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ON THE INDUSTRIAL EXPERIMENT FOR IMPROVING PEBBLE COVER STABILITY BY USING SOIL STABILIZING SOLUTION- TOP SEAL

1. Soil stabilizing material

- In foreign countries, especially in the USA and Russian Federation, soil stabilizing solution, which is a product of chemical plants, has been used for stabilization of soil bed of roads and dams, for reparation and maintenance of roads, and for decreasing dust level in mining industries.

- Main purpose of using the soil stabilizer in road constructions is: to improve strength of the soil materials such as sand, loam, sand-pebble mixture that occur along the road; and to save more expensive materials like crushed (ground) rocks, cement, and bitumen by decreasing transportation distance to lower the cost of road itself. For these purposes, some works have been conducted in our country in recent years.

- In general, the most abundant soil stabilizing materials of mineral origin that are used in Mongolia include raw materials such as cement, clay, and ashes from the coal-burning power stations.

- To build the main road network in our country, it is required to construct more than 49 thousand kilometers of roads and 11 thousand kilometers of it is central or highways of the national importance.

2. On stabilization of the pebble cover on the road between Arvaikheer and Bayankhongor using Top Seal

- The industrial experiment was conducted from September 26, 2002 to October 12, 2002 on the road from Arvaikheer, Ovorkhangai aimag. We used Top Seal to stabilize the pebble cover of 4.35 km long road, starting at the end of the asphalt-concrete road, which is 25 kilometers due west from the town Arvaikheer (Appendix 1).

- 72 barrels (1 barrel contains 208 liters) of the soil stabilizer Top Seal, a thick, white and viscous material, were supplied from the US company called GOW INTERNATIONAL as stipulated in the agreement among participating sides in the experiment. Moreover, the GOW INTERNATIONAL Company offered professional expertise during the course of the experiment by allowing a US specialist to work for 3-4 days on the site of the experiment.

- The site of the industrial experiment is elevated at 1800 meters above sea level and is located in a zone of warm summer with moisture deficiency. Air humidity in January, April, July and October is from 40 to 59 per cent and number of days with humidity of less than 30% is 144. In July, the most humid month of a summer, the precipitation is about 256-267 mm. In the fall, when we conducted our experiment, daytime temperature was +5 +12$^{\hat{I}}\tilde{N}$, whereas the night temperature was +1 $^{\hat{I}}\tilde{N}$ -2$^{\hat{I}}\tilde{N}$; and the wind velocity- about 10-12 m/sec.

- On the experimental site, we worked with the plan to stabilize pebble cover on 350 meter road per day:
  - For the first 350 meters, we spread and leveled the pebble cover with 6 meters of width. Then 7.5 cm layer from the surface was dug up to create 6-meter wide box and the lower layer was loosened to 7.5 cm depth. Both layers were sprayed with 1:5 dilution of the Top Seal solution and the soil was mixed and finally compressed.

  - For the two layers mentioned above, we spent 11 barrels (2288 liters) of the soil stabilizing solution Top Seal for the 350 m road and this was 2.3 times as much as planned beforehand.

  - Therefore, for the next 700 meters, to stabilize the pebble cover by creating box with two layers as above, we used 1:10 dilution of the Top Seal in the lower layer and 1:5 dilution in the upper layer. By doing this, we spent 12 barrels (2496 liters) of the Top Seal for the 700 meters, and the amount of the Top Seal used here decreased almost twice compared to the amount used in the first part.

- According to the preliminary recommendations given by the GOW INTERNATIONAL Company, 14-16 barrels of the Top Seal should have been used for stabilization of pebble cover for 1 km long road that is 20 cm deep and 6 meters wide. This was given by the formula of

$$\textbf{Area} \times \textbf{0.0157} \times \textbf{Layer thickness, cm} = \textbf{... liters of Top Seal}$$

and we used this formula to estimate the approximate amount of the soil stabilizer that would be required for 1 km road. However, in situations of our country it was required to increase the amount of the Top Seal. Therefore, by the advice of the US specialist, we:

  - gave the classic 8% moisture with the regular water to the soil, which is compressed well in the situation of suitable moisture (Appendix 2), and after two-layer mechanic stabilization, only the 5 cm surface layer was sprayed and diffused with 1:5 dilution of the Top Seal to decrease the amount of the soil stabilizer spent on 1 km road to 14-15 barrels (2912-3120 liters) which was the amount originally planned. By following the guidance to use the above technique, this amount of the Top Seal stabilized the pebble cover on 3.3 km road.

- In the future, in order to stabilize soil using the Top Seal in conditions of our country, where the soil is very dry, water required for creating a suitable moisture level should be used with Top Seal stabilizer. In cases of stabilizing of 8-10 cm thick pebble cover, 1:10 dilution should be used for the lower layer and 1:5 dilution of the stabilizer should be used for the upper layer. And it is estimated that this design of stabilization will require 33-36 barrels (7000-7500 liters) of the Top Seal for stabilization of a pebble cover on 1 km road.

3. Conditions after 6 months of use and the cost estimations of the 4.35 km pebble-covered road were given in Appendix 3.

4. Recommendation and Conclusion

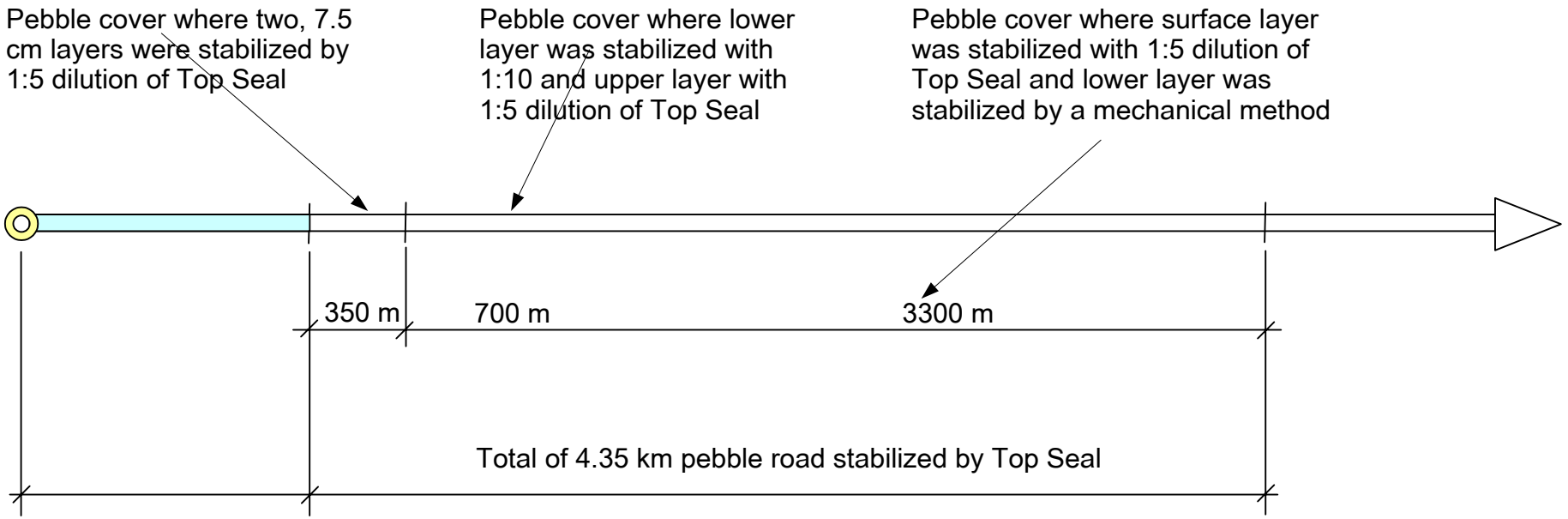
- Engineers and technicians of the Auto Zam Company of Ovorkhangai aimag who made an active effort to invent additional equipment for an autograder and water implements in the situation of shortage of technologically designated vehicles and implements have gained an appropriate experience in soil stabilization techniques.

- Insufficiency of experience of the people involved in the experiment along with the lack of some vehicles and equipment such as implements for mixing soil, implements to spray water evenly, filters for grading mineral materials by sizes in a standard requirement, and a rubber-tire roller with a good maneuver influenced the quality of the experiment in a negative way.

- It is crucial to study cheap, local soil stabilizers, if possible. And it should be used for the purpose of improving the strength of the base pavement because the stabilized pebble cover easily breaks within a year, thus the cost of road maintenance gets really high.

- Because the soil stabilization technique is a relatively new process in Mongolian conditions, involving workers in a training or practice on the industrial techniques of road constructions and technological implements are very important for getting the best possible results.

Experimental scheme for constructing the 4.35 km pebble road stabilized by Top Seal starting from the 25th kilometer from Arvaikheer in the direction to Bayankhongor (1998).




Bayankhongor
25 km paved road

Appendix 2.

Soil from Uizen II mine:

This soil has orange color.

The largest particle is 20 mm.

Composition by sieve sizes:

Sieve size, mm	**Total remainder on the sieve, %**	**Percentage passed through the sieve, %**
19.0	2.2	97.8
12.5	9.0	91.0
9.5	16.6	83.4
4.75	39.5	60.5
2.36	64.8	35.2
1.18	82.8	17.2
0.600	91.8	8.2
0.425	94.8	5.4
0.300	96.1	3.9
0.150	98.0	2.0
0.075	99.6	0.4
0.0	100.0	0.0

Loamy component determined by the method of washing – 34%

Suitable moisture level – 8.4%

Highest density when dry – 1.9% g/cm^2

A week after this soil was stabilized with the Top Seal, its stability was:

For 1:5 dilution of the stabilizer: 6.1 – 7.2 kg/cm^2

For 1:7 dilution of the stabilizer: 6.7 – 6.9 kg/cm^2

For 1:9 dilution of the stabilizer: 5.7 – 5.9 kg/cm^2

Compaction stability of completely dry samples after 23 days:

For 1:5 dilution of the stabilizer: - 27.4 kg/cm^2

For 1:7 dilution of the stabilizer: - 22.0 kg/cm^2

For 1:9 dilution of the stabilizer: - 23.6 kg/cm^2

The stability of soil that has not been stabilized with the Top Seal after a week was:

8.81 - 12.73 kg/cm^2

Appendix 3.

Specifications after 6 months of use of the 4.35 km pebble road stabilized with Top Seal in September 1998.

No.	Distance	Smoothness m/km	Compaction coefficient (10 - 20%)	Average moisture (10-20%)	Number of holes per m^2	Amount of Top Seal used
1.	Sta0+00 Sta 3+50	5.77 fair	0.9-1.02	4.5%	148.0	2288 liters (11 barrels)
2.	Sta 3+50 Sta 10+50	6.0 fair	0.9-1.1	5.1%	340.0	3952 liters (19 barrels)
3.	Sta 10+50 Sta 43+50	6.5 fair	0.91-1.14	4.45%	6.40	6864 liters (33 barrels)
4.	Total 4350m	-	-	-	-	13104 liters (63 barrels)

- At the time of the industrial experiment, 1 liter Top Seal cost 6.4 US dollars.
- It was estimated that two-layered, 1 km pebble road with 1 meter road bed stabilized by Top Seal had a cost of 64-65 million tugriks at the 1999 price level.
- 300 vehicles per day.