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IMPROVING THE PROPERTIES OF MOBILE SANDS WITH MODIFIED CONNECTORS BASED ON LOCAL RAW MATERIALS

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Abstract: The article examines the possibilities of obtaining a solid-reagent for the production of a polymer-binding additive" SXM-1", obtained on the basis of the waste of the process of production of GIPAN" Navoiyazot "AJ and" Maksam-Ammofos " AJ waste phosphogips, and the possibility of obtaining these reagents as a result of studying the possibilities of obtaining a solid-reagent, the effect of the granulometric and mineralogical composition of the polymer "SXM-1" in the composition of the sand on the hardening of the sand protective layer was determined based on the study of the laws of moisture change and absorption process on the sand surface of various binders

On the surface of wet and dry sand, an improvement in the properties of wind and frost resistance was determined based on the formation of a protective layer by means of a polymer solution "SXM-1" and an improvement in the processes of its absorption, moisture retention.

Keywords: Maxam-Ammophos, phosphorus li, diffusion fixative, polymer, HYPANE (hydrolyslangane polyacrylonite), PAA (polyacrylonite)

Today, in the world, based on the requirements of road construction in the sand zones, the importance of construction and the continuous use of roads and railways is growing. In this regard, ensuring the safety of the use of these infrastructure facilities and their operational condition, reducing the negative effects of various factors on them has become an important task. One of the factors that have a negative impact on these objects is the seasonal influence of mobile sands on roads and railways. Currently, this is an acute problem in most countries of the world. Therefore, in these countries, in particular, in the USA, Iran, China, Russia, Kazakhstan, Turkmenistan, great attention is paid to improving protection technologies against the influence of mobile sands and the wind carrying them. From this point of view, in terms of protecting roads and railways from the negative impact of mobile sands, the following are considered relevant: the development of methods and technologies for fixing sand based on modern requirements, the development of means of protection against wind deflation of sand, the creation of resource- and energy-saving methods for assessing their strength, the development of a new generation of compositions for fixing sand.

In technically and technologically developed countries of the world, a number of scientific studies are being conducted to develop biological, mechanical, physico-chemical methods and resource-saving technologies based on them to preserve roads and railways from sand deposition. It should be noted that as the most effective ways to protect roads and railways from the influence

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of mobile sands are the impregnation of connectors to mobile sands by technological means and, as a result, the improvement of physico-chemical methods of fixing them with the formation of a crust against sand deflation.

In addition, a priority and promising direction for the development of resource- and energy-saving methods based on certain criteria for assessing the strength of the sand-connecting protective crust against sand deflation is the use of secondary raw materials, waste products of local industry as a solution for fixing mobile sands in dry and wet conditions, and the development of more efficient types of sand-connecting crust based on obtaining working compositions of connectors from them.

To study the filtration rate of the erosion-resistant coating of mobile sands, we conducted research on the development of technology for the production of water-soluble fixative polymers based on phosphorylated waste with phosphorous compounds HYPANE based on waste of JSC "Maxam-Ammophos", and to study their practical properties.

The reaction product is a colorless or yellow-colored liquid, it has a peculiar smell and is very viscous, its physical and chemical properties are fully determined. Further, the surface of the sands was treated by spraying and spraying with these polymer solutions (Table 1).

Table 1

The effect of the polymer on the resulting precipitation volume, on the filtration rate and on the viscosity of the suspension filtrate

№	The concentration of the suspension in the polymer, %	Suspension, pH	Precipitation volume, sm^3	Filtration rate, ml/min	Relative viscosity of the filtrate, g/dl
1.	0	7,8	2,40	2,50	-
2	PAA -0,1	7,4	2,78	1,6	0,64
3	PAA -0,2	7,3	2,72	1,4	0,56
4	PAA- 0,5	7,1	2,68	1,2	0,48
5	CXM-1 - 0,1	7,3	2,42	2	0,8
6	CXM-1 - 0,2	7,1	3,10	1,9	0,76
7	CXM-1 - 0,5	6,9	3,24	1,5	0,6

The study revealed the dependence of the mutual influence of the synthesized polymer fixative "SXM-1" with dispersed particles on many factors, i.e., on the concentration of polymer suspension and minerals, the presence of electrolytes, temperature, salinity level and others.

So as a comparative analysis of the polymer "SXM-1" with PAA developed by us shows, when polyacrylamide preparations interact with sand granules, they form a fragile brittle layer on the surface of the sands – the reason for this lies in the fact that diffusion, i.e., the impregnation of large macromolecules of PAA into the inner layers of sand and other dispersed granules is more difficult (Fig. 1).

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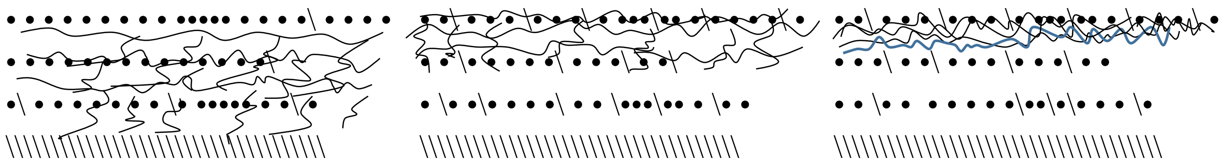

a. b. c.

Fig. 1. Diffusion of a polymer fixative solution in different concentrations into the inner layers of sand granules: a-0.1%, b-0.2%, c-0.5% solutions.

The aqueous solution of the polymer synthesized by us, as a result of its mobility, high activity and low molecular weight, easily penetrates into the inner layers of sand granules, and also leads to the formation of a strong compound with metal oxides, magnesium, calcium, iron and Si silicon elements in quartz sands, this phenomenon was revealed during the study of the IR spectrum sand samples fixed with a polymer fixator (Fig. 2).

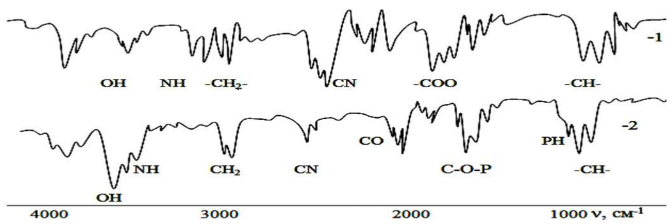

Fig. 2. IR spectrum of a sand sample fixed with a polymer fixative based on phosphorized HYPANE "SXM-1" and HYPANE.

As a result, the physical and mechanical strength of the protective layer formed on the surface of the sand was achieved, increasing its resistance to wind and water erosion.

The stability of the monolithic protective coating has shown that it completely depends on the resistance of the fixing polymers "SXM-1" to the effects of water, sunlight and weather. The sand layer treated with the connector, along with weather resistance, should have the ability to preserve the moisture content of the sand and the conductivity of atmospheric moisture – this is especially important in very hot summer conditions and periods of drought. If this layer has a combination of such properties, then the efficiency of phytomelioration increases significantly.

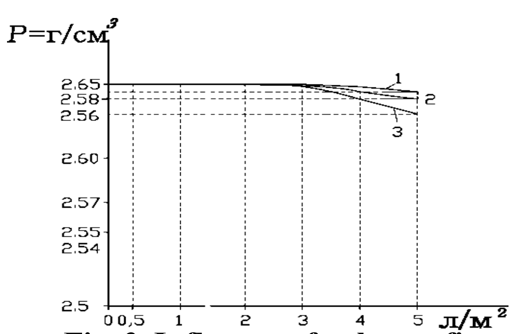

Fig. 3. Influence of polymer fixers PAA (1), "SXM-1" (2) va (3) on the actual density of sand. Fig. 4. Influence of polymer fixers PAA (1), "SXM-1" (2) va "for the relative density of sand.

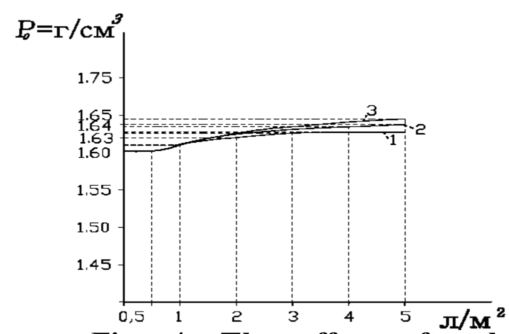

Fig. 4. The effect of polymer fixators PAA (1), "SXM-1" (2) va (3) on the relative density of sand.

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The kinetics of the formation of the polymer-sand structure depends on the rate of mutual influence of sand and polymer-fixative, on the adsorption process, which determines the viscosity properties. Therefore, in order to determine the nature of the fixing reagent, we carried out work to study the appearance of the nature of aggregate structures in the contact zone. According to this, the actual, scattering and relative density of the sands taken from different territories were determined (Fig. 3 and 4). As expected, with an increase in the time of mutual influence between the polymer-fixative "SXM-1" and sand, the actual and scattering density of the monolithic protective layer increases and the strength of this layer increases proportionally to them.

The change in the strength of the coating relative to the fixing temperature showed that the most desired result is achieved at a temperature of 40 ° C. An intensive increase in the fixing temperature leads to a decrease in plastic strength and an increase in the fragility of the material. And this, in turn, prevents aggregation and the processes of structure formation in the contact zone.

The graph of the dependence of the change in the strength of the coating on the concentration of the polymer fixative showed that at a polymer concentration from 1 l/m^2 to 3 l/m^2, the value of plastic strength does not change and is almost constant, and at a concentration from 3 l/m^2 to 5 l/m^2 increases and, this leads to an even greater decrease in the influence of the retainer. At the same time, the process of fixing the retainer in the sand worsens – this is explained by its difficult distribution on the surface of the sand.

The influence of various factors on the water resistance of the coating was also studied and the values of these factors were revealed.

The structure of the protective layer undergoes profound functional changes under the influence of various atmospheric factors and their combinations, this is mainly due to changes in the properties of the polymer-fixative. After testing the samples in the weather meter IP-1-ZM for 20, 40 and 60 cycles, a plastic change of the material of the protective layer formed as a result of impregnation of the sand dune with a solution of the polymer fixative "SXM-1" was tested. This cycle consisted of 13 hours of ultraviolet radiation at 30°C temperature and 2 hours of cooling at -10 °C temperature. By the end of the initial 20-cycle exposure, the strength of the protective layer reached 4.87 kPa, and the increase in the strength of the polymer-sand coating increases even more and reaches its maximum value up to 35 cycles, then a decrease in its strength is observed. Tests have shown that samples treated with water-soluble fixative polymers will be able to retain their practical properties for 1.5-2.5 years in a natural environment and this fully complies with regulatory requirements.

In the process of systematic research, sand suspensions brought from the Republic of Karakalpakstan, Bukhara and Khorezm regions, as well as from the Aral region, have been fully studied. The study of comparative indicators of synthesized polymers “SXM-1” with polyacrylamide (PAA) showed that polyacrylamide polymers interacting with sand particles form a structure in suspension. In the presence of HYPANES and polymers in the sand suspension, the pH value does not change, this phenomenon is explained by the influence of sand as a buffer on the change in the concentration of hydrogen ions in the suspension.

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The relative volume of sediment formed in a sand suspension under the influence of synthesized polymers varies in different ways. But with the participation of an industrial polymer filler, the sand suspension will be larger. When HOPE is added to the suspension, the change in sediment volume reaches its maximum. The increase in the volume of sediment with the participation of the studied polymers with the filtration rate does not change in a positive direction. And this indicates a better absorption of the synthesized polymer by sand particles.

The viscosity of microaggregates is greatly influenced by the granulometric composition of sand. The presence of sodium chloride and calcium chloride in the sand led to the formation of a precipitate in a loose composition when treated with the polymer A decrease in wind erosion was determined, as well as an improvement in the fixation of sand particles after the addition of phosphogypsum to the composition, strengthening of the sand structure with the polymer "SXM-1"synthesized as a result of the experiment with the participation of other components, increasing the adsorption capacity, ensuring the presence of various trace elements and conditions for rapid plant growth.

As is known, the flow properties of the structure-forming mixture can be changed by mechanical action or addition of water to it. This property of the structure-forming mixture is of great importance when it is used for processing large areas. Analysis of technical and regulatory documentation has shown that the requirements defined for coatings applied against deflation of sand should be close to the established norms of the module of rapid elastic deformation.

In the process of conducting experimental studies, we conducted survey work in order to determine the optimal concentrations and compositions of polymer solutions. These studies have shown that in order to increase the elasticity properties of the fixed sand coating, it should be treated with the polymer "SXM", and to increase the mechanical strength – with the polymer "SXM-1". The variation of these indicators, i.e., their acquisition of large or small values depends on the concentration of the polymer in the composition of the solution.

The samples of the protective layer obtained under these conditions, after determining their complexity and humidity, taking into account the conditions proposed by Frood, were studied in a wind tunnel for their resistance to wind. Then the mechanical strength, plasticity and lost mass of these samples were determined (Tables 2). Studies have shown that indicators such as mechanical strength, weight loss and wind resistance of protective coatings formed in wet sand increase by 15-16%, and the wear of the coating also has a higher level relative to dry sand.

Table 2

Indicators of wind resistance of the protective layer of sand obtained on the basis of the "SXM-1" (wind speed υ= 20 m/sec).

Consumption of fixing polymer, 0.5% q, l/m^2	On dry sand			On wet sand		
	Coating thickness, h, mm	Plastic strength, P, kPa	Sample mass loss. Δm, %	Coating thickness, h, mm	Plastic strength, P, kPa	Sample mass loss. Δm, %
5	10	7,2	0,2	16	8,4	0,12

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4	8	5,5	0,4	14	6,2	0,2
3	6	5,0	0,7	12	5,5	0,3
2	5	3,5	3	11	4,0	0,5
1,5	3	3,2	5	8	3,6	3
1,0	3	3,0	10	5	3,2	5
0,5	0-2	1,3	12	3	2,8	10

Table 3

Indicators of wind resistance of the protective layer of sand obtained on the basis of industrial polymers-fixers PAA and HYPAN (wind speed is 20 m / sec).

Consumption of fixing polymer, q, l/m^2	On dry sand			On wet sand		
	Coating thickness, h, mm	Plastic strength, P, kPa	Sample mass loss. m, %	Coating thickness, h, mm	Plastic strength, P, kPa	Sample mass loss. m, %
HYPAN-5	6	4,6	0,8	12	6,4	0,6
HYPAN-4	4	3,2	1,4	10	4,2	1,2
HYPAN-3	3	3,0	2,7	8	3,2	3,3
HYPAN-2	2	2,5	4,9	6	2,0	4,5
HYPAN-1,5	2	2,2	8,5	4	1,6	8,5
HYPAN-1,0	1,5	1,4	12.4	2	1,2	10,5
HYPAN-0,5	0-1	0,8	14,0	1	0,4	14,0
PAA-5	8	5,2	0,6	14	7,2	0,69
PAA-4	6	4,0	1,0	12,9	5,4	1,6
PAA-3	5	3,6	2,0	11,0	4,2	3,2
PAA-2	4	3,2	3,6	9,8	3,6	5,5
PAA-1,5	3	2,8	5,9	6,5	2,8	7,8
PAA-1,0	2,5	2,7	11,2	3,5	1,2	9,2

Taking into account the affiliation of mobile sands to the plains (the presence of a slope of 5-100 is typical for plains), studies were conducted to determine the required plastic strength for such slopes (Fig. 7 and 8). The plastic strength of a monolithic layer of sand on 5-100 slopes should be at least 5 kPa.

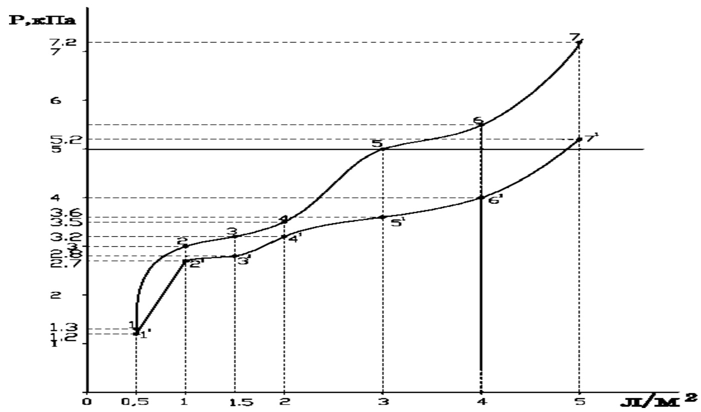

Fig. 5. Dependence of the plastic strength of the protective coating formed in dry sand on the concentration of the polymer solution "SXM-1" (1,2,3,4,5,6,7) and HYPANE $1^1,2^1,3^1,4^1,5^1,6^1,7^1$).

The indicators of a sharp increase in wind resistance with an increase in the concentration of polymer solutions of the "SXM" series on wet sand samples were studied, this was also revealed in laboratory tests with a lower polymer consumption.

This is due to the deeper impregnation of the aqueous polymer mixture in wet sand samples, as well as with the acquisition of a protective layer thickness of more than 1.5-2 times relative to a dry sand sample. As a result of the research, the presence of a difference between fixing compositions prepared on the basis of polymer solutions of the "SXM" series was also determined. That is, the efficiency of the fixing composition prepared on the basis of the polymer "SXM" is higher relative to the efficiency of the polymer "SXM-1". This is due to a deeper impregnation of the aqueous polymer mixture in wet sand samples, as well as the acquisition of a protective layer thickness of more than 1.5-2 times relative to the dry sand sample. As a result of the study, the presence of a difference between fixing compounds prepared on the basis of polymer solutions of the "SXM" series was also determined. That is, the effectiveness of the fixing composition prepared on the basis of the polymer "SXM" is higher relative to the effectiveness of the polymer "SXM-1".

Table 5

Determination of the moisture boundary for the technological feasibility of the impregnation method (consumption 5-2 l/m2)

Type of solution	**Sand humidity, W, %**	**Coating thickness at different flow rates l/m2 of solution, h, mm**			**Propritability**
		5	3	2	
HYPAN (0,5%)	24	-	-	-	No impregnation
	22	before 5	before 3	before 3	Partial impregnation
	20	15-20	10-15	8-11	Partial impregnation
	19	15-18	10-13	8-10	Lots of acquisitions
PAA (0,5%)	24	-	-	-	No impregnation
	22	before 5	before 3	before 3	Partial impregnation

	20	15-22	11-16	10-12	Partial impregnation
	19	15-19	10-15	9-11	More impregnation
SXM-1 (0,5%)	24	before 5	before 3	before 3	Less impregnation
	22	15-20	12-16	12-16	Partial impregnation
	20	25-30	20-25	18-23	Full impregnation
	19	35-40	30-35	20-25	Full impregnation

For the reason that generalized biological and physico-chemical methods were chosen to fix the sand, special attention was paid to increasing the phytomelioration efficiency in the formation of a polymer protective layer of sand.

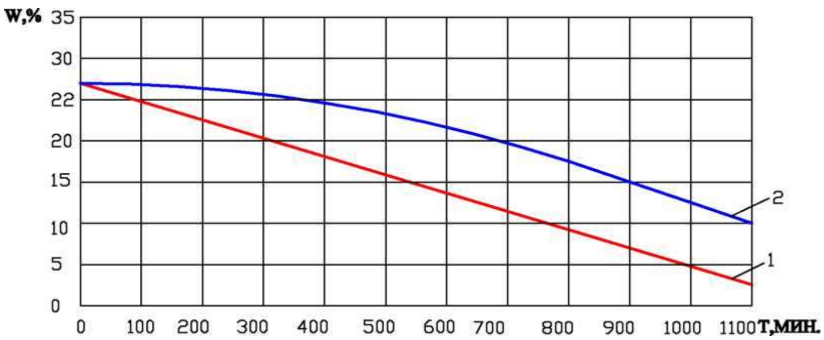

Fig. 7. 1 - change in sand moisture over time; 2 - change in sand moisture over time with the use of polymers SXM-1

For the reason that generalized biological and physico-chemical methods were chosen to fix the sand, special attention was paid to increasing the phytomelioration efficiency in the formation of a polymer protective layer of sand. To do this, create a moisture reserve under the protective layer. At the same time, for the formation of a layer with a thickness h ≥ 5 mm, the flow rate of the connector based on polymers of the "SXM" series on dry sand reaches from 2.0 to 3.0 l/m2, and on the basis of HYPANE and PAA - from 4.0 to 5.0 l/m^2.

We also determined the properties of frost resistance of CCM polymers based on tests according to GOST- 10060-2012 (Table 6).

Table 6

The results of the frost resistance test of sand samples fixed with the addition of "SXM"

Connectors	Weight of the sample Weight of the sample	Mass of the sample after the test, g	Characteristics of the fixed sand layer				
			Strength before testing, kPa	Strength after testing, kPa	Loss during cooling and melting, %		Frost resistance
					Macca	Endurance	
Water	before the test, g		-	-	100	100	
SXM-1	1732	1683	7,8	6,55	2,8	11	F35

Analysis of data on increasing the strength limit of the monolithic protective layer on the surface shows that the introduction of additives of the "SXM" series increases the ability of the monolithic protective layer to withstand strong influences at low and high operating temperature ranges of polymer fixers. And this, in turn, ensures high strength and reliability of the monolithic protective layer in a wide range of operating temperatures.

Table 7

Recommended concentrations for practical application of polymer solutions

Type of fixing polymer	Concentration, %	Consumption of fixing polymer, q, l/m^2	
		Dry sand	Wet sand
HYPAN	0,5	5-5,5	5,5
PAA	0,5	4-4,3	4,5
«SXM-1»	0,5	3,5	3

According to the new types of fixative polymers developed in the study based on local raw materials for fixing the surfaces of sandy areas around highways and railways, their technical and economic efficiency was determined by calculating their main production indicators and application in practice.

Based on laboratory and practical experiments, a technology for the production of a cheap, convenient and simplified fixative reagent of the "SXM" series based on local industrial waste has been developed.

According to certain technical and economic indicators, additional resources are required for the production of the PAA fixative polymer. And for the preparation of solutions of fixers-reagents of the "SXM" series, you can use any water resources, while using industrial man-made waste as raw materials provides a sharp reduction in costs, in addition, such production has a beneficial effect on the environmental situation.

Conclusion

It is determined that the complex natural and geographical structure of the northern desert zones of our country complicate the uniform operation of roads and railways by the presence of mobile sands, and the richness of the sand composition with various quartz, indesite, feldspar, ilmenite, metal oxides has a great resistance to the consolidation of sands.

The conducted primary studies have shown the importance and necessity of carrying out work on the consolidation of sands, for this purpose, the possibilities of using the large reserves of man-made industrial waste in the republic were studied.

The practical properties were studied and the processes of synthesis of polymer fixers ""SXM-1" and "SXM-2" were optimized by obtaining them by phosphorization of lignosulfate and waste products of JSC "Navoiazot" HYPAN.

The interaction of polymers "SXM-1" and "SXM" with sand particles leads, firstly, to the sliding of sand particles enveloped by the polymer relative to each other, and secondly, to the structuring of sand particles. As field tests have shown, when processing sand massifs with a

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polymer fixative “SXM”, there is a sharp decrease in erosion and even its complete stop. At the same time, the polymer “SXM” balances the water and temperature regime of sand, thereby accelerating the growth of desert plants.

The presence of chlorine and calcium chloride in the sand during processing with the polymer “SXM -2” led to the formation of sediment in a non-dense composition. At the same time, the efficiency of the polymers developed by us was calculated, according to the results obtained, the efficiency of the polymer “SXM” in sand samples when applied to 1 l/m2 in 0.5% concentration is expressed in savings of 1.5 times relative to the industrial polymer PAA.

The study of the properties of the polymer sand layer formed as a result of the impregnation of dry and wet sand, at a humidity of W = 20% in a certain flow rate of an aqueous solution up to 0.5% solution of the fixing polymer-fixator of the “SXM” series showed that the thickness of the protective layer under wind resistance conditions will be 1.5-2 times higher relative to the industrial polymer.

The conducted studies revealed that the use of the polymer-fixative “SXM” will give greater efficiency in areas of large sands rich in metal ions, and the polymer-fixative “SXM-1” – in small desert zones rich in salt.

The frost resistance of the polymers of the “SXM” series is 28-35 times, this ensures the strength of the sands treated by them for 1.5-2 years.

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