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 Günaydın
Department of Civil Engineering, 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 it 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. Cronstedt [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, naturel 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 pozzolanic 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. It is physical and mechanical properties are given Table 1, chemical properties are given Table 2 and particle size of zeolite are given Figure 2.
According to the XRD analysis results, it was observed that %90 of the material consists of clinoptilolite component [10] Fig 1).

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 Kahramanmaras- Elbistan thermal power plant in Turkey. It is physical and mechanical properties are given Table 1, chemical properties are given Table 2 and particle size of zeolite are given Fig. 3.

Samples are prepared according to the blend values shaped in 7 cm sided cubes molds (Fig. 4)
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). In this place $f_c$ is the compressive strength value (MPa), $P$ is the load (Newton) and the $A$ is the surface area (mm$^2$).

$$f_c = \frac{P}{A}$$  

(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.

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

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

(2)

$E_d$: Dynamic elasticity modulus (kgf/cm$^2$), $V$: ultrasound pulse velocity (km/sn), $\beta$: bulk density of concrete (kg/dm$^3$), $g$: gravity
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. Conclusion

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 additves 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
[10] www.zeomec.com