Experimental Study on Concrete using Zeolite Sand and Zeolite Powder as Partly Replacement for Fine Aggregate and Cement

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***Abstract*- Concrete is used most preferably in construction field for their high compressive strength and its properties. In this field one of the disadvantages is carbon dioxide emission from the concrete and from manufacturing of cement. 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 and split tensile strength and carbon dioxide absorption of concrete with zeolite sand and powder as partial replacement material. The cubes and cylinders were casted and tested at seven days, fourteen days and twenty eight days. The fine aggregate is replaced with zeolite sand by ten percentages, twenty percentages and thirty percentages. Cement is replaced with zeolite powder by ten percentages. The optimum result obtained from the replacement of thirty percentage zeolite sand and ten percentage zeolite powders in concrete attained a maximum high strength than conventional concrete.**

Keywords- Zeolite sand; zeolite powder; concrete; carbon dioxide.

I.INTRODUCTION

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.

II. MATERIALS AND THEIR PROPERTIES

A. Cement

According to the Bureau of Indian Standard, Ordinary Portland Cement has been classified in to 33, 43 and 53 grade. In this project OPC 53 grade was used for casting the specimen. Specific gravity is 3.15.

B. Fine Aggregate

The aggregate size of 4.75 mm and less is considered as fine aggregate. Natural river sand is used in this project. Specific gravity of used fine aggregate is 2.6, and fineness modulus is 2.3.

C. Coarse Aggregate

The size of aggregate bigger than 4.75 mm is considered as coarse aggregate. From various practical considerations, for reinforced concrete work, aggregates having a maximum size of 20 mm are generally considered satisfactory which passes 20 mm IS sieve. Specific gravity is 2.68, water absorption is 1%.

D. Water

Water is a most important ingredient in concrete which actively participates in the chemical reaction with cement. Water for making concrete should have the pH value range between 6 and 8.

E. 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%.

Fig.1 Zeolite Sand

F. 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%.

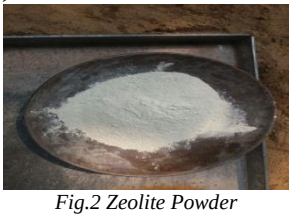

Fig.2 Zeolite Powder

III. MIX DESIGN

A. Mix Ratio

Grade designation : M30
Cement content : 394 Kg/m^3
Fine aggregate : 740.3 Kg/m^3
Coarse aggregate : 1207.84 Kg/m^3
Water : 157.6 liter/m^3
W/C ratio : 0.4
Mix Ratio : 1: 1.85: 3

B. Mix Proportions

TABLE I. DIFFERENT MIX PROPORTIONS

Mix	Cement	Fine aggregate	Coarse aggregate
1	Cement 90% + zeolite powder 10%	Fine aggregate 90% + zeolite sand 10%	Coarse aggregate 100%
2	Cement 90% + zeolite powder 10%	Fine aggregate 80% + zeolite sand 20%	Coarse aggregate 100%
3	Cement 90% + zeolite powder 10%	Fine aggregate 70% + zeolite sand 30%	Coarse aggregate 100%
Conventional Concrete	Cement 100%	Fine aggregate 100%	Coarse aggregate 100%

IV.EXPERIMENTAL ANALYSIS

A. Carbon dioxide Absorption Test

Carbon dioxide absorption from the zeolite used concrete is compared with the conventional concrete. In this test weighing balance is used. Conventional concrete and zeolite used concrete are kept in water for curing. After 7 days weight of the cubes were taken. Similarly, readings were taken on pre-planned days on 10^{th}, 14^{th}, 21^{st}, and 28^{th} day. Then carbon dioxide absorption from the cubes was calculated.

Calculation:

(1) Carbon dioxide absorbed by cube = Final weight – Initial weight / Molecular weight of carbon dioxide.

Final weight = weight of zeolite cube on 28^{th}day

Initial weight = weight of zeolite cube on 10^{th} day

Molecular weight = 44 for carbon dioxide.

TABLE II. CARBON DIOXIDE ABSORPTION TEST

On day	Mix Conventional Concrete Kg	Mix.1 ZS 10% ZP10% Kg	Mix.2 ZS 20% ZP 10% Kg	Mix.3 ZS 30% ZP 10% Kg
Weight on 10^{th} day	8.90	8.37	8.39	8.6
Weight on 14^{th} day	8.87	8.49	8.50	8.71
Weight on 21^{st} day	8.76	8.63	8.60	8.83
Weight on 25^{th} day	8.71	8.76	8.82	8.98
Weight on 28^{th}day	8.70	8.81	8.88	9.2

Result:

Amount of CO_2 absorbed by Mix.1 cube = 1.0 mole
Amount of CO_2 absorbed by Mix.2 cube = 1.1 mole
Amount of CO_2 absorbed by Mix.3 cube = 1.36mole

B. Compressive Strength Test

The strength in compression of concrete is determined from cubes of 15 cm x 15 cm x 15 cm. The cubes were tested for 7 days, 14 days, and 28 days.

(2) Compressive strength = P/A (N/mm^2)

P = Load in N

A = Area in mm^2

TABLE III. COMPRESSIVE STRENGTH TEST RESULT

Mix No	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	24.43	29.0	36.08
2	24.54	29.35	36.35
3	24.70	29.93	37.46
CC	24.0	29.43	35.38

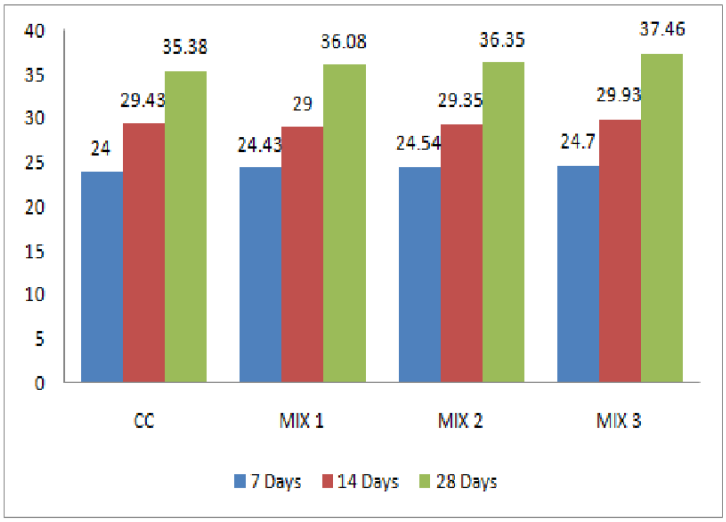

Fig.3 Compressive strength (N/mm^2) at 7, 14, 28 days

C. Split Tensile Strength Test

The split tensile strength of concrete is determined from cylinder of radius 75 mm and height 300 mm.

(3) Split tensile strength = $2P/\pi d L$

P = Maximum applied load
d = Diameter of cylinder
L = Length of cylinder

TABLE IV. SPLIT TENSILE STRENGTH TEST RESULT

Mix	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
1	2.30	3.17	3.40
2	2.22	3.11	3.60
3	2.97	3.33	3.75
CC	2.31	3.00	3.40

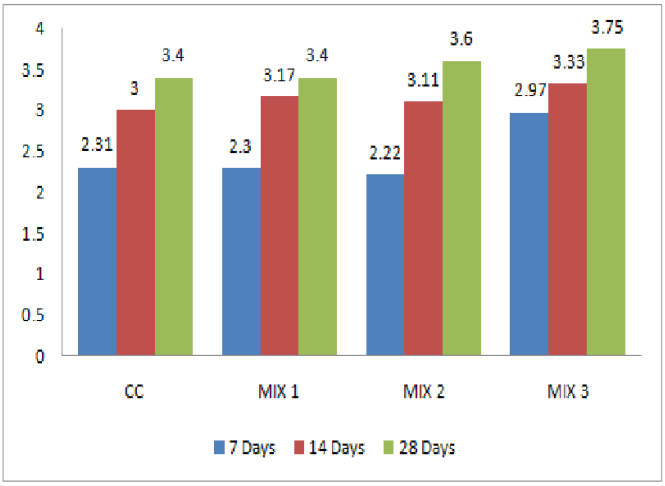

Fig.4. Split tensile strength (N/mm^2) at 7, 14, 28 days

V.CONCLUSION

The compressive strength at 28 days is found to be 6% more and split tensile strength is 10% more than conventional concrete when zeolite sand is 30% and zeolite powder is 10% replaced in concrete. So the optimum replacement ratio is zeolite sand 30% and zeolite powder 10% reached the maximum compressive and split tensile strength. The carbon dioxide absorbed by the zeolite cube proportions of zeolite powder 10% and zeolite sand 10%, 20%, 30% are 1.0,1.1,1.36 moles respectively.

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