Experimental Study on Durability of Self Compacting Concrete by Using Recycled Aggregate Incorporated with GGBS

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ABSTRACT

Self-compacting concrete is a fluid mixture suitable for placing in structures with congested reinforcement without vibration. Use of SCC can also help in minimize hearing related damage on the work site that is induced by vibration of concrete. In this paper experimental studies are carried out to understand the fresh properties of Self Compacting Concrete. Present study involves the durability properties of Self Compacting Concrete (SCC) made with Recycled Concrete Aggregates (RCA) as partial replacement of Natural Coarse Aggregates (NCA) and containing GGBS as cement replacement with adding Super plasticizer. The cement is replaced 30% of GGBS as Optimum for M30 Grade and 20% as Optimum for M40 Grade. The effect of RCA on fresh properties of SCCs was measured using Slump flow test, V-funnel test, L-box test. Whereas the durability properties like acid resistivity and rapid chloride permeability were investigated to study the effect of RCA on SCC. This investigation is to examine the durability properties of SCC having Different Grades by conducting various tests.

SELF COMPACTING CONCRETE

Self compacting concrete (SCC) is defined as a fresh concrete which possesses flow ability under maintained stability (i.e. no segregation),thus allowing self compaction that is material consolidation without any external vibration. The three properties that categorize a concrete self compacting are:

Flowing ability: The ability to completely fill all areas and corners of the formwork in to which it is placed.

Passing ability: The ability to pass through congested reinforcement without separation of constituents or blocking.

Segregation resistance: The ability to retain the coarse components of the mix in the suspension in order to maintain homogeneous material. SCC offers many advantages for the precast,

Background

For several years beginning in 1983, the problem of the durability of the concrete structures was a major topic of interest. To make durable concrete structures, sufficient compaction by skilled workers is required. However the gradual reduction in number of skilled workers in a construction industry has led to a similar reduction in the quality of construction work. One solution for the achievement of durable concrete structures independent of quality of construction work is the employment of self compacting concretes, which can be compacted into every corner of a formwork, purely by means of its own weight and without the need for vibrating compaction.

The necessity of this type of concrete was proposed by Okamura in 1986. Studies to develop self compacting concrete, including a fundamental study on the workability of concrete, were carried out by Ozawa and Maekawa at the University of Tokyo. The prototype of self compacting concrete was first completed in 1988. The prototype performed satisfactorily with regard to drying and hardening shrinkage, heat of hydration, denseness after hardening, and other properties. This concrete was named “High Performance Concrete.” At almost the same time, “High performance concrete” was defined as a concrete with high durability due to low water-cement ratio by Professor Aictin. Since then, the term high performance concrete has been used around the world to refer to high durability concrete. Therefore, Okamura has changed the term for the proposed concrete to “Self Compacting High Performance Concrete.

Sweden was the Sweden was the first country in Europe to begin development of SCC, and in 1993 the CBI organized a seminar in Sweden for contractors and producers, leading to a project aimed at studying SCC. As part of this project, large numbers of half- scale house walls were cast using SCC which were made with different filler materials. The work from this project contributed to the first European project on SCC which began in January 1997 and was completed in 2000. Later SCC has been used in bridges, buildings, tunnel construction. In last five years a number of constructions using SCC have increased worldwide. Recently in Telangana IIT Hyderabad was constructed using SCC.

LITERATURE REVIEW

KC Panda et al "Properties of SCC using recycled coarse aggregate" Procedia Engineering, pp.159-164, 2013.

This paper presents the influence of different amounts of recycled coarse aggregate obtained from a demolished about 25 years old on the properties of self compacting concrete (SCC) and compared the results with normal vibrated concrete containing 100% natural coarse aggregate (NCA).The test results indicate that the compressive strength, flexural strength and split tensile strength of SCC is less than the NVC. The compressive strength, flexural strength and split tensile strength of SCC decreases with increase in the amount of RCA. RCA show higher water absorption compared with conventional NCA due to old mortar attached with original concrete and has relatively lower specific gravity.

Prashant O. Modani et al "Self-compacting concrete with recycled aggregate: A solution for sustainable development"International Journal Of Civil And Structural engineering Volume 4, No 3, 2014 .

This investigation is an attempt to examine the influence of recycled aggregate on strength, permeability, resistance to acid attack, chloride penetration, and alkalinity of self compacting concrete. It is observed that recycled aggregate can be effectively used in the production of SCC without any significant reduction in strength and durability. There is a significant potential for growth of recycled aggregate as an appropriate and green solution for sustainable development in construction industry. Self-compacting concrete made with recycled aggregates have achieved the target strength in all the mixes and also satisfied the fresh state properties required for SCC as per EFNARC specification. It was observed that the mixes containing recycled aggregate gains quick early strength due to presence of partially hydrated cement adhered to aggregate which accelerates the hydration process.

Shahil M. Bandi et al "Study on Fresh and Hardened Properties of Self Compacted Concrete Using Recycled Concrete Aggregate" IJIRCT ,Vol5,Issue 5,2016.

This paper presents an experimental investigation 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 this study, it has been found that the workability increase with increase in dosage of super plasticizer. Higher dosage of super plasticizer can lead the high degree of segregation in SCC and after 24 hours when try to demouled cubes AND cylinder then it can collapsed. RCA show higher water absorption compared with conventional NCA due to old mortar attached with original concrete and has relatively lower specific gravity. The workability decreases with increases RCA replacement to natural aggregate because of weak properties of RCA than natural aggregate.

EXPERIMENTAL PROGRAM:

The experimental programme involved the use of Ordinary Portland Cement (OPC 53 grade), natural coarse aggregate (NCA), recycled coarse aggregate (RCA), fine aggregate, fly ash, ground granulated blast furnace slag (GGBS), superplasticizer (Conplast SP-430), and potable water. All materials were tested to determine their physical and mechanical properties in accordance with relevant IS specifications to ensure suitability for concrete production. The testing programme was designed to obtain reliable material parameters required for mix design and performance evaluation.

Cement properties such as fineness, specific gravity, normal consistency, and setting times were evaluated using standard laboratory procedures. The fineness of cement was found to be 5%, which is within the IS limit of 10%. The specific gravity of cement was obtained as 2.97, close to the standard value of 3.15. The normal consistency was observed as 32%, while the initial and final setting times were determined using the Vicat apparatus, with the initial setting time recorded as 65 minutes. These results confirm that the cement used was suitable for structural concrete applications.

Physical properties of aggregates including specific gravity, bulk density, fineness modulus, impact value, flakiness index, and elongation index were determined for both natural and recycled coarse aggregates, as well as fine aggregate. The specific gravity of NCA ranged between 2.66 and 2.70, while RCA showed slightly higher values due to adhered mortar. Bulk density values of RCA were comparatively lower, indicating higher porosity. Impact value results showed that both NCA (20%) and RCA (13.33%) possess very good toughness. The flakiness index of RCA was found to be 8%, whereas the elongation index was relatively higher at 43%. Fine aggregate showed a fineness modulus of 3.11, confirming its suitability for concrete production.

Recycled coarse aggregates were produced by crushing laboratory-tested concrete cubes, supporting the principles of reduce, reuse, and recycle (3R). The use of RCA contributes to conservation of natural resources, reduction of CO_2 emissions, and cost savings. Fly ash and GGBS were incorporated as supplementary cementitious materials to enhance workability, strength, and sustainability of concrete. Commercially available nano-sized GGBS with a specific gravity of 2.8 and high surface area was used. To achieve the required workability at reduced water–cement ratios, Conplast SP-430 (DIS-based superplasticizer) was employed, which allows significant water reduction without segregation or bleeding. These materials

collectively contributed to the development of durable and high-performance concrete mixes.

CONCLUSIONS

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

1. As per IS 10262-2019 the mix design can be done and suitable adjustments can be done as per the guidelines provided by different agencies.
2. So, we should made trail mixes for maintaining filling ability, flowing ability, passing ability, self compatibility and obstruction clearance.
3. By making the replacement of cement with GGBS increases consistency.
4. With the use of super plasticizer it possible to get a mix with low water to cement ratio to get the desired strength.
5. In this project we done Durability tests. The compressive strength of normal concrete is equal to the normal strength of 25% Fly ash and 30% GGBS.
6. Durability properties of concrete of the following mix was taken as optimum i.e 30% GGBS and 25% Fly ash, if we increase the percentage again the strength decreases.
7. In this project along with Cementecious material, Coarse aggregates are partially replaced by Recycled coarse aggregates. As we increase the % of RCA strength decreases. Recycled aggregates absorb more water compared to natural aggregates because of the mortar attached on the recycled aggregates.
8. In Acid attack test, I concluded that weight loss is little more in 56 days compared to 28 days and compressive strength is reduced due to weight loss. Strength is more for Natural aggregate concrete as compared to Recycled Coarse aggregate concrete.
9. In Rapid chloride permeability test, the concrete Permeability is Very low because the charge is less than 1000 Coulombs.

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