International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 5 ǁ May 2023 ǁ PP. 810-814

A Study on Concrete Incorporated With Zeolite and Fly Ash

Ajithaa V[1], Sasi Rega M[2], Gowrishankar R[3]
[1] Department of Civil Engineering, V. S. B. Engineering College, Karur
[2] Department of Civil Engineering, V. S. B. Engineering College, Karur
[3] Head of the Department, Department of Civil Engineering, V. S. B. Engineering College, Karur

Abstract
In this paper pozzolans like zeolite and fly ash (ZFA) are used as a partial replacement for cement for producing concrete. The present study is aimed at concrete mix with partial replacement of cement by ZFA (0%, 20%, 30%) in a 1:1 ratio, which will provide a way to reduce cement proportion in concrete. This mix in the form of cubes, cylinders, and beams was subjected to compression, split tension, and flexural to ascertain the strength parameter. As the manufacturing of cement results in the emission of CO_2, a greenhouse gas. It can be said that by reducing cement quantity in concrete, a considerable amount of CO_2 generation can be reduced.
Keywords: *Fly Ash, Zeolite, Replacement, and Strength.*

Date of Submission: 16-05-2023 Date of acceptance: 30-05-2023

I. INTRODUCTION

Cement is an important construction material all over the world, hence production of cement plays a significant role in global carbon dioxide (CO2) emissions, which is approximately 2.4 percent of global CO2 emissions from industry and energy sources. The above-mentioned data clearly states that the cement manufacturing industry has some role in global warming.

This study focuses on the reduction of cement proportions in cement, mainly in concrete through incorporating pozzolanic materials i.e. Fly ash and Zeolite powder. Fly ash, being one of the major solid wastes generated from the coal industry and naturally occurring zeolite (powdered) are used in this study in two different ratios for cement replacement. By using fly ash flowability, concrete strength can be improved and thermal cracking can be reduced. In this study, we are going to find how much strength is obtained while adding fly ash and zeolite powder together as a replacement for cement in concrete in two ratios.

The use of fly ash and zeolite in concrete has recently in popularity because of their cost-effective, durable, and sustainable options in many types of concrete applications.

In this study, we have taken fly ash type F and zeolite as admixtures as replacement materials for cement in concrete. The resulting concrete is called ZFAC (Zeolite fly ash incorporated concrete). For the study two kinds of concrete ZFAC-I and ZFAC-II having fly ash and zeolite content that is 30% and 20% of the total cement content.

II. EXPERIMENTAL WORK

Type F fly ash and zeolite powder as obtained from industries has the Physic-chemical properties within permissible limits.

Cement fly ash and zeolite blends: The fly ash and zeolite is blended in concrete by weight of cement at a rate of 10% and 30%. The ZFAC -I has 10% Zeolite and 10% fly ash by weight of cement and ZFAC-II has 15% zeolite and 15% fly ash by weight of cement. The percentage of zeolite in concrete should be in the range of 10% to 20% for better results.

Concrete Mix Design: For this study, M20 grade with nominal mix as per IS 456-2000 was used. The concrete mix proportion is 1: 1.5: 3 (cement: fine aggregate: coarse aggregate) by weight and a water cement ratio of 0.55 is taken.

Strength determination: In this test sample of concrete is filled in the mould of size 15cm x 15cm x 15cm and top of mould is strike off. As a total 21 number of cubes were casted. ZFAC-I is casted in 9 specimens and ZFAC-II is casted in 9 specimens. Then after sample is removed and kept for curing in curing tank. At 7, 14, 28, days, after the initial curing test were conducted immediately after their removal from the curing tank. Three samples are taken at each specified day and tested. The testing is done under Universal Testing Machine model no. UTM 40, Yama Engineers Kolhapur make. The load is applied smoothly and gradually. The crushing loads are noted and average compressive strength for three specimens is determined for each which is given conventional in table 1, ZFAC-I in table 2, ZFAC – II in table 3. The same procedure is repeated for split tension strength cylinder having 150mm radius, 300mm depth and flexural strength beam of 500 × 100 × 100 mm as dimension. Split tension strength results of conventional, ZFAC-I, ZFAC-II is in table 4, table 5, table 6 respectively. Flexural strength results of conventional, ZFAC-I, ZFAC-II is in table 7, table 8, table 9 respectively.

Table 1. Compressive strength of conventional

	Compressive strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	12.97	13.05	13.02	13.01
14	18.28	17.94	17.86	18.02
28	20.05	19.72	19.85	19.87

Table 2. Compressive strength of ZFAC-I

	Compressive strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	11.9	12.18	12.09	12.09
14	15.30	15.38	15.36	15.34
28	20.39	20.51	20.42	20.44

Table 3. Compressive strength of ZFAC-II

	Compressive strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	12.78	12.72	12.74	12.76
14	17.42	17.8	17.47	17.45
28	21.81	21.91	21.85	21.87

Table 4. Split tensile strength of conventional concrete

	Split tensile strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	1.42	1.51	1.44	1.46
14	1.98	2.06	2.01	2.02
28	2.18	2.26	2.20	2.22

Table 5. Split tensile strength of ZFAC-I

	Split tensile strength N/mm^2			
Days	Sample 1	Sample 2	Sample 3	Average
7	1.33	1.40	1.34	1.36
14	1.93	2.02	1.96	1.97
28	2.28	2.36	2.30	2.32

Table 6. Split tensile strength of ZFAC-II

	Split tensile strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	1.40	1.47	1.41	1.43
14	1.98	2.07	2.01	2.02
28	2.36	2.48	2.40	2.41

Table 7. Flexural strength of conventional

	Flexural strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	1.84	1.92	1.87	1.88
14	2.53	2.61	2.56	2.57
28	2.76	2.84	2.79	2.8

Table 8. Flexural strength of ZFAC-I

	Flexural strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	1.65	1.73	1.68	1.69
14	2.24	2.30	2.25	2.26
28	2.80	2.88	2.83	2.84

Table 9. Flexural strength of ZFAC-II

	Flexural strength N/mm^2			
Day	Sample 1	Sample 2	Sample 3	Average
7	1.67	1.76	1.70	1.71
14	2.25	2.34	2.28	2.29
28	2.88	2.95	2.89	2.91

III. RESULTS AND DISCUSSIONS

The properties of fresh concrete are tested and noted. The value of slump is 75mm and compaction factor is 0.92. The comparison for compressive strength, split tensile strength, and flexural strength between conventional, ZFAC-I, and ZFAC-II are in fig 1, fig 2, and fig 3. In each above-mentioned figures x-axis denotes 7, 14, and 28 days from the initial curing day and the y-axis denotes specified strength in N/mm^2. Fig 4 shows the rate of compressive strength development of ZFAC's and conventional concrete. The curves in fig 4 show the strength development of various blocks of concrete over a span of 28 days. It can be interpreted that the concrete with 0% replacement has slightly low strength than concrete with 30% replacement (15% Zeolite and 15% Fly ash). Although the concrete with 20% replacement (10% Zeolite and 10% Fly ash) doesn't have high strength than conventional concrete.

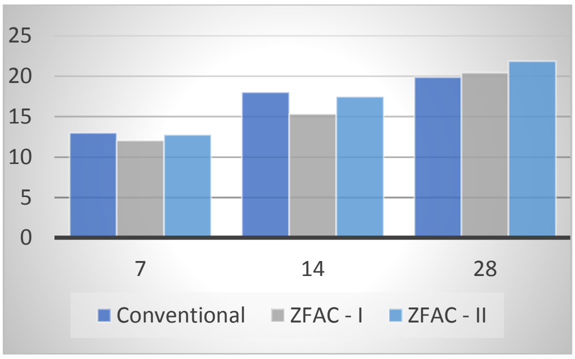

Figure 1. Comparison of compressive strength

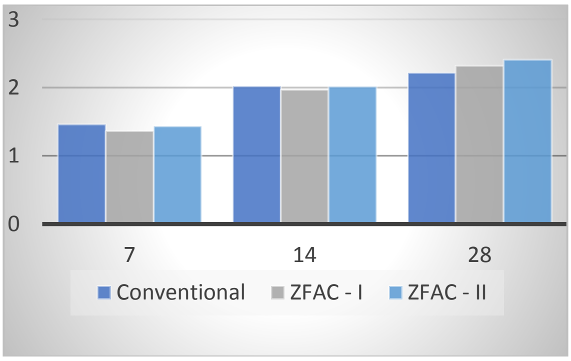

Figure 2. Comparison of split tensile strength

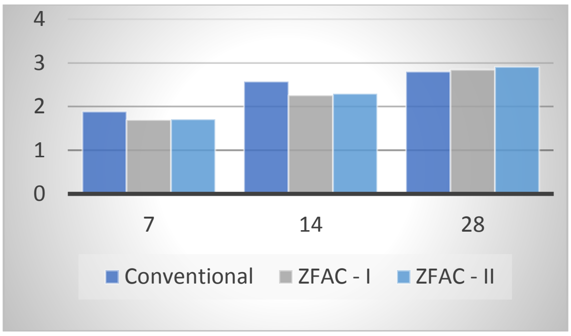

Figure 3. Comparison of flexural strength

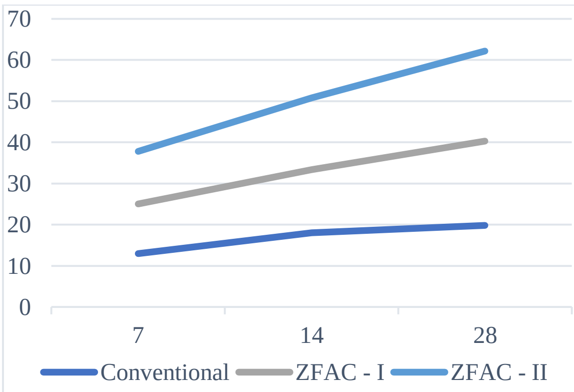

Fig 4. Compressive strength attained over 28 days

IV. CONCLUSION

The strength of attained by ZFAC (concrete with zeolite and fly ash) is slightly more than the strength attained by conventional concrete in 28 days. The strength gain for ZFAC mainly occurs after 14^{th} day, while nearing 28^{th} day.

The strength of ZFAC - II (15% zeolite and 15% fly ash) is higher than of ZFAC – I (10% zeolite and 10% fly ash). Further, the study can be expanded by increasing the replacement ratio of cement.

REFERENCE

[1]. Michael J. Gibbs, Peter Soyka, David Conneely, "CO_2 Emissions from Cement Production".
[2]. J. Kisunge, "Road Construction Materials", (2012).
[3]. Tomas U. Ganiron Jr, "Analysis of Fly Ash Cement Concrete for Road Construction". Vol.60, (2013), pp.33-44.
[4]. G. Mertens, R. Snellings, K. Van Balen, B. Bicer-simsir, P. Verlooy, J. Elsen, "Pozzolanic reactions of common natural zeolites with lime and parameters affecting their reactivity", (2009), pp 233-240.
[5]. Nitish Kumar, Reena Sehgal, Sumit Phogat, Sitender, "Fly Ash Concrete: A Technical Analysis for Compressive Strength", Vol.3.Issue 10.
[6]. Esraa Emam, Sameh Yehia, "Perfomance of concrete containing Zeolite as a supplementary Cementious Material", Vol.04. Issue 12.
[7]. I Sudarsano, S I Wahyudi, H P Adi, M D Ikval, "Effect of Zeolite on the Compressive Strength of Concreete with Different Types of Cement", Earth and Environmental Science 955(2022) 012002.
[8]. Asha C G, Veena D N, Bhagyamma R, Madhusoodana H G, Sridhar N Lokapur, "Study on Behaviour of Concrete by Partial Replacement of Cement and Coarse Aggregate by GGBS, Coir Fibers, and Recycled Plastic Waste", Vol.05 Issue: 05.
[9]. Rafal Latawiec, Piotr Woyciechowski, and Karol J. Kowalski, "Sustainable Concrete Performance—CO2-Emission", (2018).
[10]. Ahmadi B and Shekarchi M, "Use of natural Zeolite as a supplementary cementious material Cem. Concr. Compos. (2010) 32(2) 134-141.
[11]. Uzal B and Turanli L, "Blended cements containing high volume of natural zeolites properties, hydration and paste microstructure Cem. Concr. Compos 34(1) 101-109.
[12]. Kulkarni V R, "Role of fly ash in sustainable development", FAUACE (2007).