NOTE: The given conversion factors to transform H_s to $H_{2\%}$ and to transform T_m to $T_{m-1,0}$ (see notes to Figure 5.42) are only valid for deep water and standard wave energy spectra. When applying Equations 5.139 and 5.140, the locally determined values of $H_{2\%}$ and $T_{m-1,0}$ should be used; a numerical wave propagation model, like SWAN or Boussinesq-type wave models (see Section 4.2.4.10) may be used for this purpose.

Table 5.26 shows the range of validity of the various parameters used in Equations 5.139 and 5.140.

Table 5.26 *Range of validity of parameters in Van der Meer formulae for shallow water conditions*

Parameter	Symbol	Range
Slope angle	$\tan \alpha$	1:4–1:2
Number of waves	N	< 3000
Fictitious wave steepness based on T_m	s_{om}	0.01–0.06
Surf similarity parameter using T_m	ξ_m	1–5
Surf similarity parameter using $T_{m-1,0}$	$\xi_{s-1,0}$	1.3–6.5
Wave height ratio	$H_{2\%}/H_s$	1.2–1.4
Deep-water wave height over water depth at toe	H_{so}/h	0.25–1.5
Armourstone gradation	D_{n85}/D_{n15}	1.4–2.0
Core material – armour ratio	$D_{n50\text{-}core}/D_{n50}$	0–0.3
Stability number	$H_s/(\Delta D_{n50})$	0.5–4.5
Damage level parameter	S_d	< 30

Note

For further details on the field of application in terms of water depths, see overview in Tables 5.28 and 5.29.

To illustrate the use of the Van der Meer formulae for shallow water, an example is worked out in Box 5.15. To show the typical differences between deep- and shallow-water conditions the example situation as given in Box 5.13 has been taken as starting point.

Box 5.15 *Design methodology for Van der Meer formulae for very shallow water conditions*

To design armourstone for the example situation as given in Box 5.13, but now in water of limited depth, the procedure is as follows:

- define design wave conditions at the toe of the structure;
  with a numerical wave propagation model the value(s) of $T_{m-1,0}$ and with the Battjes and Groenendijk method (see Section 4.2.4.4) the values of $H_{2\%}$ at the toe of the structure are determined based on the deep water design condition(s).
- follow in general the procedure as described in Box 5.13, but read Equation 5.139 for 5.136 and Equation 5.140 for 5.137; further, the surf similarity parameter, $\xi_{s-1,0}$, is to be used instead of ξ_m.

Example

The water depth at the toe of the structure is given as: h = 8 m. Using a spectral wave propagation model (in this case starting with the deep water values H_{so} = 5 m and T_m = 10 s from the example in Box 5.13) with given bathymetry, this may lead to the following nearshore data: H_s = 4 m; T_m = 9.5 s and $T_{m-1,0}$ = 11.5 s. This gives: $\xi_{s-1,0}$ = 2.39. The method of Battjes and Groenendijk leads to a value of $H_{2\%}$ = 4.95 m. The values of the other parameters are: P = 0.4, $\tan\alpha$ = 0.33, Δ = 1.6 and S_d = 2.

Application of the deep-water formula (Equation 5.136), using T_m, will lead in this situation (a 6 h storm, ie $N = 6 \times 3600/9.5 = 2273$) to: D_{n50} = 1.27 m and M_{50} = 5.4 tonnes.

Using the shallow water formula (Equation 5.139), with again $N = 6 \times 3600/9.5 = 2273$, leads to: $H_s/(\Delta D_{n50})$ = 1.7, which results in a armourstone size of: D_{n50} = 1.4 m and a median mass of : M_{50} = 7.2 tonnes.

Conclusion: The stability of rock-armoured slopes in **very** shallow water conditions requires special attention; in this example the minimum mass of the armourstone is 30 per cent larger than expected based on the deep-water formula.

NOTE: In this example the computed values of H_s = 4 m and $T_{m-1,0}$ = 11.5 s are rather extreme values. For most coastal profiles a numerical computation of the wave conditions at h = 8 m will lead to somewhat lower values.