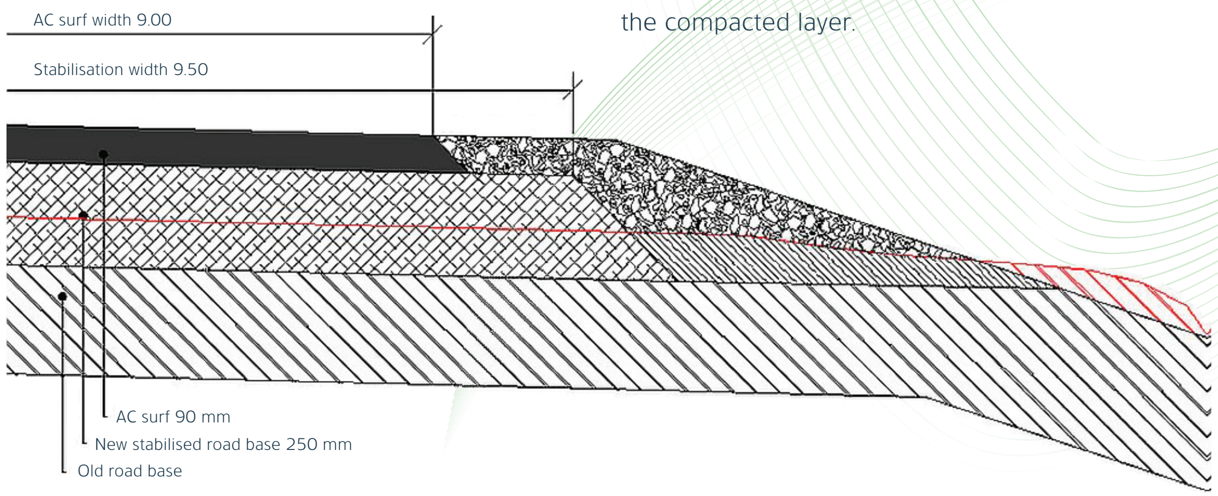
## CONSTRUCTION OF NARVA –MUSTAJÕE AND SIMUNA-VAIATU PILOT SECTIONS

### NARVA–MUSTAJÕE

(roadway No. 13109, 14.5-16.1 km)

Three types of oil shale ash were used in construction of the road base course, using cold in place recycling with cement method. The construction was performed on the 1630 metre 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.

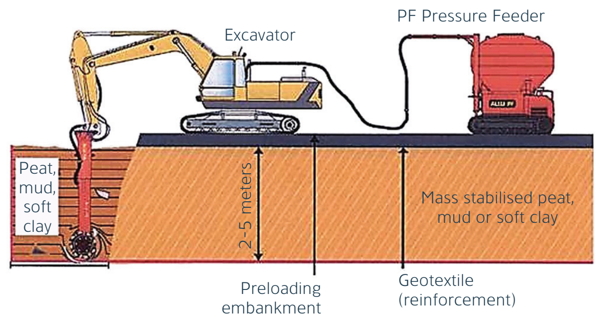



**Picture 1.** Cross section of Narva –Mustajõe pilot site.

### SIMUNA-VAIATU

(roadway No. 17192, 3.0-4.3 km)

The road area of Simuna-Vaiatu is located along a saturated terrain (peatlands). Usually, peat is completely removed and replaced by more solid material (breakstone, sand, etc.). Within the framework of the project, a relatively 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 stabilization principle is illustrated on the picture 2.




**Picture 2.** The principle of mass stabilization of soft soils.

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.

During the process of mass stabilization, shale ash and cement were delivered from two bunkers (with the use of hose pipes attached to an excavator) to the mixer – a rotating unit. Using the mixer, the binding agents were injected into the peat and at the same time mixed with it: the mixer was dropped down and taken up through the peat stratum at a depth of up to four metres. The peat, which was mixed with the binding agent, hardened over time and ensured a stable base for the subsequent construction of the road.

LIFE+ 09/ENV/000227 OSAMAT

# OSAMAT

## Management of environmentally sound recycling of oil shale ashes into road construction products. Demonstration in Estonia.

In the year 2010 the OSAMAT project was launched in Estonia within the framework of the EU's LIFE+ programme.

The main goals of the OSAMAT project are to:

- prove the feasibility of oil shale ash usage as a construction material from the technical, environmental and economic perspectives;
- extend the application areas and increase the amounts of oil shale ash used to minimize the negative environmental impact.

After completion of the project, it is planned to publish guidelines 'European Guideline for the Application of Oil Shale Fly Ash in Road Construction' based on the research studies performed within the framework of the project.

### WHAT IS THE OSAMAT PROJECT?

- The OSAMAT project is financed by the European Commission under the LIFE+ programme.
- The project budget amounts to €2,379,280, of which 48% is financed by the European Commission, 29% is financed by the Road Administration and the remaining 23% is covered by the project participants.
- Within the project framework, the application of three types of oil shale ash produced at Narva Power Plants is being studied during the construction of two pilot road sections.
- Technical research is being performed over a timescale of two years (stabilization speed, structural solidity, bearing capacity), as well as various environmental surveys (water, soil, flora).
- Project participants: Eesti Energia AS (the coordinator), Eesti Energia, Narva Elektrijaamad AS, and Nordecon AS.
- Duration of the project: From 2010 to 2016.
- Website: www.osamat.ee

Eesti Energia

## OIL SHALE ASH USED FOR THE OSAMAT PROJECT

Each year approximately 6 million tons of oil shale is disposed at the ash plateaus of the Baltic and Estonian power plants. Depending on the composition of the oil shale and the type of firing, various types of the oil shale ash with different chemical composition and properties are produced.

Oil shale ash has cementitious properties, so it can be used as a substitute for cement. Within the OSAMAT project, the condition of pilot sections constructed with oil shale ash only (in other words, 100% shale ash was used as a binding agent in the construction mix) or partly (50-75% of oil shale ash was used) is being examined.

In the frames of the OSAMAT project, the following three types of oil shale ash were used as a binding agent:

1. **Cyclone fly ash – coarse fraction of oil shale fly ash.** The ash is produced during pulverized firing of oil shale, combustion temperature is up to 1450°C.
2. **Filter ash (deSOx) – fine fraction of oil shale fly ash.** The ash is produced during pulverized firing of oil shale, combustion temperature is up to 1450°C.
3. **Electric precipitator ash (CFB) – fine fraction of oil shale fly ash.** The ash is produced during circulated fluidized bed combustion of oil shale, combustion temperature is up to 900°C.

Since the year 2011, shale ash has been registered in the European Chemicals Agency (ECHA) database in accordance with the European regulation (REACH). The registration number of oil shale ash is 01-2119703178-42-0002.

## THE MINERALOGICAL AND CHEMICAL COMPOSITION OF OIL SHALE ASH, AS WELL AS ITS PROPERTIES, ARE PRESENTED IN TABLES 1, 2 AND 3 ACCORDINGLY.

| | Filter ash - deSOx | Cyclone fly ash | Electric precipitator ash - CFB | Cement |
|---|---|---|---|---|
| Periclase $MgO$ | 5,4 | 8 | 2,9 | |
| Melilite $(Ca,Na)_2(Mg,Al)(Si,Al)_3O_7$ | 2,4 | 4,5 | 2,3 | |
| Merwinite $Ca_3Mg(SiO_4)_2$ | 3,8 | 6,7 | 2,1 | |
| $C_3S$ $Ca_3SiO_5$ | – | 2,7 | 1,4 | 45-60 |
| $C_2S$ $\beta$-$Ca_2SiO_4$ | 16,3 | 13,9 | 7,4 | 15-35 |
| $C_3A$ $3CaOAl_2O_3$ | – | – | – | 4-14 |
| $C_4AF$ $Ca_2(Al,Fe_{3+})_2O_5$ | 4,1 | 2,6 | 1 | 10-18 |
| Wollastonite $CaO \cdot SiO_2$ | 2 | 3,7 | 0,9 | |
| Orthoclase $KAlSi_3O_8$ | 8,9 | 4,3 | 14 | |
| Quartz $SiO_2$ | 7,9 | 6,8 | 19,4 | |
| Calcite $CaCO_3$ | 5,2 | 4,2 | 13,4 | |
| Anhydrite | 21,6 | 9,5 | 13,4 | |

**Table 1.** Mineralogical composition of shale ash and cement, %

| | Filter ash - deSOx | Cyclone fly ash | Electric filter ash - CFB | Cement |
|---|---|---|---|---|
| $CaO$ (C) | 39 | 53 | 28 | 61-67 |
| $SiO_2$ (S) | 26 | 22 | 39 | 19-23 |
| $Al_2O_3$ (A) | 6,7 | 11,9 | 5,8 | 2,5-6 |
| $Fe_2O_3$ (F) | 3,9 | 4,9 | 5,1 | 0-6 |

**Table 2.** Chemical composition of shale ash and cement, %

| | LOI, % | Specific surface, $m^2/kg$ |
|---|---|---|
| Filter ash - deSOx | 3,4 | 290-320 |
| Cyclone fly ash | 1,0 | 86-150 |
| Electric filter ash - CFB | 3,4 | 410 |
| Cement | 1 | 320-380 |

**Table 3.** The properties of oil shale ash and cement

The differences observed in the composition of oil shale ash can have an impact on the constructions it is used for (with regard to stabilization speed and durability).

The mechanism of hardening for the system in which oil shale ash is used differs from that of the construction, which is made on a cement base. In the event that the hardening of cement is caused by the basic 'cement minerals' (see Table 1) a small amount of cement minerals is present in the ash, while primary hardening is caused by free calcium oxide $CaO$ and by anhydride $CaSO_4$, and the main durability of the system is achieved owing to the reactions of other minerals contained in the ash. Due to these properties of the ash, the hardening of constructions made with the use of oil shale ash is slower than those made using cement. However, constructions containing oil shale ash become increasingly durable over time.