Minimising Harbour Siltation (MHS)

PIANC Working Group 43
MHS Methods

1. **KSO** : Keep sediment out – minimise sediment flux to the harbour area.

2. **KSM** : Keep sediment moving – minimise sediment settling in the harbour area.

3. **KSN** : Keep sediment navigable – take advantage of transitional properties of fluid mud or prevent it consolidating so that ships can navigate through the suspension (i.e. nautical depth principle).

4. **KSIS** : Keep sediment in the system.
PORT FACILITIES OF BREMEN
Mean Tidal Range: 408 cm
Sedimentation for B/L, Ports of Bremen

\[ q_s = 30.40 + 4.89 \ln \frac{B}{L} \]
\[ r = 0.90 \]
Training Walls in the Outer Weser

Quelle: WSA Bremerhaven
Change of cross-section Weser-km 81

Training Wall Robbenplate

CD = m
0
-2
-4
-6
-8
-10
-12
-14
-16

Main Channel

Wurster Branch

1984

1889

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PORT FACILITIES OF BREMEN
Mean Tidal Range: 408 cm

INDUSTRIAL HARBOUR
- Werftafen
- Turning Basin
- Liebentiegenhafen

COMMERCIAL HARBOUR
- Getreidehafen
- Holz- und Fabrikhafen
- Liebentiegenhafen
- Europahafen
- Flut

MITTELSBUERENER HARBOUR
- Lock Ostebranhausen
- Outer Harbour

NEUSTADT HARBOUR
- Turning Basin
- Lankau Hafen
- Becken 9

Stahlwerke Bremen

Seehausen

Scale: 0 500 1000 m

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Legend: annual sedimentation
- Yellow: 0 - 49 cm/yr
- Light Blue: 50 - 99 cm/yr
- Pink: 100 - 149 cm/yr
- Red: 150 - 199 cm/yr
- Dark Red: ≥ 200 cm/yr

Flow and Sedimentation Patterns after Closure of The Harbour Channel, Neustadt Harbour, 1992 - 1996

Legend: annual sedimentation
- 0 - 49 cm/yr
- 50 - 99 cm/yr
- 100 - 149 cm/yr
- 150 - 199 cm/yr
- ≥ 200 cm/yr

PORT FACILITIES OF BREMERHAVEN

Mean Tidal Range: 372 cm
Intake for top-up water in Weser Estuary
Comparision of tide curve v suspended sediment concentration showing low values after HW. Shaded area shows offtake period.
Sounding Map of the Emden Harbour in April 2005 (15 kHz)
Map of Differences between the 15 kHz- and 210 kHz-Horizon in the Emden Harbour

Differences between 15 kHz and 210 kHz

- Außenhafen
  - V = 499.597 m$^3$
  - A = 146.600 m$^2$
  - V/A = 3.41 m

- Nord-Südkai
  - V = 634.110 m$^3$
  - A = 328.300 m$^2$
  - V/A = 1.93 m

- Vorhafen
  - V = 208.376 m$^3$
  - A = 87.700 m$^2$
  - V/A = 2.38 m
Self-propelled hopper with underwater pump for infrequently fluidising, raising, oxydising & re-depositing fluid mud
Sounding Map of the Fishery Harbour Area in January and February 2002 (15 kHz)
Map of Differences between the 15 kHz- and 210 kHz-Horizon in the Fishery Harbour Area

Differences between 15 kHz and 210 kHz

Locked Harbour
V = 60.180 m³
A = 75.588 m²
V/A = 0.80 m

Lock Chamber
V = 16.106 m³
A = 7.446 m²
V/A = 2.16 m

Outer Harbour
V = 128.564 m³
A = 67.225 m²
V/A = 1.91 m

Sounding from January and February 2002
Water Injection Vessel

- Propulsion
- Water inlet
- Lifting cable
- Array of water jets
- Diffusor Pipe
Sounding Maps of the Outer Harbours of Brunsbüttel in September 2003 (15 kHz)
Map of Differences between the 15 kHz- and 100 kHz-Horizon in the Outer Harbours of Brunsbüttel

Differences between 15 kHz and 100 kHz

New Outer Harbour
V = 331,403 m³
A = 246,400 m²
V/A = 1,34 m

Old Outer Harbour
V = 115,376 m³
A = 70,375 m²
V/A = 1,64 m

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Longitudinal Sections through the Outer Harbours of Brunsbüttel in September 2003 (15 kHz and 100 kHz)
<table>
<thead>
<tr>
<th>Problem of Sedimentation</th>
<th>Tested device to reduce siltation and costs for the device</th>
<th>Minimisation of siltation and financial savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siltation rate (average) 1967/91</td>
<td>Costs of maintenance Kind of flow regime that causes high siltation</td>
<td>rate of siltation reduction financial savings per year pay back time for the device</td>
</tr>
<tr>
<td>257,000 m³/year</td>
<td>≈1.71 Mill €/year (dredging and dumping) ≈5.1 Mill €/year (land disposal)</td>
<td>Closure of the Harbour Channel by a sheet piling wall in Feb. 1992 Costs: 1 Mill. € average 1992/96 157,000 m³/year Reduction 100,000 m³/year 0.66 Mill €/year 2.0 Mill €/year</td>
</tr>
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## Benefit from new top-up water inlet

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<td>Siltation rate (average) 1986/96</td>
<td>Kind of flow regime that causes high siltation</td>
<td>rate of siltation reduction</td>
</tr>
<tr>
<td>≈400,000 m³/year (dredging volume)</td>
<td>Costs of maintenance</td>
<td>backfill of water into the harbour from the river through channels at the bottom of the sea locks</td>
</tr>
<tr>
<td>≈2.7 Mill €/year (dredging and dumping)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≈10.0 Mill €/year (land disposal)</td>
<td></td>
<td></td>
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# Water Injection Summary, Port of Bremerhaven

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<tr>
<td>Siltation rate (average) 1986/94</td>
<td>Kind of flow regime that causes high siltation</td>
<td>rate of siltation reduction</td>
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<tr>
<td>350,000 m³/year (dredging volume)</td>
<td>Costs of maintenance</td>
<td>Tidal and density currents</td>
</tr>
<tr>
<td></td>
<td>≈2.3 Mill €/year (dredging and dumping)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≈8.75 Mill €/year (land disposal)</td>
<td></td>
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PIANC-Kolloquium
Young Professional Group
28. Juni 2007, Hannover

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H. Nasner