The set-up is particularly high (up to 0.5 times the wave height), if only reverse drainage (outflow) is possible, back towards the sea. This may be because $L_{ph} << B$ or because the lee side of the rockfill structure is hydraulically closed, eg when a sand backfill behind a breakwater or seawall (see Figure 5.153).

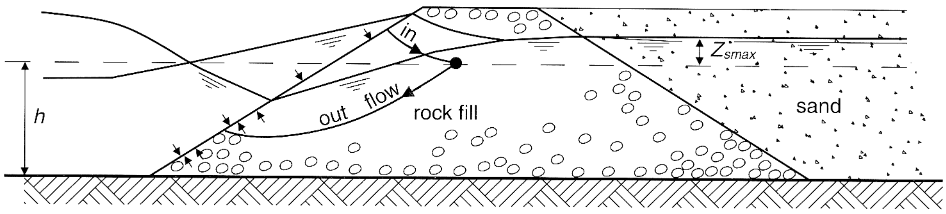

Figure 5.153 *Internal phreatic set-up due to backfill*

Box 5.39 *Typical examples of internal phreatic set-up*

> Two examples of internal set-up are given:
>
> **1. Rockfill dike (coarse armourstone) around a lake or harbour basin**
>
> Cross-sectional and structural data are: $\tan\alpha$ = 1:3, B = 30 m, h = 10 m, n_v = 0.4 and k = 0.1 m/s. The loading by (short) wind waves is characterised by H_s = 4 m and T = 4.5 s.
>
> Using these data in the Equations 5.296 and 5.297 gives: T_{ph} = 1100 s, L_{ph} = 1.9 m and consequently, B/L_{ph} = 16, $F(B/L_{ph})$ = 0.75 and b = 0.19 (Figure 5.152). Further, substituting c = 1 in Equation 5.300 gives: δ_w = 0.63, finally resulting in: $z_{s,max}$ = 2 m (by applying Equation 5.299), occurring at an approximate distance of 6 m from the waterfront.
>
> **2. The same dike and loading as under 1 above, but with a backfill of sand**
>
> In this case: T_{ph} = 1100 s, L_{ph} = 1.9 m, $F(B/L_{ph})$ = 1 (Figure 5.152) and δ_w = 0.63. Consequently, $z_{s,max}$ = 2.7 m, occurring approximately at the boundary with the backfill.

Pore pressures dominated by elastic storage

In this section, attention is given to the effects of the elastic compressibility of both the pore fluid and the skeleton. Varying pore pressures cause some variations of the volume of the pore fluid. This variation is very small if the pore fluid is pure water without any air in it, because water is practically incompressible. However, in the region of varying water level, the pore water does contain air and the resulting compressibility may be large enough to contribute to a sequential flow of water in and out the soil mass, according to the following mechanism:

- varying effective stresses, σ', result in variation of the pore volume caused by compression of the skeleton, which in turn forces pore water to flow in and out of the soil (or rockfill) mass. This flow in and out because of compression of air-containing pore water and/or grain skeleton is called *consolidation*.

When the rate of pressure changes along the external boundary becomes so quick that consolidation in the soil cannot take place completely, then elastic storage plays a role. It means that the change of pore pressure and/or effective stress is retarded by the fact that the required outflow of pore water is not possible. The soil (water/air) system has too long a permeability (low k-value of soil) and/or possesses too low a stiffness; the modulus of compression of the water/air, K_{wa} (= $\Delta p/(\Delta V/V)$ and the m_{ve}-value of the soil, being the elastic coefficient of volume change) in relation to the rate of boundary pressure changes (for definitions and descriptions, see Section 5.4.4.4).