Seadikes in Germany

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INTRODUCTION

Seadikes (Fig. 1) and estuarine dikes represent the main coastal defence structure in Germany and protect low lying areas in Lower Saxony, Schleswig-Holstein, Bremen, Hamburg and Mecklenburg-Vorpommern. More than 2,400,000 people and an area of more than 12,000 km^2 are protected by more than 1,200 km of sea dikes and estuarine dikes in Germany (Tab. 1). The protected economic values are high. In Hamburg, the protected value by estuarine dikes is more than 10 Billions of Euro, in Schleswig-Holstein more than 48 Billions of Euro (Schüttrumpf, 2008).

Tab.1: Overview of dike lengths, protected areas and population in German federal states (Schüttrumpf, 2008)

Federal state	Length of Dikes (primary defence line)	Protected area	Protected population
Lower Saxony (incl. islands)	645 km	6,600 km^2	1,200,000
Schleswig-Holstein	527 km	3,866 km^2	354,000
Bremen	74 km	360 km^2	570,000
Hamburg	78 km	270 km^2	325,000
Mecklenburg-Vorpommern	45 km	1020 km^2	90,000

Seadikes have a very long history in Germany. A first citation of seadikes can be traced back to the year 10 AD(Garbrecht, 1985). Anyway, the construction and maintenance of seadikes was firstly organised and managed from around 1150 as a joint agreement between landlords. The history of seadike design in the mediaeval times was mainly influenced by severe storm surges and the reconstruction after frequent dike failures. The consequences of extreme storm surge disasters and dike failures can still be observed at many locations along the German coast. The islands along the north-frisian coast result from storm surge disasters in 1362 and 1634. Furthermore, many lakes behind the present dikes have been developed due to the scouring process of a breaching dike. Therefore, the crest levels in former centuries correlate well with the maximum storm surge levels in that times. The memory of the severe storm surges in the past and the consequences is still fresh and not forgotten. As a result of this historical development, the local population has a special attitude towards the safety of seadikes and the importance of coastal flood defences and coastal protection is well accepted. Nowadays, maintenance and construction of seadikes are performed by the German Federal States Lower Saxony, Schleswig-Holstein, Free Hanseatic City of Bremen, Free and Hanseatic City of Hamburg and Mecklenburg-Vorpommern. Each state has a master plan for coastal flood defence and coastal protection to prioritize and to indicate dike reinforcement tasks for the future.

Fig. 1: Modern Seadike in Germany (photo: Schüttrumpf)

ORGANISATION OF STORM SURGE PROTECTION

Storm surge protection is organized on province level (Federal States) in Germany.

Each province is responsible to set-up a dike law, a coastal management master plan and design guidelines. In practice, this results in small differences in coastal protection strategies, organizational structures, design philosophies and design water levels.
Different coastal protection strategies are required due to differences in morphology, wave climate, land use and landscape.
The organisational structure depends on the length of the protected coastline and administrative purposes. In general, a ministry is responsible for supervision and financial support. Water boards are responsible for technical aspects, design and construction of coastal structures on second level. Finally, a dike board is responsible for monitoring, repair and maintenance of dikes on third level.
Anyway, provinces in Germany cooperate closely and border crossing dikes are planned, designed and constructed on a common understanding. Thus, no steps in crest levels exist at the border between two provinces.
Coastal protection is regarded as federal task in Germany and 70% of the construction costs for new coastal dikes or other coastal structures are covered by the Federal Government and 30% by the provinces. This means, that provinces without a coastline pay indirectly for coastal protection.

DESIGN OF SEADIKES

Different design philosophies are practised in the German federal states (Fig. 2). Lower Saxony and Bremen have adopted the a-b-c-d method for seadikes. The design water level is calculated based on the mean tidal water level (a), the difference between the highest spring tide water level and mean water level MHW (b), the difference between the highest water level (HWL) and MHW (c) and the sea level rise (d). This water level is compared to a water level based on the reference method. The water level based on the reference method is the highest ever observed water level plus a safety margin. The maximum of both methods is used as the design water level for seadikes in Lower Saxony and Bremen. This method is not applicable for estuarine dikes in Lower Saxony as well as in Bremen and Hamburg due to the influence of the river discharge (Weser and Elbe). Finally, a wave run-up height is added to the design water level for seadikes and estuarine dikes.

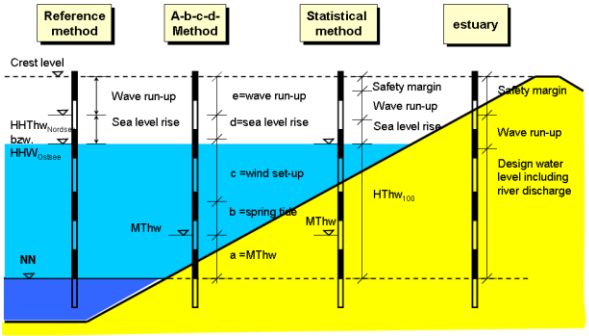

Fig. 2: Methods to calculate the design water level in Germany

Different methods are also applied along the west coast of Schleswig-Holstein to determine the design water level. The design water level should fulfil three conditions. The design water level should have (a) an occurrence probability of 1 in 200 years with respect to the year 2100 (statistical method), (b) not be lower than the ever observed highest water level (reference method) and (c) not be lower than a water level calculated from the a-b-c-d-method. In general, the statistical method gives the highest value for the west coast of Schleswig-Holstein.
Cross sections of typical dikes in Germany without and with foreland are given in Fig. 3.

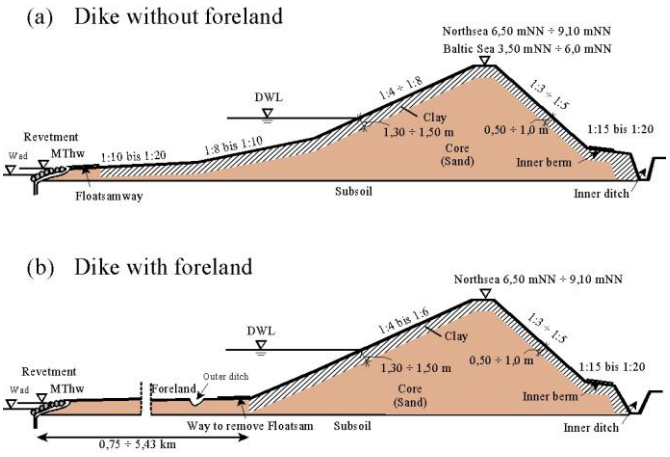

Fig. 3: Typical seadike profiles in Germany

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