Application of oil-slimes in road base and surface construction

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PROFESSIONAL PAPER

The study of oil-slime properties in the construction of road bases has been carried out. Dependence of quality of the road bases from the content of oil-slime has been defined. Based on these results 12 km of road was constructed in Mogilev, Republic of Adygea.

Key words: oil-slime, road base, mechanical additives, water-absorbing properties

Introduction

Concerning the level of negative effect on the environment oil industry takes one of the leading places among the branches of national economy. Losses of petroleum, contained in waste, according to the expert's research, equal to approximately 3% of its yearly production. With yearly oil production of 491.4 million ton in Russia annual volume of wastes generated may reach 15 million ton. It is worth noting, that the existing at present methods of oil wastes utilization are either too much expensive or, as a rule, entail irretrievable loss of precious hydrocarbon material. Application of oil-slimes as a secondary raw material is one of the most efficient methods of their utilization.

Nowadays oil-extracting and oil-refining industries play stupendous role in the economy of Russia. Unfortunately, the process of oil extraction and refinery is accompanied with the environmental discharge of hydrocarbons, which poison the environment.

The importance of the problem is specified not only by the considerable quantity, but as well by the negative impact of oil-slimes virtually on every environmental component. As a result of this impact essential change in the natural condition of geo-ecological complex takes place, as well as decrease of natural immunity of groundwater, activation of geo-chemical and geo-mechanical processes, change in natural microbiocenosis. Rampant growth of annually accumulated dangerous oil wastes and lack of the required scale of their utilization and refinery leads to withdrawal of soil resources for the long period.[1]

Results and discussion

Oil-slimes are one of the most material sources of environmental pollution. Al the existing technologies of oil-slime reprocessing may be divided into the following groups: thermal, chemical, physical, physicochemical and biological.[4] Choice of that or another method of oil-slime reprocessing and neutralization depends mainly on the quantity of oil products in the slime: in every certain case, when choosing the method of oil-slime purification, any plant should elaborate a differential approach, taking into consideration ecological and economical rates. It is worth noting, that the existing methods of oil wastes utilization, as a rule, are accompanied with irretrievable loss of precious hydrocarbon material. At the same time oil wastes belong to the secondary material resources and, according to their chemical composition and useful properties, may be used in the national economy instead of the primary material.

Road construction is one of the largest fields for oil-slime application. It is well-known, that oil-slimes may be used for mineral rocks' impregnation and surface treatment in order to achieve their stabilization and damp-proofing in asphaltic concrete.[1]

Based on the research carried out now it is possible to suggest a new method of road base construction for the roads of 3-5 class, in which oil-slime is fundamental component.[6]

We have used oil-slime with of the following composition:

Oil products	10 - 70 mas. %:
Water	10 - 85 mas. %:
Mechanical impurities	1 - 50 mas. %:
Density	860 - 970 kg/m^3

Tars (gums), pyrobitumens, aromatic and paraffin heavy hydrocarbons, being part of oil-slime oxidize and become solid by exposure to the air, providing a good damp-proofing layer and stable bond between the particles of inorganic material.

Road surface construction includes preparation of the road base by way of applying a damp-proofing coat on the sub grade, for what oil-slimes are used, its consolidation, inorganic material laying (crashed stone, aggregate or mixture of these), applying the second layer of oil-slime, its consolidation again and ageing during the time, depending on the environmental temperature. Time of consolidation is determined by the equation:

$$t = 180 - 4.1T \quad (1)$$

where T is environmental temperature, °C.

The samples were tested for solidity and water absorption for property measurement.

The road base was prepared in the following way: on the subgrade section with the length 500 m and width 7

Table 1. Test results of road base samples

Example	Oil-slime quantity, m^3/m^2		Oil product quantity in the oil-slime, % mas.	Time of road base consolidation, hours	Samples' optimal compression strength, MPa	Water absorption for 24 hours by weight, %	Environmental temperature, °C
	On subgrade	On aggregate					
1	0.5	0.8	50	77.5	8.5	0.06	25
2	0.3	1.1	50	57.0	8.2	0.06	30
3	0.7	0.5	50	221.0	8.3	0.06	10
4	0.5	0.8	20	77.5	8.1	0.06	25
5	0.5	0.8	70	77.5	8.6	0.06	25
6	0.5	0.8	18	77.5	7.1	0.09	25
7	0.2	1.1	50	77.5	5.1	0.08	25
8	0.8	0.5	50	77.5	8.5	0.06	25
9	0.5	0.4	50	77.5	5.0	0.09	25
10	0.5	1.2	50	77.5	8.0	0.07	25

m, 1 750 m^3 of oil-slim was applied, containing 50 mas.% of oil products, and then the subgrade was consolidated by the road roller. After that crushed stone was applied on it, constituting a mixture of fractions of 40-70 mm (60%) and 20 – 40 mm (40%), and coated as 16-18 cm layer. 2 800 m^3 of oil-slime was then applied on the crushed stone layer, and consolidated by road rollers with pneumatic tires for 10 runs on each trace. Environmental temperature equals to 25 °C, time of consolidation is 77.5 hours.

As we know, the quantity of oil products in oil-slimes, as well as the volume of oil-slime, applied on the subgrade and crushed stone (aggregate) influences its strength and water-absorbing properties. Based on this fact, we have used oil-slimes with the quantity of oil products equal to 10, 18, 20 and 70 mas.%, the amount of oil-slimed, applied onto the subgrade, made 0.2, 0.3, 0.5, 0.7 and 0.8 m^3/m^2, the amount of oil-slime coated onto the aggregate – 0.4; 0.5; 0.8; 1.1; 1.2 m^3/m^2. Testing was carried out at temperatures of 10, 25, 30 °C.

The results achieved are described in Table 1.

The received data allows adopt, that the following conditions are most optimal for road base construction:

- oil-slime is applied onto the subgrade at the rate of 0.3 - 0.7 m^3 per 1 m^2 and then consolidated. After that crushed stone, aggregate or their mixture are applied and, then oil-slime is coated once more at the rate of 0.5 - 1.1 m^3 per 1 m^2 of the subgrade, again consolidated and aged during the time, depending on the environmental temperature.

Though, this is only possible when using oil-slime with at least 20 mass.% of oil products. Thus, when using oil-slime, containing 18 mas.% of oil products (test N°6), strengthening and water-proofing properties of the samples deteriorate. In case of reduction of quantity of the oil-slime, applied onto the subgrade and aggregate, the same weakening of properties is observed. On the other hand, increase of oil-slime quantity per subgrade (test N°8) does not change the quality of the road base, and thus seems to be inefficient. Moreover, when exceeding the declared norm of oil-slime quantity, applied onto the inorganic material (test N°10), a slight weakening of the properties is observed, what may be explained with lack of consolidation time for solidification of exceeding quantity of oil-slime.

Time of solidification (calculated by equation 1) of ready road base at negative temperature makes about 8 days:

$t = 180 - 4.1(-5)$,

where -5 is the average temperature in winter time in Krasnodar region (South of Russia).

Negative temperature does not cause negative effect on the quality of the road base.

When comparing strengthening and water-proofing properties of the ready base to those, proposed by the authors V.D.Mariutsa, M.I. Kuchma and T.A. Melnik[5] (author's certificate of the USSR 1539248, E 01 C 3/00, 1987) and V.M. Beskrovny, T.A. Tusov, N.S. Dezhina[2] (author's certificate of the USSR 1712519, 5 E 01 C 3/00, 1990) it was found out, that the method of road base construction, proposed in the article, makes it possible to get bases with a higher strength, as well as decrease the number of operations on subgrade's solidification and damping.

Based on the results of our study 12 km of road surface was constructed in Mogilev village in the republic of Adygea in 2002. The surface has not lost its strengthening properties up to present time. Application of oil-slime in road construction is of a great economical importance for Krasnodar region and the republic of Adygea, as these are oil-extracting and oil-refining regions, what allows to use oil-slime as a material for road construction and safe time for material transportation.

Conclusion

On the basis of the achieved results we come to the following conclusion:

- road bases, constructed according to the proposed method, possess high strengthening and water-absorb-

ing properties, and at the same time this technology allows to decrease significantly the number of operations at their construction;

- the quantity of oil products in oil-slime should be at least 20%;
- the quantity of oil-slime, applied onto the subgrade, should equal to 0.3 – 0.7 m^3 per 1 m^2, for aggregated this quantity makes 0.5 – 1.1 m^3 per 1 m^2
- increase in quantity of the oil-slime applied onto the subgrade, does not influence the quality of the base, and, thus, seems to be inefficient.

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