Experimental Conduct on Classified Fine Recycled Aggregate of Construction and Demolition (C&D) Waste as Replacement of Sand

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Abstract. The developing world is increasingly enhancing the vast production of construction and demolition waste. Such wastes are now in use as recycled aggregate. Generally classified as coarse recycled aggregate and fine recycled aggregate, coarse recycled aggregates are now generally used in many fields and applications. Whereas fine recycled aggregates are still to be explored to a greater extent. In this paper, the experimental conduct of such fine recycled aggregate in replacement of sand is performed. The recycled fine aggregate from construction and demolition waste is further classified and evaluated as per the secured source. Wastes generated were broadly classified into SPT Waste, brick powder waste, and concrete waste. Consequently, wastes were further analyzed by strength analysis andXRD analysis. The compressive strength was performed with a replacement ratio of 50%, for the comparison of better performance evaluation. The test results obtained concluded that the concrete wastes had better compressive strength in comparison tothe other two types of waste, while the brick powder waste yielded a better result than the SPT waste. The compressive strength difference was meager between the brick powder waste and the SPT waste. Classifying wastes and implementing them as recycled aggregate proves that concrete waste is more efficient in comparison to other types of waste and unparalleled in its performance. This paper sheds light on that classification of waste and reusing it as recycled aggregate proves that concrete waste is better in its performance in comparison to the other types of waste and can be further classified.

Keywords: C&D Waste, SPT waste, Concrete waste, Brick powder waste

1 Introduction

The lead in development has its advantages and disadvantages. One of such disadvantages is the production of a large amount of waste, such as construction and demolition waste. The waste generated from the activity such as the construction of any structures or demolition of old structures is termed C&D Waste. Such wastes are heavy in nature

leading to vast transportation costs. They are not easily biodegradable as well and hence can harm the environment. A proper waste management facility is required for such waste but in addition, if they are reduced by reusing as a replacement of sand, it can lead to better waste management and also a way out to save over quarrying of sand from river beds.

In India, the major generator that stands first in the Buildings, followed by roads. The wastes generated from buildings are usually concrete, brick, and plaster. In my state Arunachal Pradesh, the buildings or the houses are generally made of RCC structures, bamboo, or SPT structures i.e. semi-permanent structures. The manuscript, therefore, classifies the waste into three parts that are most majorly produced as C&D waste. The waste is classified as Concrete waste of RCC structures, Brick powder waste, and plaster powder waste of SPT structures. The three classified wastes are then further used as a 50% replacement of river sand in construction work as mortar.

It is very evident that the C&D Waste recycled and reused as coarse aggregate in concrete work is highly into consideration. The manuscript deals with the replacement of such waste as fine aggregate in mortar works. The performance is based on the compressive strength of each waste, the XRD test results are compared and the best suitable type of waste for reuse is suggested. The compressive strength of each waste sample is evaluated for a fixed water-cement ratio, for better comparison. The C&D wastein this manuscript is classified into three types, i.e., RCC or concrete waste, SPT waste, and Brick powder waste.

There are numerous studies made on the use of construction and demolition waste as coarse aggregates but the use of such waste as fine aggregates are still new in trend. However, there are some studies based on the reuse of C&D waste as a replacement for natural sand in construction. One such study was done by Nenoa et al., [1]. In their paper titled "Using Fine Recycled Concrete Aggregate for Mortar Production" where the waste replacement was conducted in the replacement of 20%, 50%, and 100%. It was concluded in the study that the replacement of construction and demolition waste was feasible.

C&D waste is bulky and heavy in nature. Therefore it is generally unsuitable for disposal by incineration or composting. The growing population leads to more requirements for land, residential and commercial purposes, hence there is a reduction in the availability of land for waste disposal or Landfill sites. Hemalatha et al., [2]. “Construction and Demolition Waste Recycling for Sustainable Growth and Development" describes that Concrete and masonry make up more than 50% of waste generated. It can be reused in block form. Recycling C&D wastes by converting them to aggregates offer double benefit by saving space for landfill sites and reducing the extraction of natural raw materials such as sand for new construction works. The recycling of concrete and masonry waste is done by crushing the debris to a granular product of a given particle size.

Shrivastava, et al., [3] it has mentioned that the major components generated in demolition waste are Cement concrete, Bricks, Cement plaster, Steel, roofing support, Rubble, Stone, and Timber, respectively. It is challenging to manage C&D waste as it is bulky, heavy, and inert in nature and also a mixture of various materials each with distinctive characteristics. It also mentioned that such C&D waste cannot be incinerated

due to its high density and inertness but C&D waste handling issues must be in focus to achieve sustainable goals for our future generation [4, 5].

The Indian construction industry is the largest consumer of material resources of both natural such as stone, clay, and lime, and processed and synthetic resources Market research according to "Construction Materials in India" (2006). Therefore waste management in such a country becomes heavy for the nation. And hence, classifying and reusing such waste effectively will be highly beneficial for the environment and sustainable development.

2 MATERIAL

2.1 Cement:

It is a binding material used in construction. It sets, hardens, and adheres to other materials and binds them all together. The types of cement are classified into Rapid hardening cement, OPC, and PPC. Each comprising distinct characteristics. Here, the cement used is OPC of grade 43. This stands for ordinary Portland cement of grade 43.

2.2 Natural river sand:

The river sands for construction purposes are quarried from natural river beds. The river sand used in this work was quarried from the river side of Dikrong River, Arunachal Pradesh. The sand used was free from other impurities such as plastics and gravels etc.

2.3 Construction and Demolition Waste:

The C&D waste was obtained from the construction sites as well as demolition sites of the capital region of Arunachal Pradesh i.e. Itanagar, Papumpare district. The wastes obtained were further segregated into three components of Concrete waste, Brick powder waste, and SPT waste.

2.4 Water:

The water used was the generally used Tap water, which is commonly used in all kinds of construction purposes to keep the test result data, as practical as possible.

3 Methods and Discussion:

3.1 XRD Analysis:

To analyze the main constituents and the amount in which they are present, the XRD analysis has been conducted. Here the XRD stands for, x-ray diffraction test. The tested sample gives the graph of a structure being amorphous or crystalline in nature. It gives the

percentage of minerals present in the sample. The following graphs are the result of my analysis, where the percentage of minerals is shown in the form of a peak.

3.1.1 River sand

Since the graph shown in Fig.2is steep hence the structure is crystalline in nature. The ions, molecules, or atoms are held together in a three-dimensional set-up of ordered arrangements. The major mineral composition is found in Quartz, which is rich in silica.

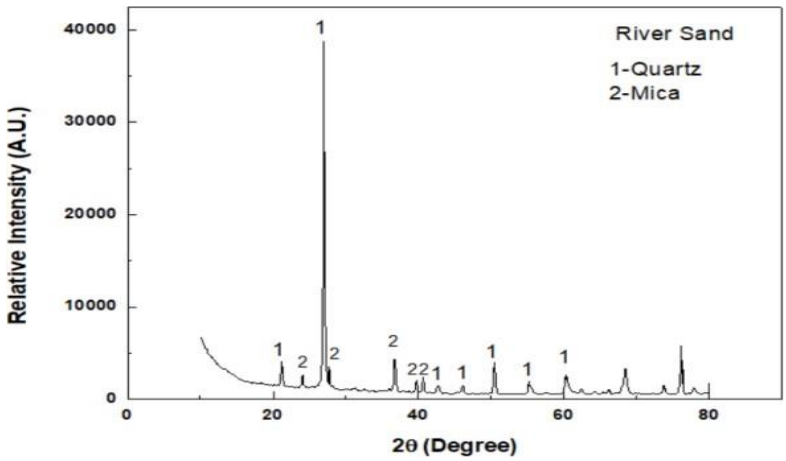

Fig. 2. XRD graph river sand

3.1.2 Concrete waste:

The graph shown in Fig.3is steep in nature, which indicates that it is crystalline in nature and the highest amount of silica is present among all the mineral compositions.

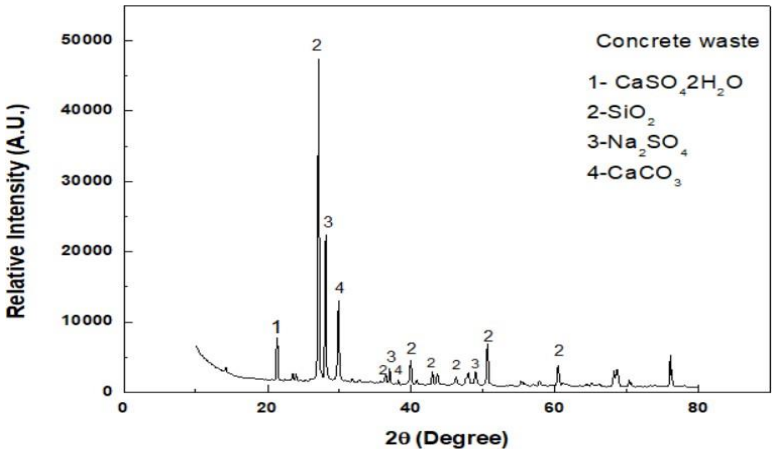

Fig. 3. XRD graph concrete waste

3.1.3 Brick Powder Waste

The graph shown in Fig.4. represents that it is crystalline in nature. The highest peak that can be observed here is silica as well followed by alumina.

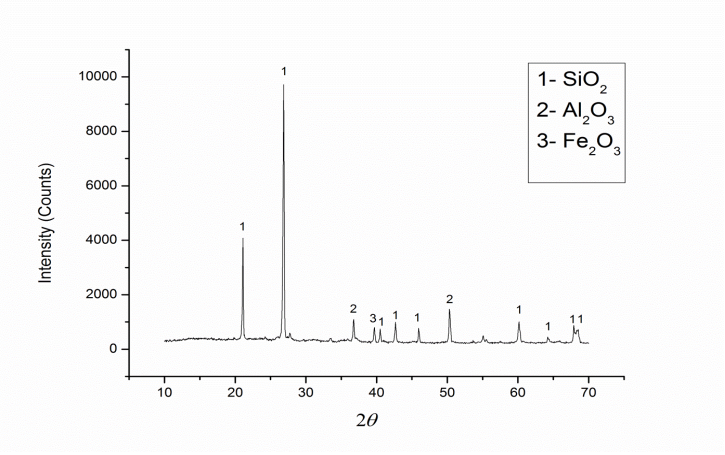

Fig. 4. XRD graph brick powder waste

3.1.4 SPT waste

The highest peak in the graph as shown in Fig.5is silica. And it also represents that it is crystalline in nature.

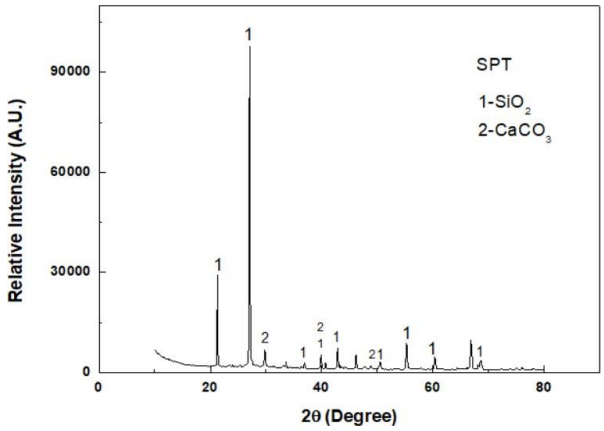

Fig. 5. XRD graph SPT waste

3.2 Compressive Strength Test

The mortar cubes were made comprising of cement, sand, and C&D waste. The mixture proportion of each sample evaluated is as follows:M_1: Cement: Sand: Concrete waste; M_2: Cement: Sand: Brick powder; and M_3: Cement: Sand: SPT waste

The M1 mix comprises 1:4 ratios, where cement is of 1 part and sand is of two parts and concrete (RCC) waste is of 2 parts. The M2 mix comprises 1:4 ratios, where cement is of 1 part and sand is of 2 parts and the Brick powder waste is of two parts. The M3 mix comprises 1:4 ratios, where cement is of 1 part and sand is of two parts and SPT powder waste is of two parts.

3.2.1 Sample Preparation

There were twenty-seven mortar cubes prepared, nine cubes for each type of wastesample. The cubes prepared were cured for 7 days, 14 days, and 28 days. An aggregate value of 3 cubes was taken for each sample.

3.2.2 Result:

The test conducted results that out of the three samples evaluated as shown in Fig.1, the concrete waste possesses the highest amount of compressive strength among all three- waste sample. Although all the samples do not differ by much amount, still the RCC concrete waste can always be preferred over SPT and Brick powder waste. All three wastes can be used as recycled material effectively. The Brick powder waste imparts better compressive strength in comparison to SPT powder waste. Although the results are highly close.

Table 1: Compressive strength analysis

Mpx	Compressive strength for days of curing in N/mm^2		
	7 days	14 days	28 days
M1	12.07	15.89	20.72
	11.67	16.29	17.91
	12.07	19.11	19.72
M2	11.87	17.30	20.72
	10.86	16.90	17.91
	9.45	153.89	19.72
M3	8.25	16.49	17.30
	10.66	14.08	16.09
	11.87	15.09	17.30

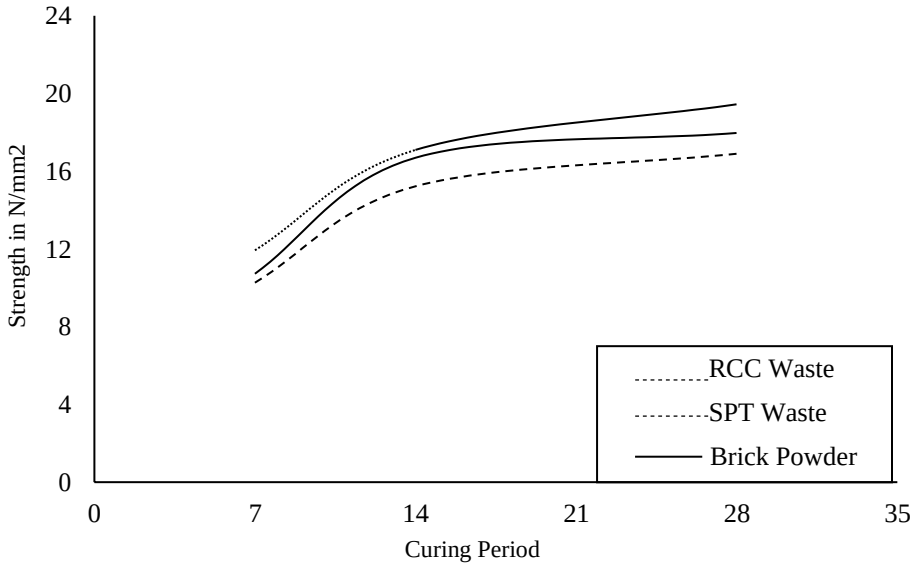

Fig. 1. Compressive strength graph

4 Conclusion

The study and experiments conducted can conclude that the classification of C&D waste is beneficial in bringing out a better performance of such waste when used as a recycled material. All the three classified waste are crystalline in nature and are rich in silica content, and therefore can be used as recycled material in replacement for sand. Concrete (RCC) waste can always be preferred over Brick powder waste and SPT waste as recycledmaterial in replacement of sand. Although all three components impart almost the same values of compressive strength, the concrete waste gives the highest value. Recycling such waste and classifying it for further use, will lead to sustainable development and as well lessen the burden on landfill sites.

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