Abstract

The possible solution to these problems is to recycle demolished concrete and produce an alternative aggregate for structural concrete. Recycled Concrete aggregates (RCA) as popularly known can be used as aggregates in concrete as partial or total replacement. Concrete made with such recycled concrete aggregate is called as Recycled aggregate concrete. However before moving further with this concept it is very important to elevate the status of recycle material through research, development and performance data for the material as compared to virgin or typical material. The paper focuses on fresh and hardened properties of Concrete designed by the aim of maximum utilization of Recycled aggregates. Use of Recycled aggregate, which has different properties, will also influence the properties of fresh concrete. Properties like Slump, workability will be studied which is also an important factor for gaining the strength of concrete.

1. INTRODUCTION

Demolition of old and deteriorated building and traffic infrastructure and their substitution with new ones, is a frequent phenomenon today in most of the part of world. The main reason for this situation are changes of purpose, structural deterioration, rearrangement of city, expansion of traffic directions and increase of traffic load, natural disasters like
earthquake, flood fire etc. As per Times of India, Dec 6, 2010 states that according to JNNURM report India generates 10-12 million tons of Concrete & Demolished waste annually. And 50% of it is Concrete and Masonry which is not recycled in India. The most common methods of disposing this material are land filling. In these way large amounts of construction waste is generated, consequently becoming a problem a special problem of human environment. For this similar reason in developing countries, laws have been bought into practice to restrict this waste in the form of prohibitions or special taxes existing for creating waste areas. To take care of the Concrete & Demolished waste in India Ministry of Environment and forests has mandated environmental clearance for all large construction projects.

1.1 Recycled Aggregate
Recycled aggregate is generally produced by two stages crushing of demolished concrete, screening and removal of contaminants such as reinforcement, wood, plastic etc. Concrete made with such aggregates is called as Recycled aggregate Concrete. RILEM Committee 121-DRG has published recommendations for the use of recycled aggregates, classifying them into three groups.

Group I- Aggregates mainly from masonry rubble
Group II- Aggregate obtained mainly from concrete rubble
Group III- A mixture of natural aggregates (>80%) and rubble from the other two groups (with up to 10% of group I).

![Figure 1: Crushing Of demolished Concrete](image)

1.2 Advantages and limitations of recycled aggregates

1.2.1 Advantages:
- **Environmental gain:** Reduction of use of natural aggregates and less amount of land filling.
- **Save Energy:** Energy can be saved by producing the aggregates on site itself. Mobile crushers can be used for the same.
Cost: The cost of recycled aggregate can be low as compared to the natural as the raw material is also available in cheaper cost.

Sustainability: The amount of waste materials used for land filling can be reduced which can now accolade for LED points.

Wide Market: Market is very wide for recycled aggregate. It is extensively used in Spain, Brazil UK etc. And spreading widely.

1.2.2 Limitations:

Hard to have permit: It is very difficult to get permit that needed air permit or permit to operate during recycling process. This will depend upon the local rules and regulations.

Lack of specification or guideline: For use of recycled aggregates there is a clear lack of specification and thus lot of emphasis has to be given for research and extensive studies.

Properties of Recycled aggregate: Some properties of recycled aggregates can be very discouraging like more amount of water absorption or more Fineness of Recycled fine aggregate which can affect the properties of Concrete like workability, Compressive strength etc. And thus similar for use in concrete.

2. PURPOSE OF THE STUDY

I. By using IS 10262:2009 design M25 grade of concrete with an aim of maximum utilization of Recycled aggregates in Concrete with other materials. IS 10262:2009 emphases on designing trials for concrete which can increase the confidence level.

II. Study the fresh and hardened properties of Concrete designed by the aim of maximum utilization of Recycled aggregates. Use of Recycled aggregate, which has different properties, will also influence the properties of fresh concrete. Properties like Slump, workability etc. will be studied which is also an important factor for gaining the strength of concrete. Compressive strength of concrete, split tensile strength flexural strength of concrete are important factors which asses the suitably of using the concrete for structural applications.

3. RESULTS

Table 1: Results for mix 1: Natural Fine Aggregate and Natural Coarse Aggregate

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Slump</th>
<th>7 day Weight</th>
<th>14 day weight</th>
<th>28 day weight</th>
<th>Avg. Density Kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>85</td>
<td>8.74</td>
<td>23.84</td>
<td>8.76</td>
<td>26.26</td>
</tr>
<tr>
<td>2</td>
<td>85</td>
<td>8.04</td>
<td>22.94</td>
<td>8.2</td>
<td>26.89</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>8.78</td>
<td>22.42</td>
<td>8.79</td>
<td>25.45</td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>-</td>
<td>23.06</td>
<td>-</td>
<td>26.20</td>
</tr>
</tbody>
</table>

2556.70
The Use Of Recycled Aggregate From Demolished Material

Figure 2: Graphical Representation of Table 1

Table 2: Results for Cement+ Conventional Fine Aggregate + Recycled coarse aggregate 40% (10mm and/or 20mm) +Admixture

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Slump</th>
<th>7 day</th>
<th>14 day</th>
<th>28 day</th>
<th>Avg. Density Kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Weight</td>
<td>N/mm²</td>
<td>Weight</td>
<td>N/mm²</td>
</tr>
<tr>
<td>1</td>
<td>70</td>
<td>8.6</td>
<td>24.68</td>
<td>8.62</td>
<td>27.47</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>8.64</td>
<td>24.54</td>
<td>8.67</td>
<td>27.50</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>8.42</td>
<td>27.23</td>
<td>8.59</td>
<td>28.10</td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>25.48</td>
<td>-</td>
<td>27.69</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 3: Graphical Representation of Table 2
4. COST ANALYSIS

Table 3: Total Cost required for obtaining the total aggregates

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of work</th>
<th>Workers (Nos.)</th>
<th>Days</th>
<th>Rate (Rs)</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demolishing the concrete cubes</td>
<td>1</td>
<td>5</td>
<td>250</td>
<td>1250</td>
</tr>
<tr>
<td>2</td>
<td>Sieving</td>
<td>2</td>
<td>3</td>
<td>250</td>
<td>1500</td>
</tr>
</tbody>
</table>

Total cost = Rs 2750

Cost of course aggregates = 0.36 X 2750 = 2357 rupees.

Cost of course aggregates for 1 m³ quantity = 6547 rupees per 1 m³

Table 4: Cost comparison between Conventional aggregate concrete and Recycled aggregate concrete

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity (kg)</th>
<th>Quantity (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>325</td>
<td>0.22</td>
</tr>
<tr>
<td>Course Aggregate</td>
<td>1004.23 kg/ lit</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Rate Analysis:

Cement = \( \frac{325}{50} = 6.5 \) bags.

Cost of cement = 6.5 X 300 = 1950 rupees

Cost of aggregates = 0.70 X 900 = 630 rupees

Cost of sand = 0.38 X 2300 = 874 rupees

Total cost of Conventional Aggregate Concrete = 1950 + 630 + 874 = 3454 rupees.

5. CONCLUSION

I. The physical and Mechanical properties of Recycled Concrete aggregates are important factors governing the strength characteristics of the concrete. And the properties of Recycled Concrete Aggregates are governed by the Parent source.

II. The experiments done on NFA, RFCA, NA-20mm & 10mm, RCA-20mm, 10mm showed large values of water absorption and moisture content for all the Recycled aggregates and more for RFA. The fact that the mortar adhered which is weak and more porous and thus absorbs more water is the main factor contributing towards decrease of compressive strength of concrete with RCA.
III. The lower value of specific gravity of recycled aggregates is an indication that recycled concrete aggregates are lighter than that of natural aggregates. The main reason for this is the existence of loose paste in the demolished wastes.

6. REFERENCES


[2] Alan Kirby (Chair) Cement & Concrete Association of New Zealand (CCANZ) David Barnard NZRMCA Plant Audit Committee Chairman Derek Chisholm (Author) Solid Concrete Solutions (October 2011) “Recycled Aggregates in New concrete.”

