STAIRCASE DESIGN REPORT

Element: Staircase Design 001

Design Code: BS EN 1992-1-1:2004 | Date: 28 October 2026

REFERENCE	CALCULATIONS	OUTPUT
§5.1.3 Geometry & Loads	**STAIRCASE GEOMETRY** Waist thickness h = 150.0 mm Riser R = 160.0 mm Tread G = 280.0 mm Effective span L_{eff} = 3000.0 mm M_{Ed} = 20.0 kNm/m V_{Ed} = 28.6 kN/m **Suitability of dimensions** G + 2R = 280.0 + 2×160.0 = 600 mm Condition: 550 ≤ G+2R ≤ 700 → OK	**M_{Ed} = 20.0 kNm/m** **V_{Ed} = 28.6 kN/m** **Status: OK**
§6.1 Flexural Design	**REINFORCEMENT DESIGN** Concrete cover = 25.0 mm Main bar diameter φ = 12.0 mm $d = h - C_c - \frac{\phi}{2} = 150.0 - 25.0 - \frac{12.0}{2} = 119.0mm$ **Moment capacity check** Allow 20% moment redistribution → δ = 0.8 $k_{bal} = \frac{0.454(\delta - 0.44)}{1.25} - \frac{0.182(\delta - 0.44)^2}{1.25^2} = 0.116$ $k = \frac{M_{Ed}}{bd^2 f_{ck}} = \frac{20.0 \times 10^6}{1000 \times 119.0^2 \times 25.0} = 0.0565$ Since k = 0.0565 ≤ k_{bal} = 0.116 → OK	**d = 119.0 mm** **k = 0.0565** **Status: OK**
	Lever arm $\frac{z}{d} = 0.5 + \sqrt{0.25 - \frac{k}{1.134}} = 0.947$ $z = 0.947 \times 119.0 = 112.7mm$ $z_{lim} = 0.95d = 113.0mm$ z = min(z, z_{lim}) = 112.7 mm	**z = 112.7 mm**
	Reinforcement area $A_{s,req} = \frac{M_{Ed}}{0.87 f_{yk} z} = \frac{20.0 \times 10^6}{0.87 \times 500.0 \times 112.7} = 408.0mm^2/m$ $f_{ctm} = 0.3\ f_{ck}^{2/3} = 0.3 \times 25.0^{2/3} = 2.56$ N/mm² $A_{s,min,req} = 0.26\ f_{ctm}/f_{yk} \cdot b \cdot d = 0.26 \times 2.56/500.0 \times 1000 \times 119.0 = 159.0$ mm²/m 0.0013 b d = 0.0013×1000×119.0 = 155.0 mm²/m $A_{s,min}$ = max(159.0, 155.0) = 159.0 mm²/m $A_{s,req}$ = max($A_{s,req}$, $A_{s,min}$) = max(408.0, 159.0) = 408.0 mm²/m	**$A_{s,req}$ = 408.0 mm²/m**
	Provided reinforcement Spacing S = 200.0 mm $A_{s,prov} = \frac{\pi \times (\phi/2)^2 \times 1000}{S} = \frac{\pi \times (12.0/2)^2 \times 1000}{200.0} = 565.0mm^2/m$ Provided: H12.0 @ 200.0 mm c/c (B1) Check: OK (565.0 ≥ 408.0)	**$A_{s,prov}$ = 565.0 mm²/m** **Status: OK**

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§7.3.3 Crack Control	**MAXIMUM BAR SPACING** **SERVICEABILITY LIMIT STATE (SLS): CRACK WIDTH / SPACING VERIFICATION**	**f_s = 223.56 N/mm²** **S_{max} = 221.0 mm** **S_{prov} = 200.0 mm** **Status: OK**

Table 7.2N Maximum bar diameters ϕ^*_s for crack control[1]

Steel stress[2] [MPa]	Maximum bar size [mm] w_k= 0,4 mm	w_k= 0,3 mm	w_k= 0,2 mm
160	40	32	25
200	32	25	16
240	20	16	12
280	16	12	8
320	12	10	6
360	10	8	5
400	8	6	4
450	6	5	-

Table 7.3N Maximum bar spacing for crack control[1]

Steel stress[2] [MPa]	Maximum bar spacing [mm] w_k=0,4 mm	w_k=0,3 mm	w_k=0,2 mm
160	300	300	200
200	300	250	150
240	250	200	100
280	200	150	50
320	150	100	-
360	100	50	-

Steel stress under service load

$$f_s = 310 \times \frac{500}{f_{yk}} \times \frac{A_{s,req}}{A_{s,prov}} = 310 \times \frac{500}{500.0} \times \frac{408.0}{565.0} = 223.56 N/mm^2$$

Maximum allowable spacing (EC2 Table 7.3N)

Stress thresholds: [160, 200, 240, 280, 320, 360] MPa

Spacing limits: [300, 250, 200, 150, 100, 50] mm

Interpolated for σ_s = 223.56 N/mm² → $S_{max,table}$ = 221.0 mm

Detailing limit (EC2 9.3.1.1(3)): min(3h, 400) = 400.0 mm

S_{max} = min(221.0, 400.0) = 221.0 mm

Provided spacing S = 200.0 mm, which is ≤ S_{max} = 221.0 mm

PASS: Provided bar spacing is adequate for crack control limit (wk = 0.3mm)

§7.4.2 Deflection Check	**SPAN-TO-DEPTH RATIO** $\rho_0 = \sqrt{f_{ck}} \times 10^{-3} = \sqrt{25.0} \times 10^{-3} = 0.005$ $\rho_{calc} = \frac{A_{s,req}}{bd} = \frac{408.0}{1000 \times 119.0} = 0.003427$ ρ = max(0.0035, 0.003427) = 0.0035 Structural system factor K = 1.5 **ρ ≤ ρ₀ → Expression (7.16a)** $\frac{L}{d} = K\left[11 + 1.5\sqrt{f_{ck}}\frac{\rho_0}{\rho} + 3.2\sqrt{f_{ck}}\left(\frac{\rho_0}{\rho} - 1\right)^{3/2}\right]$ Basic L/d = 39.31 $\frac{310}{\sigma_s} = \frac{f_{yk}}{500} \times \frac{A_{s,prov}}{A_{s,req}} = \frac{500.0}{500} \times \frac{565.0}{408.0} = 1.39$ Modification factor = min(2.0, 1.39) = 1.39 $L/d)_{permitted} = 1.39 \times 39.31 = 54.5$ $L/d)_{actual} = \frac{L_{eff}}{d} = \frac{3000.0}{119.0} = 25.21$ Check: 25.21 ≤ 54.5 → ACCEPT – slab depth OK	**ρ₀ = 0.005** **ρ = 0.0035** **Permitted L/d = 54.5** **Actual L/d = 25.21** **Status: ACCEPT – slab depth OK**

REFERENCE	CALCULATIONS	OUTPUT
§6.2.2 Shear Check	**SHEAR RESISTANCE** $k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{119.0}} = 2.3$ k = min(2.3, 2.0) = 2.0 $\rho_1 = \frac{A_{s,prov}}{bd} = \frac{565.0}{1000 \times 119.0} = 0.0048$ ρ_1 = min(0.0048, 0.02) = 0.0048 $V_{Rd,c} = 0.12k(100\rho_1 f_{ck})^{1/3} bd \times 10^{-3}$ $V_{Rd,c}$ = 0.12×2.0×(100×0.0048×25.0)$^{1/3}$×1000×119.0×10^{-3} = 65.17 kN $V_{Rd,c,min}$ = 0.035 $k^{3/2}$ $\sqrt{f_{ck}}$ b d × 10^{-3} = 58.9 kN Design $V_{Rd,c}$ = max(65.17, 58.9) = 65.17 kN Since V_{Ed} (28.6 kN) ≤ $V_{Rd,c}$ (65.17 kN) → PASS – Section is safe against shear	**$V_{Rd,c}$ = 65.17 kN** **V_{Ed} = 28.6 kN** **Status: PASS – Section is safe against shear**
§9.3.1.1 Distribution Steel	**DISTRIBUTION REINFORCEMENT** $A_{s,dist,min}$ = max(0.0013·b·d, 0.2 $A_{s,req}$) 0.0013×1000×119.0 = 155.0 mm²/m 0.2 × 408.0 = 82.0 mm²/m $A_{s,dist,min}$ = max(155.0, 82.0) = 155.0 mm²/m Provided: H12.0 @ 200.0 mm c/c $A_{s,dist,prov} = \frac{\pi \times (12.0/2)^2 \times 1000}{200.0} = 565.0 mm^2/m$ Maximum spacing (EC2 9.3.1.1(3)): min(3.5h, 450) = 450.0 mm Check: 565.0 ≥ 155.0 mm²/m; S = 200.0 ≤ 450.0 mm → OK	**φ_{dist} = 12.0 mm** **S_{dist} = 200.0 mm** **$A_{s,dist,prov}$ = 565.0 mm²/m** **Status: OK**