Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 3159-0040
Vol. 3 Issue 2, February - 2016

Use of Natural Zeolite with Fly Ash In Conventional Concrete Production

Kadir Güçlüer
Vocational School of Technical Science,
Adıyaman University
Adıyaman/TURKEY
kgucluer@adiyaman.edu.tr

Osman Ünal
Department of Civil Engineering,
Afyon Kocatepe University
Afyonkarahisar/TURKEY

Osman Günaydın
Department of Civil Engineering,
Adıyaman University
Adıyaman/TURKEY

Sadık BİLEN
Vocational School of Technical Science,
Adıyaman University
Adıyaman/TURKEY

***Abstract*— Concrete is the most used construction material in building industry. The cost of concrete production connect with cement and cement production process. In this study, it is investigated that the effect of natural zeolite and fly ash additives on physical and mechanical properties of conventional concrete. For this purpose, zeolite additive in concrete products being held constant and cement is replaced by fly ash at %10, %20 and %30 ratios. The test samples are produced in the form of 7x7x7 cm cubes and ıt was cured for 7, 28 and 56 days in laboratory. On the curing bit samples, compressive strength, ultrasonic transit time tests and dynamic elasticity modules were performed. As a result, can be said that zeolite and fly ash additives is positive impact of concrete mechanical and physical properties.**

Keywords—concrete; zeolite; fly ash; physical and mechanical properties;

I. INTRODUCTION

Fly ash (FA) is the waste material which obtained from thermal power plants. There are 19 thermal power plants established in Turkey[1] in 2014 and annual 24,2 million tons waste is becoming clearer. The formed of waste to %98,5 consist of mineral waste (ash, slag, fly ash, gypsum, etc.)[2]. The similarity of some fly ashes to natural pozzolanas of volcanic origin has encouraged the use of fly ash in conjunction with portland cement in concrete making. Not all fly ashes are suitable for this application, however; unstable chemical reactions may have adverse effects on both the hydration process and the ultimate stability of the end product. The recycling of this waste material is an important research area. Use as a pozzolanic material, particularly in the field of building materials, energy efficiency and environmental protection makes a great contribution in terms [3].

Zeolites are found in nature, and the zeolite mineral stilbite was first discovered in 1756 by the Swedish mineralogist A.F. Cronstedy [4]. Zeolites are crystalline aluminosilicates consisting of alkaline and alkaline-earth elements. In addition to be found in nature, zeolites are also synthesized using different chemical precursors and raw materials [5]. Natural zeolite, a hydrated aluminosilicate of alkali and alkaline earth cations with a three dimensional frame structure, has been widely utilized in constructions since ancient times; however, its application as a popular type of natural pozzolans in the manufacture of pozzolanic cements began from the first decades of the 20th century and shows a growing trend in the recent decades [6].

Zeolites has own low weight, highly porous, firm and solid homogenous structure. Its pozzolanic reactivity, ion make change, adsorption properties preferred in many industrial fields, including the construction industry [7]. As can be observed from previous researches, naturel zeolite as partial replacement of Portland cement can enhance mechanical properties and durability of cement and concrete composites. However, due to different chemical and mineralogical composition, contradictory results can also be seen in literatures which necessitate further studies [8]. Thanks to their high specific surface, zeolites are widely used mainly in chemical engineering as catalyst support, molecular sieves, or sorbents. In civil engineering, their utilization as pozzolans dates back already to ancient times when the mixture of zeolites containing tuff and lime was used as hydraulic binder. In today's building industry, natural zeolites are used mostly as concrete admixtures [9].

For the purpose of the reduce costs and create added value in the concrete production the use of puzzolanic material will provide a significant advantage. In this study, produced a puzzolan and naturel zeolite additive concrete and physical and mechanical properties were investigated.

II. MATERIAL AND METHODS

A. Zeolites and FA

The zeolites used in this study has obtained from Manisa-Gördes region in Turkey. İt is physical and mechanical properties are given Table 1, chemical properties are given Table 2 and particle size of zeolite are given Figure 2.

TABLE I. PHYSICAL PROPERTIES OF ZEOLITE AND FA

	Zeolite	Fly Ash
Specific Gravity	1,72 gr/cm^3	2,00 gr/cm^3
Specific Surface Area	0,501 m^2/gr	0,222 m^2/gr

TABLE II. CHEMICAL PROPERTIES OF ZEOLITE AND FA

Component (%)	SiO_2	CaO	Al_2O_3	Fe_2O_3	MgO	K_2O	Na_2O
Zeolite	71,9	2,0	13,2	1,4	1,1	3,5	0,3
Fly Ash	28,8	30,2	9,4	6,6	1,6	0,8	0,06

According to the XRD analysis results, it was observed that %90 of the material consists of clinoptilolite component [10]Fig 1).

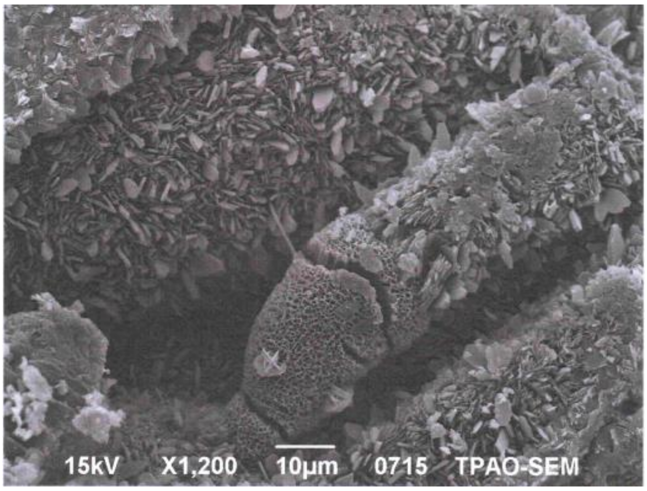

Fig 1. *SEM Figure of Zeolite samples.*

Particle size distribution of zeolite d_{10}=5,054 µm, d_{50}=28,240 µm and d_{90}=103,200 µm values was measured with Malvern Mastersizer 2000 device to "laser diffraction method''.

Fly ash used in this study has obtained from Kahramanmaraş- Elbistan thermal power plant in Turkey. İt is physical and mechanical properties are given Table 1, chemical properties are given Table 2 and particle size of zeolite are given Fig. 3.

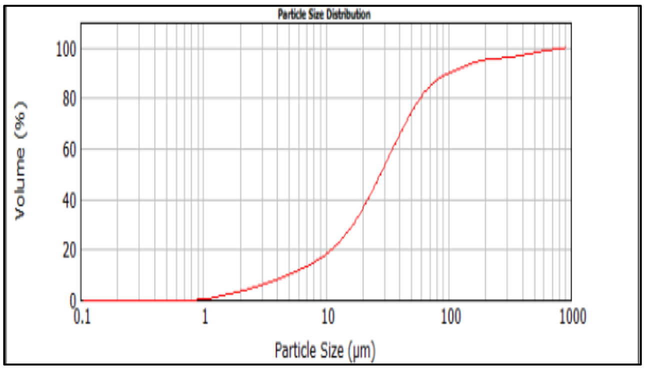

Fig 2. *Particle Size of Zeolite*

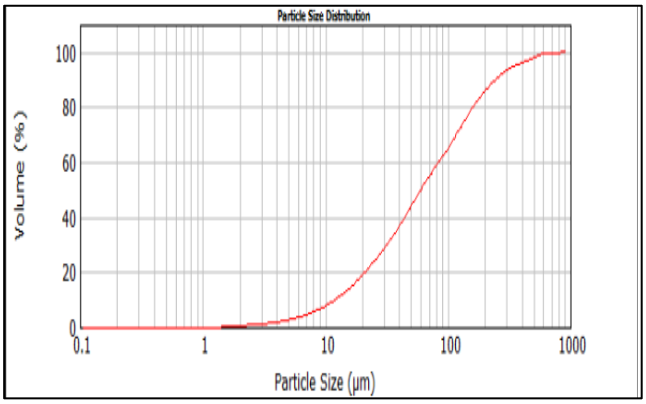

Fig 3. *Particle Size of FA*

Particle size distribution of FA d_{10}=12,123 µm, d_{50}=60,389 µm and d_{90}=245,237 µm values was measured with Malvern Mastersizer 2000 device to "laser diffraction method''.

B. Methods

Cement dosage in the production of samples 300 kg/m^3 were determined. Each mixture at this dosage of 50 kg/m^3 to form zeolite. Fly ash was replaced by cement ratio of %10, %20 and %30. Blend values of the samples are given in Table 3.

TABLE III. BLEND VALUES

SERIES NAME	CEMENT (KG)	WATER (LT)	FA (KG)	ZEOLITE (KG)	CRASHED SAND (KG)	CRASHED STONE I (KG)	CRASHED STONE II (KG)
FA-0	250	150	0	50	620	485	455
FA-10	225	150	25	50	620	485	455
FA-20	200	150	50	50	620	485	455
FA-30	175	150	75	50	620	485	455

Samples are prepared according to the blend values shaped in 7 cm sided cubes molds(Fig. 4)

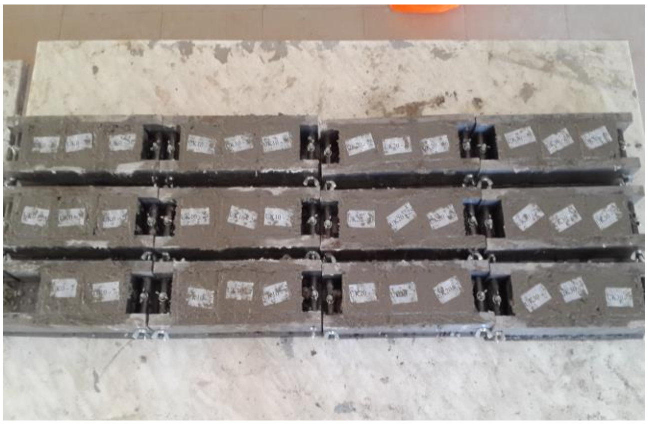

Fig 4. *Experiment Samples*

C. Findings

Samples were cured 7,28 and 56 days in laboratory condition for determining of compressive strength values. Compressive strength values of experiment samples is calculated with formula (1). İn this place f_c is the compressive strength value (MPa), *P* is the load (Newton) and the *A* is the surface area(mm^2).

$$f_c = \frac{P}{A} \quad (1)$$

According to the compressive strength findings (Fig 5-7), FA-10 series contributes to the compressive strength in 7 days. However this situation does not appear in the other series (FA-20 and FA-30). Looking to the 28 days compressive strength values of samples maximum value is seen in the FA-10 series. When looking at the 56 days compressive strength values, FA-10 series values decreases but FA-20 and FA-30 series values increases. Compared strength values in the first days, for all series compressive strength values increases in the 28 and 56 days.

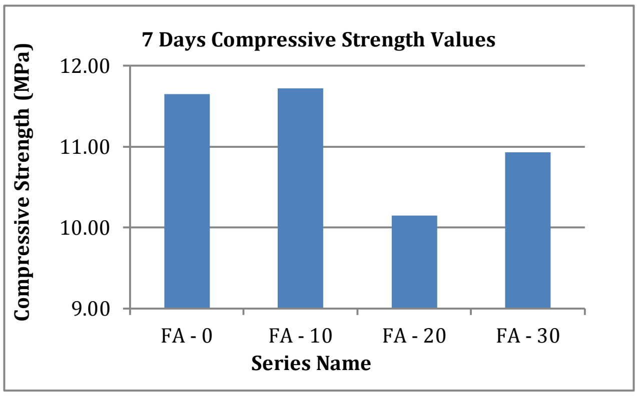

Fig 5. *7 days compressive strength values of series*

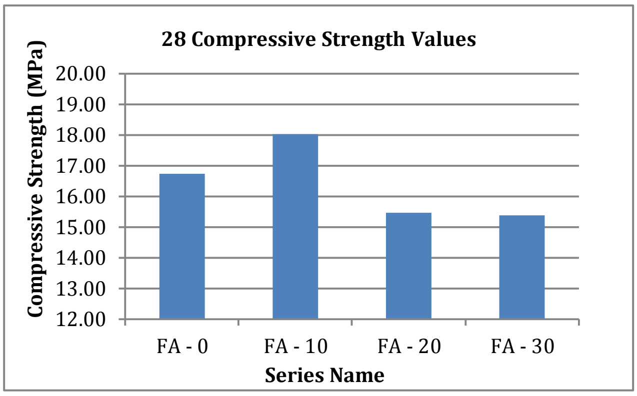

Fig 6. *28 days compressive strength values of series*

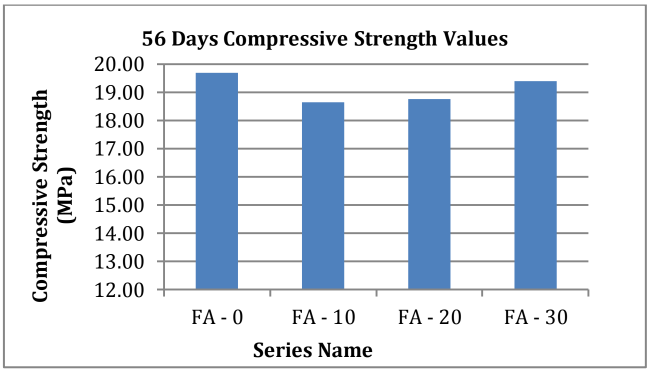

Fig 7. *56 days compressive strength values of series*

Dynamic elasticity modulus, usually use in laboratory studies for determine of concrete decomposition against chemical events[11]. Dynamic modulus of elasticity (Ed) calculated from the formula (2) [12].

$$E_d = 10^5 \times V^2 \times \frac{\beta}{g} \quad (2)$$

Ed: Dynamic elasticity modulus (kgf/cm^2), V: ultrasound pulse velocity (km/sn), β: bulk density of concrete (kg/dm^3), g: gravity

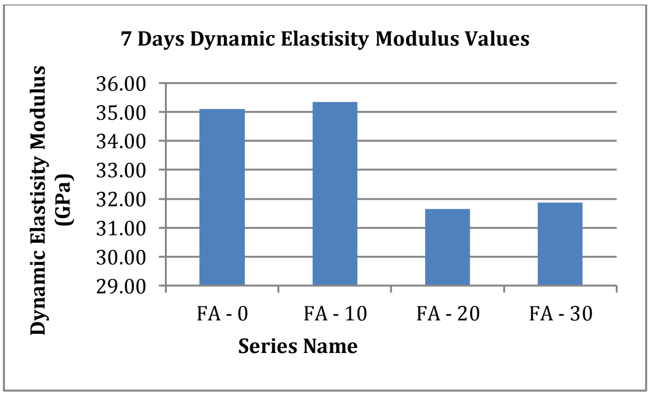

Fig 8. *7 days dynamic elasticity modulus values of series*

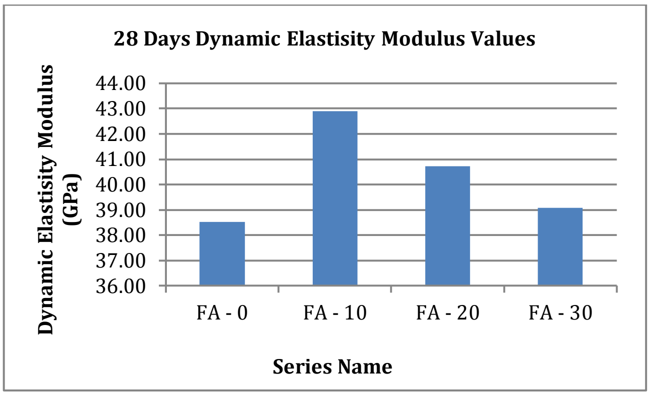

Fig 9. *28 days dynamic elasticity modulus values of series*

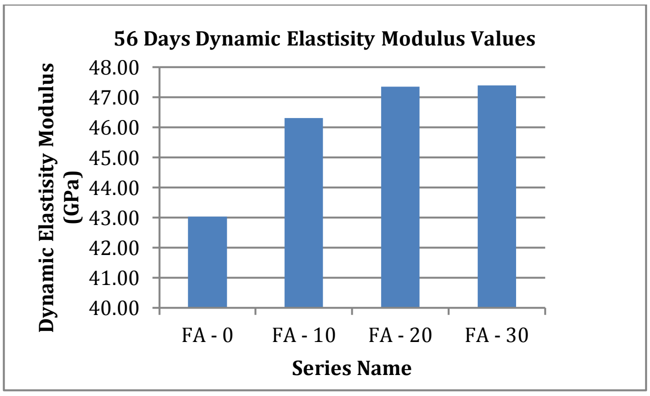

Fig 10. *56 days dynamic elasticity modulus values of series*

According to the dynamic elasticity modulus findings, for all series E_d modulus is increases in 28 and 56 days. The most significant increases is seen at FA-30 series. The reason for , fly ash is strengthening the cement-aggregate interface in coming days and it creates a tougher concrete structure.

D. Conclusıon

An investigation in this study usability of zeolite and fly ash in conventional concrete production, positive results are obtained in mechanical properties.

It has seen an increase in compressive strength values, despite the series was created by reducing the dosage of cement.

The contribution of compressive strength in the last days of fly ash are seen more clearly.

It was observed improvement in the workability of the concrete mixture by introducing into the mixture of fly ash.

Cement is the highest cost in concrete production. Zeolite and fly ash costs lower than cement. It achieved a great advantages in terms of cost with these two materials uses a mineral additives in concrete production.

When we look to the findings, it can be said to provide significant advantages of these two contributions in terms of durability.

REFERENCES

[1]https://tr.wikipedia.org/wiki/T%C3%BCrkiye%27deki_enerji_santralleri_listesi
[2] TÜİK, 2015. Termik Santral Su, Atıksu ve Atık İstatistikleri, 2014
[3] Wesche K., 1991. ''Fly Ash İn Concrete''. RILEM Report 7.
[4] Auerbach S., Carrado K., Dutta P., 2003. ''Handbook of Zeolite Scıence and Technology''.Marcel Dekker Inc., New York 12701, U.S.A.
[5] Bukhari S., S., Behin J., Kazemian H., Rohani S. ''Conversion of coal fly ash to zeolite utilizing microwave and ultrasound energies: A review''. Fuel 140(2015) 250-266.
[6] Najimi M., Sobhani J., Ahmadi B., Shekarchi M.''An experimental study on durability properties of concrete containing zeolite as a highly reactive natural pozzolan''. Construction and Building Materials 35 (2012) 1023-1033.
[7]Kibaroglu,U.,(2015).http://www.oocities.org/kibaroglu/calismalar/zeolit.htm
[8] Ranjbar M., M., Madandoust R., Mousavi Yasin S., Yosefi S.''Effects of natural zeolite on the fresh and hardened properties of self-compacted concrete''. Construction and Building Materials 47 (2013) 806-813.
[9] Vejmelkova E., Konakova D., Kulovana T., Keppert M., Zumar J., Rovnanikova P., Kersner Z., Sedlmajer M., Cerny R.''Engineering porperties of concrete containing natural zeolite as supplementary cementitious material: Strength, toughness, durability, and hygrothermal performance''.
[10] www.zeomec.com
[11] Erdoğan T. Y., 2003. Beton. Metu Press, 1. Baskı.
[12] Yazıcı, H.,2015. Yapı Malzemesi II Ders Notları. Dokuz Eylül Üni., İnşaat Müh. Bölümü.