

IMPOUNDED WATER IN SEA DIKES

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INTRODUCTION

The construction and building of dikes as a coastal defence structure especially in marsh areas along the German North Sea coast has a very long history and tradition. The development of the sea dikes goes along with the history of storm flood events and the increase of storm surge water levels in the past and the development of building and construction techniques. The following Figure shows the development of the dike profile during the last 400 years.

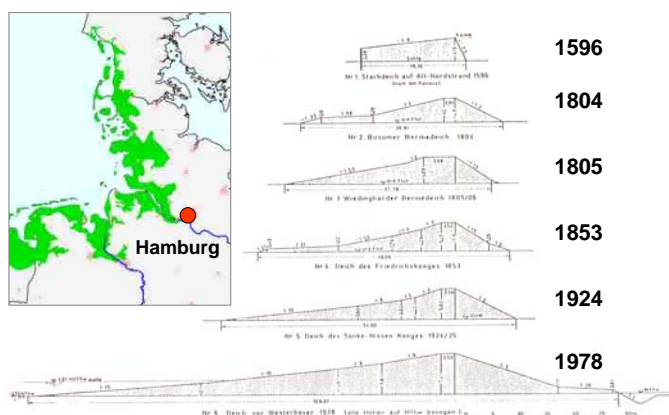


Figure 1 - Development of dike geometries over the last 400 years (selected profiles from Schleswig-Holstein)

While older dikes were built completely out of clay with relatively steep seaward slopes, modern sea dikes consist of a sand core with a covering clay layer of 1.0 m to 1.5 m thickness. The seaward slopes flattened up to 1:6 mainly as a result from dike failures during the most severe storm flood in 1962 in the Elbe estuary and along the German North Sea coast. Examples of actual dike profiles are documented in EAK (2002).

IMPOUNDED WATER IN MODERN DIKES

Depending on the local boundary conditions, modern sea dikes with a sand core were built under different soil conditions. This means that in some cases the sand core of the dike was constructed on an impermeable subsoil. In addition, the old clay dike was often cut and used as the cover layer for the modern dike. As a result, vertical and horizontal barriers of impermeable clay layers form an internal basin inside the dike. In this basin, water is stored from the construction process but also from inflow through the cover layer or coming out of the ground caused by high water levels. With progressing time more and more impounded water can be held in the hydraulic sense closed sand core, which leads to geotechnical problems with regard to structural stability and safety.

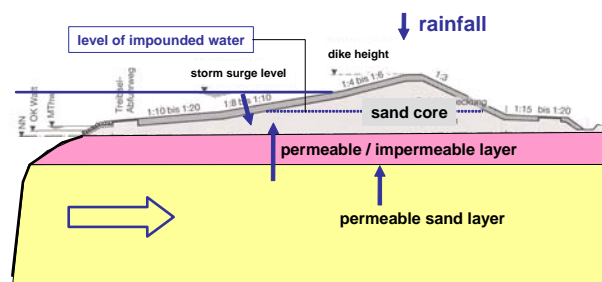


Figure 2 - Schematic cross section of a dike with sand core and permeable/impermeable soil layers

Indications, that impounded water is inside the dike core can be the leaking of water at the landward or seaward side of the dike. Several examples of dikes with impounded water are documented by Temmler (2004). The levels of impounded water were measured significantly higher than the mean tidal high water level, while a level slightly above mean water should be the normal case caused by the hydraulic connection to the estuary. There are a number of different possibilities to deal with impounded water like drainage systems. As a recommendation, it is important to investigate the detailed site conditions including the soil characteristics. It is also possible that the described effects can vary along the dike at very short distances. An expert group of the German Committee of Coastal Structures, including two of the mentioned authors, is actually working on this topic. The investigations will be completed and results will be available in the next months.

RESULTS

Hydraulic and geotechnical investigations on impounded water in dikes with a sand core will be presented. The importance of impounded waters is described. General hydraulic processes will be described according to soil and hydraulic conditions and other boundary conditions. The resulting geotechnical consequences are derived and recommendations are given for the improvement of the coastal defence structure. Therefore this topic has an international importance.

REFERENCES

- EAK (2002) Empfehlungen für die Ausführung von Küstenschutzwerken. Die Küste, Heft 65, Editor: Kuratorium für Forschung im Küsteningenieurwesen (Coastal Engineering Research Council), Westholsteinische Verlagsanstalt Boyens & Co.
- Temmler (2004) Über Grundwasserstandsbeobachtungen in Deichen. Die Hansa, 141. Jahrgang, Heft Nr. 8.