148
2.36mm	34.56	3.456	8.308	91.708
1.18mm	165.54	16.55	24.858	75.142
600 micron	170.56	17.04	41.898	58.1

300 micron	505.52	49.05	90.978	9.02
150 micron	70.56	7.56	98.51	1.48

Manufactured Sand was having Fineness Modulus – 2.71 and it was conforming to Zone – II



**Fig 2 : Particle Size Distribution Curve-Natural Sand**

## D. Aggregate selection:

Aggregates for concrete consist of gravel and sand which represents the grain skeleton for the concrete. All cavities which are within this skeleton need to be filled with binder paste as much as possible. Concrete aggregates occupy approximately 80% of total concrete weight and 70 – 75% of total concrete volume. Optimum use of the aggregates quality and size improves the concrete quality, mainly coarse aggregate maintain better improvement for performance.

**Table IV - Physical Properties Coarse Aggregates**

SLNo	Properties	Coarse aggregates	
		12.5mm	20mm
1	Loose Bulk Density kg/m <sup>3</sup>	1310.67	1299.12
2	Rodded Bulk Density kg/m <sup>3</sup>	1550.00	1460.67
3	Specific Gravity	2.62	2.68
4	Sieve Analysis		
	Sieve size	% passing	% passing
	40mm	100	100
	20mm	100	95
	12.5mm	98	60.33
	10mm	75.26	24.33
	4.75mm	35.26	3.09
Remark		Graded	Well Graded

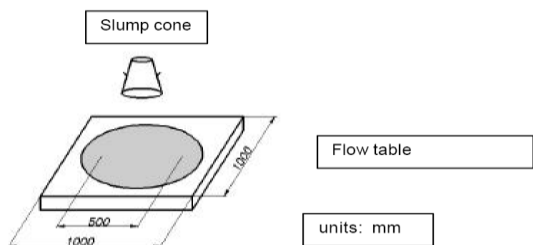
**Table V: Zonal Specification as per IS 383 1970 for C.A**

IS sieve size in mm	% Passing for all sized aggregate		Graded/ Single sized		
	40mm nominal size	20mm nominal size			
80	100		Size of sieve (mm)	Graded	Single size
40	95-100	100			
20	45-75	95-100	20.00	100	100
12.5	25-45	30-50	12.50	90-100	85-100
10	8-30	10-35	10.00	40-85	0-45
6.3	0-6	0-6	4.75	0-10	0-10

**IV. TESTS ON FRESH PROPERTIES OF CONCRETE**

**A. Slump Flow & T50 Test**

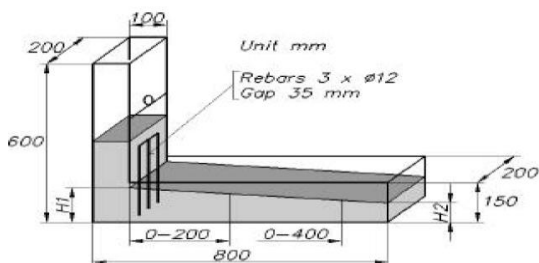
Slump flow is one of the most commonly used SCC tests at the current time. This test involves the use of slump cone used with conventional concrete as described in ASTM C 143(2002).The main difference between the slump flow test and ASTM C 143 is that the slump flow test measures the “spread” or “flow” of the concrete sample.



**Fig 3: Slump test**

**B. L-Box Test**

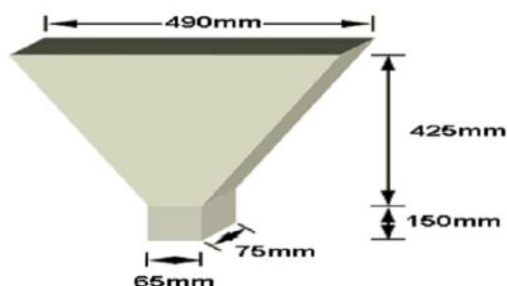
The L-box value is the ratio of levels of concrete at each end of the box after the test is complete. The L-box consists of a “chimney” section and a “trough” section after the test is complete, the level of concrete in the chimney is recorded as H1, the level of concrete in the trough is recorded as H2.The L-box value(also referred to as the “L-box ratio”, “blocking value”, or “blocking ratio” is simply H2/H1. Typical acceptable values for the L-box value are in the range of 0.8 to 1.0.If the concrete was perfect.



**Fig 4: L-Box Test**

**C. V-Funnel Test**

V-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20 mm. The funnel is filled with about 12 liters of concrete and the time taken for it to flow through the apparatus is measured .After this the funnel can be refilled concrete and left for 5 minutes to settle .If the concrete shows segregation then the flow time will increase.



**Fig 5: V-Funnel apparatus**

**Table VI: Fresh properties of SCSCC**

Sl.No.	Method	Unit	Result
1.	Slump flow by Abrams cone	Mm	690
2.	T <sub>50 cm</sub> Slump flow	Sec	7
3.	V-funnel	Sec	11
4.	L-box	(h <sub>2</sub> /h <sub>1</sub> )	0.9

**V. TESTS STRENGTH AND DURABILITY PROPERTIES OF HARDENED CONCRETE**

**A. Compressive strength**

The compressive strength of all mixes was measured with cube specimen of size 150mmx150mmx 150mm.The specimens were tested after curing for 7 days and 28 days fully immersed in water tank as per IS0516:1959 for method of tests for strength of concrete. Compressive strength = P/A (Unit = N/mm<sup>2</sup> or MPa) Where P = Load, A = Area of Specimen.

**B. Split Tensile Strength**

The split tensile strength of all mixes was measured with cylinder specimen of size 300mm x 150mm.The specimens were tested after curing for 28 days fully immersed in water tank as per IS 5816:1999 for method of test splitting tensile strength of concrete.

**C. Acid attack**

Acid attack involves conversion of calcium compound to calcium salts after attacking acid. The structure of the hardened concrete destroyed by acid attack, the rate of deterioration depends not only on the strength of the reactants but also upon the solubility of the resultant salts and their transport. The acids like sulfuric acid ,hydrochloric acid , nitric acid etc..., destroy concrete by converting hardened concrete, and its pore system. Impermeability of concrete is of little consequence in this case. In this paper we used HCL for the curing of concrete for 7 and 28 days . It leads to loss in the mass of the concrete and strength of the concrete, which leads to early deterioration of concrete structure.

**D. Sulphate attack**

Sulphate attack is on only aluminate compounds, calcium and hydroxyl of hardened Portland cement forming ettringite and gypsum. In the presence of sufficient water, these reactions of delayed ettringite formation cause expansion of concrete leading to irregular cracking. The cracking of concrete provides further access to penetrating substances and to progressive deterioration. The effects of sulphate on concrete depend upon the severity of attack, accessibility (Permeability and Cracking), presence of water and susceptibility of cement- Concrete can be protected against sulphate attack by limiting the aluminates between 3 to 8%.

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## VI. TESTS ON BEAM SPECIMEN

RC beams of 150mm X 250mm X 2000 mm overall and 150mm X 219mm X 2600mm effective will be casted. with different reinforcing conditions. Linear variation deflection transmission(LVDT) were used to note down the deflections of the test beams at three positions. One below mid- span and other two below the loading points as shown in figure 6



Fig 6: Experimental setup of beam

## VII. CONCLUSIONS

The property of concrete in fresh state was satisfactory according to EFNARC Specification. SCC mix improves the flowability properties of SCC, with increased rheology in terms of slump flow, Slump T50, V Funnel and L Box. Therefore, Better rheological properties of SCC can be achieved using Fly ash as secondary cementitious material and Alcoffine as ternary cementitious material in SCC. The rate of strength development in Partially replaced concrete will be very slow at 3<sup>rd</sup> days and 7<sup>th</sup> day due to pozzalonic behaviour. The grade of concrete with appropriate strength will be fixed and the casting of beams will be done. The beams will be tested for ultimate loading capacity and the values will be noted down , after the beams obtains its ultimate load carrying capacity the beam fails. The failure beam will be retrofitted for two kinds of retrofitting methods such as Concrete jacketing and carbon wrapping method, the values of three loading methods will be noted down and the appropriate method for retrofitting will be concluded by test results.

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