Solution – Design Example V7a – EC6 Double Curvature Strut model

Slenderness ratio:

Effective thickness of inner leaf, t_{ef} = $t_{ef} = \sqrt[3]{t_1^3 + t_2^3}$

= $t_{ef} = \sqrt[3]{(100^3 + 100^3)}$ = 126 mm

Effective height = 1,0 x 2500 = 2500 mm with $\rho_n = 1,0$

$\frac{h_{ef}}{t_{ef}} = \frac{2500}{126} = 19,84$

Eccentricity of wall head roof loading = t/6

Hence eccentricity of design vertical load, $e_i = (M_{id} / N_{id}) + e_{he} \pm e_{init} \geq 0,05t$

Therefore e_i = 16,67 + 0 + 5,56 = 22,23 mm (i.e. 0,222t)

where M_{id}/N_{id} = *16,67 mm*

e_{he} = *0 (horizontal loads effect)*

$e_{init} = h_{ef}/450$ = *(2500 x 1,00) / 450 = 5,56 mm*

e_i is 0,222 t at top and bottom of the wall for EC6 strut in double curvature

Therefore $\phi_i = 1 - 2(e_i / t) = 1 - 2(0,222t / t) = 0,56$

And eccentricity of design vertical load, $e_m = (M_{md} / N_{md}) + e_{hm} \pm e_{init} \geq 0,05t$

Therefore $e_{mk} = e_m + e_k$ = 0 + 0 + 5,56 = 5,56 mm (i.e 0,056t)

where M_{md}/N_{md} = *0 (point of contraflexure of double curvature strut)*

e_{hm} = *0 (horizontal loads effect)*

$e_{init} = h_{ef}/450$ = *(2500 x 1,0) / 450 = 5,56 mm*

e_k = *0 (creep effect)*

e_{mk} is 0,056t at mid-height of the wall for EC6 strut in double curvature

Hence for $E = 1000f_k$ Part 1.1 Annex G equations or Figure G1 gives:

Φ_m = 0,62   Therefore 0,56 governs design

$f_k = K f_b^{\alpha} f_m^{\beta}$ = $0{,}55 \times 4{,}0^{0{,}7} \times 4{,}0^{0{,}3}$ = 2,20 N/mm^2

Design resistance per unit length $N_{Rd} = \Phi_{min}\, t\, f_d$

Where design strength, $f_d = \dfrac{f_k}{\gamma_m}$ and γ_m = 2,7 from UK National Annex

N_{Rd} = 0,56 x 100 x 2,20 / 2,7 = 45,6 kN/m run

Wall will carry a design vertical load of 45,6 kN/m run under the conditions given using the EC6 double curvature strut model

Solution – Design Example V7b – BS 5628 Part 1 Strut model

Slenderness ratio:

$\frac{h_{ef}}{t_{ef}} = \frac{2500}{126} = 19,84$ as V7a

Eccentricity of wallhead floor loading = t/6

Hence eccentricity of design vertical load, $e_i = (M_{id} / N_{id}) + e_{he} \pm e_{init} \geq 0,05t$

Therefore $e_i = 16,67 + 0 + 5,56 = 22,23$ mm (i.e. 0,222t)

where $M_{id}/N_{id} = 16,67$ *mm*

$e_{he} = 0$ *(horizontal loads effect)*

$e_{init} = h_{ef}/450 = (2500 \times 1,00) / 450 = 5,56$ *mm*

e_i is 0,222 t at top of the wall for BS 5628 strut model using EC6 Part 1.1

Therefore $\phi_i = 1 - 2(e_i / t) = 1 - 2(0,222t / t) = 0,56$ as 7a

Using BS 5628 strut model mid-height eccentricity, $e_{mk} = e_m + e_k$

$= 0,6e_i + e_{hm} \pm e_{init} + e_k$

Therefore $e_{mk} = (0,6 \times 16,67 \text{ mm}) + 0 + 5,56 + 0 \text{ mm} = 15,56$ mm (i.e 0,156t)

where $e_{hm} = 0$ *(horizontal loads effect)*

$e_{init} = h_{ef}/450 = (2500 \times 1,0) / 450 = 5,56$ *mm*

$e_k = 0$ *(creep effect)*

e_{mk} is 0,156t at mid-height of the wall for BS 5628 strut model

Hence for $E = 1000f_k$ Part 1.1 Annex G equations or Figure G1 gives:

$\Phi_m = 0,40$ governs design

$f_k = Kf_b^{\alpha}f_m^{\beta} = 0,55 \times 4,0^{0,7} \times 4,0^{0,3} = 2,20$ N/mm^2

Design resistance per unit length $N_{Rd} = \Phi_{min}\, t\, f_d$

Where design strength, $f_d = \frac{f_k}{\gamma_m}$ and γ_m = 2,7 from UK National Annex

N_{Rd} = 0,40 x 100 x 2,20 / 2,7 = 32,9 kN/m run

Wall will carry a design vertical load of 32,9 kN/m run under the conditions given using EC6 Part 1.1 but with the BS 5628 Part 1 strut model applied

Comment: It can be seen that the double curvature strut model as used in EC6 Part 1.1 gives more favourable vertical design load capacities than using a BS 5628 Part 1 strut model with the resultant load concentric at the base of the loaded wall. For walls with significant rotational top restraint, such as those supporting heavy concrete floors or roofs, the model appears reliable. For single storey walls with light timber floors or roofs or where rotational restraint from floors and roofs is not so substantive the designer may wish to consider the modified BS 5628 strut model in determining vertical design load capacity.