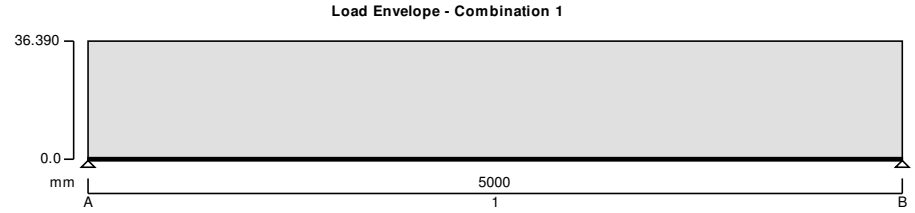
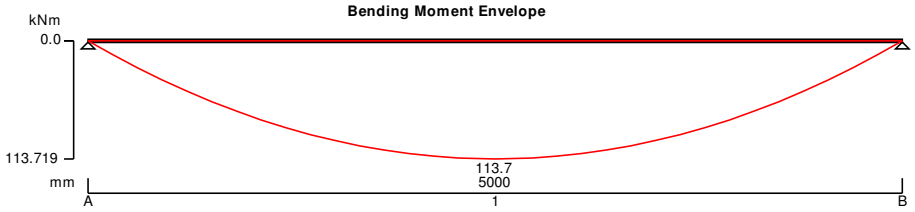
	Project				Job no.	
	Calcs for				Start page no./Revision 1	
	Calcs by MG	Calcs date 27/04/2018	Checked by	Checked date	Approved by	Approved date

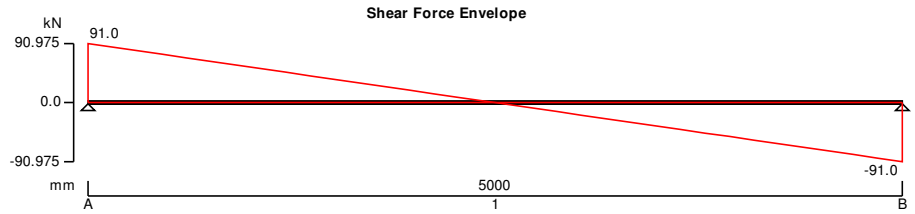
RC BEAM ANALYSIS & DESIGN (EN1992-1)

In accordance with UK national annex

TEDDS calculation version 2.1.13







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

wall propping reaction	Imposed full UDL 1.13 kN/m
wall propping reaction	Dead full UDL 25.7 kN/m

Load combinations

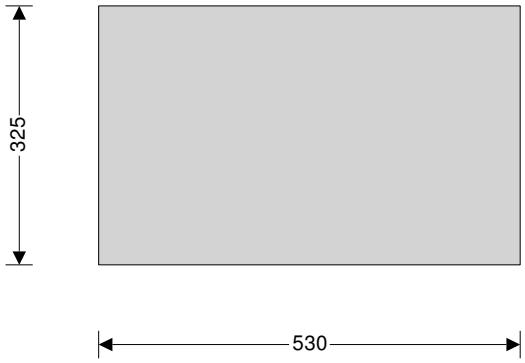
Load combination 1	Support A	Dead × 1.35
		Imposed × 1.50
	Span 1	Dead × 1.35
		Imposed × 1.50
	Support B	Dead × 1.35
		Imposed × 1.50

Analysis results

Maximum moment support A	M_{A_max} = **0** kNm	M_{A_red} = **0** kNm
Maximum moment span 1 at 2500 mm	M_{s1_max} = **114** kNm	M_{s1_red} = **114** kNm
Maximum moment support B	M_{B_max} = **0** kNm	M_{B_red} = **0** kNm
Maximum shear support A	V_{A_max} = **91** kN	V_{A_red} = **91** kN
Maximum shear support A span 1 at 275 mm	$V_{A\_s1\_max}$ = **81** kN	$V_{A\_s1\_red}$ = **81** kN
Maximum shear support B	V_{B_max} = **-91** kN	V_{B_red} = **-91** kN
Maximum shear support B span 1 at 4725 mm	$V_{B\_s1\_max}$ = **-81** kN	$V_{B\_s1\_red}$ = **-81** kN
Maximum reaction at support A	R_A = **91** kN	
Unfactored dead load reaction at support A	R_{A_Dead} = **64** kN	
Unfactored imposed load reaction at support A	$R_{A\_Imposed}$ = **3** kN	
Maximum reaction at support B	R_B = **91** kN	
Unfactored dead load reaction at support B	R_{B_Dead} = **64** kN	
Unfactored imposed load reaction at support B	$R_{B\_Imposed}$ = **3** kN	

Rectangular section details

Section width	b = **530** mm
Section depth	h = **325** mm



Concrete details (Table 3.1 - Strength and deformation characteristics for concrete)

Concrete strength class	**C35/45**
Characteristic compressive cylinder strength	f_{ck} = **35** N/mm^2
Characteristic compressive cube strength	$f_{ck,cube}$ = **45** N/mm^2
Mean value of compressive cylinder strength	$f_{cm} = f_{ck}$ + 8 N/mm^2 = **43** N/mm^2
Mean value of axial tensile strength	f_{ctm} = 0.3 N/mm^2 $\times$ (f_{ck}/ 1 N/mm^2)$^{2/3}$ = **3.2** N/mm^2
Secant modulus of elasticity of concrete	E_{cm} = 22 kN/mm^2 $\times$ [f_{cm}/10 N/mm^2]$^{0.3}$ = **34077** N/mm^2
Partial factor for concrete (Table 2.1N)	γ_C = **1.50**
Compressive strength coefficient (cl.3.1.6(1))	α_{cc} = **0.85**
Design compressive concrete strength (exp.3.15)	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C$ = **19.8** N/mm^2
Maximum aggregate size	h_{agg} = **20** mm

Reinforcement details

Characteristic yield strength of reinforcement	f_{yk} = **500** N/mm^2
Partial factor for reinforcing steel (Table 2.1N)	γ_S = **1.15**
Design yield strength of reinforcement	$f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm^2

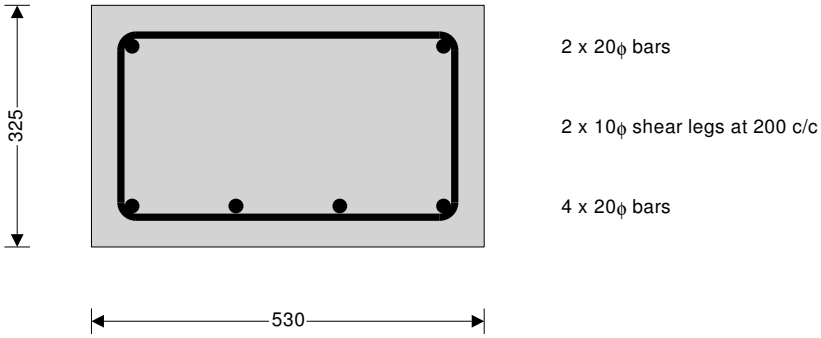
Nominal cover to reinforcement

Nominal cover to top reinforcement	c_{nom_t} = **35** mm

Nominal cover to bottom reinforcement c_{nom_b} = **35** mm

Nominal cover to side reinforcement c_{nom_s} = **35** mm

Mid span 1



Rectangular section in flexure (Section 6.1) - Positive midspan moment

Design bending moment $M = abs(M_{s1\_red})$ = **114** kNm

Depth to tension reinforcement $d = h - c_{nom\_b} - \phi_v - \phi_{bot} / 2$ = **270** mm

Percentage redistribution $m_{rs1} = M_{s1\_red} / M_{s1\_max} - 1$ = **0** %

Redistribution ratio $\delta = \min(1 - m_{rs1}, 1)$ = **1.000**

$K = M / (b \times d^2 \times f_{ck})$ = **0.084**

$K' = 0.598 \times \delta - 0.181 \times \delta^2 - 0.21$ = **0.207**

K' > K - No compression reinforcement is required

Lever arm $z = \min((d / 2) \times [1 + (1 - 3.53 \times K)^{0.5}], 0.95 \times d)$ = **248** mm

Depth of neutral axis $x = 2.5 \times (d - z)$ = **54** mm

Area of tension reinforcement required $A_{s,req} = M / (f_{yd} \times z)$ = **1054** mm²

Tension reinforcement provided $4 \times 20\phi$ bars

Area of tension reinforcement provided $A_{s,prov}$ = **1257** mm²

Minimum area of reinforcement (exp.9.1N) $A_{s,min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times b \times d$ = **239** mm²

Maximum area of reinforcement (cl.9.2.1.1(3)) $A_{s,max} = 0.04 \times b \times h$ = **6890** mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Rectangular section in shear (Section 6.2)

Shear reinforcement provided $2 \times 10\phi$ legs at 200 c/c

Area of shear reinforcement provided $A_{sv,prov}$ = **785** mm²/m

Minimum area of shear reinforcement (exp.9.5N) $A_{sv,min} = 0.08$ N/mm² $\times b \times (f_{ck} / 1$ N/mm²$)^{0.5} / f_{yk}$ = **502** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (exp.9.6N) $s_{vl,max} = 0.75 \times d$ = **203** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Design shear resistance (assuming cot(θ) is 2.5) $V_{prov} = 2.5 \times A_{sv,prov} \times z \times f_{yd}$ = **211.9** kN

Shear links provided valid between 0 mm and 5000 mm with tension reinforcement of 1257 mm²

Crack control (Section 7.3)

Maximum crack width w_k = **0.3** mm

Mean value of concrete tensile strength $f_{ct,eff} = f_{ctm}$ = **3.2** N/mm²

Stress distribution coefficient k_c = 0.4

Non-uniform self-equilibrating stress coefficient $k = \min(\max(1 + (300$ mm $- \min(h, b)) \times 0.35 / 500$ mm$, 0.65), 1)$ = **0.98**

Depth of tensile zone	$h_{cr} = h - x =$ **271** mm
Area of concrete in the tensile zone	$A_{ct} = h_{cr} \times b =$ **143369** mm^2
Adjusted maximum bar diameter (exp.7.6N)	$\phi_{mod} = \phi_{bot} \times (2.9\ N/mm^2 / f_{ct,eff}) \times 2 \times (h - d) / (k_c \times h_{cr}) =$ **18** mm
Maximum adjusted bar diameter	$\phi_{max} =$ **32** mm
Tension bar spacing	$s_{bar} = (b - 2 \times (c_{nom\_s} + \phi_v) - \phi_{bot}) / (N_{bot} - 1) =$ **140** mm
Maximum tension bar spacing	$s_{max} =$ **300** mm
Minimum allowable bar spacing	$s_{min} = \max(\phi_{bot}, h_{agg} + 5\ mm, 20\ mm) + \phi_{bot} =$ **45** mm
Maximum stress permitted (Tables 7.2N & 7.3N)	$\sigma_s =$ **200** N/mm^2
Minimum area of reinforcement required (exp.7.1)	$A_{sc,min} = k_c \times k \times f_{ct,eff} \times A_{ct} / \sigma_s =$ **904** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

PASS - Actual bar spacing exceeds minimum allowable

Deflection control (Section 7.4)

Reference reinforcement ratio	$\rho_{m0} = (f_{ck} / 1\ N/mm^2)^{0.5} / 1000 =$ **0.006**
Required tension reinforcement ratio	$\rho_m = A_{s,req} / (b \times d) =$ **0.007**
Required compression reinforcement ratio	$\rho'_m = A_{s2,req} / (b \times d) =$ **0.000**
Structural system factor (Table 7.4N)	$K_b =$ **1.0**
Basic allowable span to depth ratio (7.16b)	$span\_to\_depth_{basic} = K_b \times [11 + 1.5 \times (f_{ck} / 1\ N/mm^2)^{0.5} \times \rho_{m0} / (\rho_m - \rho'_m) + (f_{ck} / 1\ N/mm^2)^{0.5} \times (\rho'_m / \rho_{m0})^{0.5} / 12] =$ **18.129**
Reinforcement factor (exp.7.17)	$K_s = \min(A_{s,prov} / A_{s,req} \times 500\ N/mm^2 / f_{yk}, 1.5) =$ **1.192**
Flange width factor	F1 = **1.000**
Long span supporting brittle partition factor	F2 = **1.000**
Allowable span to depth ratio	$span\_to\_depth_{allow} = \min(span\_to\_depth_{basic} \times K_s \times F1 \times F2, 40 \times K_b) =$ **21.619**
Actual span to depth ratio	$span\_to\_depth_{actual} = L_{s1} / d =$ **18.519**

PASS - Actual span to depth ratio is within the allowable limit