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INVESTIGATIONS OF THE PROCESSES OF STRUCTURE FORMATION IN CONCRETE CONDITIONS ON WINTER CONCRETING

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Abstract

This article describes the processes of the composition of concrete in the process of concreting in a cold climate, i.e. the influence of chemical changes on the properties of heavy concrete when using a modern complex additive. These analyzes were obtained and compared as a result of chemical analyses.

Keywords: Complex, chemical additive, concrete, frost-resistant, chemical process.

Introduction

The cold resistance of concrete is said to be its ability to withstand repeated freezing and thawing when saturated with water. Under such conditions, the main cause of concrete failure will be an increase in pressure on the walls of the pores and microcracks of water freezing. The volume of frozen water increases by 9%; the solid base of the concrete does not allow the water to expand, the tension inside it being greatly increased. Repeated freezing and thawing loosen the concrete structure, causing it to collapse. First the edges of the concrete, then the surface, and finally its interior. The stresses caused by the difference between the linear temperature coefficient and the temperature-humidity gradient of the concrete components are also affected to some extent. Sequential freezing and thawing methods are used to determine the frost resistance of concrete. The test method, in particular the freezing temperature, the water swelling conditions of the sample, the size of the sample, the duration of the cycle have a significant effect on the performance of the concrete in terms of frost resistance. Erosion of concrete is especially rapid when the freezing temperature is lowered, especially when frozen in a solution of water or salts. The criterion of frost resistance of concrete is the amount of cycles with a decrease in the mass of the sample less than 5% and a decrease in strength not exceeding 25%. The amount of cycles determines the brand of concrete in terms of frost resistance. For example, F 100 is assigned to F 200 and higher depending on the operating conditions.[1]

Determining these cycles will improve the strength of the building. To do this, it is effective to use complex chemical additives to achieve the strength of concrete in cold climates

LITERATURE REVIEW

The following foreign scientists' literature was used to cover the topic, which provided information on the process of winter concreting: Mironov S.A., Besser Y.R., Batyanovskiy E.I; Barabanshikov Y. G., Gendin V.Y., Grapp A.A., Rozenberg T.I., Oskorov S.D., Arbenyev A.C., Nerenst P., Rastrup E., Idorn G.M., Bajenov Y.M., Krilov B.A., Lagoyda A.B., E.M. Pliss., I.V. Tixonov., A.I. Rusakov., B.N Tarasivich.,

A number of scientific studies were also carried out by the scientific experts on the development of the compositions of complex-mineral additives, the improvement of the structure and properties of the cement paste. In their scientific research Kasimov E.U., Akramov Kh.A., Gaziev U.A., Samigov N.A., Mirakhmedov M.M., Tulaganov A.A., Turapov M.T., Kamilov Kh. Kh., Shakirov T.T. and others in different years have achieved certain successes and important scientific results in this direction.

MATERIALS AND METHODS

During the research, the following materials were used:

a) binder

Ahangaron PTs 400 D 20 brand cement was used for the study. The chemical composition of ahangaron portland cement is given in the table below.

Table 1

Name	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	R_2O
Portland cement	**21,55**	**4,96**	**3,91**	**64,47**	**2,76**	**0,96**	**1,38**

Portland cement properties. The fineness is determined by the amount of cement passed through the sieve No. 008 (pore size 0.08 mm); at least 85% of the sieved variety must pass through the sieve. The average size of cement grains is 15-20 mkm, which corresponds to a surface area of 2500-3500 cm2 / g. The density of Portland cement without mineral additives is 3.1 g / cm3

b) sand

According to GOST 10268-80, sand, crushed stone from natural stone, gravel and crushed stone from gravel can be used as small and large aggregates.

Determination of the grain composition and modulus of fineness of sand was carried out according to the method of GOST 8735-88 p.3.

Granulometric composition of coarse sand (fractions less than 5 mm)

Table 2

Residue name	Residues, % by weight, on sieves					Passage through a sieve with mesh No. 0.16 (014), % by mass
	2,5	1,25	0,63	0,315	0,16 (0,14)	
Private a_i	26,6	9,6	11,2	26,8	16,4	9,4
Full A_i	26,6	36,2	47,4	74,2	90,6	100

The sand size module is Mk-2.75, according to the size modulus, the sand is coarse.

The total residue on the sieve No. 0.63 M0.63 is 47.4%, the sand is coarse.

The content of dust and clay particles, % by weight-2%.

The bulk density of coarse sand with screening of grains larger than 5 mm was 1590 kg/m3.

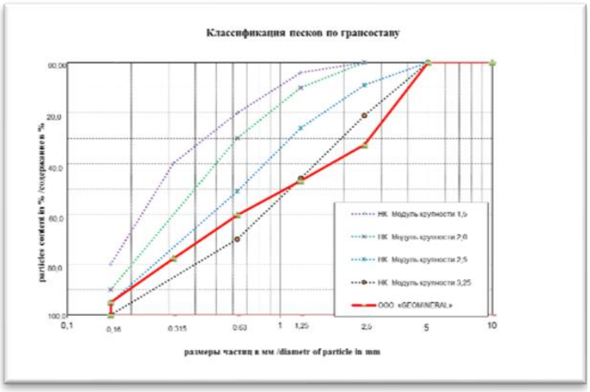


Figure 1. Sand classification by grantee

c) gravel

Tests of crushed stone to determine the grain composition were carried out according to the method of GOST 8269.0-97 p.4.3., The grain composition of crushed stone was determined by sieving the sample on a standard set of sieves.

The average partial residues of crushed stone of a fraction of 5-20 mm on sieves in%, according to Table 3, amounted to:

Table 3

Sieve opening diameter (мм)	40-20	20-10	10-5	<5
Partial residue, % by weight on sieves	25,3	65,2	8,4	1,1

Sieve opening diameter (мм)	40-20	20-10	10-5	<5
Total residue on sieves in %	25,3	85,5	93,9	100

d) chemical additives:

“Beton strong 17” is a complex chemical additive that acts on the following properties of concrete even at a temperature of -20 o C

- prevents freezing of concrete in cold climates;

- prevents hydration in concrete from stopping at temperatures from minus 5 to minus 20oC;

- leads to a decrease in the W/ C ratio, resulting in cost-effectiveness;

RESULTS AND DISCUSSION

In order to make our research results clear and perfect, we compared the results obtained with the addition and without the addition of chemical additives to the concrete samples at normal and -20oC temperatures. We tested B30 grade concrete in Ohangaron PTs 400 D20 cement at -10oC by adding superplasticizer BETON STRONG 17 to prepare heavy concrete and test its strength at -10oC and achieved the following results. First of all, we selected the following composition per 1m3 when preparing the mixture:[2,3]

Table 4

	Requirements for concrete and mix				C/W	Cement brand and type	The volumetric theft of the concrete mix is kg / m³	Filler type	Day	Consumption of materials for 1m3 concrete mix, kg				
	Concrete grade in terms of strength	W	F_1	CS						Cement	Sand	Gravel	Water	Chemical additive 2% (from cement mass)
1.	B30 (M400)	6	200	П3	0.45	Pts.400 D20	2455	Gravel 5÷20 мм	28	440	910	910	195	8.8

Samples of 10x10x10 cm were prepared from this composition and the compressive strength of 7- and 28-day concrete at normal and -10oC temperatures was determined.

Normal conditions

Table 5

№	C/W (%)	The amount of cement gr	The amount of water ml	Chemical additive %	CS	Strength MPA 7 days	Strength MPA 28 days
1	0.45	3080	1365	0	П3	33.5	37
2	0.35	3080	1092	2	П3	35.8	51.26
3	0.45	3080	1365	2	П5	30.73	37.11
4	0.50	2156	1092	2	П3	33.36	37.48

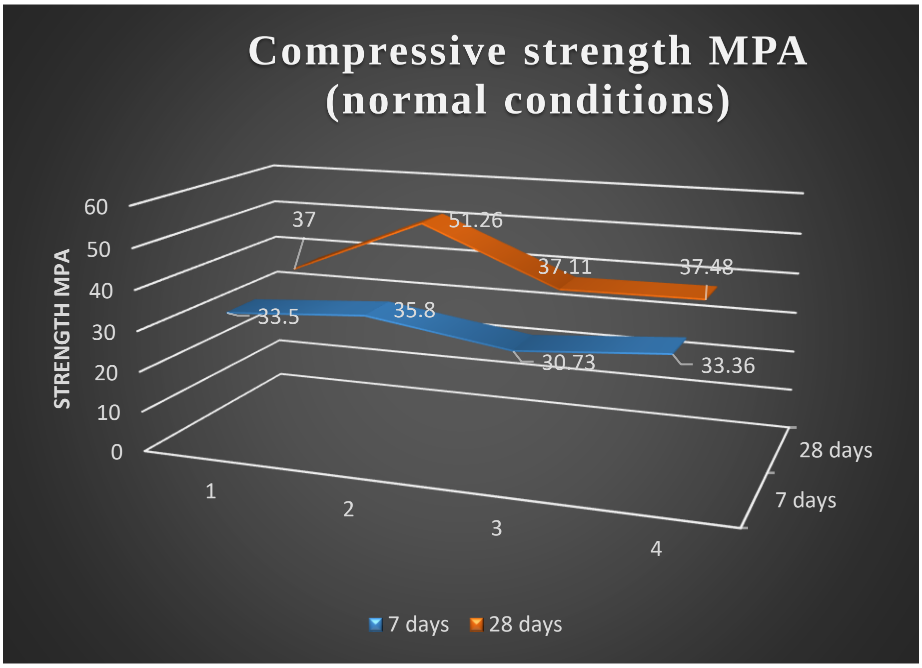


Figure 2. “Beton strong17” Effect of complex chemical additive on concrete strength under normal conditions

When a complex chemical additive "BETON STRONG 17" is added to the concrete (at a temperature of -10oC)

Table 6

№	C/W (%)	The amount of cement gr	The amount of water ml	Chemical additive %	CS	Strength MPA 7 days	Strength MPA 28 days
1	0.45	3080	1365	0	П3	9	10
2	0.35	3080	1092	2	П3	29.66	35.72
3	0.50	2156	1092	2	П3	30.24	38

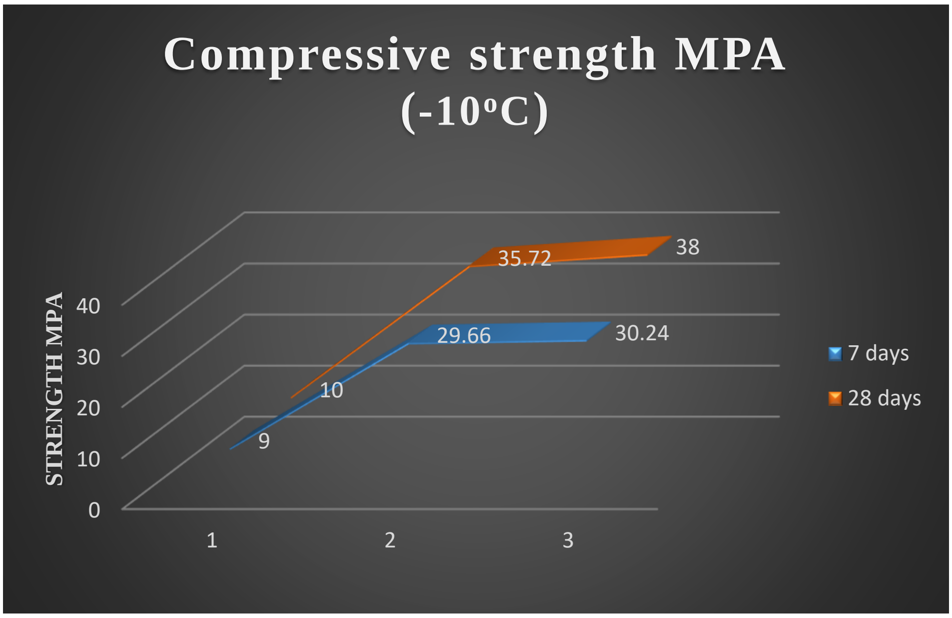


Figure 3. “Beton strong17” Effect of complex chemical additive on concrete strength under at a temperature of -10oC

The above results show the effect on the mechanical properties of concrete with and without the addition of complex chemical additives in normal and cold climates.

Based on the experimental results, chemical changes in the concrete with and without additives were also identified. In doing so, we used the following analyzes:

- Electron microscope scanning concrete. The microstructure and element composition were studied;

- The phase of the substance was considered in the X-ray diffractometer;

- IR spectrometer (for liquid substance);

- DTA analyzes were obtained.

A scanning electron microscope (SEM) is a type of electron microscope that creates images of a sample by scanning the surface with a focused electron beam. The electrons interact with the atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample. The electron beam is scanned as a bitmap and the position of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electrons, the radiation of atoms excited by an electron beam is recorded using a secondary electron detector (Everhart–Thornley detector).

We also used this analysis to analyze changes in heavy concrete composition during experimental research. To do this, we studied the addition and non-addition state of a 2% complex chemical additive for a temperature of -10oS, and the results of the analysis are given below.

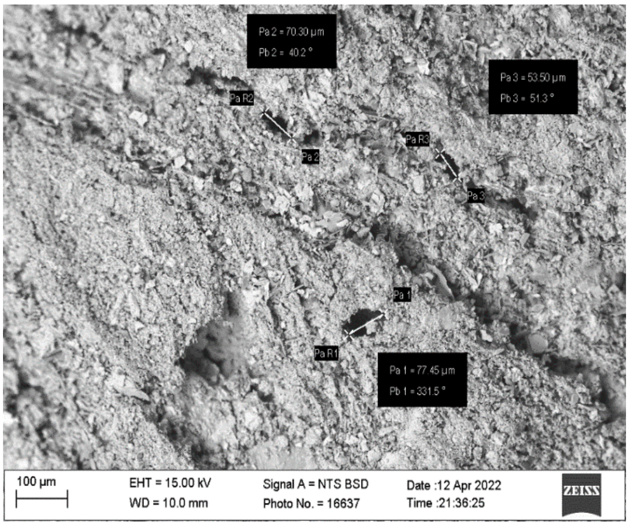


Figure 4. Structure of concrete after freezing (C / W = 0.45) without chemical additive

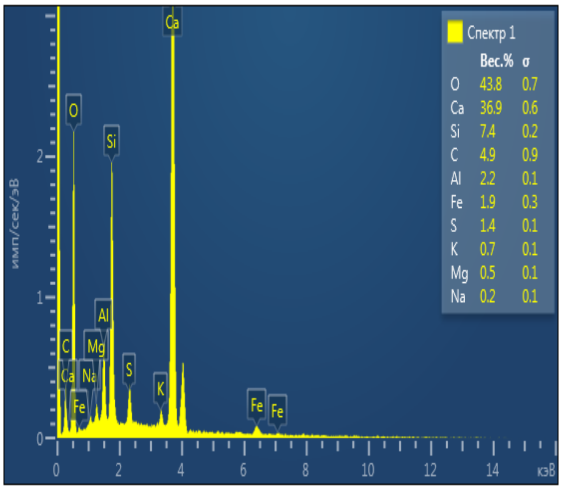


Figure 5. Structure of concrete after freezing (C / W = 0.45) without chemical additive

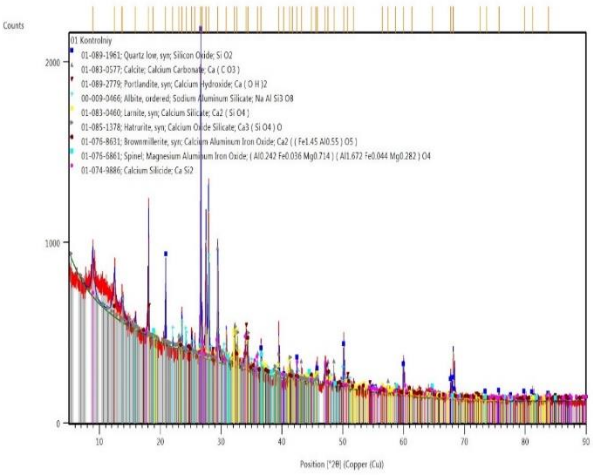


Figure 6. Structure of concrete after freezing (C / W = 0.45) without chemical additive

From the results of the analysis we can see the composition of the concrete without the addition of complex chemical additives (Figure 4). The results show that if we do not prevent the concrete from freezing in cold climates, many pores will form, which will negatively affect its strength.

It should also be noted, that any chemical additive can cause a change in the chemical composition of the concrete. As a result of the analysis (Figure 5.6) we can see the chemical composition of heavy concrete without superplasticizer prepared using Ahangaron PTs 400 D 20 cement.

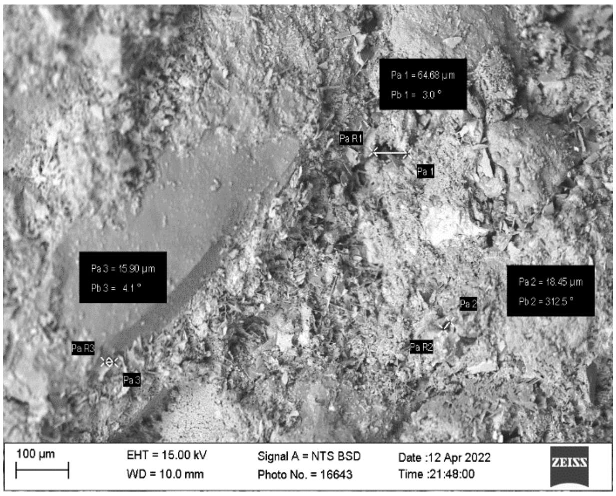


Figure 7. Structure of concrete after freezing (C/W = 0.35) with chemical additive

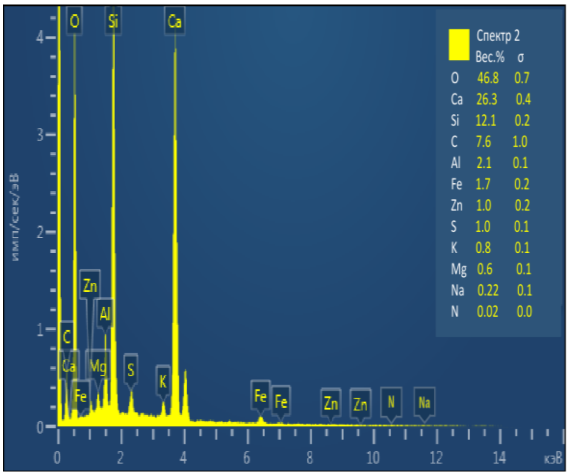


Figure 8. Structure of concrete after freezing (C/W = 0.35) with chemical additive

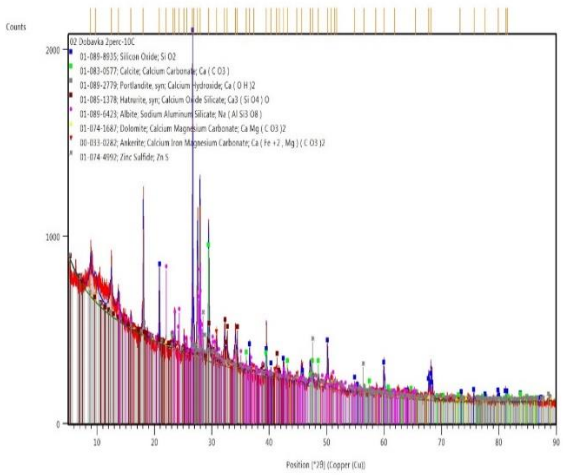


Figure 9. Structure of concrete after freezing (C/W = 0.35) with chemical additive

As can be seen from the results of the above analysis, the decrease in C / W ratio when we added a complex chemical additive led to a sharp decrease in the number of pores in the concrete composition, which ensures its strength (Figure 7).

It can also be seen from figure 8.9 that the complex chemical used prevents the concrete from freezing at cold temperatures, as evidenced by the presence of metal nitrates in its composition.

We can see from the X-ray results that the lower the C/ W ratio, the more it does not adversely affect the strength of the concrete when using a chemical additive, but rather increases its strength due to better compaction and reduced porosity.

In order to clarify the experimental studies, a complex chemical additive was obtained for analysis even from the powder state, and the following results were obtained.

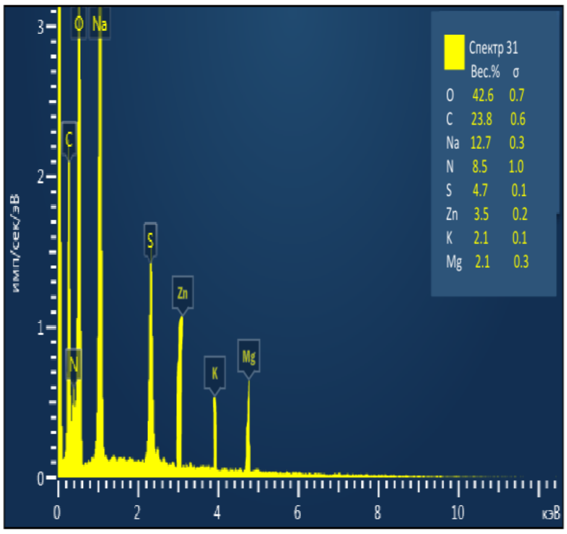


Figure 10. The powder state of the chemical additive

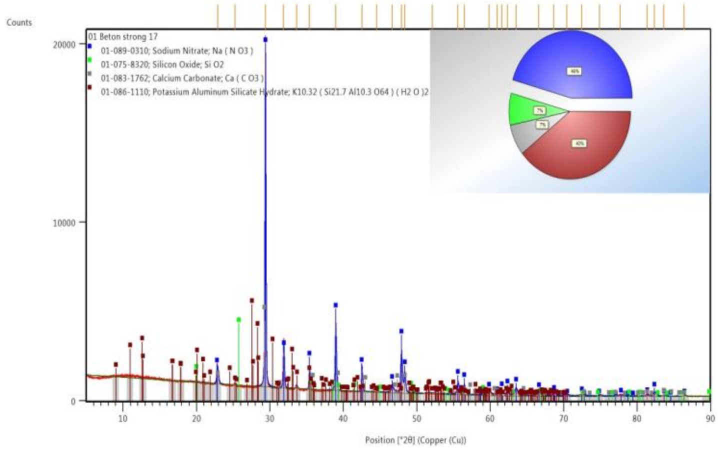


Figure 10. The powder state of the chemical additive (content relative to dry mass)

From the results of chemical analysis it can be concluded that the composition of the superplasticizer "Concrete strong17" is naphthalene sulfate. This prevents the freezing of the admixture in cold conditions when the additive is added to the concrete mix, accelerates the setting time, increases the plasticity of the mix and at the same time protects the reinforcement from corrosion.

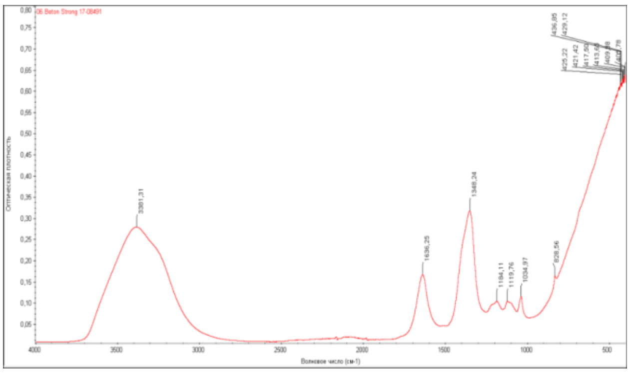


Figure 11. IR spectral analysis of "Beton strong 17" superplasticizer.

- From the analysis of this analysis, the following conclusions can be drawn:

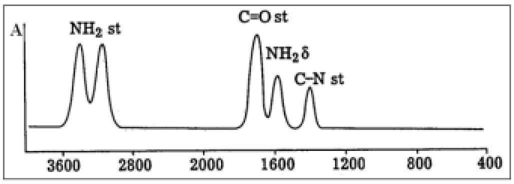
- 3381.31 см-1 -OH group in aliphatic alcohols was detected in the absorption region.

V-OH см-1=3381,31 [4]

Association parameters of hydrocarbon hydroperoxides with bases (according to IR spectroscopy, 20 0C)

GP	Protonacceptor	V_{OH}, $см^{-1}$	ΔV_{OH}, $см^{-1}$	K,l/mol	ΔH, kj/mol	Δ S, J/mol*K
GPTA	Acetone	3380	172		15±2	
	Dioxane	3375	180		17±2	
	diethyl ether	3247	208		15±2	
	oxide					
	b-isoamylene	3393	162		17±2	
	pyridine	3170	385		29±2	
GPIPB	acetophenone	3432	119	2,28		
	benzoquinone	3430	121	1,25		
	benzophenone	3425	126	1,67		
	acetone	3375	176	1,92	15±2	54±6
	cyclohexanone	3365	136	2,5	11±1	30±4
	dioxane	3367	194	2,2	17	
	diethyl ether	3335	216			
	tert-butyl peroxide	3400	151	0,65		
	diisopropyl ether	3326	225	1,78	12	
GPTB	methylethylketone	3413	146	2,8	15	58
	dimethylacetamide	3334	225	11,4	22	94
	dimethyl sulfoxide	3203	356	34,9	24	108
	hexamethylphosph-orotriamide	3192	367		29	
	pyridine	3170	389		30	
	diethyl ether	3357	202	1,6	18	69
	diisopropyl ether	3351	208	1,49	21	71
	butyl ether	3359	200	1,63	20	69
	propylene oxide	3386	173	1,73	17	62
	cyclohexanone			4,3	9±1	19±1
	acetone	3387	172	2,6	13±2	31±3
	dioxane	3381	172	2,59	18	67

- 1636.25 a group of amides has been identified in the absorption region [4,5]



- 1348.24-1020 metal nitrates in the region [3]

- 850-670 in the range of mainly intensive absorption lines of nitrate ions [4,5]

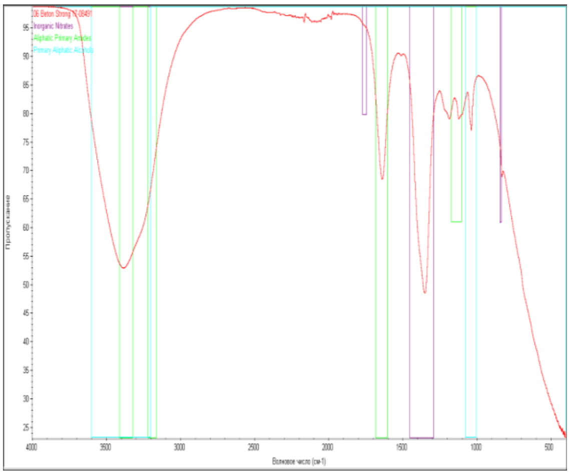


Figure 12. IR spectral analysis of “Beton strong 17” superplasticizer.

From the results of chemical analysis we can see that the presence of high aliphatic amides and aliphatic alcohols is evidence that the complex chemical additive is composed of naphthalene sulfate. The presence of the element N in the chemical additive (Figure 10) is precise evidence of the appearance of high aliphatic amides in IR spectral analysis. Inorganic nitrates, i.e. metallic nitrates, seen in spectral analysis, sharply reduce the freezing point of the mixture in cold climates, which ensures the strength of the concrete.

The IR spectrum is a functional analysis that shows each functional group in a molecule in separate absorption lines, as well as each functional group in separate oscillations and in deformation oscillations. It also identifies symmetrical and asymmetric absorption lines through this analysis.

CONCLUSION

1.Taking into account all the above indicators, the chemical additive (potash, sodium nitrite, calcium nitrite with urea) only prevents the water in the concrete mix from freezing at cold temperatures. The complex chemical additive "Concrete strong 17" simultaneously accelerates the setting time of the mixture, increases its plasticity and, most importantly, prevents the concrete from freezing

2.The results of the experiment show that the application of this complex chemical additive reduced cement consumption by 30% and water consumption by 20%.

3. The use of complex chemical additives does not require excessive effort and expense in construction.

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