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Experimental study on fresh and hardened properties of concrete by incorporating fly ash, metakaolin and brick powder by partial replacement of cement for M40 grade concrete

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ABSTRACT

The present dissertation is on replacement of fine aggregate, as metakaolin, brick powder & fly ash, in this present construction concrete world the natural resources are undergoing to depletion and wastage of various materials are increased day by day. The construction growth also increased due to the heavy population .in this present manuscript the various materials are used as fine aggregate and check the concrete characteristics at various curing periods and know the behavior of the concrete. In this present study deals with the strength properties of concrete by using flyash,metakaolin& brick powder as partial supplements for fine aggregate at 0,5,10,15,20 at various curing periods 7,28,56 days. The use of materials in cement concrete a) Materials will modify properties of the concrete b) Control the concrete production cost c) To overcome the scarcity of fine aggregated) clever usage of waste materials

Keywords: *Flyash, Metakaolin, Brick powder, Replacement*

1. INTRODUCTION

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent characteristics and advantages either when green or hardened. The use of reinforcement in concrete has brought a revolution in applications, design and construction techniques. Its great versatility and relative economy in filling a wide range of needs have made it a very competitive building material.The most important pozzolonic materials are fly ash, and metakaolin, brick powder whose use in cement and concrete is thus likely to be a significant achievement in the development of concrete technology in coming few decades.

So, we have to search for different materials to reduce the quantity of basic natural materials in the concrete mix without changing any mix design procedure and considerations. We cannot replace the whole basic material in the concrete, but to some extent, we can replace with other materials. There are some research were done on waste materials which are very near to our surroundings like , Stone dust, over burnt bricks, M – sand, brick powder, coconut shells, waste tyres, slag, fly ash produced from industries, broken glass pieces, rich husk ash, coconut shell ash, etc. to use them in concrete mix along with basic natural aggregates. In their methodologies, some of the above materials were used to replace the cement and some of the materials used to replace the aggregate. In those researchers observed that these materials can be used to some extent percentages. In these experimental studies, by testing the concrete samples with0% 5%, 10%, 15%,20% etc., replacement of basic material with waste material, estimated the optimum percentages of wasted materials can use in the concrete mix. But there are some problems faced with these materials like the improper mix with other materials, lack of bonding in concrete due to a smooth surface, for some materials there is a strength decrement when compared to the conventional mix due to less toughness when compared to the basic aggregates etc. These are the main drawbacks when using other materials as an aggregate in the concrete mix. When mixing the concrete, observed that there is an improper bonding of plastic materials with cement and other aggregates in the concrete mix. This problem was faced because plastic material having a smooth surface and lack of angularity in them. And when compressive strength test conducted after 7,28.56 days curing period on these cube sample, observed that there is a decrement in compressive strength when compared to the conventional mix.

2. OBJECTIVES

The objectives of this study are as follows:
a) To investigate the best mix proportion of the partial replacement for fine aggregate in concrete cement in concrete.
b) To investigate the feasibility of the partial replacement of above material in concrete by determining the destructive and non-destructive tests.

c) Based on the test results, to suggest a most approximate level of adding brick powder& fly ash, metakaolin.

3. SCOPE OF THE STUDY

The scope of the study is to establish to achieve the objectives and this study will be mainly concentrated on experimental works. Experiments regarding compression strength and split tensile strength on the partial replacement brick powder, metakaolin,flyash in concrete will be carried out in order to study the behavior of concrete. All testing methods and procedure are specified according to Indian Standards.

4.LITERATURE REVIEW

Praveen Kumar.M shows that the Experiment is explained that the brick powder and fly ash is replaced 10%,20% and 30% by cement in concrete in addition with 5%,10%,15% of the weight of cement. The brick powerreplacement is sufficient enough for getting higher strength. The flexural strength of concrete increases with the addition of powder. The Split tensile strength of the powder concrete decrease with theaddition of brick powder.

Olanitori LMet.al., (2015) Shows that the experiment is explained that using a mix design ratio of 1:2:4 and water binder ratio of0.63 concrete cubes were cast using varying Ordinary Portland Cement: Palm Kernel shell, fly ash & Ordinary Portland cement: coconut shell ash ratios of 100:0, 90:10, 80:20, 70:30, 60:40, & 50:50 respectively. Reducing the production cost and the environmental pollution caused by the dumping of the agricultural waste.

Nekel and netaa et.al., (2015) Explained that the experiment is explained that the replacing the cement by fly ash and bricks 5%, 10%, 15% and Fine aggregate by Rubber (CR) 2.5%, 5%, 7.5%&10%. The compressive strength of concrete decreased withincrease in varying percentage of Crumb rubber Result of Replacing cement by 5% brick powder in 10% Crumb Rubberreplaced concrete shows increase in both flexural and split tensile strength.

Sukaa ,Nikka , Mull K, et.al., (2014) Explained that the experiment is explained that the cement is partially replaced with brick powder as 5%, 10%, 15%, 20%, 25%,30% by weight of cement. specified in their research journal the combined replacements are very useful in the present era of construction .the waste materials are very badly cumulated on earth these used as replacements for concrete fine aggregates.

Amarnath Yerramala et.al. (2014) studied the Properties of concrete with eggshell powder as cement replacement. This paper describes research into the use of poultry waste in concrete through the development of concrete This literature review deals with related to studies on Blended Concrete and Effects and performance of concrete with mix with the fly ash brickpowder,& metakaolin

During the yearago, hardly anybody in India was aware of the use of metakaolin, flyash and brick powder in concrete. The developments that have taken place and increased awareness of production of metakaolin in the country, the replacement materials are very rarely used start of indigenous commercial production and many investigations on the development of concrete mixes containing metakaolin.

Metakaolin &fly ash: The uses of using metakaolin or fly ash separately in concrete as a partial replacement for Portland cement are fairly well-established, especially for fly ash. However, because the cost of metakaolin is about 4-5 times the cost of ordinary Portland cement, thus using metakaolin is a supplementary cementitious material (SCM) may not be cost-effective. On the other hand, the slow reaction rate of fly ash can make its use impractical when rapid early strength development is required.

The Effect Of Metakaolin improving The Concrete Compressive Strength This paper shows the performance of metakaolin (MK) on compressive strength and durability of concrete. t can decrease permeability, increase tensile strength, and concrete durability.

M.Sree and et al the increment of metakaolin increase the properties of concrete at various percentages with combination cement and fine aggregate (2001 & 2009).

Stuart & hog (2016) specified in their research journal the combined replacements are very useful in the present era of construction. The waste materials are very badly cumulated on earth these used as replacements for concrete fine aggregates,**Robert,andmullack** in the experimental studies so that the split tensile strength results in very satisfactory .the compressive strength at various days 56 the results giving very good and very less at 30 % replacements .so the fine aggregate content and water-cement ratio are the major reasons.

5. REPLACEMENT MATERIALS

5.1 Flyash powder:

Fly ash, a principal by-product of the coal-fired power plants, is well accepted as a pozzolonic material that may be used either as a component of blended Portland cement or as a mineral admixture in concrete.

Advantages of Using Fly Ash

1. Fly ash generally can make more workable and can improve finishing.
2. Fly ash can reduce the heat of hydration and delay setting times reducing thermal stresses in early age concrete.
3. Fly ash can increase the ultimate strength of concrete.
4. Fly ash can make concrete more durable, particularly to mitigate ASR and sulphate attack.

5. Fly ash reduces the CO2.
6. Using Fly ash in concrete reduces disposal problems and also underground contamination.

5.2 Metakaolin

Metakaolin is that one of the innovative clay products developed in recent years. it's made by controlled thermal treatment of kaolin.Metakaolinis often used as concrete constituent, substitution a part of the cement content since it's pozzolanic properties. the utilization of Metakaolin as a partial replacement material in mortar and concrete has been studied wide in recent years. The study is required to see the contribution of Metakaolin (MK) to the performance of hardened concrete. There are great considerations on the strength and durability of Metakaolin-concrete once used as construction materials within the construction industries. If it's established that the concrete is durable and powerful, this can result in the use of Metakaolin to exchange a part of the cement.

Advantages of Using Metakaolin

1. Increased compressive and flexural strengths
2. Increased resistance to chemical attack
3. Reduced permeability
4. Reduced effects of alkali-silica reactivity (ASR)
5. Improved finish ability, color,and appearance

5.3 Waste Brick Powder

Bricks are a wide used construction and building material around the world. In developing countries, bricks are still one amongst the most common construction materials. India is that the second largest producer of fired clay bricks when China. Bricks are a wide used construction and building material around the world. The waste brick utilized in the current. The waste brick powder is used as a cement substitute.

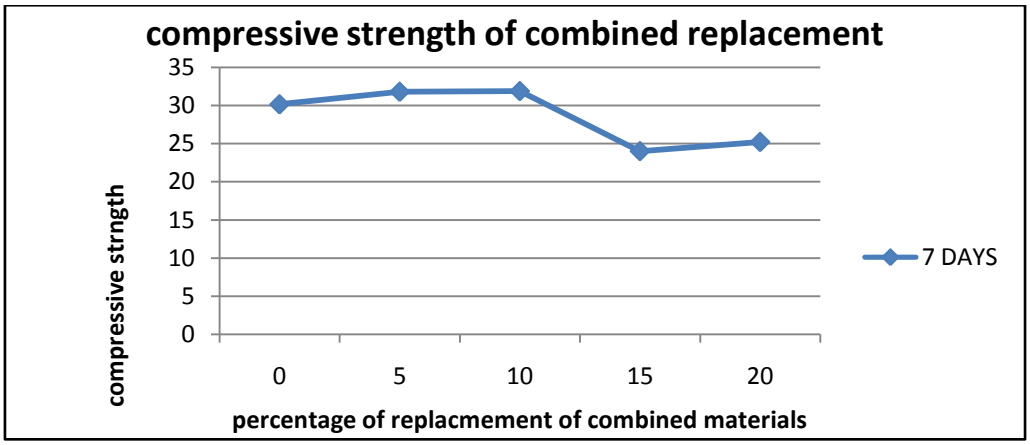
5.4 Concrete Mix Design

Concrete Mix Design of grade M 40has been done as per of the recommended guidelines of IS: 10262-2009. The weight ratio of mix proportion is **1:1.89:3.29** keeping water-cementitious ratio as 0.38.

5.5 Compressive strength results

Table 1: Percentage of Metakaolin + Flyash + Brick powder for 7 days

% of Metakaolin + Flyash + Brick powder			7DAYS
0 %	0 %	0 %	30.15
5%	5%	5%	31.80
10%	10%	10%	31.89
15%	15%	15%	24.00
20%	20%	20%	25.21



Graph 1: Compressive strength of combined replacement

Table 2: Percentage of Metakaolin + Flyash + Brick powder for 28 days

% of Metakaolin + Flyash + Brick powder			28 Days
0 %	0 %	0 %	48.00
5%	5%	5%	49.3
10%	10%	10%	49.32
15%	15%	15%	42.85
20%	20%	20%	41.00

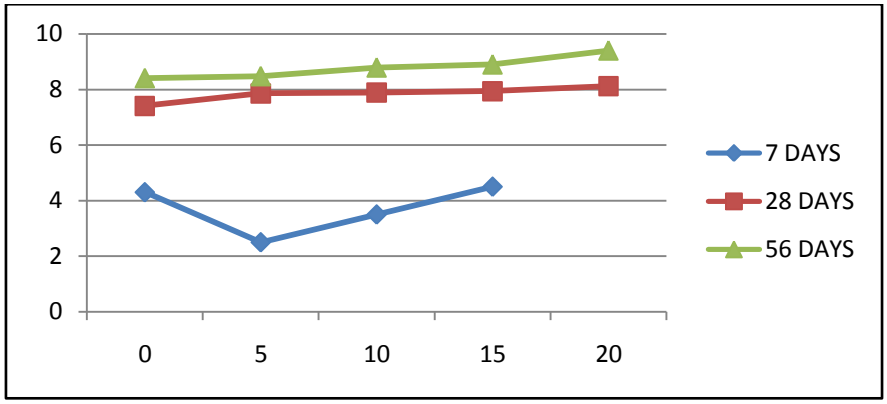
5.6 Split tensile strength results:

Table 3: Percentage of Metakaolin + Flyash + Brick powder for 7 days

% ofMetakaolin + Flyash + Brick powder			7 Days
0 %	0 %	0 %	4.91
5%	5%	5%	5.46
10%	10%	10%	5.84
15%	15%	15%	5.98
20%	20%	20%	6.13

Table 4: Percentage of Metakaolin + Flyash + Brick powder for 28 days

% of Metakaolin + Flyash + Brick powder			28 Days
0 %	0 %	0 %	7.41
5%	5%	5%	7.86
10%	10%	10%	7.89
15%	15%	15%	7.94
20%	20%	20%	8.12



5.7 Ultrasonic pulse velocity test:

Table 5: Percentage of Metakaolin

S No.	% Metakaolin	Obtained average velocity(m/s)	Quality of Concrete
1	0	4512	EXCELLENT
2	5	4523	EXCELLENT
3	10	4531	EXCELLENT
4	15	4600	EXCELLENT
5	20	4521	EXCELLENT

Table 6: Percentage of fly ash

S No.	% Of fly ash	Obtained average velocity(m/s)	Quality of Concrete
1	0	4524	EXCELLENT
2	5	4532	EXCELLENT
3	10	4590	EXCELLENT
4	15	4621	EXCELLENT
5	20	4444	GOOD

Table 7: Percentage of brick powder

S No.	% of brick powder	Obtained average velocity(m/s)	Quality of Concrete
1	0	4234	Good
2	5	4590	EXCELLENT
3	10	4627	EXCELLENT
4	15	4676	EXCELLENT
5	20	4578	EXCELLENT

Table 8: Percentage of Metakaolin + Flyash + Brick powder

S No.	% OF Metakaolin + Flyash + Brick powder	Obtained average velocity(m/s)	Quality of Concrete
1	0	4570	Excellent
2	5	4579	Excellent
3	10	4794	Excellent
4	15	4798	Excellent
5	20	4800	Excellent

6. DISCUSSIONS

1. Metakaolin and flyash are the effective replacements and results in enhanced early strength and ultimate strength of concrete.
2. The compressive strength of hardened concrete, i.e., 7, 28 days is improved by blending the OPC with 10%, 15 %, of metakaolin,flyash, brick powder by weight.
3. The 10% replacement with metakaolin is the most optimum replacement, enhancing the concrete's compressive strength at all ages.
4. The 28-days compressive strength of concrete was improved by partial replacements of OPC by metakaolin in the range up to 10% by weight and was at the 20% level still maintained. The highest 28-days strength improvement of concrete can be expected at partial replacements in the 10-15% range.
5. The combined use of metakaolin and a super plasticizer allowed increasing the aforementioned partial replacement levels, i.e. to 10 %, 15 % in the case of maintaining strength.
6. Ternary blending by Metakaolin in combination with Fly Ash, & brick powder was found leading to further technical improvements to concrete strength.
7. Fly ash is a low-cost material which is useful to cast concrete slabs and further when combined with the ternary blends.
8. The split tensile strength results are also satisfactory when replacements of MATERIALS (M,F,& BP).
9. The non-destructive test also gives the optimum results when tested.
10. The overall performance of the concrete is very good with three replacements.
11. The only disadvantage is three partial supplements for fine aggregate.

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