Utilization of Brick Aggregate in Concrete

Ayush Bhardwaj
Department of Civil Engineering

Abstract—due to continuous spreading of urbanization and industrialization, a significant problem of accumulation and management of construction waste is arising. To eradicate this problem construction and demolition waste are being recycled and used as a raw material for construction of new structures. Recycled brick aggregates which are recovered from destroyed masonry structures can be consumed to manufacture newer concrete mixtures. To ensure a sustainable waste management technique a detailed study of its engineering properties and purpose of utilization has to be specified.

Key words: Cement Concrete, Clay Bricks, Crushed Aggregate

I. INTRODUCTION

In the recent years, the wastes from construction and demolition zones are of large volume and that this volume is increasing year by year which is of great concern. Predominantly in India, a huge quantity of waste is produced every year from construction sites and due to failure of buildings from earthquakes [1,2]. Whereas, the demand for housing is estimated to be more than two millions units and conventional construction materials like natural sand and aggregate are becoming rare [3]. Waste disposal is a serious environmental issue, especially for tier one cities where there is lack of disposal sites. Wastes from construction sites, material factories, demolition sites, and earthquakes are until now rarely used in India. Therefore it is needful to recycle as many waste materials possible.

Crushed bricks as aggregates can be used to help in minimizing the problem of waste dumping and successively helps in safeguarding of the natural aggregate resources. There are however some complications in the use of crushed bricks aggregates in concrete. Cohesive limitations on water absorption and presence of impurities and lack of knowledge about the behavior of concretes made of crushed bricks creates a mistrust in users. One of the first use of crushed brick as an aggregate material with Portland cement was recorded in Germany (1860) for the manufacturing of small scale concrete products, but the first noticeable use of crushed brick as coarse aggregates in recent years has been recorded for the rehabilitation of destructed structures after the Second World War [4].

The aim of this paper, is to present the results of bricks aggregates used as coarse aggregate. Replacing natural aggregate in the varying percentage of 0, 25, 50, 75 or 100 % be weight. Compressive and flexural strengths are evaluated and compared till 28 days of age. Specific properties of the aggregates are also compared. Porosity, water absorption, water permeability and shrinkage are also measured.

II. EXPERIMENTAL SETUP

The experimental procedure includes natural coarse (NG) and fine (NS) calcareous aggregates, coarse (RG) and fine (RS) crushed bricks aggregates and a Portland cement as raw material. The grain size distribution of natural and crushed brick aggregates is shown in Figure 1.

Fig. 1: Grain size distribution of aggregates

Recycled brick aggregates shows a relatively low bulk density and high water absorption compared to natural aggregates. The higher water absorption of crushed brick aggregates is due to the higher porosity of the clay bricks.

Table 1: Properties of aggregates

<table>
<thead>
<tr>
<th>Properties</th>
<th>NG</th>
<th>NS</th>
<th>RG</th>
<th>RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific weight</td>
<td>2822</td>
<td>2987</td>
<td>2232</td>
<td>2496</td>
</tr>
<tr>
<td>Bulk density</td>
<td>1695</td>
<td>1847</td>
<td>1924</td>
<td>1010</td>
</tr>
<tr>
<td>Water absorption</td>
<td>1.5</td>
<td>1.0</td>
<td>11.5</td>
<td>14.0</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>38.82</td>
<td>59.54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Composition of concrete mixes

<table>
<thead>
<tr>
<th>Mix notation</th>
<th>Type of concrete</th>
<th>W/C</th>
<th>NG (%)</th>
<th>RG (%)</th>
<th>NS (%)</th>
<th>RS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0</td>
<td>C0</td>
<td>0.61</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>C1</td>
<td>C25</td>
<td>0.60</td>
<td>75</td>
<td>25</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>C2</td>
<td>C50</td>
<td>0.59</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>C3</td>
<td>C75</td>
<td>0.58</td>
<td>25</td>
<td>75</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>C4</td>
<td>C100</td>
<td>0.57</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
evaluated on mature concrete 28 days old and using 75 mm × 75 mm × 75 mm block specimens.

III. RESULTS AND DISCUSSION

A. Fresh Concrete Properties

In order to compare all the specimen on a common basis, entire research is carried out at a constant workability (slump between 50 mm and 65 mm), the water content has been adjusted accordingly and is shown in Fig. 2. Erstwhile to mixing the crushed brick aggregate is soaked in water for 24 hours and brought to saturated surface dry condition (SSD), so that it does not absorb water from the mix.

Fig. 2: Water content in mix

The color of the concrete recycled brick specimen changes from greyish to a pink tinted color according to the percentage of recycled aggregates. The densities were found to be lower in case of crushed brick concrete, whereas the entrained air percentage increased.

B. Compressive Strength

The compressive strength of the various mixes are portrayed in Fig. 3 for ages of 3, 7, 28 days. It can be clearly observed that compressive strength shows a decreasing trend for crushed brick concrete with respect to the rate of substitution. At 28 days old, the decrease in compressive strength is about 15–30% in case of recycled coarse aggregates concrete as compared to natural aggregate concrete.

Fig. 3: Compressive Strength

C. Flexural Strength

A decrease in flexural strength is observed in a similar pattern to that observed for compressive strength even though the angular shape of the brick material and its

IV. CONCLUSIONS

The following conclusions can be made based on the present investigations:

1) Recycled brick aggregates present relatively lower bulk density up to 17%, and higher water absorption compared to natural aggregates.
2) The decrease in compressive strength at 28 days of age was about 35 to 40% when coarse aggregates are substituted.
3) Water reducing and plasticizer admixtures are highly recommended to reduce the water content in the mix. The decrease of flexural strength was about 15% in substituted mix.
4) The modulus of elasticity varies in the same way as the compressive strength and a reduction of 30%, was observed for coarse crushed bricks concrete.
5) For an ideal application of this type of concrete, the level of replacement should be limited to 25%.
6) Due to the low performance of concrete with crushed bricks aggregates, application of concrete used in structural member should be limited and be used in pavements and foundation bases.

REFERENCES


