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Research Article

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Experimental investigation on partial replacement of cement with brick powder and fine aggregate with saw dust in concrete

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Keywords

Brick Powder, Saw dust, Compressive Strength and Tensile strength.

Abstract

With increase in industrialization in a developing country like India cost is an important area of concern for the modern day construction. The recent study has shown us that amount of saw dust waste produced in our country is around 30000-33000 tons annually. This study focuses on the experimental investigation of using saw-dust as a partial replacement of Fine Aggregate in the properties of concrete mix. Saw dust also known as wood dust is a by-product or waste product of wood working operations such as sawing, milling, planing, routing, drilling and sanding. The purpose of this thesis is to investigate how brick powder as a replacement the cement and saw dust replace the fine aggregate. Specially, it is aim to examine the impact of brick powder content in concrete and to compare it with the compressive and tensile strength of M30 grade concrete. We are also trying to find the percentage of brick powder in concrete that makes the strength of the concrete maximum. Nowadays brick powder has become a waste material. So, by partially replacement of cement with brick powder and fine aggregate with saw dust, we are proposing a method that can be of great use in reducing waste materials to a great extent.

Introduction

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens (cures) over time. In the past, lime based cement binders, such as lime putty, were often used but sometimes with other hydraulic cements, such as calcium aluminates cement or with Portland cement to form Portland cement concrete. When aggregate is mixed with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses.

This Use of brick powder or surkhi has been used as pozzolana in India for many years. This material is used as a partial replacement of cement to produce mortar or concrete, which results in improved concrete properties which include reduction of permeability and resistance to sulphate attack and alkali-aggregate reaction. It has been used in Europe since ancient times, where powdered brick was mixed with hydrated lime to produce mortars. There are many examples across Europe of Roman buildings bearing the fact that these mortars have been used since long time in past and hence, the fact that these materials are durable is proved. So potential use for ground brick powder is possible, not only for repair of important historic buildings where compatibility of materials is important, but this can also be used for the production of durable and impermeable concrete or mortars. The pozzolanicity of brick powder depends upon the burning or calcining temperature of clay. The most reactive state of clay is when the burning temperature results in loss of hydroxyl and a collapsed and distorted clay structure, the burning temperature to produce this active state is usually in the range of 600-900°C.

Objectives:

The following parameters are proposed to be investigated:

- Brick powder as a replacement of cement & saw dust as replacement of fine aggregate.
- To study the effect of brick powder on the properties of concrete.
- To study the effect of sawdust on the properties of concrete.
- To find compressive strength, and flexure test after 7days 14 days, and 28 days, and check as per I.S code

Literature Review

Dr. Suji. D, Narayanan. A.M, et al (June 2016), "Experimental Study on Partial Replacement of Fine Aggregates with Quarry dust and Sawdust". In this study the effect of quarry dust and sawdust, by adding quarry dust of0%,10%,20%,30% and 40%. And sawdust of0%,5%,10%,15% and 20% with fine aggregate, a matured fine aggregate has prepared.

K. Gopinath, K. Anuratha (August 2015). "Utilization of Sawdust in Cement mortar and Cement Concrete". In this study as the percentage sawdust increase the density is found to decrease. Wastage of sawdust is minimized and recycled for construction work.

Shoab Hussain, Savinth Kumar (May 2017). "Experimental Study on Partial replacement of fineaggregate with Sawdust and Quarry dust. In this study the effect of quarry dust and sawdust, by adding 10%,15% and20% with the fine aggregate, a matured fine aggregate has prepared.

Vignesh B, Lingaraju D (Dec 2016). "Experimental study on partial replacement of quarry dust and saw dust in fine aggregate". In this research was experimentally carried out to investigate properties of both sawdust and quarry dust when used as partial replacement in brick.

C. Marthong is published a paper on The possibility of using Sawdust Ash (SDA) as a construction material was experimentally investigated. Saw dust was burnt and the ash sieved using a 90 micron sieve. Three grades of

ordinary Portland cement (OPC) namely; 33, 43 and 53 as classified by Bureau of Indian Standard (BIS) are commonly used in construction industry. A comparative study on effects of concrete properties when OPC of varying grades was partially replaced by SDA is discussed in this paper. Percentage replacement of OPC with SDA was 0, 10, 20, 30 and 40% respectively. Experimental investigations are carried out on mortar cubes, concrete cubes and beams specimens. The mix was designed for target cube strength of 30 MPa at 28 days with water-cement ratio of 0.38. The compressive strength, water absorption, shrinkage and durability of concrete were mainly studied. Test results shows that, inclusion of SDA cause little expansion due to low calcium content. Early strength development was observed to be about 50-60% of their 28 days strength. The study suggests the use of SDA as partial replacement of cement up to a maximum of 10% by volume in all grades of cement.

Properties of Cement

Physical properties	
Specific gravity	3.15
Chemical properties	
Calcium chloride	63.6%
Silicon dioxide	20.3%
Aluminium oxide	6.3%
Iron oxide	3.12%
Magnesium oxide	1.6%
Sodium oxide	0.4%
Potassium oxide	0.51%
Loss of ignition	1.13%

Coarse aggregate

Decorative stones such as quartzite, small river stones or crushed glass are sometimes added to the surface of concrete for a decorative "exposed aggregate" finish, popular among landscape

Experimental Study

Materials and Methods

Cement

Portland cement is hydraulic cement that is made by finely beating the clinker created by calcining to nascent combination a blend of calcareous and argillaceous materials. This is fine grey powder, which is the essential elements of concrete; consequently the name is cementing concrete. In contact under air or water, when the cement goes through a synthetic response with the water and the cement sets. Normal crude materials used to make bond are limestone ($CaCO_3$), stale mud (SiO_2, Al_2O_3, $Fe_{e2}O_3$), and iron mineral (Fe_2O_3). Along these lines the synthetic parts of concrete are calcium (Ca), silicon (Si), aluminum (Al), and iron (Fe). Calcareous part, lime (CaO), limestone, chalk, marble and so forth. Argillaceous fixing (SiO_2, Al_2O_3, Fe_2O_3), is got from mud and shale. Cement selected for current study is Ordinary Portland Cement of 43 grades. Properties of cement have been tested in accordance with Indian Standard (IS8112- 1989).

Cement

designers. Aggregates which cannot pass through 4.75 mm sieve are recognized as coarse aggregates. They are obtained by natural breakdown or by non-natural crushing of rocks. 80 mm can be the utmost size of aggregate. In this study, 20mm size of coarse aggregates confirming to zone III are used as per IS 383-1970.

Properties of coarse aggregate

Sr.No.	Characteristics	Value
1.	Color	Grey
2.	Size	20mm
3.	Shape	Angular
4.	Specific gravity	2.74

Fine aggregate

The sand used for the experimental program was procured and the grading was consistent with zone III. To remove any particles greater than 4.75 mm, the sand was first taken out of the 4.75 mm sieve and was washed to remove the dust. Indian standard specifications have been tested against penalty consolidation IS: 383-1970.

Physical Properties of Fine Aggregate

S. No.	Characteristics	Values
1	Type	Natural
2	Specific gravity	2.72
3	Water absorption	1%
4	Fineness modulus	2.22
5	Grading	III

Water

In this project potable water free from organic substance was used for mixing as well as curing of concrete. Combining water with a cementitious material forms a cement paste by the process of hydration. As stated by Abrams' law, a lower water-to-cement ratio yields a stronger, more durable concrete, whereas more water gives a freer-flowing concrete with a higher slump. Hydration involves many different reactions, often occurring at the same time. As the reactions proceed, the products of the cement hydration process gradually bond together the individual sand and gravel particles and other components of the concrete to form a solid mass.

Chemical chemist notation $C_3S + H \rightarrow C\text{-}S\text{-}H + CH$

Standard notation: $Ca_3SiO_5 + H_2O \rightarrow (CaO)\cdot(SiO_2)\cdot(H_2O)(gel) + Ca(OH)_2$

Balanced: $2Ca_3SiO_5 + 7H_2O \rightarrow 3(CaO)\cdot 2(SiO_2)\cdot 4(H_2O)(gel) + 3Ca(OH)_2$

(Approximately; the exact ratios of the CaO, SiO_2 and H_2O in C-S-H can vary)

Brick powder

About 1-5% of waste bricks are generally produced in all brick companies, which add to quantity of waste materials considerably. This varies from 50,000 tons for a large scale company to 100 tons for a small scale company. Recycling of these waste bricks is one of the most challenging problems worldwide with the extraordinary growth of the world population. The waste from these companies is crushed and sold as low grade aggregate at prices varying between Rupees 129 to 430 Rupees per ton. Although this is a much lower cost than cement (4300 Rupees per ton) however there will be added cost of crushing if this is to be used as cement replacement. It is the waste material produced from brick kilns which is of no use adds to the waste to environment, which is to be landfilled.

Brick powder

Saw dust

Sawdust is obtained from wood. The saw dust consist of chippings from various hardwoods. It was sundried and kept in waterproof bags .The sawdust is sieved through 1.18 mm.

Chemical characteristics of saw dust

Sr.No.	Constituents	Percentage (By weight)
1.	SiO_2	87
2.	Al_2O_3	2.5
3.	Fe_2O_3	2.0
4.	MgO	0.24

Concrete mixes

Mix design for M30 grade of concrete was carried out using the guidelines prescribed by IS: 10262-1982. The concrete mix for M30 served as basic control mix (CM). The cube combinations of various percentages are as follows:

C0: Cube with 0% brick powder as a partial replacement of cement and 0% saw dust as a partial replacement of fine aggregate.
C1: Cube with 5% brick powder as a partial replacement of cement and 0% saw dust as a partial replacement of fine aggregate
C2: Cube with 0% brick powder as a partial replacement of cement and 5% saw dust as a partial replacement of fine aggregate
C3: Cube with 5% brick powder as a partial replacement of cement and 5% saw dust as a partial replacement of fine aggregate
C4: Cube with 10% brick powder as a partial replacement of cement and 0% saw dust as a partial replacement of fine aggregate
C5: Cube with 0% brick powder as a partial replacement of cement and 10% saw dust as a partial replacement of fine aggregate
C6: Cube with 10% brick powder as a partial replacement of cement and 10% saw dust as a partial replacement of fine aggregate
C7: Cube with 10% brick powder as a partial replacement of cement and 5% saw dust as a partial replacement of fine aggregate
C8: Cube with 5% brick powder as a partial replacement of cement and 10% saw dust as a partial replacement of fine aggregate.

Batching, mixing, and curing:-

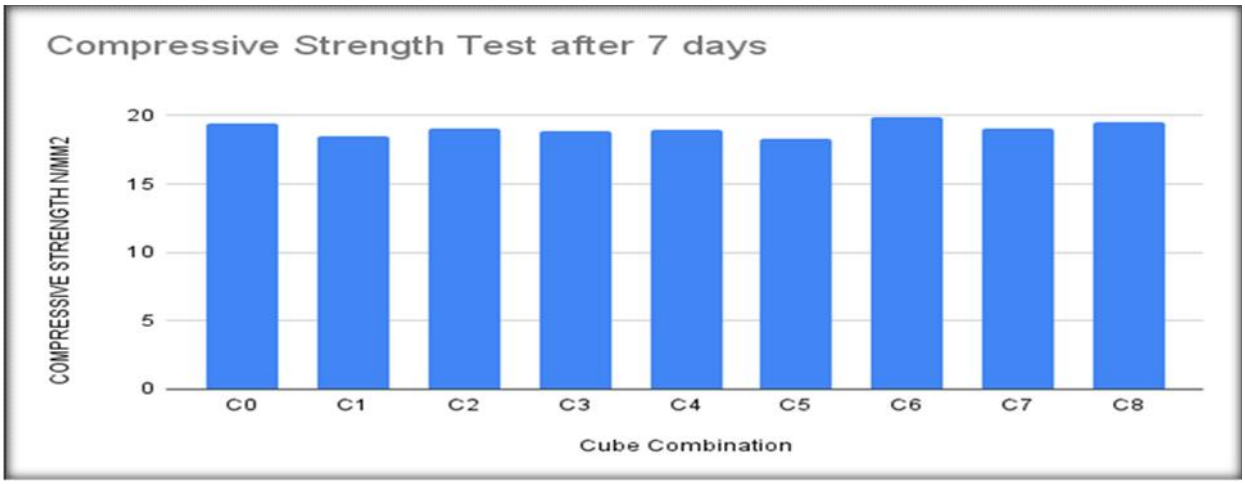
The concrete ingredients viz. cement, sand and coarse aggregate were weighed according to M30 and are dry mixed on a platform. To this the calculated quantity of brick powder and saw dust was added and dry mixed thoroughly. The required quantity of water was added to the dry mix and homogenously mixed. The homogeneous concrete mix was placed layer by layer in moulds kept on the vibrating table. The specimens are given the required compaction both manually and through table vibrator. After through compaction the specimens were finished smooth. After 24 hours of casting, the specimens were demoded and transferred to curing tank wherein they were immersed in water for the desired period of curing.

Results and Discussion

The compressive strength of casted cube after 7 days, 14 days and 28 days are as follows:

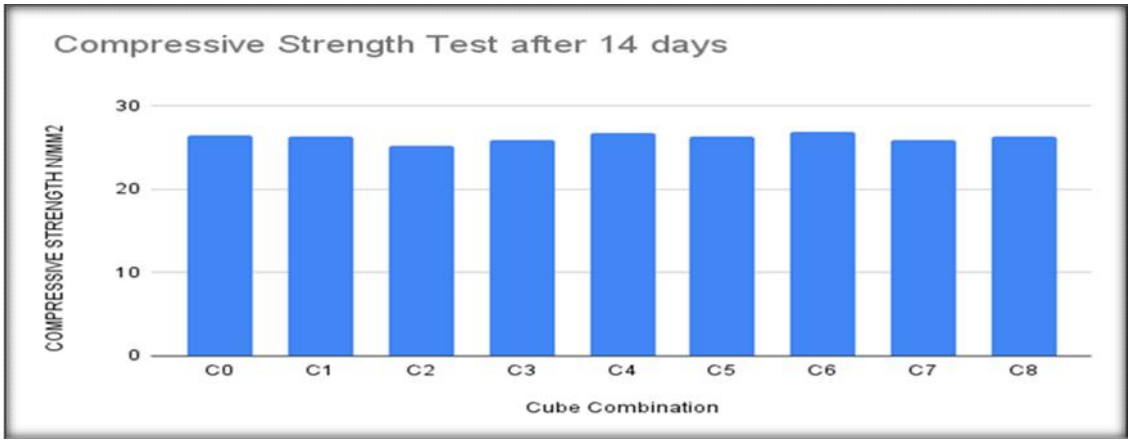
Compressive Strength Test after 7 days

S.No	Sample	Brick powder	Saw dust	Compressive strength n/mm^2	Average compressive strength n/mm^2
1: C0	1 2 3	0%	0%	19.60 19.90 18.90	19.46
2: C1	1 2 3	5%	0%	18.30 18.60 18.40	18.5
3: C2	1 2 3	0%	5%	18.90 19.20 19.20	19.10
4:C3	1 2 3	5%	5%	18.50 18.20 18.80	18.9
5:C4	1 2 3	10%	0%	18.90 18.95 19.00	18.95
6:C5	1 2 3	0%	10%	18.20 18.40 18.30	18.3
7:C6	1 2 3	10%	10%	19.80 20.00 19.90	19.9
8:C7	1 2 3	10%	5%	19.00 19.20 19.10	19.1
9:C8	1 2 3	5%	10%	19.50 19.60 19.40	19.5



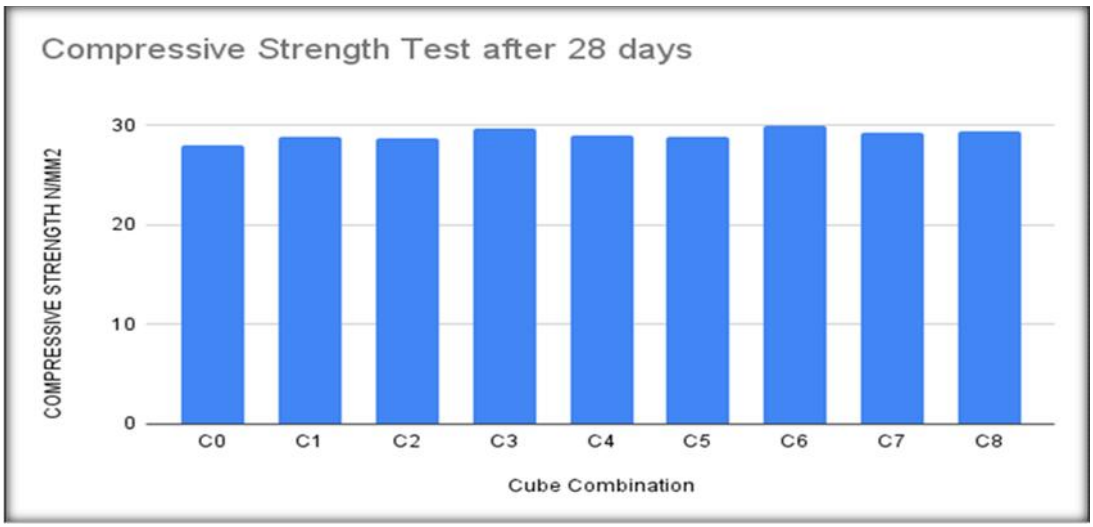
Compressive Strength Test after 14 days

S.No	Sample	Brick powder	Saw dust	Compressive strength n/mm^2	Average compressive strength n/mm^2
1: C0	1 2 3	0%	0%	26.30 26.70 26.50	26.50
2: C1	1 2 3	5%	0%	26.10 26.40 26.70	26.40
3: C2	1 2 3	0%	5%	25.60 25.30 25.00	25.30
4:C3	1 2 3	5%	5%	25.80 26.00 25.90	25.90
5:C4	1 2 3	10%	0%	26.40 27.00 27.00	26.80
6:C5	1 2 3	0%	10%	26.00 26.80 26.40	26.40
7:C6	1 2 3	10%	10%	26.75 26.95 26.85	26.85
8:C7	1 2 3	10%	5%	25.80 26.00 26.90	25.90
9:C8	1 2 3	5%	10%	26.50 26.30 26.10	26.30



Compressive Strength Test after 28 days

S.N0	Sample	Brick powder	Saw dust	Compressive strength n/mm^2	Average compressive strength n/mm^2
1: C0	1 2 3	0%	0%	27.90 28.00 28.10	28.00
2: C1	1 2 3	5%	0%	29.00 28.90 28.80	28.90
3: C2	1 2 3	0%	5%	28.50 28.90 28.70	28.70
4:C3	1 2 3	5%	5%	29.60 29.00 29.60	29.70
5:C4	1 2 3	10%	0%	29.10 28.90 29.00	29.00
6:C5	1 2 3	0%	10%	28.90 28.70 29.10	28.90
7:C6	1 2 3	10%	10%	30.00 29.95 29.90	29.95
8:C7	1 2 3	10%	5%	29.50 29.10 29.30	29.30
9:C8	1 2 3	5%	10%	29.50 29.30 29.40	29.40



It was observed that the average compressive strength of concrete was 26.85 MPa and 29.95MPa with the replacement of 10% Brick Powder and 10% Saw Dust which shows that 1.32 % and 6.96 % increase in the compressive strength at 14 and 28 days respectively.

Conclusion

This conclusion deals with the presentation of results obtained from various tested conducted on material used for developing concrete. In order to achieve the objectives of present study, an experimental program was planned to investigate the effect of brick powder and saw dust on compressive strength of concrete at 7 days, 14 days and 28 days respectively. The experimental program consists of casting, curing and testing of controlled and brick powder and saw dust concrete specimen at different ages. Following conclusions were obtained.

- The compressive strength of concrete made by partial replacement of cement with brick powder and partial replacement of fine aggregate with saw dust is increased by sufficient amount.
- Compressive strength increased at 6.96 % artial replacement of cement with brick powder and partial replacement of fine aggregate with saw dust.
- After the curing of the concrete, it was found that the concrete got a reddish colour which increased the aesthetical view of the concrete.

The experimental results have shown that the use of brick powder obtained from the demolished buildings in the replacement of cement and use of saw dust in concrete can provide an alternative solution to minimize the environmental pollution due to unscientific disposal of these wastes. So the replacement of cement with brick powder and saw dust in concrete is really advisable.

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