

# Foam concrete production with şırnak mine waste claystone and fly ash

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**Abstract.** Fly ash and Mine Waste clay stone thrown as waste in Şırnak City of Turkey were used in foam concrete production. Waste mixture at certain proportions decreasing instead of cement used, fine aggregate in specific proportions decreasing instead of fly ash used improved mechanical strength and porosity. Even fine clay stone aggregate minus 3 mm reducing porosity rather than fly ash, such as using three different size fractions are evaluated in foam concrete production. Effects of mechanical properties of waste clay stone and fly ash on foam concrete production were studied intensively. The main purpose of this study is to develop the ready-mixed foam mortar and concrete industry using local waste, Şırnak Coal Mine Waste clay stone and fly ash.

**Keywords.** Foam concrete, lightweight concrete, foam mortar, fly ash, claystone

## Introduction

Foam concrete is produced by aerated foaming slurry which containing cement sand and water mixtures. Low density concrete product may be so advantageous in construction works. Particularly, fly ash addition to foam shotcrete and mortar applications may provide very low density protective layer and aerating and even insulation layer concerns [1-5]. The beneficial properties of fly ash and use of foam concrete were defined in detail [6-8]. Pozzolans alone cannot bind pulverized calcium hydroxide at ordinary temperature and humid environments characterized by reacting chemically bonding materials such as fly ash and clay stone [9,10]. Pozzolans in foam concrete are used as mineral admixture. Mineral additives increasing the durability of foam concrete strength[11-14]. Concrete or cement added into the pozzolanic material may lead the heat of hydration to reduce the high target strength and low permeability ensures alkali silica reaction and sulfate attack [15-17]. Pozzolanic materials in foam concrete are commonly fly ash, silica fume and slag furnace [17,18].

Various researches [18-20] were evaluated sand, clay and fly ash cement mixtures. However, industrial wastes containing ash and sand were used as pozzolanic material or filler in foam concrete [21-22]. Influence of filler type on the properties of foam concrete fly ash instead of sand .economic and friendly ecological disposal of fly ash as waste. Comparison with air cured foam concrete made with cement-sand cement and fly ash showed higher strength. In the world today, 600 million tons of fly ash, but it is estimated that only 10% are evaluated in concrete technology [18].

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Fly ash concrete to reduce the cost of providing energy conservation and environmental problems due to the reduction area has a wide use in concrete [23-25]. Fly ash concrete mixture for use in cement certain proportions decreasing instead of fly ash used , fine aggregate in specific proportions decreasing instead of fly ash used in or as fine aggregate and the cement in proportions to reducing rather than fly ash , such as using three different methods are performed [26-29]. Effects on mechanical properties of fly ash in concrete have been studied intensively over. In this study, the amount of fly ash on properties of fresh and hardened concrete to study briefly mentioned, but basically changes the amount of substitution of fly ash concrete workability and setting time was to determine the effect.

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### 1. Method

In this study, Cizre sand obtained from Dicle Stream and waste clay stone of Şırnak Coal Mine were used as fine aggregate, which was broken minus 3mm. Aggregate mixture ratios were set in four different size fractions and as given the limit values in the standards[29-32] between the 20% natural sand, 30% 0-5 mm crushed clay stone , 25% of 5-8 mm crushed clay stone and 25% of 8-12 mm were set in clay stone. The results of sieve analysis of aggregates used in the experiments are given in Figure 1, respectively.

CEM I 32,5 type cement as a binder was used. Silopi fly ash used in the experiments was supplied from power plant chemical composition of and the standard fly ash is given in Table 1, respectively.

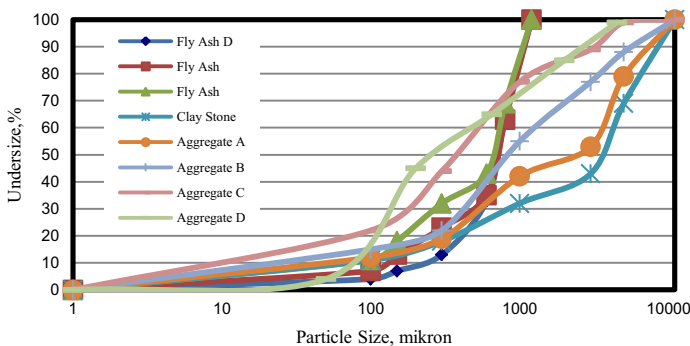


Figure 1. Sieve analysis of fly ash and fine aggregate used in tests

### 2. Results and Discussions

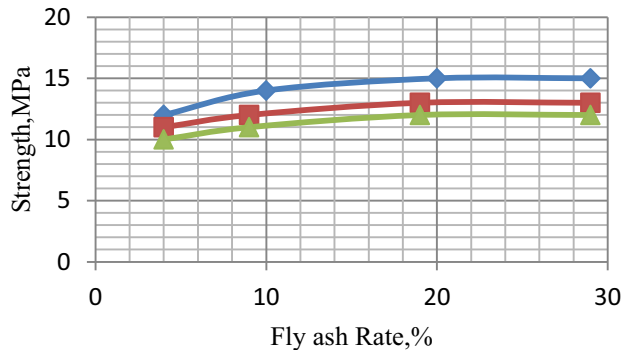
In order to determine the effect of amount of fine clay stone aggregate and Silopi fly ash on workability of the foam concrete, firstly 5 %, 10% , 20%, 30%, 40% clay stone added in to the foam concrete and secondly only 5 % , 10% , 20% and 30% of fly ash added in to the foam concrete. The curing time, strengths, densities and water

absorption amounts were determined as given in the standards. For each mixture, prepared by the method of penetration resistance of concrete and concrete stiffening time test 0.5 MPa till 3 MPa resisting the durations were observed. The concrete 10x10x10 cm blocks were prepared from every mixture and the 28-day compressive strength was determined. In the production of best foam concrete, concrete component quantities, dosage and suitable density value were selected [33-37].

This study was aimed to the production of low density 1200-1400 kg/m<sup>3</sup> grade foam concrete. The optimum water/cement (w/c) ratio in consideration was determined after 28 days regarding compressive strengths of concrete foam blocks to be produced have been selected as high water/cement ratio. Due to the high water absorption results of prior experiments on the w/c ratio, it was decided to be 3/1. TS 802 de [38] mentioned mixture of water and air flow by taking the amount of concrete components in the foam concrete. The results of fly ash addition on strength of foam concrete blocks are illustrated in Figure 2. 10% fly ash addition was sufficient in strength increase reaching 13-15 MPa replaced to cement. The fresh foam concrete for measuring the 1MPa resistance to penetration as given in ASTM C 403 standard, the determined comprising setting times were increased from 220 h to 317 h. That has showed that fly ash addition may improve workability time of foam concrete.

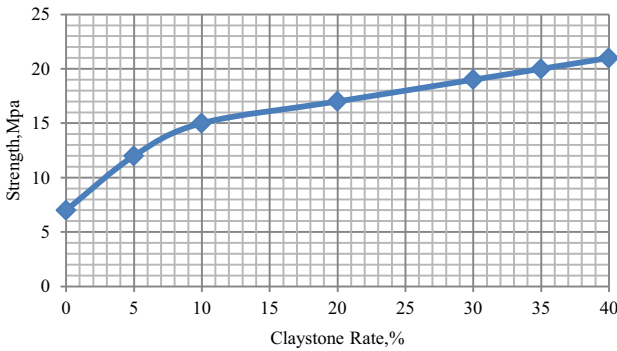
**Table 1.** Chemical composition of Silopi Fly Ash and standards

Oxide(%)	Fly Ash	TS EN 450 F	TS EN 197-1 F	TS 639 C	ASTM C 618
SiO <sub>2</sub>	48,53				
Al <sub>2</sub> O <sub>3</sub>	9,61				
Fe <sub>2</sub> O <sub>3</sub>	7,9				
S+A+F	67,04	> 70,00	> 70,00		> 50,00
CaO	23,8			< 5,00	
MgO	2,28			< 5,00	< 5,00
SO <sub>3</sub>	2,48	< 3,00	< 5,00		
K <sub>2</sub> O	2,51				
Na <sub>2</sub> O	0,35	<5,00	< 5,00	< 5,00	< 10,00
Ignition lost	1,79			< 6,00	< 6,00
Cl <sup>-</sup>	0,05			< 0,10	
Free CaO	2,1			< 1,00	
Reac. SiO <sub>2</sub>	35,2	> 25,00	> 25,00		> 25,00
Reac. CaO	21,7	7,5	< 10,00	> 10,00	



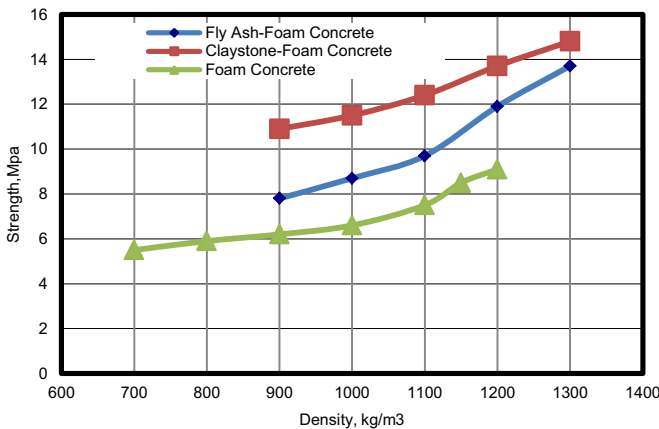
**Figure 2.** Uniaxial compressive strength results of Fly Ash addition on foam concrete at 28 day

After the determination 3/1 of water/cement rate and effective amount of fly ash addition the foam concrete blocks, fine clay stone aggregate mixtures were prepared with the mixture of fine clay stone minus 3mm at weight rates of of 5%, 10%, 20% and 30% 40% with 10% fly ash replacing cement. For each foam concrete block, the compressive strength and water absorption rate were studied. The results are shown in Figure 3. At the end of the 28 days the compressive strength of foam concrete blocks with 20-30% fine clay stone aggregate raised to 17-19MPa. Water absorption rate decreased at 35 and 40 % fine aggregate addition to 23-33%.



**Figure 3.** Uniaxial compressive strength results Fine Clay Stone Addition on foam concrete at 28 day.

In order to determine the effect of apparent low density of foam concrete on strength, the produced foam concrete blocks without fly ash and fine clay stone aggregate were tested. As seen from Figure 4 only foam concrete densities ranged between 700 kg/m<sup>3</sup> and 1200 kg/m<sup>3</sup> and the strengths were changed between 7 MPa and 9 MPa. With fine clay stone aggregate addition that strength raised to 15 MPa.



**Figure 4.** The Effect of density on uniaxial compressive strength results of foam concrete at 28 day.

### 3. Conclusions

A 3/1 of water/cement rate and 10% Silopi fly ash addition in to the foam concrete was effective and water absorption rate of foam concrete was sufficient for thermal isolation. The high porosity and the lower densities of 900-1100 kg/m<sup>3</sup> values were provided in foam concrete production. The high amount of fly ash addition workability of the foam concrete blocks improved.

Fine aggregate clay stone mixtures provided much resistive compressive strength with the mixture of fine clay stone minus 3mm at weight rates of 30% 40% with 10% fly ash replacing cement.

At the end of the 28 days the compressive strength of foam concrete blocks with 20-30% fine clay stone aggregate raised to 17-19MPa. Water absorption rate decreased at 35 and 40 % fine aggregate addition to 23-33%.

In conclusion, depending on the amount used the fly ash in foam concrete, workability significantly changed and even significant the pressure increase in resistance values depending on the amount of fly ash and foam substituent were reduced. Also in the mixture of fly ash used concrete curing time depending on the amount of substitution was found to reduce the porosity.

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