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Partial Replacement of Cement by Barites and Lime Powder in Concrete

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Abstract : This study represents the behavior of concrete, having partial Replacement of cement with barites and lime powder. M30 grade concrete was used for which the barites and lime powder is replaced and an experimental study was carried out and the effect on compressive strength characteristics (0%, 10%, 20%, 30%) was studied. The result of this present investigation indicates that the replacement of cement with barites and lime powder showed an increase in the compressive strength in the early stages 7th day. The compressive strength when tested on 14th day showed almost the same results for all the mixes, but the results did not show any positive results for 28th day. The usage of barites and lime powder as a replacement for cement in concrete not shown increases in compressive strength in 28th day.
Keywords : barites , lime powder, concrte, compressive strength.

Introduction

Concrete is composed mainly of cement, aggregate, water. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used more than any other man-made material in the world. The most common form of commercial lime used in concrete is slaked lime. In 19 th century the use of lime mortar in new construction gradually declined, largely due to Portland's ease of use, quick setting & high compressive strength. Barite is a clean, smooth, naturally unresponsive and inexpensive mineral. It is non-toxic & also chemically and physically unreactive. Barite has the ability to block x-ray & gamma-ray emissions .It is used to make high-density concrete to block x-ray emissions in hospitals, power plants & laboratories.

Materials Used

Fine Aggregate Natural river sand with material passing through a 4.75mm sieve and retained a 60 micron sieve is used for the preparation of concrete. Coarse Aggregate: Coarse aggregate of the maximum sizes 20 mm, 16mm and 12.5mm is used for the preparation of concrete. Cement: The cement used to be locally available 53 Grade of ordinary Portland cement. The cement has a specific gravity of 3.15. Water: Portable water available in the laboratory with pH value of 7.0 and conforming. It is used for making the concrete and curing the specimens as well. Baryte powder: Natural barium sulfate known as barite, it is a high brightness, high specific gravity, low oil absorption insert filler. It finds use in powder coatings because of its high specific gravity, good brightness and low oil absorption. Lime powder : A dry white powder consisting essentially of calcium hydroxide obtained by treating lime with water —called also slaked lime. The addition of limestone filler to neat cement pastes and mortars reduces the diffusion coefficient of chloride ions. They also reported

that the amount of limestone increases the heat of hydration, as well as the free lime and compressive strength while the total porosity decreases at early ages. Table 1 shows the M30 concrete mix design.

Table 1 M30 Concrete Mix Design

	Grade Designation	**M30**
1	Type of Cement	OPC 53 grade
2	Maximum Nominal Aggregate Size	20 mm
3	Minimum Cement Content	310 kg/m^3
4	Maximum Water Cement Ratio	0.45
5	Workability	50-75 mm (Slump)
6	Exposure Condition	Normal
7	Degree of Supervision	Good
8	Type of Aggregate	Crushed Angular Aggregate
9	Maximum Cement Content	540 kg/m^3
Test Data for Materials		
1	Cement Used	OPC 53 grade
2	Sp. Gravity of Cement	3.15
3	Sp. Gravity of Water	1.00
4	Sp. Gravity of 20 mm Aggregate	2.884
5	Sp. Gravity of 10 mm Aggregate	2.878
6	Sp. Gravity of Sand	2.605
7	Cement Used	OPC 53 grade
8	Degree of Supervision	Good
9	Type of Aggregate	Crushed Angular Aggregate
10	Maximum Cement Content	540 kg/m^3
Target Strength for Mix Proportioning		
1	Target Mean Strength	Target Mean Strength
2	Characteristic Strength @ 28 days	Characteristic Strength @ 28 days
Selection of Water Cement Ratio		
1	Maximum Water Cement Ratio	0.45
2	Adopted Water Cement Ratio	0.42
Selection of Water Content		
1	Maximum Water content	186 Lit.
2	Estimated Water content for 50-75 mm Slump	160 Lit.
Calculation of Cement Content		
1	Water Cement Ratio	0.42
2	Cement Content (160/0.42)	380 kg/m^3
Proportion of Volume of Coarse Aggregate & Fine Aggregate Content		
1	Vol. of Coarse Aggregate	62.00%
2	Adopted Vol. of Coarse Aggregate	62.00%
	Adopted Vol. of Fine Aggregate (1-0.62)	38.00%
Mix Calculations		
1	Volume of Concrete in m^3	1.00
2	Volume of Cement in m^3	0.120
	(Mass of Cement) / (Sp. Gravity of Cement)x1000	
3	Volume of Water in m^3	0.160
	(Mass of Water) / (Sp. Gravity of Water)x1000	

4	Volume of All in Aggregate in m^3	0.720
	Sr. no. 1 – (Sr. no. 2+3)	
5	Volume of Coarse Aggregate in m^3	0.4464
	Sr. no. 4 x 0.62	
6	Volume of Fine Aggregate in m^3	0.2764
	Sr. no. 4 x 0.38	
Mix Proportions for One Cum of Concrete (SSD Condition)		
1	Mass of Cement in kg/m^3	380
2	Mass of Water in kg/m^3	160
3	Mass of Fine Aggregate in kg/m^3	711
4	Mass of Coarse Aggregate in kg/m^3	1283
	Mass of 20 mm in kg/m^3	924
	Mass of 10 mm in kg/m^3	359
5	Water Cement Ratio	0.42

Methodology

Experimental procedures:

The barites and lime used were fine powder. The barites powder taken from kodur mamgamma mines. 3 trials were conducted during the project. The 3 trails were conducted by differing the barites and lime powder mixing quantity. The quantity of barites and lime were varied by 0%, 10%, 20%, and 30%.The experiments were designed to include M30 mix. A total of 36 concrete cubes of sizes 150 X 150 X 150 mm was cast and tested. The above blocks were cast and tested for 7, 14, 28 days of curing. Compressive strength test was conducted to assess the strength of concrete.

Casting and curing of concrete:

We made by hand mixing until the concrete appears to be homogeneous and of the desired consistency. The mould was cleaned and the concrete was filled, then compacted with tamping rod .Level the top surface and smoothen with a trowel. The test specimens are stored in moist air for 24 hours and after this period. The specimens are marked and removed from the moulds and kept submerged in clear fresh water until taken out prior to testing.

Compressive strength of concrete:

Fig 1shows the compression testing machine. Compressive strength of a concrete is a measure of its ability to resist static load, which tends to crush it. This test was performed to find the increase and differences of strength according the increasing percentage of fiber in the concrete. The compressive strength of concrete with different mixture proportions was determined at the age of 7, 14, 28 days.

Following are the procedure for compressive strength test of concrete cubes:

Fig 1: compression testing machine

1. Remove the specimen from water after the specified curing time and wipe out excess water from the surface. 2. Take the dimensions of the specimen to the nearest 0.2mm 3. Clean the bearing surface of the machine. 4. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. 5. Align the specimen centrally on the base plate of the machine. 6. Rotate the movable portion gently by hand so that it touches the top surface of the specimen. 7. Apply the load gradually, without shock till the specimen fails. 8. Record the maximum load and note any unusual features of the type of failure.

Results – Deflection and Load

The test on cubes were effectively conducted from compression testing machine and the readings, load and deflection were noted for each cube in every stage. Compressive strength value was calculated from the readings. The graph was drawn from the test results. Fig 2 shows the deflection and load value on 100% cement at 7 days, fig 3 shows the deflection and load value on 10% replacement of cement in 7 days, fig 4 shows the deflection and load value on 20% replacement of cement in 7 days, fig 5 shows the deflection and load value on 30% replacement of cement in 7 days.

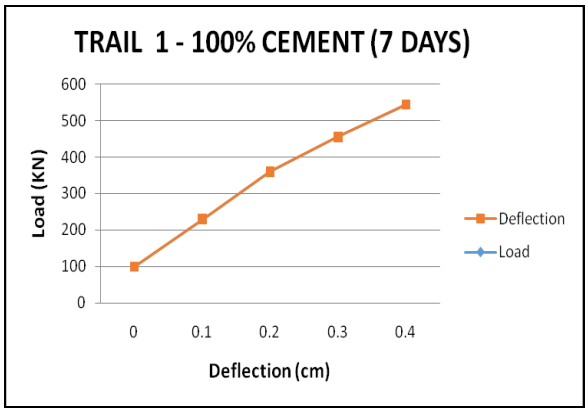

Fig 2: Deflection Vs load graph on 100% of cement in 7 days

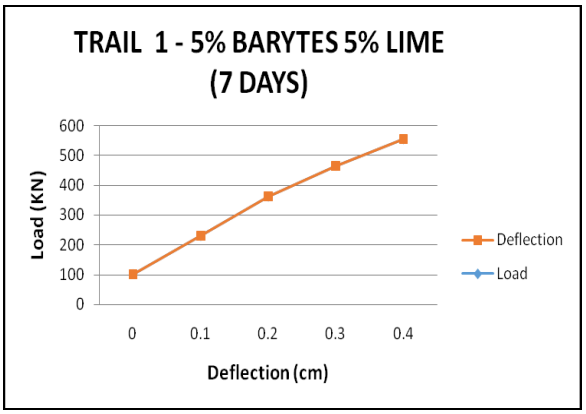

Fig 3: Deflection Vs load graph on 10% replacement of cement at 7 days

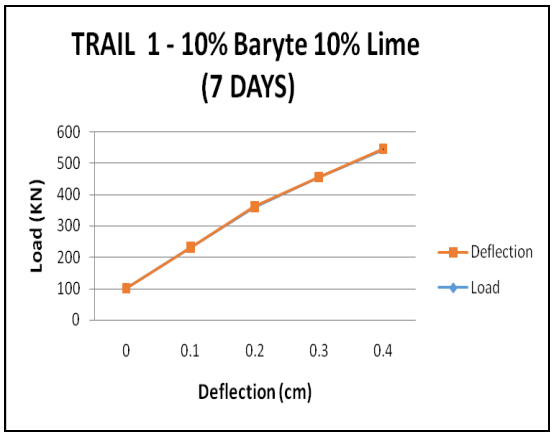

Fig 4: Deflection Vs load graph on 20% replacement of cement in 7 days

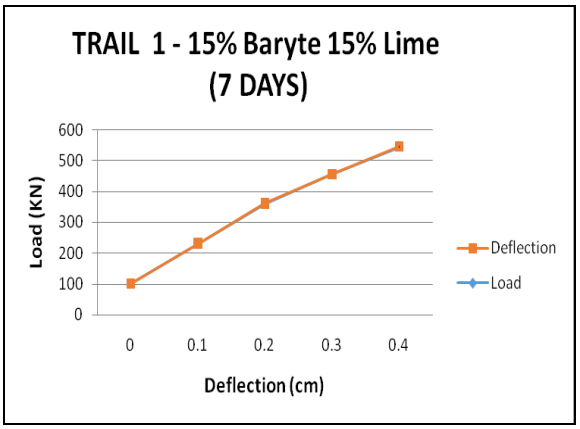

Fig 5: Deflection Vs load graph on 30% replacement of cement in 7 days

Results – Compressive Strength

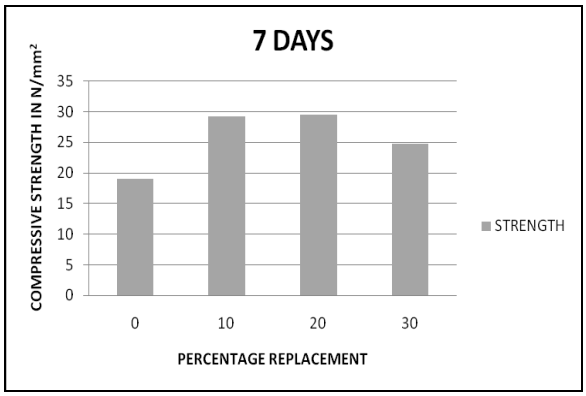

Fig 6: Compressive strength value in 0,10%, 20%, 30% replacement of cement in 7 days

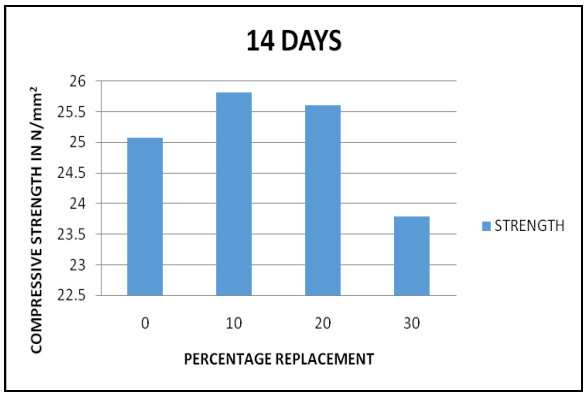

Fig 7: Compressive strength value in 0,10%, 20%,30% replacement of cement in 14 days

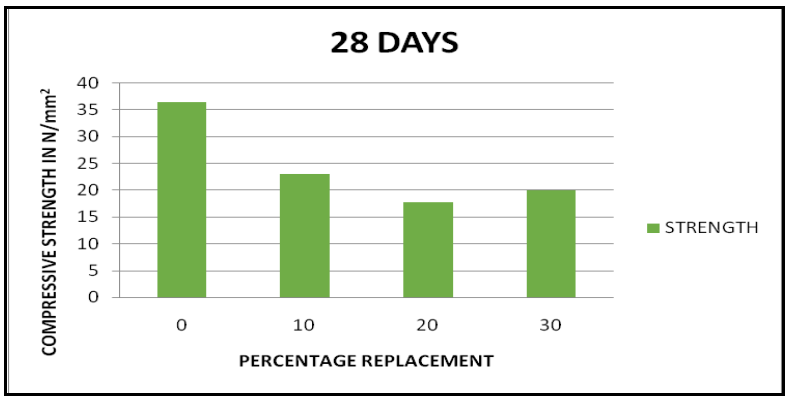

Fig 8: Compressive strength value in 0,10%, 20%, 30% replacement of cement in 28 days

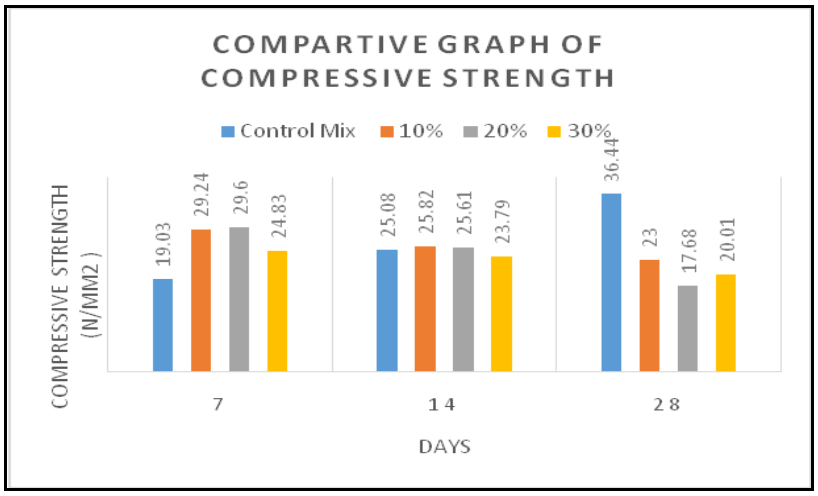

Fig 9: Variation of compressive strength in 0,10%, 20%, 30% replacement of cement in 7, 14, 28 days

- After 7th day testing, when compared to control mix, the compressive strength (fig 6) obtained for control mix is 19.03 N/mm^2, for 5% barites and 5% lime, replacement is 29.24 N/mm^2, for 10% barites and 10% lime replacement is 29.6 N/mm^2, for 15% barites and 15% lime replacement is 24.83 N/mm^2.
- After 14th day testing, When compared to control mix, the compressive strength (fig 7) obtained for control mix is 25.08 N/mm^2, for 5% barites and 5% lime replacement is 25.82 N/mm^2, for 10% barites and 10% lime replacement is 25.61 N/mm^2, for 15% barites and 15% lime replacement is 23.7(N/mm^2.

- After 28th day testing, When compared to control mix, the compressive strength (fig 8) obtained for control mix is 36.44 N/mm^2, for 5% barites and 5% lime replacement is 23 N/mm^2, for 10% barites and 10% lime replacement is 17.68 N/mm^2, for 15% barites and 15% lime replacement is 20.01$N/mm^{2.}$.
- Fig 9 shows the variation of Compressive strength value of concrete in 0,10%, 20%, 30% replacement of cement in 7, 14, 28 days

Conclution

This research study, shows the partial replacement of cement in concrete mixes and studies the effect of compressive strength. The following conclusions could be extracted from this study. From the above graphs we can observe that the initial strength of the concrete is gained, but later it decreased than the initial strength, so the replacement of cement by both barite and lime is not successful.From the literature review, we can observe that the only replacement by barite has shown good results, so the replacement of both barite and lime are not recommended.

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