

# Usage of mud in the land reclamation of harbor areas building a handling area for automobile export in Bremerhaven, Germany

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In many harbors at shallow tidal estuarine systems problems arise with tide driven accumulation of highly organic muds. Dredging operations for maintenance of maneuverable harbor water depth lead to vast amounts of organic rich often contaminated sediment.

Due to a German federal regulation the “ocean dumping” of contaminated material is strongly limited and requires to compare alternatives such as re-use or disposal on specially equipped disposal sites. Disposal capacities are limited in northern Germany and costs rose of more than 35 Euro per cubic meter. Therefore on-site disposal, e.g. using the harbor mud as filling and construction material, is a favorable option.

In Bremerhaven, Germany, the usage of dredged harbor mud as construction material was proved to be applicable in a pilot project in the years 2005 to 2007.

A shallow harbor basin in Bremerhaven, situated at the mouth of the river Weser, is refitted with 550 m of new RoRo (roll on, roll off) piers for car-carriers. The main project goals are: increase of RoRo pier length, fast creation of highly needed 60,000 square meters of handling area for automobile export, maintenance of the harbor basin water depth to allow full maneuverability for deep sea car-carrier and the on-site disposal of the dredged material. The project was accompanied by an intense geotechnical monitoring program and its successful completion has led to a reduction of disposal material in equivalent of 2 years of disposal capacity of the federal Bremen facility.

During the construction phase 7 m of dredged harbor mud (water content up to 280 %) was transferred behind the sheet piling leading to local thickness of up to 16 m of soft soils.

Special care was taken to reduce water intake of the mud during dredging and relocation. A geotextile, which prevents density induced mixing, capped and separated the mud layer from a following 4 m thick sand layer. An approximately 0.8 m spaced vertical vacuum drainage system with a total drainage length of more than 1,200 km was installed to accelerate dewatering and consolidation.

Despite of the preventive measures, intense vertical ground movements of the mud layer occurred during the under water placing of sands.

Due to the deformation of the mud layer the construction sequence had to be changed. After the installation of the vertical drainages by floating equipment, a system for vacuum consolidation was arranged.

Above the vacuum system 1.5 m dry sand had to be placed in thin layers by “Pistenbullies” before the last part of the top layer could be built in by a hopper dredge.

During the whole project the mud was extensively observed and measurement data was gained on the characteristics of mud as construction material.



**Fig. 1:** a new handling area for automobile export in Bremerhaven, Germany.



**Fig. 2:** dredged harbor mud.  
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