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Physical and Chemical Research Methods of Lightweight Concrete

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Abstract--- *This research paper discusses the physicochemical, microscopic methods for studying the influence of porous aggregate micro-filler on improving the structure formation of lightweight concrete composition and the effect on lightweight concrete construction and technical properties on a filler consisting of quartz porphyry and carbonized clay.*

Keywords--- *Cement, Durability, Hydration, Porous Aggregate, Light Weight Concrete, Micro-filler, Mortar, Solidity.*

I. INTRODUCTION

The strength characteristics of lightweight concrete depend not only on the density and hardening conditions, but also on hydration processes, structure formation, microstructure and the resulting neoplasms in the hardening process.

The fly ash of the Angren state district power station was used as a microfiller.

The analysis of the results showed that the following components were identified in the IR spectrum of fly ash of Angren HES: amorphous quartz 470.15 cm^{-1}, 1098.09 cm^{-1}; α quartz-787.93 cm^{-1}; calcite-1084.49 cm^{-1}; 1785.62 cm^{-1}; feldspar-555.02 cm^{-1}. (Fig. 1.)

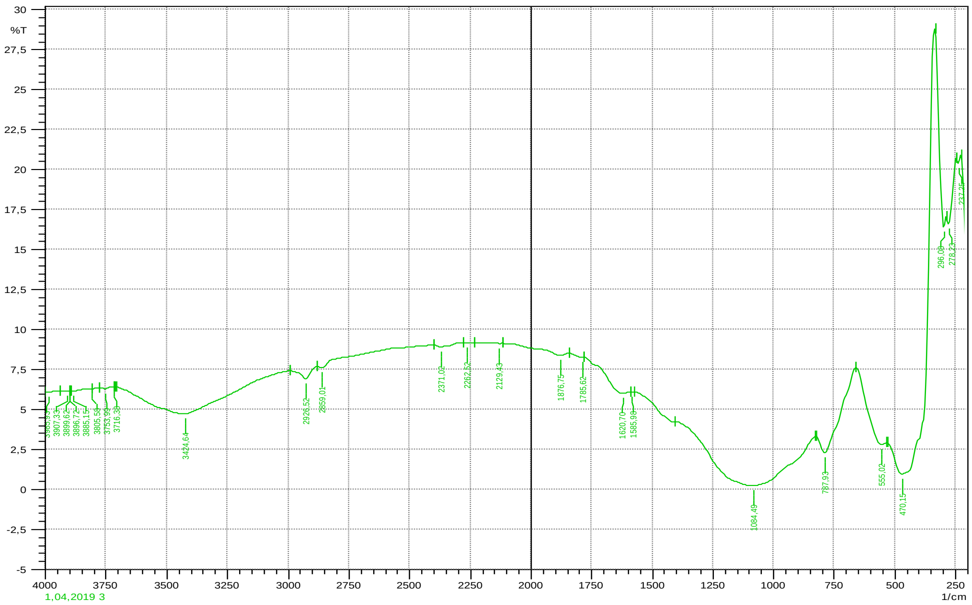

Fig. 1: IR Spectrum of Fly Ash of Angren GRES

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To determine the influence of the microfiller of fly ash on the structure formation of lightweight concrete, physicochemical studies of the optimal composition of concrete were carried out [1].

The first stage of the study was the IR spectrum analysis of the cement mortar: cement, sand, fly ash.

The results of the analysis of the tests showed that, the following components were identified in the IR spectrum: calcite - 873.75 cm^{-1}; α quartzite-777.31 cm^{-1}; dolomite 694.37 cm^{-1}; feldspar-648.08 cm^{-1}; albite-993.34 cm^{-1}; feldspar-437.84 cm^{-1}; gypsum 365.78 cm^{-1}; quartzite - 511.14 cm^{-1}; feldspar-437.84 cm^{-1}; feldspar-555.50 cm^{-1}. (Fig. 2.).

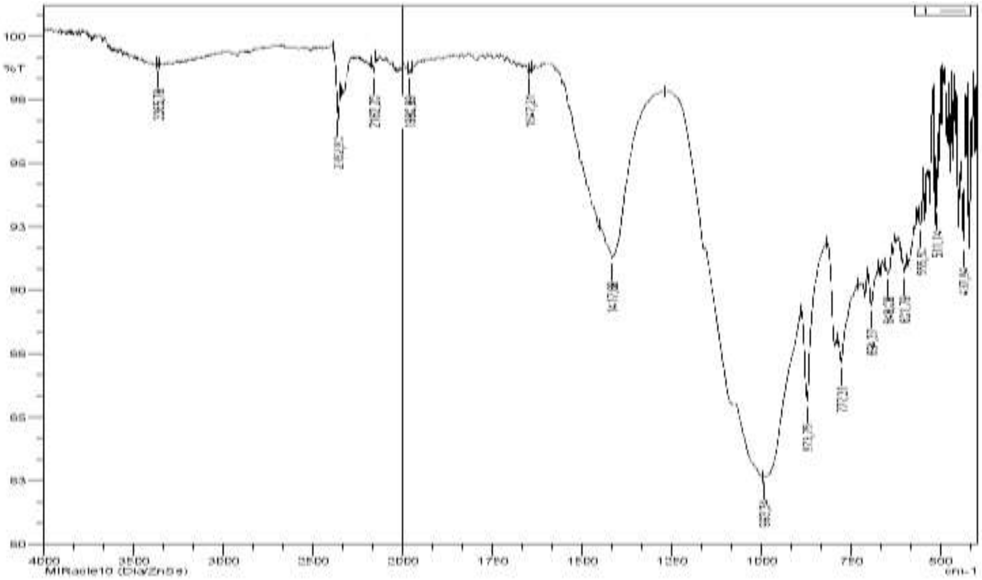

Fig. 2: IR Spectrum Analysis of Cement Mortar: Cement, Sand, Fly Ash

The next step was the IR analysis carried out in optimal lightweight concrete, namely in compositions consisting of cement, sand, fly ash and aggregate. From table 3 it can be seen that the identification of the Calcite line is 1417.68 cm^{-1}; feldspar-650.01 cm^{-1}; feldspar-549.71 cm^{-1}; calcite-1083.99 cm^{-1}; calcite-873.75 cm^{-1}; α quartzite-962.48 cm^{-1}; gypsum-2645.28 cm^{-1}; gypsum-725.28 cm^{-1}; gypsum-3404.36 cm^{-1}; quartzite - 592.15 cm^{-1}.

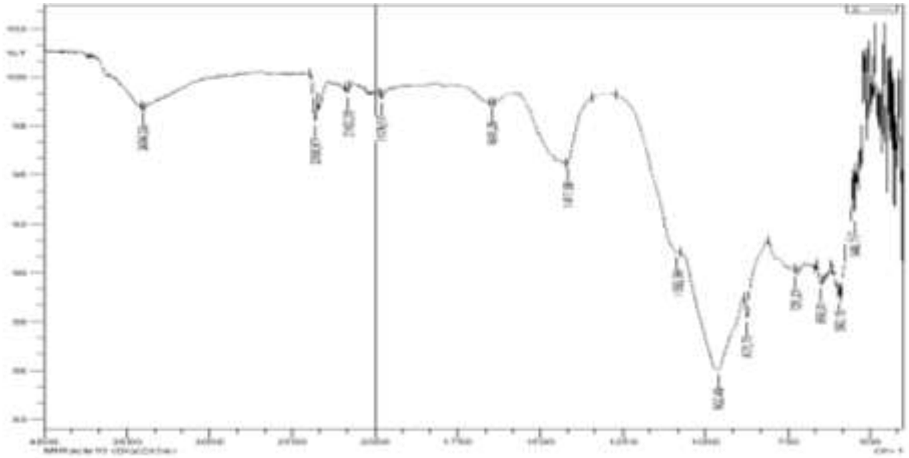

Fig. 3: IR-spectrum Analysis of Concrete Composition: Cement, Sand, Fly Ash, Lightweight Aggregate

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Results IR-spectrum analysis of the absorption of a concrete sample 28-day hardening is characterized by frequencies typical for calcite-1417.68 cm^{-1}, feldspar-650.01 cm^{-1}. Summarizing all the results of analyzes of studies of ash, mortar and concrete showed that the components identified in all three compositions are repeated at different frequencies [2].

To study the composition of concrete and its components, X-ray diffraction analysis of the following materials was used: a solution consisting of fly ash, cement and sand, light concrete after-28 days of normal hardening. The tests were carried out on devices of a new generation spectrophotometer company ***SHIMADZU*** series ***IRAffinity-1.***

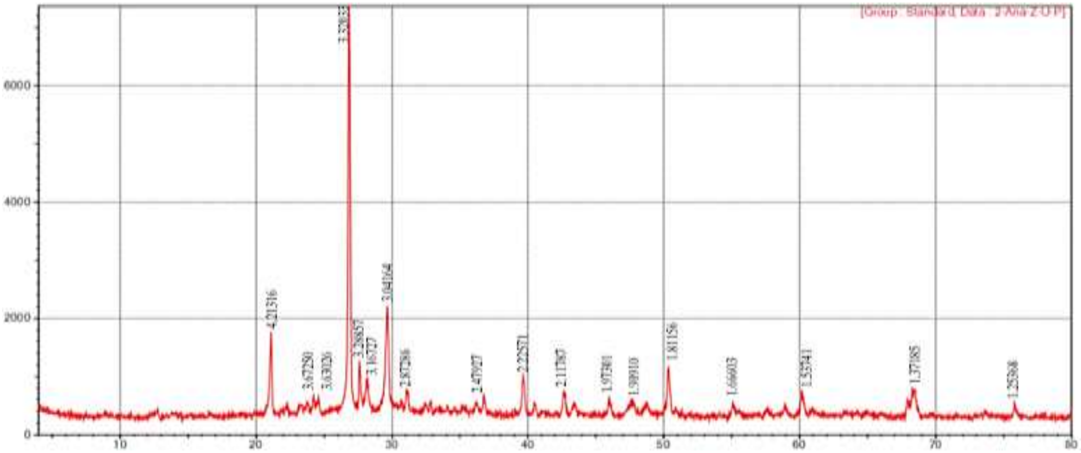

Fig. 4 Radiograph (28 Days) of the Sample Solution: Cement, Sand and Fly Ash

The x-ray of the solution shows: minerals such as quartz SiO_2 (d=4.27; 3.35; 1.818; 1.543 A^0), calcite $CaCO_3$(d=3.86; 3.04; 2.28; 1.913; 1.876 A^0), dolomite $CaMg(CO_3)_2$ (d=2.90; 2.02 A^0), plagioclase (anorthitis) (d=4.04; 3.68; 3.22 A^0) calcium feldspar (d=3.77; 3.25; 3.15 A^0), hydromica (d=9.78; 4.49 A^0) diffraction lines are characteristic of low basic hydrosilicates in the general formula C-S-H, like portlandite (d=4.91; 2.63; 1.927 A^0), four calcium aluminoferrite (d=7.24; 2.78; 2.63 and 1.93 A^0), calcium hydrosilicate (d=7.02; 2.56 A^0), gillebrandit - $2CaO$ x SiO_2 x $3H_2O$ (d=10.89; 2.63 A^0).

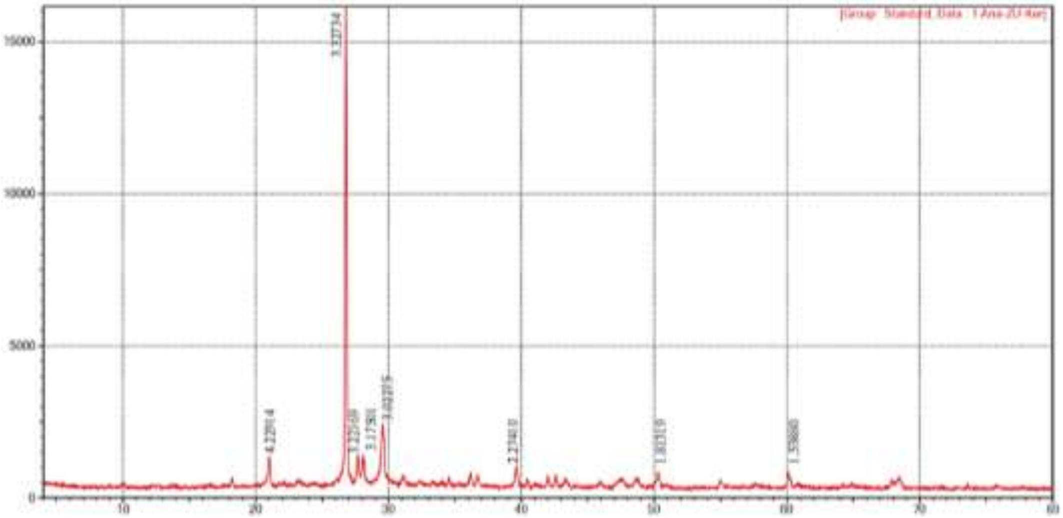

Fig. 5: Radiograph (28 days) of a Sample Of Light Concrete: Cement, Sand, Fly Ash and Aggregate

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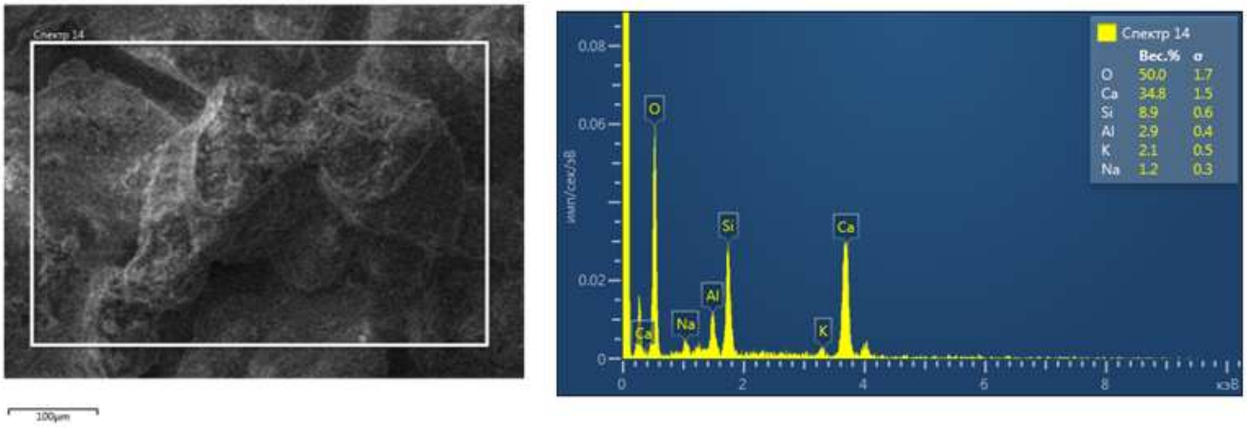
X-ray diffraction pattern of lightweight concrete is represented by: mineral quartz (d=4.27; 3.35; 2.46; 1.818; A^0), calcite $CaCO_3$ (d=3.86; 3.04; 2.28; 1.875 A^0), plagioclase (anorthitis) (d=3.71 A), portlandite d=4.91; 2.63; 1.927 A^0), calcium feldspar (d=3.77; 3.25; 3.15 A^0), hydromica (d=9.78; 4.49 A^0) as well as low basic hydrosilicates, four calcium aluminoferrite (d=7.24; 2.78; 2.63 and 1.93 A^0), calcium hydrosilicate (d=7.02; 2.56 A^0), gillebrandit -$2CaOxSiO_2x3H_2O$ (d=10.89; 2.63 A^0). dolomite (d=2.90; 2.02 A^0), mullite -$3AlO_3x2SiO_2$, cristoballite - SiO_2 (d=10.889; 2.56 A^0).

Physicochemical studies (X-ray diffraction and IR spectra) confirm amorphous participation in the structure formation of quartz. It has been established that the micro filler of fly ash due to an increase in the formation of low-basic hydration products will provide strength, therefore, it will improve the construction, technical and operational characteristics of lightweight concrete.

To study the composition of concrete and neoplasms in its structure, a microscopic analysis was used, which allows obtaining information about neoplasms. The studies were carried out on the ***SHIMADZU*** instrument with the composition of the sample mortar and light concrete. Increase *x10μm, x20μm, x100μm, x200μm.*



a) b)

Fig. 6: a) x100µm The microstructure of the sample solution: Cement, sand and fly ash; b) X-ray phase analysis

Table 1: The Chemical Composition of the Solution

№	Element	Weight.%	Sigma Weight.%
1	O	50.04	1.68
2	Na	1.22	0.31
3	Al	2.94	0.39
4	Si	8.94	0.60
5	K	2.10	0.48
6	Ca	34.75	1.47
7	Amount:	100.00	

The microstructure of the composition: cement, fly ash on the first day of hardening, is represented by needle crystals, intergrowths of small lamellar crystals sprouting at different angles, at 28 days of hardening, the number of hydrosilicates gradually increases, forming a uniform crystalline microstructure.

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It has been established that fly ash additives have a strong effect on calcium hydroaluminates and therefore, to stabilize the cement mixture in the presence of the additive, a reduced amount of gypsum in the cement composition is required. Therefore, to assess the effectiveness of the fly ash we use, not only the plasticization effect and the effect on the strength properties of minerals are important, but also on the hydration process of the mixed binder. In connection with this similar study, the *composition of cement + aggregate + fly ash* was subjected.

The amount of cement-bound water amounted to 28 days of hardening “cement-ash-fly-away” solution of 17.5%. Consequently, fly ash slows down the hydration process and contributes to the creation of a “clinker fund” for continued hydration in the subsequent hardening periods.

Thus, in the time of hardening of the solution under normal conditions, hydration of calcium oxide (CaO) occurs in the initial dry sampling ash; complete assimilation of $Ca(OH)_2$ during hardening is not achieved, which is a reserve for the growth of the strength of the solution over time. This hypothesis is confirmed by a change in the strength of the solution as a result of testing the samples after 7.28.60.90 and 180 days.

In a solution of the optimal composition based on "cement-fly-ash", the formed matrix in the hardened binder is more uniform, the structure is densified and strengthened due to the growth of the crystalline phase and the replacement of water contacts between individual neoplasms. The solid skeleton of all binder samples is composed of individual grains of fly ash and cement, as well as particles of aggregate waste of varying fineness with interaction with neoplasms [3].

II. CONCLUSION

From the analysis of the physical, chemical and microscopic studies it follows that the introduction of a fine ground filler of fly ash in an amount of 30 % improved the structure of lightweight concrete, which will affect the construction and technical properties of lightweight concrete on the aggregate consisting of quartz porphyry and carbonized clay.

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