Study of Crumb Rubber waste in Cement stabilized soil blocks

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ABSTRACT
The Nation faces ecological problems due to the accumulation of waste automobile and truck tires. The best management strategy for scrap tires that are worn out beyond hope for reuse or retreading is recycling. Utilization of scrap tires should minimize environmental impact and maximize conservation of natural resources. The regulatory practices include landfill bans and scrap tire fees. Because rubber waste does not biodegrade readily, even after long periods of landfill treatment, there is renewed interest in developing alternatives to disposal. One possible solution for this problem is to incorporate rubber particles into cement-based materials. Scrap tires can be shredded into raw materials for use in hundreds of crumb rubber products

While very little rubber from used tires goes into the production of new tires, a host of other products made from recycled tire rubber have come on the market. Chips of shredded tire rubber are used as fill in engineering projects. More finely chipped and screened tire rubber is used is playground and landscaping mulch. Crumb rubber is used to make better asphalt, while rubber mixed with urethane is used to make athletic track surfaces and a variety of molded products. The crumb rubber market has been one of the fastest-growing scrap tire markets over the last six years.

In this study, use of Treated Crumb rubber wastes in producing cement stabilized soil blocks has been investigated. There are several parameters involved in using Treated Crumb rubber waste in cement stabilized soil blocks production, namely the rate of added Treated Crumb rubber waste, the amount of cement used as stabilizer and block processing. The performance of these parameters can be measured by the interplay between main factors: constituent materials used (modified crumb rubber, cement, soil and water) and quality of block processing methods employed.

Powdered tyre rubber, was surface-treated in aqueous solutions, at room temperature, under stirring. The tests revealed that the optimum Treated crumb rubber content was found to be 7% by weight of Cement. The use of Treated tyre rubber as addition to cement paste show satisfactory results in mechanical properties, it has few desirable characteristics such as lower density, higher fracture toughness and better Rutting performance. The paper concludes that it is possible to significantly, improve the dimensional stability and rutting performance of cement stabilized soil blocks to the extent, that they can be suitably used for construction of Pedestrian and low volume roads.

Keywords: Cement(C), Treated Crumb rubber (CR), Compressive strength, Flexural strength, Cement Stabilized Soil Blocks (CSSB),
1. Introduction

Adequate shelter is a basic human need, yet about 80% of the urban population in developing countries still lives in spontaneous settlements as they cannot afford the high cost of building materials. Stabilized mud blocks are being used for the masonry construction in India and elsewhere. The compressed and stabilized blocks (CSB) has been identified as a low-cost building material with the potential to readdress the problem and reverse the shelter backlog. While its other properties are well understood, the durability of the material remains enigmatic.

Over the years, disposal of tires has become one of the serious problems in environments, and landfilling is becoming unacceptable because of the rapid depletion of available sites for waste disposal. Used tire are required to be shredded before landfilling. Innovative solutions to meet the challenge of tire disposal problem have long been in development.

The focus of the experimental program was to investigate the performance of Cement Stabilized Soil Blocks (CSSB) with treated crumb rubber as a partial replacement of cement to produce cement stabilized soil blocks. By using cement as a binder and a conventional soil cement stabilized blocks production process, the treated crumb rubber cement stabilized soil blocks is expected to be more durable and absorb higher energy under impact.

The principal objective of this investigation is to investigate the durability of Cement Stabilised Soil Blocks using treated crumb rubber along with cement for the stabilization of soils blocks with the aim of making them more suitable for construction purposes. Hence an effort has been made to utilize scrap tires in cement stabilized soil blocks.

2. Block making process

Soil Stabilized mud blocks are manufactured by compacting a wetted mixture of soil, sand, and stabilizer in a machine into a high-density block. Such blocks are used for the construction of load-bearing masonry. Ordinary Portland cement has been used as Stabilizer for the preparation of soil-cement blocks.

Powdered tyre rubber 50 mesh maximum size (300micron) was surface treated with saturated NaOH aqueous solution for 20-30 minutes at room temperature under stirring. The mixture was then filtered the rubber was rinsed with water until neutral pH and allowed to dry at room temperature. Then the crumb rubber is submerged in a mixture containing 30% of Dimethylsulfoxide (DMSO) and 70% d-limonene by volume for 4 hours. The hardness of rubber is adequately reduced. Then the rubber is soaked in a bath containing soapy water to wash off the residual DMSO and D-limonene. The processed rubber was soft and slightly sticky powdered consistency having greatly reduced hardness.

In this study, conventional 230mm x190mm x100 mm block making was selected. The manufacturing process is quick and simple, and starts with placing the cement stabilized soil into the mould compacting it under pressure Static compaction is obtained by applying a static pressure using a compacting machine on stabilized soil place in the mould and compacted at the strain rate of 1.27mm/mn until the desired compaction stress is
obtained. After demoulding the height and the density of the specimen are measured and the specimens are cured by keeping under wet burlap for the required period of time. After 7th day and 28th days curing period the blocks are dried inside the laboratory (at the ambient temperature) the blocks were soaked in water for 48 hours prior testing. Compressive strength tests were carried out in a displacement controlled testing machine at a rate of 1.25 mm per minute. The strength obtained in this manner is designated as 7th day or 28th day wet compressive strength appropriately. The results given in this paper represents the mean of 5 values.

3. Experimental Procedure

Dried and powdered soil sample is mixed with the required quantity of Ordinary Portland cement and treated crumb rubber, manually. The soil-cement-treated crumb rubber mixture is spread into a thin layer and then water of required content is sprinkled and thoroughly mixed by using shovel. Any lumps formed while mixing water are broken, so that the water is uniformly distributed in soil-cement mixture. The wetted soil-cement-rubber mixture is moulded into blocks of 230x190x100mm, employing static compaction process using a metal mould and hydraulic jack.

Experimental work was carried out in two stages. In the 1st stage of investigation, Cement Stabilized Soil Blocks (CSSB), with 10% water content and cement content of 5%, 7% and 10% were cast under compaction pressure of 8 Mpa. They were tested for Compressive strength, Flexural strength and Rutting performance, for 7th day and 28th day curing period.

In the 2nd stage of investigation, Treated Crumb Rubber in percentages of 10 and 20 was added as Partial replacement of 5%, 7% and 10% cement content added to Cement Stabilized Soil Blocks (CSSB), with 10% water content, blocks were cast at compacting pressure of 10Mpa. Compressive strength, Flexural strength, and Rutting performance for 7th day and 28th day curing period.

Compressive strength of compressed earth blocks is strongly related to dry density achieved in compaction. Compressive strength of individual blocks consistently increases as dry density increases. This relationship between strength and density has been consistently proven by test data over the years in India. Prior to production the density and compressive strength of prototype blocks are determined in the laboratory. Subsequently block density, for given a compactive effort, is ensured by carefully measuring, by mass, the quantity of material added to the mould.

Compressive strength of the stabilized block is very sensitive to the block density, irrespective of soil type and stabilizer content. Bulk Density of all the soil cement blocks in all the cases is kept constant at 20.2 kN/m3, which was controlled by compacting pressure. In this experimental work Compressive loading responses of the crumb rubber Cement Stabilized Soil Blocks (CSSB) was compared to the regular CSSB (without crumb rubber). The compressive strength properties of CSSB were found to decrease with increasing crumb rubber content (Fig.1).
Fig. 1. Compressive strength of CSSB using various % of treated Crumb rubber of Cement content

The flexural responses of CSSB with and without treated crumb rubber examined. Similar to the case of compressive response, the flexural strength of crumb rubber CSSB was found to be smaller than the CSSB without crumb rubber. However, the responses were found to denote greater flexibility and toughness with larger deflections at peak load, longer post-peak responses and higher fracture energy. The fracture toughness calculated from the area under the load-deflection curve up the point of failure is plotted in (Fig. 2). At 10% replacement, the toughness of crumb rubber CSSB was found to be larger than that of the CSSB without crumb rubber, even though the strength was lower. This was due to the higher post-peak response. At 20%, the fracture energy of crumb rubber blocks slightly increased but there was considerable decrease in peak load. The larger fracture toughness of crumb rubber CSSB indicates that the block was able to absorb larger quantities of energy after the peak load and prior to the final failure.

Fig. 2. Fracture energy of CSSB with various % of treated crumb rubber
The Rutting responses of CSSB with and without treated crumb rubber were examined. Ruts occur when vehicle load is greater than the blocks bearing capacity. Rutting is the physical disturbance on the surface of the Block. Estimates of rut depth in blocks are calculated. Rut depth measurements is collected from hydraulically operated Machine, where in the pressure is applied on Two rollers coupled with to and fro movement of the rollers. The response of CSSB with Treated Crumb rubber was found to be better than CSSB without Crumb rubber.

4. Conclusion
The investigation demonstrates that treated crumb rubber waste can be made used in Cement stabilized block production without unduly affecting its performance, to some extent solving the environmental problem of waste tire disposal. The following conclusion can be made from the results of the investigation.

The surface of powdered tire rubber was modified by adding reagents to increase its adhesion to cement paste. Test on Treated Crumb rubber wastes, cement plus and soil were carried out. The results have shown that the crumb rubber wastes produced from tires can improve the performance of the cement stabilized soil blocks in terms of wear resistance.

Reduced compressive and flexural strength of CSSB due to the inclusion of treated crumb rubber do limit its use in major load baring walls, but it has few desirable characteristics such as lower density, higher fracture toughness and better sound insulation etc. The fracture toughness calculated from the area under the load-deflection curve up the point of failure indicate, at 10% replacement, the toughness of crumb rubber CSSB was found to be larger than that of the CSSB without crumb rubber, even though the strength was lower. This was due to the higher post-peak response; these properties can be advantageous to some construction applications.

The test results showed that the treated crumb rubber enhances the adhesion of tire rubber particles to cement paste, and mechanical properties such as flexural strength and rut resistance improved with the use of tire rubber particles.

The paper concludes that it is possible to significantly raise the strength, improve the dimensional stability of cement stabilized soil blocks to the extent that they can be safely be used as paving blocks and in unrendered walls in the humid tropics.

Soil cement stabilized blocks using crumb rubber could possibly be used in the following areas:
(i) Where minor vibrations damping is needed, such as in car parks and foundation pad for small machinery,
(ii) For trench filling and pipe bedding and paving slabs
(iii) Because of its light unit weight may be suitable for architectural applications like false facades, stone backing, and interior construction

References
[3]. Indian Standard specifications for soil based Blocks used in general Building constructions, IS1725, First revision, Indian Standards Institution, New Delhi, 1983


