

FULL SCALE TESTING OF SEDIMENT REMEDIATION TECHNOLOGIES FOR NORDIC CONDITIONS

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Outline of the presentation

- Introduction
- Stabilisation of contaminated sediments
- Washing/Separation of contaminated sediments
- Results from full scale tests (including costs)
- Discussion/Conclusions

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Introduction

Cleaning up of contaminated sediments in the Nordic countries is mainly done by:

- Capping in situ (a clean layer of sediments is placed on top of the contaminated layer)
or
- Dredging and disposal. The disposal of dredged material is either in a land/nearshore confined disposal or an open water disposal which normally has to be capped.

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Introduction

Capping, pilot project Kristiansand



Dredging, pilot project Trondheim



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Introduction

- In the Norwegian Pilot Project programme alternative technologies have been tested for handling contaminated sediments with special emphasis on technologies suitable for Nordic conditions.
- The Norwegian Pilot Project programme has been initiated by the Ministry of the Environment and administrated by the Norwegian Pollution Control Authority.
- The project has been performed as a joint venture project between The Port of Trondheim, Rambøll, Skanska and DNV Consulting.

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Introduction

- In Trondheim harbour two technologies have undergone a full scale pilot test:
- Stabilisation of contaminated sediments with cement + different additives
- Washing of contaminated sediments (separation in clean and contaminated fractions)

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Stabilisation of contaminated sediments - Overview

1. Dredging

2. Transport and unloading

3. Mixing with binders

Approximately 25 000 m³ of contaminated sediments were stabilised

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Stabilisation of contaminated sediments – Mixing technique

Technique 1: Mixing in a separate unit

Technique 2: Mixing directly in the CDF

Technique 2 was more efficient and did also give less disturbance of the stabilised material.

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Stabilisation of contaminated sediments

Several binders were tested in the laboratory (cement, filter ash, silicate and lime) with respect to strength and leaching of contaminants.

- The most promising was a mixture of cement and filter ash (50/50) with 60 kg cement/m³ sediment + 60 kg filter ash/m³ sediment.
- In a later phase, mixing was also done with only cement (100 kg cement/m³ sediment) to reduce the mixing time.

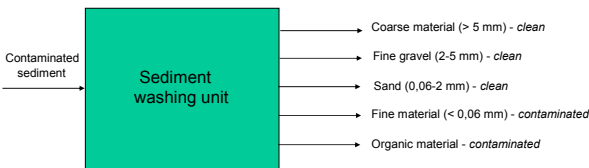


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Washing/Separation of contaminated sediments - Flow chart



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Washing/Separation of contaminated sediments



The mobile washing/separation unit that was used in Trondheim harbour

- Max. capacity: 5 tons/hour
- Average capacity: 2,5 tons/hour
- 2 100 m³ contaminated sediments were treated

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Results: Stabilisation of contaminated sediments

The stabilisation of contaminated sediments was successful.

- The stabilisation was performed during winter time without any negative influence on the result.
- The uniaxial strength of the material which was obtained in the field satisfied the criteria for the project (100 kPa based on lab. tests).



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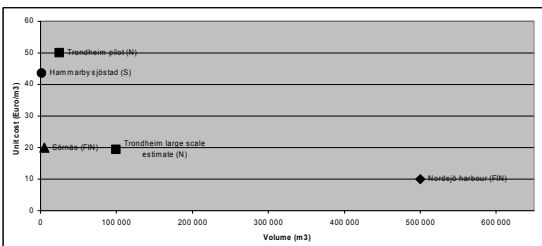
Results: Stabilisation of contaminated sediments - Costs

- The cost for stabilisation in the pilot project was approximately 50 €/m³ sediment.
- Based on the costs from the pilot project, a cost estimate of 20 €/m³ was made for a larger project (100 000 m³).

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Results: Stabilisation of contaminated sediments – Unit costs



Trondheim: Ref. Brånås and Laugesen (2005)

Sörnäs and Nordsjø harbour: Ref. Leppänen (2006)

Hammarby Sjöstad: Ref. Cementa (2002).

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Results:
Washing/Separation of contaminated sediments

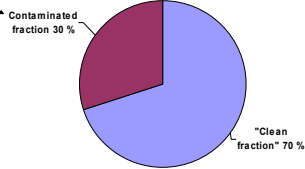
- The washing/separation of the contaminated sediments had some initial problems with organic particles (wood chippings) in the fine gravel fraction.
- This was solved by adding an air blower which removed the lightweight organic particles.



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Results:
Washing/Separation of contaminated sediments

The contaminated fraction contained 60-70 % of all the heavy metals and 85-95 % of the organic contaminants (PAH and PCB)



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Results:
Washing/Separation of contaminated sediments

- The main benefit of the washing/separation is that the amount of sediments which have to be placed in a disposal facility can be substantially reduced.
- The 70 % which was the "clean" fraction was close to fulfilling the Norwegian criteria for free use of soil or for dumping in the sea.
- It is anticipated that with minor developments of the washing unit, the criteria for free disposal of treated material should be possible to fulfil.

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Results:

Washing/Separation of contaminated sediments - Costs

- The unit cost for the pilot test was very high because only a relatively small amount of contaminated sediments were treated (2 100 m³).
- An estimate for a larger commercial washing/separation project (100 000 m³) indicated a cost of 80 €/m³ (45 €/metric ton) including disposal of a 30 % contaminated residual fraction.

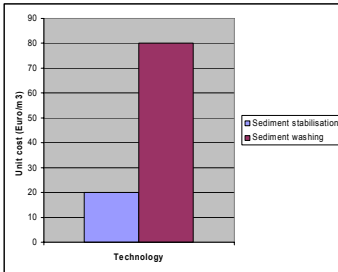
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Discussion/Conclusions

- Both technologies proved to be suitable for Nordic conditions.
- Stabilisation can be a cost-effective solution today.
- Sediment washing is expected to be cost-effective in the future (disposal costs are anticipated to be increasing)



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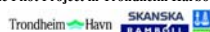
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Thank you for your attention !



You can read more about the Pilot project in Trondheim on:
<http://www.trondheim.havn.no/english/pilotproject>

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