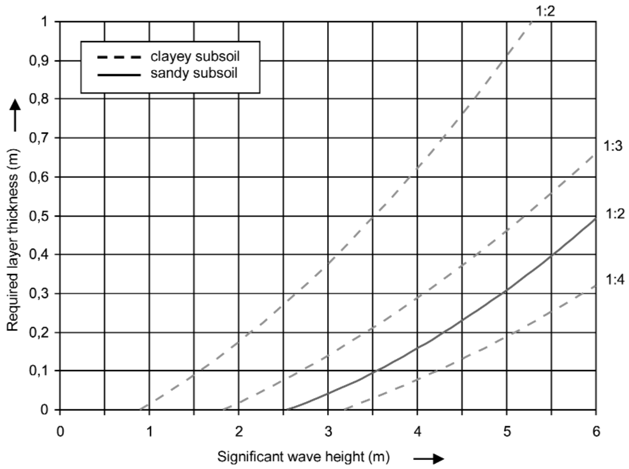
stone to the asphalt grout. If a smaller grading of stone is used (50/150 mm or 80/200 mm), for example as a new layer over an existing revetment, asphalt mastic must be used as the penetration grout instead of asphalt grout, as this is more viscous and will penetrate the voids more easily (see also Section 3.15).

If fully penetrated revetments are applied in the tidal zone, the revetment needs to be designed for water pressure. For more information on this, reference is made to the *Technical report on the use of asphalt in water defences* (TAW, 2002a).



Note

The minimum layer thickness is 1.5 D_{n50} (see page 617)

Figure 5.68 *Layer thickness for fully penetrated rock revetments*

For pattern penetrated rock revetments or armourstone cover layers (for example following a pattern of dots or strips) the same design method as for loose armourstone is used and the layer thickness is determined by the size of the armourstone. However, a reduction factor can be applied depending on the degree of penetration, based on Equation 5.183. If the voids are filled up to approximately 60 per cent a value for the upgrading factor ϕ_u = 1.5 can be used. With a narrow grading, and if monitored carefully during construction, this value can be increased up to ϕ_u = 2.0. For the stability parameter the value ϕ_{sw} = 2.25 can be used, however depending on the number of waves and the safety factor required this value may need to be modified. The parameter b in Equation 5.183 depends on the interaction between the waves and the revetment. For revetments with pattern penetration the value b = 0.5 is recommended, for surface penetration b = 2/3 is a typical value. With pattern penetrated rock revetments (or armourstone cover layer) good results have been obtained for values of the significant wave height up to 3 to 4 m. More information about penetrated rock revetments can be found in TAW, 2002a.

5.2.2.8 *Stepped and composite slopes*

The stability formulae as described in Section 5.2.2.2 are applicable to straight slopes. Sometimes structures are a combination of slopes (composite slopes) and/or have a horizontal berm below the water level (stepped slopes). Design curves are given in this section for three types of structures. Stepped slopes were investigated by Vermeer (1986) and composite slopes by Van der Meer (1990a). The results are shown in Figures 5.69–5.71. The reference for stepped or composite slopes is always the stability of a straight slope, described in Section 5.2.2.2. The stability of the stepped or composite slope is then described by an increase in stability relative to a similar, but straight rock-armoured layer with the same slope angle. This increase in stability, described with a factor f_i, has a value f_i = 1.0, if the stepped or composite slope has the same stability as a straight slope. The factor has a value f_i > 1.0, as the step or transition of the slope has a positive effect on the stability. The curves in Figures 5.69–5.71 are given for start of damage, S_d = 2-3.