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USING ROSK ASPHALT FOR ROAD CONSTRUCTION

Abstract

In Mongolia, natural bitumen is distributed in several localities in the form of rock asphalt. Some countries have gained an experience of using such natural bitumen for road constructions. In Mongolia, we conducted a series of experiments on using natural bitumens in road constructions and proved that it was possible to use it for the purpose. However, due to limiting economic resources, it has not been used extensively for road construction. In cases of building roads near the natural rock asphalt deposits, economic cost can be lowered with the decrease in the transportation distance. Therefore, the rock asphalt should be studied extensively and it can be used in the future in a cost-effective way.

Keywords: natural bitumen is bitumen close to petroleum bitumen in its characteristics and is usually found diffused in rocky and sandy materials

Bitumen content is an amount of bitumen in natural rock asphalt

In Mongolia, rock asphalt deposits are located in places such as Zuunbayan of Dornogovi aimag, Bayan-Erkhet of Tov aimag, and Tamsag of Dornod aimag. In terms of resource level, the deposits of Bayan-Erkhet and Zuunbayan have been relatively well studied and have enough recourse to exploit at an industrial scale. The bitumen content in the Zuunbayan rock asphalt deposit is 7.65-11.63%, whereas it is 8.1-11.29% for the Bayan-Erkhet deposit.

In normal conditions, the rock asphalt is a bitumen-containing sand of smaller particle sizes. The rock asphalt can be readily used for road constructions as it is a natural binding material.



For our country, an annual budget dedicated for road constructions decreased in the first few years right after the transition to the market economy system. In relation with this, there have been several studies and experiments with the purpose to use domestic resources and to decrease the amount of bitumen, which was imported from other countries at a high cost.

Although there are several methods of using the rock asphalt, they are very costly. The method of separating bitumen from rock asphalt and using it alone is not very appropriate for our situation, therefore we chose a method of using the natural rock asphalt without isolating and removing the rock and sand parts from it.

From the deposits of rock asphalt that have been discovered in places like Zuunbayan and Bayan-Erkhet, the best-studied and exploited rock asphalt deposit is the one in Bayan-Erkhet. A bitumen content in this deposit is 8-11% on average and bitumen and the depth of needle to plunge into the bitumen varies between 40 and 60.

Table 1. Sand particle composition in rock asphalt.

Sieve size, mm	Percentage passed through the sieve, %
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9.5	100
4.75	98.5
2.36	94.7
0.6	67.6
0.3	53.2
0.15	29.6
0.075	6.2

1. Experiments of using rock asphalt for asphalt-concrete mixture

Experiments and studies to use rock asphalt for road constructions started in late 1980s and three to four different amounts up to 30% of rock asphalt have been tested in several places of 18.1 km long road between Terej valley and Aguitiin Hotol. The lower layer of cover with the rock asphalt was 4 cm and the upper layer was 3 cm. However, this experiment did not yield a fruitful result. The road build during this experiment was quickly broken, parts were peeled off in several places and heaps (lumps) formed in some locations. It was possible to observe all kinds of road damages from this road.

Some mistakes during this experiment are:

- amount of the rock asphalt used for the road was too high;
- technological regulations of preparing and spreading the mixture were not carefully followed;
- there was not enough number of technological implements.

In 1996-1997, the project to build a road from Bayandavaa to Erdene soum was implemented by the free grant from the government of Japan. Within this project, some changes and improvements were made by learning from the mistakes of the previous experiment. These include:

- Amount of rock asphalt to be used in asphalt-concrete mixture was decreased by 20%;
- Rock asphalt was divided into 4 types by its particle size and bitumen content;
- Storage conditions of rock asphalt were greatly improved;
- Pavement thickness was compacted to 6 cm of one layer;
- Technological regimes were carefully followed during the mixture production, pavement, and compaction.

Although pot-holes and peeling of the filler materials have not occurred on this road, so many cross cracks developed there. The reason that there occurred that many cracks resulted from factors such as bitumen in rock asphalt was fairly hard and it was heated at a high temperature while puddling (mixing). After filling the cracks appeared in the winter of the first year with bitumen, it got less likely to get additional cracks in such high numbers. This road has been used for 6 years to the present day because the level or smoothness of this road is good and there has not been any damage other than cracks.

2. Experiments of using rock asphalt alone for road constructions

An experiment of using the rock asphalt alone for road constructions was conducted on the road of Zuunbayan, as well as on the extension of the road of Bayandavaa. Because a bitumen content of the rock asphalt used for the road of Zuunbayan was high and the weather is hot in the area, smoothness of the road was lost and wave-like developments have occurred on the road.

Whereas, the extension of the Bayandavaa road, which was build using the rock asphalt is in a better shape than the Zuunbayan road in terms of smoothness, even though it is relatively worse than an asphalt-concrete road, which was built next to it.

In order to use the rock asphalt alone for road constructions, it is required to grind it. As long as particle size of the rock asphalt is small, it is spread evenly.

Following is the result of the Marshall test at 20°C after heat compaction of 4 types of the rock asphalt at different temperatures in laboratory.

Table 2. Results of rock asphalt compaction experiment at different temperatures.

Rock asphalt types	Compaction temperature, °C	Density, g/cm ³	Stability at 20°C, kgf	Flow value, 1/100 cm
E-15 5-0	20	1.695	946	57
	30	1.786	506	59
	40	1.882	670	39
	50	1.909	823	39

	60	2.006	782	36
E-15 15-5	20	1.670	1344	87
	30	1.728	647	91
	40	1.784	596	57
	50	1.907	1181	50
	60	1.967	920	46
E-7 5-0	20	1.599	673	37
	30	1.667	458	44
	40	1.760	596	33
	50	1.823	1106	45
	60	1.912	1075	38
E-7 15-5	20	1.570	832	51
	30	1.610	426	44
	40	1.671	505	43
	50	1.763	1219	46
	60	1.793	1084	41

The result suggests that the stability of a sample of rock asphalt with high bitumen content is highest at 20°C, i.e., when it is not heated.

However, the stability of rock asphalt with low bitumen content is highest at 50°C, or in other words it was 30 to 40% higher than the stability at 20°C. At 40-50 °C bitumen in the rock asphalt gets soft and flexible, therefore, samples compressed at these temperatures showed the highest stability.

In terms of the flow value, the flow rate tends to decrease as the heating temperature increases.

3. Special conditions of using rock asphalts

3.1 Mining

The rock asphalt should be obtained only in winter season when the average daily temperature is –10°C –15°C. After peeling off the surface soil of the deposit to a layer containing the rock asphalt, it is obtained by the method of explosion. In the situation of Mongolia, this type mining is possible during the period from late December to early March.

3.2 Storing

Once obtained, the rock asphalt should be separated by its bitumen content and then it is to be ground (crushed) and graded by fractions. Graded rock asphalts should not be mixed with each other. To prevent it from melting from the sun radiation heat and binding, it should be stored in a special shed or it should be protected by some kind of cover.

3.3 Mixing

Rock asphalt should be put in a hot bunker where concrete is puddled to mix, but without heating it beforehand. By mixing it this way, puddling time is prolonged.

Conclusion

- Rock asphalt has to be separated in its bitumen content by visual inspection;
- Rock asphalt should be ground (crushed) and separated (graded) by its size of fractions;
- If rock asphalt is to be used for hot asphalt-concrete mixture, it is better to choose a mixture with fine-sized particles because sand particles contained in the rock asphalt are small;
- Another method to improve the asphalt-concrete mixture with the rock asphalt is to improve quality of pebbles and bitumen;
- To use rock asphalt alone for pavement and filling local roads, it is recommended to heat and compress it at 50 °C;
- If rock asphalt is to be used alone for pavement of a local road, the lower layer has to be levelled and compacted carefully.

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