From Soulsby's book

1 Total Shear Stress

Total shear stress induced by wave and currents can be calculated by (p92, (69))

$$\tau_m = \tau_c \left[1 + 1.2 \left(\frac{\tau_w}{\tau_c + \tau_w} \right)^{3.2} \right] \tag{1}$$

where τ_c and τ_w represent current and wave-induced shear stresses, respectively.

2 Calculating τ_c and τ_w

2.1 τ_c

For current-induced shear stress (p53, (30))

$$\tau_c = \rho C_D \bar{U}^2 \tag{2}$$

where $\bar{U}$ is depth-averaged velocity, and C_D has two forms (p48):

$$C_D = \alpha \left(\frac{z_0}{h} \right)^{\beta} \tag{3}$$

and

$$C_D = \left[\frac{0.40}{1 + \ln(z_0/h)} \right] \tag{4}$$

The latter one may be popular one used in sediment transport formulas.

2.2 τ_w

In p76, (57):

$$\tau_w = \frac{1}{2} \rho f_w U_w^2 \tag{5}$$

where U_w is wave orbital velocity amplitude.

There are several formulas which can be used to calculate f_w Soulsby, p78, (62):

$$f_w = 1.39 \left(\frac{A}{z_0} \right)^{-0.52} \tag{6}$$

and Swart (1974) which is used for example

$$f_{wr} = 0.3 \quad \text{for} r < 1.57 \tag{7}$$

$$f_{wr} = 0.00251 \exp(5.21 r^{-0.19}) \quad \text{for} r > 1.57 \tag{8}$$

where $r = A/k_s$, in which A is semi-orbital excursion ($U_w T/2\pi$) and $k_s = 30z_0$, Nikuradse equivalent sand grain roughness

$$k_s = 30z_0 \tag{9}$$

3 calculating roughness length z_0

z_0 is total roughness length

$$z_0 = z_{0s} + z_{0f} + z_{0t} \tag{10}$$

in which z_{0s}, z_{0f} and z_{0t} are roughness length corresponding to skin friction, form drag, and sediment transport (mobilization). p48, (25)

$$z_{0s} = d_{50}/12 \tag{11}$$

For both wave/current generated ripples (p123, (90))

$$z_{0f} = a_r \frac{\Delta_r^2}{\lambda_r} \tag{12}$$

where Δ_r and λ_r are ripple height and length, respectively. For current-only case, in p59, (42)

$$z_{0t} = \frac{5\tau_{0s}}{30g(\rho_s - \rho)} \tag{13}$$

where τ_{0s} is skin-friction shear stress.

For wave generated ripples Nielsen's formula may be used (p124, (92)),

$$z_{0t} = 5.67(\theta_{ws} - 0.05)^{0.5} d_{50} \tag{14}$$

where θ_{ws} is skin-friction Shields parameter. When using Nielsen's formula, ripple height and length have to be evaluated using p122 (89) and $a_r = 0.269$.