International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

# Use of Zeolite Powder as a Supplement of Cement in Concrete: A Review

**Shiva Ji Gond[1]AkhandPratap Mitra[2]Sandeep Yadav[3]Jayprakash Yadav[4]Virendra Kumar Saxena[5]**

*[1, 2,3,4,5]UG Student*
*[1, 2, 3, 4,5]Department of Civil Engineering*
*[1, 2, 3, 4,5]Buddha Institute of Technology Gida Gorakhpur, 273209, India*

**Abstract-**This study focuses on the use of zeolite powder in concrete as partial replacement of cement. Encourage the supplement product as a construction material is the main objective of this work. Zeolite powder is a natural material which is being obtained during chemically reaction of volcanic ash mixed up with sea water. In this work, we used the I.S method for mix design and M20 grade for concrete. We prepared concrete mixtures for making cubes with different proportion of zeolite powder ranging from-(0%NZ+100%C), (10%NZ+90%C), (20%NZ+80%C), (30%NZ+70%C). The curing was done for 7, 28 days. From the above test result we found that after 7 days, the compressive strength of concrete was less than the compressive strength of conventional concrete. But compressive strength was increasing as we increase the replacement level of cement with zeolite powder. We also found that the compressive strength of zeolitic concrete is maximum when we replace 10% of cement with zeolite powder and curing is done for 28 days.

To evaluate the mechanical and durability properties of concrete mixtures containing natural zeolite powder up to 10%, 20% and 30% replacements is carried out. Zeolite, a type of natural pozzolanic material, is abundantly founded in China and is easy to quarry. Due to partial replacement of cement by zeolite resulted in the decrement of compressive strength, especially the early strength.

**Keywords: Experimental Study, Water absorption, Absorption of CO2, M20 Concrete, Zeolite.**

## I. INTRODUCTION

This projects report on the effect of using zeolite as a replacement of cement on the strength, workability, durability properties. Concrete is most popular, important and most economical construction material. Concrete is used very widely everywhere making architectural structure and infrastructure. Concrete is a mixture of different kind of materials which is composed of water, cement, coarse aggregate and fine aggregate. Cement is a most durable material of concrete. Nowaday's cement production is abundant which causes the reduction in the source of cement. To fulfill this gap created by cement, we can use zeolite powder as replacement material. We found that zeolite powder is a good substitute of replacement of cement. It can reduce the cost of construction. Due to the production of cement the environment gets polluted and causes the source of CO2 emission. This entire process causes global warming and Global warming resulted from the emission of greenhouse gases has received widespread attention. In the sense of greenhouse gases, more than 60% to global warming caused due to contribution of CO2 because of its huge emission amount. According to latest scenario about 400 ppm CO2 concentration in atmosphere is measured.

### A. Scenario of Zeolite

This review paper is containing the information related to Zeolite and this information collected from different sources such as research papers, journals, magazines and websites. In this review paper we tried to collect much information related to Zeolite from already published article.

## II. SIGNIFICANCE OF STUDY

In this study we are trying to focus on the very special type of engineering material like Zeolite. Their property was not properly utilized. In some extent Zeolite contain some advantageous property like CO2 absorption as well as reduction in water absorption when mixed with cement.

## III. LITERATURE REVIEW

**B. Uzal et.al. (**2010) studied the Pozzolanic activity of clinoptilolite, the most common natural zeolite mineral, was studied in comparison to silica fume, fly ash and a non-zeolitic natural pozzolana. The results showed that the clinoptilolite possessed a high lime–pozzolanic reactivity that was comparable to silica fume and was higher than fly ash and a non-zeolitic natural pozzolanic. The high reactivity of the clinoptilolite is attributable to its specific surface area and reactive SiO2 content. Relatively poor strength contribution of clinoptilolite in spite of high pozzolanic activity can be attributable to larger pore size distribution of the hardened zeolite–lime product compared to the lime–fly ash system.

**Babak Ahmadi and Mohammad Shekarchi** (2010) studied the effectiveness of a locally quarried zeolite in enhancing mechanical and durability properties of concrete is evaluated and is also compared with other pozzolanic admixtures. The experimental tests included three parts: In the first part, the pozzolanic reactivity of natural zeolite and silica fume were examined by a thermos gravimetric method. In this case, the results indicated that natural zeolite was not as reactive as silica fume but it showed a good pozzolanic reactivity. In the second part, zeolite and silica fume were substituted for cement in different proportions in concrete mixtures, and several physical and durability tests of concrete were performed. Based on these results, the performance of concretes containing different contents of zeolite improved and even were comparable to or better than that of concretes prepared with silica fume replacements in some cases.

**B.Uzal and L.Turanl** (2012) studied the properties and hydration characteristics as well as paste microstructure of blended cements containing 55% by weight zeolite tuff composed mainly of clinoptilolite mineral were investigated. Super plasticizer requirement and compressive strength development of blended cement mortars were also determined.

**Subash.S, Sasikumar.G, Praveenkumar.V, KarthikeyanV.R Er. Jegan Mohan** - "Partial replacement of zeolite with cement", Imperial Journal of Interdisciplinary Research (IJIR).

**Eva Vejmelkova, Dana Konˇakova, Tereza Kulovana, Martin Keppert, Jaromir Z umar, Pavla Rovnanikova, Zbyne k Keršner, Martin Sedlmajer, Robert C erny** "Engineering properties of concrete containing natural zeolite as supplementary cementitious material: Strength, toughness, durability, and hydrothermal performance" Cement & Concrete Composites.

**B.D. Ikotun, S. Ekolu "**Strength and durability effect of modified zeolite additive on concrete properties" Construction and Building Materials.

## IV. MATERIAL USED

### Cement

The binding materials used in concrete are Ordinary Portland cement. This cement is of 53 grades conforming to IS 456-2000 and is having desired properties. The properties of cement were determined by adopting standard procedure. The properties are given in the following table. The normal consistency, initial and final setting time, specific gravity and fineness are main basic properties which were determined.

**Table 1: Physical properties of cement and their value**

| PHYSICAL PROPERTIES | VALUE |
|---|---|
| Normal consistency | 32% |
| Initial setting time(min) | 54 |
| Final setting time(min) | 340 |
| Specific gravity | 3.15 |
| Fineness | 7% |

### Fine Aggregate

Fine aggregate used is M-sand. Laboratory test was conducted on fine aggregates to determine the different physical properties as per IS 2386 (part-3)-1963(Reaffirmed 2002). The test results are tabulated in table 2. The fineness is obtained using the sieve analysis and the result is such that the fine aggregate is confirming to IS 383 – 1970.the properties of fine aggregate regarding to specific gravity is 2.65and fineness modulus is 5.41 and water absorption is 1.7%.

### Coarse aggregate

The coarse aggregate for the work is crushed stone. Angular shape aggregate of size is 20mm and below. The aggregate which passes through 75mm sieve and retain on 4.75mm are known as coarse aggregate. The grading of coarse aggregates should be as per specifications of IS 383-1970. The fineness is calculated from sieve analysis and the result is such that confirming to IS specifications.

### Water

Water is an important ingredient of concrete. It gives strength to cement and workability to the concrete. Potable water is used for casting and curing.

### Zeolite

Zeolites are porous crystalline aluminosilicates. The zeolite framework consists of an assemblage of SiO4 and AlO4 tetrahedral, joined together in various regular arrangements through shared oxygen atoms to form an open crystal lattice containing pores of molecular dimensions into which molecules can penetrate. Like most silicates the Zeolites are based on TO4 tetrahedral, where T is an aluminum or silicon atom. The vast 3-dimensional networks are a result of all four corners for the tetrahedral being shared, producing low density micro porous materials. Zeolite structures can be thought to exist of finite or infinite (chains, Layers etc.) Component units

**Figure 1: Zeolite powder**

**Table 2: physical properties of zeolite and their value**

| | |
|---|---|
| Normal consistency | 38% |
| Initial setting time(min) | 55 |
| Final setting time(min) | 410 |
| Specific gravity | 2.98 |
| Fineness | 8% |

## V. EXPERIMENTAL RESULTS.

**Table 3. WATERABSORPTION TEST (IN PERCENTAGE)**

| S.NO. | SAMPLE | 7 days | 28 days |
|---|---|---|---|
| **1** | M0(0% Zeolite) | 1.43 | 2.40 |
| **2** | M1(10% Zeolite) | 1.24 | 1.65 |
| **3** | M2(20% Zeolite) | 1.41 | 2.13 |
| **4** | M3(30% Zeolite) | 2.19 | 2.89 |

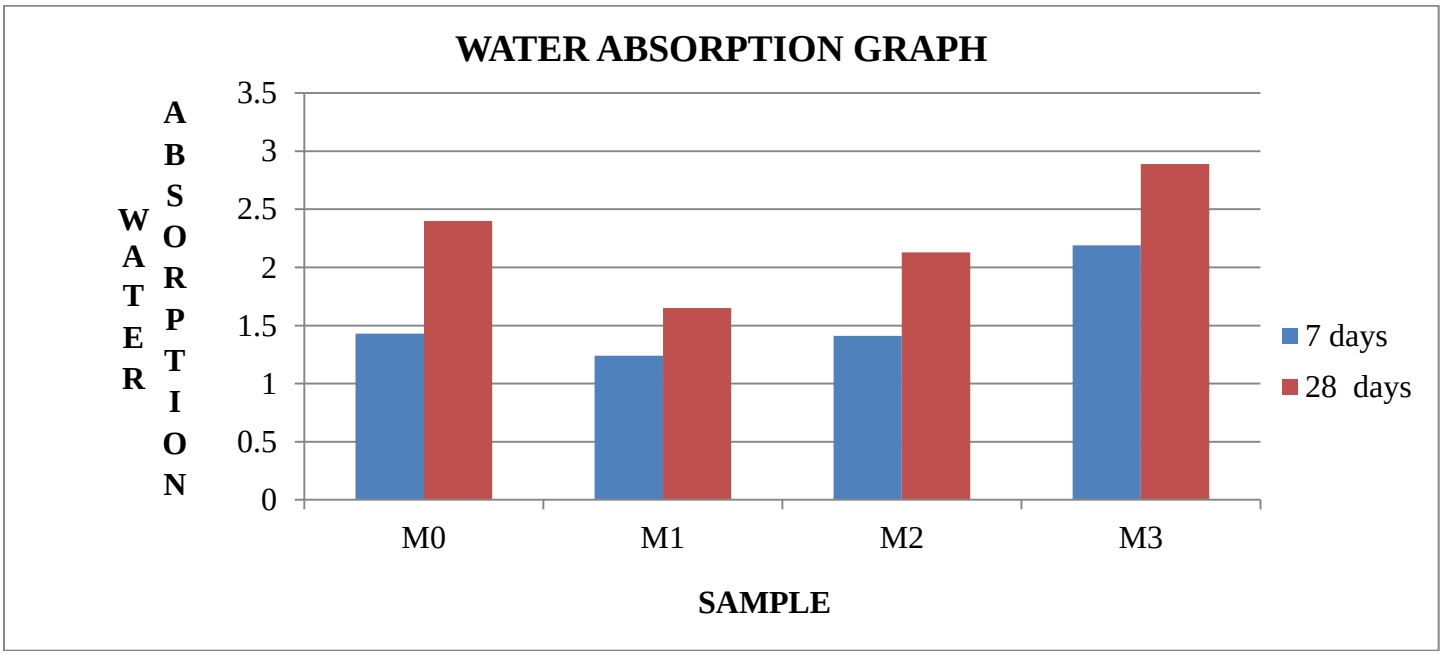


**Figure 2: Water absorption value after 7 and 28 days**

**Table 4. COMPRESSIVE STRENGTH RESULT (IN N/MM²)**

| S.N. | SAMPLE | 7 DAYS | 28 DAYS |
|---|---|---|---|
| 1 | M0(0% Zeolite) | 13.5 | 20 |
| 2 | M1(10% Zeolite) | 13.33 | 20.44 |
| 3 | M2(20% Zeolite) | 13.12 | 16.22 |
| 4 | M3(30% Zeolite) | 7.78 | 11.12 |

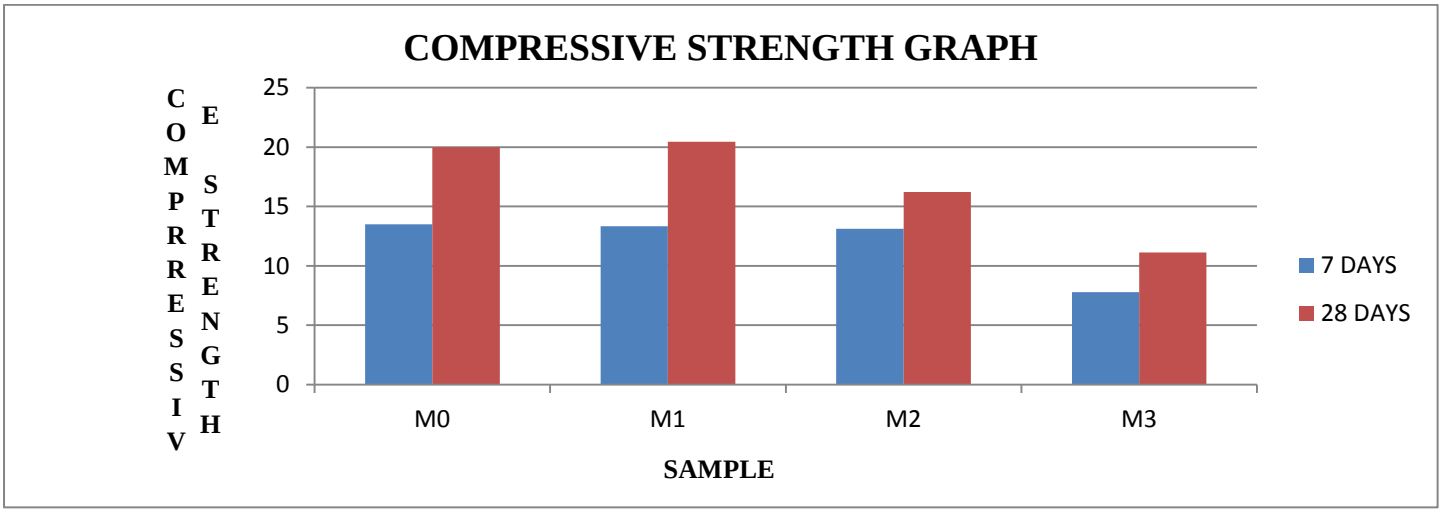


**Figure3: Compressive strength value after 7 and 28 days**

**Table 5.CO2 ABSORPTION VALUE (IN MOLE)**

| S.N. | SAMPLE | 7 DAYS | 28 DAYS |
|---|---|---|---|
| 1 | M0(0% Zeolite) | 0 | 0 |
| 2 | M1(10% Zeolite) | 0.44 | 0.58 |
| 3 | M2(20% Zeolite) | 0.48 | 0.73 |
| 4 | M3(30% Zeolite) | 0.74 | 0.96 |

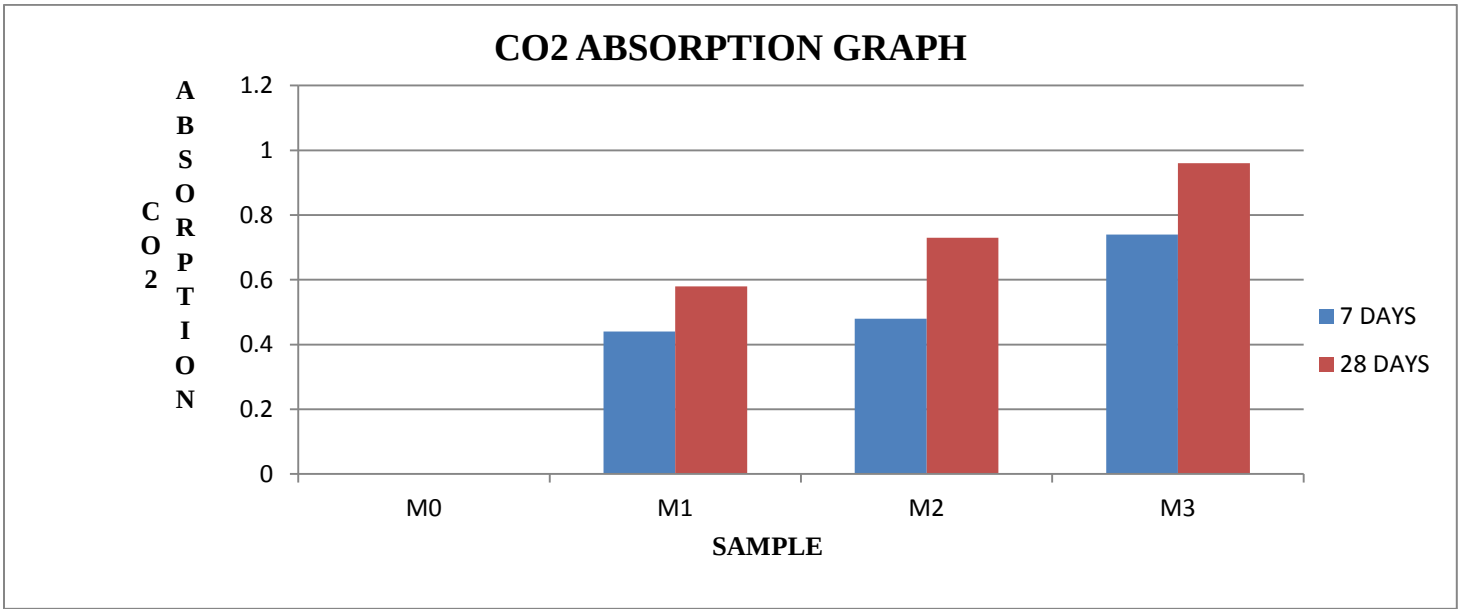


**Figure 4:CO2 absorption value after 7 and 28 days**

## VI. CONCLUSIONS

From the results of this experimental study, the following conclusions can be drawn:

1) The behavior of zeolite powder is different from cement. It helps for consuming the amount of CO2 which is used as fine aggregate in mortar.
2) It is a perfect substitute of fine aggregate in mortar.
3) The highest value of compressive strength was obtained 20.44N/mm2at 10% replacement of cement with zeolite powder.
4) The compressive strength of concrete was increasing as decrease in the replacement proportions of cement with zeolite powder.
5) It balances the environmental issues and also acts as a substitute material.
6) It reduces the cost of construction.
7) Concrete (By using zeolite) has the capacity of absorbing CO2 without any emission of it. The zeolite concrete block of size 15x15x15 cm has ability to absorb around (0.982) ,1 mole of CO2 in 35 to 40 days without affecting its strength and durability.
8) 10% replacement of cement by zeolite can yield a concrete which absorb minimum water.
9) It is eco-friendly. It reduces cost of construction. On the other hand, economical and technical point of view, its reducing construction cost without compromising of strength.

## REFERENCES

**1.** Uzal, B. et al. "Pozzolanic Activity of Clinoptilolite: A Comparative Study with Silica Fume, Fly Ash and a Non-Zeolitic Natural Pozzolana." Cement and Concrete Research 40 (2010): 398-404.

**2.** Ahmadi, Babak& Shekarchi, Mohammad. (2010). Use of natural Zeolite as a supplementary cementitious material. Cement and Concrete Composites. 32. 134-141. 10.1016/j.cemconcomp.2009.10.006.

**3.** Uzal, B. & Turanlı, L... (2012). Blended cements containing high volume of natural zeolites: Properties, hydration and paste microstructure. Cement and Concrete Composites. 34. 101–109. 10.1016/j.cemconcomp.2011.08.009.

**4.** S. Subash.S, G. Sasikumar.G, V. Praveenkumar.V, V. R. KarthikeyanV.R, Er. K. Jegan Mohan. "Partial Replacement of Zeolite with Cement." Imperial Journal of Interdisciplinary Research (IJIR) 2.5 (2016): 449-453.

**5.** Eva Vejmelkova, Dana Konˇakova, Tereza Kulovana, Martin Keppert, Jaromir Z umar, Pavla Rovnanikova, Zbyne k Keršner, Martin Sedlmajer, Robert C erny "Engineering properties of concrete containing natural zeolite as supplementary cementitious material: Strength, toughness ,durability and hydrothermal performance cement and concrete composites Vol.55,(2015) pp 259-267M.

**6.** Ikotun, Bolande&Ekolu, Stephen. (2010). Strength and durability effect of modified zeolite additive of concrete properties construction and building materials. 24. 749-757. 10.1016/ j. conbuildmat.2009.10.033.