EXPERIMENTAL INVESTIGATION ON DURABILITY PROPERTIES OF SELF COMPACTING CONCRETE BY PARTIAL REPLACEMENT OF FLY ASH AND GGBS

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ABSTRACT: *Self-compacting concrete is a fluid mixture suitable for placing in structures with congested reinforcement without vibration. Self-compacting concrete development must ensure a good balance between deformability and stability. Also, compatibility is affected by the characteristics of materials and the mix proportions; it becomes necessary to evolve a procedure for mix design of SCC. The paper presents an experimental procedure for the design of self- compacting concrete mixes. The test results for acceptance characteristics of self-compacting concrete such as slump flow, V-funnel and L-Box are presented. Further, compressive strength at the ages of 28, 56, and 90 days was also determined and results are included here.*

Key words: Self-compacting Concrete; Fly Ash; Mix Design; Fresh Properties; Hardened Concrete; Properties; Compressive Strength

I. INTRODUCTION

Concrete has become one of the most popular construction materials in worldwide, this because its raw materials can be provided widely in different places around the world and it is considered as the man-made material. Moreover, it has a key role to play in sustainable construction, since it needs less effort in its manufacture. These facts have not only led to many inventions in the field of concrete but have also led to many studies in order to improve its quality, reducing the cost of implementation and make the concrete friendly with the environment; besides, amending its aesthetical appearance when it is used as a structural construction members.

Nowadays, It can be seen that as a result of the research progressions concerned the concrete technology, various types of concrete such as High Performance Concrete, Ultra High strength concrete, Light Weight Concrete, Architectural Concrete and Self-compacting concrete (SCC) are commonly heard not only among engineering Society but ordinary people also. In this prospective, the awareness and more knowledge regarding the concrete types should be considered. In fact, civil engineers should have more awareness and information about concrete types so as to be able to keep themselves abreast with the most recent developments, new technological innovations and future prospects. Utilization of waste materials and by-products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. Further, their utilization may improve the micro structure, mechanical and durability properties of mortar and concrete, which are difficult to achieve by the use of only OPC.

Self- compacting concrete (SCC) skill is based on raising the amount of fine materials similar to fly ash; lime stone filler, etc., without changing the water content compared to plain concrete. Mix proportions used in self-compacting concrete as compared to conventional concrete mix. These variations in proportions modify the rheological performance of the concrete.

GUIDELINES, SPECIFICATIONS, AND ACCEPTANCE CRITERIA

Concrete that requires little vibration or compaction has been used in Europe since the early 1970's but SCC was not developed until the late 1980's in japan. In Europe it was probably first used in civil works for transportation networks in Sweden in the mid 1990's. In 2002 the European federation of specialist construction chemicals and concrete systems (EFNARC) published their "Specification and guidelines for self-compacting concrete" which, at that time provided state of the art information for producers and users. Since then, much additional technical information on SCC has been published.

The self-compacting concrete European project group was founded in January 2004 with representatives from.

- The European precast concrete organisation (BIBN)
- The European cement association (CEMBUREAU)
- The European ready mix concrete organisation (ERMCO)
- The European federation of concrete admixture associations (EFCA), and
- The European federation of specialist construction chemicals and concrete systems (EFNARC).

II LITERATURE REVIEW

PRAJAPATI et al carried out investigations on self-compacting concrete using various percentages of fly ash as replacement of cement. Based on the investigations they concluded that the addition of fly ash resulted in decrease of super plasticizer content for same or better workability. The addition of fly ash resulted as decrease in 7 days and 28 days compressive strength. The 28 days compressive strength decrease to 22 to 23% as the fly ash content is increased to 30%.

PRATIBHA AGGARWAL et al presented a procedure for the design of self-compacting concrete mixes based on an experimental investigation. At the water/powder be satisfactory, passing ability, filling ability and segregation resistance are well within the limits. SCC was developed without using VMA in this study. Further, compressive strength at the ages of 7, 28 and 90 days was also determined. By using the OPC 43grade, normal strength of 25MPa to 33MPA at 28 days was obtained, keeping the cement content around 350kg/m^3 to 414 kg/m^3.

Dr. ELSON JOHN et al carried out investigation by replacing various percentages (10%, 20%, 30%) of natural aggregates in SCC with recycled coarse aggregates and evaluated the properties of SCC. For the M30 grade of concrete, fly ash was used as an additive also a poly carboxilic based super plasticizer was used to get sufficient flow ability. Test for fresh and hardened properties were carried out for traditional concrete and SCC. By comparing the results it was observed that SCC is a good alternative of traditional concrete with and without using recycled aggregates.

PRAVEEN MATHEW [2015], in his study replaced the natural coarse aggregate with RCA at varying amounts of %, 50%, 70% and 100%. The properties of all these mixes in fresh state as well as in hardened state are studied. The effects of polypropylene fibres are also studied. The experimental results indicate that the fresh state properties of SCC can be effectively achieved using RCA. In the hardened state, strength of SCC decreases with an increase in recycled aggregate replacement ratios. But the loss of strength seems to be only marginal which highly encourages the use of RCA in the construction industry as a sustainable solution to environmental protection.

M. V. SESHAGIRI RAO, carried out investigation on SCC of grade M20 with RCA designed on the basis of modified NAN-SU mix design and the workability tests performed in his research were as per The European (EFNARC) Guidelines for Self Compacting Concrete (SCC) Specification to arrive at the SCC mix proportions. Workability and hardened state properties of Self-compacting concrete (SCC) with various percentages of RCA as partial replacement of natural aggregates (NA) (0%, 25%,50% 75% & 100%) were studied. The results have indicated that the natural aggregate can be replaced completely with the RCA for low strength concrete with more or less 10% deviation in strength which can be compensated by proper designing of mix.

M. SEETHAPATHI, Evaluated the fresh and hardened properties of SCC using recycled concrete were evaluated. Four series of SCC mixtures were prepared with maximum of 30% of coarse recycled aggregates. The cement content was kept constant for all concrete mixtures. The SCC mixtures were prepared with 0, 10, 20 & 30% of recycled coarse aggregate. The strength test namely Compressive Strength Test, Split Tensile Strength Test and Flexural Strength Test are carried out in this investigation. To test the characteristics of self-compacting concrete, Slump cone test, J-ring test, L-box test were conducted to test the characteristic of SCC. There is an improvement in the strength of self-compacting concrete by using recycled coarse aggregate, maximum of 30% is better than concrete with natural aggregates

OZAWA completed the first prototype of self-compacting concrete using materials already in the market. By using different type of super plasticizers, he studied the workability of concrete and developed a concrete which was very workable. It was suitable for rapid placement and had a very good permeability. The viscosity of the concrete was measured using the v-funnel test. Further, more experiments were carried out by ozawa aiming on the influence of mineral admixtures, like blast furnace slag and fly ash, on the properties of segregation resistance and flowing ability of self-compacting concrete. He observed that flowing ability of the concrete improved remarkably when Portland cement was partially replaced with blast furnace slag and fly ash. By investigating with different proportions of the admixtures, he finally concluded that 25 to 45% of slag and 10 to 20% of fly ash, by mass, showed best flowing ability in concrete and strength characteristics.

JAGADISH VENGALA et al studied about the mix proportioning procedures for the self-compacting concrete. The study reviews the principles and method of mixture proportioning of SCC as developed by investigator. This study describe the japans method, European practice and specification, Nan-Su, et al method and Jagadishvengala et al. method in detail for mix proportioning of SCC. This study concludes as, SCC mixes, which are arrived by any one of the above methods, are likely to have high paste content. For concrete with coarse aggregate a maximum size of 16 to 20mm the paste content is likely to range from 38 to 45% by volume. Viscosity modifying agent are needed in all SCC mixes so that no bleeding or segregation occurs when there is variation in the moisture content of the aggregates a phenomenon that is usually encountered at construction sites. Though the V-funnel, L-Box, U-Box and slump flow tests are yet to be incorporated into national standard they have become now universally accepted by researchers and practitioners alike.

NAN SU et al at Taiwan in, proposed a new simple mix proportioning method for self-compacting concrete. The required amount of aggregates was determined, and the binder paste is then filled into voids of the aggregates to ensure the concrete has obtained self-compacting ability, flow ability, and other important desired SCC properties. The major factors influencing the properties of SCC which are to be used involves the required amount of aggregates, amount of binders and mixing water, as well as the type and dosage of high range water reducing admixtures or super plasticizers. The results obtained by fresh properties and compressive strength test indicated that the method proposed by Nan-Su could produce SCC successfully of high quality.

VIPUL H. VYAS, investigated on strength aspects like compressive and split tensile strength of self-compacting concrete using recycled concrete aggregate and workability tests like (slump, L-box, J-ring, V-funnel and V- funnel T50) are carried out. In his study water to powder ratio is kept constant at 0.33, and Natural aggregate is partially replaced with Recycled concrete aggregate by10%, 20%, 30%, and 40% and Fly are replaced 25% for all mix for reducing the cost. To reduce the water absorption of recycled concrete aggregate, RCA submerged in water for 24 hours and used after saturated surface dry condition. The results of present study recommend SCC marginally achieves required compressive strength up to 30% replacement of Recycled concrete aggregate.

FARAH AMIN et al, in their study observed that fresh stateproperties of Self compacting Concrete using recycled aggregates (SCCRA) were within the EFNARC standards and the compressive strength of SCCRA was slightly less than self-compacting concrete containing normalaggregates (SCCNA). There is significant potential for growth of recycled aggregatesas an appropriate and green solution for sustainable development in construction industry.

Y.V.AKBARI et al, studied the influence of different amounts of recycled coarse aggregate(RCA) obtained from a demolished Cancer Hospital, Located at Rajkot, Gujarat, about 50years old on the properties of self-compacting concrete(SCC) and compared the results with normal vibrated concrete(NVC) containing100% natural coarse aggregate(NCA). Important properties such as physical andmechanical properties of natural and recycled aggregates are carried out. NCA is partially replaced with RCA by an amount 10%, 20%, 30%, 40% and 50%. The effect of RCA on the properties of SCC in green state (e.g. Slump flow test, V-Funnel test and L-Box Test) andproperties of concrete in hardened state (e.g. compressive strength, flexural strength, and Split tensile Strength) are studied.

Dr. SUNIL S.PIMPLIKAR, determined basic changes in all aggregate properties and their effects on concreting work are discussed at length. Similarly the properties of recycled aggregate concrete are also determined. Basic concrete properties like compressive strength, flexural strength, workability etc. were explained for different combinations of recycled aggregate with natural aggregate. Codal guidelines of recycled aggregates concrete in various countries are stated with their effects, on concreting work. In general, present status of recycled aggregate in India along with its future need and its successful utilization were discussed.

III MATERIALS

Cement

A cement is a binder, a substance used in construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used solely, but is used to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. Cement is the most usually used cementing ingredient in present day concrete comprises phase that consist of compounds of calcium silicon, aluminum, iron and oxygen. In this project we hired

Commercially available 53grade ordinary Portland cement manufactured by Ultra Tech Cement with Specific Gravity of 3.2 and Fineness Modulus of 225m²/kg used in all concrete mixes.

Aggregates

'Aggregate' is a term for any particulate material. It includes gravel, crushed stone, sand, slag, and recycled concrete and Geosynthetics aggregates. Aggregate may be natural, manufactured or recycled. Aggregates make up some 60 -80% of the concrete mix. They provide compressive strength and bulk to concrete. Aggregates in any particular mix of concrete are selected for their durability, strength, workability and ability to receive finishes. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

Coarse Aggregate

Aggregates are primarily naturally occurring, inert granular materials such as sand, gravel, or crushed stone. But, technology is broadening to include the make use of recycled materials and man-made products. In this investigation used 12mm size aggregates are used for Self-Compacting Concrete.

Fine Aggregate

Fine Aggregate can be natural or manufactured sand, but it have to be of uniform grading. The particle fineness than 150um sieve are considered as fines. To achieve a balance between deformability or fluidity and stability, the total content of fineness has to be high, usually about 520 to 560kg/m³. According to IS 383:1970 the fine aggregate is being classify in to four similar zones that is zone-I, zone-II, zone-III, and zone-IV. In this investigation Zone-IV fine aggregate as used in Self Compact Concrete.

FLY ASH

Fly ash, also known as "pulverized fuel ash" in the United Kingdom, is a coal combustion product composed of fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash.

Fly ash conforming to the requirements of IS 3812 manufacturing from Rayalaseema Thermal Power Project (RTPP) in dharmal village near to Predator Kadapa district. The specific gravity of fly ash is 2.2 and specific surface area of fly ash 280m²/kg was used as supplementary cementitious material in concrete mixtures. 85% of particles are passed through 45um sieve. In this investigation Class F fly ash is used in Self Compacting Concrete.

Fig.: Cement & Fly Ash

Ground Granulated Blast Furnace Slag (GGBS)

Ground Granulated Blast Furnace Slag (GGBS) is a byproduct of Iron industry and which is obtained from during the manufacture of iron. The molten slag is a secondary product of sintering of the raw materials and this is quenched under high pressure of water jets, which results as granulates. In the case of pig iron manufacture the flux consists mainly of a mixture of limestone and forsterite or within some cases dolomite. In the blast furnace the slag float on top of top of the iron and is decant for separation. Slow cool of slag melts results in an uncreative crystalline material consisting of a collection of Ca-Al-Mg silicates. Towards get a good slag reactivity or hydraulicity, the slag liquefy desires to be rapidly cooled or quench below 800 °C in order to avoid the crystallization of merwinite and melilite. In this research, commercially obtainable GGBS particle size less than 20 Nano meters was supplied by ASTRRA chemicals pvt, Chennai with specific gravity 2.8 was used for all concrete mixtures. Specific gravity shell area of Ground Granulated Blast furnace Slag is 400m²/kg.

Fig.: GGBS

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Super Plasticizer Admixture

Super plasticizers, moreover known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is necessary. These polymers be used as dispersants to avoid particle segregation (gravel, coarse and fine sands), and to improve the flow characteristics (rheological) of suspensions such as in concrete applications. Their addition to concrete or mortar allow the decrease of the water to cement ratio, not affect the workability of the mixture, and enable the manufacture of self-compacting concrete and high performance concrete. This effect drastically improves the performance of the hardening fresh paste. The strength of concrete increase when the water to cement ratio decreases. Though, their working mechanisms require a filled understanding, revealing within confident cases cement-super plasticizer incompatibilities.

Fig.:Super plasticizer

MIX PROPORTIONS

The aim of self-compacting concrete mix proportioning is to develop producers that consistently produce high quality concrete using locally available materials and processes. This mix design development may require numerous trial and modification procedures that iterate on the desired responses from a specific fresh concrete property or a combination of fresh concrete properties. Once satisfactory fresh concrete performance is achieved, the mix is evaluated and hardened concrete performance.

As discussed in the foregoing, sections, self-compacting concrete mix proportions requires in general a low coarse aggregate content, increased paste content, high powder content, low water to powder ratio, high doses of super plasticizer and viscosity modifying agent; there are large number of variables to be considered.

In this investigation used the EUROPEAN GUIDELINES for concrete mix proportions. This proportion mix design is based on the effectiveness issue of fly ash and GGBS at different replacements levels. The maximum cement content 450kg/m³. The cementitious content was fixed as 453.2 and water content as 199 kg/m³. The SCC mixtures were produced at a constant water/cement ratio of 0.35 and one control mixture and 4 different mixtures with different dosage of and fly ash. As SCC mixtures constant as fly ash 10% and GGBS as 0%, 10%, 15% as replace in concrete.

Table: Required materials for concrete

Cement – 453.2 kg/m³	Fine aggregate – 850.805 kg/m³
Binder (cement + fly ash+ GGBS) – 533 kg/m³	Coarse aggregate – 771.84 kg/m³
Fly ash – 53.3 kg/m³	Water content – 199.677 lit/m³
GGBS – 26.65 kg/m³	Superplasticizer = 4.8 lit/ m³

In the present study from the above mix design we have choosen the following cases for casting

i. NORMAL CONCRETE, A1
ii. 10% FLY ASH AND 0% GGBS, A2
iii. 10% FLY ASH AND 5% GGBS, A3
iv. 10% FLY ASH AND 10% GGBS, A4

CASTING OF SPECIMENS

Before placing the concrete inside faces of the mould are coated with the machine oil for easy removal afterwards after completion of the workability tests, the concrete has been placed in the standard metallic moulds in three layers and has been compacted each time by tamping rod. Before placing the concrete inside faces of the mould are coated with the machine oil for easy removal afterwards. The concrete in the moulds has been finished smoothly.

CURING

After casting the specimen the moulds were air dried for one day and then the specimens were removed from the moulds after 24 hours of casting of concrete specimens. Markings have been done to identify the different percentages of Granulated Blast furnace slag specimens. Then specimens were kept for normal water curing until testing age.

IV EXPERIMENTAL INVESTIGATION

Workability Tests for SCC

In this investigation workability tests are followed by

1. Slump Flow Test with T_{500}
2. L-Box Test
3. V-funnel and T_5
4. J-Ring Test

COMPRESSIVE STRENGTH TEST

Concrete cubes ofsizes150mm×150mm×150mm were tested for crushing strength. Compressive strength depends on loads of factor such as w/c ratio, cement strength, excellence of concrete material and excellence control during manufacture of concrete.

These cubes are tested by compression testing machine after 7 days, 14 days or 28 days curing. The sample is placed centrally on the base plate of machine and the load have to be apply gradually at the rate of 140 kg/cm2 per minute till the specimen fails. Load at the failure separated by area of sample gives the compressive strength of concrete. The sample to increased load breaks down and no greater load greater load can be constant. The maximum load applied to specimen shall then be recorded and any unusual value noted at the time of failure brought out in the report.

The cube compressive strength, then $f_c=P/A$ N/mm^2
Where P is an ultimate load in N, A is a cross sectional area of cube in mm^2.

Fig. Compressive Strength Test

SPLIT TENSILE STRENGTH OF CONCRETE

The following tests are conducted for the calculation of compressive strength

- ACID RESISTANCE TEST
- SULPHATE ATTACK TEST
- ALKALINITY TEST
- RCPT (RAPID CHLORIDE PERMEABILITY TEST)

Acid Attack Test

The concrete cube specimens of various concrete mixtures of size 150 mm were cast and after 28 days of water curing, the specimens were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. The pH was maintained throughout the period of 90 days. After 90 days of immersion, the concrete cubes were taken out of acid water. Then, the specimens were tested for compressive strength. The resistance of concrete to acid attack was found by the % loss of weight of specimen and the % loss of compressive strength on immersing concrete cubes in acid water.

Sulphate Attack Test

The resistance of concrete to sulphate attacks was studied by determining the loss of compressive strength or variation in compressive strength of concrete cubes immersed in sulphate water having 5% of sodium sulphate (Na_2SO_4) and 5% of magnesium sulphate ($MgSO_4$) by weight of water and those which are not immersed in sulphate water. The concrete cubes of 150mm size after 28days of water curing and dried for one day were immersed in 5% Na_2SO_4 and 5% $MgSO_4$ added water for 90days. The concentration of sulphate water was maintained throughout the period. After 90days immersion period, the concrete cubes were removed from the sulphate waters and after wiping out the water and girt from the surface of cubes tested for compressive strength following the procedure prescribed in IS: 516-1959. This type of accelerated test of finding out the loss of compressive strength

Alkaline Attack Test

To determine the resistance of various concrete mixtures to alkaline attack, the residual compressive strength of concrete mixtures of cubes immersed in alkaline water having 5% of sodium hydroxide (NaOH) by weight of water was found. The concrete cubes which were cured in water for 28 days were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. Then the cubes were immersed in alkaline water continuously for 90 days.After 90 days of immersion, the concrete cubes were taken out of alkaline water. Then, the specimens were tested for compressive strength. The resistance of concrete to alkaline attack was found by the % loss of weight of specimen and the % loss of compressive strength on immersion of concrete cubes in alkaline water.

RAPID CHLORIDE PERMEABILITY TEST

Corrosion of reinforcing steel due to chloride ingress is one of the most common environmental attacks that lead to the deterioration of concrete structures. Corrosion-related damage to bridge deck overlays, parking garages, marine structures, and manufacturing plants results in millions of dollars spent annually on repairs. This durability problem has received widespread attention in recent years because of its frequent occurrence and the associated high cost of repairs. Chlorides penetrate crack-free concrete by a variety of mechanisms: capillary absorption, hydrostatic pressure, diffusion, and evaporative transport. Of these, diffusion is predominant.

The rapid chloride permeability test meets these goals. RCPT has had results that correlate well with results from the classical 90-day salt ponding test. Standardized testing procedures are in AASHTO T 277 or ASTM C 1202. The RCPT is performed by monitoring the amount of electrical current that passes through a sample 50 mm thick by 100 mm in diameter in 6 hours (see schematic). This sample is typically cut as a slice of a core or cylinder. A voltage of 60V DC is maintained across the ends of the sample throughout the test. One lead is immersed in a 2.4 salt (NaCl) solution and the other in a0.3 M sodium hydroxide (NaOH) solution. Based on the charge that passes through the sample, a qualitative rating is made of the concrete's permeability.

V EXPERIMENTAL RESULTS

FRESH PROPERTIES OF SCC

Table: Fresh properties of self-compacting concrete

PERCENTAGE REPLACEMENT OF FLY ASH AND GGBS	SLUMP FLOW IN mm	SLUMP FLOW IN sec (T_{50cm})	V-FUNNEL in sec	L-BOX (H_2/H_1)
10% & 0%	670	5	10	0.9
10% & 5%	650	7	9	0.83
10% & 10%	630	7	12	0.8
10% & 15%	625	7	8	0.79

Observations:

From the table, it has been observed that fresh properties of SCC such as such as Slump flow and T_{50cm} slump flow, V-Funnel test, L-box test for replacement to cement by Fly ash and GGBS is within their limits.

HARDENED PROPERTIES OF SCC

The following are the tables give the test results of Self-compacting concrete, when cement is partially replaced by FLY ASH and GGBS, for Compressive strength and Split tensile strength, flexure strength, rebound hammer test and Young's modulus test.

Table 5.: Mix proportions

Mix Designation	Proportions of Binding Materials
A1	100% cement
A2	90% cement + 10% fly ash
A3	85% cement + 10% fly ash + 5% GGBS
A4	80% cement + 10% fly ash + 10% GGBS
A5	75% cement + 10% fly ash + 15% GGBS

COMPRESSIVE STRENGTH RESULTS

The Compressive strength results for various replacement levels of fly ash and GGBS by Cement such as 0%, 5%, 10% & 15% are tabulated below in table.

- ❖ Compressive strength of the cubes when they are tested under the following parameters are given below

ACID RESISTANCE TEST
SULPHATE ATTACK TEST
ALKALINITY TEST
RCPT (RAPID CHLORIDE PERMEABILITY TEST).

TEST RESULTS IN NORMAL CURING

Table.:COMPRESSION TEST RESULT @NORMAL CURING

Mix Designation	Compressive strength N/mm² 28 days
A1	43.4
A2	33.86
A3	35.3
A4	30.63
A5	29.89

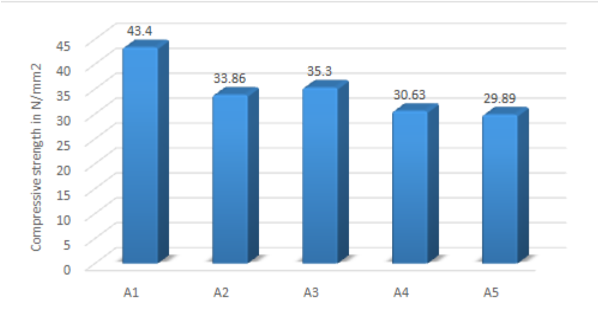

Fig.: Compressive Strength test results (normal curing)

As we observed the compressive strength of 28 days strength for SCC at acid attackfor (30days normal curing + 30days acid curing) i.e. Total 60 days as 10%FA & 0%GGBS, we can observe that among all the mixes increase in compressive strength was seen in cement concrete mix i.e., A1 in normal curing compared to all the remaining mixes.

TEST RESULTS IN ACID ATTACK at 60days curing

Table.: COMPRESSION TEST RESULT @ ACID ATTACK.

Mix Designation	Compressive strength N/mm²
	60 days
A1	33.0
A2	33.8
A3	36.3
A4	41.6
A5	32.4

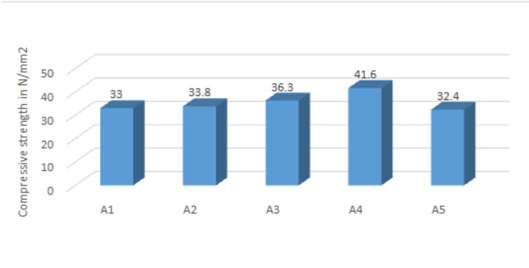

Fig.: Compressive Strength test results (Acid Attack @ 60DAYS)

As we observed the compressive strength in 28 days strength SCC at acid attackfor (30days normal curing + 30days sulphate curing) i.e. Total 60 days, after the sulphate curing in 30days then the compressive strength of all the mixes then more compressive strength is seen in 10% flyash and 10% GGBS compare to all mixes.

TEST RESULTS IN SULPHATE ATTACK at 90 days curing

Table:COMPRESSION TEST RESULT @ SULPHATE ATTACK.

Mix Designation	Compressive strength N/mm²
	90 days
A1	35.53
A2	37.4
A3	40.2
A4	41.36
A5	30.5

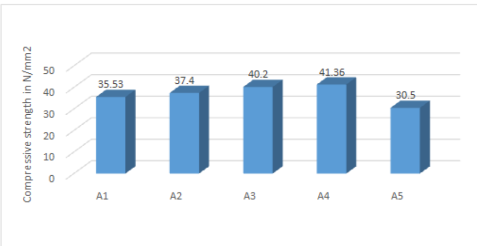

Fig.: Compressive Strength test results (Sulphate Attack)

As we observed the compressive strength is 28 days strength in SCC at sulphate attackfor (30days normal curing + 60days sulphate curing) i.e. Total 90 days from the fig: 6.5 we can notice in the sulphate attack the compressive strength the cube with 0% to 15% increase in fly ash and GGBS, increment was done in 10% Fly ash and 10% GGBS.

TEST RESULTS IN ALKALINITY TEST at 60 days curing

Table.:COMPRESSION TEST RESULT @ ALKALINTY TEST

Mix Designation	Compressive strength N/mm²
	60 days
A1	37.93
A2	42.6
A3	29.23
A4	48.06
A5	28.42

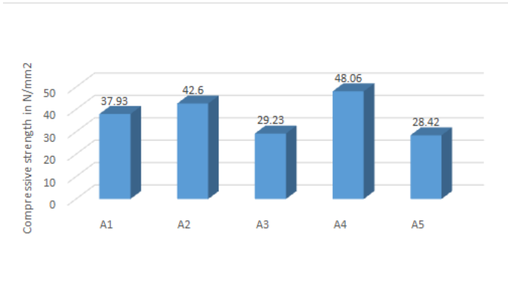

Fig.: Compressive Strength test results (ALKALINITY TEST)

As we observed the compressive strength is 60 days strength in SCC at alkalinity for (30days normal curing + 30days chemical curing) i.e. Total 60 days from the graph we can notice in that with the alkalinity attack the compressive strength the cube with 10% Fly ash to 0% GGBS increase in fly ash and GGBS, increment was done in 10% Fly ash and 10% GGBS.

TEST RESULTS IN ALKALINITY ATTACK at 90 days curing

Table .: COMPRESSION TEST RESULT @ ALKALINITY TEST.

Mix Designation	Compressive strength N/mm²
	90 days
A1	38.5
A2	39.5
A3	40.2
A4	42.3
A5	38.2

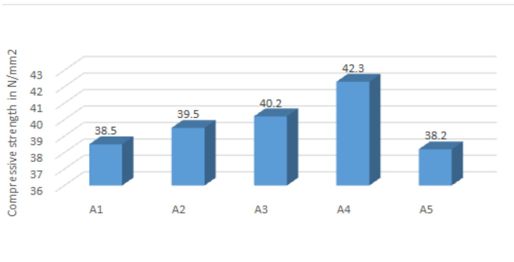

Fig.: Compressive Strength test results (ALKALINITY TEST)

As we observed the compressive strength is 90days strength in SCC at alkalinity for (30days normal curing + 60days chemical curing) i.e. Total 90 days from the graph we can notice in that with the alkalinity attack the compressive strength the cube with 10% Fly ash to 0% GGBS increase in fly ash and GGBS, increment was done in 10% Fly ash and 10% GGBS.

Table.RCPT VALUES @28 DAYS & 60 DAYS

MIX PROPORTIONS	CHARGE PASSED (COULOMBS)	
	28DAYS	60 DAYS
A1	1672.5	1296.7
A2	1485.4	1078.5
A3	1183.6	963.55
A4	1088.7	785.89
A5	1185.6	995.3

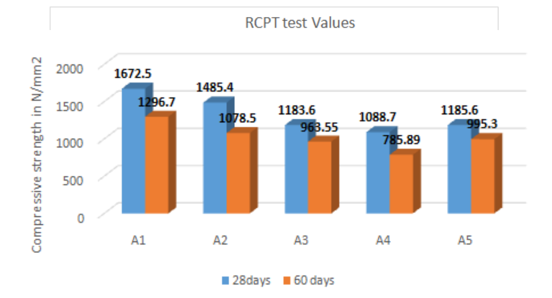

Fig.: RCPT Values

From the graph we can prove that, the chloride permeability is more in case of Normal concrete then it is decreased while adding GGBS 5%, 10% to the concrete for 60 days of curing. The chloride permeability of concrete with 10%FLY ASH + 10% GGBS is less while compared with the all proportions for 90 days.

V CONCLUSION

Based on the investigation conducted for the durability study on behavior of self-compacting concrete the following conclusions are arrived.

- As no specific mix design procedures for SCC are available mix design can be done with conventional BIS method and suitable adjustments can be done as per the guidelines provided by different agencies.
- So, we should made trail mixes for maintaining filling ability, flowing ability, passing ability, self-compatibility and obstruction clearance.
- By making the replacement of cement with GGBS increases consistency.
- With the use of super plasticizer it possible to get a mix with low water to cement ratio to get the desired strength.
- In this project we done compressive strength of the cubes in the acid, sulphate and alkalinity attack
- The compressive strength of normal concrete is almost equal to the strength of 10% fly ash and 10% GGBS.
- From this project we can conclude that the mix proportion 10% fly ash & 10% GGBS withstands all the strengths and we got optimum results for the above mix
- Mechanical and Durability properties of concrete of the following mix was taken as optimum i.e. 10% Flyash and 10% GGBS, if we increase the percentage again the strength decreases.

SCOPE OF FUTURE WORK

- Fly ash can replace a significant part of the necessary filler when used into a self-compacting concrete composition.
- SCC is favourably suitable especially in highly reinforced concrete members like bridge decks or abutments, tunnel linings or tubing segments, where it is difficult to vibrate the concrete, or even for normal engineering structures.
- The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction. Based on these facts it can be concluded that SCC will have a bright future.

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