

Effect of Recycled Concrete Waste Aggregate on the Fresh State Properties of Self Compacting Concrete

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Abstract: In this investigation an attempt is made to replace coarse aggregate partially or fully by recycled concrete waste aggregates and the fresh state properties of modified SCC (Self Compacting Concrete) was elaborated by conducting slump flow, V-funnel, L-Box and J-ring tests. The properties such as filling ability, passing ability, segregation, bleeding and stability of the modified SCC were determined by using the fresh state tests. The results of this experiment revealed that it is possible to modify SCC by partially or fully replacing the coarse aggregate by RCWA. The optimum mix also determined by varying RCWA and mineral admixture content in SCC.

Keywords: Self Compacting Concrete, Recycled Concrete Waste Aggregate, Fresh state properties, segregation, passing ability.

I. INTRODUCTION

Self compacting concrete (SCC) was first introduced in Japan. Mainly SCC mix is used in complex structural applications. Concrete materials are taken from the natural resources which causes environmental degradation and pollution. In recent years SCC is widely used in various applications because of its high workability. Normally contribution of aggregates in SCC mix is about 60 %. So it plays an important role in fresh properties of SCC mix. Based on the aggregate shape, size and texture values of fresh state properties values get varied. Various alternative materials have been identified to replace the aggregates partially or fully. The size and shape of the coarse aggregate has an impact on amount of necessary to bind all the particles [1]. Flow ability of the SCC mix was reduced by the interlocking of the angular particles of crushed aggregates at the same time flow ability increased with rounded aggregates [2]. To achieve a successful and economical SCC, it is necessary to use properly graded aggregates. Production of SCC mix may also be possible with the poorly graded aggregate but providing adequate viscosity to eradicate segregation problem. Passing ability of the mix depends on the size of the coarse aggregate an increase in size of aggregate reduces the passing ability of the concrete. The optimum size of coarse aggregate is selected by two parameters such as size and shape. Maximum size of aggregate size in SCC mix is about 10-12 mm [3]. This investigation is aimed at attaining an optimum content of RCWA which yields desired SCC fresh state properties.

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Mixes were prepared in various percentages (30 %, 40% and 50 %) of RCWA. In addition to this Steel fibre in suitable proportion of the order of 0.5, 0.75 and 1% was added to the SCC mixes and the fresh state properties were determined..

II. EXPERIMENTAL PROGRAM

A. Work Materials

Ordinary Portland cement of grade 43 was used in this experimental investigation. Fly ash is the mineral admixture used as a partial replacement to cement in order to enhance the workability properties of the concrete. Fly ash is derived from thermal power plant situated in Neyveli district. Addition of fly ash in SCC mix also regulates the level of viscosity [4]. Fly ash also provides resistance to sulphate attack and hinders the alkali aggregate reaction. Recycled concrete waste aggregate taken from nearby demolished buildings and of size about 10 mm- 12mm was used in the investigation. Addition of RCWA percentages was varied from 30% to 50%. Water absorption ratio of the concrete mix was observed to be about 0.5. Poly carboxylate based super plasticizer was used as a water reducing agent in this investigation.

B. Mix proportions

Mix proportioning was made as per the guidelines given in EFNARC. Water to binder ratio value is fixed about 0.5 and the water content of 208 lit/ m³ was determined and the cement content is 291.2 kg/ m³. Cement was partially replaced by fly ash and the volume of fly ash is fixed about 124.8 kg/m³. RCWA content is varied from 30% to 50%. While preparing the SCC mixes the stability of the mixtures were determined using visual stability index. To achieve the required stability the contents of the SCC mixture were varied. The SP content was about 7.23 lit/ m³ to achieve the slump flow values of 700 ± 40 mm [5]. Normal SCC mix is taken for the reference mix (M0). M1 is prepared by replacing 30% of RCWA in the place of natural aggregates. Similarly M2 and M3 were prepared by replacing natural aggregates by 40% and 50% respectively. M4, M5 and M6 were prepared by replacing RCWA in the place of natural aggregates and the steel fibre addition is in the order of 0.5, 0.75 and 1% respectively. Mix proportions are tabulated in Table I.

A. Procedures for testing

The fresh state properties are tested based on the guidelines given in EFNARC (2005) [6]. The values of slump flow diameter, T500 flow time, L-box height ratio, V funnel flow time values are fixed according to EFNARC guidelines. Figure 1 represents the rough draft of slump flow testing equipment.



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Normally slump flow value 650 mm is the optimum value of SCC mix and the flow time decreases with increase in flow ability.

Table I Mix proportioning of SCC

Sl. No.	Mix ID	Steel Fibers (%)	Cement (kg/m ³)	Fly ash (kg/m ³)	Water (l/m ³)	Water to binder ratio	FA (kg/m ³)	CA (Kg/m ³)	RCW (Kg/m ³)	SP % CM	SP (L/m ³)
1	M0	-	291.2	124.8	208	0.5	989.84	809.87	-	1.68	7.0
2	M1	-	291.2	124.8	208	0.5	989.84	566.9	242.9	2.16	9.5
3	M2	-	291.2	124.8	208	0.5	989.84	485.93	323.94	2.58	10.75
4	M3	-	291.2	124.8	208	0.5	989.84	404.93	404.93	2.95	12.28
5	M4	0.5	291.2	124.8	208	0.5	989.84	566.9	242.9	2.35	9.8
6	M5	0.75	291.2	124.8	208	0.5	989.84	485.93	323.94	2.64	10.98
7	M6	1.0	291.2	124.8	208	0.5	989.84	404.93	404.93	3.04	12.67

Flow ability of the SCC mix values were determined by the slump flow and flow time.

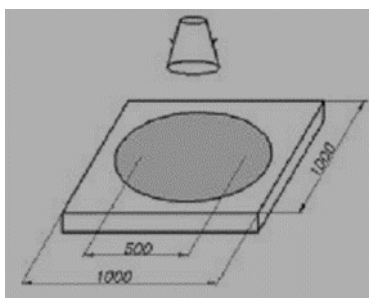


Figure 1 Slump cone apparatus, EFNARC (2005)

By using the apparatus represented in figure 1 was used to inspect the consistence of fresh concrete. T500 time was used to determine the concrete segregation resistance and uniformity of the SCC mix. SCC mix takes to flow 500 mm diameter was mentioned using flow time.

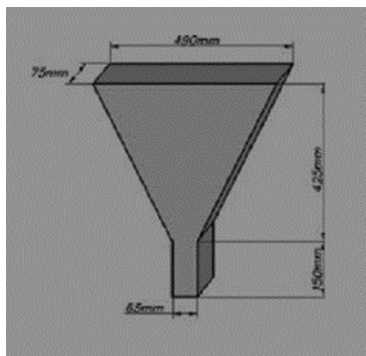


Figure 2 V-Funnel Apparatus EFNARC (2005)

Computation of T50 slump flow time and V-funnel time was used to determine the viscosity value of SCC. V-shaped funnel apparatus was utilized to determine the value of V-funnel flow time. Funnel is filled with the SCC mix and then it is allowed to flow out. The time period required to empty the V-funnel apparatus was noted as V-funnel time. The passing ability of SCC mix was determined by using J-ring test. Test apparatus setup is shown in figure 3. J-ring was situated around the slump cone. The difference in slump flow is observed as passing ability [8].

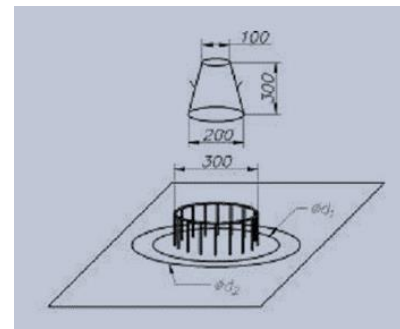


Figure 3 J-Ring Apparatus EFNARC (2005)

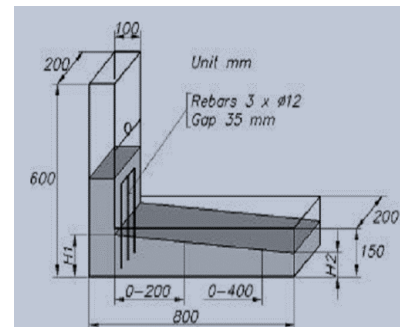


Figure 4 L-Box Test Apparatus EFNARC (2005)

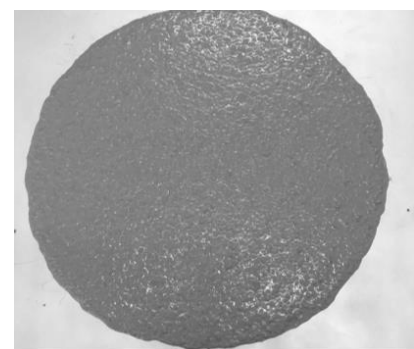


Figure 5 Slump flow measurement of SCC



Figure 6 L-box test on SCC



Figure 7 J-ring test on SCC trial mix

This test also explains the horizontal movement of fresh SCC mix through the vertical reinforcing rods. The height of the concrete at both the ends of the horizontal section was measured and expressed as H_2/H_1 . Slump flow, L- Box and J-ring tests were performed and the results are tabulated in table II

Table II Fresh state properties of SCC

MIX ID	Fresh state test				
	Slump flow		J-ring (mm)	L-Box (mm)	V-Funnel (Sec)
	D (mm)	T ₅₀₀ (Sec)			
M0	740	2	7.3	1.0	8.31
M1	735	2.37	7.6	0.97	8.94
M2	723	2.98	7.7	0.89	9.17
M3	718	3.25	8.5	0.87	9.52
M4	723	3.65	8.9	0.85	10.25
M5	717	3.97	9.5	0.83	10.88
M6	707	4.29	9.9	0.82	11.08

III. RESULTS AND DISCUSSION

A. Fresh properties

The stability and filling ability of SCC mixes were determined by the factors such as passing capacity, flow ability, viscosity and segregation resistance. Each of these factors were evaluated by single or multiple testing procedures given in EFNARC. Flow capacity of SCC mix was assessed by slump flow test. Viscosity of SCC mix was attained by conducting T500 slump flow time and V-funnel time tests. The values of all the tests were recorded and graphically represented in figure 8.

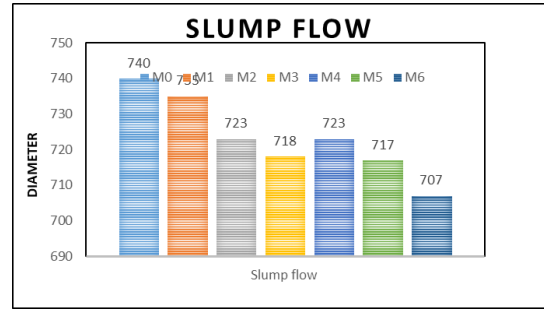


Figure 8 Slump flow values of SCC mix

From the results it is evident that the replacement of natural aggregates by RCWA reduced the slump flow values of SCC mix. Increasing the RCWA content more than 50% caused an unacceptable flow. This is due to the high angularity of RCWA content in SCC mix and it reduced the workability of the concrete mix.

B. T500 measurements

T500 times of SCC mixes are shown in figure 9. As seen in figure T500 time is gradually increase with increase in RCWA content in SCC and more than 50% of RCWA.. The mobility values are decreased with increase in RCWA content.

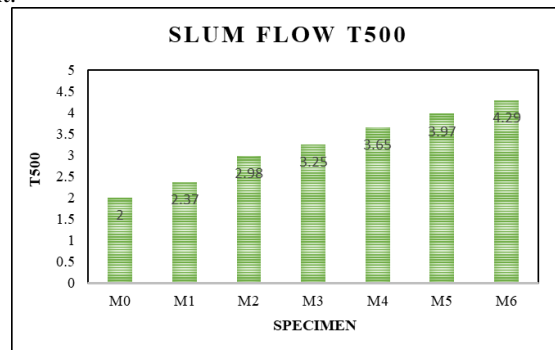


Figure 9 T500 time of SCC mix

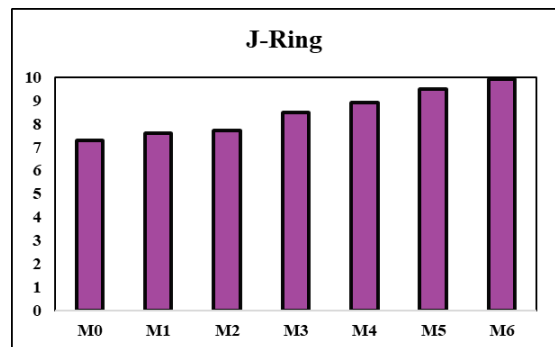


Figure 9 J-Ring test of SCC mix

C. L-Box tests

The blocking ability of SCC mixes are determined by using L-Box apparatus. The values are graphically represented in figure 10. As seen in figure the ratio of H_2/H_1 reduced with increase in RCWA content. Higher replacement levels of RCWA exhibits the negative behaviour of SCC mix. So the optimum values of viscosity is attained at 30% of replacement levels.

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Figure 9 L-Box test of SCC mix

B. V-Funnel Time

V-funnel time of the SCC mixtures exhibited similar tendency to that of T500 slump flow time. From the figure it is revealed that the increase in replacement levels of RCWA elevated the V-Funnel times.

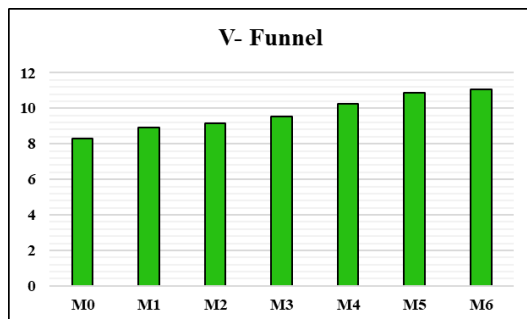


Figure 10 V-Funnel test of SCC mix

IV. CONCLUSION

This investigation has suggested an alternate coarse aggregate for the preparation of Self Compacting Concrete mix. The flow ability of SCC decreases with increase in RCWA content. The addition of fly ash as a partial replacement of cement reduced the flow ability of SCC mix and increased the viscosity which enhanced the strength properties of modified SCC. From this investigation it is inferred that the usage of RCWA in SCC mix satisfactorily meet the requirements of SCC mix.

REFERENCES

1. Neuwald, A (2004). " Self-Consolidating Concrete" MC Magazine, pp. 2-4.
2. Alexander, C. and Prosk (2003), T.," Self-Compacting Concrete-Influence of the Coarse Aggregate on The fresh Concrete Properties" <http://www.darmstadt-concrete.de> ,, pp. 1
3. Petersson, O. (1997), "Preliminary Mix Design"Final Report of Task 1, Swedish Cement and Concrete Research Institute, pp.15-19.
4. A. Bilodeau, V. Sivasundaram, K.E. Painter, V.M. Malhotra, Durability of concrete incorporating high volume of fly ash from source in US, ACI Mater.J. 91 (1) (1994) 3–13.
5. K.-H. Yang, Y.-B. Jung, M.-S. Cho, S.-H. Tae, Effect of supplementary cementitious materials on reduction of CO2 emissions from concrete, J.Clean. Prod. 103 (2015) 774-783, <https://doi.org/10.1016/j.jclepro.2014.03.018>.
6. EFNARC (2005) Specification and guidelines for self-compacting concrete.
7. K. Ozawa, K. Maekawa, H. Okamura, Self-Compacting High-Performance Concrete. Collected Papers, University of Tokyo: Department of Civil Engineering, 1996, pp. 135–149.
8. M.U. Chandrakant, U.P. Pradnya, M.H. Shriram, K. Ravi, Comparative study of properties of self compacting concrete with metakaolin and cement kiln dust as mineral admixtures, Int. J. Res. Eng. Technol. 2 (4) (2014) 37–52.