UDC 625 731

Part 3

ASH AND SLAG HANDLING

3.5. Applications of ash and slag from power coals

3.5.2. Road construction

3.5.2.3. Monitoring results of an experimental area of roadbed made of ash-and-slag mixture

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ABSTRACT

Analysis of the Perspective Plan of large-tonnage usage of ash-and-slag of OJCS "TGC-11" TPPs for the period from 2011 to 2020 shows that vertical land planning, liquidation of subsurface management consequences and road construction are the ways of large-tonnage usage of ash-and-slag materials. Roadbed construction takes the third place according to volumes of TPPs' ash-and-slag usage (from 20 up to 100 thous. m^3 per 1 km). Effective normative documents allow using ash-and-slag mixtures for mentioned purpose [1] but multiple "myths" about "enormous harm of ash-and-slag wastes (such as radiation, radium, extra frost swelling, difference in properties) and lack of application experience of such materials lead to vigilance of the companies, negative attitude of the engineers and contractors of road projects.

INTRODUCTION

In the course of proprietary standard development for Omsk Branch of Territorial Generation company #11 laboratory tests of ash-and-slag mixtures from Omsk TPP-2, TPP-4 and TPP-5 were done [2]. For detailed study of water-heat regime of roadbed made of ash-and-slag mixtures, for calculation of its parameters and effectiveness determination an experimental an embankment was made at the territory of SibADI. Embankment was made of 120 m^3 of ash-and-slag mixtures from operating ash pond of Omsk TPP-5 (Ekibastuz coal) and 60 m^3 of light dusty sand clay (typical ground of roadbed for comparison).

Construction is an embankment with road pavement of 1.2 m height: fractional crushed stone with gutting 18 cm, small-grained, hot asphalt concrete 7 cm (Fig.1).

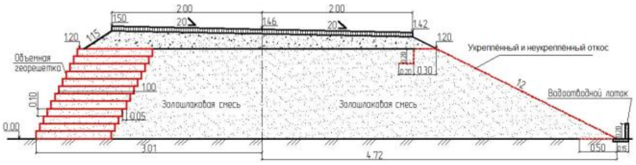

Fig. 1. Cross profile of the road construction of the embankment

Length of the embankment is 12 m, width of the carriage way is 4 m. The carriage way surface slope is considered as 20‰ lean to the side of the right slope. From the left side the slope is forced with big geoweb laid in the form of retaining wall with gradient 1:0,5 (Fig.2).

Right slope has gradient 1:2 and it is divided in four equal sites with different reinforcement:

1) geomate with base made of nonwowen geotextile material covered with layer of fertile land with sowing of grass (geomate depth is 13 mm, land layer depth is 10 cm);

Fig. 2. Left slope forced by type of retaining wall

2) geomate covered with layer of fertile land with sowing of grass (geomate depth is 15 mm, land layer depth is 10 cm);
3) layer of fertile land with sowing of grass which depth is 10 cm;
4) slope made of compacted ash-and-slag mixtures without reinforcement and sowing of grass.

Ash-and-slag mixtures were collected from the ash-pond with the help of a digger, transported with dumptrucks with fly-sheets and packed in embankment with moisture content of W = 35..40 %. *Dumping and leveling layer by layer each of which is 0,3 m was done manually, material was packed up to* K_{packed}= 0,95 with the help of vibroplate and vibroroller.

Geomembrane devides the embankment into three sites (4 m and 8 m from ash-and-slag mixtures and 4 m from sand clay) (Fig.3), there is also a drainage tray for water-drainage or water saving at the base of slope.

Fig. 3. Packing of geomembrane and tray

Multipoint digital temperature sensors (thermistor chains) are set at the sites, that register groung temperature change with accuracy up to 0,1 ^{o}C thought the height and width of the embankment (Fig. 4) Embankment probes for humidity are selected manually by horizontal drilling.

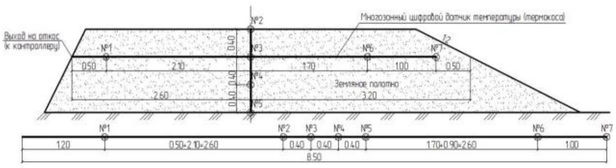

Fig. 4. Scheme of sensors location in the ground

Ash-and-slag embankment underwent a lot of rains (including showers) and dry hot weather without any reinforcement during a period of two months. There were no washing or dusting during this period.

Embankment was artificially moistened before the winter 2010-11. We couldn't make total flooding of the embankment near the slope base during autumn 2010 due to hermetical tray absence. At the beginning of winter humidity of ash-and-slag mixtures was 40...50 % (maximum capillary moisture capacity) and sand clay humidity was about 15...17 % (within reasonable).

Temperature recording was done from February 1, 2010 to April 26, 2011. Daily average temperature was also recorded (Fig.5).

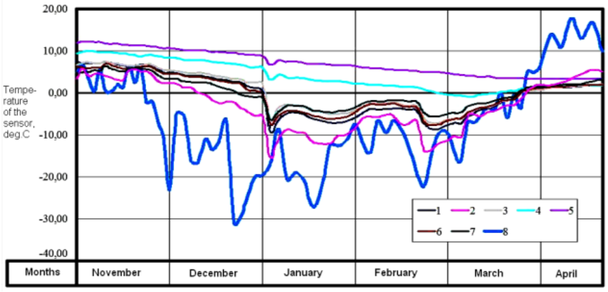

Fig. 5. One of the diagrams of temperature change by months: 1, 2, 3, 4, 5, 6, 7 – daily average temperature of the sensors (numbers of sensors correspond to fig.4), 8 – daily average air temperature

On the basis of this data we made figures of frost penetration and defrosting of the ground from ash-and-slag mixtures and light dusty sand clay (Fig.6).

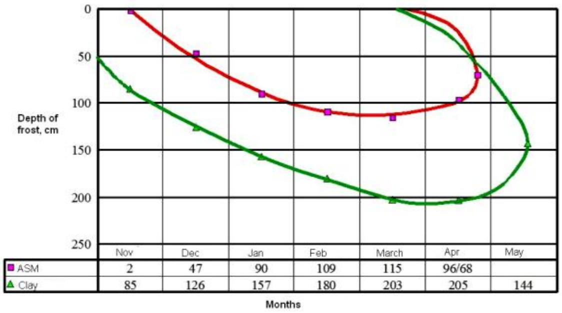

Fig. 6. Figure of frost penetration and defrosting of ash-and-slag mixture and light dusty sand clay

Results of dimensions show that low thermal conductivity of ash-and-slag mixtures (even if humidity is 40%) predetermines later frost penetration and defrosting of the ground. Frost penetration of the ground made of ash-and-slag mixtures is twice lower as the same of sand clay ground. Lower layer of ash-and-slag embankment and nature base ground underneath didn't freeze nevertheless winter of 2010-2011 was very severe.

Frost swelling of the top of road construction was estimated by grading of 15 fixed points along the axis and on the edges during winter time.

Swelling degree was estimated according to GOST 28622. Swelling degree results of the ground made of ash-and-slag mixtures and sand clay in the end of frosting period are presented in Table 1.

Results of dimensions made at experimental field prove experimental data that was recorded in the laboratory [3]. Relative frost swelling of ash-and-slag mixtures is four times less than of light dusty sand clay.

Table 1. **Swelling degree of the experimental grounds**

Denomination of the ground	measurement average of vertical deformation, m	Relative swelling deformation, items	Swelling degree
Ash-and-slag mixture	0.025	0.021	low-swelling
light dusty sand clay	0.067	0.096	high-swelling

We organized extra watering and flooding of one site of ash-and-slag roadbed slope during autumn 2011. This will allow us to determine degree of relative freezing swelling at the third ground type according to moistening conditions and considering humidity of ash-and-slag mixtures is 60...65 % (full water capacity). Second site wasn't moistened additionally, its humidity was at the level of 20...25 %.

Monitoring of the experimental field goes on. Average depth of ash-and-slag embankment freezing was about 1 m (open campus ground freezing depth is about 1.6 m) by January 31, 2012. Frost swelling at the subsite with additional moistening and flooding is not more than 2.0 cm, without additional moistening is ±0,5 cm.

Apart from water-thermal regime at the experimental field we conducted other studies (including construction reinforcement with flat geoweb), we determined slope rigidity. However the results of the present study are beyond the scope of this publication.

CONCLUSION

1. The study, normative-methodical documents and foreign countries experience analysis of TPPs' ash-and-slag wastes usage in road construction allowed to develop a Corporate standard STO 82982783.01-2010 "Ash-and-slag materials of Omsk TPPs for road construction. Technical standards." according to OJSC "TGC-11" task. Ash-and-slag properties and calculation parameters, constructional and technological decisions that are efficient and sufficient for design and construction of road objects are presented in this document.

2. Laboratory studies and monitoring of experimental site proved that ash-and-slag mixtures from Omsk TPPs can be used in road construction of any road category without swelling danger even in conditions of its total moisture capacity.

3. Low thermal conductivity of ash-and-slag mixtures conduce less depth of freezing of such constructions in 1.5...2 times in comparison with natural ground embankments. Thus if the height of ash-and-slag embankment is more than 1.2 m in our region it protects natural ground from freezing and keeps possibility of capillary moisture ascent of ground waters low.

4. One of ash-and-slag peculiarity is high water conductivity (in comparison to sand clay and clay) that is why precipitation water and water draining from the road surface doesn't flow over the slope surface washing it out. This water gets absorbed and filtered by ash-and-slag and goes out at the slope base. That is why slope of ash-and-slag embankment is not subjected to surface washing after precipitations. It's necessary to study general competence of the slope part of high ash-and-slag embankments with steep slopes. We consider that geosynthetical materials for these purposes are most effective.

5. When we worked with ash-and-slag mixtures in summer we didn't notice prominent dusting of this material (dusting is not more than of small dusty sand). Humidity of ash-and-slag mixtures in ash ponds is not less than 20 % and dusting occurs when humidity is 3%. Nevertheless it is recommended to cover dump trucks with fly-sheets during transportation.

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