The 2nd International Mass Stabilisation Conference 2015 Lahti, Finland

MASS STABILISATION OPPORTUNITIES

D.SC.(TECH.) PENTTI LAHTINEN

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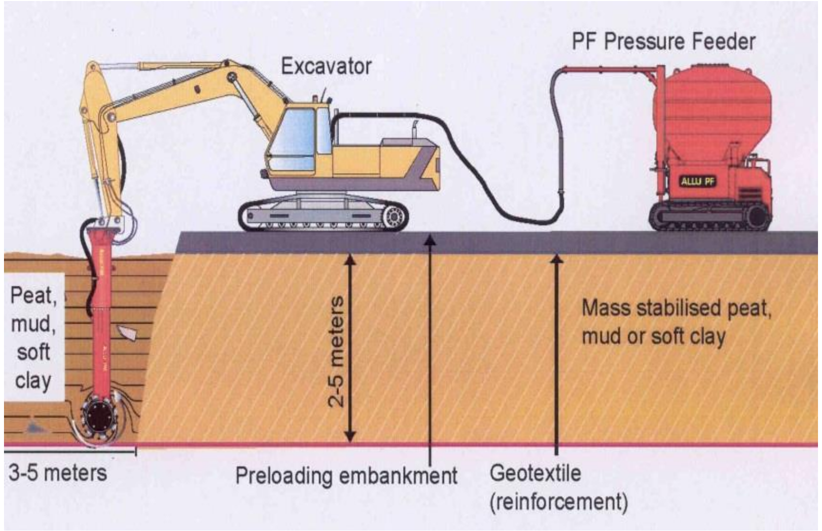
MASS STABILISATION METHOD

- A deep mixing method for ground improvement
- Applicable for soft soils like peat, mud and clay



MASS STABILISATION IS A VERSATILE TECHNOLOGY

- For the improving of soft soils
- For the improving of low-quality soils
- For the treatment of contaminated soils
- For the improving and utilisation of both pure and contaminated sediments

THE BEGINNING

Mass stabilisation at Veittostensuo 1993

Mass stabilisation of dredged sediments at Hamina harbour 1996

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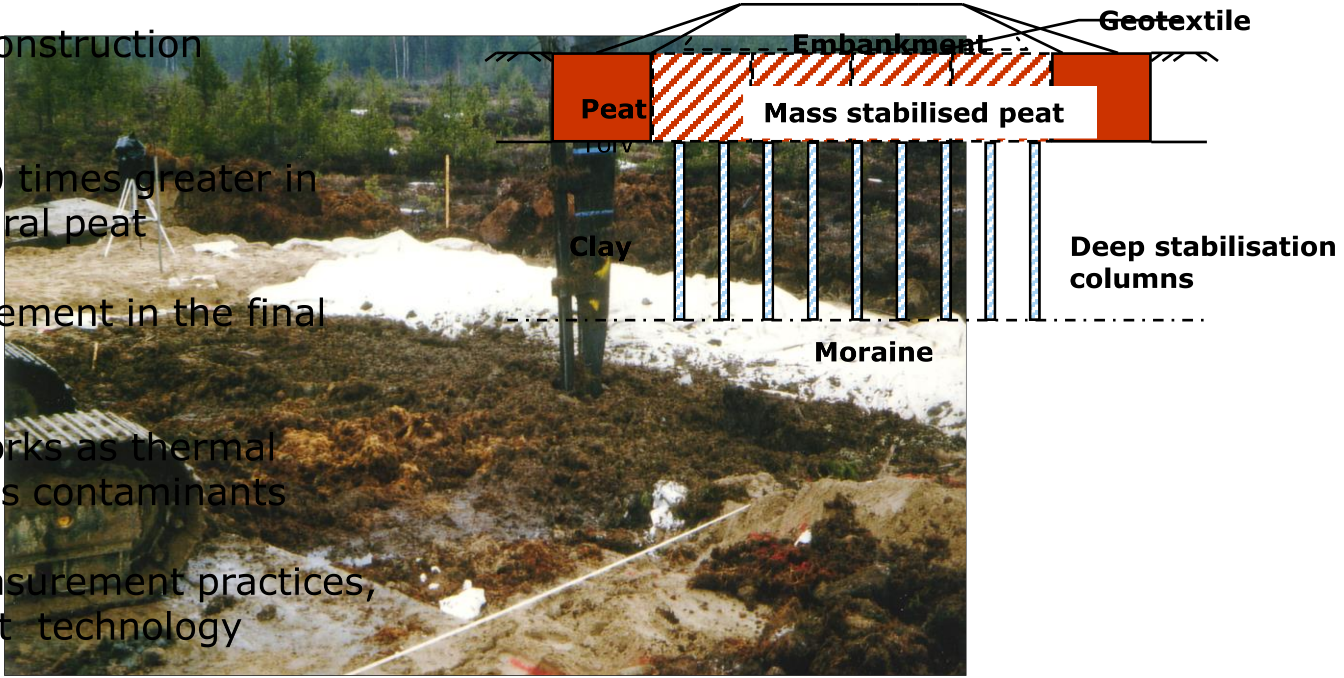
GEOTECHNICAL R&D/CASES
PEAT STABILISATION IN VEITTOSTENSUO

- Stabilised peat as construction foundation
- The strength 10…20 times greater in comparison with natural peat
- In practice, no settlement in the final structure
- In addition, peat works as thermal insulation and absorbs contaminants
- Laboratory and measurement practices, binder and equipment technology developed



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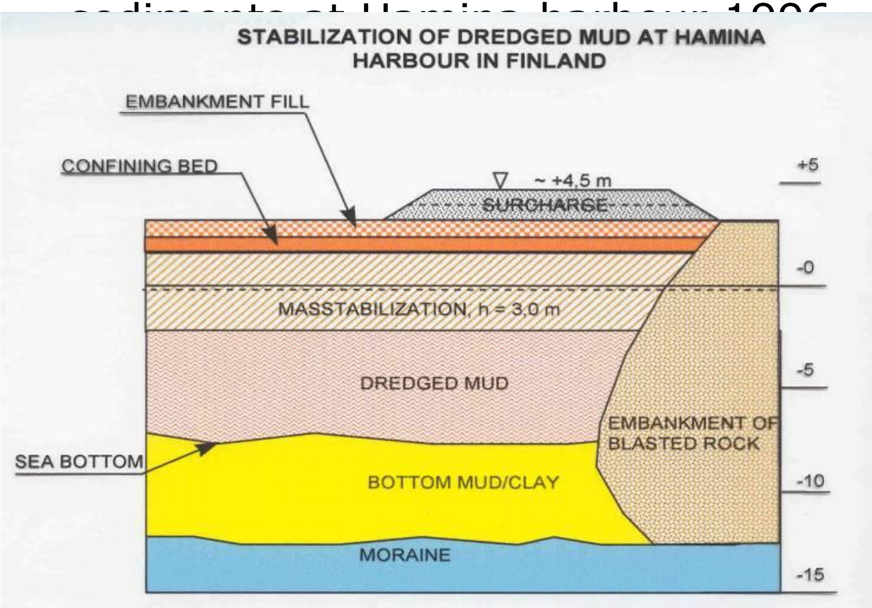
THE BEGINNING

Mass stabilisation of dredged sediments at Hamina harbour 1996



MASS STABILISATION, A COST EFFECTIVE METHOD, THAT PROMOTES THE PRINCIPLES OF SUSTAINABLE DEVELOPMENT

MASS STABILISATION OF SOFT SOILS

Clay, sludge, peat
- Mass stabilisation equipment

MASS STABILISATION OF DREDGED SEDIMENTS

- Pure and contaminated, soft sediments
- Mass stabilisation equipment
- Process stabilisation equipment
- Stack mixer

MASS STABILISATION OF CONTAMINATED SOILS

- Mass stabilisation equipment
- Stack mixer
- Screening scoop

MASS STABILISATION OF LOW-QUALITY ABANDONED SOILS

- Mass stabilisation equipment
- Stack mixer
- Screening scoop
- Process stabilisation equipment

Applications:
ROADS, STREETS, PIPELINES, PARKING AREAS, SPORTS FIELDS, COMMERCIAL CENTERS, RESIDENTAL AREAS, INDUSTRIAL AREAS, HARBOURS, STORAGE AREAS

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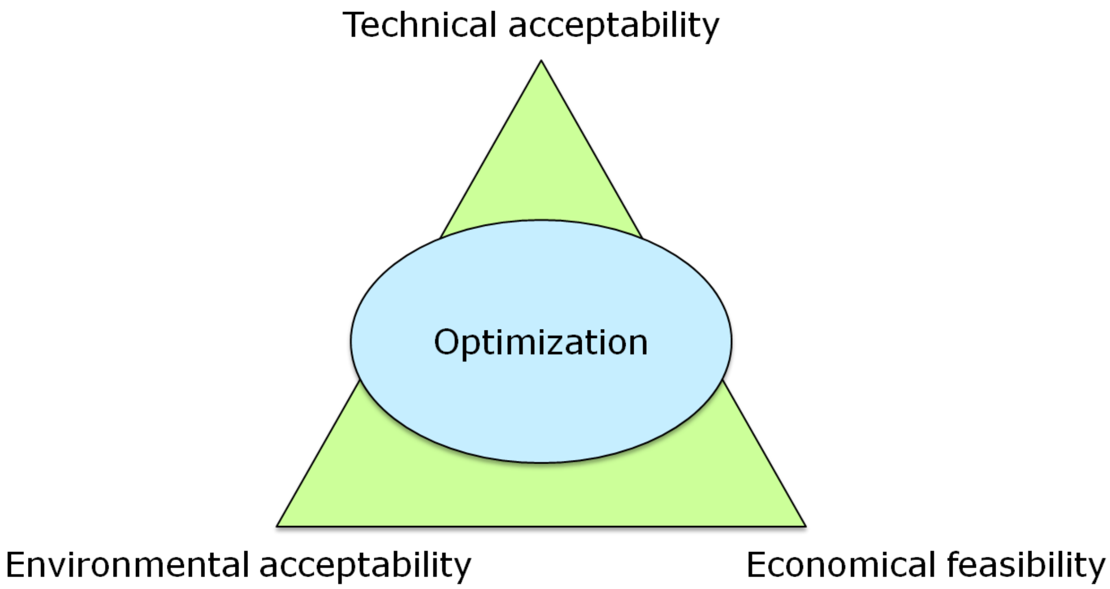
GEOTECHNICAL, ECONOMICAL & ENVIRONMENTAL ADVANTAGES

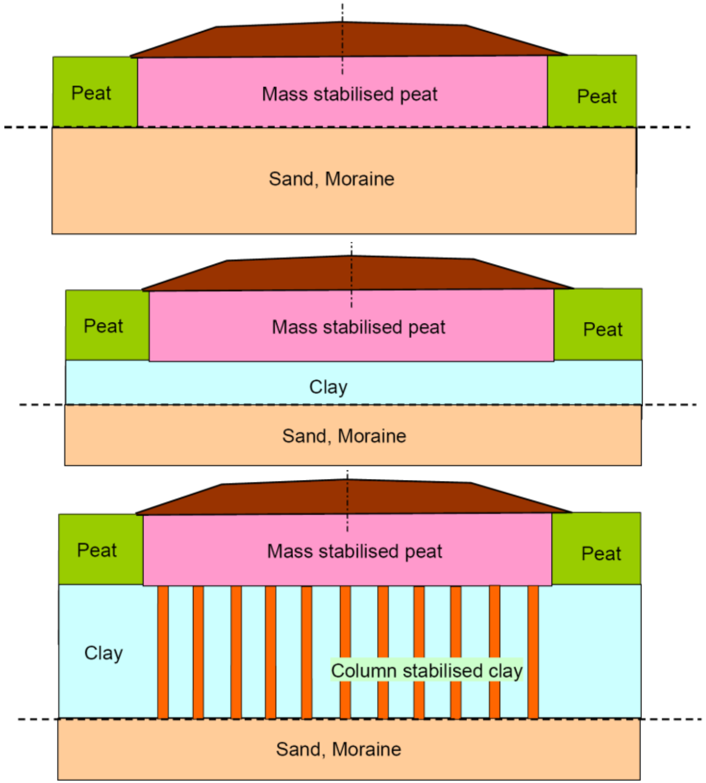
- Reduction of settlements (embankments, structures ...)
- Improvement of stability
- Support of slopes and excavations
- Improvement of bearing capacity
- Reduction of vibrations
- Utilisation possibilities of contaminated soils and sediments
- Cost savings (no excavating and filling)
- Saving in natural resources
- Saving in landfilling capacity
- Environmental image of the project

MASS STABILISATION: OPTIMISATION OF PROPERTIES



”FEASIBILITY STUDY”

- Thickness of the soft soil layer
  < 5 m or > 5 m ?
- Stability
- Settlement requirements
  - acceptable settlement ?
  - settling time ?
- Contaminants ?
  Bearing capacity …
- Costs (Soft soil = Peat, Mud, Clay, etc.)



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MASS STABILISATION OF PEAT, ROAD 601 SUNDSVÄGEN, RÅNEA, NORTHERN SWEDEN

Before stabilisation

Mass stabilisation ongoing

Road in use

RAILWAY TRACK, NORTH OF STOCKHOLM, SWEDEN, 1996

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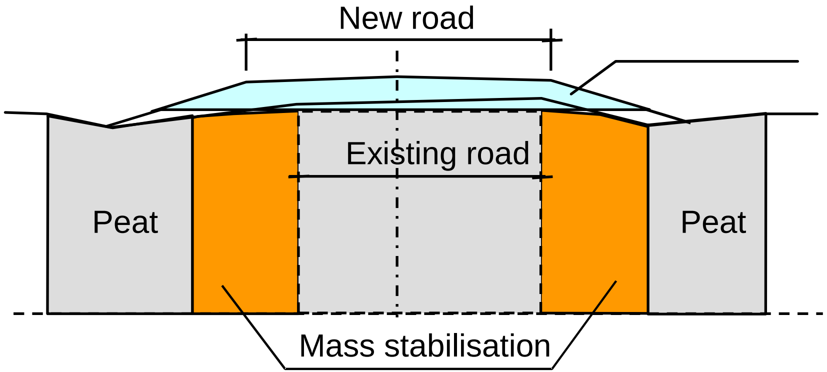
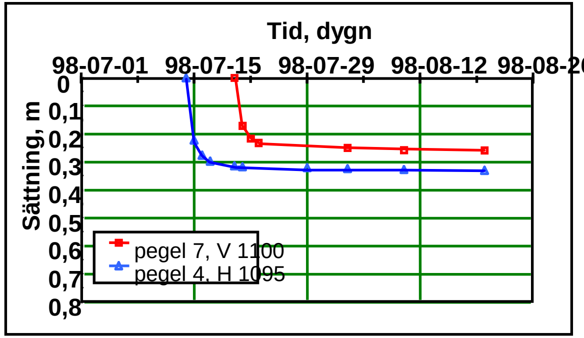
ROAD 45 IN NORTHERN SWEDEN, 1998





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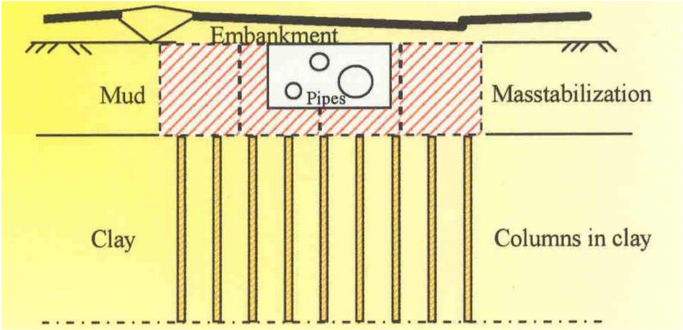
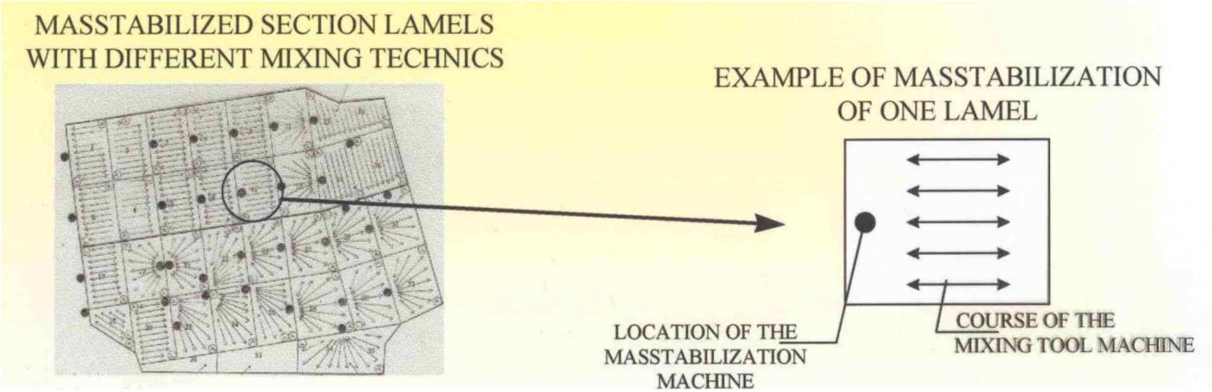
MUNICIPAL ENGINEERING, APPLICATIONS

LEPPÄVAARA, FINLAND

- Principle of masstabilization
- Development of masstabilization technics in the project





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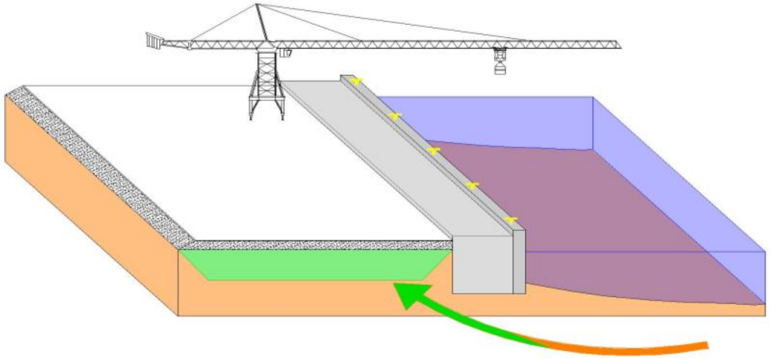
APPLICATIONS FOR STABILISED SEDIMENTS



Sediments dredged from the sea are mass stabilized and utilized as a filling material in the port field and for the construction of the lower part of the pavement.

Mass stabilization of a foundation for a container storage area of Port of Valencia in 2006

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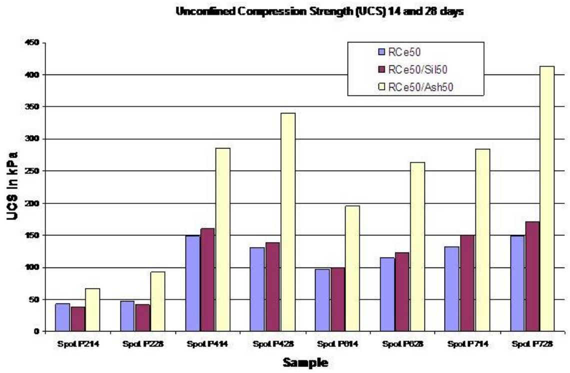
STABILISATION OF CONTAMINATED DREDGED MASSES WITH FLY ASH BINDER ADMIXTURE

The pilot project in Trondheim harbour

Unconfined compression tests – stabilized sediments



Pilotprosjektet i Trondheim havn

Trondheim Havn · SCC · SELMER SKANSKA · DNV

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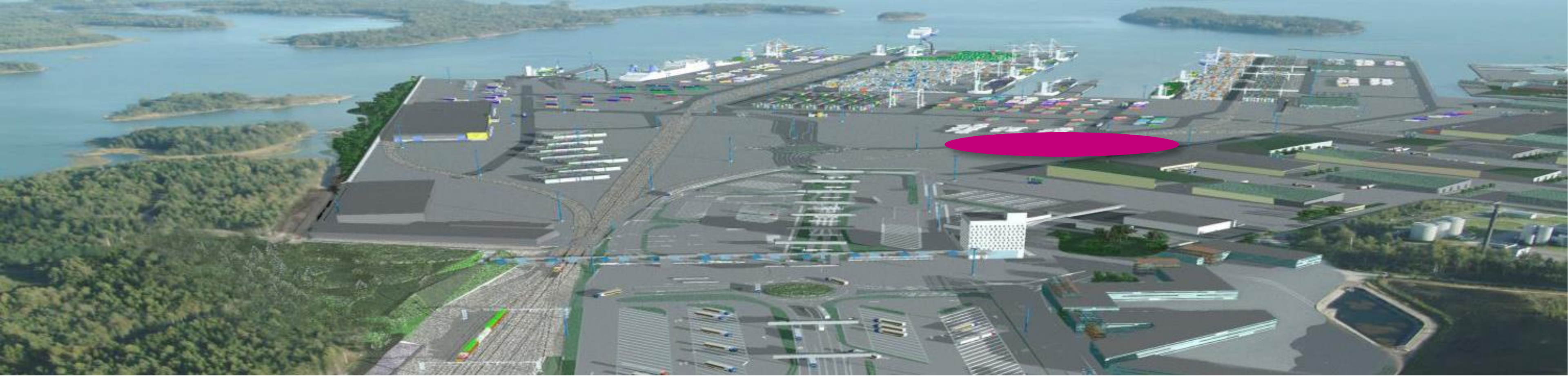

CASE VUOSAARI
MASS STABILISATION OF TBT–SEDIMENT IN A HARBOUR IN HELSINKI

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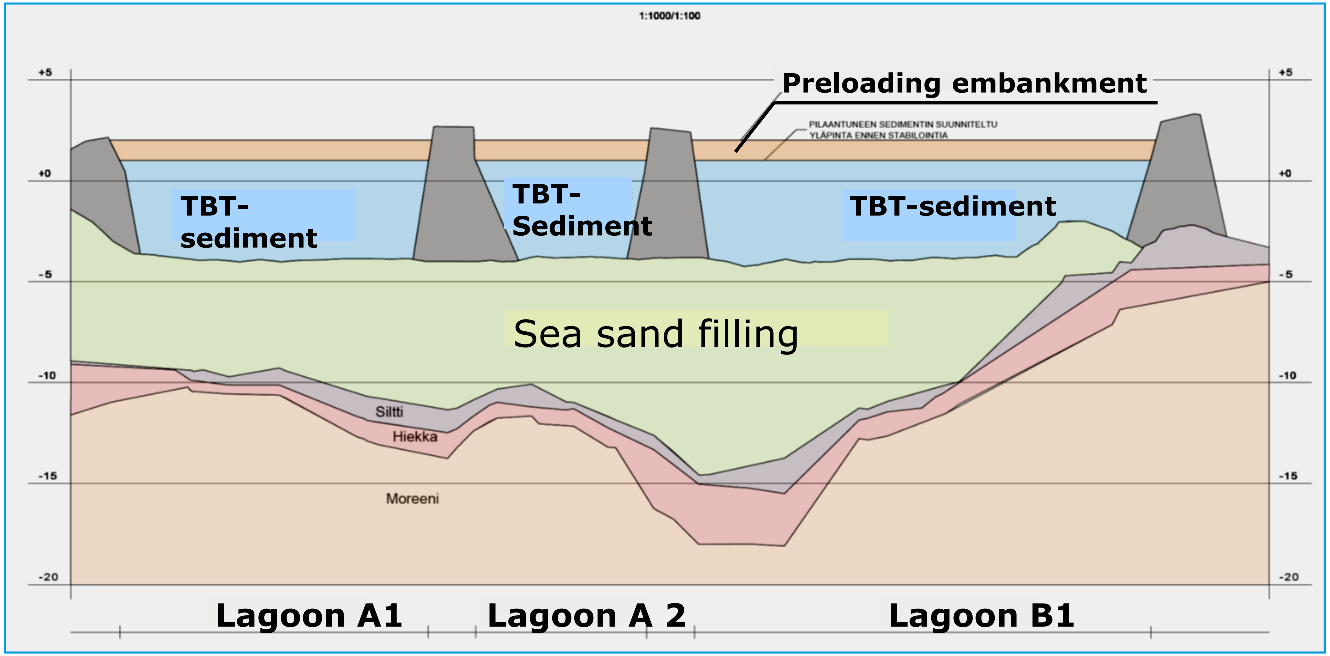
THE LARGEST MASS STABILISATION PROJECT IN FINLAND

- Total area ~11 ha (5 500 blocks á 20 m^2/~100 m^3)
- Mean depth ~ 5 m
- Total volume ~ 500 000 m^3 ~ stabilisation rate ~1 700 m^3/day
- Binder: CEM II/A-M (S-LL) 42,5 N); 130 kg/m^3 of sediment ~ 70 000 tons

SECTION OF THE STABILISATION AREA



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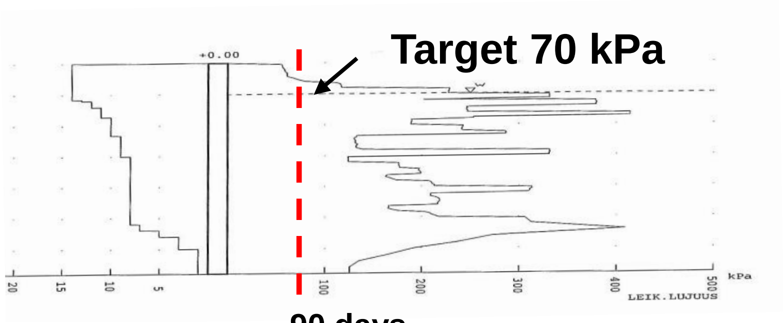
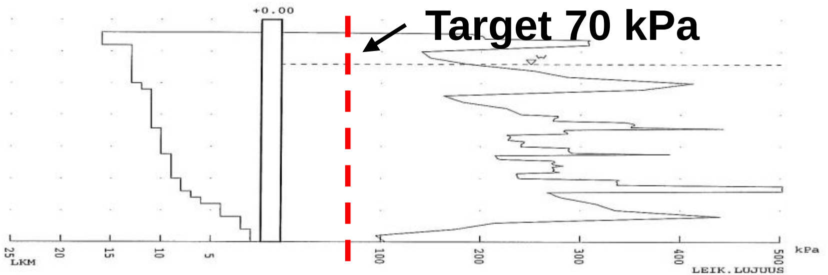
TARGETS OF MASS STABILISATION IN VUOSAARI HARBOUR

- Target 1: Shear strength (90 days) > 70 kPa
- Target 2: Permeability k < 5 x 10^{-9} m/s

QC/QA - TEST SOUNDINGS IN LAGOON A1 (90 DAYS AND AFTER PRELOADING)



90 days

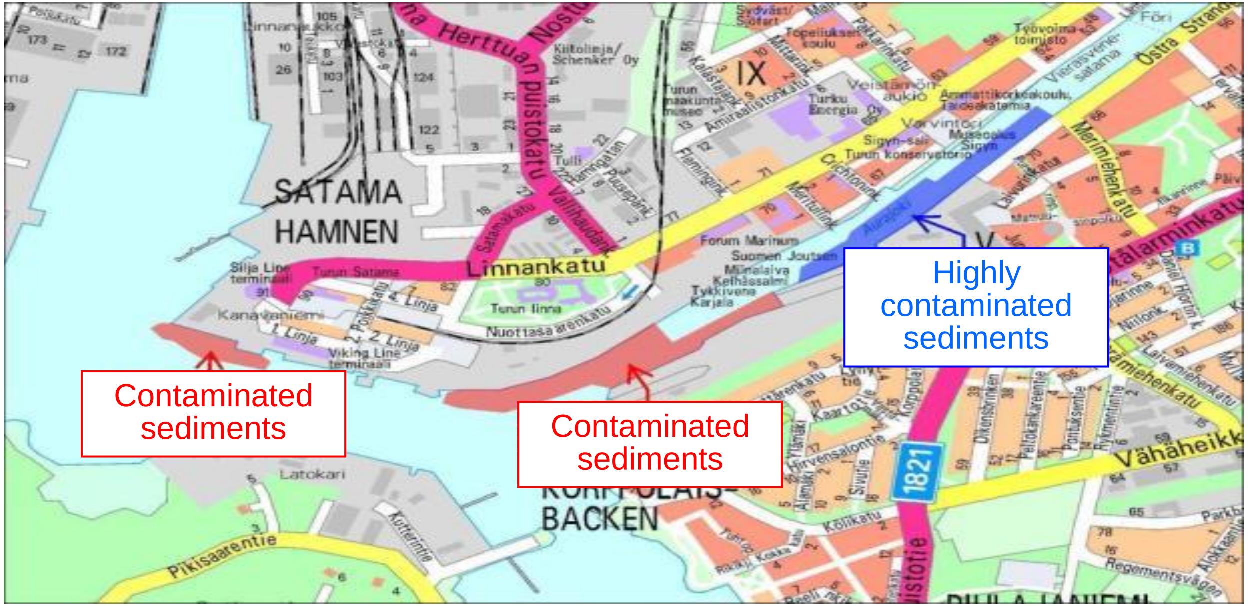


90 days + preloading 12 months

Average diagram of column sounding tests **after 90 days** (20 tests)

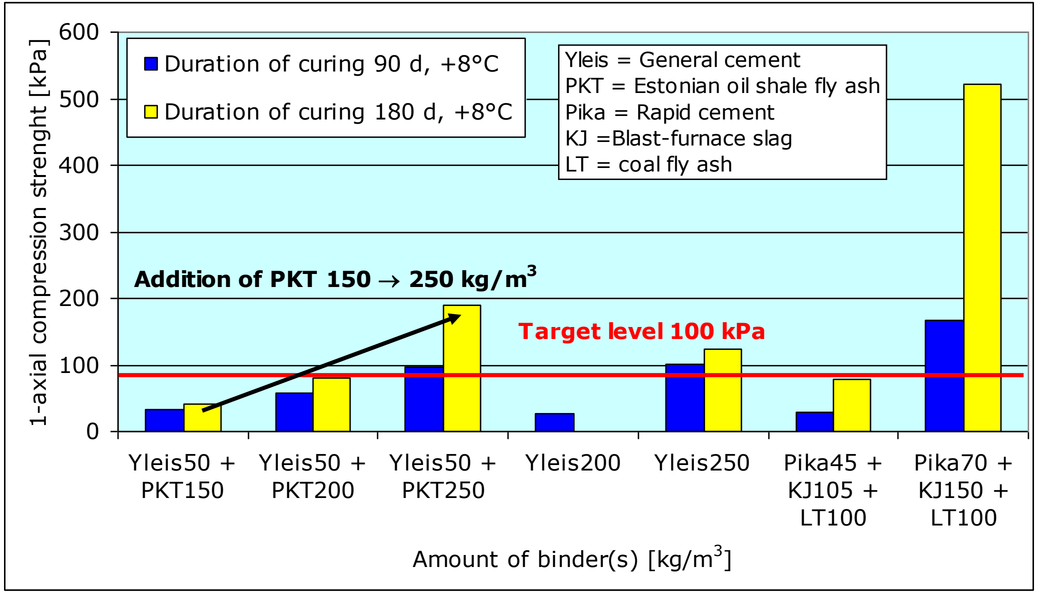
Average diagram of column sounding tests **after 90 days + preloading time** ~12 months (25 tests)

MAP OF THE CONTAMINATED AREAS IN THE RIVER AURA



BINDER RECEPTATION

It is very effective and economical to use industrial by-products. In the case of the river Aura the most effective by-products combined with cement are coal fly ash, blast-furnace slag and oil shale ash.



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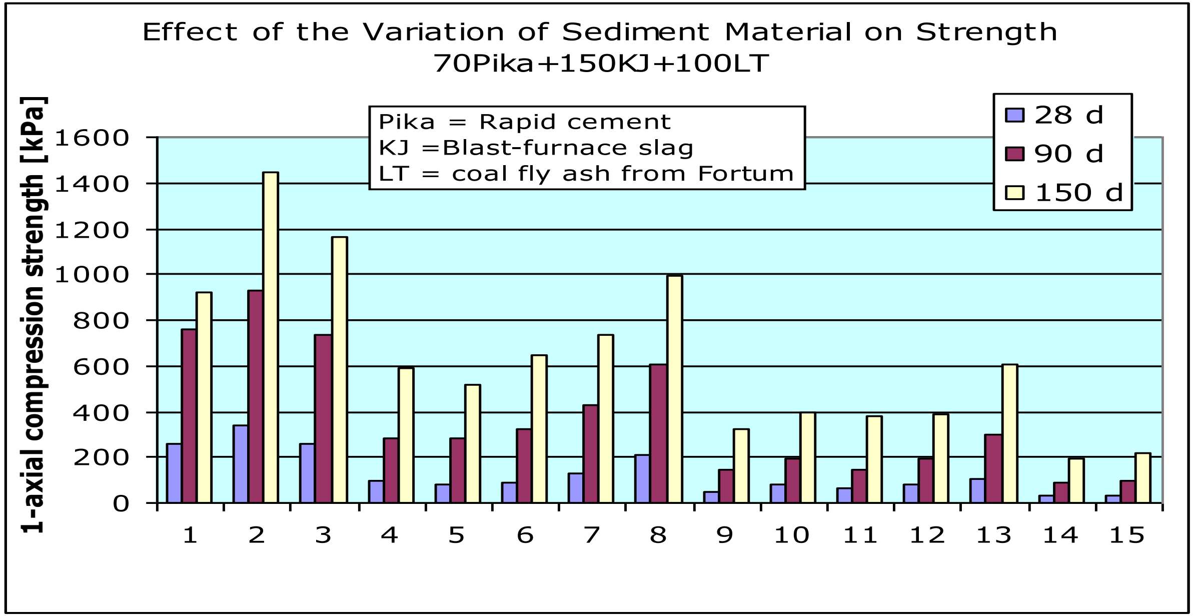
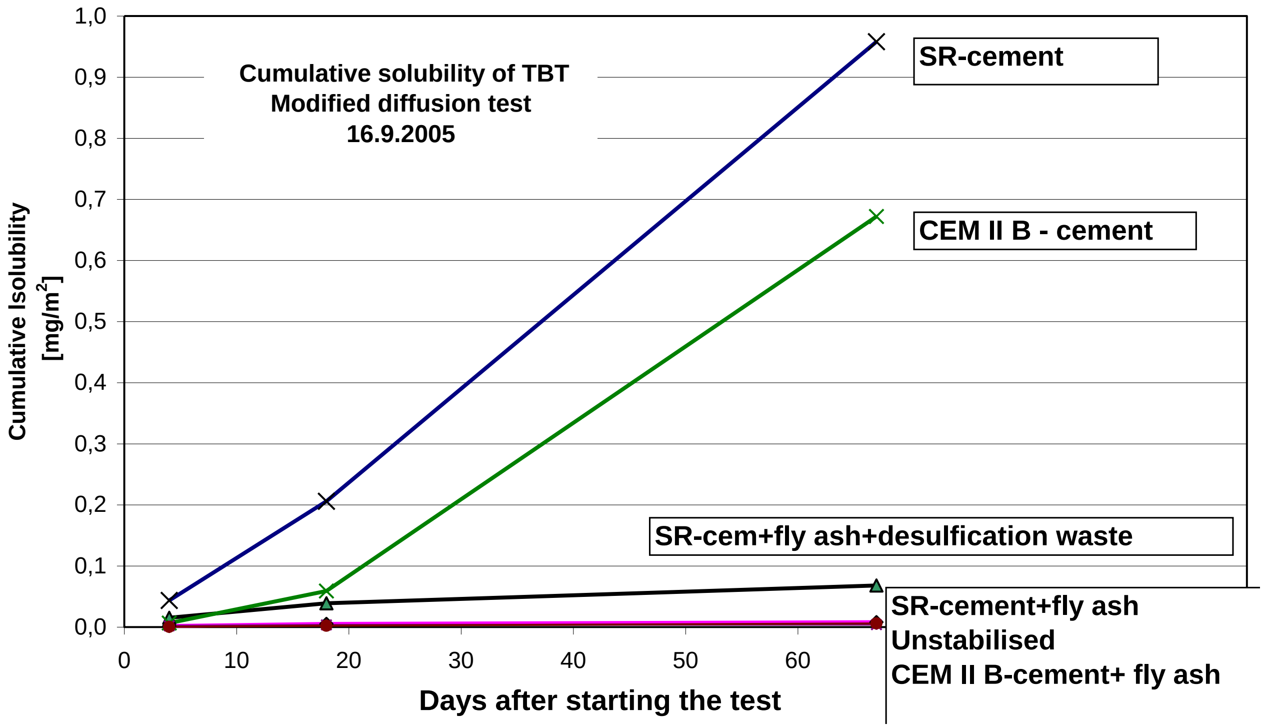
EFFECT OF THE VARIATION OF SEDIMENT MATERIAL ON STRENGTH



BINDER RECEPTATION

Results of a leaching test



TRANSPORTATION ROUTE OF THE SEDIMENTS, PANSIO LAGOON

EU-LIFE STABLE LIFE06 ENV/FIN/000195

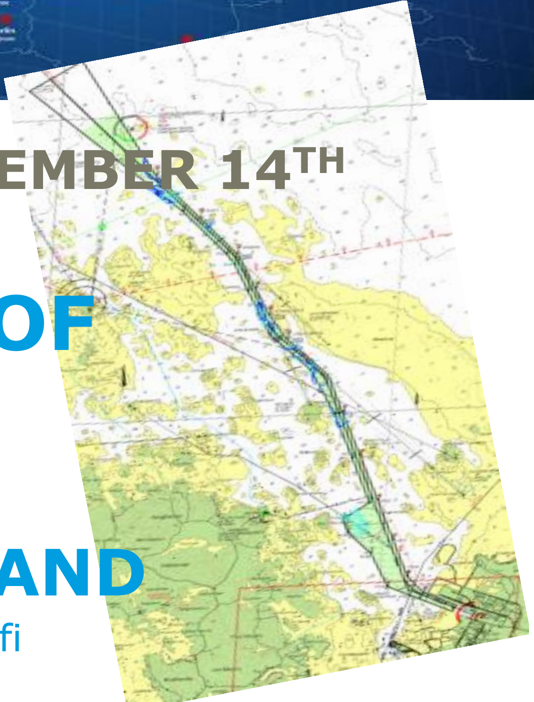
Controlled Treatment of TBT-Contaminated Dredged Sediments for the Beneficial Use in Infrastructure Applications. CASE: Aurajoki (river Aura)– Turku, Finland

Dredging with environmental grab

Transportation

Process stabilisation, mass stabilisation in barge

Utilisation in harbour fillings



SMOCS WORKSHOP, KOKKOLA 2011 SEPTEMBER 14TH

SUSTAINABLE MANAGEMENT OF CONTAMINATED SEDIMENTS,

CASE KOKKOLA

PENTTI LAHTINEN, RAMBOLL FINLAND

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CASE KOKKOLA

DREDGING AND DUMPING

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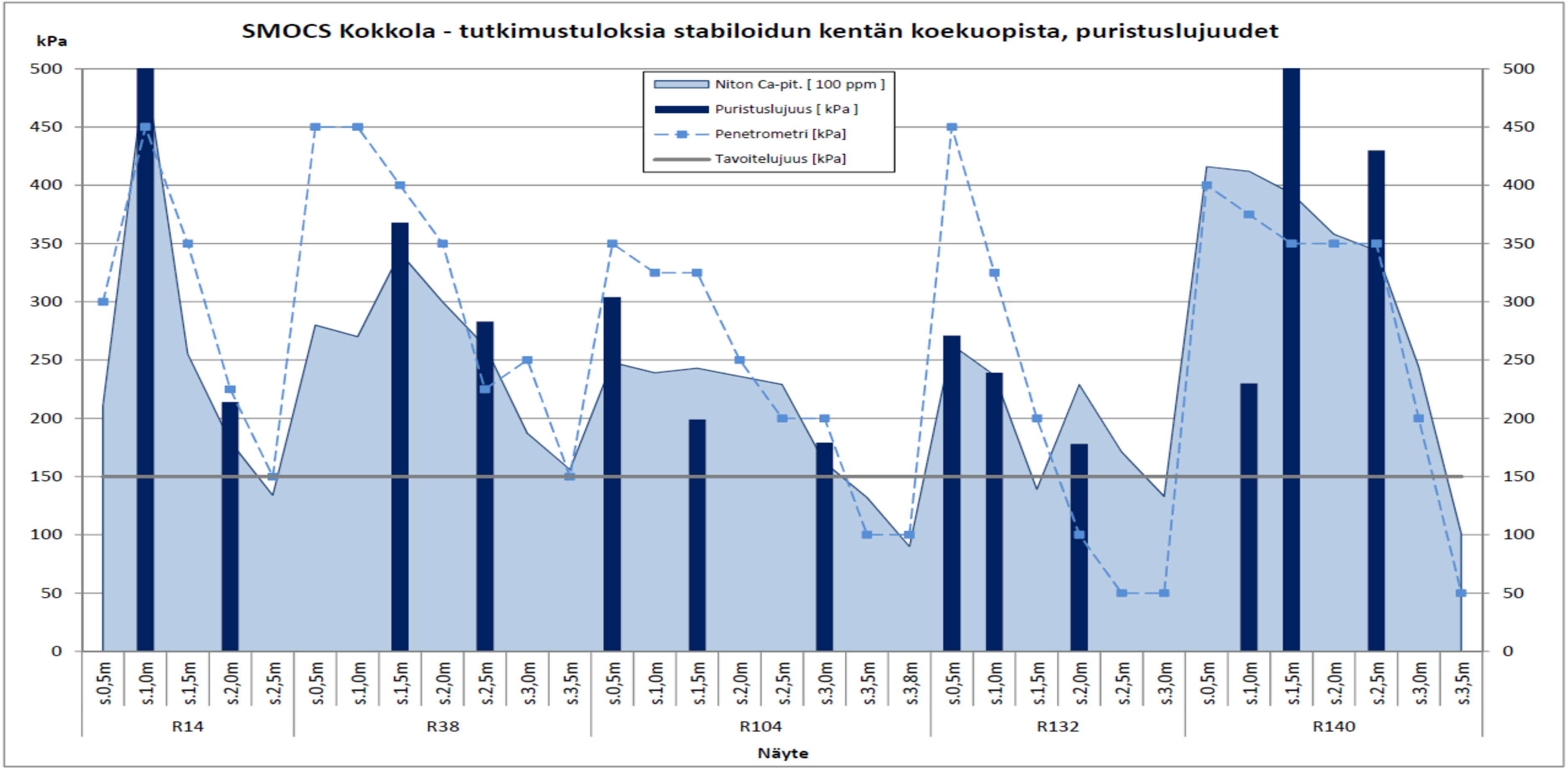
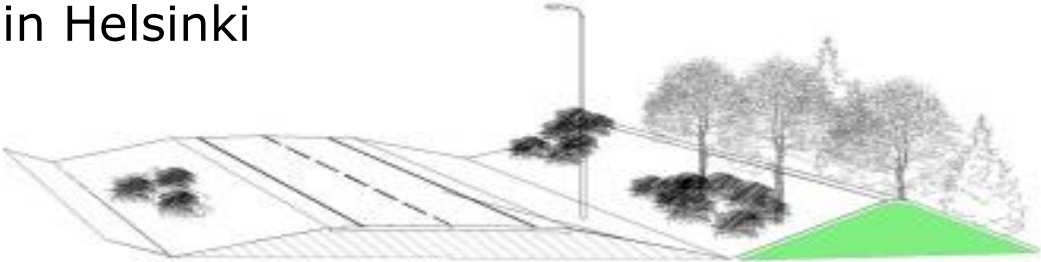
FIELD TEST RESULTS, ONE YEAR AFTER STABILISATION



APPLICATIONS FOR STABILISED SEDIMENTS

Dredged sediment is mass stabilized in a basin and after strengthening utilized elsewhere, for example in noise barrier.

West Harbour (Jätkäsaari) in Helsinki



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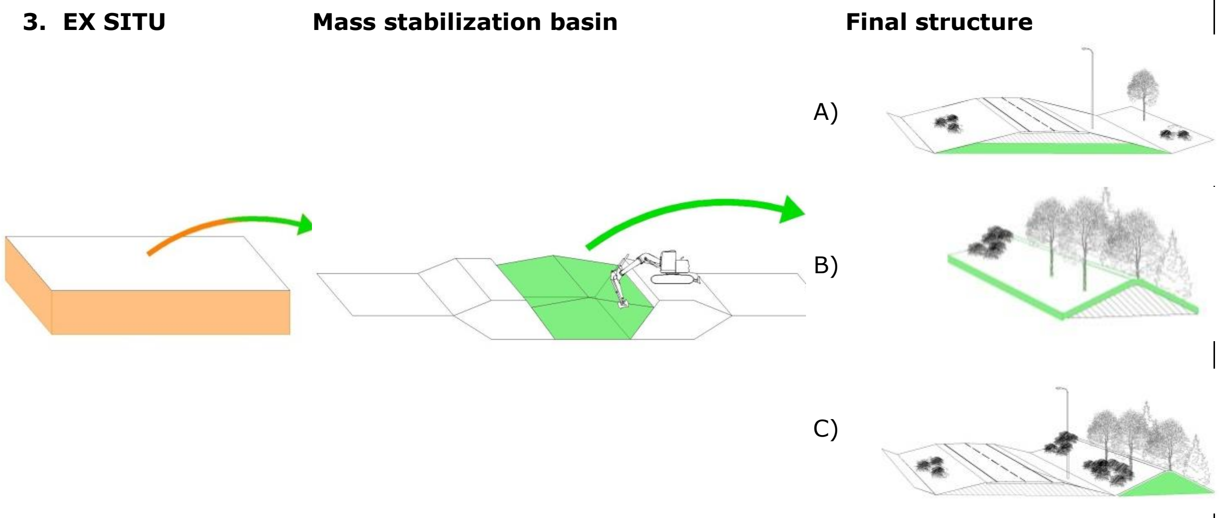
EX SITU MASS STABILISATION: STABILISED MASS IS UTILISED IN A STABILISATION BASIN



Excavated material is mass stabilized in a basin and after strengthening utilized elsewhere.

A) Road embankment fill
B) Water retaining layer, e.g., on top of blasted rock or a tyre crush filling and beneath the topsoil
C) Noise barrier

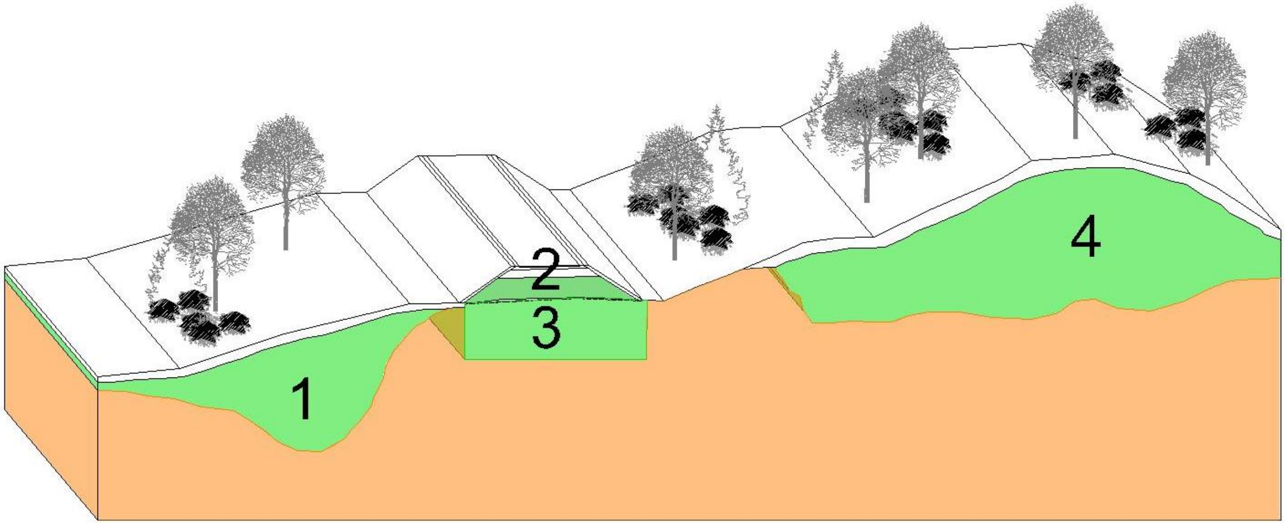
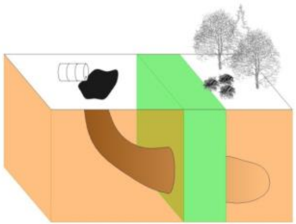
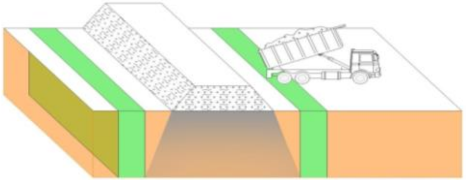


Figure 4.12 Filling carried out with the use of stabilized poor quality, surplus soil in green areas development projects and landscaping: 1) landscaping filling, 2) filling of a path embankment, 3) landscape hillocks and 4) subgrade improvement of a path

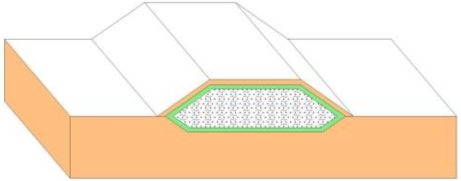
a) reactive wall



b) barrier walls



c) landfill bottom, cover and other barrier structures



d) treatment of contaminated soils and their utilization as filling material in construction of recreation areas

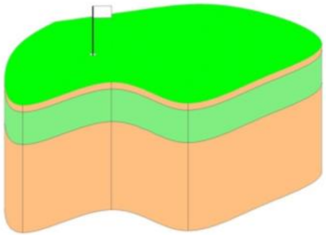
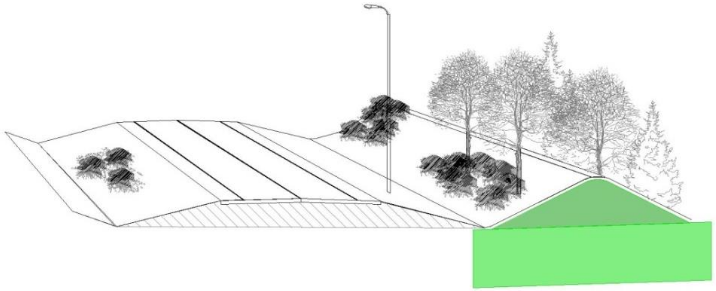
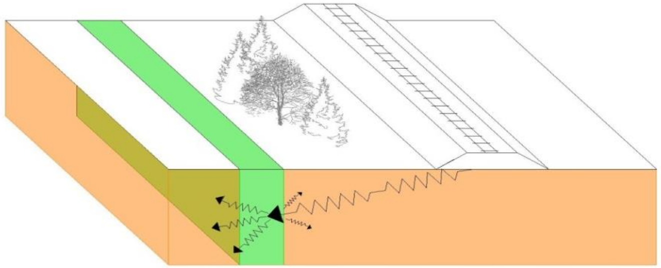


Figure 4.15 Environmental engineering structures. a) reactive wall, b) barrier wall, c) landfill barrier structures and d) treatment of contaminated soils to turn them into a low leaching form.

a) noise barrier, where the subgrade is reinforced with mass stabilization and the stabilized mass is used as material in the wall embankment



b) vibration reducing structure, where the mass stabilized wall to reduce vibrations is built into the subgrade



c) flood protection dam, where the subgrade is mass stabilized and the embankment’s material is a stabilized clay

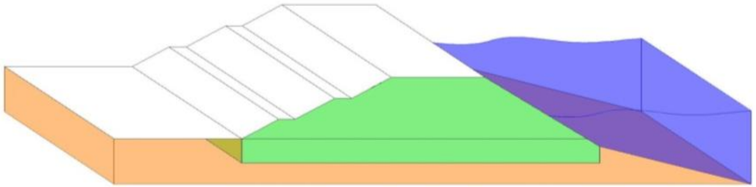


Figure 4.14 Environmental engineering structures. a) Noise barrier, b) vibration reducing structure and c) flood protection dam.

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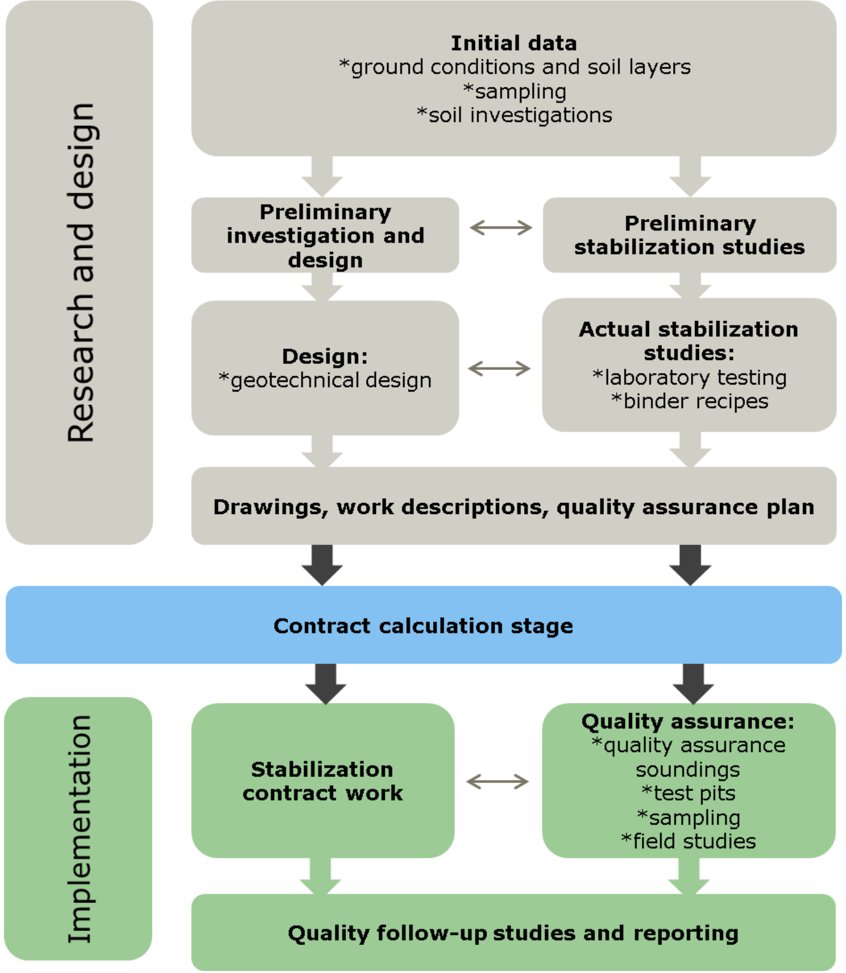
Developer
Authority
Contractor
Mass stabilization project
Geotechnician
Laboratory
Binder supplier
Quality controller
Ground investigator


Research and design
Initial data
*ground conditions and soil layers
*sampling
*soil investigations
Preliminary investigation and design
Preliminary stabilization studies
Design:
*geotechnical design
Actual stabilization studies:
*laboratory testing
*binder recipes
Drawings, work descriptions, quality assurance plan
Contract calculation stage
Implementation
Stabilization contract work
Quality assurance:
*quality assurance soundings
*test pits
*sampling
*field studies
Quality follow-up studies and reporting

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D6. DIMENSIONS AND TARGET STRENGTH OF STABILISED SOIL

1. Soundings

- thickness of soft soil layer
- area
- sampling

2. Laboratory tests

- type of binder (cement, fly-ash, slag, gypsum, mixture, …)
- dosing of binder

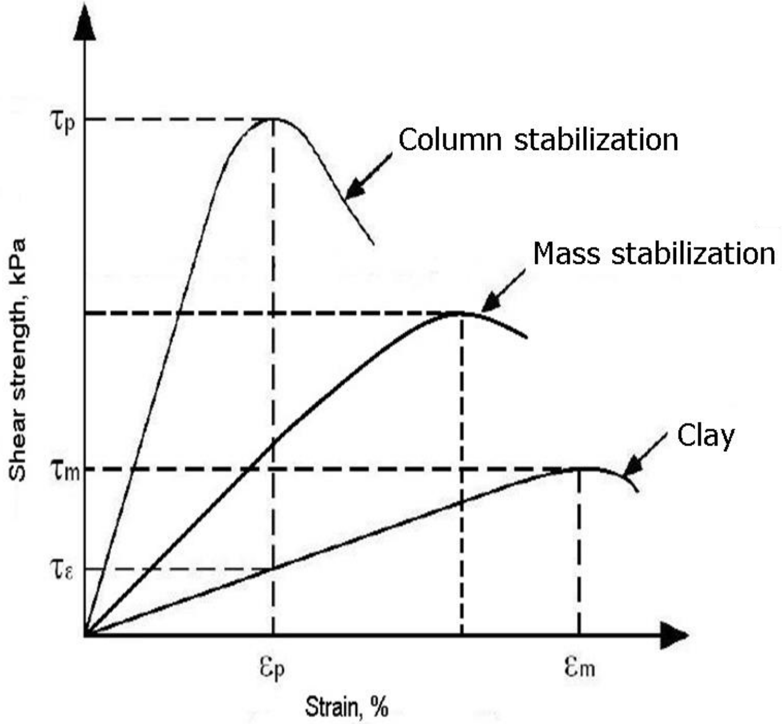
4. Stability calculations

- loadings
- width, length, depth of stab
- F ≥ Frequired
  → target strenth

5. Settlement calculations

- loadings
- depth of mass stabilisation
- modulus (<= strength)
  → target strenth

THE IMPACT OF STABILISATION ON THE UNCONFINED COMPRESSIVE STRENGTH AND THE DEFORMATION OF CLAY



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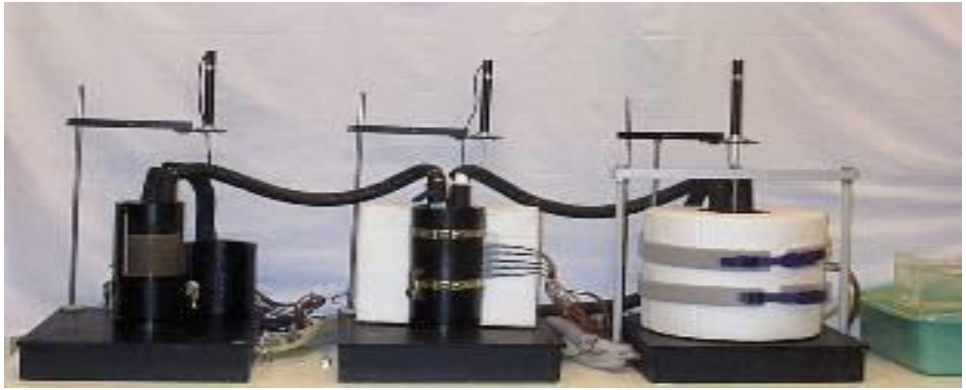
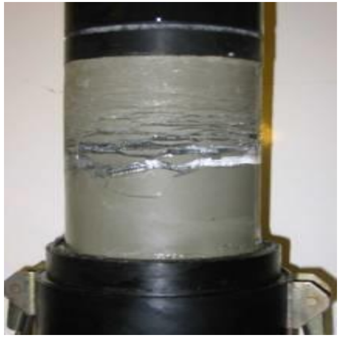
LABORATORY SERVICES



MATERIAL TESTS

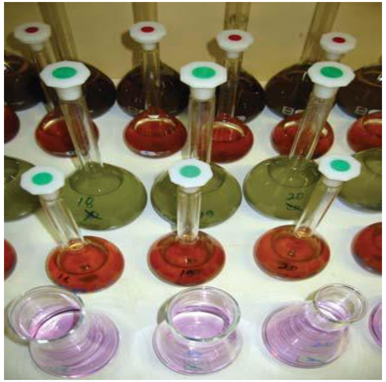
- Characterisation
- Compressibility/workability
- Strength properties
- Permeability
- Durability
- Frost susceptibility
- Thermal conductivity
- Determinations of binder content
- R&D for industrial by products



LABORATORY SERVICES

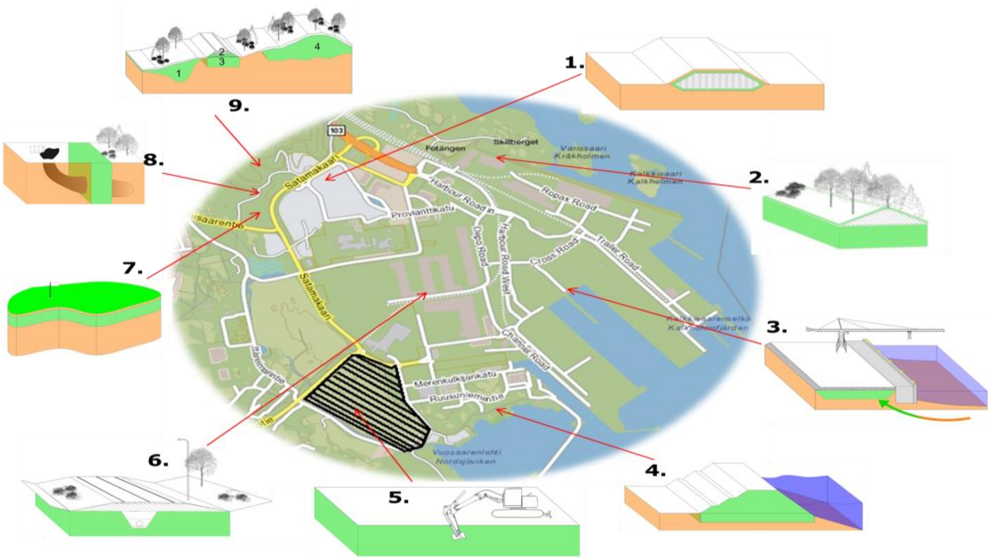
ENVIRONMENTAL INVESTIGATIONS

- Tests and analytical data
- Solubility tests:
- Column tests NEN 7343, CEN/TS 14405
- Modified diffusion test NVN 7347
- Petroflag: carbon hydrides etc.
- Analysis of binder content
- Testing by Niton XL-3t 900 röntgenfluorometeranalysator: heavy metals, chemical elements

MASS STABILISATION HANDBOOK

- Mass stabilisation method and equipment
- Mass stabilisation impact on soil properties
- Applications
- Stages of mass stabilisation project
- Binders
- Design
- Construction
- Quality assurance



http://www.ladec.fi/massstabilisation

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THANK YOU.