# The influence of superplasticizers on the porous structure and thermal conductivity of lime foam concrete waste

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**Abstract.** the results of laboratory experiments are presented, where the use of lime waste (sludge) in foam concrete and the possibility of their use as a filler for foam concrete are analyzed. It is shown that the total porosity, thermal conductivity and structural quality of foam concrete with waste lime were taken as parameters of the porous structure.

## 1 Introduction

Industrial emissions have increased to such an extent that pollution levels in some areas of the world significantly exceed acceptable health standards. This leads to an increase in the number of people with chronic diseases, especially among urban populations. The problem of recycling solid industrial waste has become significantly worse; it affects the change in the chemical composition of the soil, leads to a deterioration in its quality, in addition, transportation costs increase, and valuable material resources that can be recycled are irretrievably lost.

It is known that for most enterprises of chemical fertilizers, petrochemical, chemical-pharmaceutical engineering, hydrolysis, energy and other industries, a big environmental problem is the disposal of lime (sludge) waste generated in large quantities at water neutralization stations, in sludge accumulators or in industrial landfills.

At the Fergana Polytechnic Institute, in order to optimize the strength of foam concrete with lime waste, experiments were carried out using the chemical additive SDj-3, research on which was carried out at the Tashkent Chemical-Technological Institute of the Uzkimyosanoat association. complex chemical additives in its composition, their positive effect was achieved mainly by changing the microstructure of the composite, that is, accelerating the formation of the structure of the cement stone. It is known that the porous structure of foam concrete with lime waste has a great influence on its properties. Thermal conductivity is one of the most important properties of foam concrete made from lime waste, reflecting the ability to transport thermal energy. This criterion determines the scope and possibilities of using foam concrete with lime waste, as well as the areas of its application. Moreover, thermal conductivity is closely related to such basic parameters as material

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density, porous structure and strength. Therefore, it is important to study the factors influencing the heat-saving properties of foam concrete.

## 2 Method

The porous structure of foam concrete from lime waste was studied on samples of 150x150x150 mm in size, without additives and 8; 10 and 12% of chemical additives Sdj-3, cured under normal conditions for 28 days Table 1.

The parameters of the porous structure were taken as total porosity ($P_{common}$), open porosity ($P_{open}$), closed porosity ($P_{closed}$), average pore size index (f) and pore size uniformity index (α), given in the normative document GOST 12730.4-78. Picture 1.

The thermal conductivity and structural quality index of foam concrete with waste lime measuring 150x150x150 mm and 150x150x20 mm without additives is 8; 10 and 12% of chemical additives SDj-3 were studied in samples cured for 28 days under normal conditions picture 1, 2, 3.

The thermal conductivity coefficient of the samples was determined using an ITS-1 device.

## 3 Analysis

Test results are shown in tables 1, 2, 3 and picture 1, 2, 3.

The curves shown in picture-1 and the data given in table-1 indicate that the structure of the porous structure of foam concrete with lime waste depends on the amount of complex chemical additives. The addition of SDj-3 has virtually no effect on the overall porosity of foam concrete with lime waste, but allows you to increase the percentage of closed pores while simultaneously increasing the volume of open pores. Instead of irregular pores or open capillaries, a series of evenly distributed small spherical pores are formed in the concrete, the walls between the pores are thickened.

From the curves shown in picture - 2, 3, and the data given in table - 2, it is clear that the chemical additive has a significant effect on the thermal conductivity of foam concrete with lime waste. Modification with the addition of SDj-3 made it possible to increase the thermal conductivity coefficient of foam concrete with lime waste to 21%, and the design quality indicator to 1.5 times.

**Table 1.** Parameters of the porous structure of foam concrete samples with lime waste

| **Indicators** | **Number of additives SDj-3,%** | | | |
|---|---|---|---|---|
| | 0 | 0.6 | 1.0 | 1.2 |
| $P_{common}$ | 67,0 | 69,0 | 71,1 | 70,1 |
| $P_{open}$ | 31,1 | 24,0 | 20,1 | 20,2 |
| $P_{closed}$ | 35,9 | 45, | 51,0 | 49,9 |
| f | 1,7 | 1,5 | 1,3 | 1,4 |
| α | 0,3 | 0,7 | 0,9 | 0,6 |

**Table 2.** Heat transfer coefficients of foam concrete samples with lime waste

| **Chemical additive quantity SDj-3, %** | **Average density ρ, kg/m$^3$** | **construction quality factor MPa/ (kg/m$^3$)** | **Humidity W, %** | **Thermal conductivity λ, W/(m$^o$C)** | **Compressive strength MPa** |
|---|---|---|---|---|---|
| 0 | 600 | 0,0038 | 21 | 0.172 | 3,5 |

| | | | | 100 | |
|---|---|---|---|---|---|
| 0,4 | 603 | 0,0042 | 21.4 | 0.162<br>94 | 3,6 |
| 0,6 | 606 | 0,0045 | 21.8 | 0.155<br>90 | 3,8 |
| 0,8 | 610 | 0,0048 | 22 | 0.150<br>87 | 4,1 |
| 1,0 | 612 | 0,0053 | 22.7 | 0.135<br>78 | 4,5 |
| 1,2 | 615 | 0,0053 | 22.4 | 0,142<br>83 | 4,4 |
| 1,5 | 620 | 0,0052 | 22.1 | 0.147<br>85 | 4,1 |

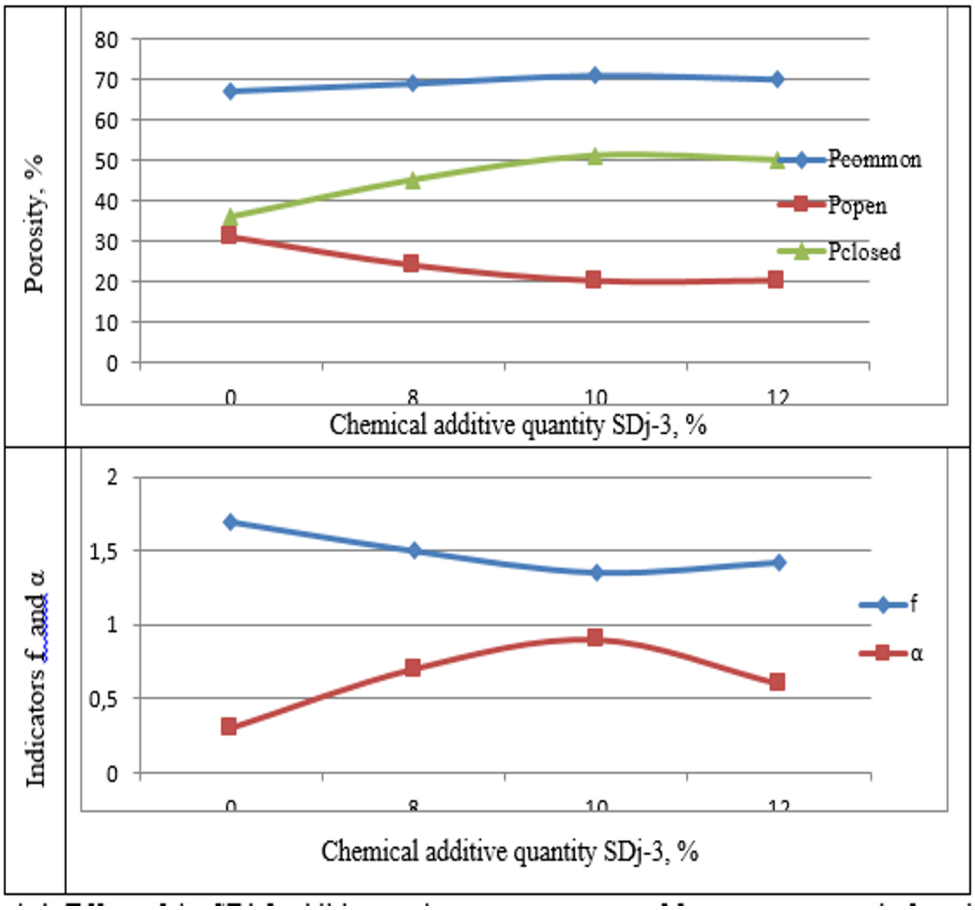


**Fig. 1.** Effect of the SDj-3 additive on the pore parameters of foam concrete made from lime waste

Small pores of the same size are formed in foam concrete with lime waste as a result of modification with lime waste as a filler and the chemical additive SDj-3.

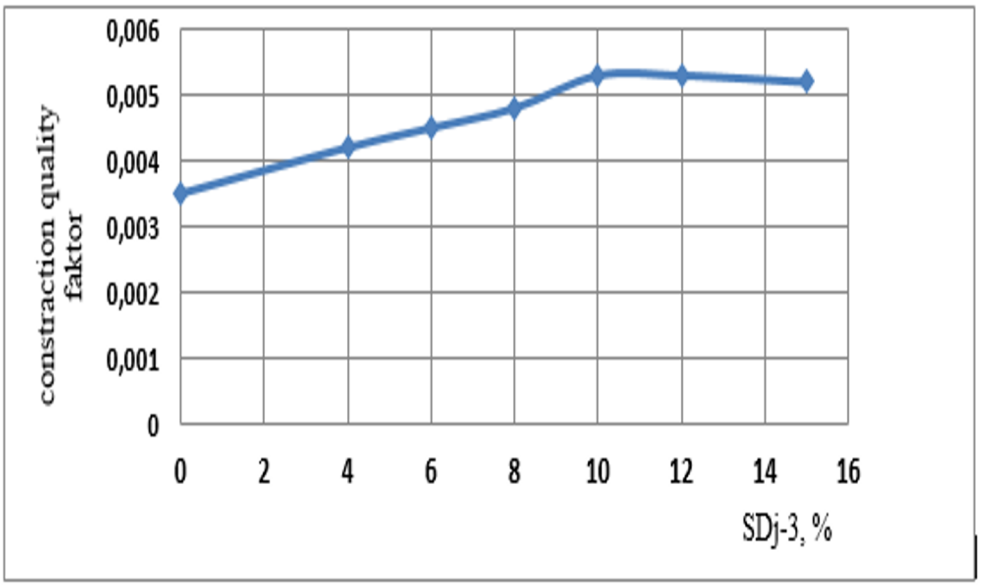


**Fig. 2.** The influence of the SDj-3 additive on the construction quality factor foam, concrete with lime waste

Such a positive effect of the SDj-3 additive on the properties of foam concrete with lime waste can be explained by the formation in concrete, instead of uneven pores and open capillaries, of a number of spherically distributed small pores, and an increase in the percentage of closed pores and thickening of interpose walls.

Based on the results of the research, the heat saving standard [GOST 25485-89]. Porous concrete. Technical conditions] samples of foam concrete were taken with a lime waste content 25-30% higher than normal.

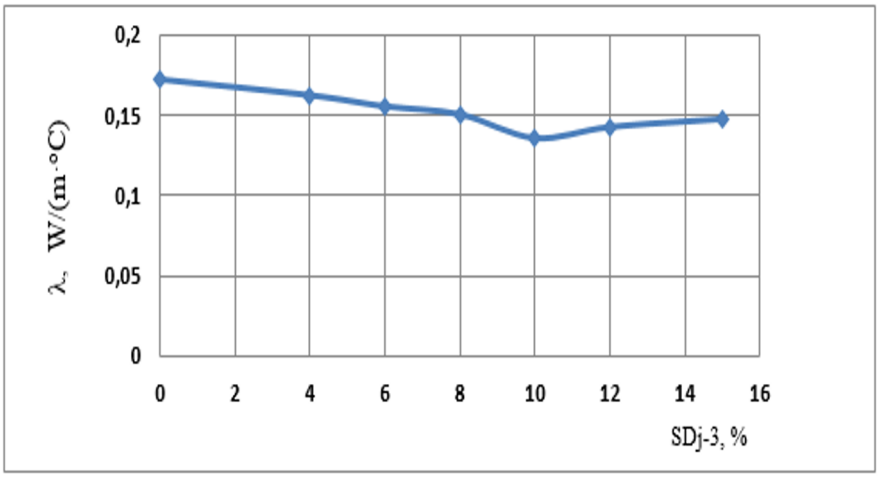


**Fig. 3.** Effect of the SDj-3 additive on the heat transfer coefficient (λ) of foam concrete with lime waste

## 4 Conclusion

The article, based on laboratory experiments, analyzes the use of lime waste (sludge) in foam concrete and the possibility of using lime waste (sludge) as a filler for foam concrete. The parameters of the porous structure were taken as total porosity, an indicator of thermal conductivity and structural quality of foam concrete with waste lime, an indicator of thermal conductivity and structural quality of foam concrete with waste lime, chemical additives SDj-3 were studied in samples, which made it possible to increase the thermal conductivity coefficient of foam concrete with lime waste to 21%, and the structural quality indicator is up to 1,5 times. Such a positive effect of the SDj-3 additive on the properties of foam concrete with lime waste can be explained by the formation in concrete, instead of uneven pores and open capillaries, of a number of spherically distributed small pores, and an increase in the percentage of closed pores and thickening of interpore walls.

Based on the results of the studies, it was shown that optimization of the pore structure of foam concrete with lime waste can be achieved by adding superplasticizer SDj-3 in an amount of 10% relative to the weight of Portland cement. This, in turn, makes it possible to increase the strength of concrete, frost resistance properties and energy saving.

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