

# Effect of Replacement of Cement by Pozzocrete on Strength Parameters of Plain and Reinforced Cement Concrete

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## ABSTRACT

The demand of concrete is increasing day by day for satisfying the need of development of infrastructure facilities. It is well established fact that the production of OPC not only consumes significant amount of natural resources and energy but also releases substantial quantity of carbon dioxide to the atmosphere. Therefore, it is essential to find alternatives to make the concrete environment friendly. Pozzolanas are siliceous or siliceous and aluminous material which in them possess little or no cementitious value but will chemically react, in finely divided form and in the presence of moisture, with calcium hydroxide at ordinary temperatures to form compounds possessing the cementitious properties. From the research result of laboratories on pozzocrete, it has been well established that use of pozzocrete in concrete considerably improves the strength of concrete. This minimizes the shrinkage problem of concrete; it fills voids and increases the workability of concrete. Because of fineness of pozzocrete, which is more than cement, this gives more specific surface, resulting concrete or mortar giving good appearance.

In the present study we have studied the structural behavior of pozzocrete and further investigated the amount or percentage of cement replacement by pozzocrete to achieve greater economy as well as higher strength of structural member. An experimental research investigation of pozzocrete in reinforced cement concrete is reported. Weigh batching were 10% to 30% replacement of cement by pozzocrete for M20 standard. For flexural behavior it was found that 30% replacement of cement by pozzocrete in R.C.C. is effective. Workability and ductility of concrete is also found to be increased with increase in flexural strength.

# **1. INTRODUCTION**

Plain cement concrete is one of the most widely used construction material because it can be cast to any shape. Concrete has a high compressive strength compared to its very low tensile strength. While it is not difficult to make concrete which can have a crushing strength over 40N/mm2, using the pozzocrete in some percentage replacement of cement, we can increase the strength of concrete by 50% that of plain cement concrete.

Pozzocrete is a high efficiency pozzolanic material obtained by processing of power station fly ashes resulting from the combustion of pulverized bituminous or sub-bituminous coal. Pozzocrete is subjected to strict quality control. Pozzocrete is one of the cheapest available pozzolanic materials with its high existing production capacity. The properties of pozzocrete with various parameters such as w/c ratio, types of pozzocrete and its effect on the strength has now been well established and much research has been carried out.

Production of pre-cast concrete products involves intricate, difficult patterns. Pozzocrete concrete mixed can help pre-casters solves challenges in many areas of production. In any concrete structure, accelerated curing, typically employed to enhance early age concrete strength for handling shipping of the product utilization, accelerates the pozzocrete to help develop the necessary early strengths. While the early strength gain characteristics of pozzocrete have generally been considered too slow for use in the mixture, conditions are changing towards the use of pozzocrete in the applications. Pozzocrete is widely considered as beneficial ingredient to increase the workability of these dry, harsh mixes. Pozzocrete used in pre-cast concrete products improves the workability, resulting in product with sharp, distinctive corners and edges.

## 2. OBJECTIVE & METHODOLOGY

The objectives of the current study is to -

- 1. Study the flexural and shear stresses by using the flexural testing machine (single point loading).
- 2. Study the compressive stresses by using the compression test on cubes.
- Methodology

The current study has been divided into following steps -



- 1. Properties of cement, sang aggregates, water has been found out.
- 2. Using I.S. Code method concrete mix design is done.
- 3. Properties of pozzocrete reinforced concrete have been found out from literature review.
- 4. From the above results pozzocrete content was fixed.

5. Properties of pozzocrete reinforced concrete have been studied by casting cubes (150 x 150 x 150mm) and beams (150 x 150 x 1000mm).

The details of mix design for concrete mix 1 to 7 are given in table 1 below:

#### Table 1: Mix Design

Sr. No.	1	2	3	4	5	6	7
					10%	20%	30%
	Standard	10%	20%	30%	Replacement	Replacement	Replacement
Mix Design	MOO	Reduction	Reduction	Reduction	of Cement	of Cement	of Cement
	IVIZU	in Cement.	in Cement.	in Cement.	with	with	with
					Pozzocrete	Pozzocrete	Pozzocrete

# 3. LABORATORY TESTS

## I) Compression Test:

Compression test is most common test conducted on hardened concrete, partly because it is an easy test to perform and because most of desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compression test is carried out on cubical specimens, which is of size 150 mm x 150 mm x 150 mm, if the largest nominal size of aggregate doesn't exceed 20mm.

#### II) Flexural Test:

The concrete structures are called upon to resist tensile stresses due to external loads which may cause high tensile stresses due to bending. Direct measurement of tensile strength of concrete is difficult. The beam tests are found to be dependable on measurement of flexural strength of the concrete. In the current study the concrete beams are tested with a single point load at mid-span of the beam. The standard size of beam specimen is kept as 150mm x 150mm x 1000mm long as largest size of aggregate in kept 20mm.

#### III) Shear Test:

The structural members such as beams are subjected to shear stresses. Direct measurement of shear strength is difficult. The beam tests are found to be dependable to measure shear strength property of concrete with a single point load at mid-span of the beam.

# 4. RESULTS AND DISCUSSIONS

The test specimens for flexural & shear tests were casted with proportion of 1:1.92:3.63 with w/c ratio of 0.58. The pozzocrete percentage was varied from 0% to 30% in replacement of cement.

1) Compressive Strength: Table I shows the compressive strength of concrete mixes 1 to 7 at 3 days, 7 days and 28 days. Considering the compressive strength of concrete at 28 days, it has been found that, at 20% and 30% replacement of cement by pozzocrete, increase in compressive strength is achieved compared to that of M20 standard concrete.



Table 2: Results of Cube Co	mpression Test for Concrete Mixes 1 to 7
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Concrete Mix	Compressive Strength N/mm2				
	3 Days	7 Days	28 Days		
M20 Std	12.00	12.44	24.44		
10% Rd	11.56	12.00	22.22		
20% Rd	11.11	11.56	20.00		
30% Rd	7.56	8.88	17.78		
10% Rpl	8.90	13.33	20.00		
20% Rpl	12.00	15.10	24.44		
30% Rpl	13.33	16.44	26.67		

2) Flexural Strength: Table II shows the flexural strength of concrete mixes 1 to 7 at 3 days, 7 days and 28 days. Considering the flexural strength of concrete at 28 days, it has been found that, for 10% replacement of cement by pozzocrete flexural strength is 21.22% greater, for 20% replacement flexural strength is 8.9% greater and for 30% replacement flexural strength is 38.12% greater than that for M20 standard.

	Flexural Strength N/mm <sup>2</sup>					
3 Days	7 Days	28 Days				
12.71	12.78	12.25				
13.74	12.46	13.30				
14.21	12.87	12.08				
13.57	13.07	13.20				
13.65	11.80	1 <mark>4</mark> .35				
14.40	13.32	<mark>13.3</mark> 4				
14.03	13.30	16.92				
		len.				
	3 Days   12.71   13.74   14.21   13.57   13.65   14.40   14.03	3 Days   7 Days     12.71   12.78     13.74   12.46     14.21   12.87     13.57   13.07     13.65   11.80     14.40   13.32     14.03   13.30				

Table 3: Results of Flexural Strength for Concrete Mixes 1 to 7

3) Shear Strength: Table III shows the shear strength of concrete mixes 1 to 7 at 3 days, 7 days and 28 days. Considering the shear strength of concrete at 28 days, it has been found that, for 10% replacement of cement by pozzocrete shear strength is 21% greater, for 20% replacement shear strength is 8% greater and for 30% replacement shear strength is 38% greater than that for M20 standard.

Table 4. Results of Tiexdial Strength for Concrete Mixes 1 to 7						
Concrete Mix	Flexural Strength N/mm <sup>2</sup>					
Concrete Mix	3 Days	7 Days	28 Days			
M20 Std	1.03	1.04	1.07			
10% Rd	1.12	1.29	1.08			
20% Rd	1.16	1.04	0.98			
30% Rd	1.10	1.06	1.07			
10% Rpl	1.11	0.96	1.21			
20% Rpl	1.17	1.08	1.08			
30% Rpl	1.14	1.08	1.38			

#### Table 4: Results of Flexural Strength for Concrete Mixes 1 to 7



The key to the acceptability of pozzocrete for use in structural concrete was to control the quality of concrete, principally its fineness. As a general rule, finer pozzocrete produces better quality concrete. When high quality pozzocrete is used the following benefits have been observed compared with conventional concrete containing OPC.

1. After the experimentation it can be concluded that replacement of cement by pozzocrete upto certain percentage is economical.

2. There has been continuous increase in strength with every 10% replacement of cement by pozzocrete from 10% to 30% for M20 standard.

3. It has been found that 30% replacement of cement by pozzocrete achieves more strength and economy than all other variations.

4. A reduction in water demand usually in excess of 5% and increasing with percentage increase in pozzocrete content has been observed.

- 5. Improved workability at a given slump and better pumping ability.
- 6. Improved ease of finishing.
- 7. A slower rate of setting, reducing risk of cold joints.
- 8. Reduced temperature rise due to hydration and less risk of early thermal cracking.

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