LIFE+ 09/ENV/EE/227

Eesti Energia

MAANTEEAMET

NORDECON

Management of Environmentally Sound Recycling of Oil Shale Ashes into Road Construction Products. Demonstration in Estonia

OSAMAT

BACK-GROUND

OSAMAT is an acronym for "Management of Environmentally Sound Recycling of Oil Shale Ashes into Road Construction Products. Demonstration in Estonia".

Over 90% of the Estonian basic power supply is covered by oil shale. Every year about 11 million tonnes of oil shale is fired at power plants.

Estonian oil shale is characterized by a high content of mineral matter: after combustion 45–48% of the oil shale is left over as ash, producing about 5–7 Mt of oil shale ash (OSA) annually, that is mostly deposited on the ash plateaus. The highly alkaline leachates from the ash deposits pose an environmental risk, and the ash plateaus are considered as major pollution sources. To reduce the environmental risks the properties of OSA have been intensively studied. The previous researches have shown that OSA could be considered as valuable binder material replacing commercial materials on construction sites thus mitigating environmental impacts.

OSAMAT project has come into life on the firm belief of the beneficiaries that the eventual environmental problems connected to OSA can be overcome by exploiting the technical properties of OSA to transform it to a reliable construction material in favourable conditions.

The generation of OSA as a by-product doesn't consume energy and generate airborne releases of greenhouse gases. That creates a great potential for OSA to become a valuable material in local and European construction markets and replace cement and other commercial additives in a cost-effective way.

In the frames of OSAMAT project OSA has been tested as a binder material replacing cement in construction of two road sections.

OSAMAT project addressed the challenges of the European policies and legislation concerning waste and promotion of end-of-waste, waste recovery and sustainable recycling with a focus on life-cycle thinking and development of recycling markets.

WHY OSAMAT PROJECT?

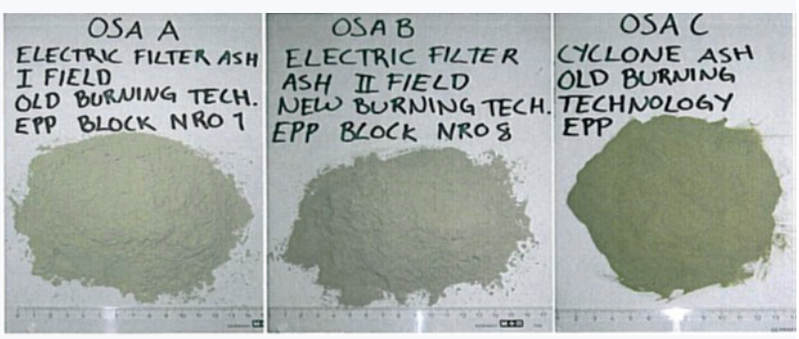
- Every year around 6 million tonnes of OSA is landfilled posing environmental risks to the nature. Only 120 000 t/y of OSA is used as a product nowadays.
- Due to its chemical content OSA is considered as a valuable binder material, which could be used to improve stabilization and strength of civil-engineering structures.
- Usage of OSA as a construction material mitigate the environmental burden by landfilling less ash, reducing CO_2 emissions and eliminating the withdrawal of natural resources needed for construction of roads, railways, harbours and for other construction activities.
- OSA has a great potential to compete with traditional construction materials as cost-effective and technically suitable substitute.
- Pilot construction reaches wide audience of interested groups and has demonstrative outcomes for decision makers.
- OSAMAT project had a very practical approach to cover all important project phases: material tests, laboratory analysis, engineering, construction, monitoring and follow-up activities.
- OSAMAT pilot project - is a several years of experience, including construction and monitoring phases. The project data serve as a support for further steps towards larger use of OSA and other industrial by-products in Europe.

AIMS AND OBJECTIVES

The purpose of the OSAMAT project was to demonstrate the possibility and the methods of converting OSA into valuable secondary materials for civil-engineering applications. The more efficient and waste-free use of oil shale would reduce the impact on the environment while also generating economic benefits.

OBJECTIVES:

- to provide technically, environmentally and economically feasible civil-engineering aggregates and additives based on OSA for appropriate applications in road construction;
- to introduce and test new and advanced methods of roads construction using OSA;
- to disseminate the results and know-how of the methods demonstrated in the project to the target groups: municipalities, road administrations, contractors, politicians, legislative authorities, scientists and other professionals and specialists in Europe as well as in Estonia;
- to secure the absence of the impacts to the environment while using OSA;
- to calculate the economic and environmental benefits for European societies when substituting traditional materials with OSA;
- to issue the guidelines based on the results of the project for the construction companies about the methods of OSA usage in the construction of the roads;



THE LONGER TERM GOAL -
the civil-engineering materials based on OSA will be accepted and become a common practice in Europe and provide a significant competitor to cement and other commercial additives.

METHODS USED IN THE PILOTS PROJECT

Within the project framework, the application of three types of the oil shale ash produced at Narva Power Plant have been studied during the construction of two pilot road sections.

OSA has cementitious properties and can be used as a substitute for cement. Within the OSAMAT project the structures of pilot sections constructed with oil shale ash only (100% shale ash was used as a binding agent in the construction mix) or partly (50-75% of oil shale ash was used) were being examined.

THREE TYPES OF OIL SHALE ASH WERE USED AS A BINDING AGENT:

1. Oil shale ash from the cyclone filters, pulverized firing (CYCL) - coarse fraction of oil shale fly ash.

2. Bag filter oil shale ash from pulverised firing (BF PF) – fine fraction of oil shale fly ash.

3. Electrostatic precipitator ash from circulating fluidised bed combustion (EF CFB) - fine fraction of oil shale fly ash.

The project encompassed testing of two different technologies with using oil shale ash in road construction – layer-stabilisation with coarse materials on road base and mass-stabilisation of peat on weak surfaces.
Different stabilisation techniques were tested on Simuna-Vaiatu and Narva-Mustajõe road sections.

PILOT APPLICATIONS

Narva-Mustjõe pilot section

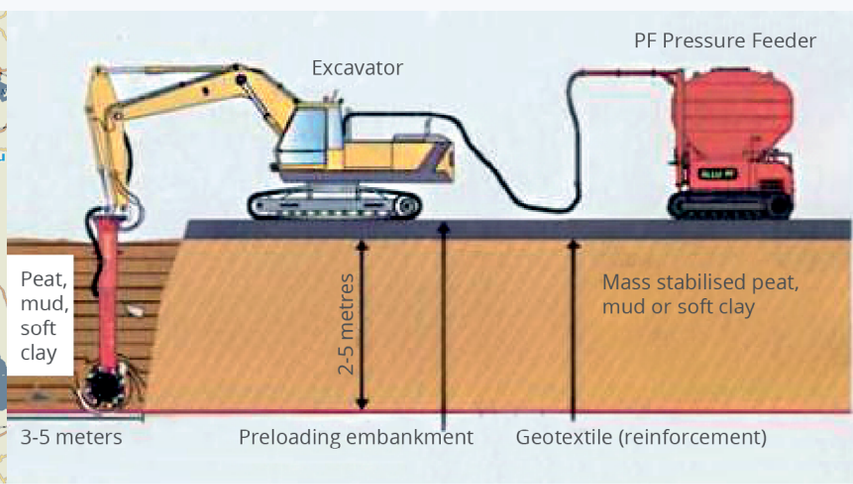
NARVA–MUSTAJÕE (road no. 13109, 14.5-16.1 km)
Three types of oil shale ash were tested in construction of the road base course, using layer stabilisation. The construction was performed on the 1630 m long pilot section. The constructed course thickness was 25-35 cm. Construction stages included removal of the old asphalt coating, its milling, spreading of a crushed limestone and milled asphalt onto the sandy gravel layer, cement distribution and mixing by rotary mixer. After the first mixing the oil shale ash were distributed and the layer were mixed again with water addition, followed by compaction. Finally, two layers of asphalt were applied to the compacted layer.

Simuna-Vaiatu pilot section

SIMUNA-VAIATU (road no. 17192, 3.0-4.3 km)
The road section of Simuna-Vaiatu is located along a saturated terrain (peatlands). Usually, peat is completely removed and replaced by more solid material (gravel stone, sand, etc.). Within the framework of the project, a new technology – the mass stabilization of peat with the use of shale ash was tested. The technology is based on the principle of mixing the peat with the binding agent on site, rather than extracting the peat. A mixture of oil shale ash and cement was used as a binding agent. The construction stages included the removal of the old surface, mass stabilization of peat, followed by construction of embankment, road coarse and pavement on a stabilized peat layer.

Section	Length	Stabilization technology
0+50 – 5+00	450 m	Layer stabilisation, 25 cm New base aggregate: Mining Waste Aggregate (MWA) + Milled Asphalt Concrete (MAC) EF PF 6 % + Composite Cement 3 %
5+00 - 9+50	450 m	Layer stabilisation, 25 cm New base aggregate: MWA + MAC CYCL 5 % + CC 5 %
9+50 - 10+50	100 m	Layer stabilisation, 35 cm Base aggregate: MWA + MAC EF PF 6% + CC 3%
10+50 - 11+50	100 m	Layer stabilisation, 35 cm, EF CFB 9 %
11+50 - 12+50	100 m	Layer stabilisation, 35 cm, CYCL 5% + CC 5%
12+50 - 15+80	330 m	Layer stabilisation, 25 cm, EF PF 6% + CC 3%
15+80 - 16+80	100 m	Layer stabilisation, 25 cm, EF CFB 9%

Narva-Mustajõe stabilisation sections and related binders



Mass stabilisation technology tested in Simuna-Vaiatu section

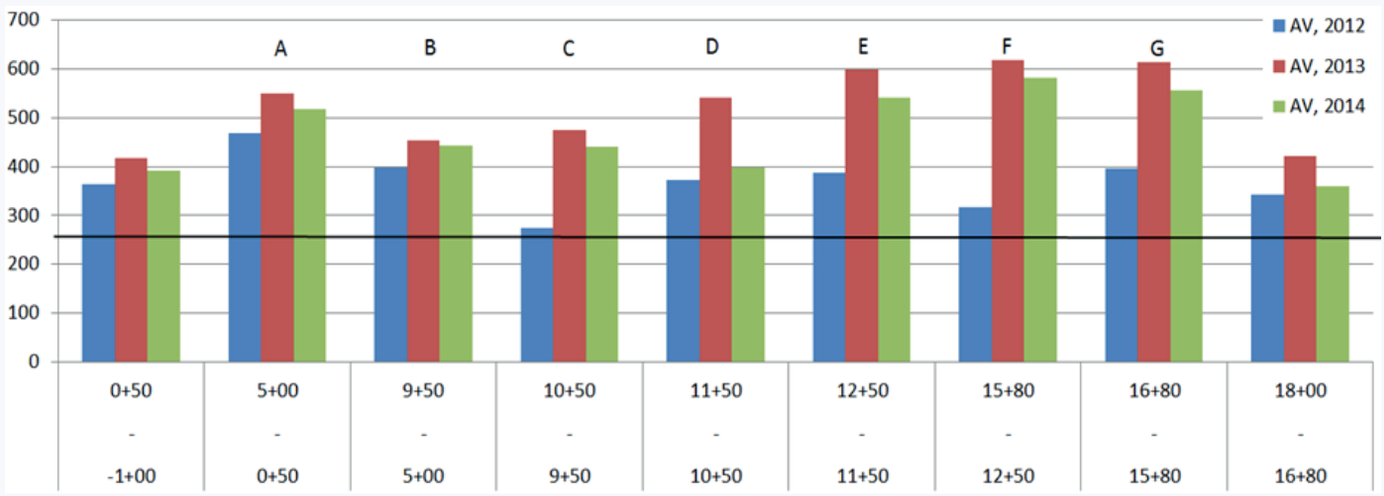
RESULTS

Narva-Mustjõe pilot section

- Laboratory tests proved that it is possible to utilise oil shale ashes and mining waste construction of road base courses.
- The pilot section constructed with electrostatic precipitator ash (CFB combustion) used 100% without cement addition has the same strength development and road bearing capacity as the sections constructed with cement addition.
- The dry binding agent mixing method worked a lot better than its wet counterpart.
- It is important that the ashes tested in laboratory and ashes, used in stabilisation process on site, should have same age and storage conditions, because the CaO content is changing in time through contact with water vapour.
- Controlling the water content and interrelated compactness is very important.
- Bearing capacities in all the test constructions were clearly higher than target value 260 MPa.
- According to the monitoring results, the use of oil shale ash does not involve any additional immediate negative impacts on the environment.
- Compared with commercial additives (cement, gypsum) OSA has considerably lower net cost.

Simuna-Vaiatu pilot section

- In Simuna-Vaiatu mass-stabilisation works were carried out for the first time in Estonia on existing road which is in daily use.
- The results of the stabilisation show that the peat samples had similar total strength development and no big differences between the samples could be found.
- All the peat samples achieved the targeted 100 kPa compressive strength.
- Important OSA characteristics for proper mass-stabilisation process are: unit weight (the lower the better) and secondly, OSA should be very dry (air moisture can cause “clots”).
- Monitoring of water, soil and flora showed clearly that utilisation of OSA had no negative impact on the surrounding environment.
- Mass-stabilisation has potential in Estonia as it has number of areas with weak or unstable soil conditions.
- Using OSA in mass-stabilisation is much more environmentally friendly than taking excavated material from mines.
- Using OSA in mass-stabilisation in large infrastructure projects is economically more feasible than alternatives like mass exchange.
- Mass-stabilisation with OSA has big potential in construction of roads, ports and other constructions in Estonia and Europe.



Progress of road bearing capacity in Narva-Mustajõe section (target value was 260 MPa)

ENVIRONMENTAL BENEFITS

- OSA is a by-product of energy production and its generation does not require additional energy and generate airborne releases of greenhouse gases (the production of cement generates close to 0.7 tonnes CO_2 per 1 tonne of cement).

- The utilisation of OSA may help in reducing CO_2 emissions at least by 4.2 million tonnes each year.

- This project particularly contributed to the implementation of the environmental policies on better resource efficiency and on waste management.

- Using OSA combined with ground materials instead of natural materials may decrease using natural materials from non-renewable resources by 500 million tonnes in Europe.

- By very general prognosis - using OSA may decrease construction costs in Europe by ca 4000 million EUR per year.

- In Narva-Mustajõe section about 500 tonnes of OSA and 5600 tonnes of mining rock material were used instead of traditional commercial products.

- In Simuna-Vaiatu section about 2900 tonnes of OSA was used to mass-stabilise 11 000 m^3 of peat, which would traditionally be replaced with quarry material.

- Environmental monitoring of water, soil and flora at pilot sites showed no impacts to the surrounding environment.

- OSAMAT demonstrated that with using OSA and mining rock aggregates we can decrease usage of commercial products in road construction.

- Mass-stabilisation with OSA is an innovative technology to offer alternative to traditional mass exchange method, which is not environmentally sustainable.

DISSEMINATION

The OSAMAT project team members have taken an active role in disseminating the information on the project and its objectives in discussions with various stakeholders both in Estonia and internationally. Continuous networking activities have increased the level of knowledge and raised the awareness of the importance of solving the issue of surplus oil shale ashes. The project has received very positive feedback.

- PROJECT webpage: http://osamat.ee/en/
- OSAMAT video (http://osamat.ee/en/)
- LIFE notice boards at piloting sites
- Guidelines for the European practice in order to give advice for the appropriate construction of different civil-engineering applications with help of OSA
- LCA/LCC Report (http://osamat.ee/en/)
- Layman's report on webpage and as high quality printed publication
- Conference papers, conference presentations, posters, numerous networking activities, publications, media articles
- International Workshop in Estonia in 2016

OSAMAT project in a nutshell

Start: September 2010 - end: August 2016
Coordinating beneficiary Eesti Energia
https://www.energia.ee/en/avaleht
Associated beneficiary: Eesti Energia Narva Power Plants
https://www.energia.ee/en/organisatsioon/narvajaamad
Associated beneficiary:
Nordecon http://www.nordecon.com/
Co-financed by the Estonian Road Administration
Co-financed by the EU LIFE+ Environmental Policy & Governance programme (LIFE09 ENV/EE/000227)
Total project budget: 2 379 280 €
Estonian Road Administration financial contribution: 700 000 €
European Commission financial contribution: 1 142 490 €

OSAMAT

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LIFE programme

LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. Since 1992, LIFE has co-financed some 4306 projects.
For the 2014-2020 funding period, LIFE will contribute approximately €3.4 billion to the protection of the environment and climate.
More information can be found here:
http://ec.europa.eu/environment/life/index.htm