Evaluating The Influence of Zeolite Powder And Zeolite Sand on Mechanical Properties of M25 And M30 Grade Concrete

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Abstract- *The increasing demand for infrastructure due to the continuous population growth, and the high rate of urbanization, have led to increased consumption of concrete. The rapid production of cement creates big problems to environment. First environment problem is emission of CO2 during the production process of the cement. The CO2 emission is very harmful which creates big changes in environment. According to the estimation, 1 tone of carbon dioxide is released to the atmosphere when 1 tone of ordinary Portland is manufactured. As there is no alternative building material which totally replace the cement. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. To overcome this issues zeolite material is introduced in concrete to absorb carbon dioxide from the environment and also to reduce the cement and natural river sand in construction. This paper presents an experimentally investigation to evaluate the compressive strength, split tensile strength and flexural strength of concrete with zeolite powder as partial replacement to cement and zeolite sand as a fine aggregate replacing material. Hence, this project is aimed at decreasing the hazardous problem causing by cement, by way of conducting experimental program with the replacement of zeolite in desired percentages in order to increase the strength properties..*

Keywords- Zeolite powder, Zeolite sand, Compressive strength, split tensile strength test, flexural strength test.

I. INTRODUCTION

In the construction field, Cement is the main ingredient for the production of concrete. But the production of cement requires large amount of raw material. During the production of cement burning of lime stone take place which results in emission of carbon dioxide (CO2) gas into the atmosphere. There are two different sources of CO2 emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of burning limestone.

In the last three decades, supplementary cementitious materials such as fly ash, silica fume and ground granulated blast furnace slag have been judiciously utilized as cement replacement materials as these can significantly enhance the strength and durability characteristics of concrete in comparison with ordinary Portland cement (OPC) alone, provided there is adequate curing. Fly ash addition proves most economical among these choices, even though addition of fly ash may lead to slower concrete hardening. However when high strength is desired use of silica fume is more useful however, this product is rather expensive.

There are many materials available to reduce the usage of cement and fine aggregate in concrete production. One of them is natural zeolite which is partly replaced as a substituent for cement and sand. By reducing the amount of cement and natural sand in concrete gives both economical and ecological benefits. By using natural zeolite in concrete for cement and fine aggregate can absorbs carbon dioxide from the atmosphere. Carbon dioxide reduction is the required process to control the environmental pollution.

The main objective of the present study is to know the influence of zeolite powder and zeolite sand on properties of concrete and detecting workability, compressive strength, flexural and tensile strength on comparison with conventional concrete and M25, M30 grade concrete.

II. REVIEW OF LITERATURE

This part of the study deals with the review of several research papers related to compressive strength and workability of concrete poised by employing various source materials such as fly ash, zeolite etc. But considering availability of material and cost considerations many researchers studied various properties of concrete are given below.

Anas Shahid Multani, A K Nigam (2017) Investigated on Partial Replacement of Cement with Metakaolin in Association with Super Plasticizer. Metakaolin seems to be an auspicious additional cementitious material for superior cement. Properties of cement with metakaolin are for the most part favoured added substances in superior cement. The metakaolin consolidations increment the quality of the concrete specimens. In this work, the impact of various contents of Metakaolin included to concrete containing super plasticizer its compressive quality strength and workability has been contemplated. Samples with 0%, 5%, 10%, 15%, 20% and 25% content of metakaolin replacing the cement have been evaluated for M30 grade. The outcomes have been contrasted and those for the control test and practicality of adding metakaolin to concrete has been examined. It was watched that up to 15% of concrete can be supplanted with metakaolin blended with superplasticizer.15% substitution is the ideal rate at which expanded quality of test sample is seen from the base sample test.

Deb, P. S., Nath, P., & Sarker, P. K. (2014): Ground granulated blast furnace slag (GGBS) with mixture of flyash content showing huge improve in the consequences of workability and high strength contrasted with Ordinary Portland Cement (OPC). By changing dissimilar (0%,10% and 20%)contents of Ground granulated blast furnace slag (GGBS) with various proportions of flayash content showing a few blemishes, One of them is with increment in GGBS content workability is diminishing simultaneously strength is expanding. By keeping up silicates to alkaline proportions of 1.5 to 2.5 and following ACI 318 and AS 3600 codes for curing we can accomplish above outcomes when contrasted with OPC.

Goriparthi, M. R., & TD, G. R. (2017): He arranged geopolymer concrete consolidating fly ash and ground granulated blast furnace slag (GGBS) as a limiting material, Alkaline materials Sodium silicate (Na2SiO3) and Sodium Hydroxide (NaOH) as activators. And contrasted the consequences of both OPC and geopolymer concrete and closed the accompanying aftereffects of two evaluations of concrete GPC20 AND GPC50. Significant boundaries of corrosive mass misfortune factor (AMLF) by submerging in 5% of H2SO4 solution and strength properties (Compressive, Tensile and Flexure) were resolved.

Mr. R. Srinivasan et al., has investigated on “Experimental Study on pulp Ash in Concrete” that they had ascertained that Sugar Cane pulp is fibrous waste-Product of sugar industry, and inflicting serious environmental drawback that principally contain metal particle and oxide. Hear pulp ash has been with chemicals and physically characterised, and part replaced within the quantitative relation of 1/3, 5%, 15%, twenty fifth by weight of cement in concrete.

G. Mertens, et al (2009): The Pozzolanic reaction between portlandite and different types of nearly pure natural zeolite was studied. Analcime, phillipsite, chabazite, erionite, mordenite and clinoptilolite-rich tuffs were mixed with portlandite and water (1:1:2 by weight), and the progress of the Pozzolanic reaction was quantitatively determined by thermo gravimetrical analyses from 3 to 180 days. A thorough characterization of the raw materials was performed by quantitative XRD, XRF, SEM-EDX, BET specific surface area measurements, grain-size analyses, FTIR and Cat ion Exchange Capacity measurements.

Dipayan Jana (2007): most common natural zeolite occurring as widespread tuffaceous lacustrine sedimentary deposits in the Western United States was used as a pozzolan at 0 to 40 percent by mass of Portland cement replacements in concrete mixtures to investigate the effects of zeolite on fresh and hardened concrete properties, and durability. Fresh concrete properties, e.g., temperature, air content, yield, unit weight were apparently unaffected by zeolite incorporation. A reduction in bleeding, and an accelerated initial setting at 10 to 30 percent cement replacement levels was noticed by zeolite.

III. MATERIALS AND METHODS

The experimental investigation work is started with various tests on the constituent materials. The constituent materials are given below.

1. Cement
2. Coarse aggregate
3. Water
4. Fly ash
5. Metakaolin.
6. Super plasticizer

Cement

Ordinary Portland Cement (OPC) was used in the experimental work which is conforming to I.S 4031-1988.The O.P.C is classified into three grades, those are 33grade, 43grade and 53 grade, depending upon the strength of the cement in this experiment 43grade cement is used.

Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through

4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970.

Coarse Aggregate

The crushed aggregates used were of 20mm nominal maximum size.Aggregate most of which is retained on 4.75-mmIS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

Zeolite Powder

Zeolite is also available in powder form for the partly replacement for cement in concrete. It has the good pozzolanic reactivity and ability to absorb carbon dioxide from the atmosphere. Specific gravity of zeolite powder is 2.8, fineness modulus is 3.3%, and water absorption is 1.5%. Silica content is 80.5%, alumina is 4.2%, iron oxide is 2.2%, magnesia is 1.5%, and lime is 4.3%..

Zeolite sand

The origin of zeolite is a rock which contains alumnium, silicon, and oxygen. It is a natural mineral available in fine aggregate form. This zeolite sediments bed was obtained in many regions of the world. It is also used as partly replacement for fine aggregate in concrete. Specific gravity of zeolite sand is 2.7. Fineness modulus is 3.0, and water absorption is 1.5%

Superplasticizer

Naphthalene based super plasticizer namely Fosroc Conplast SP430 is a chloride free, super plasticizing admixture based on sulphonated naphthalene polymer is used to upgrade or boost the workability as well as strength of concrete. The dosage is raging from 1.00 to 3.00 litres per 100 kg of cementitious material.

IV. MIX DESIGN

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance. Percentage dosage of super plasticizer was fixed as per the mix design method described in IS 10262- 2009. Mix proportion was arrived through various trial mixes. The grade of concrete prepared for the experimental study was M25 and M30 grade concrete.

V. TESTS ON FRESH CONCRETE

5.1 WORKABILITY OF CONCRETE

It is the important property of fresh concrete which gives the behavior of concrete from mixing to compaction. The workability of concrete is the most complex property, which is difficult to define and measure. A concrete which has high consistency and which has high consistency and which is more workable, need not be of right workability for a particular job. Every job requires a particular workability.

The vertical settlement of unsupported fresh concrete, flowing to the sides and sinking in height is known as slump. Slump is a measure indicating the consistency or workability of cement concrete.

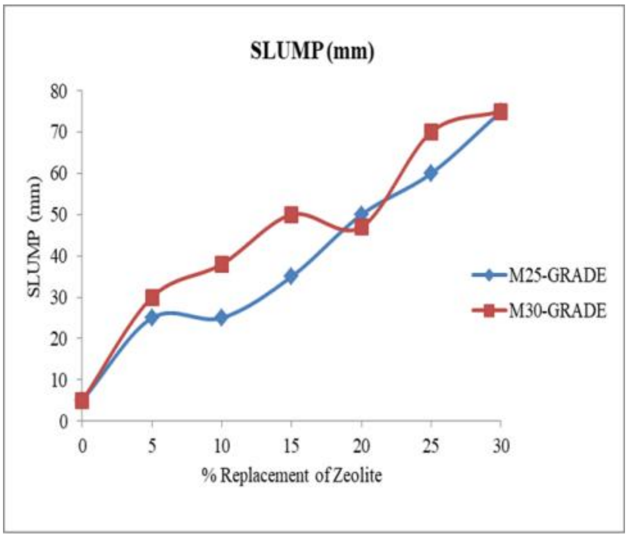

Fig 5.1: Plot shows the Variation of Slump Values for % replacement of natural zeolite-M25 & M30 Grade

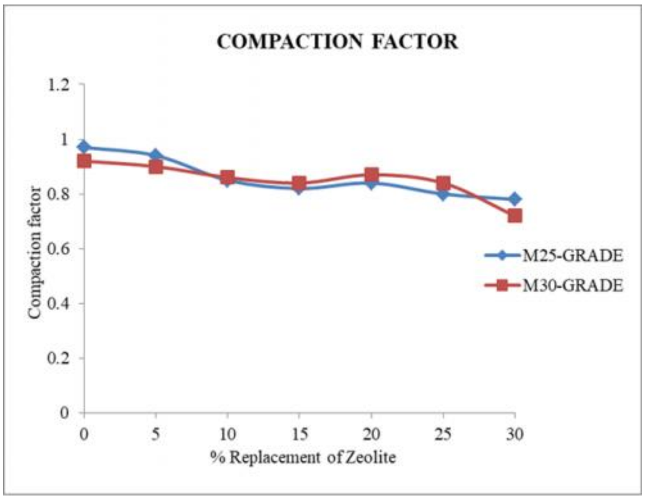

Fig 5.2: Plot shows the Variation of Compaction factor Values for % replacement of natural zeolite-M25 & M30 Grade

VI. TESTS ON HARDENED CONCRETE

6.1 VARIATION OF COMPRESSIVE STRENGTH FOR DIFFERENT MIXES

Compressive strength of concrete replaced with palm oil fuel ash for curing period of 7-days, and 28-days respectively and figure shows the summarized Compressive strength Results for different curing periods– M25 & M30 grade.

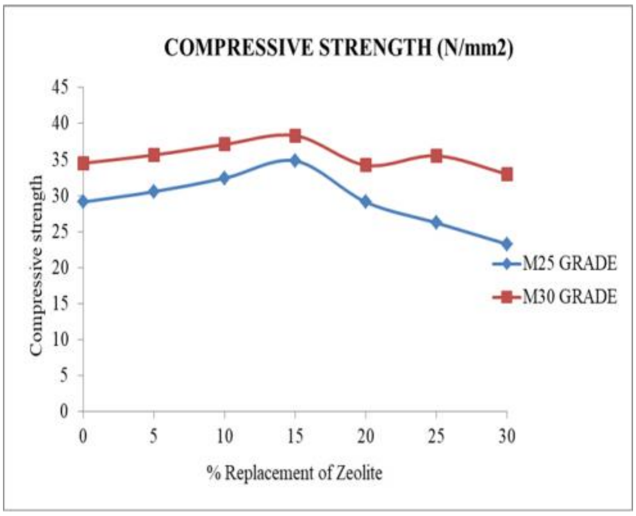

Fig 5.3: Plot shows the Variation in Compressive Strength for % Replacement of zeolite for M25 & M30 Grade concrete

As the percentage of zeolite powder (ZP) and zeolite sand (ZS) increases the compressive strength of concrete tends to increase up to certain percentage and then start's decreasing with the increase of ash content.

The strength of 15% zeolite powder (ZP) and zeolite sand (ZS) concrete is more than remaining percentages of concrete. This shows that till 15% zeolite powder (ZP) and zeolite sand (ZS) in concrete the strength increases .

This increase in strength in natural zeolite concrete is due to presence of Silica in zeolite. Silica in zeolite powder (ZP) and zeolite sand (ZS) react with residual CH after the formation of C-S-H gel, and increase the amount of C-S-H gel and results in increase the strength.

6.2VARIATION OF SPLIT TENSILESTRENGTH FOR DIFFERENT MIXES

The size of specimens 150 mm dia and 300 mm length was used and the specimens were cured in normal water. Concrete specimen cubes are used to determine split tensile strength of concrete and were tested as per as per IS 516 (1959) and IS 5816 (1999).

Split tensile test is also used to determine the tensile stress in concrete; this method is also called as Brazilin test. In this we place the cylindrical specimen of size 300 mm height and 150 mm diameter is placed in horizontal between the loading surfaces of compression test machine and load is applied until the failure of the specimen along the vertical diameter. This test is performed as per IS: 5816 code.

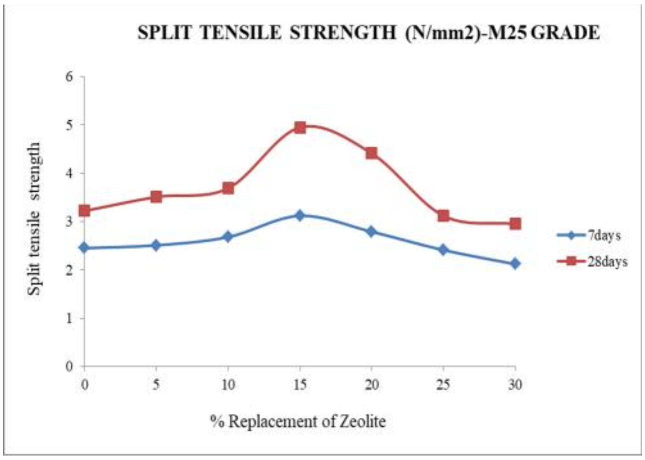

Fig 6.4: Plot shows the Variation in Split Tensile strength for different percentages of zeolite for M25 Grade concrete

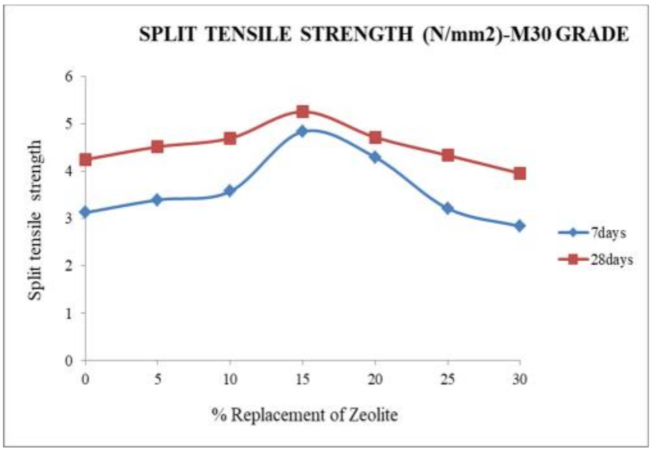

Fig 6.5: Plot shows the Variation in Split Tensile strength for different percentages of zeolite for M30 Grade concrete

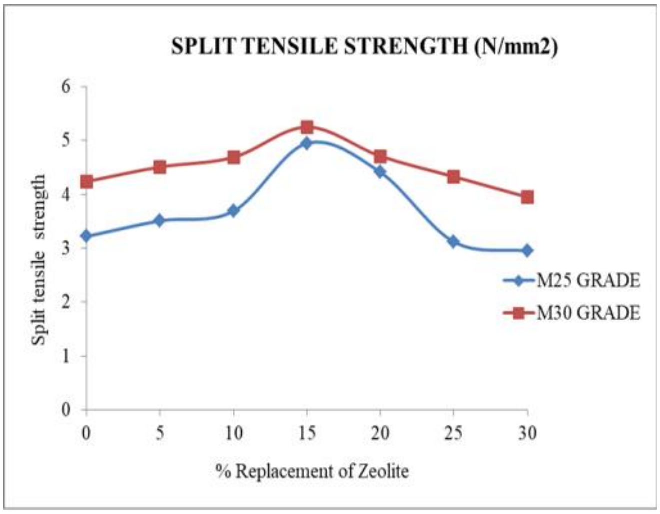

Fig 6.6: Plot shows the Variation in Split Tensile strength for different percentages of zeolite for M25 & M30 Grade concrete

6.3 VARIATION OF FLEXURAL STRENGTH FOR DIFFERENT MIXES

Tensile stress is developed in concrete due to drying shrinkage, rusting of steel reinforcement, temperature gradient and many other reasons. Therefore, the knowledge of tensile strength of concrete is important. We measure the tensile strength of concrete in indirect method like flexural test. In flexural test we find the modulus of rupture (extreme fibre stress in bending), this value depends up on the dimension of beam manner of loading. In the flexural test two types of loading conditions, there are central point loading, third point loading. In our experimentation use third point loading with a size of beam is 70 x 15 x 15 cm. this test performed as per IS: 516 code.

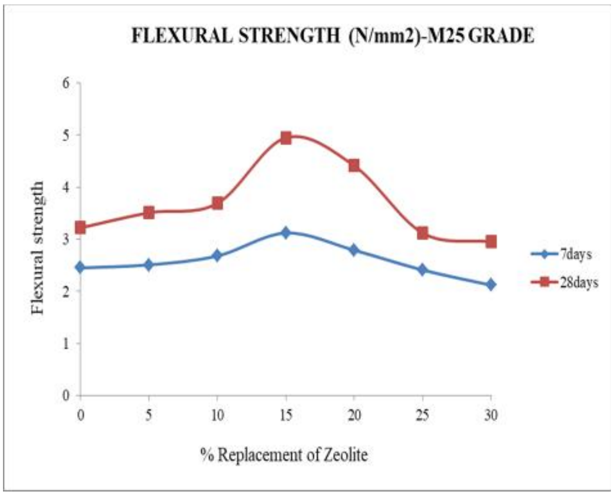

Fig 6.6: Plot shows the Variation in flexural strength for different percentages of zeolite for M25 Grade concrete

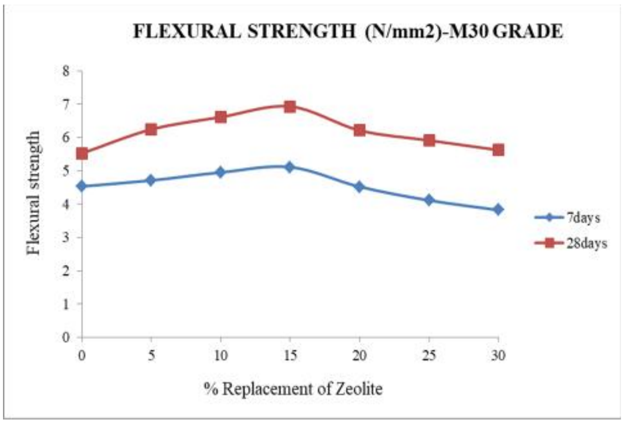

Fig 6.7: Plot shows the Variation in flexural strength for different percentages of zeolite for M30 Grade concrete

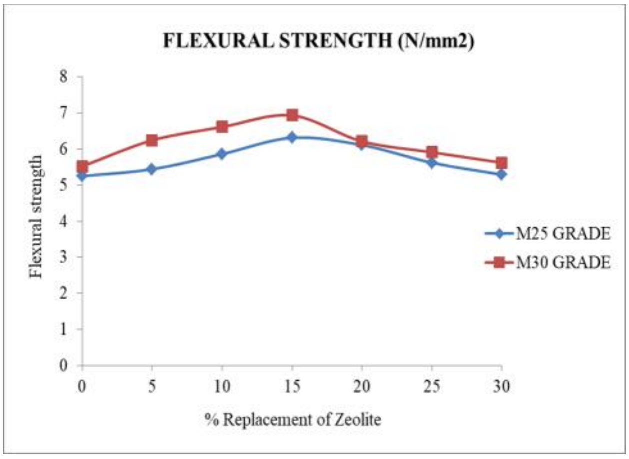

Fig 6.8: Plot shows the Variation in flexural strength for different percentages of zeolite for M25 & M30 Grade concrete

VII. CONCLUSION

The Conclusions and Recommendations that could be drawn from the results of this project and experiments are summarized and the use of zeolite powder (ZP) and zeolite sand (ZS) as a cement and fine aggregate replacing material in concrete production was studied and after the research work is done, the following conclusions were made:

- It has been observed that by the incorporation of zeolite in fresh and plain concrete decreases workability when compared to the workability of normal concrete.
- Zeolite concrete performed better when compared to ordinary concrete up to 15% replacement of zeolite powder (ZP) and zeolite sand (ZS). The bond strength exhibited improvement with zeolite replacement level.

- The significant improvements in strength characteristics were observed with zeolite powder and zeolite sand in concrete. For M25, the compressive strength achieved after 15 percent replacement of zeolite powder and sand for 28 days curing was 34.82N/mm2, and for M30, the compressive strength obtained after 15 percent replacement of zeolite powder and sand for 28 days curing was 38.34N/mm2.
- Split tensile strength for cylindrical specimens is maximum at 15% for M25 was 4.95N/mm2, and maximum at 15% for M30 was 5.25 N/mm2 of replacement of zeolite powder and sand for 28 days curing.
- Flexural strength maximum at 15% for M25 was 6.31 N/mm2, and maximum at 15% for M30 was 6.93 N/mm2 of replacement of zeolite powder and sand for 28 days curing.
- It is evident from the present investigation that the replacement of zeolite powder and zeolite sand to concrete improve strength properties of the mix.
- Thus zeolite is a good alternative for replacing cement by incorporating good mechanical properties into the blended cement. The use of zeolite powder and sand combined is economic when compared to cement in concrete. Likewise reduces the cement price rise and intensities of CO2 release by the cement production. Also these materials make the concrete more sustainable, light weight and low energy emitting which is noble.

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