

Pozzocrete: Modern Material Partially Replaced with Cement in Mortar

Rushabh A. Shah, Jayeshkumar Pitroda

Abstract-Pozzocrete (P40, P60 and P100) a processed quality assured fly ash, investigated for its use as a partial replacement for cement in cement mortar (1:3). The utilization of Pozzocrete (P40, P60 and P100) as cement replacement material in mortar or as additive in cement introduces many benefits from economical, technical and environmental points of view. This paper presents the results of the cement mortar of mix proportion 1:3 in which cement is partially replaced with Pozzocrete (P40, P60 and P100) as 0%, 10%, 30% and 50% by weight of cement. Four set of mixture proportions were made. First were control mix (without Pozzocrete (P40, P60 and P100) with regional fine aggregate (sand)) and the other mixes contained Pozzocrete (P40, P60 and P100) obtained from DIRK India Private Limited, Nashik, Maharashtra state. The compressive strength has been obtained with partial replacement of Pozzocrete (P40, P60 and P100) with cement. Test results indicate the decreases in the strength properties of mortar with Pozzocrete (P40, P60 and P100) for strength at 28 days as partial replacement with the cement in the cement mortar 1:3. So it can be used in non-structural elements with the low range compressive strength where strength is not required and low cost temporary structure is prepared.

Keywords: Pozzocrete (P40, P60 and P100), Partial replacement, Compressive strength, Cement, Fine aggregate, Cost

I. INTRODUCTION

Mortar is a globally accepted construction material in all types of civil engineering structures. Masonry is the construction of building units like stone or brick bonded together with mortar. It is one of the major building crafts and one of the oldest. Stone and Brick masonry construction is very much preferred one for load bearing structures and high rise buildings, especially in the developing and under developed countries because of its ease in construction and economy. It has been used for the construction of a number of historical and traditional buildings. Though these masonry is not much understood in the aspect of strength and other parameters, because of its non-homogeneity. Most of the walls of buildings and residential houses are masonry walls, made of stones, bricks or concrete blocks, with rendering on both sides. Even though mortar makes up as little as 7% of the total volume of a masonry wall, it plays a crucial role in the performance of the structure. Due to the environment concern and the need to conserve energy, various research efforts have been directed toward the utilization of waste materials.

The cost of cement is also steadily increasing. With ever-increasing environmental problems because of industrial waste products comes a great need to use these products in an appropriate manner to reduce health and environmental problems.

For this purpose, experimental investigation is carried out to develop the data on the compressive strength development of mortar with time and with different percent replacement of Pozzocrete (P40, P60 and P100).

The objectives of the present study are:

- ✚ To select the Pozzocrete (P40, P60 and P100) mix proportion for cement mortar.
- ✚ To investigate change in compressive strength of cement mortar with Pozzocrete (P40, P60 and P100) replacement.
- ✚ To perform the experiments on the time-dependent compressive strength of cement mortar with Pozzocrete (P40, P60 and P100). The strengths were measured at the age of 28 days.

II. DESIGN MIX MATERIALS

A. Cement

The cement used is SANGHI OPC 53 grade cement. The Ordinary Portland Cement of 53 grade conforming to IS: 8112-1989 is to be used. Tests were conducted on cement like Specific Gravity, Consistency Tests, Setting Tests, Soundness and Compressive Strength N/mm² at 28 days.



Fig 1: SANGHI OPC 53 Grade Cement

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TABLE - 1 PROPERTIES OF CEMENT

Sr.no.	Physical properties of SANGHI OPC 53cement	Result	Requirements as per IS:8112-1989
1	Specific gravity	3.15	3.10-3.15
2	Standard consistency (%)	31.5 %	30-35
3	Initial setting time (hours, min)	91 min	30 minimum
4	Final setting time (hours,min)	211 min	600 maximum
5	Soundness	2.8 mm	10mm maximum
6	Compressive strength N/mm ² at 28 days	58 N/mm ²	53 N/mm ² minimum

B. Fine aggregate

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand is used as fine aggregate conforming to the requirements of IS: 383. The river sand is wash and screen, to eliminate deleterious materials and over size particles.

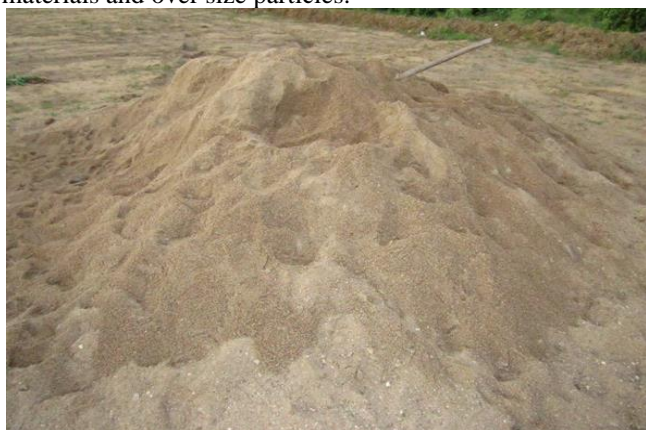


Fig 2: Fine aggregate (River sand)

TABLE- 2 PROPERTIES OF FINE AGGREGATE

Property	Fine Aggregate (River sand)
Fineness modulus	3.1
Specific Gravity	2.767
Water absorption (%)	1.2
Bulk Density (gm/cc)	1.78

C. Water

Water is an important ingredient of Mortar as it actually participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully.

D. Pozzocrete (P40, P60 and P100)

Pozzocrete (P40, P60 and P100) is a high efficiency pozzolanic material, obtained by selection, processing and testing of power station fly ash resulting from the combustion of coal at electricity generating power stations. It is subjected to strict quality control procedures. P60 confirms to IS: 3812

part-1 fly ash and P40 confirms to ASTM 618 fly ash for use as component of cement with Portland clinker.

TABLE- 2 GENERAL PROPERTIES OF POZZOCRETE

Property	P40	P60	P100
Presentation	Finely divided dry powder	Finely divided dry powder	Finely divided dry powder
Specific Gravity	2.3	2.3	2.3
Colour	Light grey	Light grey	Greyish white
Bulk weight (tonne per m ³)	1.0 tonne per m ³	1.0 tonne per m ³	0.65 tonne per m ³
Loss on Ignition	<2.5%	<2.5%	<2.5%
Particle size	<25% retained on 45 micron sieve	<18% retained on 45 micron sieve	Zero retaintion on 45 micron sieve , less than 0.25% retained on 25 micron sieve
Particle shape	Spherical	Spherical	Spherical
Package	1 tonne big-bags and bulk tankers	30 kg bags, 1 tonne big-bags and bulk tankers	30 kg bags

III. DESIGN MIX METHODOLOGY

Mortar compositions

A cement mortar mix 1:3 was designed as per IS: 269 methods and the same were used to prepare the test samples. The design mix proportion is done in Table 4 and 5.

TABLE - 4 MIX DESIGN PROPORTIONS

	Water	Cement	Fine aggregate
By weight, [gms]	86	200	600
By volume, [m ³]	0.43	1	3

TABLE - 5 DESIGN MIX PROPORTIONS FOR MORTAR (1:3)

Types of Mortar	W/C ratio	% Replac ement in cement	Design Mix Proportions For Mortar (1:3)				
			C	F.A.R.	P40	P60	P100
A1	0.45	0	1	3	-	-	-
B1	0.45	10%	0.9	3	0.1	-	-



B2	0.45	30%	0.7	3	0.3	-	-
B3	0.45	50%	0.5	3	0.5	-	-
C1	0.45	10%	0.9	3	-	0.1	-
C2	0.45	30%	0.7	3	-	0.3	-
C3	0.45	50%	0.5	3	-	0.5	-
D1	0.45	10%	0.9	3	-	-	0.1
D2	0.45	30%	0.7	3	-	-	0.3
D3	0.45	50%	0.5	3	-	-	0.5

W= Water, C= Cement, F. A.R.= Fine AggregateRegional,
C.A. = Coarse Aggregate, P= Pozzocrete

TABLE -6: CEMENT REPLACEMENT BY POZZOCRETE (P40, P60 AND P100)

Sr. No.	Types of Mortar	Description of Mortar
1	A1	River sand Mortar (1:3)
2	B1	10% Cement Replacement by Pozzocrete (P40)
3	B2	30% Cement Replacement by Pozzocrete (P40)
4	B3	50% Cement Replacement by Pozzocrete (P40)
5	C1	10% Cement Replacement by Pozzocrete (P60)
6	C2	30% Cement Replacement by Pozzocrete (P60)
7	C3	50% Cement Replacement by Pozzocrete (P60)
8	D1	10% Cement Replacement by Pozzocrete (P100)
9	D2	30% Cement Replacement by Pozzocrete (P100)
10	D3	50% Cement Replacement by Pozzocrete (P100)

IV. EXPERIMENTAL METHODOLOGY

A. Testing methodology

The evaluation of Pozzocrete (P40, P60 and P100) for use as a supplementary cementitious material (SCM), i.e., as a pozzalona, begins with the mortar testing. Mortar is similar to concrete in that it contains cement, water and aggregate, except that in mortar graded fine aggregate is the only aggregate present. With the control mortar, i.e.10%,30% and 50% of the ordinary Portland cement (OPC) confirming IS 269IV is replaced with Pozzocrete (P40, P60 and P100),The data from the Pozzocrete (P40, P60 and P100)mortar is compared with data from a "control" mortar without Pozzocrete (P40, P60 and P100). Three cube samples were cast on the mould of size 70.7 x 70.7 x 70.7 mm for each 1:3 cement mortars with partial replacement of cement with Pozzocrete (P40, P60 and P100) with w/c ratio as 0.43 were also cast. After about 48 h the specimens were de-moulded and water curing was continued till the respective specimens were tested after 28 days for compressive strength.



Fig 3: Set up of Vibrating Machine and Crucible for Mixing Cement and Fine Aggregate (Sand)

B. Compressive strength

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm² per min. The comparative studies were made on their characteristics for cement mortar ratio of 1:3with partial replacement of cement with Pozzocrete (P40, P60 and P100) as 0%, 10%, 30%and 50%.



Fig 4: Set up of Compressive Testing Machine

V. RESULT

TABLE -7: COMPRESSIVE STRENGTH OF CEMENT MORTAR (N/mm²) AT 28 DAYS

Types of Mortar	Average Ultimate Compressive Strength of cement mortar (N/mm ²) at 28 days	% change in compressive strength of cement mortar (N/mm ²) at 28 days
A1	50.42	0
B1	48.55	-3.71
B2	34.88	-30.82
B3	22.34	-55.69
C1	39.41	-21.83
C2	35.61	-29.37
C3	21.81	-56.74
D1	42.21	-16.28
D2	33.21	-34.13
D3	29.01	-42.46

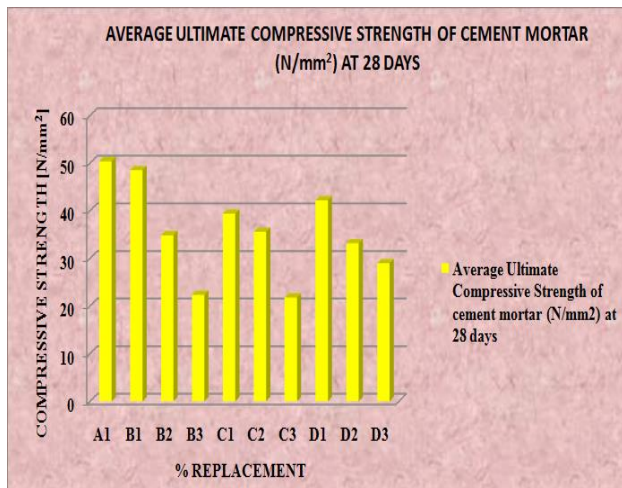


Fig 5: % Replacement of Pozzocrete (P40, P60 and P100) versus Compressive Strength of Cement Mortar (1:3) N/mm²

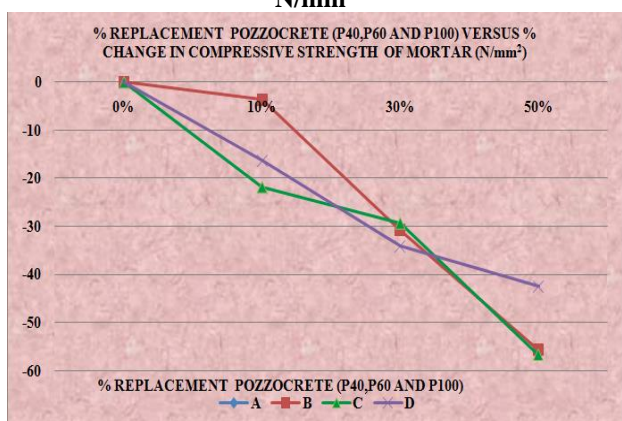


Fig 6: % Replacement of Pozzocrete (P40, P60 and P100) % Change in Compressive Strength of Cement Mortar (1:3)

VI. ECONOMIC FEASIBILITY

TABLE- 8 COSTS OF MATERIALS

Sr. No.	Materials	Rate (Rs/Kg)
1	Cement (SANGHI OPC 53 grade)	6.00
2	Fine aggregate (Regional)	0.61
3	Pozzocrete (P40)	3.50
4	Pozzocrete (P60)	4.40
5	Pozzocrete (P100)	12.20

TABLE - 9 MATERIALS FOR DESIGNE MIX MORTAR (1:3)

Types of Mortar	% Replace ment in cement	Materials					Total Cost [m³]	% Change in Cost
		C [kg/m³]	F.A.R. [kg/m³]	P40 [kg/m³]	P60 [kg/m³]	P100 [kg/m³]		
A1	0	566.57	1699.72	0	0	0	4504.24	0
B1	10%	509.91	1699.72	56.65	0	0	4362.60	(-) 3.14
B2	30%	396.59	1699.72	169.97	0	0	4079.31	(-) 9.43
B3	50%	283.28	1699.72	283.28	0	0	3796.03	(-) 15.72
C1	10%	509.91	1699.72	0	56.65	0	4413.59	(-) 2.01
C2	30%	396.59	1699.72	0	169.97	0	4232.28	(-) 6.03
C3	50%	283.28	1699.72	0	283.28	0	4050.98	(-) 10.06
D1	10%	509.91	1699.72	0	0	56.65	4855.51	7.79
D2	30%	396.59	1699.72	0	0	169.97	5558.06	23.39
D3	50%	283.28	1699.72	0	0	283.28	6260.61	38.99

C= Cement, F. A.R. = Fine Aggregate Regional, C.A. = Coarse Aggregate, P= Pozzocrete

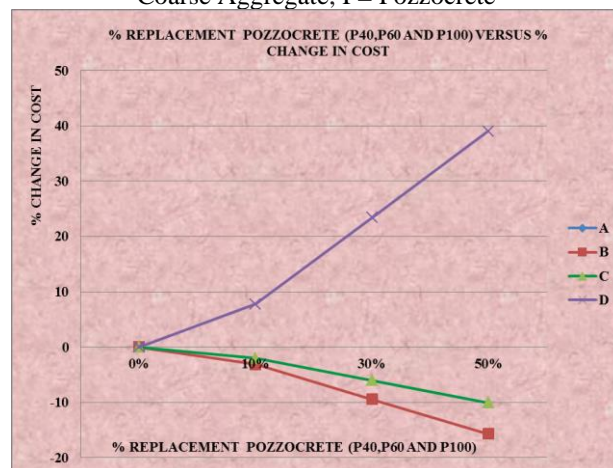


Fig 7: % Replacement Pozzocrete (P40, P60 and P100) versus % Change in Cost

VII. CONCLUSION

From this study the following conclusion can be drawn:

- The results presented in this paper, indicate that the incorporation of a Pozzocrete (P40, P60 and P100) in mixed cement is less feasible for making masonry mortars for high strength.
- Adequate strength developments were not found in mortars made of the mixed cement and Pozzocrete (P40, P60 and P100) as cement replacement for 1:3 mortars at 28 days.
- Pozzocrete (P40, P60 and P100) may be used in masonry mortar to improve the long-term bond strength.
- Pozzocrete (P40, P60) can be used to prepared low cost temporary structure.
- The results indicate that the % change in cost reduce up to 15.72 for 50% replacement of Pozzocrete (P40) and 10.06 for 50% replacement of Pozzocrete (P60).
- The results indicate that the % change in cost increases up to 38.99 for 50% replacement of Pozzocrete (P100).

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