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Production Of Heat-Resistant And Frost-Resistant Composite Hermetic Mastics For Filling Cracks In Asphalt Concrete Roads And Defensive Joints Of Roads With Concrete Pavement

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Annotation: The article presents the results of research on the production of cold-heat-resistant composite hermetic mastics with specified sets of physical, mechanical and technological properties based on local organic-mineral ingredients and industrial waste for filling cracks in asphalt concrete roads and expansion joints of roads with concrete surfaces. They can be used in various climatic conditions and in mountainous areas at temperatures from -30^0 to + 170^{0}C, and will also help to increase the long-term operation and productivity of airfields, highways and bridges

Keywords: Physical and mechanical properties, hermetic composite mastic.

Introduction.

The technical condition of the transport network is very important in the state, strategic and economic aspects. Roads, bridges and airports are becoming especially important at the state level, since they account for 90% of the cargo of the national economy and 98% of passenger traffic. But at present, the existing roads are not strong enough and require quick repair. This is especially evident in alpine and hot climatic conditions.

In hot climatic conditions, it is very important to seal asphalt and concrete joints for long-term operation of roads, asphalt concrete pavements on airfields and road bridges. Currently, prices for bituminous composite mastics, which are imported from foreign countries, are quite high. Moreover, their softening point is relatively low. Locals are not durable enough, they eat quickly deteriorate or move away from the road surface.

It should be noted that composite bitumen mastics imported from foreign countries and mastics produced in our country have relatively low physical, chemical and operational properties, especially thermal resistance.

The introduction and development of new innovative technologies in the field of composite materials science is important for the production of effective compositions of sealants used in various climatic conditions.

Purpose of the study

Is the creation of effective compositions and optimal technological modes, obtaining composite materials and sealing mastics based on them.

Research objects

There are bitumens BN90 / 10, BN70 / 30, viscous gossypol resin, oxidized gossypol resin, finely ground rubber crumb and slaked lime, lignin, mechanically activated wollastonite, basalt fiber, ash and slag mixtures.

Table 1 Comparativecharacteristicsofbitumen

Thenameofindicators	Standards in accordance with GOST 11952-66				Resultsofcontrolstudies			
	BND 60/90	BND 40/60	BN-70/30 (BNI IV)	BN-90/10 (BNI V)	BND 60/90	BND 40/60	BN-70/30	BN-90/10
Needle Penetration Depth: at 25^{0}C at 0^{0}C (GOST11501-65)	61-90 20	41-60 13	21-40 2	5-20 3	76 25	50 16	30 2	15 3
Softening point, ^{0}C, not lower (GOST11505-66)	47	51	70	90	50	54	60	80
Brittleness temperature according to Fraas, ^{0}C, (GOST 11507-65)	-15	-12	-9	-7	-17	-20	-11	-10
Elongation at 25^{0}C, mm, not less (GOST11505-65)	55	45	3,0	1,0	54	48	4	2
Content of water-soluble compounds,%, not more (GOST 11508-65)	0,3	0,3	0,2	0,2	0,25	0,25	0,18	0,18
Flash point, 0C, not lower	230	230	240	240	260	265	270	280

(GOST 4333-70)								

Due to the physicochemical properties of the aforementioned binders and fillers, our main focus was on wollastonite and ash and slag. The physicochemical properties and structure of wollastonite are considered. Wollastonite ore is concentrated by flotation [1-5].

Table 2 Chemical analysis of the Kuytash wollastonite ore before and after flotation.

Try	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	Na_2O	K_2O	П.п.
Beforeflotation	45,89	3,18	2,53	33,2	2,13	0,46	0,52	1,60	9,93
Afterthefirstflotation	57,79	3,67	2,22	26,8	0,83	0,20	0,83	0,88	6,66
Afterthesecondflotation	58,54	3,71	2,22	26,7	0,83	0,18	0,84	0,73	5,73

During flotation, $CaCO_3$and $MgCO_3$, which, in turn, leads to an increase in active silicon oxide, that is, to an increase in the composition of the main mineral wollastonite, due to the release $CaCO_3$and $MgCO_3$in the process of ore dressing [1-5].

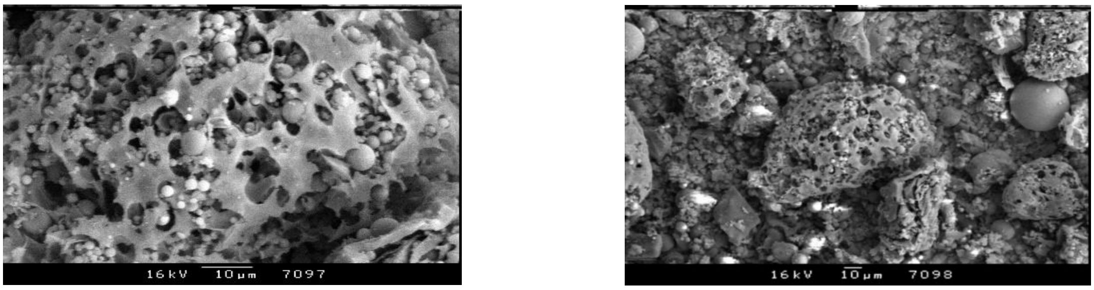
Investigation of the structure and physicochemical characteristics of ash and slag waste. It is known that 650 thousand tons of ash and slag are produced annually at the Angren and Novo-Angren thermal power plants.

The chemical composition of the ash and slag of the Angren deposit is shown in the following table 3.

Table 3 Chemical composition of ash and slag

Connections	SiO_2	Al_2O_3	FeO	CaO	MgO	SO_2	TiO_2	K_2O	Na_2O	P_2O	MnO
%	62	27,3	5,65	1,17	0,49	0,47	1,49	0,42	0,32	0,52	0,17

Chemical analysis showed that the composition of ash and slag up to 62% consists of active silicon oxide. Electron microscopic studies have shown that most of the ash and slag particles have different sizes and shapes. Particle sizes range from 1 µm to 5 µm (Figures 1 a, b) [1-5].



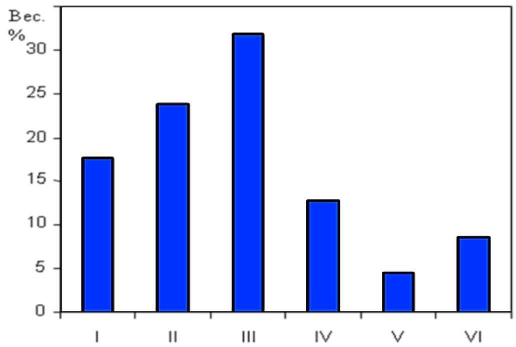
Picture 1. The morphological composition of the ash and slag of the Angren CHP

The results of the study showed that 32% of ash consists of a fraction with a size of III-42 microns, the fractional composition of ash and slag waste is shown in Figure 2, and their diffraction pattern in Fig. 3.

Thus, the composition of ash and slag is dominated by silica, alumina, iron and calcium oxides. The ratio of the sum of basic oxides (CaO, Al_2O_3, MgO, FeO, Fe_2O_3, MnO) to the sum of sour (SiO_2, P_2O_5, TiO_2) refer more to slags [1-5].

I – 21; II – 33; III – 42; IV – 55; V – 83; VI – 204.**Figure 2. Average fractional composition of ash and slag, microns.**

* mullite;°α-quartz; + magnetite**Picture No. 3.**



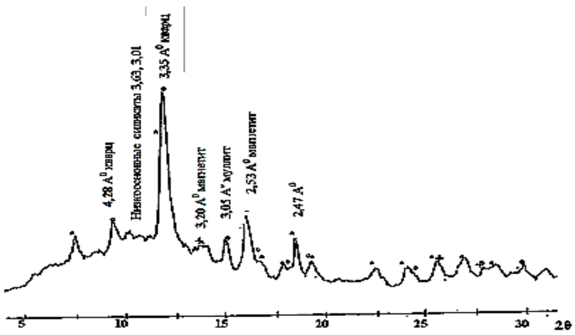


Figure 2 shows that 32% ash consists of W-42 microns fraction.

Ashes are classified as fine materials. A detailed study of the composition and properties of ash slabs will ensure their use in the field of materials science, especially for the production of various products on their basis. In this case, it will be possible to achieve both economic effects and solve a number of environmental problems [1-5].

Thus, the research results show that almost all of the aforementioned organomineral ingredients can be one of the potential components for obtaining effective composites and sealants for the repair and construction of concrete and asphalt-concrete pavements, which means that our organic substances can act as a binder. Minerals, especially mechanically activated wollastonite and thermally activated ash and slag, can enhance their physical and mechanical properties and resistance to high temperatures, since their composition consists mainly of acrylic silicon, aluminum and other oxides.

First of all, a model composition was investigated and determined, consisting of 50% of BN-90/10 bitumen, 26% of BN-70/30 bitumen, 18% of gossypol resin and 6% of crumb rubber, as well as its properties. Was selected and investigated an exemplary composition, where the softening temperature was 50-700C, extensibility at 250C; 1-3.8 cm, penetration 18-30mm-1 and adhesion strength to concrete 0.1-0.4 MPa, while the cooking temperature is 180 ± 50C, and the cooking time was 3 hours.

The significance of indicators of physical and mechanical properties of model composite sealing mastics was determined depending on the content of bitumen, gossypol resin, rubber powder, lignin, recycled polyethylene and polyvinyl chloride, basalt fiber, slaked lime, mechanically activated wollastonite and ash and slag.

It should be noted that the best result was obtained in the study of the physicomechanical properties of the composition with the addition of wollastonite and ash and slag to the composition of the sealant.

The composition of the created composite sealing mastics is shown in tables No. 5 and No. 6.

Table 5 Composition of bituminous compositions based on local raw materials.

№	Nameofingredients	Ingredient content, parts by weight						
		KGM-100	KGM - 110	KGM - 120	KGM - 130	KGM - 140	KGM - 150	KGM - 170
1	Bitumen BN-90/10 (BNI-V)	35	35	35	30	30	30	30
2	Gossypolresin	40	40	30	30	30	28	28
3	Rubbercrumb	13	13	15	14	10	10	8
4	Lignin	3	2	5	2	2	3	3
5	Recycledpolyethylene	3,0	3,5	5	7	7	4	3
6	Secondarypolyvinylchloride	5	5	7	8	8	8	7
7	Ashandslagmixtures	-	-	-	2	4,5	6	7
8	Slakedlime	1,0	1,5	2	2	2,5	3,0	4
9	ActivatedVollostonite (AkV)	-	-	-	3	4	5	6
10	Basaltfiber	-	-	-	2	2,5	3	4

Table 6 Physical and mechanical properties of bituminous compositions

Thenameofindicators	Determination methods	Indicator values						
		KGM -100	KGM -110	KGM -120	KGM -130	KGM -140	KGM -150	KGM-170
Softening temperature according to KiSh, ^{0}C, not less	GOST 26589	95	102	112	125	135	145	165

Brittleness temperature according to Frass, ^{0}C, not higher	GOST 11507	-20	- 20	- 22	- 23	- 25	- 26	-27
Extensibilityat25^{0}C	GOST 11056	6,2	5,8	5,4	5.0	4,6	4,2	4,2
Bond strength to concrete, MPa	TU-RUz 04/14/2004	0,5	0,5	0,7	0.9	1,0	1,1	1,3
Penetration depth of the needle in mm $^{-1}$at a temperature 25^{0}C	GOST 11501	32	30	28	24	19,0	16	16
Waterabsorption,%	Nomorethan 0.2	0,2	0,18	0,18	0,18	0,17	0,16	0,15

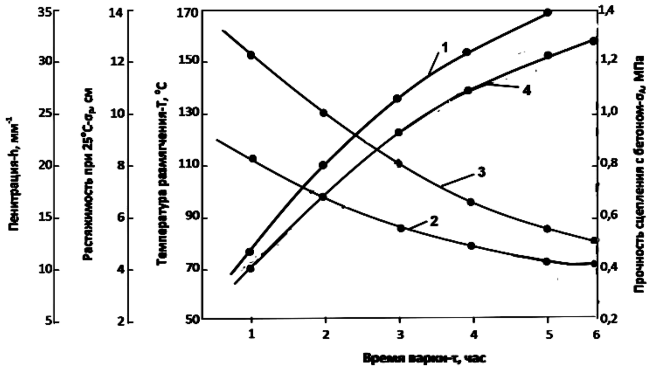


Figure No. 4. Dependence of the physical and mechanical properties of the composite sealing mastics of the KGM-150 and KGM-170 brands on the cooking time at a temperature 180 ± 5ºC

1 – softening point, ºC;

2-extensibility –25 ° C cm;

3 – penitration, mm $^{-1}$;

4– strength of adhesion to concrete, MPa

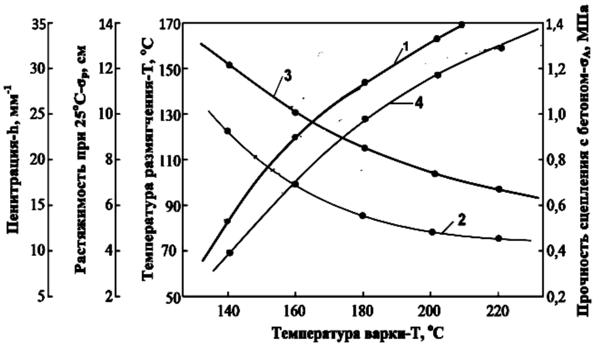


Figure № 5. Dependence of the physical and mechanical properties of the composition-sealing mastics of the KGM-150 and KGM-170 brands on the cooking time 4.5 hours

1 - softening temperature, ºC;

2 - extensibility at a temperature of 25 ° C, cm;

3 - penitration, mm^{-1};

4 - adhesion strength to concrete, MPa

From the above, it becomes clear that the technological regime has a tangible effect on the formation of important indicators of sealing composite materials. Based on the results of the experience, an optimal technological regime for obtaining composite sealing materials with high physical, mechanical and operational characteristics was developed. (Table 7).

Table 7 Indicators of the optimal technological mode for obtaining a sealing composite mastic

Technological indicators	Марка мастики						
	KGM -100	KGM -110	KGM -120	KGM - 130	KGM - 140	KGM - 150	KGM - 170
Cooking temperature, ^0C	180±5	185±5	190±5	195±5	200±5	205±5	210±5
Cooking time, hour.	5 - 5,5	5 - 5,2	4,8 - 5	4,5-4,8	4,5	4,5	4,5-5,0

Table 8 Physicomechanical indicators of sealing composite mastics created on the basis of the developed technology and optimal technological regime

Thenameofindicators	Determination methods	The value of indicators						
		KGM -100	KGM -110	KGM -120	KGM -130	KGM -140	KGM -150	KGM - 170
Softening temperature by KiSh, ^0C	GOST 26589	102	113	121	132	142	151	172
Brittleness temperature according to Frass	GOST 11507	-20	- 22	- 24	- 26	- 28	- 30	-30
Elongationat 25 ° C	GOST 11056	6,0	5,6	5,2	4,8	4,4	4,0	4,0
Bond strength with concrete, MPa	TU-RUz 04/14/2004	0,5	0,6	0,8	1,0	1,16	1,2	1,4
Penetration mm-1, at 25 ^0C	GOST 11501	32,0	29,0	27,0	23,0	18,0	15,0	15
Waterabsorption,%	No more than	0,2	0,18	0,17	0,16	0,14	0,12	0,10

	0.2							

Thus, several brands of composite materials have been created for sealing deformation segments and seams of highways, bridges, concrete and asphalt surfaces of airfields, for use in various climatic conditions: KGM - 100; KGM - 110; KGM - 120; KGM - 130; KGM -140; KGM - 150; KGM-170. Composite hermetic mastic can be used in conditions from -30 ° C to + 170 ° C.

CONCLUSION

A scientific and technological basis is recommended for obtaining an effective composition of mastics that can be used at temperatures from minus 30 to plus 170 degrees, that is, under extreme climatic conditions, to seal cracks in asphalt concrete and expansion joints of concrete road surfaces, to increase their wear resistance and durability exploitation.

The regularity of the effect of technological parameters on the physical and mechanical properties of composite sealing mastics was revealed, based on a model composition containing: 50% BN 90/10 bitumen, 26% BN 70/30 bitumen, 6% rubber crumb and 18% gossypol resin. It is shown that with an increase in the content of BN-90/10 bitumen, the softening temperature and adhesion strength to concrete improve, and the indicators of penetration and extensibility gradually decrease. When using bitumen grade BN-70/30, the opposite pattern was revealed, i.e. the parameters of extensibility and penetration with an increase in the content of bitumen in the composition increases, and the indices of the softening temperature and the strength of adhesion to concrete decreases. Gossypol resin behaves in a model composition identically to bitumen grade BN-70/30, and with the introduction of recycled polyethylene and polyvinyl chloride, it significantly improves the physicomechanical properties of the developed composition by increasing its molecular weight.

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