Experimental Investigations on Building Demolition Waste Using as a Fine Aggregate in Concrete

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Abstract - *Due to continued mining and high transportation costs, the key ingredient in concrete, fine aggregate (river sand), is in short supply, which has become a significant concern for the construction sector. Limiting the abuse of river sand and providing an alternate supply for fine aggregates are the major goals of this research. In this experiment, pulverized concrete from razed structures will take the place of fine aggregates. When correctly disassembled, the concrete from the destroyed building is used as fine aggregate in new concrete. Recycling helps us reduce the quantity of garbage we have to dispose of in landfills. It is a substance that helps the environment and makes it possible to protect natural resources. There are no requirements or regulations for using recycled concrete aggregate in constructions. In this experiment, recycled aggregate was substituted for fine aggregate in a range of ratios, including 0%, 10%, 20%, 30%, 40%, and 50%. Concrete made with recycled aggregates has the potential to store 42% more water. The optimal percentage for replacement concrete is 30% replacement construction debris. When compared to conventional concrete, that 33% replacement concrete is sturdy. Flexural strength is improved by 5.71%, split tensile strength is increased by 0.57%, and compression strength is enhanced by 1%.*

Key Words: **Recycled aggregates, Mechanical properties, Crushed concrete, Fine aggregates**

1.INTRODUCTION

The world's largest man-made substance is concrete, which is notable. Many recycling techniques for recovered concrete aggregate have been carefully investigated and developed during the past twenty years. These recycling methods limit the amount of waste that is dumped in landfills, cut down on transportation costs, and save raw materials. Construction and demolition, sometimes known as C&D Waste [1], is the process of constructing new structures as well as maintaining and demolishing existing ones. Concrete makes up 40% of the total building demolition garbage, ceramics 30%, plastic 5%, wood 5%, metal 5%, and various combinations 10% [2]. According to a report by Global Insight, rising construction costs would rise by 4800 billion US dollars in 2013. Given that recovered concrete aggregates make up the majority of old concrete, recycling aggregates from demolition trash might close the supply-demand imbalance [3]. Construction trash is produced as a result of natural disasters (earthquakes, hurricanes, etc.). The structure was chosen as the primary source of recovered aggregate because it can recycle a considerable volume of broken demolition cement concrete [4]. The test results show that RCAs are around 20% lighter than common aggregates, both coarse and fine. The lower density of the RCAs was due to the older mortar's adhesion to the common aggregates [5]. The initial slump of recycled aggregate concrete was not significantly affected by the relative water absorption of aggregates, but the rate of slump loss increased as the relative water absorption of aggregates increased [6]. The first slump of new concrete somewhat decreased as the replacement amount of recycled particles increased. The initial slump of recycled aggregate concrete was significantly influenced by the moisture content of the aggregates [7]. The compressive strength of concrete using recycled fine aggregate with better absorption was lower than that of the control specimen by 20 to 40%. Relative compressive strength is developed at ages of 1 and 3 days. [8]. The compressive strengths for all combinations after 1, 14, and 28 days of curing show that there is a bigger replacement of recycled aggregates the lower the compressive strength for all curing durations. Both coarse and fine recycled aggregates weaken during compression [9]. The difference between the lower and higher strengths was 7% and 13% for testing ages of 7 days and 90 days, respectively, indicating that the crushing age had a far less significant impact on recycled OPC concrete. The fall in splitting tensile strength brought on by the use of RCAs as opposed to conventional aggregates is more noticeable in a normal-strength-normal-aggregate concrete [10] than the reduction in compressive strength. Recycled concrete aggregates (RCA) cause more concrete to shrink than natural aggregates due to their lower elastic modulus and tendency for shrinkage[11].

2. MATERIAL PROPERTIES AND MIX PROPORTIONING

2.1 Cement

In the widest sense of the word, cement is a binder—a substance that binds other materials together and sets and hardens on its own. Cement acts as a binder in concrete, holding the other elements together and forming a substantial mass structure. Ordinary Portland Cement (OPC) of grade 43 is the substance used [12].

Table 1 Physical properties OPC 43 grade cement

Property	Value
Initial setting time	30 minutes
Final setting time	10 hours
Specific gravity	3.15 Kg/m³
Consistency	30%

2.2 Fine Aggregate

River sand that went through a 4.75 mm filter and was retained on a 600 m screen, both of which complied with Zone II of IS 383-1970, served as the fine aggregate in the current experiment. The sand has no biological impurities, clay, or silt. The aggregate was assessed for its physical characteristics, including gradation, fineness modulus, specific gravity, and bulk modulus, in accordance with IS: 2386-1963 [13]. The particle size distribution curves for river sand and recycled fine aggregate are shown in Chart 1.

Fig -1: Demolished Fine aggregate

Table 2 Test result for natural fine aggregate and Recycled fine aggregate

SI.NO	Test properties	Results		Relevant Indian standards
		Sand	Recycled fine aggregate	
1	Specific gravity	2.6	2.63	IS 2386(part III) 1963
2	Fineness modulus	3.16	3.81	IS 2386(part I) 1963
3	Bulk density (kg/m³)	1750	1545	IS 383-1970
4	Water absorption (%)	1.07	6.48	IS 2386(part III) 1963
5	Zone	II	II	IS 383- 1970

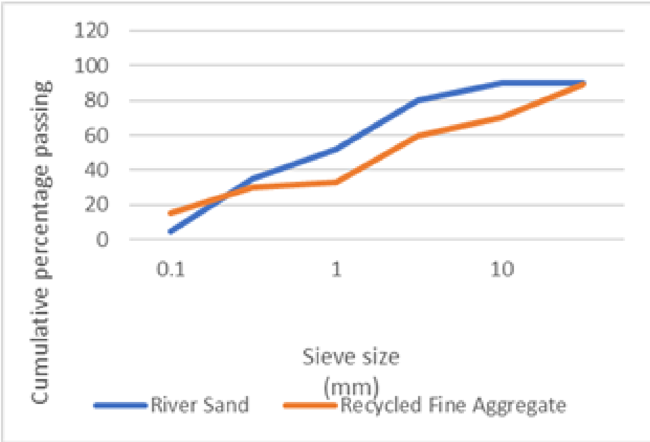

Chart -1: Particle size distribution curve for Sand and Recycled Aggregate

2.3 Coarse Aggregate

Although there are many various components that go into making concrete, the coarse aggregate is the key one that provides the finished product its strength and homogeneity. Coarse aggregate is used in a variety of building projects because it resembles regular rock fragments rather than fine aggregate, which more closely resembles sand [14].

Coarse aggregate is a crucial component in many construction-related applications. It can also be used in combination with other materials, such as asphalt or concrete mixtures, or on its own as a granular foundation poured beneath a slab or pavement.

In general, rock larger than a typical No. 4.78mm sieve and less than 50.8mm is referred to as coarse aggregate[15].

2.4 Water

Concrete that complies with the requirements of IS 456-2000 is mixed in a portable water source with a pH value of 7.0, curing the specimen [16].

2.5 Mix Proportioning

Table 3 Ingredients required for per m³of concrete

SI NO	Property	Value
1	Cement	350 kg/m³
2	Water	157.5 kg/m³
3	Fine aggregate	758.46 kg/m³
4	Coarse aggregate	1180 kg/m³
5	Water/ Cement ratio	0.45

3. EXPERIMENTAL INVESTIGATIONS

3.1 Compressive Strength Results

In Chart-2, the compressive strength of various concrete mixtures was shown visually. According to the observed data[17], recycled concrete mix has higher strength compared to reference concrete at 30% replacement of fine aggregate, and there is a strength loss at more than 30% replacement of fine aggregate.

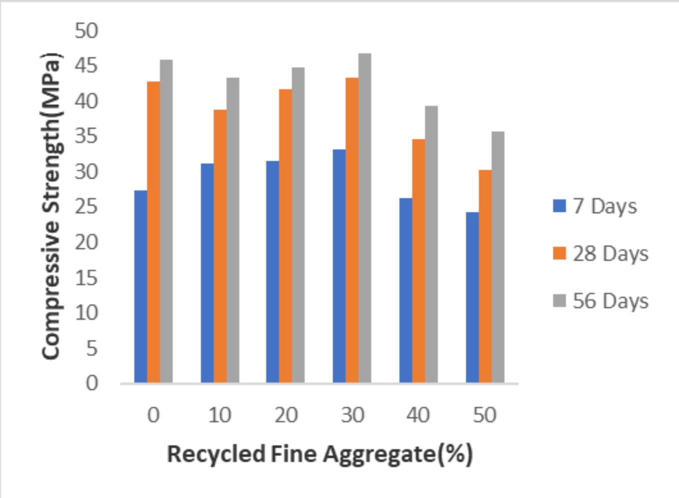

Chart -2: Compressive strength of natural and recycled aggregate concrete

Due to insufficient hydration and a weak interface zone that formed between various concrete matrix components as a result of a significant amount of old cement paste on the surface of recycled aggregates, this decrease can result in a poor development of the compressive strength of concrete [18]. In addition, an uneven surface of recycled fine aggregate would result in many microcracks between the aggregates and cement paste, lowering the compressive strength of the concrete.

Fig -2: Compression Testing Machine

3.2 Split Tensile Strength

The split tensile strength of the concrete is shown in Chart 3 with a significant decrease in this parameter as the percentage of FNA replacement with FRA rises [19]. Given the more porous character of the recycled aggregates, it follows that a reduction happens as the replacement ratio increases [20]. The recycled concrete mix has a 15% better strength than the reference concrete at a 30% replacement of fine aggregate [21].

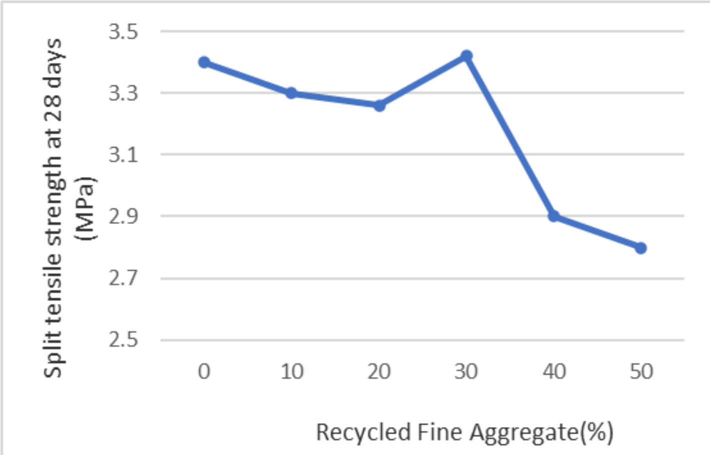

Chart -3: Split tensile strength of concrete

Fig -3: Split Tensile Testing Machine

3.3 Flexural Strength

The observed findings show that recycled concrete mixes with 50% of the fine aggregate offer a 20.8% reduction in flexural strength and higher strength compared to reference concrete up to a 30% replacement level [22]. The lower flexural strength would be brought on by the weaker connection between the various elements of the concrete matrix brought on by the cement paste on the surface of recycled aggregates [23].

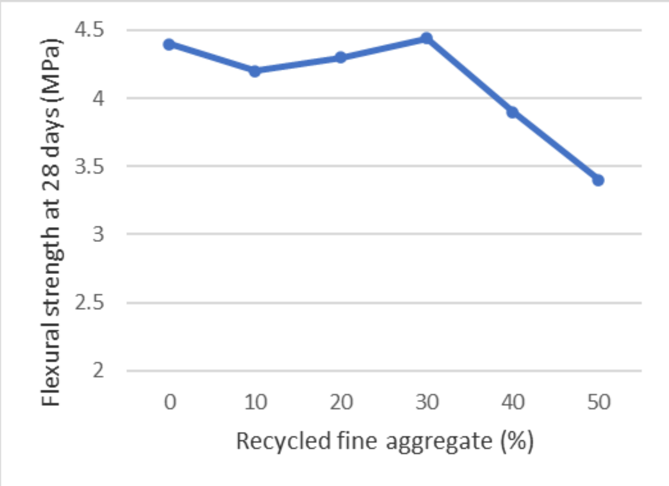

Chart -4: Flexural strength of concrete

3. CONCLUSIONS

1. Recycled aggregate concrete absorbs 42% more water than natural aggregate concrete.

2. The greater water absorption of recycled fine aggregate had very little impact on the early slump of concrete containing recycled material.

3. The compressive strength of the 30% replacement concrete was 1% greater than that of standard concrete.

At 7, 28, and 56 days, concrete's compressive strength is reduced by 20–40% when the replacement level for fine aggregate is made up mostly of recycled material.

4. Flexural strength and tensile splitting on concrete with 30% replacement increased by 0.568 and 5.71%, respectively. Once the replacement ratio exceeds 30%, both tensile splitting and flexural strength steadily decline.

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