



1. Preface

Because space is at a premium, it is planned to erect a permanent flood protection wall along a length of approximately 500 m. It is necessary to design the cut-off wall against piping.

2. The system

The system is shown in Figure 1. The water behind the flood protection wall is ponded to 50.80 m AD. On the air side, at 47.80 m AD, ground level is 3.0 m below the highest water level.

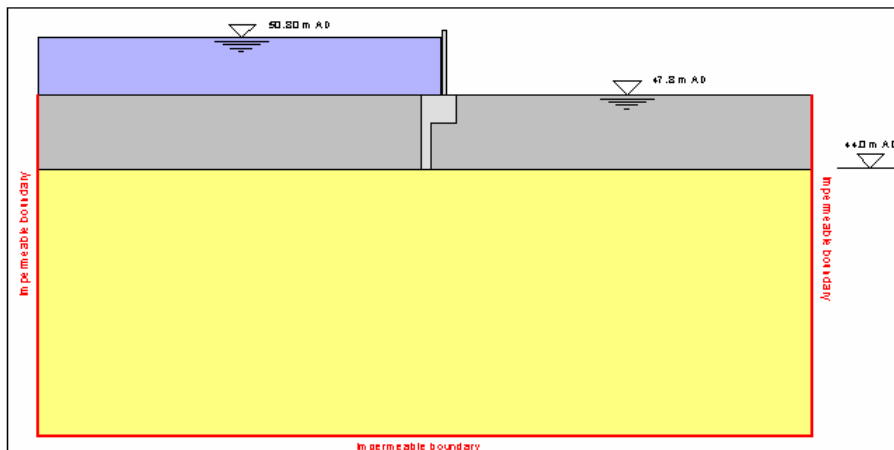


Figure 1

The ground consists of a two-layer system. Silty sands occur down to 3,8 m below ground level. Below this follow gravels. The permeabilities of the two layers are:

- Silty sands: $k = 1.5 \cdot 10^{-5} \text{ m/s}$
- Gravels: $k = 1.0 \cdot 10^{-3} \text{ m/s}$

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3. Subsurface hydraulics analysis

Analysis of subsurface hydraulics is based on the finite-element method using the GGU-SS-FLOW2D program. The basic version of the system used for investigations (Figure 2) assumes the left, right and lower model boundaries to be impermeable. The implementation of the system as a finite-element mesh is shown in Figure 2. The mesh consists of 9116 triangles with 4716 nodes.

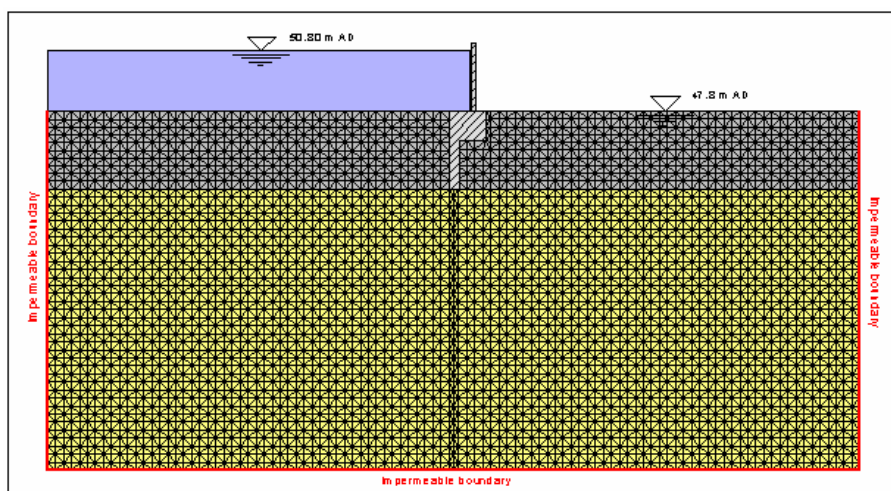


Figure 2

The lines of equal potential can be seen in Figure 3.1. As expected, it is shown that pressure dissipation principally takes place in the silty sand layer.

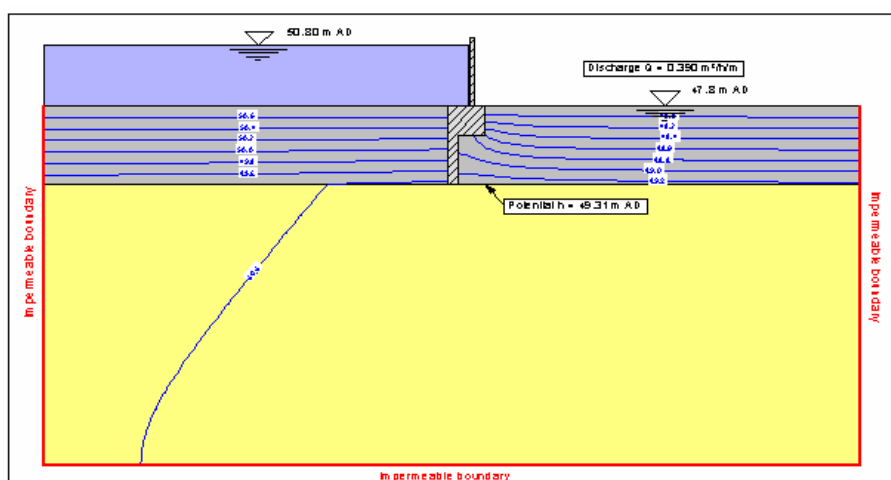


Figure 3.1

For determination of buoyancy safety in the silty sand layer, the potential at the most unfavourable point was determined as 49.31 m AD. The buoyancy safety of the system can thus be analysed using the GGU-UPLIFT program.

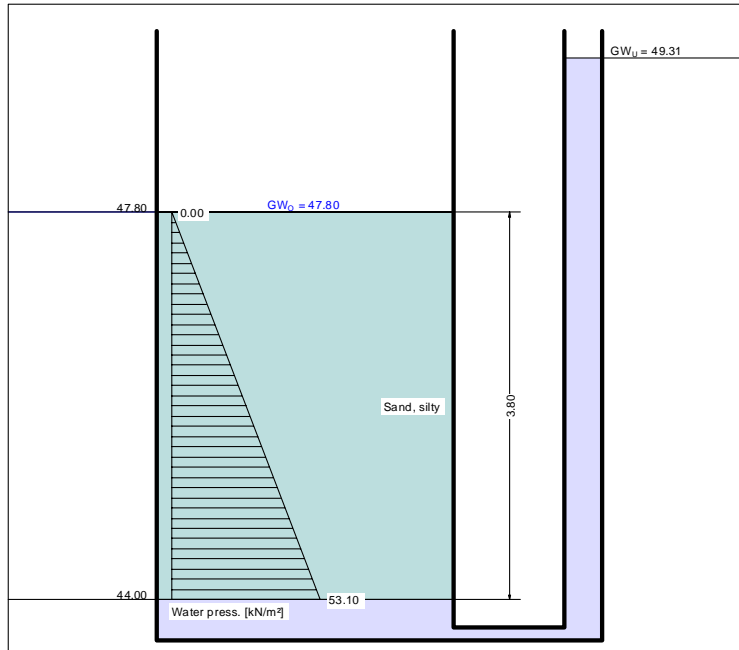


Figure 3.2

It can be seen from Figure 3.2 that the buoyancy safety, at $\eta = 1.36$, is substantially above the minimum value of 1.10 demanded by DIN 1054; it is therefore sufficiently safe. The discharge on the air side is $0.390 \text{ m}^3/\text{h}/\text{m}$.

In Annexes 4 to 6, modifications to the basic system have been made.

- **Annex 4**

Weak spot on the water side

In this variant, a 2 m wide weak spot is assumed on the water side.

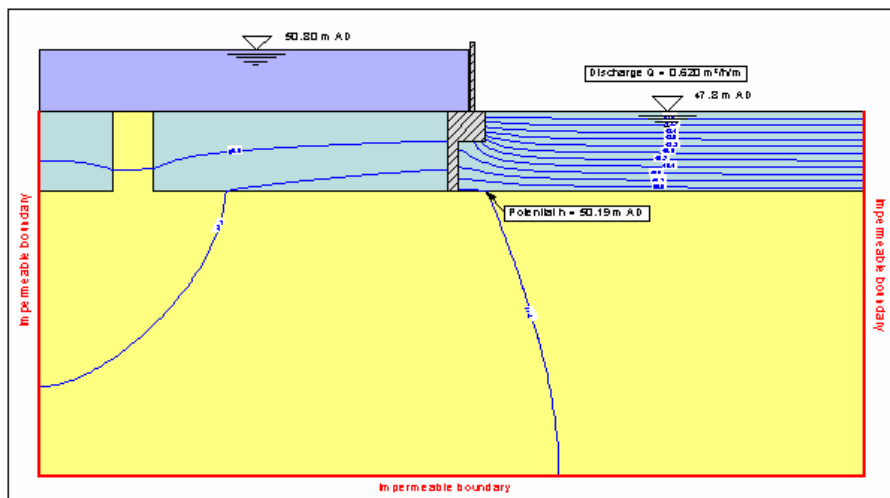


Figure 4.1



- **Annex 5**

Cover layer missing on the water side

In this variant, an existing silty sand layer was completely removed from the water side.

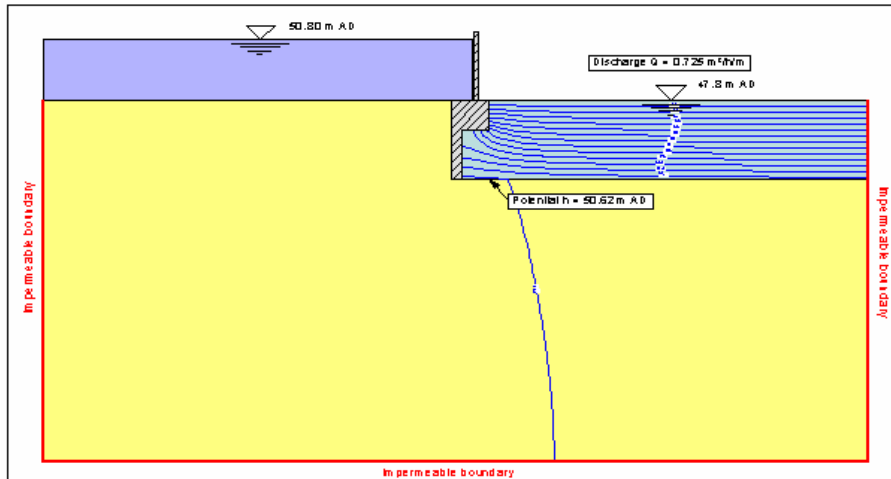


Figure 5.1

- **Annex 6**

Without weak spot, left boundary permeable

In this variant, the left model boundary is permeable.

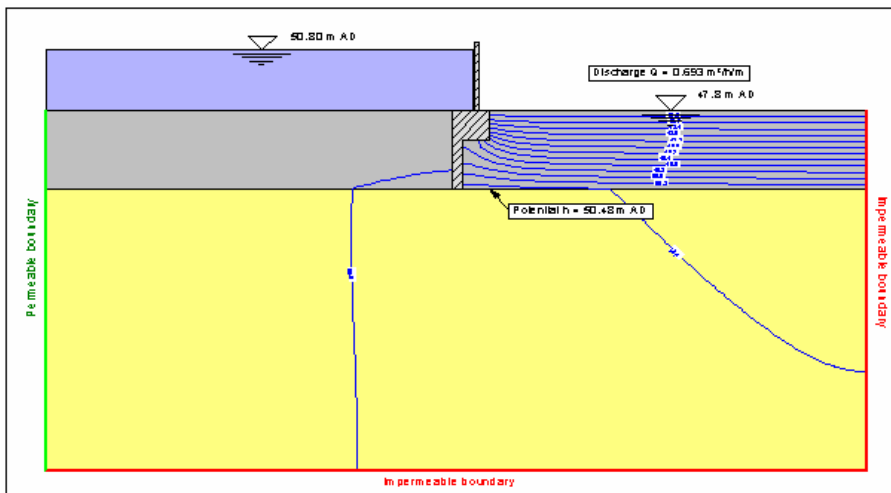


Figure 6.1

The results of all analyses are summarised in the following table.

	Potential at base of silty sand layer [m AD]	Buoyancy safety	Discharge air side [m³/h/m]
Annex 3	49.31	1.36	0.390
Annex 4	50.19	1.17	0.620
Annex 5	50.62	1.09	0.725
Annex 6	50.48	1.11	0.693



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Only in one case (system shown in Figure 5.1) is the required buoyancy safety slightly (less than 1 %) violated, which can be accepted here. In this variant, the discharge is also the greatest at $0.725 \text{ m}^3/\text{h}/\text{m}$.