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Short Communication

Prospects of utilization of construction and demolition waste for developing structural grade concrete – the way forward

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Abstract

Disposal of Construction and Demolition Waste (CDW) poses serious challenges worldwide. Recycling of CDW to produce recycled aggregates can minimize the gap between demand and supply of natural aggregates in construction sector. Use of recycled aggregates in structural applications has not gained momentum due to non-availability of standard guidelines pertaining to specifications, concrete mix design procedures for producing structural grade concrete i.e. M35, M40, M45, M60 and self compacting concrete. The present study is aimed to develop the above guidelines for producing structural grade concrete i.e. M35, M40, M45, M60 and self compacting concrete from the locally available commercial RCA.

Keywords: CDW, Recycled coarse aggregates (RCA), Structural applications, Guidelines for specifications, Concrete mix design procedure for RCA.

Introduction

Construction and Demolition Waste (CDW) is generated as the byproduct of construction activities pertaining to demolition, new construction, repairs, renovation and rehabilitation[1]. Left over materials and discarded cast structural components resulting from construction activities also add to the generation of CDW. Disposal of CDW poses serious challenges[2]. In India, it is estimated that construction industries generate about 15 million tons of waste annually[3]. In construction sector, there is a huge demand of natural aggregates but a large gap exists between demand and supply[4]. This gap can be minimized by recycling CDW with a systematic approach to produce recycled aggregates[2,5,6]. In India, the recycled aggregates have been used mostly in non-structural applications.

Use of recycled coarse aggregates (RCA) in structural applications has not gained momentum due to non-availability of standard guidelines pertaining to specifications, concrete mix design procedures, for producing structural concrete of various grades from RCA i.e. M35, M40 (Prestressed Concrete), M45, M60 (High Strength Concrete), Self-Compacting Concrete[7]. The current ongoing study is aimed to develop guidelines for producing structural concrete of various grades i.e. M35, M40 (Prestressed Concrete), M45, M60 (High Strength Concrete), Self-Compacting Concrete from the locally available commercial RCA[8].

Objectives: The present study is aimed to develop guidelines and specifications for mixdesign of concrete of structural grades M35,M40,M 45andM60 using recycled aggregatesobtained from the processing of construction and demolition waste[9].

Scope of work: i. To prepare experimental plan to study the material properties of concreteproduced from commercially available recycled aggregate. ii. To prepare different concrete specimens using different percentages of recycled coarse aggregates replacing the natural coarse aggregates in accordance to the prepared experimental plan. iii. To carry out experimental investigation in terms of laboratory testing of concretespecimens to find out compressive strength, splitting tensile strength, flexuralstrength, stress-strain curve and non-destructive testing on concrete made withnatural and recycled aggregate. iv. Analysis and interpretation of results and finalising the recommendations for structural use of recycled aggregate.

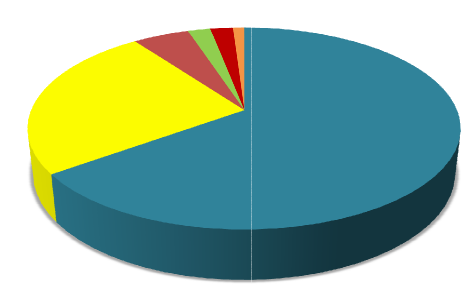


Figure-1: Composition of CDW in India[3]

Figure-2: Recycled Coarse Aggregate (RCA)[9].

Figure-3: London Olympics Stadium[10].

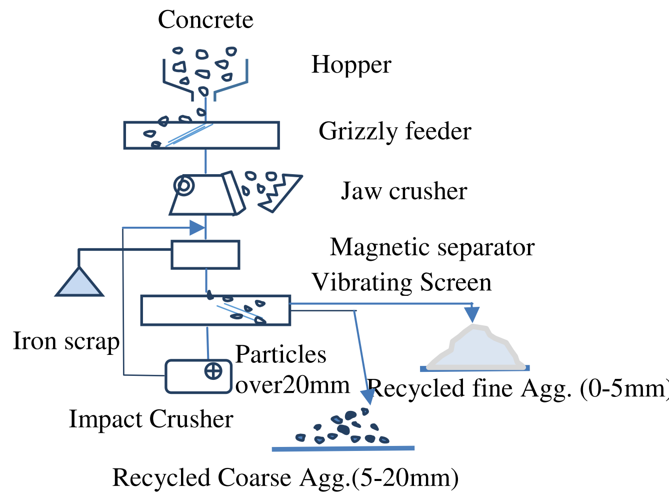


Figure-4: Schematic Diagram of CDW Processing Plant[11].

Materials and methods

In the current study, statistical methods have been employed to standardise the concrete mix design procedure for producing structural concrete of M35, M40 grade. Higher variation in moisture absorption and specific gravity characteristics of RCA on account of the interfacial transition zone (ITZ) needs logical adjustments which have been tried on the basis of available guidelines of RILEM and IS: 456: 2000[10,12]. New methods of mixing of materialsi.e. Two stage mixing and Three stage mixing have been used[13]. Optimum dosages of admixtures based on their efficiency have been used[14,15]. A comprehensive experimental plan has been developed wherein experiments on green concrete in terms of Slump Cone Test, Material Properties' Evaluation Tests, Destructive Tests on hardened concrete i.e. Cube Test, Cylindrical Test, Flexural Test, Elastic Modulus Test, and Non-destructive Tests i.e. Rebound Hammer Test, Ultrasonic Pulse Velocity Test, have been conducted.

(a) (b) (c) (d)

Figure-5: (a) Compressive Strength Test, (b,c) Los Angeles AbrasionTest, (d) Slump Cone Test.

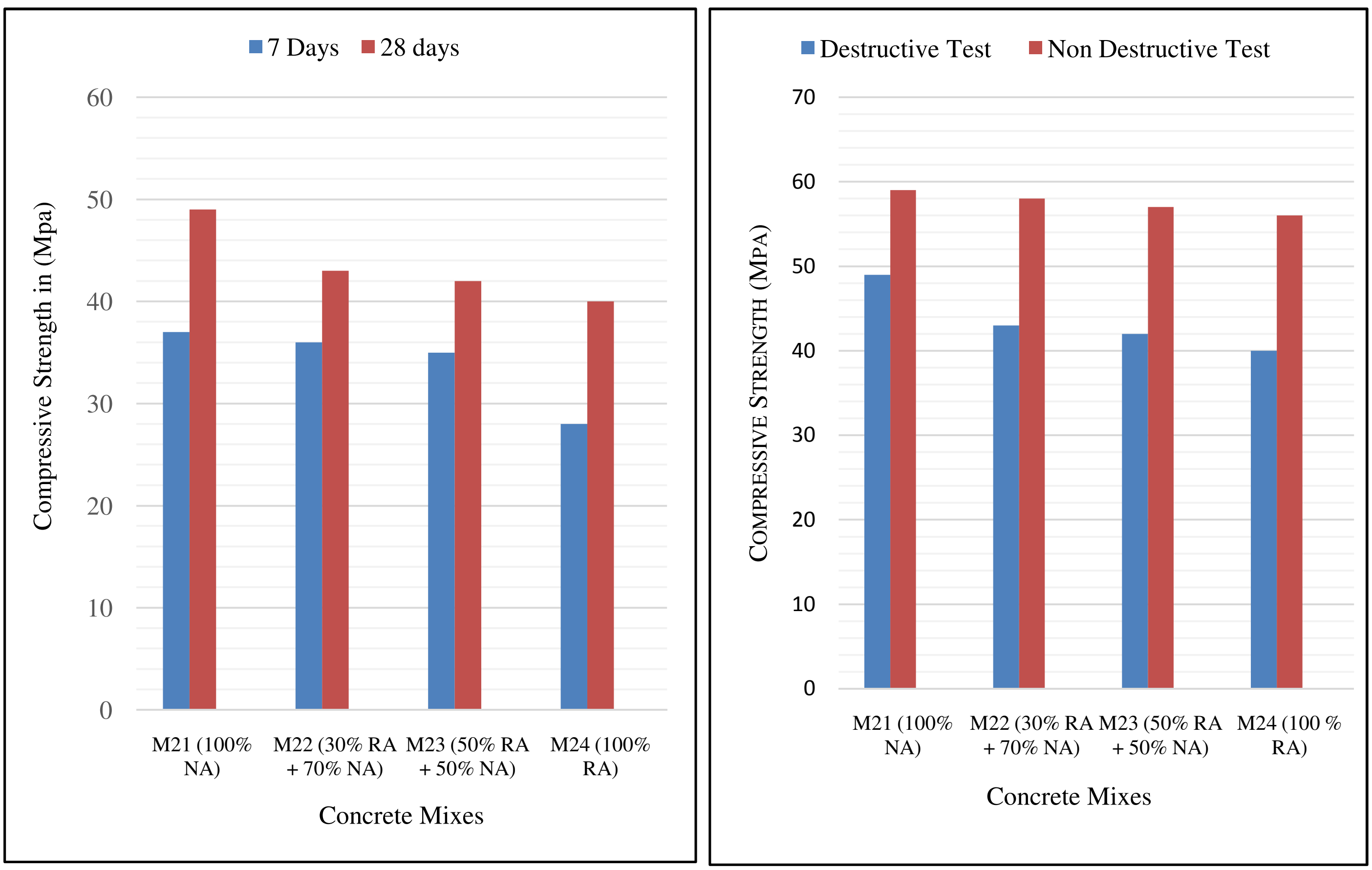
Results and discussion

Due to ITZ, RCA have been found to possess inferior properties as compared to NCA[9]. Higher values of standard deviation can be used to design a concrete mix with RCA[16].

Engineering properties like compressive strength, splitting tensile strength and rupture modulus of concrete of M35 and M40 grade produced from RCA with different replacement levels i.e. 30%, 50%, 100% were evaluated. No significant change in the performance was observed at 30% replacement levels, however for 50% and 100% replacement level, lower performance was observed. In case of NDT, performance of concrete using NCA and that of concrete using RCA have been found comparable.

(a) (b) (c)

Figure-6: (a) Four Point Flexural Test, (b) Extensometer, (c) Elastic Modulus Test.



(a) (b)

Figure-7: (a) Compressive strength after 7 days and 28 days at different replacement levels (M40 grade) (b) Comparison of 28 days Compressive Strength obtained from Destructive and Non-Destructive Test.

Figure-8: UPV Measurements on Cylindrical Specimen.

Table-1: UPV Measurements on M40 Concrete.

Concrete Mix (M40)	Age (Days)	Average Pulse velocity (km/sec)	Concrete Quality
M21	7	4.83	Excellent
	28	5	Excellent
M22	7	4.59	Excellent
	28	4.83	Excellent
M23	7	4.54	Excellent
	28	4.83	Excellent
M24	7	4.16	Good
	28	4.41	Good

Table-2: Ultrasonic Pulse Velocity criterion for concrete quality grading[17].

Concrete Quality	Excellent	Good	Medium	Doubtful
Pulse Velocity (km/Sec)	Above 4.5	3.5 to 4.5	3.0 to 3.5	Blow 3.0

Conclusion

RCA produced from CDW can be used for making structural grade concrete which can be designed by a standard procedure with higher values of statistical parameters such as standard deviation. Higher replacement levels of NCA by RCA affect the structural behaviour of concrete. NDT techniques can be used for evaluating the micro level properties of concrete made with RCA.

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