Ports as dredging laboratories

Essential research by port authorities and dredging companies is providing useful data for ports all over the world. P&H reports

Bremerhaven: laboratory for advancement of dredging techniques and sustainable development

What's causing our ports to silt up – fishing trawlers, dredging or stormy weather? Scientific studies at Bremerhaven have been conducted with the aim of reducing sedimentation inside the brackish tidal zone in the harbor.

Bremerhaven is not only a buzzing, busy harbor playing a crucial role in Germany's trade – it's now the fourth-largest container harbor in Europe – it is also a 'laboratory' for the advancement of dredging techniques and sustainable development. Sediment intrusions into the various harbor basins require annual dredging of sediment, which has to be disposed of on land after separation and specific treatment. For the moment, vessels can be accommodated to a maximum draught of 14.5m at low tidal waters.

To ensure Bremerhaven's future growth, port access channels will have to be kept open and made deeper. But this needs to be done in a sustainable, environment-neutral way.

For these reasons, Bremerhaven, situated at the lower end of the Weser estuary, is being used for several important dredging research studies and experiments. One study seeks to assess the impact of dredging-induced sediment plumes in the broader context of natural processes such as storms, winds and changes of season, along with other human activities like fishing.

Another study aims to find technical solutions that will discourage sedimentation caused by natural tidal flows in the harbors.

Always in the forefront of technology, the private dredging industry is funding and promoting a research programme called TASS (turbidity assessment software). The programme aims to determine whether suspended sediment concentrations resulting from dredging operations are really environmentally more damaging than fishing or natural occurrences.

The field trials in Bremerhaven yielded eight successful experiments, two of which were undertaken during maintenance dredging and six others during offshore sand mining for the construction of the planned new terminal.

Another study at the Port of Bremerhaven, established by the German Federal Ministry of
Education and Research, is examining the interaction of the brackish waters of the river at the harbor entrance caused by tidal currents. Understanding how tidal changes work is an important step in trying to develop solutions to minimise sedimentation in the port.

If sedimentation can be minimised there is a possibility that the need for annual maintenance dredging can be reduced.

Reduced maintenance dredging would, in turn, limit potential impacts, reduce port authority costs and ultimately benefit all stakeholders.

This type of research by the dredging industry and port authorities has yielded useful data for ports all over the world. As transporting goods by water remains the most efficient and environmentally sound means of global trade, ports will continue to expand. This type of scientific data is essential to enable this process to continue.

This is certainly the case at Bremerhaven, where port expansion plans are on the drawing board to provide facilities able to handle more than 5.5M containers a year in a port that extends over some 3M m² and where more than 1.3M cars annually pass through a port area of 2M m².

The study was quite complex, using measurements from a harbor basin and some river profiles in front of Bremerhaven North Lock. Comparison has to be done extremely carefully and time is needed to produce an area map of flow velocities.

Studies were conducted of the water exchange and sedimentation between the harbor and the River Weser for different harbor entrances during tides. Model results showed that sedimentation occurs mainly at the end of the flood period.

This helped identify the period that the main sediments are transported into the harbors. Maximum suspended sedimentation can be found at the end of the flood period and at the end of the ebb period of the spring tides.

A summary of the results of the water exchange and basin sedimentation showed that sedimentation increases. Without the salinity gradient the inflowing sediment would be driven out of the basin.

The results will be used to redesign the entrance of the harbor in front of the North Lock. Four entrance variants were tested:
- Reduction of the entrance width by 40%
- Construction of a current deflection wall (CDW) to reduce flow effect
- Use of a sill/bottom to influence density currents in front of the original entrance
- Combined use of level difference and CDW.

The water exchange between the river the and harbor was reduced significantly by decreasing the width of the entrance. By contrast, sedimentation height was reduced only through a combination of the two methods.

No relationship between water exchange and mean sedimentation height could be found.

"Bremerhaven field trials yielded eight successful experiments"

The study concluded that sediment intrusion from tide- and density-driven estuaries into a diverting harbor basin will remain a major factor in the operation and maintenance of harbors. From the studies, an effective method of reducing harbor sedimentation has been devised.

It has reached a reliable standard for identification of local influences, including flow, tide, density effects on sediment intrusion and deposition. Rational arguments can be demonstrated for maintenance dredging, fluidisation measures or structures that will need to be built against sedimentation.

All of this will help port authorities decide on the optimum orientation of the harbor axis and entrance width. Ports now have the assurance of a tool that can help them significantly decrease harbor sedimentation. PH

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