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Experimental investigation on the utilization of plastic waste and construction demolition waste in brick manufacturing.

Investigación experimental sobre el aprovechamiento de residuos plásticos y residuos de demolición de la construcción en la fabricación de ladrillos.

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ABSTRACT

Bricks have been a significant construction and building material for a long time bricks are made of clay burnt under high and are widely use around the world. Traditional masonry temperatures, resulting in high energy consumption, environmental contaminations and decreased natural raw materials. So in order to limit nature risks, waste materials such as plastic waste and construction demolished waste can be used to produce bricks. It is estimated that the construction industry generates about 10-12 million tons of construction waste and nearly 300 million tons of plastic wastes annually, which cause a threat to the environment. So the introduction of new technologies to recycle and convert waste into useful materials is crucial for environmental protection and sustainable development. The study deals with an experimental investigation on the use of plastic waste and construction demolished waste in brick manufacturing. This work aims at establishing the optimum percentage of plastic waste in construction demolition waste by adding various percentages of plastic (20%, 25%, 30%) in construction demolition waste based on compressive strength. From tests it is observed that brick incorporating plastic waste and CDWs with 30% of plastic waste gives the highest compressive strength of 7.84 N/mm2 which meets the strength requirement for second class bricks. Hence the bricks incorporating the plastics and CDW can be successfully manufactured and can be used for various applications.

Keywords: building, bricks, plastic waste.

RESUMEN

Los ladrillos han sido un importante material de construcción durante mucho tiempo. Los ladrillos están hechos de arcilla cocida a fuego alto y se utilizan ampliamente en todo el mundo. Temperaturas tradicionales de albañilería, lo que resulta en un alto consumo de energía, contaminaciones ambientales y disminución de materias primas naturales. Por eso, para limitar los riesgos naturales, se pueden utilizar materiales de desecho como residuos plásticos y residuos de demolición de la construcción para producir ladrillos. Se estima que la industria de la construcción genera entre 10 y 12 millones de toneladas de desechos de construcción y casi 300 millones de toneladas de desechos plásticos al año, lo que representa una amenaza para el medio ambiente. Por eso, la introducción de nuevas tecnologías para reciclar y convertir residuos en materiales útiles es crucial para la

protección del medio ambiente y el desarrollo sostenible. El estudio aborda una investigación experimental sobre el uso de residuos plásticos y residuos de demolición de la construcción en la fabricación de ladrillos. Este trabajo tiene como objetivo establecer el porcentaje óptimo de residuos plásticos en los residuos de demolición de la construcción añadiendo varios porcentajes de plástico (20%, 25%, 30%) en los residuos de demolición de la construcción en función de la resistencia a la compresión. De las pruebas se observa que los ladrillos que incorporan desechos plásticos y CDW con un 30% de desechos plásticos dan la resistencia a la compresión más alta de 7,84 N/mm2, lo que cumple con el requisito de resistencia para los ladrillos de segunda clase. Por lo tanto, los ladrillos que incorporan plásticos y CDW pueden fabricarse con éxito y utilizarse para diversas aplicaciones.
Palabras clave: construcción, ladrillos, desechos plásticos.

INTRODUCTION

Plastic is a substance that is extremely dangerous and challenging to decompose. It is a major issue on the global scale. Plastic is widely used in everyday items including polythene bags, garbage disposals, furniture, food packaging, and other accessories. According to their chemical composition, plastic comes in a wide range of different varieties. The primary significant issue we face is the separation of plastic garbage. Although the usage of plastic cannot be eliminated, it can be recycled. When it comes to the construction sector, materials can account for up to 60% to 70% of the project's overall cost. Rapid population expansion, urbanization, and industrial development are the causes. Promoting proper management of the vast number of solid wastes produced by industrial production and consumption patterns is one of the main concerns of society today. Consequently, the development of new technologies for recycling and it is essential for environmental sustainability to turn trash into usable products. In this study, feasibility of manufacturing bricks from waste plastic and construction demolition waste (CDW) is studied and the behavior of these brick incorporating plastic waste and CDWs is evaluated by compression test. This study yields a brick manufactured using plastic as the binder and construction demolition waste as aggregate which will result in a brick manufactured from 100% recycled materials. By this there will be more cycling of plastic waste and reduction in the dumping of plastic waste. By using plastic as the binder, the total weight of the brick can be decreased this will result in a more efficient light weight brick, with low water absorption property. By developing this brick, it will increase sustainability factor and create a solution for plastic waste and demolition waste recycling.

Leela Barathi S.M, Johnpaul V, Praveen Kumar R, Surya R, Vishnu Kumar T (2020) aims to study the strength properties of a low carbon brick incorporating plastic waste and CDWs which is manufactured using plastic waste and M sand. The manufacturing process include heating the M sand to a particular temperature and adding plastic to it in required proportions and mixing it properly, after this the mixture is molded and cured. Two samples were made using ratio 1:1 (sample 1) and 1:2 (sample 2) plastic waste and M sand respectively. Compressive strength of sample 1 and sample 2 are 45.45 N/mm^2 and 55.91N/mm^2. The compressive strength of normal brick is 6.36 N/mm^2, from which it is clear that the increase in compressive strength is really impressive. By using plastic as

binder material, the weight of the brick can be reduced.

Bhushaiah Rajarapu, Shaik Mohammed, Srinivasa Rao D (2019) studied the strength properties of a brick incorporating plastic waste and CDWs. The materials used in the manufacturing of this brick are plastic, cement, sand, water, and fly ash. In this process melted plastic is added during the mixing of materials. The percentage of plastic added are 5%,10%,15%,20% respectively. The methodology includes collection of materials, batching, melting, mixing, molding and curing. The compressive strength of the specimen bricks shall be calculated after 7,14 and 28 days of curing. The compressive strength of brick at 28 days with 0% plastic is 18 N/mm^2 and the maximum compressive strength obtained was 20 N/mm^2 when 15% of plastic is added, for 5%,10%,20% there is no reduction in compressive strength. It is also seen that when the percentage of plastic addition is increased rate of water absorption is decreased.

Seco A, Omer J (2018) aims to study the utilization of construction demolition waste in building materials manufacturing and their properties. In this study he replaced 50% of aggregates with construction demolition waste and 30% of soil by ceramic waste for the manufacturing of bricks. For each combination of soil construction demolition waste and additives were mixed for 10 minutes to obtain a completely dry and homogenous mixture, then the required amount of water is added. This mixture is then molded using 9Mpa pressure. After this the bricks were cured by covering with polyethene sheet in a wet chamber. This specimen is tested after 7,14 and 28 days. The compressive strength is obtained is 8.6 N/mm^2. By analyzing the result, the brick can be used for construction works

MATERIAL AND METHODS

The materials required for the manufacturing of the brick was collected. The materials used for the manufacturing of brick are plastic waste and construction demolition waste, plastic waste consists of plastic bags and the construction demolition waste consists of concrete blocks and mortar. Construction demolition waste was collected from a demolition site near Mulanthuruthy the collected mainly consists of concrete block with mortar. The collected waste is free from other foreign particles like clay brick, soil etc. CDM was powdered and graded to various sizes by sieving in the following sizes (600 µm - 1.18 mm, 1.18 mm - 4.75 mm, 4.75 mm- 10.00 mm).

Fig. 1 Construction demolition waste

Plastic waste was collected from Mulanthuruthy panchayat, and the plastic waste was then processed. The plastic collected was mostly plastic carry bags, the collected plastic was then cut into small pieces (Fig. 2) for increasing the surface area of the plastic.

Fig. 2 Shredded Plastic Waste

Feasibility test was done by preparing a plastic block specimen with 25%-30% of plastic waste and demolition waste. Two specimens were casted of size 7.5×5×3 cm. The feasibility test was conducted to identify the binding properties of plastic with demolition waste.

Fig.3 Manufacturing of test specimen

The average compressive strength obtained for these test block is 4.6 N/mm^2 which satisfies the minimum strength requirement for a brick.

Proportioning-Mixes with 20, 25 and 30 % of Plastic waste are designated as CP20, CP25 and CP30. The details of mix proportioning is shown in Table 1 below.

Table. 1 Mix Proportioning

Mix Proportioning	CDW (Kg)	Plastic Waste (Kg)
CP20	2.4	0.48
CP25	2.4	0.60
CP30	2.4	0.72

Casting: Brick incorporating plastic waste and CDW is casted to dimension 19×9×9cm. The ratio of CDW used is 1:2:3 (600µm-1.18mm, 1.18mm-4.75mm, 4.75mm-10mm).

Fig. 4 Casting Process

RESULTS AND DISCUSSION

Compressive Strength Results for the various mixes is shown in Table below.

Table. 2 Compressive strength

Mix Design	Compressive Strength (N/mm^2)			
	Sample 1	Sample 2	Sample 3	Avg
CP20	3.99	3.97	3.95	3.97
CP25	5.45	5.51	5.49	5.48
CP30	7.87	7.85	7.81	7.84

It is seen from the results that the compressive strength increases as the percentage of plastics increases. For 30% addition of plastic highest compressive strength of 7.84 N/mm^2 is obtained which satisfies the strength requirement of second class clay bricks. As the percentage of plastics increases the binding property increases which results in greater strengths.

Feasibility test performed on sample plastic block of size 7.5×5×3 cm revealed that the casting brick incorporating plastic waste and CDW is feasible. The average compressive strength obtained for sample plastic block is 4.6 N/mm2 when 25-30 % of plastic waste is added to CDM. Brick incorporating plastic waste and CDWs with 30% of plastic waste gives the highest compressive strength of 7.84 N/mm2 which meets the strength requirement for second class bricks. Hence the bricks incorporating the plastics and CDW can be successfully

manufactured and can be used for structural applications.

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