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Recycle Concrete Aggregates

Go green Approach - For Sustainable Development

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Abstract:- *According to eleventh five year plan, Construction industry is the second largest economic activity after agriculture. The impact caused to the environment by Indian construction industry is tremendous. Construction industry consumes high volume of raw materials and products. Building materials accounts of about almost half of overall material used as well as solid waste generated. This has major impact on environment starting from extraction of raw material to disposal at the end of structure's life span. By considering latest scenario, where we have to concentrate more on environmental issues, construction and demolition (C&D) can be considered as a major recoverable material in life cycle process of structure. According to current figures in India out of 48 MT of total solid waste generated per annum (C&D) Waste is about 14.5 MT. According to few studies, out of all C&D) Waste almost 65% is waste concrete. So this waste concrete can be used as a better alternative for aggregate. This paper enlightens the importance of managing the construction waste by reusing it as a better substitute for aggregate in construction which will be one of the best approach to reduce burden of solid waste management as well as curtailing cost of construction.*

Keywords: C&D, demolition, construction

1 Introduction

Concrete is the world's second most consumed material after water which is one of the most important material essential for development. But along with concrete construction we have to give prior attention develop various methods for disposal of this concrete after it's serving period. According to Central pollution control boardabout 25 billion tons of concrete are manufactured in India. Also in India 25% to 45% of the total waste generated is of construction and demolition waste (C&D), out of which concrete represents almost 25%. These figures forced us to go for recycle out of 3 R-Reduce, Reuse & Recycle for sustainable development.

Infrastructure sector is a key driver for the Indian economy. India has a lot of potential for development in the infrastructure and construction sector. Some of the recent major government initiatives such as development of 98 smart cities are expected to provide a major boost to the sector. The Government of India has made a record allocation Rs 221,246 crore (US$ 33.07 billion) for several infrastructure projects in Union Budget 2016-17, which is expected to provide significant boost to Indian infrastructure sector. The government plans to invest over Rs 7,000 crore (US$ 1.04 billion) in FY2016-17 to develop its network in the north-eastern region for better connectivity.

Many countries have recycling schemes for (C&D) to avoid dumping to landfill, as suitable landfill sites are becoming scarce particularly in heavily populated countries. The reuse of hardened concrete as aggregate is a proven technology - it can be crushed and reused as a partial replacement for natural aggregate in new concrete construction. The hardened concrete can be sourced either from the demolition of concrete structures at the end of their life recycled concrete aggregate, or from leftover fresh concrete which is purposefully left to harden leftover concrete aggregate. All these processes avoid dumping to landfill whilst conserving natural aggregate resources, and are a better environmental option.

For sustainable development life cycle analysis of manufactured product is of prior importance. Life-cycle analysis assesses not just environmental impact of manufacturing but also its use and disposal. Recycled concrete can be the foundation of sustainable infrastructure by introducing it in construction of buildings, road sub base, paving as well as in cement manufacturing. Greater and smarter use of concrete can offset the impact of cement manufacturing and help to create a cleaner, safer and healthier planet which is the ultimate objective of sustainability.

For this recycling of concrete various activities are required like breaking, removing and crushing existing concrete into material of specified size and quality.Recycling of concrete not only conserves resources but also saves landfill space as

well as use of manufactured sand in place of river sand is a best option for environmental issues.

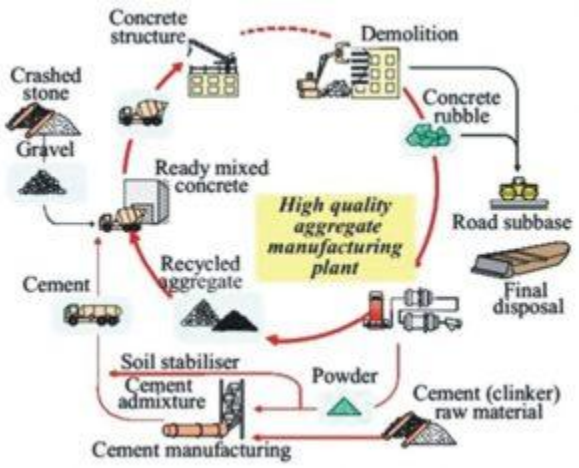


Figure 1: Recycling of Concrete

But concrete with aggregate from recycled concrete, which enables saving sources of natural aggregate, is considered to have generally worse mechanical properties than common concrete. So the idea to add fibers to a concrete mixture with recycled aggregate will change material properties of such concrete was researched, which would in turn improves the behavior and bring about new types of applications. Fiber reinforced concrete with recycled aggregate can be considered as optimal structural concrete for various applications.

1.1 Problem Statement

Various studies have been carried out on Recycled concrete aggregates, but it has been seen that the mechanical properties of the obtained concrete by these aggregates are worse than the common concrete. Also the desired strength could not be obtained after various percentages of replacementsie. 50%, 60%, 70%, and to mitigate the poor performance we haveused 1% steel fibers with recycled concrete aggregates. Thus, our aim is to study the properties of recycled concrete aggregate, reinforced with hooked up steel fibers.

Figure 2:Old concrete and other building materials

1.2 Materials

Figure 3: Obtaining Recycled Concrete Aggregates by crushing the Conventional Concrete

Figure4: Steel fibers with hooked ends

Many types of steel fibers are used for concrete reinforcement. Round fibers are the most common type and their diameter ranges from 0.25 to 0.75 mm. Rectangular steel fibers are usually 0.25 mm thick, although 0.3 to 0.5 mm wires have been used in India. Deformed fibers in the form of a bundle are also used. The main advantage of deformed fibers is their ability to distribute uniformly within the matrix. Fibers are comparatively expensive and this has limited their use to some extent.

Below are some properties that the use of steel fibers can significantly improve:

- **Flexural Strength:** Flexural bending strength can be increased of up to 3 times more compared to conventional concrete.
- **Fatigue Resistance:** Almost 1 1/2 times increase in fatigue strength.
- **Impact Resistance:** Greater resistance to damage in case of a heavy impact.

1.3 Material Testing

The following are the tests carried out on RCA

- Aggregate impact value test
- Aggregate crushing value test on coarse aggregate
- Fineness of sand for fine aggregates
- Specific gravity of aggregates
- Specific gravity of cement
- Water Absorption Test on Concrete (RCA)

Table1:Comparison of Actual Test Results with Standard

Test Name	Actual Result	Standard Value
Aggregate Impact Test	11.46%	10-20%(Strong)
Fineness Of Sand	3.51%	3-4%(Coarse Sand)
Aggregate Crushing Value	9.96%	<30% for concrete pavements
Specific Gravity Of Cement	3.1g/cc	3.15 g/cc
Specific Gravity Of Aggregates	2.6 g/cc (NA)	3.15g/cc
Water Absorption	0.28% (NA)	1.1%

Values

1.4 Concrete Mix Design

Concrete mix design for M30 is carried out according to IS method. Concrete cubes were casted by varying % of RCA by 0%, 50%, 60%, 70%. And testing is carried out. Total 36 specimen were casted & tested.

1.5 Various steps involved in concrete casting

1.5.1 Recycled coarse aggregate for casting

Figure5: - Obtaining RCA

1.5.2 Proportioning of materials

Figure6: - Weighing of materials

1.5.3Mixing of materials

Figure7: - Mixing of materials

1.5.4 Casting of Cubes, cylinders & beams

Figure8: - Casting of Cubes

Figure9: - Casting of Beams

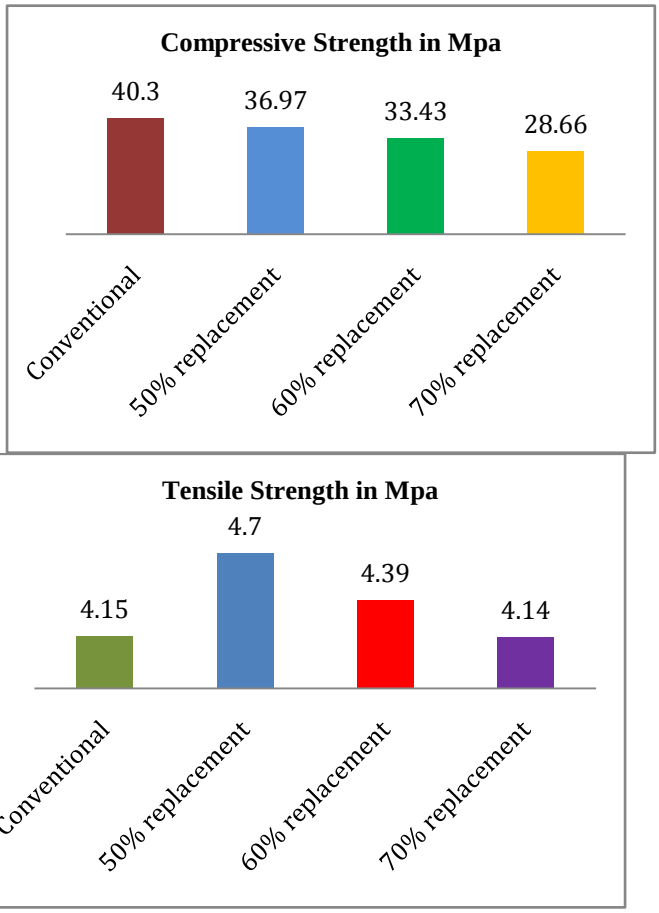
Figure10: Slump test for RCA variations

Figure 11: Compressive Strength of Concrete

1.6 Tests on Hardened Concrete

1.6.1 Compressive Strength of Concrete

1.6.1.128 Days Compressive test Results



Graph 3: Results for 28 Days Split Tensile TestofRCA

1.6.1.2 Split Tensile Test on Concrete

Figure 13: Split Tensile Test of Concrete

Figure 14: Flexural Test of Concrete

1.6.1.Flexural test on Concrete

1.7Result and discussion

After performing the various tests on conventional concrete and RCA with percentage variation as 50%, 60%, 70% various conclusions can be drawn. They are as follows:

a. For Compressive test after referring graph we can conclude that the maximum strength is obtained when

50% RCA replacement is done. As the % replacement of RCA goes on increasing, the compressive strength goes on decreasing.

b. For Split Tensile test we can observe that the tensile strength is maximum for 50% RCA replacement and so on. 1% steel fibers added act as reinforcement and thus better tensile strength is achieved.

c. Even for flexural test on RCA with steel fibers we can conclude that 50% RCA replacement has maximum flexural strength and descending to 60% and 70% RCA replacement.

d. So we can conclude that the we can replace aggregate with recycled concrete in range of 50% to 60% to achieve fair results. In addition to that we have to use steel fibers to improve tensile strength.

1.8Applications of RCAfor sustainable environment

As we can observe from results that except tensile strength, concrete with RCA gives lesser strength than conventional concrete. So we can use such concrete for non-structural work like -

- Precast & cast in situ gutters &kerbs, shoulders
- General bulk fills
- For bank protection
- In base or fill for drainage structures
- For pavement sub-bases as well as for road also
- Sidewalks
- Paving blocks
- Noise barriers
- For embankments

1.9 Conclusion

Basically by introducing Recycled Concrete Aggregate (RCA), we can achieve solid waste management also we can avoid burden on natural resources. Even we can achieve less emission of carbon due to less crushing.There are no detrimental effects on concrete& it is expected that the increase in the cost of cement could be offset by the lower cost of RCA.

If we directly used the recycled aggregates from concrete demolition waste, it was observed that their strength was on lower side than the normal conventional natural aggregates.

- Thus it is advisable that the parent concrete to obtain the RCA should be same. Any variation in parent concrete leads to result variation as well.
- Desired strength is not achieved by using RCA only,So to enhance properties of concrete, we have to introduce Steel Fibers with hooked ends.Steel Fibers act as reinforcement and thus desired strength of the concrete is achieved.
- Thus, overall we can conclude that as the replacement of RCA increases, the strength of concrete decreases.The strength achieved is maximum for 50% and accordingly it goes on decreasing for 60%, 70% and so on.

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