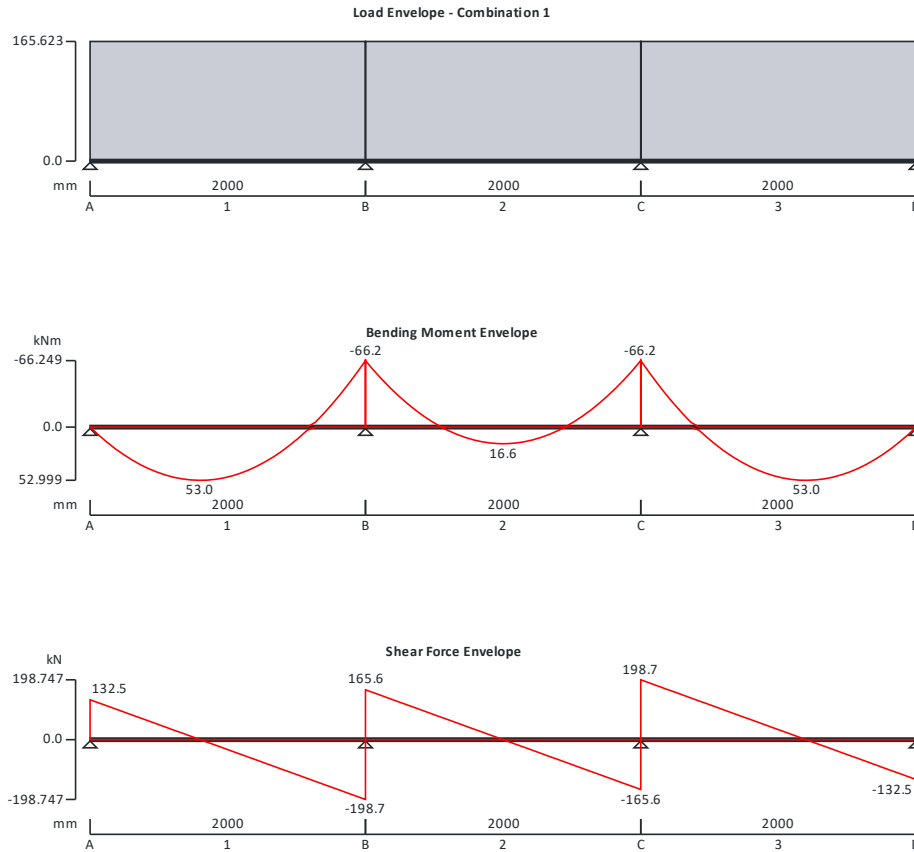


RC BEAM ANALYSIS & DESIGN BS8110

TEDDS calculation version 2.1.14



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Support C

Vertically restrained

Rotationally free

Support D

Vertically restrained

Rotationally free

Applied loading

Dead self weight of beam $\times 1$

Imposed full UDL 95 kN/m

Load combinations

Load combination 1

Support A

Dead $\times 1.40$

Imposed $\times 1.60$

Span 1

Dead $\times 1.40$

Imposed $\times 1.60$

Support B

Dead $\times 1.40$

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Imposed $\times 1.60$

Span 2

Dead $\times 1.40$

Imposed $\times 1.60$

Support C

Dead $\times 1.40$

Imposed $\times 1.60$

Span 3

Dead $\times 1.40$

Imposed $\times 1.60$

Support D

Dead $\times 1.40$

Imposed $\times 1.60$

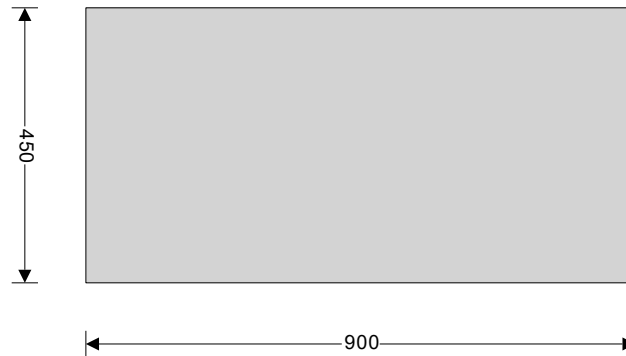
Analysis results

Maximum moment support A	$M_{A_max} = 0 \text{ kNm}$	$M_{A_red} = 0 \text{ kNm}$
Maximum moment span 1 at 800 mm	$M_{s1_max} = 53 \text{ kNm}$	$M_{s1_red} = 53 \text{ kNm}$
Maximum moment support B	$M_{B_max} = -66 \text{ kNm}$	$M_{B_red} = -66 \text{ kNm}$
Maximum moment span 2 at 1000 mm	$M_{s2_max} = 17 \text{ kNm}$	$M_{s2_red} = 17 \text{ kNm}$
Maximum moment support C	$M_{C_max} = -66 \text{ kNm}$	$M_{C_red} = -66 \text{ kNm}$
Maximum moment span 3 at 1200 mm	$M_{s3_max} = 53 \text{ kNm}$	$M_{s3_red} = 53 \text{ kNm}$
Maximum moment support D	$M_{D_max} = 0 \text{ kNm}$	$M_{D_red} = 0 \text{ kNm}$
Maximum shear support A	$V_{A_max} = 132 \text{ kN}$	$V_{A_red} = 132 \text{ kN}$
Maximum shear support A span 1 at 400 mm	$V_{A_s1_max} = 66 \text{ kN}$	$V_{A_s1_red} = 66 \text{ kN}$
Maximum shear support B	$V_{B_max} = -199 \text{ kN}$	$V_{B_red} = -199 \text{ kN}$
Maximum shear support B span 1 at 1600 mm	$V_{B_s1_max} = -132 \text{ kN}$	$V_{B_s1_red} = -132 \text{ kN}$
Maximum shear support B span 2 at 400 mm	$V_{B_s2_max} = 99 \text{ kN}$	$V_{B_s2_red} = 99 \text{ kN}$
Maximum shear support C	$V_{C_max} = 199 \text{ kN}$	$V_{C_red} = 199 \text{ kN}$
Maximum shear support C span 2 at 1600 mm	$V_{C_s2_max} = -99 \text{ kN}$	$V_{C_s2_red} = -99 \text{ kN}$
Maximum shear support C span 3 at 400 mm	$V_{C_s3_max} = 132 \text{ kN}$	$V_{C_s3_red} = 132 \text{ kN}$
Maximum shear support D	$V_{D_max} = -132 \text{ kN}$	$V_{D_red} = -132 \text{ kN}$
Maximum shear support D span 3 at 1600 mm	$V_{D_s3_max} = -66 \text{ kN}$	$V_{D_s3_red} = -66 \text{ kN}$
Maximum reaction at support A	$R_A = 132 \text{ kN}$	
Unfactored dead load reaction at support A	$R_{A_Dead} = 8 \text{ kN}$	
Unfactored imposed load reaction at support A	$R_{A_Imposed} = 76 \text{ kN}$	
Maximum reaction at support B	$R_B = 364 \text{ kN}$	
Unfactored dead load reaction at support B	$R_{B_Dead} = 21 \text{ kN}$	
Unfactored imposed load reaction at support B	$R_{B_Imposed} = 209 \text{ kN}$	
Maximum reaction at support C	$R_C = 364 \text{ kN}$	
Unfactored dead load reaction at support C	$R_{C_Dead} = 21 \text{ kN}$	
Unfactored imposed load reaction at support C	$R_{C_Imposed} = 209 \text{ kN}$	
Maximum reaction at support D	$R_D = 132 \text{ kN}$	
Unfactored dead load reaction at support D	$R_{D_Dead} = 8 \text{ kN}$	
Unfactored imposed load reaction at support D	$R_{D_Imposed} = 76 \text{ kN}$	

Rectangular section details

Section width	$b = 900 \text{ mm}$
Section depth	$h = 450 \text{ mm}$

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Concrete details

Concrete strength class	C32/40
Characteristic compressive cube strength	$f_{cu} = 40 \text{ N/mm}^2$
Modulus of elasticity of concrete	$E_c = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 28000 \text{ N/mm}^2$
Maximum aggregate size	$h_{agg} = 20 \text{ mm}$

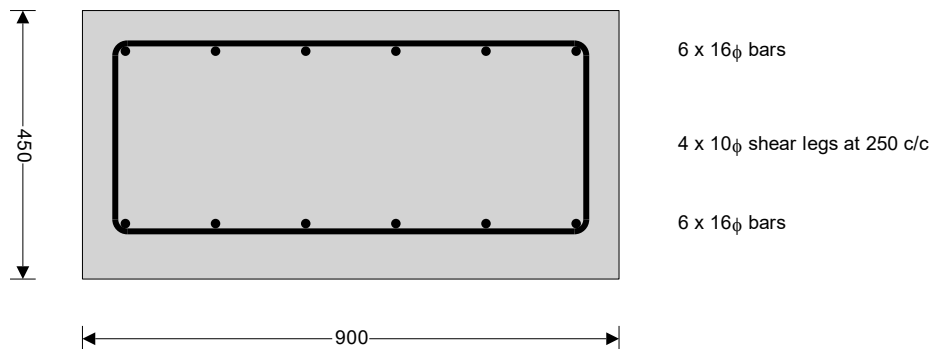
Reinforcement details

Characteristic yield strength of reinforcement	$f_y = 500 \text{ N/mm}^2$
Characteristic yield strength of shear reinforcement	$f_{yv} = 500 \text{ N/mm}^2$

Nominal cover to reinforcement

Nominal cover to top reinforcement	$C_{nom_t} = 50 \text{ mm}$
Nominal cover to bottom reinforcement	$C_{nom_b} = 75 \text{ mm}$
Nominal cover to side reinforcement	$C_{nom_s} = 50 \text{ mm}$

Mid span 1



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment	$M = \text{abs}(M_{s1_red}) = 53 \text{ kNm}$
Depth to tension reinforcement	$d = h - C_{nom_b} - \phi_v - \phi_{bot} / 2 = 357 \text{ mm}$
Redistribution ratio	$\beta_b = \min(1 - m_{rs1}, 1) = 1.000$
	$K = M / (b \times d^2 \times f_{cu}) = 0.012$
	$K' = 0.156$

$K' > K$ - No compression reinforcement is required

Lever arm	$z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 339 \text{ mm}$
Depth of neutral axis	$x = (d - z) / 0.45 = 40 \text{ mm}$
Area of tension reinforcement required	$A_{s,req} = M / (0.87 \times f_y \times z) = 359 \text{ mm}^2$
Tension reinforcement provided	6 x 16φ bars

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Area of tension reinforcement provided

$$A_{s,prov} = 1206 \text{ mm}^2$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 \times b \times h = 527 \text{ mm}^2$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 \times b \times h = 16200 \text{ mm}^2$$

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

Rectangular section in shear

Shear reinforcement provided

$$4 \times 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 1257 \text{ mm}^2/\text{m}$$

Minimum area of shear reinforcement (Table 3.7)

$$A_{sv,min} = 0.4N/\text{mm}^2 \times b / (0.87 \times f_{yv}) = 828 \text{ mm}^2/\text{m}$$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing (cl. 3.4.5.5)

$$s_{vl,max} = 0.75 \times d = 268 \text{ mm}$$

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

Design concrete shear stress

$$v_c = 0.79N/\text{mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400\text{mm} / d)^{1/4}) \times (\min(f_{cu}, 40N/\text{mm}^2) / 25N/\text{mm}^2)^{1/3} / \gamma_m = 0.549 \text{ N/mm}^2$$

Design shear resistance provided

$$V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.607 \text{ N/mm}^2$$

Design shear stress provided

$$V_{prov} = V_{s,prov} + v_c = 1.156 \text{ N/mm}^2$$

Design shear resistance

$$V_{prov} = V_{prov} \times (b \times d) = 371.4 \text{ kN}$$

Shear links provided valid between 0 mm and 2000 mm with tension reinforcement of 1206 mm²

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension

$$s = (b - 2 \times (c_{nom,s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = 137 \text{ mm}$$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension

$$s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 99.3 \text{ N/mm}^2$$

Maximum distance between bars in tension

$$s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$$

PASS - Satisfies the maximum spacing criteria

Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)

$$\text{span_to_depth}_{basic} = 26.0$$

Design service stress in tension reinforcement

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 99.3 \text{ N/mm}^2$$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477N/\text{mm}^2 - f_s) / (120 \times (0.9N/\text{mm}^2 + (M / (b \times d^2))))) = 2.000$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = 1.111$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

$$\text{span_to_depth}_{allow} = \text{span_to_depth}_{basic} \times f_{tens} \times f_{comp} = 57.8$$

Actual span to depth ratio

$$\text{span_to_depth}_{actual} = L_{s1} / d = 5.6$$

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