International Journal of Advanced Technology in Engineering and Science
Vol. No.08, Issue No. 08, August 2020
www.ijates.com
ijates
ISSN 2348 - 7550

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

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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 selfcompacting 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.

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 mould ability, 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 payments, 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.

GUIDELINES, SPECIFICATIONS, AND ACCEPTANCE CRITERIA

SCC may be used in pre-cast applications or for concrete placed on site. It can be manufactured in a site batching plant or in a ready mix concrete plant and delivered to site by truck. It can be placed either by pumping or pouring into horizontal or vertical structures. The workability of SCC can be characterized by the following properties:

- Filling ability
- Passing ability
- Segregation resistance

A comprehensive list of test methods for assessing the workability properties of SCC is shown in below table

S. NO	TEST METHOD	PROPERTY
1	Slump-flow by Abrams cone	Filling ability
2	T50cmslumpflow	Filling ability
3	J-ring	Passing ability
4	V-funnel	Filling ability
5	V-funnel at T5minutes	Segregation resistance
6	L-box	Passing ability
7	U-box	Passing ability
8	Fill-box	Passing ability
9	GTM screen stability test	Segregation resistance
10	Orimet	Filling ability

LITERATURE REVIEW

Nan Su et al. (2001) proposes a basic plan blend technique for Self-compacting concrete. Essentially, required amounts of totals are assessed and cover glue is then poured in to space of totals to ensure that solid achieved flowability, its very own compactability and different properties of SCC. To watch the conduct of SCC compressive test were completed. Gotten result shows this technique could create effectively high caliber of self-compacting concrete. As contrast with the Japanese Ready-Mixed Concrete Association this strategy is simpler, straightforward for execution, time utilization is less and financially savvy. Jian-Tong Ding et al. (2002) tentatively discovered the impacts of Metakaolin and Silica rage on the properties of cement. Exploratory examination with seven solid blends of 0,5,10 and 15% by mass supplanting of bond with high reactivity Metakaolin or

Silica rage on the usefulness, quality, shrinkage and protection from chloride entrance of cement was researched. The consolidation of both Metakaolin and Silica rage in cement was found to decrease the free drying shrinkage and limited shrinkage breaking width. It is likewise detailed that the joining of Metakaolin or Silica rage in cement can lessen the chloride dispersion rate fundamentally. The execution of Silica rage was observed to be superior to Metakaolin.

MATERIALS AND METHODOLOGY

Chemical composition (%) of Fly ash

Compound	Content %Wt.
Sio_2	58
Al_2O_3	22.5
Fe_2O_3	5.75
TiO_2	5.6
Cao	2.12
MgO	1.6
SO_3	1.77
Na_2O	0.89
LOI	6.02

Chemical Composition (%) of GGBS

Compound	Content %wt.
Cao	36.5
SiO_2	38.1
Al_2O_3	12.4
MgO	10.9
K_2O	0.6

Characteristics of Fresh Self- Compacting Concrete

Self-Compacting concrete is characterized by its special properties in fresh state namely flow ability, viscosity, blocking tendency, self-levelling and strength of mixture. These workability parameters are ground into three key properties, namely,

1. **Filling ability or deformability:** This is the ability to flow into and entirely fill complicated and complex form in its own weight.
2. **Passing ability:** This is the ability to pass through along with bond to dense reinforcement in its own weight.

3. **Stability:** This represents high resistance to aggregate segregation.

While adequate flow is generally the main parameter use to consider SCC, a high quality, SCC must not only fill formwork and combine in its own weight, it must also remain homogenous all through the entire construction process, i.e., it must be stable.

The Visual Stability index test ranks the stability of the SCC on a scale of 0-3, with 0 indicating highly stable SCC and 3 indicating unacceptable SCC. However, the short duration of the test may not indicate segregation that occurs over a longer period of time. The individual nature of the VSI determination further limits the precision of the test.

EXPERIMENTAL INVESTIGATION

TEST PROCEDURES FOR SELF-COMPACTING CONCRETE (SCC):

This section describes the various tests generally performed on self-consolidating concrete (SCC). The physical characteristics of SCC as determined using these tests are critical for ensuring quality structures that are safe, durable and economical.

Testing fresh concrete As discussed earlier Self-Compacting Concrete is characterized by its special properties in fresh state namely flow ability, viscosity, blocking tendency, self-levelling, and constancy of mixture. However, the tests for filing and passing abilities of self-compacting concrete are usually enough to monitor construct quality at the site. Because SCC flows so readily, the flow ability is measured in terms of spread as an alternative of slump, i.e., as a replacement for of measuring the slumping distance vertically; the mean spread of the resulting concrete patty is measured horizontally.

A number of tests have been suggested to evaluate the properties of fresh SCC but the commonly used field methods are: Slump flow / inverted slump flow which also includes visual stability index (VSI) and T_{500} test methods. ASTM has standardized three tests for SCC namely the J-Ring test for passing ability, slump flow test for flow ability, and the column segregation technique for segregation resistance. The European Guidelines for Self-Compacting Concrete Specification, Production and used as standardized four tests namely, slump flow test with T_{500},V-funnel and T5 Tests, L-box test and sieve stability test.

In evaluating the workability of SCC, tests should measure filling ability, passing ability, and segregation resistance independently. Such an approach is preferred to pass / fail-type tests that measure multiple aspects of workability. Measuring each property individually provides a more direct insight into the performance of the concrete and allows more effective troubleshooting. These advantages outweigh the need to conduct multiple tests.

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

The following tests are conducted for the calculation of compressive strength

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

EXPERIMENTAL RESULTS AND DISCUSSION

INTRODUCTION

This chapter explains the mechanical strength properties like compressive strength, split tensile strength, flexural strength, non- destructive test (rebound hammer) and young's modulus test of concrete mixture with fly ash and ground granulated blast furnace slag and discussion are presented.

The results completed in the present investigation are reported in the form of Tables and Graphs for various fresh properties and hardened properties of Self-compacting concrete for various percentage of fly ash and GGBS as a partial replacement to cement in SCC by fly ash taken constant of 10% and GGBS taken as percentages like 0%, 5%, 10%&15%, are worked out and tabulated in the table below.

FRESH PROPERTIES OF SCC

Fresh properties of self-compacting concrete

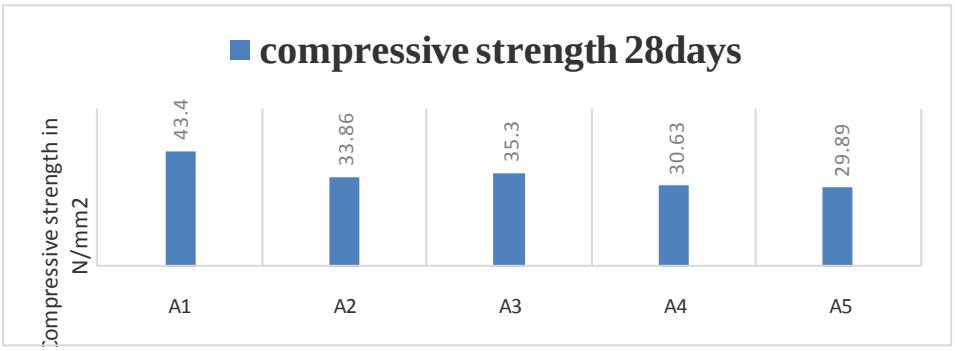
PERCENTAGE REPLACEMENT OF FLY ASH AND GGBS	SLUMP FLOW IN mm	SLUMP FLOW IN sec (T_{50cm})	V-FUNNEL in sec	L-BOX (H_2/H_1)
10% & 0%	670	5	10	0.9
10% & 5%	650	7	9	0.83
10% & 10%	630	7	12	0.8
10% & 15%	625	7	8	0.79

Observations:

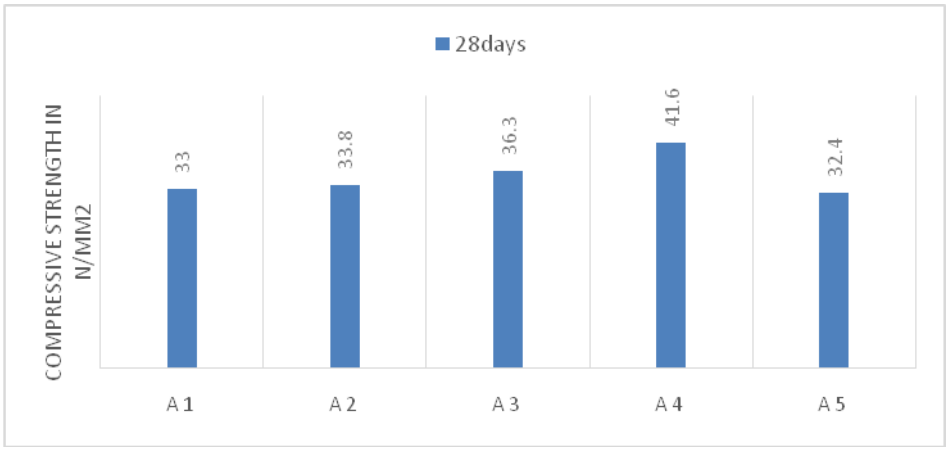
From the table, it has been observed that fresh properties of SCC such as such as Slump flow

and T_{50cm} slump flow, V-Funnel test, L-box test for replacement to cement by Fly ash and GGBS is within their limits.

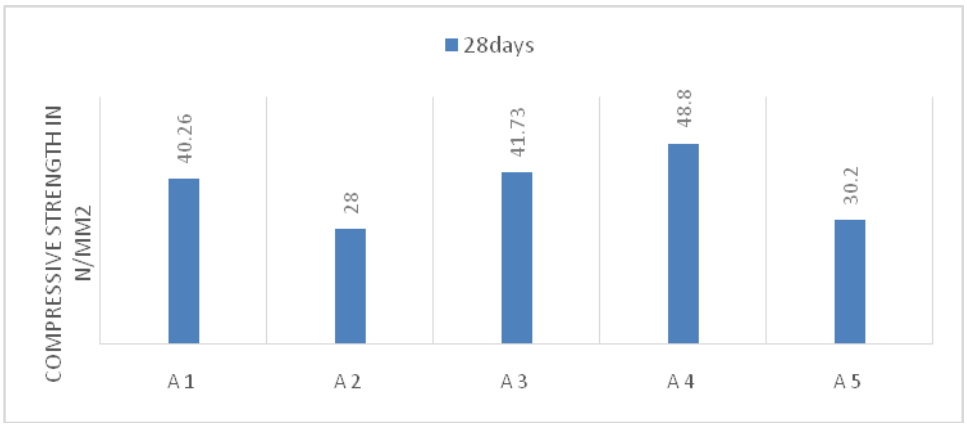
TEST RESULTS IN NORMAL CURING



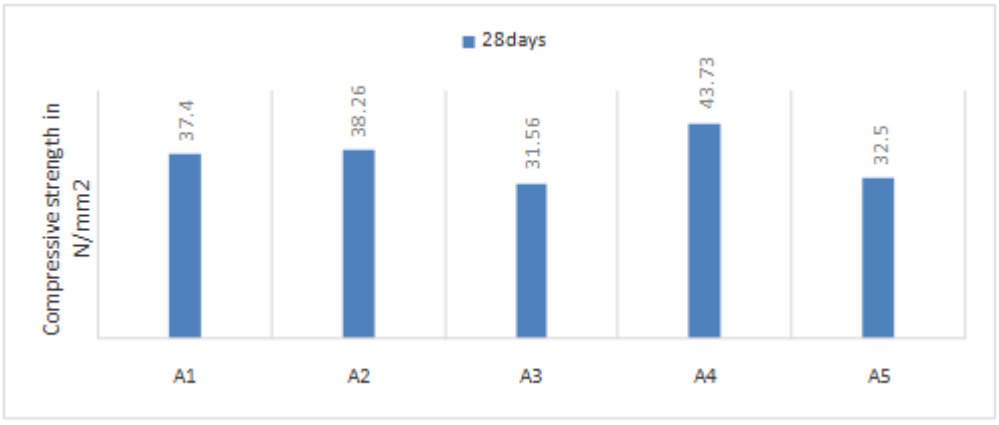
Compressive Strength test results (normal curing)



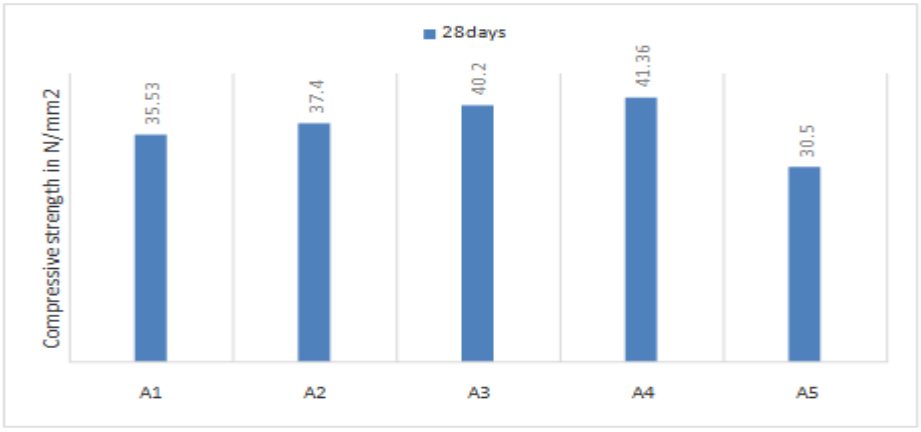
Compressive Strength test results (Acid Attack @ 60DAYS)



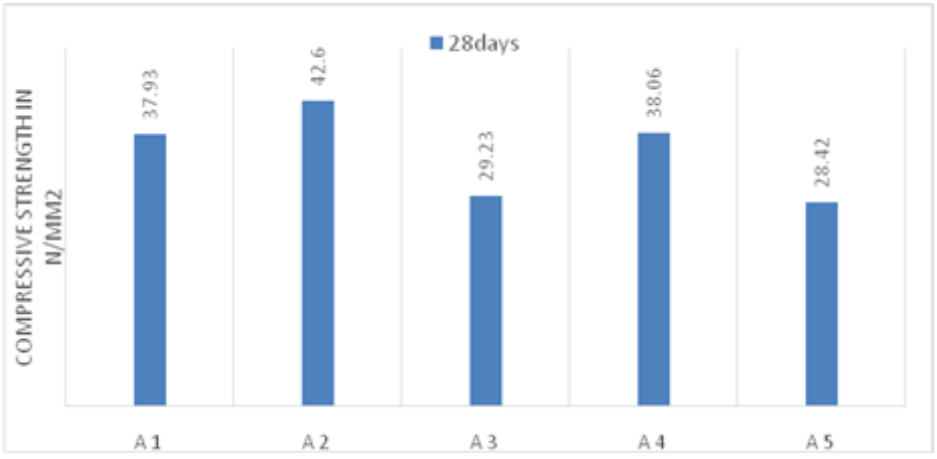
Compressive Strength test results (Acid Attack @90 DAYS)



Compressive Strength test results (Sulphate attack @60 DAYS)



Compressive Strength test results (Sulphate Attack)



Compressive Strength test results (ALKALINITY TEST)

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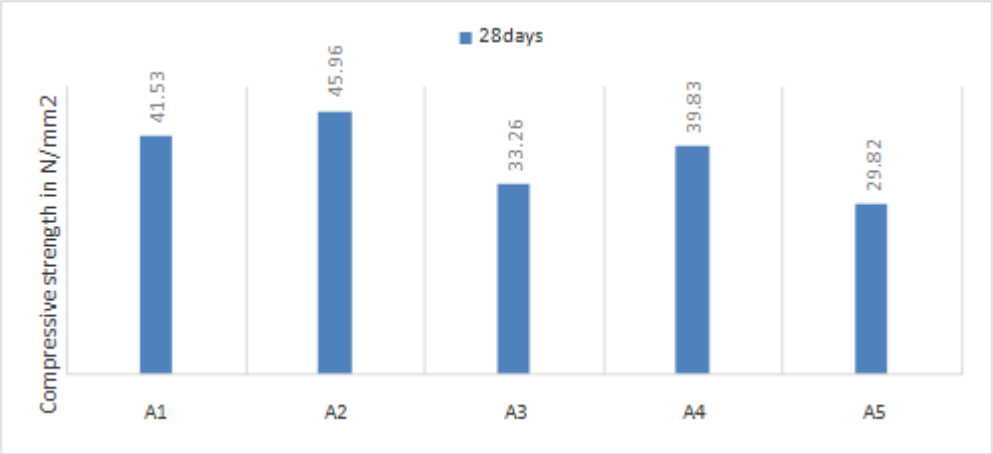
www.ijates.com
ijates
ISSN 2348 - 7550

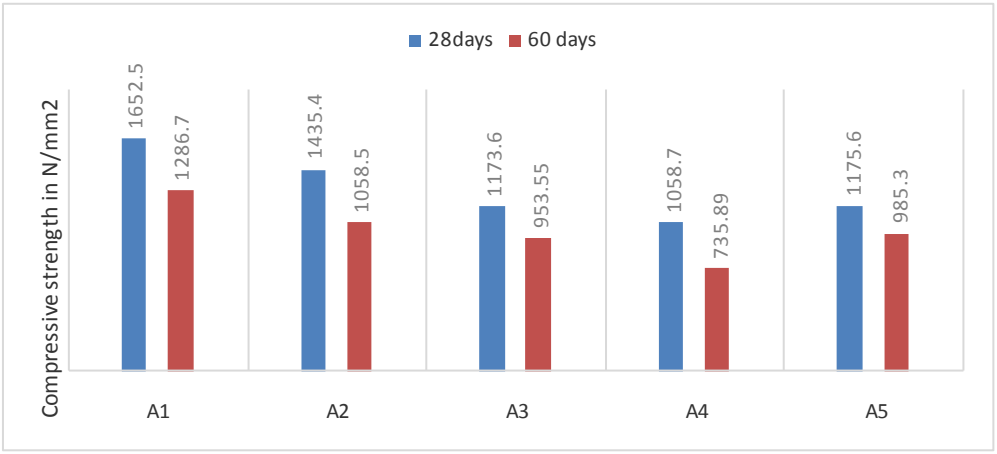


Compressive Strength test results(ALKALINITY TEST)

RCPT (RAPID CHLORIDE PERMEABILITY TEST)

RCPT VALUES @28 DAYS & 60 DAYS

MIX PROPORTIONS	CHARGE PASSED (COULOMBS)	
	28DAYS	60 DAYS
A1	1652.5	1286.7
A2	1435.4	1058.5
A3	1173.6	953.55
A4	1058.7	735.89
A5	1175.6	985.3



CONCLUSION

- The latest example in strong research is to use present day symptoms in setting up the strong mixes. The extension of Saw Dust as mineral included substances in SCC is a phase that would profitably use these two for the most part waste things whose exchange is an issue in itself. In this work, SCC orchestrated using these mechanical symptoms are surveyed similar to self-decreased limit, compressive quality, and solidness consider, the going with end may be drawn:
  - in sawdust.

SCOPE OF FUTURE WORK

- Fly fiery debris can supplant a critical piece of the fundamental filler when utilized into a self-compacting solid organization.
- The disposal of vibrating hardware enhances nature insurance close development and precast destinations where concrete is being set, diminishing the presentation of laborers to clamor and vibration.
- The enhanced development practice and execution, joined with the wellbeing and security benefits, make SCC an extremely alluring answer for both precast concrete and structural designing development. In light of these certainties it tends to be presumed that SCC will have a brilliant future.

ENGINEERING SIGNIFICANCE

Cementitious material is the help of present day framework. Expanding interest for cement in more up to date applications prompts engineer the properties of cement at crisp and solidified state. A standout amongst the most vital execution criteria for cement is the ease at crisp state. Fitting crisp state properties are accomplished by building reasonably the philosophy of cement. Such designing is accomplished by joining concoction and mineral admixtures into cementitious framework. The improvement of self-compacting concrete is essentially accomplished by planning the fitting religious philosophy utilizing diverse cementitious framework, admixtures, and so forth.

Self-compacting (or merging) concrete (SCC) is a specific solid blend which sshas a unique act prerequisite of self– combination or compaction at the time situation. In any case, at the solidified state, there isn't much distinction as far as mechanical properties and toughness among SCC and other kind of cement blends viz. elite concrete(HPC), ordinary quality cement.

The vital parts of accomplishing the useful prerequisites (filling capacity, passing capacity and protection from isolation) of SCC are connected with:

- Appropriate portrayal of fixings
- Mix extent
- Mixing technique
- Placement