Experimental Study on the Substitution of Waste Rubber Tyre Ash with Natural Sand in the Cement Concrete

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Abstract. The importance of using recycled materials like rubber in construction materials is rising rapidly today. By incorporating used rubber into cement and mortar, we can save landfill space and reduce our dependence on natural resources. Rubber scrap can be mixed in as either fine or coarse aggregate. Add it to Portland cement for a stronger, more durable product (PC). This paper reviews the studies conducted so far on the feasibility of using waste rubber in place of conventional PC-based mortar and concrete's natural fine aggregate. The strength and water-absorption capacity of materials made from ash from scrap rubber tyres were measured. Test results indicate that waste rubber ash was substitute with natural sand up 10% then strengths of the sample were enhanced after increasing the content of waste rubber tyre ash then strength was decreased. Water absorption capacity of samples was improved as increased the content of waste rubber tyre ash into concrete mix.

Keywords: Waste rubber tyre ash, compressive strength, natural sand, water absorption.

1 Introduction

Automobile mobility gained steam as contemporary societies advanced in the wake of the industrial revolution. The byproduct of this practical revolution is rubber waste, which adds a whole new dimension to the issue. The waste rubber from tyres is becoming an increasingly
serious environmental issue [1-3]. The number of worn out tyres is estimated at 1 billion each year. Presently, huge numbers of tyres are either stored or disposed of in landfills, posing a severe ecological concern [4]. Debris tyre dumps are a major cause of habitat loss, and the tyres themselves contain poisonous and soluble materials that can seep into the groundwater and harm wildlife [5-8].

Second, there is always the possibility of fire when dealing with used tyres. When tyres start to burn due to unintended causes, high temperatures occur, noxious gases are produced, and tyres melt, releasing an oil that contaminates the soil and water [9]. Millions of tyres continue to be buried in landfills throughout the globe. However, this method can only recycle a small fraction of the rubber scraps that are now being used for paving [10]. An artificial reef creation is a different possibility, but its viability has been called into question by researchers [11-14]. Tyre pyrolysis, the thermal decomposition of these wastes without oxygen to yield poor economic viability byproducts like carbon black, can also be used in cement kilns for energy purposes [15]. There is preliminary evidence that concrete with improved toughness and sound insulation qualities can be made by replacing some of the gravel with recycled tyres [16].

Both mechanical grinding at room temperature and cryogenic grinding below the glass transition temperature can be used to extract rubber aggregates from used tyres [17-19]. To substitute coarse aggregates, the first technique creates chipped rubber, whereas the second typically yields crumb rubber. In this paper, we will examine the current state of research on the characteristics and longevity of concrete made with tyre rubber wastes [20]. The report also analyses how different waste treatments, particle size, and volume of waste replacement affect concrete's fresh and hardened qualities. Current research indicates that applications subjected to strong dynamic motions, such as railway sleepers, benefit greatly from using tyre waste concrete [21-22]. Non-load bearing applications include soundproof walls constructed from this material [23]. Research on rubber waste concrete has revealed that the performance of the concrete varies greatly depending on the waste materials used. Extra research is required to determine, for example, which properties optimize concrete's performance [24-27]. In this study check the impact on strength and water absorption capacity with the substitution of waste rubber tyre ash with natural sand in cement concrete.

2 Materials

Normal, high-strength Portland cement was used. When developing the blend, this cement was factored in. Prior to consumption, it was sealed in airtight containers [28]. Fine aggregates consisted of 4.75-millimeter-sized natural river sand. The methods used to evaluate sand's durability were same to those used to evaluate gravel's toughness. This project's coarse aggregate was comprised of crushed gravel with a nominal maximum size of 20 mm [29-32]. After being submerged in water for 24 hours, the coarse aggregate utilized in this study had their water absorption tested under SSD (saturated surface dry) conditions by having the excess surface water wiped off with a wet cloth. When there is no surface water available, it was presumed that the aggregates were in the SSD state. Here, researchers experimented with replacing some of the fine aggregate in concrete with rubber from recycled tyres. For this purpose, raw rubber tyres were fed into a machine to extract rubber particles of 0.16mm in diameter. The particles of rubber must be the same size and shape as sand for this to work. Further, the rubber particles must be unadulterated.
3 Methodology

Sixty samples of concrete were made, each with a different percentage of rubber ash to achieve a 0.45 water-to-cement ratio [33]. The compressive strength and water absorption of these specimens were measured in accordance with the relevant codes. Specimens were cast with the use particles of recycled rubber tyres. In this investigation, rubber ash was used to replace fine aggregates at varying percentages, from 0% to 20% by increments of 5%. When the mixture reaches the desired workability, it is poured into a mould and vibrated on a table vibrator in accordance with the regulations [34]. The specimens were de-molded after being stored for 24 hours in plastic wrap at room temperature.

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Fine Aggregates (%)</th>
<th>Recycled rubber tyre ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>SC95</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>SC90</td>
<td>90</td>
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<td>SC85</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>SC80</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
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4 Result and Discussion

4.1 Compressive Strength

Figure 1 depicts the compression machine that was used for this test. Composite concrete samples with rubber concentrations ranging from 0% to 20% were also tested. Particles of recycled rubber ash were substituted for some of the sand in the test specimens' composition [35]. After 7 days of curing for the control samples and 28 days of curing for the composite samples, all samples were evaluated.

Fig. 1. Compressive Strength of Samples
The compressive strength was increased as replacement of waste rubber tyre ash up to 10% after increasing the amount of waste rubber tyre ash then compressive strength began to reduce [36-38]. From the figure 1, it very clear that compressive strength was increased up to 10% substitution of waste rubber tyre ash with fine aggregates. The compressive strength values were 36.5MPa and 43.1MPa at 7 days and 28 days for 10% substitution of waste rubber tyre ash.

4.2 Water Absorption

The samples of concrete were tested for their capacity to absorb water. The experiments were carried out after 7 days and 28 days of cure. Concrete samples with 0 percent, 5 percent, 10 percent, 15 percent, and 20 percent rubber were subjected to a water absorption test [27]. After weighing each sample, they were submerged in water for a whole day. After waiting 24 hours, the samples were weighed once more [39-41].

![Fig. 2. Water Absorption Capacity of Sample](chart.png)

From the figure 2, it was clearly observed that water absorption values were enhanced as increase the substitution level of waste rubber tyre ash in the concrete mix [42-45]. The water absorption values of sample SC100, SC95, SC90, SC85 and SC80 were 7.5, 7.7, 8, 8.3 and 8.5% at 28 days.

5 Conclusion

1. The compressive strength of concrete mix was improved upto 10% substitution of waste rubber tyre ash with natural sand.
2. The compressive strength of concrete mix was 14.93% improved upto 10% substitution of waste rubber tyre ash as compared to standard concrete.
3. Water absorption capacity of samples was increased as increased the substitution level of waste rubber tyre ash in the concrete mix.
References


