STUDY ON DURABILITY CHARACTERISTICS OF SELF COMPACTING CONCRETE WITH FLYASH

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Abstract
This project investigates the study of workability and durability characteristics of Self-Compacting Concrete (SCC) with Viscosity Modifying Admixture (VMA) and containing Class F fly ash. The mix design for SCC was arrived as per the Guidelines of European Federation of National Associations Representing for Concrete (EFNARC). In this investigation, SCC was made by usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixture fly ash. The experiments are carried out by adopting a water-powder ratio of 0.40. Workability of the fresh concrete is determined by using tests such as: slump flow, T50, V-funnel, L-Box and U-box tests. The durability test of concrete that is acid attack test was performed. M30 Grade of concrete was opted. Four mixes were prepared varying aggregate ratios from 51% to 54%. The durability of concrete was determined at the age of 28 days.

Keywords: **Durability, Acid attack test, aggregate, Self-compacting concrete**

1. INTRODUCTION

One of the basic infrastructural facilities that man needs for good living is shelter. The development of technology in materials and construction has made it possible to build even skyscrapers. However, the increasing cost of conventional construction materials has made it difficult to meet the shelter requirements of the teeming population of developing countries. Fast expansion in the construction industry brought forth with it associated problems

Due to its versatility and easy mouldability, worldwide concrete is recognized as a premier construction material. It is the material of choice for a variety of applications such as housing, bridges, highway pavements, industrial structures, water-carrying and retaining structures, etc., The credit for this achievement goes to well-known advantages of concrete such as easy availability of ingredients, adequate engineering properties for a variety of structural applications, adaptability, versatility, relative low cost, etc.,

One of the major factors that influence the strength and durability of concrete structures is the degree and quality of consolidation and effective curing of concrete. The lack of uniform, and complete compaction and curing had been

Identified as the primary factor responsible for poor performance of concrete structure.

Thus, the purpose for the development of self-compacting concrete (SCC) and self-curing concrete was the social problem on durability characteristics of concrete structures. Employment of self-compacting concrete(SCC) which possesses highly superior flowabilty under a maintained stability (without bleeding or segregation) becomes an ideal solution for such

situations for making durable concrete independent of quality of construction

2. LITERATURE REVIEW

Present-day self-compacting concrete had been classified as "the most sought development in construction industry due to its numerous inherited benefits." As the name itself reflects, vibration is not required for achieving full compaction. This kind of concrete offers many benefits and advantages over conventional concrete. These include an improved quality of concrete and reduction of on-site repairs, lowers overall costs, faster construction times, and facilitation of introduction of the automation into the concrete construction. A crucial improvement in health and safety is achieved through terminating the handling of the vibrators and a significant reduction in the environmental noise loading on and around the construction site. The composition of SCC mixes includes substantial proportions of fine-grained inorganic materials and this gives possibilities for utilization of mineral admixtures, which are currently waste products with no practical applications and are costly to dispose off

P. Dinakar, K.G. Babu, Manu Santhanam made a study on durability properties of SCC by incorporating high volume replacements of material fly ash in the concrete. A total of eight types of fly-ash SCC mixtures of various grades of strength were developed at desired fly ash percentages of 0%, 10%, 30%, 50%, 70% and 85%, by comparing with five different grades of normally vibrated concretes. The durability properties were performed to study the water absorption, acid attack tests, measurement of permeable voids and chloride permeation. The results obtained indicated that SCC of lower grades of strength (20–30 MPa) can be produced at a fly ash replacement of about 70–85%, while higher strength grades of about 60–90 MPa can be produced with about 30–50% fly ash replacement.

3 MATERIALS AND PROPERTIES

3.1 Cement

Cement plays vital role in concrete. One of the important criteria tricalcium aluminate (C_3A) content, tricalcium silicate (C_3S) content, dicalcium silicate (C_2S) content etc. It is also necessary to ensure the compatibility of chemical and mineral admixtures with cement.

In this study, Zuari Cement of 53 grade Ordinary Portland Cement conforming to IS: 12269–1987 was used for the entire work. The cement was purchased from single source and was used for casting of all specimens. The physical properties of cement are furnished in Table No.1

Table 1 physical properties of cement

S.No	Characteristics	Test Results	Requirements as per IS 12269 - 1987
1	Fineness (retained on 90-µm sieve)	6%	<10%
2	Normal Consistency	33%	--
3	Initial setting time of cement	90 min's	30 minutes (minimum)
4	Final setting time of cement	340 min's	600 minutes (maximum)
5	Expansion in Le-chatelier's method	4 mm	10 mm (maximum)
6	Specific gravity	3.15	3.10 – 3.25

3.2 FINE AGGREGATE

The natural sand taken for this investigation is the locally available natural river sand. It was collected and cleaned for impurities, so that it is free from clayey matter, salt and organic impurities. Particles passing through IS sieve of 4.75 mm conforming to grading zone-II of IS: 383-1970 were used in this work. Properties such as gradation, specific gravity, fineness modulus, bulking, and bulk density had been assessed. The physical properties of sand are furnished in Table 2.

Table 2 physical properties of Fine Aggregate

S.No.	Tests Conducted	Results Obtained		Permissible Limits as per IS 383-1970
1	Specific gravity	2.65		2.5 to 3.0
2	Fineness modulus	3.05		--
3	Bulk density	**Loose State**	1415 kg/m^3	1400 to 1750 kg/m3
		Compacted State	1525 kg/m^3	
4	Water absorption (%)	1.09		Max 3%
5	Sieve Analysis	Zone – II		--

3.3 COARSE AGGREGATE

Locally available machine Crushed angular granite, retained on 4.75mm I.S. sieve of maximum size of 20mm confirming to I.S: 383-1970 was used in the present experimental investigation. It is free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is tested for its various properties such as specific gravity, fineness modulus, elongation test, flakiness test, sieve analysis, bulk density in accordance with in IS 2386 – 1963. The physical properties of Coarse Aggregate are furnished in Table 3.

Table 3 physical properties of Coarse Aggregate

S.No.	Tests Conducted	Results Obtained		Permissible Limits as per IS 383-1970
1	Specific gravity	2.73		2.5 to 3.0
2	Fineness modulus	7.52		--
3	Bulk density	**Loose State**	1480 kg/m^3	1400 to 1750 kg/m3
		Compacted State	1560 kg/m^3	
4	Water absorption (%)	1..20		Max 3%
5	Flakiness Index	21%		Max 25%
6	Elongation Index	23%		Max 25%

3.4 WATER

Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth (or) other substance that may be deleterious to bricks, stone, concrete, or steel. Potable water is generally considered satisfactory for mixing.

Water acts as a lubricant for the fine and coarse aggregates and acts chemically with cement to form the binding paste for the aggregate and reinforcement. Less water in the cement paste will yield a stronger, more durable concrete; adding too much water will reduce the strength of concrete and can cause bleeding. Impure water in concrete, effects the setting time and causing premature failure of the structure.

To avoid these problems quality (potable) water must be proffered in construction works and PH value of water should be not less than 6. And also Quantity of water to be taken is important

3.5 FLY ASH:

Fly ash, one of the most widely utilized by-product in the construction industry resembling the Portland cement. In order to utilize fly ash for various applications, most of the thermal power stations had established a dry fly ash evacuation and storage system. Class F fly ash produced from Rayalaseema Thermal Power Plant (RTPP), Muddanur, A.P is used as an additive used as a filler material. The physical and as obtained by RTPP are presented in the Table – 4

Table 4 Physical properties of chemical admixture

Characteristics	Test Results
Specific gravity	2.12
Fineness (Kg/m2)	360

3.6 SUPER PLASTICIZER

In the present work, water-reducing admixture Master Glenium SKY 8630 which is an inbuilt Viscosity Modifying Agent conforming to ASTM C494 Type G, EN 934-2 T3.1/3.2 and IS 9103: 1999 is used. Master Glenium SKY 8630 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. The physical properties of chemical admixture are furnished in table –5.

Table 5 Physical properties of chemical admixture

S.No	Characteristics	Test Results
1	Aspect	Light brown liquid
2	Relative Density	0.08+/- 0.01 at 250°C
3	Ph	≥6
4	Chloride ion Content	<0.2%

3.7 MIX PROPORTIONS

Table 6 Quantities of Ingredients per Cum of M30 Grade Concrete

Grade of Concrete	Mix 1	Mix 2	Mix 3	Mix 4
Cement(Kg/m^3)	375	375	375	375
Fly Ash(kg/m^3)	136	136	136	136
Fine Aggregate(kg/m^3)	779	795	810	825
12 mm Coarse Aggregate(kg/m^3)	746	731	716	700
Master Glenium SKY (Super Plasticizer)(lit)	3.88	3.88	3.88	3.88
Water(lit)	178	178	178	178

4 EXPERIMENTAL INVESTIGATION

4.1 CONCRETE MIX PREPARATION

Design of concrete mix requires complete knowledge of various properties of the constituent materials. Initially the ingredients such as cement and fine aggregate were mixed, to which the coarse aggregate are added followed by addition of water and thoroughly mixed. Prior to casting of specimens, workability is measured in accordance with the code IS 1199-1959 by slump cone test.

4.2 DURABILITY OF CONCRETE

The concrete cubes of size 150 mm × 150 mm × 150mm were prepared and it is tested for its durability at the age of 28 days. The percentage loss of weight of the concrete specimen and percentage loss in compressive strength were calculated.

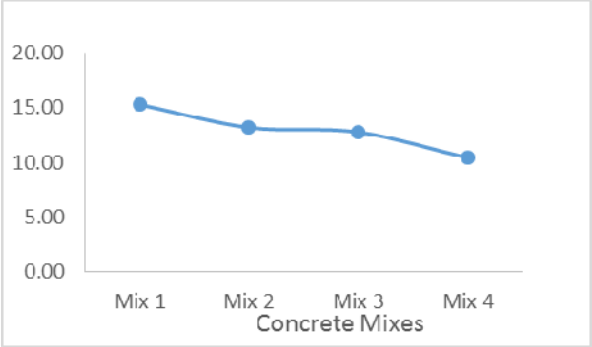
5 RESULTS AND DISCUSSIONS

5.1 Durability of concrete

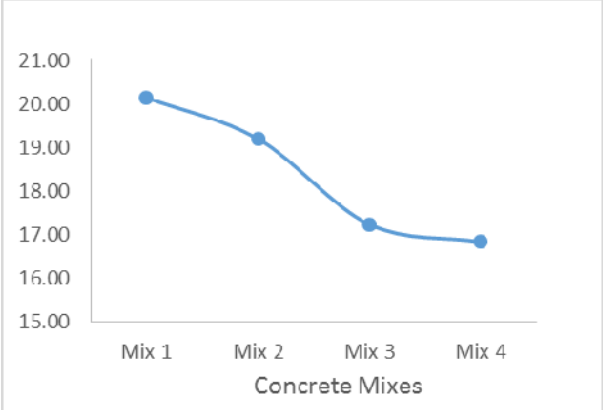
a) Acid attack test:

Acid attack test was performed for all four mixes at the age of 28 days. The percentage loss in weight and percentage loss in compression strength was determined. From the test result it is noted that the mix 1 shows more percentage in weight and mix 4 shows less loss in weight. It is also noted that the loss of compressive strength is more for mix 1 and less for mix 4.

S. NO	Mix Design nation	Weight of cubes (kg)		% Loss in wt	Compressive strength N/mm^2		% loss in comp. strength
		Before	After 28 Days		Before	After acid attack	
1	Mix 1	8.19	6.94	15.26	28.65	22.88	20.14
2	Mix 2	8.35	7.25	13.17	29.84	23.15	19.20
3	Mix 3	8.55	7.46	12.75	36.65	30.33	17.24
4	Mix 4	8.68	7.66	10.414	37.83	31.46	16.84



Variation of Percentage Loss in Weight of Different Mixes of Concrete



Variation of Percentage Loss in Compressive Strength of Different Mixes of Concrete

6 CONLUSIONS

1. It has been verified, by using the slump flow, V-funnel, L-box test and U-box test on fresh SCC that self-compacting concrete (SCC) achieved consistency and self- compact ability under its own weight, without any external vibration or compaction.
2. The loss of weight in percentage at 28 days with sulfuric acid is found to be maximum for mix 1

3. The loss of compression strength with sulfuric acid was found to be maximum for mix 1.

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