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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT BY ZEOLITE IN M40 CONCRETE

[1]G.Vinoth Kanna,[2] P.Ranjith Kumar
[1]Assistant professor,[2]UG Scholar
[1,2]Department of Civil Engineering
[1,2]S.A Engineering College

Abstract*— The purpose of this research is to find the suitability of Zeolite with the high performance concrete M40 grade. The experimental studies were divided into Preliminary tests were conducted to find the properties of materials used in concrete to carry out the mix design. A fresh concrete test was made to study the workability properties of partial replacement of zeolite concrete and conventional concrete. Hardened concrete tests on cubes, prisms and cylinders were made to study the strength of concrete made of, partial replacement of zeolite concrete and conventional concrete. The content of water has been replaced by super plasticizer as per manual mix design according to IS 10262.The influence has been studied in different proportioning (0%, 10%, 20% & 30%) of zeolite powder to improve the performance characteristics of concrete. Hardened concrete properties of all strength of the concrete on 7, 14, & 28 days has been achieved .The maximum strength had attained at 20% of replacing of zeolite powder with cement.

***IndexTerms*— OPC53 Grade Cement, Zeolite, Flyash, River Sand**

I. INTRODUCTION

1.1GENERAL:

There are several construction techniques as well as construction material used presently. Most of the materials used are detrimental to the environment which cause of several calamities. This detrimental material concludes cement, aggregate, sand and admixtures etc. Even now days we are preceding constructions with advance construction material like polymer rubbers as well as different sands etc. Though we use advance material we are far away from dominating pollution intensity. That is only reason we are facing multitudinous problems. But still we are unable to reduce percentage emission of carbon dioxide. As it is been found that obtuse quantity of carbon dioxide get expelled from construction; impending it would definitely reduce the total percentage of carbon dioxide. An experimental investigation was carried out to evaluate the mechanical and durability properties of concrete mixtures containing natural zeolite (NZ), Natural zeolite is a crystalline hydrated aluminosilicate and alkaline earth cations having an infinite, open and three dimensional structures. This low-cost natural mineral is generally easily mined by the surface methods. Huge beds of zeolite-rich sediments were discovered in the United States, China and in many other parts of the world since the late 1950s. In concrete industry, natural zeolites have been used as lightweight aggregate, mineral admixture and partial replacement for cement through pozzolanic reaction. Expanded zeolitic tuff is widely used as Lightweight insulating materials or lightweight aggregates in concrete in many countries.

1.2 SCOPE OF THE PROJECT

- To increase the strength and workability of concrete.
- It is a more beneficial technology in utilization of ZEOLITE, which otherwise might be disposal issues.
- The ZEOLITE reduces the co2 emission.
- To identify the various factors affecting strength and workability of concrete by using ZEOLITE.
- To identify the water cement ratio required for ZEOLITE concrete.
- To compare the cost of works.
- The addition of ZEOLITE to a concrete
- Mixture has been increase corrosion
- Resistance and self-weight..

II.LITERATURE SURVEY

[1]**B. Uzal et.al.(2009)** 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 pozzolan. The results showed that the clinoptilolite possessed a high lime–pozzolan reactivity that was comparable to silica fume and was higher than fly ash and a non-zeolitic natural pozzolan. The high reactivity of the clinoptilolite is attributable to its specific surface area and reactive SiO_2 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.

[2]**Babak Ahmadi and Mohammad Shekarchi (2009**) 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 thermo 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

[3]**B.Uzal and L.Turanl(2011)** studied the properties and hydration characteristics as well as paste microstructure of blended cements containing 55% by weight zeolitic tuff composed mainly of clinoptilolite mineral were investigated. Superplasticizer requirement and compressive strength development of blended cement mortars were also determined. The blended cements containing high volume of natural zeolites were characterized with the following properties; (i) no free Ca(OH)2 in hardened pastes at the end of 28 days of hydration, (ii) less proportion of the pores larger than 50 nm when compared to portland cement paste, (iii) complete decomposition of crystal structure of zeolite at the end of 28 days of hydration, (iv) presence of tetra calcium aluminate hydrate as a crystalline product of pozzolanic reaction, (v) more compatibility with the melamine-based superplasticizer when compared to the naphthalene based product, and (vi) similar 28 days compressive strength of mortars to that of reference portland cement.

[4]**F. Canpolat et.al.(2003)** studied the effects of zeolite, coal bottom ash and fly ash as Portland cement replacement materials on the properties of cement are investigated through three different combinations of tests. These materials are substituted for Portland cement in different proportions, and physical properties such as setting time, volume expansion, compressive strength and water consistency of the mortar are determined. Then, these physical properties are compared with those of PC 42.5. The results showed that replacement materials have some effects on the mechanical properties of the cement. The inclusion of zeolite up to the level of 15% resulted in an increase in compressive strength at early ages, but resulted in a decrease in compressive strength when used in combination with fly ash. Also, setting time was decreased when zeolite was substituted. The results obtained were compared with Turkish Standards (TS), and it was found that they are above the minimum requirements

[5]**Meysam Najimi et.al. (2012)** studied the application of natural zeolite as a supplementary cementitious material has been investigated. To this aim, some mechanical and durability properties of concrete made with 15% and 30% of natural zeolite are studied in comparison with concrete without natural zeolite replacement. The results revealed considerable effectiveness of natural zeolite application on water penetration, chloride ion penetration, corrosion rate and drying shrinkage of concrete; however, satisfactory performance was not observed in acid environment. Altogether, from the practical point of view, the incorporation of 15% natural zeolite was found as an appropriate option for improving strength and durability properties of concrete.

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III. COLLECTION OF MATERIALS

3.1 Cement:

Ordinary Portland cement of Birla gold conforming to IS 269-1976 and IS 4031-1968 was adopted in this work. The cement used is 53 grade. Cement is a generic term that can apply to all binders.

3.2 Fine Aggregate:

The sand which was locally available and passing through 4.75mm IS sieve is used. The specific gravity of fine aggregate was 2.60. Locally available river sand conforming to Grading zone I of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens.

3.3 Coarse Aggregate:

Aggregates generally occupy 70 to 80 percent of the volume of concrete and can therefore be expected to have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone or natural gravels) and sands, although synthetic materials such as slag and expanded clay or shale are used to some extent, mostly in lightweight concretes.

3.4 Water:

Water is a key ingredient in the manufacture of concrete. It is also material on its own right. Understanding its properties is helpful in gaining and understanding of its effects on concrete and other building materials. It should be free from organic matter and the pH value should be between 6 to 7.

3.5 ZEOLITE:

In construction many material are used for partial replacement cement with fiber glass, ash, etc. By using zeolite may reduce the consumption of cement in concrete.it reduces of production of co2 while production of cement in industries. Natural zeolite as volcanic or volcano sediment material has a3D frame structure and is classified as a hydrated alumino silicate of alkali and alkaline earth cations. Crystals are characterized by a honeycomb like structure with extremely small pores .To eliminate 1 billion tonnes of CO2 per year. Through the concrete sector, approximately 50% of the clinker factor (CF) of Portland cement must be replaced with materials produced with very low carbon dioxide emissions. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of zeolite mineral are available in china and volcanic places are generated in natural stone processing plants with an important impact on environment and human. Natural Zeolite is a popular type of natural pozzolan which has been widely utilized in constructions since ancient times. Zeolite group of minerals currently include more than forty naturally occurring species, and is the largest group of silicate minerals. Clinoptilolite, heulandite, analcime, chabazite, and mordenite are the most common types of natural zeolite minerals on the earth. It is known that they show considerable pozzolanic activity despite their distinct crystalline structure. Pozzolanic activity of natural zeolites has been principally attributed to dissolution of zeolitic crystals of three dimensional framework structures under the attack of hydroxyl ions available in hydrating cementitious system. Application of natural zeolite in the manufacture of pozzolanic cements began from the first decades of the 20th century and shows a growing trend in recent decade . It is reported that in the construction of the Los Angeles aqueduct with 240 mile long in 1912, about 25% of cement was replaced by zeolite leading to economic benefits. Recently, the most important utilization of natural zeolite in cement and concrete industry is reported in China. As mentioned by Feng and Peng in 2005, the total quantity of zeolite consumed for this purpose was as much as 30 million tons per year in China.

Figure 1. ZEOLITE POWDER

IV. RESULT AND DISCUSSION

4.1 FRESH CONCRETE TEST

4.1.1 Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199-1959 is followed**.** Slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality.

- Slump is measurement of concrete's workability, or fluidity.
- It's an indirect measurement of concrete consistency or stiffness**.**

Workability of the concrete in slump cone test is 110mm.

4.2 HARDENED CONCRETE TESTING

4.2.1 Compression strength test

The specimen is tested by compression test machine after 7 days, 14 days and 28 days curing. Load should be applied gradually at the rate of 140kg/cm2 per minute till specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Figure 2. Compression strength test

4.2.2 Flexural test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 6 inch * 6 inch concrete beam with a span length of at least three times the depth.

Figure 3. Flexural test

4.2.3 Split tensile test

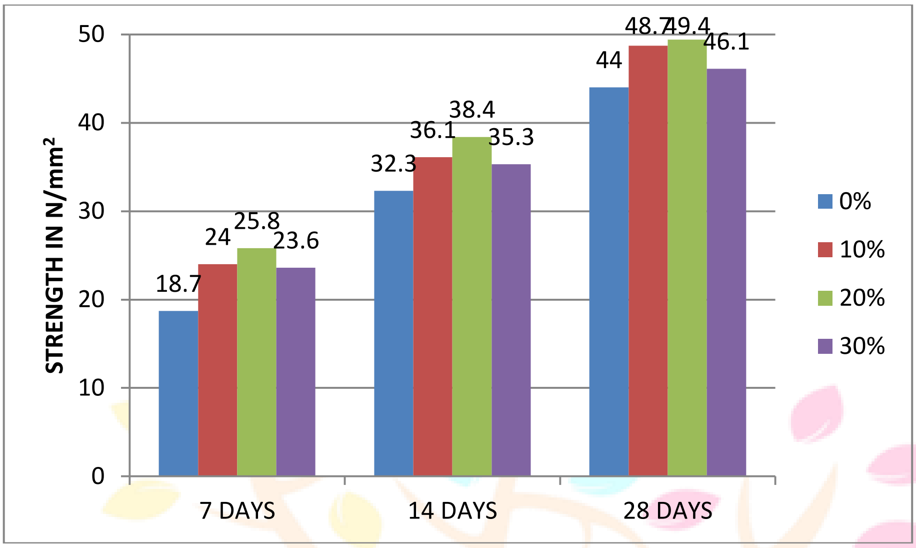
The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete.

The concrete is very weak in tensile due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may cracks.

Figure 4. Split tensile test

Table 1. Compression Strength Test Results

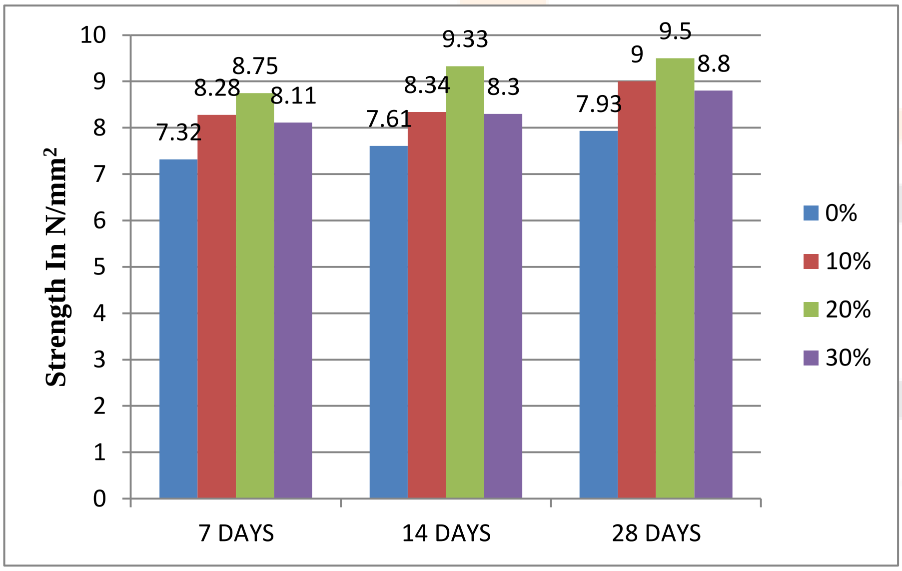
Percentage of Zeolite (%)	7 days/N/mm^2	14 days/ N/mm^2	28 days/ N/mm^2
0	18.7	32.3	44
10	24	36.1	48.7
20	25.8	38.4	49.4
30	23.6	35.3	46.1



Graph 1. Bar Chart for Compressive Strength

Table 2. Flexural Strength

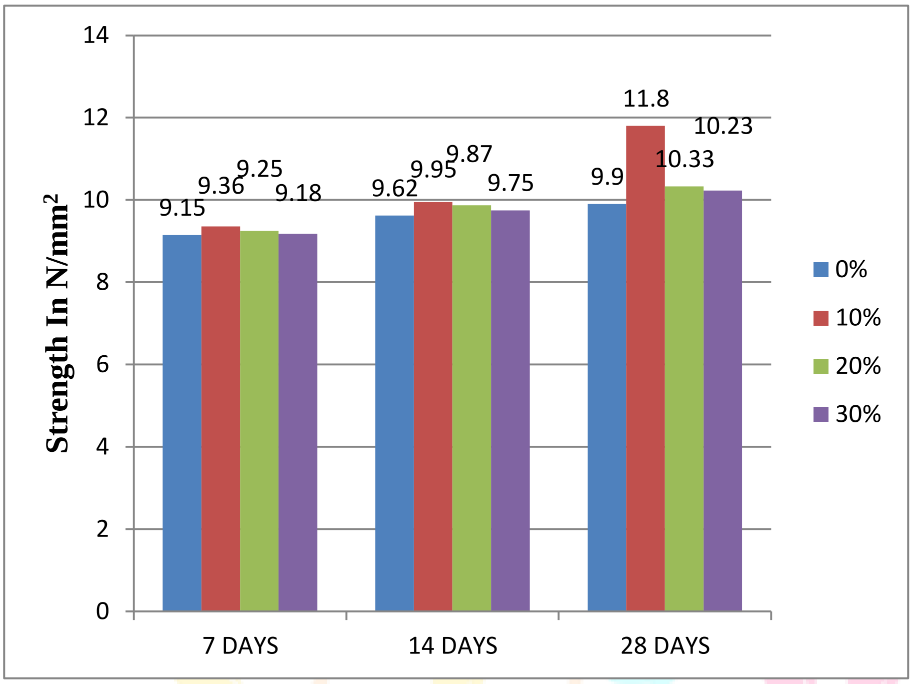
Percentage of Zeolite (%)	7 day/ N/mm^2	14 days/ N/mm^2	28 days/N/mm^2
0	7.32	7.61	7.93
10	8.28	8.34	9
20	8.75	9.33	9.5
30	8.11	8.3	8.7



Graph 2. Bar Chart for Flexural Strength

Table 3. Split Tensile strength

Percentage of Zeolite (%)	7 days/ N/mm2	14 days/ N/mm2	28 days/ N/mm2
0	9.15	9.62	9.90
10	9.36	9.95	11.80
20	9.25	9.87	10.33
30	9.18	9.75	10.23



Graph 3. Bar Chart for Split tensile strength

V.CONCLUSION

The following conclusions are presented based on experimental results from the present investigation.

- Slump is decreasing with the addition of zeolite. More the zeolite-cement ratio, more is the decrease in slump due to absorbency of water by zeolite. Hence the use of proper super plasticizer which does not effect other properties except workability is recommended for higher zeolite-cement ratios.
- Compressive strength at 10%, 20% and 30% were 48.7 N/mm2, 49.4 N/mm2and 46.1% respectively. The percentage increase in strength at 10%, 20% and 30% were 10.6%, 12.27% and 4.77% respectively compared to conventional concrete of strength 44 N/mm2.
- Flexural strength at 10%, 20% and 30% were 9 N/mm2, 9.5 N/mm2 and 8.7 N/mm2 respectively. The percentage increase in strength at 10%, 20% and 30% were 13.46%, 19.79% and 9.71% respectively compared to conventional concrete of strength 7.93 N/mm2.
- Split tensile strength at 10%, 20% and 30% were 11.8 N/mm2, 10.33 N/mm2 and 10.23 N/mm2 respectively. The percentage increase in strength at 10%, 20% and 30% were 19.19%, 4.34% and 3.33% respectively compared to conventional concrete of strength 9.9N/mm2.

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