$2 \leq \phi_u < 2.5$, the accepted associated level of loading of the individual stones is roughly twice that at incipient motion.

The two requirements are summarised as follows:

1 **Static stability of the unit** of thickness D'.

2 **Dynamic stability of stones** of charactertistic size D_{n50} inside the basket.

For preliminary design purposes these requirements can be assessed with Equations 5.184 and 5.185 (Pilarczyk, 1998). These equations are adapted from Equation 5.183 and are considered valid for $H_s \leq 1.5$ m (or $H_s \leq 2$ m for less frequent waves).

1 **Static stability of the units** with a thickness, D': Check static stability (stability number $H_s/(\Delta' D') = 1$ to 4) with Equation 5.184, using $F = \phi_u \phi_{sw} \leq 7$, the relative buoyant density of a unit, $\Delta' \cong 1$ (-), and $D' \geq 1.8 D_{n50}$ (m):

$$\frac{H_s}{\Delta' D'} = \phi_u \phi_{sw} \frac{\cos\alpha}{\xi_p^{2/3}} \tag{5.184}$$

2 **Dynamic stability of stones** of charactertistic size, D_{n50}: Check dynamic stability inside the basket with Equation 5.185, using for the stability factor, $F = \phi_u \phi_{sw} \leq 5$ (-) and with Δ equal to the relative buoyant density of the armourstone, usually $\Delta \cong 1.65$ (-):

$$\frac{H_s}{\Delta D_{n50}} = F \frac{1}{\xi_p^{1/2}} \tag{5.185}$$

In all situations the stone size must be larger than the size of the wire mesh in the basket; this defines the minimum size.

In multi-layer gabions or mattresses (more than two layers) it is preferable to use a finer stone below the armour layers (ie up to $0.2 D_{n50}$) to create a better filter function and to diminish the hydraulic gradients at the surface of the underlying subsoil (Section 5.2.2.10 and Section 5.4.5.3). In either case it is important that both the subsoil and the stone filling inside the gabion basket or mattress are adequately compacted. For design conditions with $H_s > 1$ m, a fine granular sub-layer (about 0.2 m thick) should be provided between the gabion basket or mattress and the subsoil. For other conditions it is sufficient to place the mattress directly onto the geotextile and compacted subsoil. For practical reasons, the minimum thickness of mattresses is about 0.15 m.

Bound or grouted stone

Fully penetrated rock revetments need to be designed for wave impacts. The graph shown in Figure 5.68 can be used to design the required layer thickness. This design graph has been compiled for hydraulic and climate conditions as found in the Netherlands and presents the required layer thickness for different slope angles and types of core material (sand and clay) as a function of the significant wave height, H_s.

The minimum layer thickness needed in the wave impact zone is also determined by the stone diameter, D_{n50}. To obtain a well penetrated revetment, the thickness needs to be more than $1.5 D_{n50}$. For a fully penetrated rock revetment, the stone grading 5–40 kg is usually suitable although, if required, a stone grading of 10–60 kg can be used. Based on an apparent rock mass density of $\rho_r = 2650$ kg/m^3, this leads to a layer thickness of 0.30 m for the grading 5–40 kg and 0.35 m for the grading 10–60 kg.

When stone gradings larger than 10–60 kg are used, the voids between the stones will be too big which will result in the asphalt grout flowing away through the revetment. This can be limited by using a less viscous mixture or by adding a coarser grading of gravel or crushed