COMPRESSIVE STRENGTH OF MASONRY BLOCKS MADE WITH RECYCLED FINE AGGREGATES

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ABSTRACT

Construction debris from demolition of old masonry buildings and construction sites are used to fill low lying areas and potholes in minor roads in many parts of Sri Lanka. Even though this material is treated as a waste, recycled aggregates from this construction waste can be put into more important use.

Cement sand blocks collected from demolished buildings consist of cement, sand and aggregate particles bonded together. These blocks were crushed, sieved, washed and oven-dried to get the recycled aggregates for the new masonry blocks. These aggregates were sieved in order to find the particle size distribution. New blocks were made with these recycled aggregate, OPC cement and water. The newly made masonry blocks were tested for compressive strength in the laboratory.

***Key words*:** Cement sand blocks, recycled sand, compressive strength

1. INTRODUCTION

With the rapid development of a country, many new buildings are being constructed by demolishing the existing old buildings. The debris from the demolition of existing buildings is mainly used in landfills. However, if the land filling is not properly done, water ways and catchments can get obstructed and flood situations could arise. The same thing happens with the construction debris of a new construction site. This has become a serious environmental issue in and around urban areas of the country due to current development activities [4].

Construction industry in Sri Lanka uses river sand as the main source of fine aggregate for plastering, concreting and all other masonry work. The uncontrolled sand mining to cater the demand for sand has created so many adverse impacts to the environment and also to the eco-systems such as erosion of river banks, ingression of salty water through river channels, etc. Therefore, this study investigates the possibility of using recycled fine aggregate for construction work to mitigate these environmental impacts.

Broken masonry block pieces were obtained from a demolition of a 20 year old house. These block pieces were crushed, sieved, washed and dried to obtain the recycled fine aggregates. Subsequently, the recycled fine aggregate was tested for particle size distribution. Finally, the blocks were made from each category of the recycled sand and tested for unit compressive strengths.

2. METHODOLOGY

As mentioned before, this study investigates the possibility of using recycled sand as an alternative fine material. For this purpose, eighteen samples are collected and subsequently, categorized into six groups in order to have three samples per each group. The six groups are defined depending on the methodology used to wash the samples. The following text summarizes the all the steps involving in collecting and testing the samples.

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2.1 Collection of construction waste

Approximately 100 kg of broken solid cement sand masonry blocks were collected from a demolition of a 20 year old house in Athurugiriya. The demolition was still going on at the time of collection. Only pieces and full solid blocks were collected from a heap of construction debris. The block pieces were free of paint but some were covered with moss. The material was wet at the time of collection.

2.2 Removal of unwanted material

Only unwanted material in these blocks was moss with which 10% of the blocks were covered. This moss was scraped out with the use of a spatula and the blocks were then sun-dried.

2.3 Crushing of broken block pieces
Samples were taken and spread over a concrete floor. Subsequently, they were crushed manually with the use of 1 pound hammer. The crushed material was then collected into polythene bags.

2.4 Sieving
Each crushed sample was sieved through a 10 mm sieve and 0.075 mm sieve to remove metal pieces and cement dust, respectively.

2.5 Washing
Sieved samples were washed with water and acid. Acetic acid was used with a concentration of 3% (0.03 mol/dm^3). Time parameter was taken as 5, 15 and 30 minutes.

2.6 Drying
The washed samples were sun dried. The electric oven was also used. When the samples were fully dried, they were again sieved through a 0.075 mm sieve to remove cement dust.

2.7 Sampling
These were divided into two samples for the testing of sand and for the making of blocks and mortar cubes. 30% were separated for the testing and the rest (70%) was kept to make cement blocks. These were divided using a sample splitter according to the following categories.

Category 1: Washed with water for five minutes
Category 2: Washed with water for fifteen minutes
Category 3: Washed with water for thirty minutes
Category 4: Washed with acid for five minutes
Category 5: Washed with acid for fifteen minutes
Category 6: Washed with acid for thirty minutes

2.8 Particle size distribution of recycled sand
This was performed for all six samples, one from each category. A set of BS standard sieves including 10 mm, 4.75 mm, 2.36 mm, 1.8 mm, 0.6 mm, 0.3 mm, 0.15mm and 0.075 mm was used.

2.9 Making of cement blocks
Three blocks, each having dimensions (L) 350 mm x (W) 100 mm x (H) 175 mm from each category were made using this recycled sand to obtain the compressive strength. The blocks were tested to check the compressive strength in 7, 14 and 28 days.

3. RESULTS

The following text discusses the results obtained from the particle size distribution analysis and the compressive tests of the cement blocks.

3.1 Particle size distribution Analysis
Figure 1 illustrates the particle size distribution curves obtained by measuring the weight of the sand retained in each sieve for the samples taken from six categories [3]. Figure 2 shows the variation of weight retained in different sieve of each category of sand.

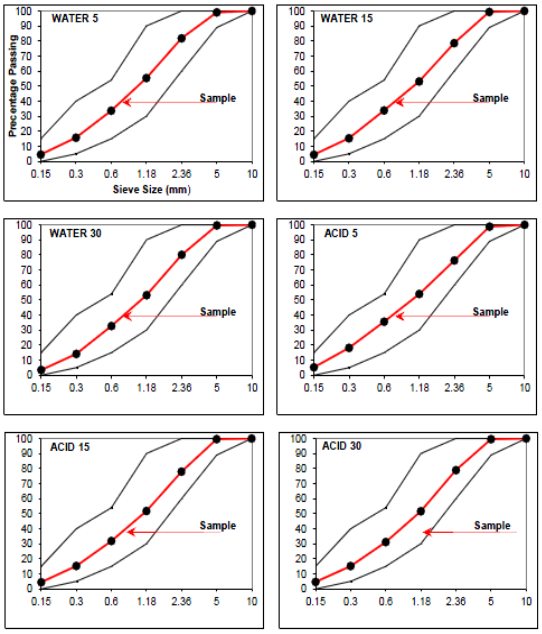

Figure 1: Particle size distribution curves of six categories of sand

If this recycled fine aggregates is to be considered as a suitable alternative material, its particle size distribution curve should be placed in between the two extreme lines which are indicated in black lines in Figure 1. However, it is clear from Figure 1 and 2 that every sample from each category had its distribution curve well within the accepted limits and no significant variation among the different curves is observed.

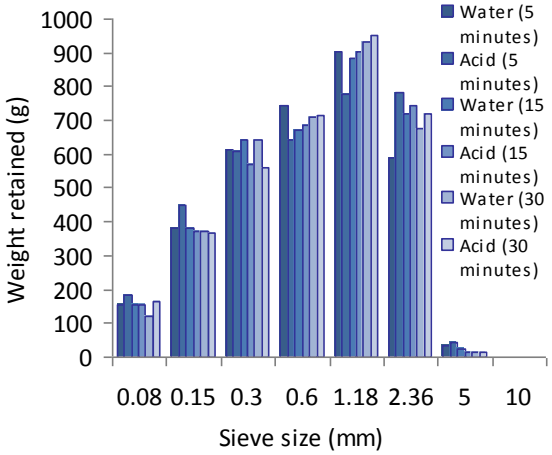

Figure 2: Weight retained in each sieve of each category of sand

3.2 Compressive strength of cement blocks
All the specimens are tested according to the SLS 855 Part 1 & Part 2 [1,2]. Table 1 presents the average compressive strength and percentage of its increment with respect to the specimen made in normal sand tested after 14 days.

Table 1: Unit Compressive strength of tested specimens

Category	Compressive strength (N/mm^2)	Percentage of increment
SLS 855*	1.20	-
Normal Sand**	4.09	-
Water 05 min	4.30	5.1%
Water 15 min	4.29	4.9%
Water 30 min	4.34	6.1%
Acid 05 min	3.38	-17.4%
Acid 15 min	3.57	-12.7%
Acid 30 min	3.32	-18.9%

Note:
*-Recommended minimum unit compressive strength in SLS 855 Parts I & II.
**-Normal cement sand block used for the strength compassion purposes

The results show that average compressive strength of the blocks made from the recycled sand washed with water is increased by 5.4% compared to the compressive strength of the blocks made from normal sand. However, average compressive strength of the blocks made from the recycled sand washed with Acetic acid is decreased by 16.3% compared to the compressive strength of the blocks made from normal sand.

4. CONCLUSIONS

Objective of this study was to find out whether it is possible to use construction debris after recycling, as fine aggregate in manufacturing masonry blocks. As the first phase of the study, we have to prove that recycled sand comply with the requirements of the SLS standards. In the second stage, our challenge was to find out whether the blocks manufactured with this recycled fine aggregate comply with the requirement given in SLS standards.

From the phase one of the research, it was found that the recycled fine aggregate washed in Acetic acid has resulted the best quality fine aggregate. Even the recycled fine aggregate obtained after washing with water qualifies as a fine aggregate as per SLS standards. Also it was observed that the period of washing had no effect on the final quality of the recycled fine aggregate.

Compressive strength of blocks manufactured using recycled fine aggregate washed with Acetic acid was found to be decreased compared to that of the fine aggregate obtained after washing only in water. If recycled fine aggregate to be used in block making further tests are to be done to ascertain its chemical properties and physical properties as specified in the SLS standards. Also in our opinion washing time less than five minutes should also be tried to arrive at the optimum washing time.

5. REFERENCE

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