Comparative Study on Partial Replacement of Fine Aggregates with Wood Powder and Quarry Fines in Cement Blocks

Vikram Tripathi, Dr. Manoj Sharma

*M. Tech Students, IPS College of Technology & Management, Gwalior M.P.
** Professor, IPS College of Technology & Management Gwalior M.P.

ABSTRACT

This project aimed to investigate the potential of using wood powder and quarry fines as partial replacements for fine aggregates in cement bricks. The study included a comparative analysis of the mechanical properties and water absorption of cement bricks made with varying proportions of wood powder and quarry fines. Compressive strength tests were carried out on the bricks for 7, 14, and 28 days. Water absorption tests were also conducted on the bricks after 7, 14 and 28 days.

The results of the study indicated that the use of wood powder and quarry fines as partial replacements for fine aggregates in cement bricks led to a decrease in compressive strength and an increase in water absorption. However, it was observed that the reduction in compressive strength was not significant, and the water absorption values were still within acceptable limits for building materials. Additionally, the cost analysis showed that the use of wood powder and quarry fines could lead to cost savings in the production of cement bricks.

Keywords- fine aggregates, cement, Water absorption, Quarry fines, wood powder, building materials.

INTRODUCTION

Cement blocks are an essential building material used in construction projects around the world. These blocks are typically made from a combination of cement, sand, and water, which are mixed together and then poured into molds to create a range of different shapes and sizes. One of the primary advantages of cement blocks is their strength and durability. They are resistant to weathering, pests, and fire, and can withstand heavy loads without cracking or breaking. They are also relatively inexpensive compared to other building materials, making them a cost-effective choice for construction projects of all sizes. Another benefit of cement blocks is their versatility. They can be used for a variety of different applications, including building walls, foundations, and retaining structures. They can also be manufactured with different surface finishes and colors to meet specific aesthetic requirements.

In addition, cement blocks offer good thermal insulation properties, helping to keep buildings warm in the winter and cool in the summer. This can result in significant energy savings and reduced utility bills. Overall, cement blocks are an important building material that provide strength, durability, versatility, and cost-effectiveness, making them a popular choice for construction projects of all types and sizes.

SCOPE OF THE PROJECT

OBJECTIVE

- To compare the compressive strength of cement blocks with different percentages of wood powder and quarry fines.
- To compare the water absorption of cement blocks with different percentages of wood powder and quarry fines.
- To assess the cost-effectiveness of using wood powder and quarry fines as partial replacements for fine aggregates in cement blocks.
- To evaluate the concrete specimens by replacing fine aggregate into partial replacement of quarry dust and wood dust.

LITERATURE REVIEW

N. S. Potty,et al (2011) was explained about the demand for high quality sustainable materials has increased and encouraged the researchers in building technology to find new alternatives. Rice husk generated from the rice production poses a major problem of disposal especially when open burning is no longer permitted due to the environmental issues. The use of pozzolanic materials is being investigated to reduce the carbon dioxide emitted per tonne of concrete produced and utilized. This study investigates the potential of using Microwave Incinerated Rice Husk Ash (MIRHA) in mortar mixes made of Ordinary Portland Cement (OPC). The MIRHA was obtained by burning rice husk at controlled temperature using microwave incinerator.

Nisha Devi. A (2016) was explained about the reduction in natural resources requires a substitute for those materials. In order to replace the natural resources used in the concrete many replacements has been made such as replacement of cement by fly ash, silica flume, wood ash, etc., replacement of fine aggregates by quarry dust, copper slag, industrial waste etc., In the present investigation, concrete made of crushed spent fire blocks replacing fine aggregates up to 25% are used to study the strength parameters of M30 grade of concrete.

R.Mahidhar Reddy, et al (2017) was analyzed about the cost of construction material is rising mainly due to high demand of concrete and scarcity of raw material affecting the economy of the structure. With increasing demand and consumption of cement, researchers and civil engineers are in search of developing alternate binders that are eco-friendly and contribute towards waste management. In such case, the use of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economic and environmental.

Athira A R. et al (2017) was explained about the concrete is a composite material composed mainly of water, aggregate, and cement. Usually there are additives and reinforcements included to achieve the desired physical properties of the finished material. For solving the disposal of large amount of recycled plastic material, reuse of plastic in concrete industry is considered as the most feasible application. The reuse of material can reduce the normal usage of ingredients in concrete and thereby reduce the cost of construction.

N. Bhuvaneswari, et al (2017) was studied about the main objective of this paper is to find out the alternative materials for concrete to meet the demand of fine aggregate for the upcoming years, to provide adequate strength at minimum cost, to make the eco-friendly structure. Use of steel and welded slag waste industrial by-product of welded and steel production provides great opportunity to utilize it as an alternative to normally available aggregate(fine).

Nicholas Niakoh, et al (2018) was studied explores and compares the properties of sandcrete blocks produced with sawdust as partial replacement to the traditional sandcrete blocks in an attempt to establish the percentage replacement of sawdust that yield properties and characteristics that meets acceptable standards. After a review of relevant literatures, samples of materials (sawdust, sand, cement and appropriate water cement ratio) required were collected and batched by volume to a mix proportion of 1:6.

Akshay Mangraj,et al (2018) was explained about the purpose of this research is to study the properties of fresh and hardened states of M40 grade concrete, using Crushed ROCK Powder (CRP) as fine aggregate to full amount of sand with Partial replacement of block powder at 0%, 5%, 10%, 15% and 20% to existing cement content. This

paper investigates quantitavely the strength of concrete mix at different ages.

Syed Farrukh Anwar, et al (2018) was studied on Metakaloin (MK) and silica fume (SF) is a popular type of natural pozzolanic material which has been widely utilized in constructions since ancient times and silica fume is the largest group of silicate minerals. The present study is, carried out in two phases in first phase mix of M30 grade concrete with partial replacement of cement by 0%, 10%, 15%, 20%, and 25% Metakaolin (MK) and silica fume (SF) both are mixed with same percentages is carried out to determine the optimum percentage of replacement at which maximum compressive strength, tensile strength, flexural strength is achieved

Dixit Patel, et al (2019) Global warming and environment demolition have become manifest problems in recent years. The present day world is witnessing the construction of very challenging and difficult civil engineering structures. In this study test will be conducted for concrete of grade M20 [1:1.5:3] and ratio 70 – 29 – 1 [i.e.70% of concrete and 29% f Fly Ash 1% of admixtures]. The compressing strength test will be conducted of 7, 14, 28 days strength. Experimental studies will show the comparison of compressive strength of material [glass fiber, wheat husk fiber / rice husk fiber, coconut fiber & fly ash]. Graphical representation of compressive strength results are shown & compared to that of each other.

Bincy U I, et al(2019) was studied on the purpose of this research is to study the properties of fresh and hardened states of M40 grade concrete using block powder as partial replacement of cement at 5%,10%,15% and fly ash at 15%,30%and 45%. This project investigates quantitatively the strength of concrete mix at different ages.

B. Manoj Yadavo, et al (2019) address the challenges of availability, price, quality, and pollution, this research analyses the viability of employing industrial waste such as Ground Granulated Blast Furnace Slag (GGBFS) and Rice Husk Ash (RHA) on cement. By replacing cement with GGBFS and RHA by weight at a percentage of 0%, 10%, 20%, 30%, and 40%, cubes of solid masonry blocks of size 150X150X15 of M30 Grade Concrete were cast and made ready for testing for 7 days, 1seven days, and 28 days. Strength tests were conducted.

Tanweer Ahmad, et al (2019) was explained about the use of Glass Powder and other is Stone dust as partial replacement of cement and concrete production. In this research we analyze the strength of concrete made with using these waste materials one is Glass Powder and other is Stone dust. The Glass Powder is used as 20% replace by weight of cement and Stone Dust as the partial replacement of Fine Aggregate from 0%, 10%, 20%, 30% and 40%.

N B Azmi, et al (2021) was studied on the Natural fine aggregate materials are commonly used in development and commercial construction in Malaysia. In fact, concrete production was increased as linear with the growing Malaysia economy. However, an issue was production of concrete was to locate adequate sources of natural fine aggregates. There lot of studies have been conducted in order to replace the fine aggregate in which natural fine aggregate replace with the waste material in concrete preparation. Therefore, this study aims to utilize the Recycled Concrete Aggregate (RCA) and ceramic waste which has great potential to replace the natural aggregate in concrete mix with different type of method, admixture, and parameters.

Priyadharshini et al (2021) was explained on the Concrete is a mix of cement, fine aggregate and coarse aggregate with water in correct proportion. Many attempts had been to replace the fine aggregate, coarse aggregate and cement in concrete. In this row replacement of coarse aggregate by cashew shells was tried. Over 66% of the overall country export cashew kernels. The cashew seeds is well acclaimed for its good quality and appearance. Concrete cubes and beams had casted using cashew shell as a partial replacement of the coarse aggregate in the proportion of 10%, 20% and 30% replacement. The specific gravity of the shell was analyzed and 16mm shell were selected for the experiment.

Kiran C J, et al (2022) was explained on the study of cement, fine aggregate, coarse aggregate and water are the major constituents of cement block. Aggregate, being an important constituent, is used as a filler material and affects the strength and durability properties of concrete. The extraction process of aggregate from quarry contaminates air and water with sulphur dioxide and other pollutants, putting wildlife and local populations at risk.

Used Materials

(i) **quarry fines-** quarry fines, also known as quarry dust or quarry screenings, are a byproduct of the quarrying industry. They are essentially crushed stone particles that are too small to be used as aggregate in concrete, but too large to be considered a fine aggregate. As a result, they are often discarded as waste. they have a high percentage of fines, with particle sizes ranging from 75 microns to 5 mm.

Fig no.1.0 quarry fines

Chemical Properties

In terms of chemical composition, quarry fines are primarily composed of silicon dioxide (SiO2), aluminum oxide (Al2O3), and iron oxide (Fe2O3). Trace amounts of calcium, magnesium, and potassium may also be present, depending on the source rock. Due to their mineral composition, quarry fines can have pozzolanic properties, which means they can

Physical Properties of quarry fines –

Table no. 1

S.no.	Property of quarry dust	Value
1	Specie gravity	2.57
2	Maximum dry density(g/cc)	2.08
3	Optimum moisture content (%)	8.03
4	Gravel size particles (%)	1.08
5	Sand particles (%)	

WOOD POWDER

Sawdust or wood dust is a byproduct of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with the saw or other too ; it is composed of fine particles of wood. It is also the byproduct of certain animals, birds and insects which live in wood, such has woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of flammability

Fig no. 2.0 wood powder

In general, wood powder particles are small, typically ranging from 50 to 500 microns in size.

Chemical composition

Table no. 2 Fig.no. Chemical Composition

S.No.	Oxide	Percentage (%)
1	Sio2	38.26
2	Al2o3	12.87
3	Cao	14.30
4	Fe2o3	7.64
5	K2o	3.28
6	Mgo	1.94
7	Alkalis	.84
8	moisture content	1.45

Physical Properties of wood powder

Density, Thermal conductivity, Water absorption, Thermal insulation

Methodology

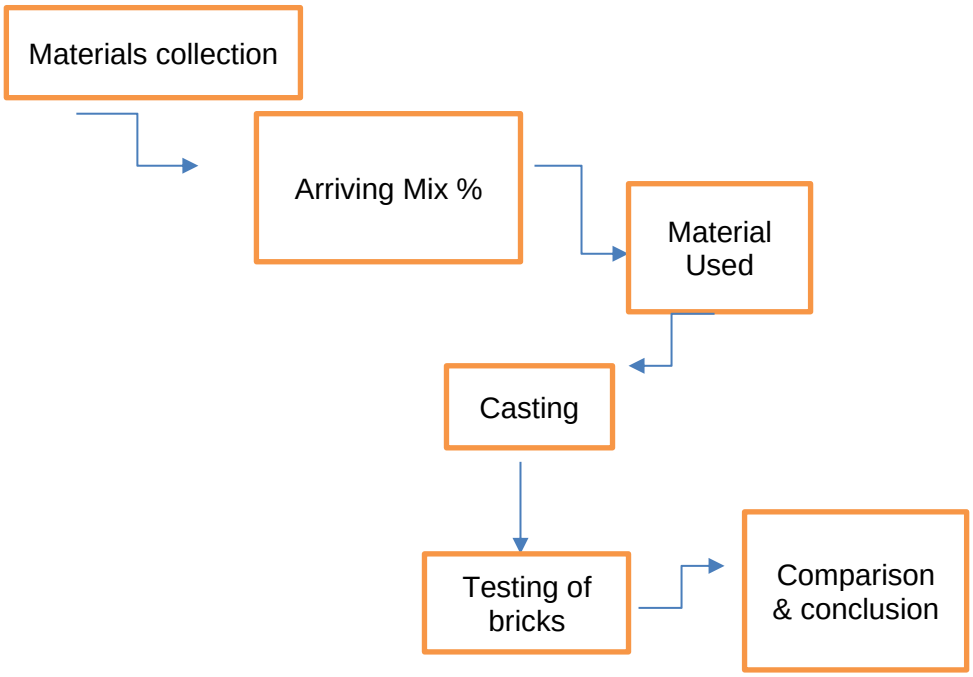


Fig.no. 3 Methodology

Experimental analysis

Procedure

The samples are prepared by adding different proportional materials.

Sampling of material

Representative samples of the materials of block for use in the particular construction work shall be obtained by careful sampling. Test samples of block shall be made of different proportion of materials on the site.

Proportions of block

Now, we are going make 7 samples of cement block with different proportions in below table.

	CEMENT	SAND	QUARRY FINES	WOOD POWDER
SAMPLE(1)	9.09%	90.91%	0%	0%
SAMPLE(2)	9.09%	60.91%	30%	0%
SAMPLE(3)	9.09%	50.91%	40%	0%
SAMPLE(4)	9.09%	40.91%	50%	0%
SAMPLE(5)	9.09%	60.91%	0%	30%
SAMPLE(6)	9.09%	50.91%	0%	40%
SAMPLE(7)	9.09%	40.91%	0%	50%

Table.no. 3 Proportions of block

Quantity of materials used

	CEMENT	SAND	QUARRY FINES	WOOD POWDER
SAMPLE(1)	0.3kg	0.9kg	0	0
SAMPLE(2)	0.3kg	0.63kg	0.2kg	0
SAMPLE(3)	0.3kg	0.54kg	0.32kg	0
SAMPLE(4)	0.3kg	0.45kg	0.42kg	0
SAMPLE(5)	0.3kg	0.63kg	0	0.5kg
SAMPLE(6)	0.3kg	0.54kg	0	0.6kg
SAMPLE(7)	0.3kg	0.45kg	0	0.7kg

Table.no.4 Materials used

Preparation of cement block

Cement blocks are a common construction material used in the building industry due to their durability, strength, and affordability.

The process of preparing cement blocks involves several steps, including selecting the raw materials, mixing, and molding, drying, and curing.

Fig.no.5 cement blocks

RESULTS AND DISCUSSION

TESTING OF SAMPLE

The following test has to be conducted.

(i) Compressive strength (2) Water absorption test

Compressive strength test of block

The blocks are dried in room temperature for 7 days, 14 days and 28 days in two replaced blocks. In this test three blocks in each set of mix are taken for testing. The surface of the blocks was cleaned properly with a cotton cloth to make an even contact. Each block is placed on the bearing plate of UTM machine. One of the important properties of concrete is its strength in compression. The strength in compression has a definite relationship with all other properties of concrete i.e. these properties improved with the improvement in compressive strength. A total of 7 blocks of size 22.5x10.5x7 cm were casted and tested for 7days, 14 days, 28 days testing. The concrete is prepared with definite proportion is poured in the mold and tempered properly so as not to have any void. Load is applied gradually at a uniform rate of 550kg/cm² per minute. The load is applied until the specimen fails. Note the reading and the average of three specimens gives the Dry compression strength of block in MPa.

The formula used for the calculation of Dry compression of the block = P/A in MPa.

Where,

P = Ultimate load at which the specimen fails in N. A = Loading area of the specimen in mm².

Size of the blocks = 22.5 x 10.5 x 7 cm
The values are given below for both, quarry fines and wood powder.

	7 DAYS	14 DAYS	28 DAYS
0%	6.1N/mm2	7.02N/mm2	7.76N/mm2
30%	5.2N/mm2	5.9N/mm2	7.52N/mm2
40%	5.1N/mm2	5.7N/mm2	6.3N/mm2
50%	4.9N/mm2	5.4N/mm2	5.95N/mm2

Table.no.5 Compressive strength for quarry fines

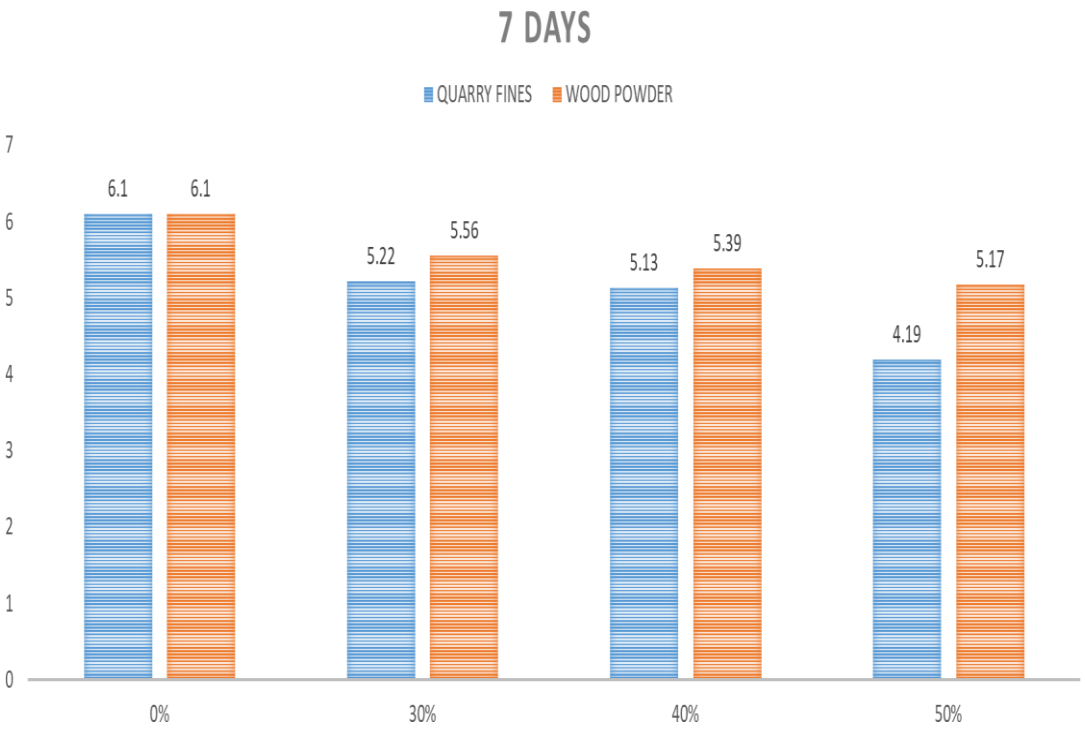
	7 DAYS	14 DAYS	28 DAYS
0%	6.1N/mm2	7.02N/mm2	7.76N/mm2
30%	5.56N/mm2	6.21N/mm2	6.84N/mm2
40%	5.39N/mm2	6.03N/mm2	6.52N/mm2
50%	5.17N/mm2	5.73N/mm2	6.24N/mm2

Table.no 6 Compressive strength for wood powder

Graph for Compressive strength- 7 days

The compressive strength of the cement blocks is taken in first session for after 7 days in drying in various percentage replacement of fine aggregates as 30%, 40% and 50% in both quarry fines and wood powders with comparison of the conventional blocks.

Size of the blocks = 22.5 x 10.5 x 7 cm



Replacement percentage of fine aggregates

Fig.no. 6 compressive strength graph for 7days

Water absorption test: Water absorption test on blocks are conducted to determine durability property of blocks such as block with water absorption of less than 7% provides better resistance to damage by freezing. The degree of compactness of blocks can be obtained by water absorption test, as water is absorbed by pores in blocks. The water absorption by blocks increase with increase in pores. So, the blocks, which have water absorption less than 3 percent can be called as vitrified. This test provides the percentage of water absorption of blocks. The average water absorption shall not be more than 20% by weight up to class 12.5 and 15% by weight for higher class.

The formula for the calculation of percentage of the absorbed water =

Wwet- Wdry/ Wdry x 100

The test is typically conducted by measuring the weight of the material before and after it is soaked in water for a specified amount of time. The difference in weight is used to calculate the water absorption of the material, which is expressed as a percentage of the original weight. A total of 7 blocks of size 22.5x10.5x7 cm were casted and tested for 7 days, 14 days, and 28 days testing.

Table.no. 7 water absorption for quarry fines

	7 days	14days	28 days
0%	14.38 %	15.24%	15.59%
30 %	15.61%	16.48%	16.79%
40%	17.47%	18.32%	18.56%
50%	19.71%	20.19%	21.56%

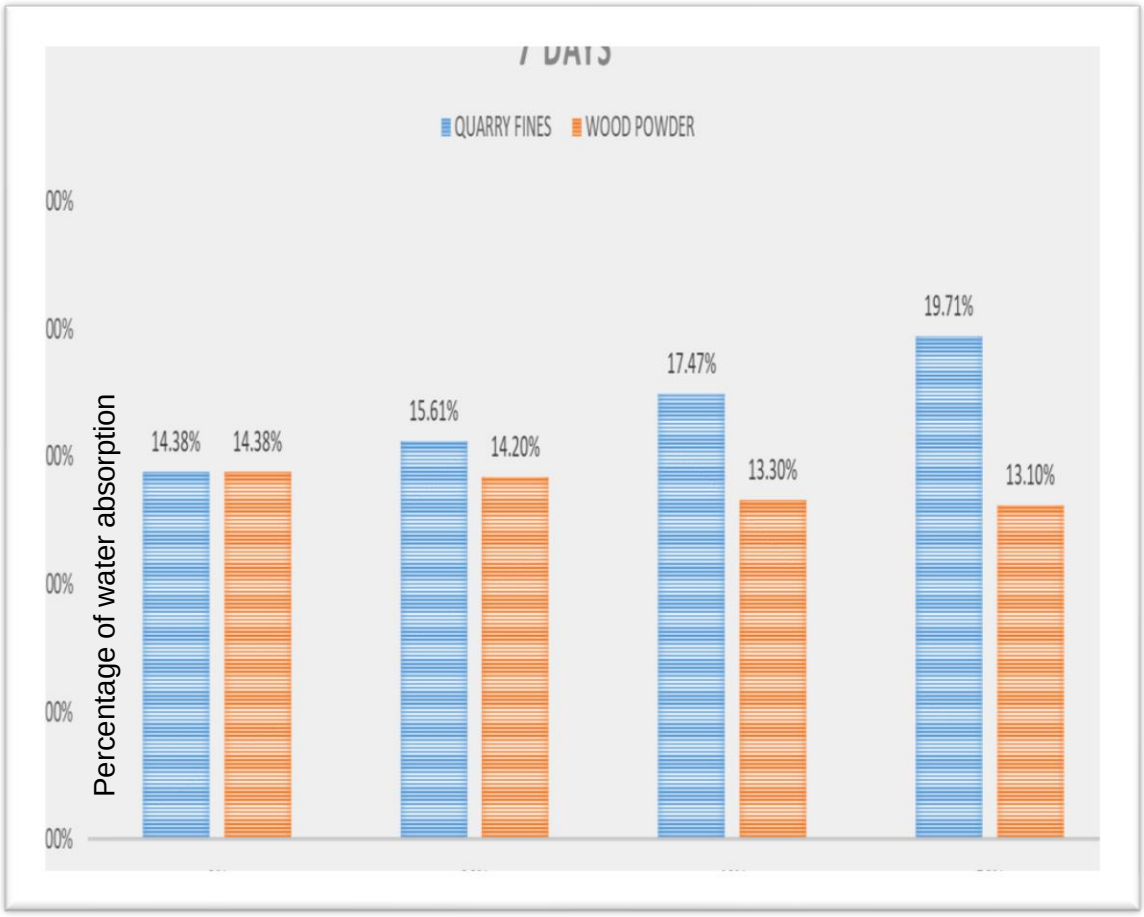
	7 days	14 days	28days
0%	14.38%	15.24%	15.59%
30%	14.26%	16.20%	17.50%
40%	13.76%	14.7%	16.50%
50%	13.1%	14.20%	15.9%

Table.no.8 water absorption for wood powders

Graph for water absorption test- 7 days

The water absorption test of the cement blocks is taken in first session for after 7 days in drying in various percentage replacement of fine aggregates as 30%, 40% and 50% in both quarry fines and wood powders with comparison of the conventional blocks.

Size of the blocks = 22.5 x 10.5 x 7 cm



Replacement percentage of fine aggregates 7 days

Fig.no . 7 Water absorption test graph for

Cost Analysis

Commercial block

Cement used in one brick is 0.3 kg which price is 3 rupees Sand used in brick is 0.9 kg which price is 10.6 rupees' Total amount is 13.6 rupees + Labor cost.

Quarry fines replaced blocks

Cement used in one brick is 0.3 kg which price is 3 rupees in 30%,

Sand used in brick is 0.63 kg which price is 9.2 rupees

Quarry fines used in brick is 0.2 kg which price is 0.16 rupees

= 3 (cement) + 9.2 (sand) + 0.16 (quarry fines) = 12.36 + Labor cost

In 40%, Sand used in brick is 0.54 kg which price is 6.3 rupees
Quarry fines used in brick is 0.32 which price is 0.26 rupees

= 3 (cement) + 6.3 (sand) + 0.26 (quarry fines) = 9.56 rupees + Labor cost

6.4.2Wood powder replaced blocks

Cement used in one brick is 0.3 kg which price is 3 rupees

In 30%, Sand used in brick is 0.63 kg which price is 9.2 rupees

Wood powder used in brick is 0.5 kg which price is 1 rupee

= 3 (cement) + 9.2 (sand) + 2 (wood powder) = 13.2 + Labor cost

In 40%, Sand used in brick is 0.54 kg which price is 6.3 rupees
Wood powder used in brick is 0.6 which price is 1.4 rupees

= 3 (cement) + 6.3 (sand) + 0.6 (quarry fines) = 10.7 rupees + Labor cost.

CONCLUSION

Both wood powder and quarry fines can be used as partial replacements for fine aggregates in cement blocks.

- Up to 40% replacement of fine aggregates with wood powder can be made without significantly compromising the compressive strength of the cement blocks, while up to 30% replacement of fine aggregates with quarry fines is possible.
- The cost savings are particularly significant when using wood powder or quarry fines as a replacement for a higher percentage of fine aggregates, such as 40%.
- The optimal replacement percentage for wood powder and quarry fines appears to be around 30-40%, as higher percentages can result in reduced strength and increased water absorption.
- Despite the cost savings, it is important to consider other factors such as strength and water absorption when deciding on the optimal percentage of replacement for wood powder or quarry fines.

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