PARAMETRIC STUDY ON ECO-FRIENDLY CEMENT MORTAR USING CARBON BLACK POWDER

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Abstract: In any construction brick masonry is very much of used to make a walling units and in that cement mortar is one of the important ingredients it makes up as little as 7% of total volume of brick masonry. Brick masonry also prevent moisture and air penetration so in short cement mortar is very much of use in brick masonry so if change certain amount of cement with any other material which is less in cost than cement. The other material reduces the danger to the environment so it is essential to check that how much amount of cement is replaced by various materials. In India carbon black powder are generated from the different rubber industries. This waste, causing major environmental problem due to their disposal. The goal of this study is to replace the cement by carbon black powder to reduce the waste. In this study the different proportion of carbon black powder replaced with cement is 0%, 5%, 10%, 15%, 20%, 25% and 30% by weight. The compressive strength test carried out at 7, 14 and 28 days and water absorption test is carried out in 28 days. As a result, this investigation work is done on mortar for optimum proportion of the partial replacement of cement by carbon black powder.

Keywords **- Carbon Black Powder, Cement Mortar, Eco-friendly, Compressive Strength, Water Absorption, cost**

I.INTRODUCTION

Building mortars are blends utilized for the jointing of blocks, stones, squares, and so on. Mortar might be characterized as a glue acquired by adding water to a blend of fine totals, for example, sand and restricting material, e.g., Earth, gypsum, lime or bond or their mixes. The pyramids of Egypt have been worked with mud gypsum, gypsum-lime and lime mortars. Indians have utilized lime mortar for amazing structures, for example, Tajmahal and fortifications. In the years that took over, it was found that consuming limestone with clayey substance created pressure driven line of high water-safe properties. Lime with a still higher substance on earth prompted the make of Roman concrete. In past Portland bond showed up; today it is thought to be the most grounded restricting material for making mortar. The mortar piece is planned by the volume or weight of material in 1 m^3 of mortar or by the relative measure of materials with the measure of restricting material taken as solidarity. For basic mortars made out of one sort of restricting material and containing no mineral admixtures, the arrangement will be assigned, say 1:3.

By doing this replacement of cement and sand with various industrial wastes which are known as a supplementary cementitious material (SCMs). By doing this replacement we can reduce cost and damage to the environment. They possess nearly the same characteristics like cement and will reduce the cost of the product.

Cement plays an important part in mortar production, but it will produce the maximum amount of carbon dioxide, so find out such material which possess the same properties like cement and give Mortar same binding as cement, so produce Eco-friendly Mortar.

II.EXPERIMENTAL MATERIALS

The following materials are used in the present research were:

2.1 Carbon Black Powder

Carbon black powder is a material that produced by the imperfect combustion of the heavy petroleum products such as coal tar, FCC tar, a small amount from vegetable oil and ethylene-cracking. Carbon black powder is waste of the rubber industry. Uses of carbon black powder in different sectors are tired and rubber products, paints and varnishes, high performance coatings, plastics, printing inks and special products such as flower soil, decor paper and toners. Figure 1 shows the carbon black powder.

Figure 1 Carbon black powder

Following table 1 shows the properties of carbon black powder.

Table 1 Properties on carbon black powder

Sr. No.	Parameter	Unit	Result
1	Iodine Absorption No.	gm/kg	1328
2	DBP No.	ml/100gm	130
3	Ctab Absorption	m^2/kg	124
4	Heating loss@125 °C	%	0.48
5	Ash Content	%	1.25
6	Sieve Residue N35	%	Nil
7	Fine Content	%	4.90
8	Pour Density	kg/m^3	315
9	Sulphur Content	%	0.25
10	Color Strength	%	129
11	DBP No after Pressing	ml/100gm	100
12	PH Value	-	8.88
13	Toluol Extract	%	81
14	Pellet Hardness	gm	46

2.2 Cement

A cement is the binder materials which can be used to bind the other materials in the mortar. The Ordinary Portland cement (OPC) is used as most corporate cement in the construction industry. The Ordinary Portland cement of 53 grade, which is as per IS 12269-1987 is used for making cement mortar mixture.

2.3 Fine Aggregate

In General the sand is used as a fine aggregate in mortar. Fine aggregate is the naturally available materials as river sand. The fine aggregate is passing through from 4.75 mm to 150 micron sieve are known as a fine aggregate as per Indian standard. The fine aggregate which is as per IS 383-1970 is used for making mortar mixture.

2.4 Water

Water is the most important ingredient of mortar. If water is not properly using then it lead to poor quality of the mortar. Fresh potable water must be used for preparing the mortar. The water cement ratio is used in mortar mixture is 0.43.

III. EXPERIMENTAL METHODOLOGY

The following mix designs were used in the present research work:

3.1 Mix Designs for Cement Mortar

A mix of mortar was designed as per IS 516:1959 and the same was used the carbon black powder based mortar. Material requirement for $1m^3$ control mix and carbon black powder based mortar is shown in table 2.

Table 2 Material requirement for $1m^3$ cement mortar

Cement Mortar Mixes	**Design Mix for Cement Mortar (1:3) (By Weight)**			
	Cement (kg)	**Fine Aggregate (kg)**	**Carbon Black Powder (kg)**	**Water (ml)**
A1 Control Mix	566.56	1699.72	-	0.43
B1 (5% CBP)	538.23	1699.72	28.33	0.43
B2 (10% CBP)	509.90	1699.72	56.66	0.43
B3 (15% CBP)	481.58	1699.72	84.98	0.43
B4 (20% CBP)	453.25	1699.72	113.31	0.43
B5 (25% CBP)	424.92	1699.72	141.64	0.43
B6 (30% CBP)	396.60	1699.72	169.97	0.43

3.2 Compressive Strength Test (IS 512: 1956)

Compressive strength tests were performed on compression testing machine using mortar mixtures. Three samples per batch were tested. An average of three values gives the compressive strength of mortar. Compressive strength test on mortar after 7 days, 14 days and 28 days are carried out on 2000 kN capacity compression testing machine figure 2 shows the setup for compressive strength testing machine.

Figure 2 Setup of compressive strength testing of mortar

3.3 Water Absorption (IS 2185 Part 1:2005)

To carry out the water absorbtion test of cement mortar the dry specimen are placed in oven at 85°C for 24 hrs. After that cool the specimen to room temperature and obtain its weight is called dry weight. After that the dry specimen are immersed in water for 24 hrs and remove the specimen from water and with the specimen figure 3 shows the water absorption of mortar.

Figure 3 Water absorption of mortar

IV. Results And Discussion

The result and discussion are the present research are as follows:

4.1 Compressive Strength test

The compressive strength of carbon black powder based mortar was investigated. Following table 3 shows compressive strength results of control mix and carbon black powder based mortar in different proportions.

Table 3 Compressive strength of various cement mortar mixes (1:3)

Cement Mortar Mix	Compressive Strength (N/mm^2)			% Change in Compressive Strength		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
A1 Control Mix	32.21	36.28	48.08	0	0	0
B1 (5% CBP)	10.34	12.20	16.40	(-) 67.89	(-) 66.37	(-) 65.89
B2 (10% CBP)	10.67	12.60	18.87	(-) 66.87	(-) 62.37	(-) 60.75
B3 (15% CBP)	14.07	32.34	34.41	(-) 56.31	(-) 10.85	(-) 28.43
B4 (20% CBP)	23.07	36.34	36.54	(-) 28.37	(+) 0.16	(-) 24.00
B5 (25% CBP)	37.14	43.75	56.48	(+) 15.30	(+) 20.58	(+) 17.47
B6 (30% CBP)	12.87	20.47	24.34	(-) 60.04	(-) 43.57	(-) 49.37

Following figure 4 shows the results of compressive strength of control mix and carbon black powder based mortar mixes in different proportions at 7 days, 14 days and 28 days.

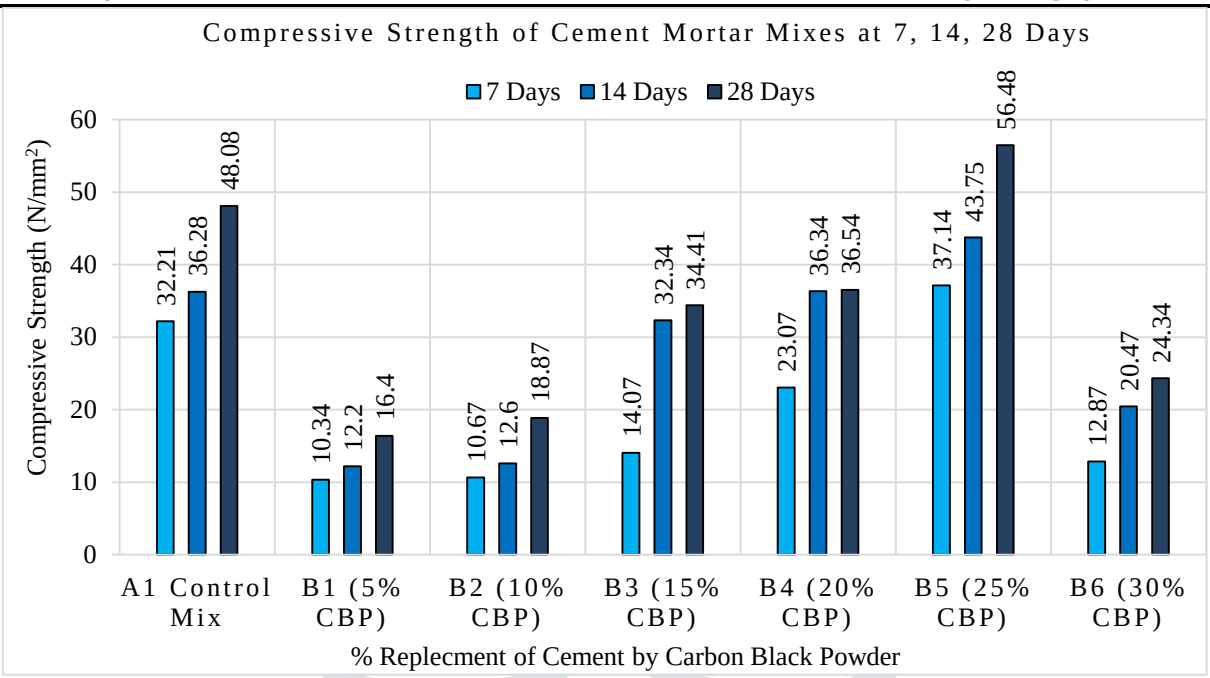

Figure 4 % Replacement of cement by carbon black powder V/S compressive strength (N/mm^2) in different proportion of cement mortar (1:3)

From above figures 4 the compressive strength of cement mortar mixes is increased with increase in days. The compressive strength is increased with the increase in proportions of carbon black powder in cement mortar content up to 25% carbon black powder replaced with cement and after 25% its decrease the compressive strength.

4.2 Water Absorption

In this study, Water absorption of carbon black powder based mortar was investigated. Following table 4 shows water absorption results of control mix and carbon black powder based mortar with different proportions.

Table 4 Water absorption of various cement mortar mixes (1:3)

Cement Mortar Mixes	Water Absorption (%) at 28 days
A1 Control Mix	0.65
B1 (5% CBP)	4.02
B2 (10% CBP)	4.20
B3 (15% CBP)	3.75
B4 (20% CBP)	1.16
B5 (25% CBP)	0.77
B6 (30% CBP)	1.39

Following figure 5 shows the water absorption of mortar mixes: Control mix and carbon black powder based mortar in different proportions at 28 days.

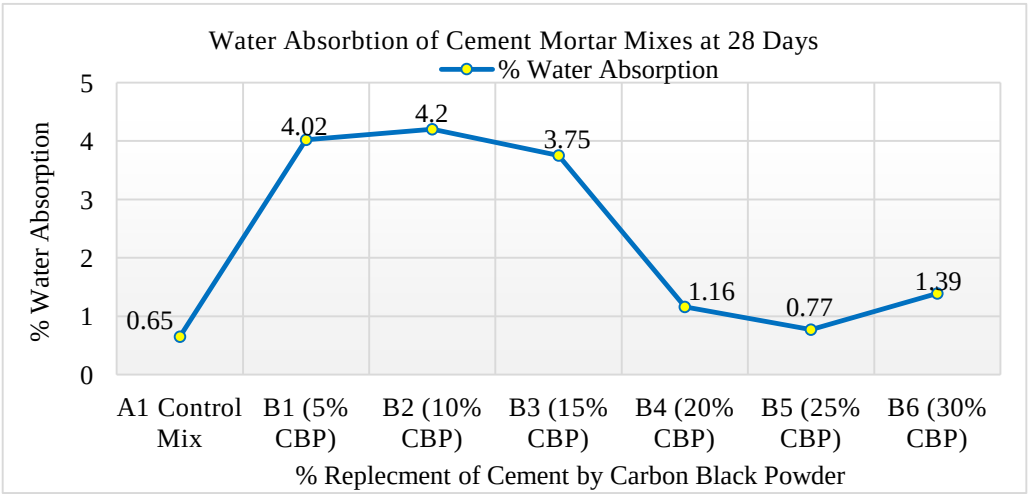

Figure 5 % Water absorption in different proportion of cement mortar (1:3)

From above figure 5 the mortar mixes percentage of water absorption was increased with the increase of carbon black powder content up to 10% after that percentage of water absorption was decreased with the increase of carbon black powder content up to 25%, and after that percentage of water absorption was increased and 25% (B5 mix) is near to Standard mortar.

4.3 Cost Analysis

Following table 5 shows the cost of materials and table 6 shows the total cost of cement mortar mixes for 1 m^3.

Table 5 Cost of materials

Materials	Cost Rs/kg
Cement	6.30
Fine Aggregate	0.60
Carbon black powder	0.20

Table 6 Total cost of various cement mortar mixes (1:3) for 1 m^3

Materials	Total Cost Rs/m^3	% Change on Total cost
A1 Control Mix	4589.16	0
B1 (5% CBP)	4416.36	(-) 3.76
B2 (10% CBP)	4243.53	(-) 7.53
B3 (15% CBP)	4070.78	(-) 11.29
B4 (20% CBP)	3897.97	(-) 15.06
B5 (25% CBP)	3725.15	(-) 18.83
B6 (30% CBP)	3552.41	(-) 22.59

Following figure 6 shows the cost analysis of control mix and carbon black powder based mortar mixes in different proportion for 1 m^3 cement mortar.

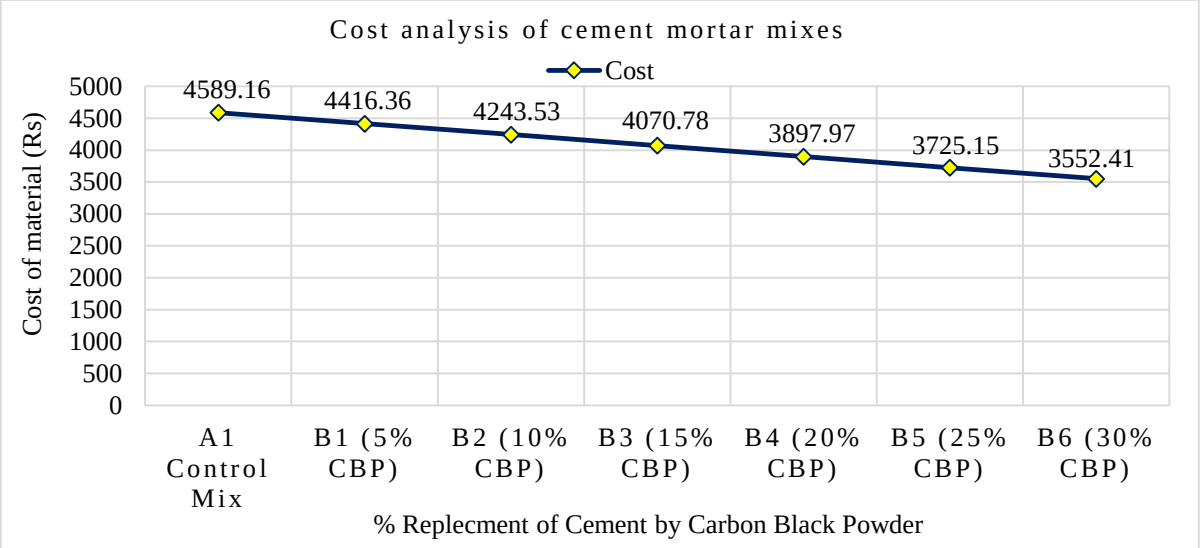

Figure 6 Total cost of 1 m^3 cement mortar mixes (1:3)

From above figure 6, it can be said that carbon black powder based mortar mixes in different proportion have lesser rates to compare to control mix for 1 m^3. Rates of carbon black powder based mortar decrease with increases of carbon black powder content compared to control mix.

V. CONCLUSION

Based on investigations, research concerning compressive strength, water absorption and coat analysis for control mix and carbon black powder based mortar in different proportions, the following conclusions are drained out for various parameters:

1) Compressive strength shows a progressive modification in the carbon black powder based mortar.
2) Results show that the highest strength is achieved in the B5 (25% carbon black powder replaced with cement) type of mortar mix which is 15.30% at 7 days, 20.58% at 14 days and 17.87% at 28 days increase in compressive strength that is 37.14 N/mm^2 at 7 days, 43.75 N/mm^2 at 14 days and 56.48 N/mm^2 at 28 days as compared to A (control mix) type of mix.
3) As test results show that the B5 (25% carbon black powder replaced with cement) mix percentage water absorption is 0.77, which is minimum from all the carbon black powder based mortar mixes.
4) Rates of carbon black powder based mortar decreases with increases in carbon black powder content in the carbon black powder based mortar compared to control mix cement mortar.
5) Based on the cost calculations, it can be concluded that 18% of cost can be saved in the production of carbon black powder based mortar.

6) For 1 m^3 of cement mortar 566.56 kg cement is used. If replacement is made of cement with carbon black powder, the same quantity of waste material can be utilized. Also problem of industrial waste disposal can be easily solved and it reduces pollution load on the environment.
7) Compressive Strength of carbon black powder based mixes is higher than required strength. So, use of carbon black powder is economical as well as effective.
8) As per Lower Income Group (LIG) housing schemes of India. Construction of many lower cost houses is target in India every year. The maximum amount of waste can be utilized for construction of lower cost houses.

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