Behaviour of Self Compacting Concrete Using Recycled Aggregate in Various Proportion With Various Proportion of Fly Ash

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Abstract- *Concrete is one of the most widely used construction material having several advantages such as high strength, good mound ability and high durability. Conventional concrete used in building construction and engineering application requires compaction to attend strength,durability and homogeneity. The typical method of compaction by vibration generates delays and additional cost in projects and could possesses a serious health hazard due to noise pollution in and around construction site. Self compacting concrete is a concrete which is highly flowable, can flow readily into places, fill the formwork without any compaction and without undergoing any significant segregation recycling is the act of processing the used material for creating a new useful product. Construction and demolished waste also generate recycled aggregate. Such a recycled aggregate proved to be a reliable alternative to natural aggregate in concrete. Use of aggregate from building demolished waste and abraded aggregates from road side in structural concrete is definitely and important stride. The present study focuses on mechanical strength behavior of self compaction concrete by partially replacing natural aggregate with recycled aggregate. Roadside abraded aggregates are used as coarse aggregate partial substitution in concrete, with aim to achieve sustainable concrete.*

Keywords- Recycled aggregate, self-compacting concrete, superplasticizers, fly ash, flowability, passing ability, resistance to segregation.

I. INTRODUCTION

Concrete is one of our most common building materials, it consists of aggregates bonded by cement paste. The compressive strength of concrete is to a large extent dependent on the water to cement ratio (w/c). Cement is a hydraulic binder, meaning it hardens by a reaction with water to something that is not water soluble. The smallest particles of the concrete paste are in the range of micro-meters (or even nanometers), the largest particles, the aggregates, are ranging several centimeters. The types and proportions of the concrete constituents not only influence concrete's hard properties, but also its fresh properties. Concrete is the most widely consumed material in the world, after water. Placing the fresh concrete requires skilled operatives using slow, heavy, noisy, expensive, energy-consuming and often dangerous mechanical vibration to ensure adequate compaction to obtain the full strength and durability of the hardened concrete. It was against this background that self-compacting concrete (SCC), which eliminates the need for compaction, has been developed and its advantages exploited. Pioneering studies in Japan in late 1980s was followed by several spectacular uses; the technology then spread rapidly many other in countries in Asia. Self-compacting, or "self-consolidating" concrete (SCC) was first developed in Japan in the early nineties. Self-compacting concrete (SCC) is composed of a combination of cementitious materials, water, sand, gravel and chemicals (such as superplasticizer), and mineral (silica fume or limestone filler) admixtures. The key characteristics of SCC are flowability, segregation resistance, and passing ability. Quality control of flowability is typically predicted by the values of plastic viscosity and yield stress, and empirical testing. Segregation resistance concerns the ability to retain homogeneous distribution of aggregates; segregation can occur both during and after casting. The ability to maintain the homogeneity of the aggregate distribution is governed by volume fraction, distribution, and the physical properties of the aggregates, along with the rheological properties of the suspending matrix, which is the cement paste or the mortar for concrete systems.

II. OBJECTIVES AND SCOPE OF STUDY

1. The present study focuses on mechanical strength behavior of self compacting concrete by partially replacing natural aggregate with recycled aggregate.
2. Road side abraded aggregate is used as coarse aggregate in the concrete, with aim to achieve sustainable concrete with required fresh and hardened properties.

III. METHODOLOGY

Materials:

1. *Ordinary Portland Cement* (OPC) conforming to IS 12269 (1987) was used as main binderfor the research work.
2. *Fine aggregate* passing through 4.75mm was provided by college.
3. Natural *coarse aggregate* passing through 12.5mm and 16mm obtained from local supplier was provided by college.
4. *Fly ash* is used as a mineral admixture and was brought from KORADI ThermalPower Station.
5. Poly Carboxylate Ether (PCE) based *Superplasticizer: Viscos Flux-2202* was used confirming IS 9103: 1999 and ASTM C-494 types AF and G. It wasbrought from Apple Chemie, Nagpur. The main reason of using superplasticizer as it gives good flowability with very high slump that is to be used in experimental study.
6. Roadside abraded *Recycled Coarse Aggregate* (RCA) were used for present study maximum size of aggregate was limited to 16mm.

TESTING OF MATERIALS: Following tests were performed on Coarse aggregate& fine aggregate

1. Specific Gravity: -

Pycnometer test was performed on Coarse Aggregate and Specific Gravity of "2.74" was found out.
Pycnometer test was performed on fine aggregate and specific gravity of "2.65" was found out.
Pycnometer test was performed on roadside recycled coarse aggregate and specific gravity of "2.70" was found out.

Following tests were performed on cement:
1. Soundness Test: - Le-chateliar's soundness apparatus was used and 11mm difference was observed after curing of 24 hrs.
2. Consistency Test: -Vicat's apparatus is used to determine the consistency and it is found out to be "31%".
3. Initial Setting Time and Final Setting Time: -Vicat's apparatus is used to determine initial setting time and final setting time is found to be 37 minutes and 547 minutes.
4. Fineness Test: - test was performed on cement by dry sieving IS-90-micron sieve confirming to IS-456 (1962) and standard balance with 100 gm weighing capacity were used the percentage weight of residue over the total sample is reported as it is found to be 7.3%.

IV. MIX DESIGN FOR M40 GRADE OF CONCRETE

The concrete mix was designed by using EFNARC specifications and following outputs were calculated.

Ingredient	SCC
Water (Kg/m^3)	175
Cement (Kg/m^3)	530
Fly Ash (Kg/m^3)	70
F.A. (Kg/m^3)	751
C.A. (Kg/m^3)	789
Admixture (Kg/m^3)	9

Using this as a reference mix, we have prepared 12 mixes with 10%, 15%, 20% fly ash content each bach having one normal mix and recycled aggregate of 25%, 30% and 35% respectively.

V. RESULT

Fresh State Properties

Self Compacting concrete is characterized by filling ability, passingability, flowing ability and resistance to segregation. The fresh state properties of self compacting concrete were tested by following methods as suggested by EFNARC. L-Box test is for testing filling ability and V-Funnel test is for testing passing ability of concrete.

1. V-Funnel test:

The V- funnel test is used to assess the viscosity and filling ability of self compacting concrete. V shaped funnel is with fresh concrete and the time taken for the concrete to flow out of the funnel is measured and recorded as the V-funnel flow time. The flow time value should be 8 to 12 seconds.

Mix	**Flow Time** (in seconds)
Mix 1	16
Mix2	18
Mix3	19
Mix4	25
Mix5	14
Mix6	20
Mix7	20
Mix8	12
Mix9	28
Mix10	30
Mix11	12
Mix12	22

2.L-Box Test:

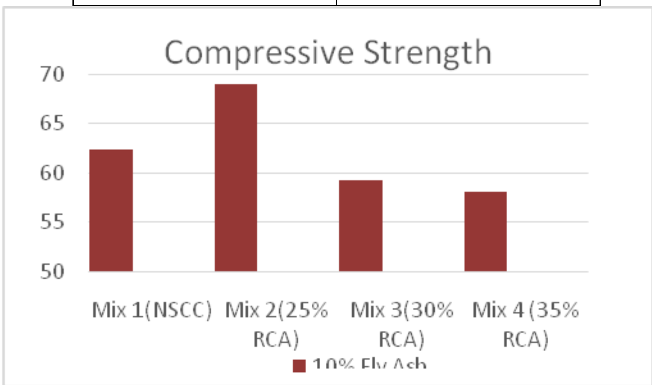
The L-Box test is performed to check the passing ability and filling ability of fresh concrete. Two measurements are taken (H1 and H2) heights of concrete at the beginning and end of the horizontal section respectively. The ratio H2/H1 represents the filling ability and typically this ratio should be 0.8 to 1, while the passing ability can be detected visuallyby inspecting the area around the rebar.

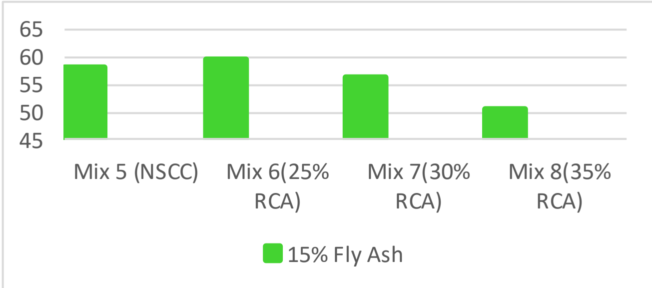
Mix	**H2/H1**
Mix 1	1.00
Mix 2	0.83
Mix 3	0.80
Mix 4	0.83
Mix 5	0.83
Mix 6	0.85
Mix 7	0.96
Mix 8	1.00
Mix 9	0.99
Mix 10	1.01
Mix 11	0.88
Mix 12	0.82

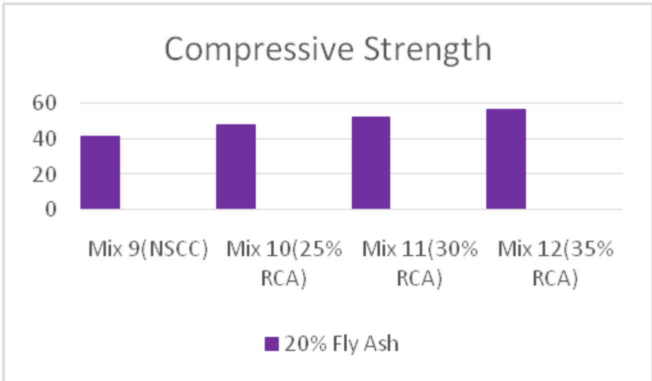
COMPRESSIVE STRENGTH

- The hardened concrete properties such as compressive strength were tested in the laboratory. The results are presented along with their graphical plots and discussions.
- Compressive strength measured using both cube and cylindrical specimens. The size of cube specimen is 150mm*150mm*150mm.
- Table below shows the results of 28 days compressive strength of concrete from the results the compressive strength seems to be increase slightly with the addition of recycled aggregate.
- This could be due to higher absorption capacity of aggregate. When the water is absorbed by aggregates, more space left by water being absorbed can be occupied by aggregates in a unit volume. Hence the density of recycled concrete is lower.
- The results of compressive strengths of concrete with 0%, 25%, 30%, and 35% replacement of recycled aggregate which is achieved after testing are given below also the graph shows details about the strength obtained.

Mix Type	**Compressive strength MPa (28 days)**
10% Fly Ash	
Mix 1 (NSCC)	62.37
Mix 2 (25%RCA)	68.99
Mix 3 (30%RCA)	59.22
Mix 4 (35%RCA)	58.11
15% Fly Ash	
Mix 5 (NSCC)	58.11
Mix 6 (25%RCA)	59.55
Mix 7 (30%RCA)	56.22
Mix 8 (35% RCA)	50.44
20% Fly Ash	
Mix 9 (NSCC)	41.11
Mix 10 (25%RCA)	47.78
Mix 11 (30%RCA)	52.22
Mix 12 (35%RCA)	56.45







VI. CONCLUSION

1. The results of V-Funnel test of all mixes were found to be 12-30 sec.
2. The results of L-Box test of all mixes werefound to be 0.8 to 1.01, hence all the mixes confirmed to the criteria laid by EFNARC.
3. The compressive strength of self compacting concrete with recycled aggregate of 11.66% and 15% of fly ash was found to be lower than self compacting concrete with normal conventional aggregate by 35% of recycled aggregates but for substitution 20% of fly ash this value is found to be higher.
4. The compressive strength of mixes was higher for11.66% of fly ash and also it is higher for 15% fly ash but for 20% of fly ash content the compressive strength was found to be lower. This confirms the research work by Heba (2011).
5. There is significant potential for growth of recycled aggregates as an appropriate and green solution for sustainable development in construction industry.

VII. FUTURE SCOPE

1. Further research can be done by replacing the fine aggregates with sand dust available on roadside.
2. Again, the different admixtures with viscosity modifying agents can be use to obtain sustainable concrete replacing 30% of conventional aggregate to recycled aggregate.

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