www.ijiarec.com

ISSN:2348-2079

Volume-8 Issue-3

International Journal of Intellectual Advancements and Research in Engineering Computations

An experimental study on self-compacting concrete with recycled concrete aggregate

Vismaya S[1], M.A Asha[2]

[1]Master of Engineering Student, Civil Engineering Department, EASA College of Engineering and Technology, Coimbatore

[2]Assistant Professor, Civil Engineering Department, EASA College of Engineering and Technology, Coimbatore

ABSTRACT

The usage of natural aggregate is becoming more intense with the advanced development in construction. Recycled aggregate can be used as a suitable replacement for natural aggregate. Recycling of aggregate material from construction and demolition waste may reduce the demand-supply gap and reduce consumption of natural resources. The advance in the prestressed concrete and multistoried structures has given impetus for making high performance concrete. At the point when the overall exhibition of cement is significantly higher than that of ordinary kind concrete, such cement is viewed as elite cement (HPC). High-execution concrete (HPC) surpasses the properties and constructability of typical cement. HPC is usually more brittle when compared with normal strength concrete, especially when high strength is the main focus of the performance. These deficiencies can be overcome by adding fibres. Fibre reinforced concrete has become popular due to its crack arresting mechanism, strengthening property, high energy absorption properties, ductile behavior and post-cracking tensile strength. The aim of this thesis is to study the flexural as well as shear behavior of fibre reinforced high performance recycled aggregate concrete in beams under monotonic for optimum percentages of fibres.

Keywords: Recycled aggregate, Self-compacting, Strength.

INTRODUCTION

An introduction to the recycled concrete aggregate (RCA) and self-compacting concrete (SCC) along with the need for using RCA in SCC is included in this chapter. Problem definition, objectives and the organization of the thesis are also stated.

Recycled concrete aggregate in self-compacting concrete

The growing need for infrastructural development produced a huge demand on construction materials. Concrete is the widely used construction material and it requires a large percentage of natural resources for its production. Thus concrete construction industry became the largest consumer of natural resources. The increase in demand leads to over exploitation and scarcity of natural resources. So it is high time to concentrate in developing eco-friendly and sustainable methods in concrete production. For this reason producing a durable concrete with the available waste materials without affecting the functionality of concrete, will direct a sustainable path for the construction industry. Accumulation of waste and its management became a threat to environment and society. In India, about 960 million tons of solid wastes are being generated per year. Of this 14.5 million tons are from construction industry [1]. Construction wastes include brick, bitumen, sand, gravel, masonry and concrete. These wastes are recycled and utilized in buildings and the share of recycled materials is 25% for old buildings and 75% for new buildings

Author for correspondence:
Civil Engineering Department, EASA College of Engineering and Technology, Coimbatore

[2]. Concrete waste can be effectively recycled to produce RCA which we can use in concrete in place of natural aggregates. RCA should be graded according to the requirement and it can replace both coarse and fine aggregates provided it should not affect the strength and durability of the produced concrete. The usage of RCA for the production of concrete is much advisable, not only it reduces the use of virgin raw materials but also gives a better solution for the disposal problems of demolished concrete structures.

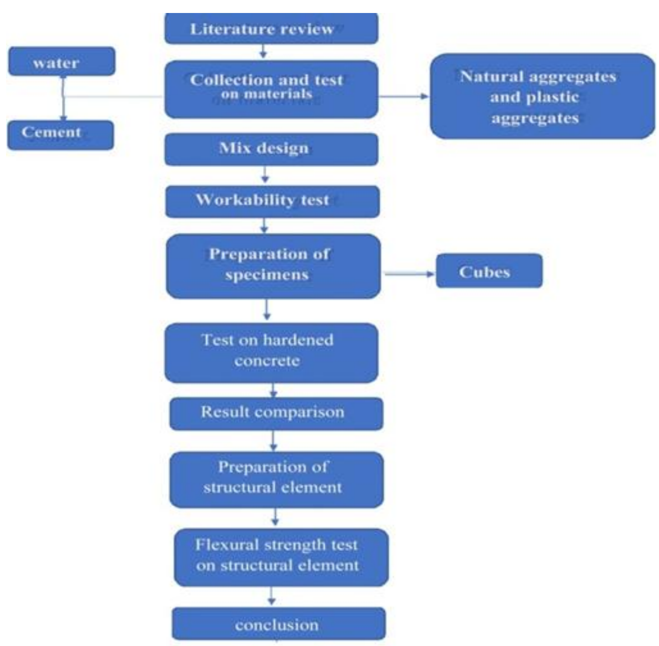
SCC is a type of concrete which compacts by its own weight without any segregation. It is well known by its greater freedom in design over conventional concrete. SCC is the concrete of present generation because it overcomes the deficiency of skilled labors, which is a main issue that is facing by construction industry. Therefore, adding RCA in SCC is a better proposal in construction field and it is a solution for the issue of waste disposal of construction and demolition of structures and thus increases the ecological value of the concrete.

AIMS AND OBJECTIVES

- To find the maximum possible replacement of NCA by RCA in SCC with respect to cube compressive strength for M50 grade.
- To assess the mechanical properties of NASCC and RASCC such as compressive strength, modulus of elasticity, split tensile strength, modulus of rupture.
- To compare the early and later compressive strength (7, 28, 90, days curing) of both mixes of SCC.
- To evaluate and compare the durability characteristics of RASCC mix with that of control mix using water absorption, sorptivity, RCPT and acid resistance.
- To study the bond strength characteristics of NASCC and RASCC for 10mm, 12mm, 16mm and 20mm diameter steel bars.
- To analyses and compare the flexural properties of RC beams made of RASCC with that of control mix.

METHODOLOGY

The flowchart given explains the detailed methodology of this study.



LITERATURE REVIEW

This chapter includes a brief account of the published literature related to the present investigation. Several experiments have been done in the past to study the behavior and mechanical properties of plastic modified concrete. The following papers are the studies based on the specimens like cubes, prisms and cylinders (including fresh concrete properties and hardened concrete properties)

Upadhyay, dealt with the development history of SCC and its basic principles. High flow ability, segregation resistance, and passing ability were studied under different test methods. Different mix design methods using a variety of materials were discussed and it was found that the mix proportion and material properties influences self-compatibility to a great extent [3]. In development of mix proportion of SCC the investigation by Aggarwal gave a procedure for the design of SCC mixes based on an experimental investigation. At the water/powder ratio of 1.180 to 1.215, passing ability; filling ability and segregation resistance were well within the limits. SCC was developed without using viscosity modifying agent (VMA) in this study [4]. Earlier studies conducted by Okamura, addressed the two major issues faced by the international community in using SCC, namely the absence of a proper mix design method and jovial testing method. They proposed a mix design method for SCC based on paste and mortar studies for super plasticizer compatibility followed by trail mixes. However, it was emphasized that the need to test the final product for passing ability, filling ability, and flow ability and segregation resistance was more relevant [5]. Different from trial mixes, Nan Su proposed a new mix design method for SCC. Aggregate content was fixed first and the amount of paste of binders which fills in the voids were calculated so as to fulfill the fresh properties of SCC. The property changes according to the type of super plasticizer (SP) and the amount of water content. It is a step by step method of calculating material contents and the result produced a SCC with high quality [6].

Chen, the effect of paste amount on the properties of SCC containing fly ash and slag were studied. Performances of SCC under different water to cementations material ratio and different cement paste were compared and the result showed that the less the cement paste, denser the blended aggregate, the lower the early age compressive strength and higher the long- term compressive strength [7]. In the same year Raharjo, optimized the composition of SCC containing fly ash, silica fume and iron slag. Using optimal composition, SCC were prepared with silica fume (0-20% of fly ash weight) and super plasticizers (0.5 -1.85 of cement weight). Authors also provided a formula for optimal composition [8]. Also Dhiyaneshawaran obtained the workability and durability characteristics of SCC with VMA, and Class F fly ash. The results showed that the increase in addition of super-plasticizer improves the workability and optimum fly ash replacement which was observed as 30%. The addition of VMA should be carried with at most care because even a small change in the amount of VMA will affect the properties of SCC [9]. The results showed that SCC with 15% of SF gives higher values of compressive strength than those with 30% of FA and water cured specimens for 28 days give the highest values of compressive strength. Earlier studies were available with comparing effect of multi admixtures on SCC [10]. In the investigations of Selvamony, the effect of replacing the cement, coarse aggregate and fine aggregate by limestone powder (LP), SF, quarry dust (QD) and clinkers respectively were evaluated. The use of SF in concrete significantly increased the dosage of SP. It was proposed that, at the same constant SP dosage (0.8%) and mineral additives content (30%), LP can better improve the workability than that of control and fine aggregate mixtures by 5% to 45%. However, the results of this study suggested that certain QD, SF and LP combinations can improve the workability of SCCs, more than QD, SF and LP alone [11].

The research conducted by Felekoglu, discusses the effect of water cement ratio on the fresh and hardened properties of SCC. The effect of material properties and water cement ratio has the ability to change the workability and hardened properties of SCC. According to the author adjustment of water cement ratio and super plasticizer dosage is one of the key properties in proportioning of SCC mixtures. In this research, fine mixtures with different combinations of water cement ratio and super plasticizer dosage levels were investigated. The results of this research showed that the optimum water cement ratio for producing SCC is in the range of 0.84-1.07 by volume. The ratio above and below this range may cause blocking or segregation of the mixture [12].

DISCUSSION

It was observed that the increment in powder content increases the compressive strength. Also small increment in water reduced the compressive strength. Dosage of SP was increased to achieve the workability as well as strength. The trial mix 10 was taken as control mix which gave required compressive strength from various test results It was observed that the results obtained from various workability tests were conforming to the limit set.

Mix proportion of RASCC

The compressive strength and flow properties obtained by replacing NCA by different percentages of RCA are shown in Table 7.3 and Table 7.4. In all the trial mixes of RASCC, the proportion of cement, SF, fine aggregate, super plasticizer and water were kept same as that of the control mix. Mix designation of RASCC was given according to the % of RCA in each mix it was clear that the compressive strength decreased gradually with the addition of RCA. The decrease in compressive strength of RA-SCC-100 compared to NASCC was only 11 %.The workability of SCC decreased very slightly with the addition of RCA. The decrease in slump flow value of RASCC-100 with that of NASCC were 2%. The L-box value decreased by 6% but V-funnel and U-box of RASCC-100 increased to 22% and 9% respectively.

The decrease in slump flow and L-box value indicates increased viscosity of RASCC. The increase in V-funnel and U-box results of RASCC may be due to decrease in flow ability. Since all the values were within the permissible limit as per EFNARC specifications, it can be concluded that complete replacement of RCA is possible according to the workability criteria.

A difference of 5 N/mm^2 from the target strength was permitted, as per IS 456, Hence RA-SCC-100 having 53.33 N/mm^2 compressive strength can be taken as the optimum mix of RASCC, which has maximum replacement level as well as satisfactory strength and workability criteria. The better performance of RCA in the present study may be due to high powder content and reduced course to fine ratio. This will help to cover the irregularity and surface cracks of RCA. Also since we adopted TSMA for mixing RCA, the fine particles fills into the pores and provides better strength as well as reduced water absorption.

CONCLUSIONS AND RECOMMENDATIONS

- The decrease in flow area of slump flow test indicates a decrease in the deformation of the mix.
- The increase in the V funnel time indicates a decrease in the relative flow time and thereby higher viscosity
- The decrease in the L-box value indicates a decrease in the relative flow of the mix.
- The research has shown that partial replacement of fine aggregate by 10% recycled aggregate and coarse aggregate by 25% recycled aggregate with addition of steel fibres increases the 7 days and 28 days compressive strength, split tensile strength and flexural strength of the concrete.
- Further increase in recycled aggregate content increases the 7 days compressive strength and reduces 28 days compressive strength. It also reduces 7 days and 28 days split tensile strength and flexural strength. However, for 35% replacement of coarse aggregate by recycled aggregate compressive strength is above the target mean strength for M 35 concrete.
- For 30% replacement of coarse aggregate by recycled aggregate the compressive strength drops below the target mean strength.
- For 35% replacement of coarse aggregate by recycled aggregate the compressive strength is almost equal to characteristic strength.

REFERENCES

[1]. Sherif A. Khatanga, ‘Production of High strength self-compacting concrete using recycled concrete as fine and /or coarse aggregates. “World applied sciences journal, 29(940), 2014, 465-474.

[2]. M. Seethapathi, Dr.S.R.R. S and Dr. K. Senthilkumar and Dr. Chinnaraju, “High performance Self compacting concrete using recycled coarse aggregate. “International journal of applied engineering research, 10(47), 2015, ISSN 0973-4562.

[3]. Ajith V and Praveen Mathew ‘A study on the self-compacting properties of recycled concrete incorporating a new mix proportioning method. “International journal of science technology and engineering, 2(5), 2015.

[4]. Revathi Purushothaman, Kavithi. P, Senthamilselvi .R.” Experimental studies on SCC with recycled aggregate.” International journal of research in engineering and technology (IJRET), 05(20), 2016.

[5]. Md. Safiuddin.,”Use of recycled concrete aggregate in concrete.” Journal of civil engineering and management, 19(6), 2013.

[6]. Jitender Sharma and Sandeep single” Study of recycled concrete aggregate.” International journal of engineering trends and technology, 13, 2014.

[7]. C.Sumanth reddy, K.v. Ratna sai,”Recycled aggregate based self-compacting concrete (RASCC) for structural applications.”International conference on advances in science and technology of concrete, 2014.

[8]. Prashant O.modani, Vinod M Mohitkar ”Self-compacting concrete with recycled aggregate” International journal of civil and structural engineering, 4(3), 2014.

[9]. Kamal M.M, Safan M.A., Etman Z.A and Eldaboly E.A.”Evaluating the prolonged properties of fresh self-compacting, 2013.