Experimental Investigation on Concrete Using Treated Recycled Aggregate

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Abstract. It has been observed that huge quantity of demolition waste which is generated in various sectors are simply dumped in low lying area and used in highways for pavement works. Subsequently the usage of natural resources for new constructions has increased in recent and it leads to depletion and affecting sustainable development. In this study, the demolition waste is utilized in construction activities as a recycling and reusing material in concrete based upon the basic properties like specific gravity, crushing strength, impact value, water absorption and abrasion which produces optimal result in using recycled aggregates in concrete. The properties pertaining to mechanical behavior of recycled aggregate is carried out with different replacement ratios namely 25, 50, 75 and 100% and the experimental values shows that the implication of recycled aggregate is effective and it can be further used by adopting suitable methods. Hence treated recycled aggregate was found to be effective in usage in concrete.

1. Introduction

The buildings are getting out dated due to its style and materials used in it. It leads to go for new buildings in urban areas which lead to demolition of the old ones. The demand for the materials increased and the use of natural resources substantially made the changes in the environment. In order to address the needs of the growing demand as well as tread upon the path of sustainability [1,2] research is being done to find suitable materials which serve as an alternative to it the constituents of concrete in terms of parameters like strength, durability or environmental impact. As the production of concrete rises at an alarming rate, little is being done about construction and demolition waste, which is either disposed at landfills or in the vicinity of a construction [5] site, thus seeking out a way to address the problem by using reclaimed concrete also known as born again concrete.

Recycled concrete cannot be used directly on site, owing to reasons like a weak Inter Transition Zone (ITZ) due to the mortar surrounding the aggregates and a high water absorption capacity. Hence by treating the aggregates, the mortar attached is removed from the surface of the aggregates, utilizing its functionality [6]. Prior to its use on site, the aggregates are sent to a crushing unit where the aggregates are crushed by means of compression causing the size of the aggregates to diminish. The aggregates are then sorted accordingly based on its size and then had the steel rebar’s embedded in the concrete removed by using a powerful magnet followed by removal of harmful contaminants. [8,9] Recycled concrete has been used in the construction of highways or embankments but hasn’t seen much use in the construction of infrastructure owing to reasons like lack of awareness among contractors and designers or the initiative to implement a new material in the mix or lack of...
knowledge about the after effects of implementation and up gradation of technical standards (there isn’t any specific code pertaining to the design). Hence research is done to determine various parameters which make recycled concrete the most viable material in the construction sectors.

2. Materials and Methods

The various materials in concrete will have a direct effect on the properties of concrete. Testing of the materials is done to determine its quality prior to its use in concrete. Selection of the right kind of materials used is a major factor while preparing the mix design of concrete as parameters like the mixing ability of the materials as well as its effect of mixing should be considered. Cement of 53 grade is IS 2269(1987) and normal river sand is adopted confirming to IS 383-2016 and normal aggregate is done par with IS 383-2016 and potable water is used according to IS 456-2000. The testing of the untreated and treated coarse aggregates was used for the experimental investigation. Casting, curing and testing of the concrete specimens having concrete mixes consisting of virgin, untreated and treated aggregates was done and the results used were interpreted in understanding the influence of salvaged aggregates at various substitution proportions.

Treatment of reclaimed aggregates is done to cause changes in the properties of the recycled aggregates such that it has comparable properties with ordinary aggregates by removing the mortar affixed to the aggregates. Since the recycled aggregates have a weak ITZ making it porous, the mortar attached is removed, thus utilizing its functionality in the present research done. Thermal mechanical abrasion was the treatment process selected. The compressive strength test conducted confining to IS 516-1959. The casted specimen consisting of alternative coarse aggregate are tested at 7, 14 and 28 days. The following test were conducted on coarse aggregates specific gravity, impact value, crushing value, Los angel abrasion test, water absorption for both natural aggregate, recycled aggregate, treated recycled aggregate, where as properties of aggregates are studied and it is used in concrete. To use the treated recycled aggregate in concrete and to find its mechanical properties viz split tensile strength, compressive strength of the concrete. The specimen are casted and test is conducted for compression, split tensile strength with replacement ratios with cube mould size of 150x150x150mm, cylinder mould size of 150x300mm. The specimen are tested with interval of 7, 14, 28 days. The compressive and split tensile test is conducted according to the confirming IS 516-1959, IS 5816:1999.

3. Treatment of Recycled Aggregates

In this process the recycled aggregates were placed in an oven and heated for 24 hours, with 300° centigrade to embrittle the aggregates. The aggregates were then subjected to abrasion using the Los Angeles abrasion machine for 100 rotations, causing a loss in weight of the aggregates, followed by sieving to get aggregates of maximum size 20mm. Hence the amount of mortar loss in recycled aggregate is determined by this process and test result shows these values are acceptable to use.

Figure 1. Specimens under compression test.
aggregates were then used in casting the cube and cylindrical specimens, where testing was done at 7, 14 and 28 days. The mix ratio adopted for this work is 1:1.3: 2.5: 0.45.

![Figure 2. Treated recycled aggregate.](image)

![Figure 3. Untreated recycled aggregate.](image)

4. Results and Discussion

To use the aggregate in concrete according to the requirements of IS 383. The basic test which is conducted on the virgin aggregate, recycled aggregate and treated aggregate shows that there is an improvement in treated recycled aggregate hence these results show there is a considerable increase in the properties and further it can be utilized in the replacement of virgin aggregates.

| Sl. No | Tests Conducted              | NA  | RAC | TRAC |
|-------|------------------------------|-----|-----|------|
| 1.    | Specific gravity             | 2.68| 2.5 | 2.6  |
| 2.    | Aggregate crushing strength  | 18.72| 59.51| 22.59|
| 3.    | Aggregate impact value       | 19.43| 32.8 | 21.67|
| 4.    | Water absorption (%)         | 1.2 | 5.7 | 2.05 |
| 5.    | Los Angeles abrasion test     | 3.2 | 8.2 | 4.24 |

Note: NA: Natural Aggregate, RAC: Recycled Aggregate Concrete, TRAC: Treated Recycled Aggregate

5. Compressive Strength

The results obtained are shown in Table for the concrete specimens having Treated Recycled Aggregates surpass the compressive strength (CS) of specimens having conventional as well as Untreated Aggregates. In Untreated Recycled Aggregate Concrete, replacement percentages of 25 and 50% have comparable CS values to that of Conventional Aggregate Concrete. Moreover, Concrete specimens having Untreated Recycled Aggregate Concrete has lower strength than the specimens having conventional Aggregates. The compressive strength of CC, RA, TRA are compared with the replacement ratios. The result shows improvement treated recycled aggregate in accordance with control mixes shown in figure 4.
6. Split Tensile Strength
The split tensile strength (STS) is done to determine the maximum load carrying ability on a specimen placed in a horizontal manner as of IS 5816-1970. The casted specimens are tested at 7, 14 and 28 days. The results obtained are shown in graph. An improvement in the split tensile strength of concrete specimens having Treated Recycled Aggregates is experiential, when compared to the standard aggregates used. In Untreated Recycled Aggregates, substitution percentages of 25 and 50 have higher split tensile strength values than that of Conventional Aggregates. Moreover, Concrete specimens having Untreated Recycled Aggregate Concrete has a lower split tensile strength than the specimens having Conventional Aggregate (Fig. 5).

7. Conclusion
Replacement of Treated Aggregates at 25% with that of Natural Coarse Aggregates, as enhance in both the CS, STS is observed. Treated Recycled Aggregates showed higher values in the tests on properties in comparison with Conventional Aggregates. Untreated Aggregates have comparable values to that of Conventional Aggregates. By involving treated recycled in concrete reduces the cost of construction. It can be inferred that the replacement of Natural Aggregates with Recycled Aggregates can be implemented but as the substitution ratio increases, the strength of concrete increases.
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