

Calculation Title Sheet

Job No:

T25.01

Project Title:

Proposed Garage Design

Client/Address:

Dakota House
Baglan, Port Talbot

Design Synopsis

1. Brief description of the Design Philosophy :

Hand calculations and Tedds software.

2. Main Standards used in the Design :

BS EN 1991-1-1:2002 Actions on structures
BS EN 1992-1-1:2004 Design of concrete structures
BS EN 1993-1-1:2005 Design of steel structures
BS EN 1995-1-1:2004 Design of timber structures
BS EN 1996-1-1:2005 Design of masonry structures
BS EN 1997-1:2004 Geotechnical Design

Design Output

Refer to Dwg's T25.01.001 to 006

Calculation Sheet

Project : Dakota House - Garage

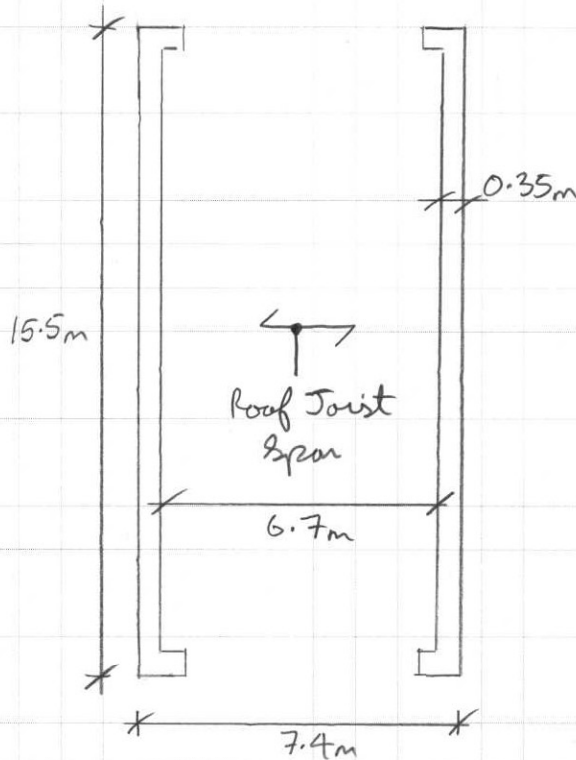
Calc Sheet No. : 1

Ref :

Output :

Proposed Garage

Dimensions : 15.5m L x 7.4m W x 2.7m H



PLAN

Unit Loads

Roof Dead Load

Artificial Grass	= 0.05
Geotextile	} = 0.05
Audrain GeoCell	
GRP Fibreglass	
18mm Plywood	= 0.15
Insulation	= 0.05
Plasterboard	= 0.15
Easi Joists	= 0.2
ΣW_{DL}	= 0.65 kN/m ²

Roof Imposed Load

Garden UDL = 1.5 kN/m²

Calculation Sheet

Project : Dakota House Garage

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Output :

Easi-Joist Roof

Easi-Joist - Clear span = 6.7m
Effective span = 6.8m

Dead Load (excluding self weight) = 0.45 kN/m^2

Imposed Load = 1.5 kN/m^2

Total Load = $0.45 + 1.5 = 1.95 \text{ kN/m}^2$

WS400 (Depth = 417) @ 400 c/c

Chord dimensions, 147w x 47d

From literature : Max span = 8.2m

Suspended Floor

The GI determined that the ground behind the retaining wall underlying the proposed ground is a very soft clay fill and is not suitable as a bearing strata. The garage floor will therefore need to be suspended above the fill.

- Propose Beam & Block suspended floor

- Cemen - 225mm deep beams @ 315mm c/s

- For Superimposed load = 2.5 kN/m^2

- Effective span = 7.54m

- Self weight = 3.04 kN/m^2

- Based on 50 mm screed

Imposed Loads

BS EN 1991-1-1:2002 - Table 6.8

Cat F $\rightarrow q_k = 2.5 \text{ kN/m}^2$ or $Q_k = 20 \text{ kN}$

Calculation Sheet

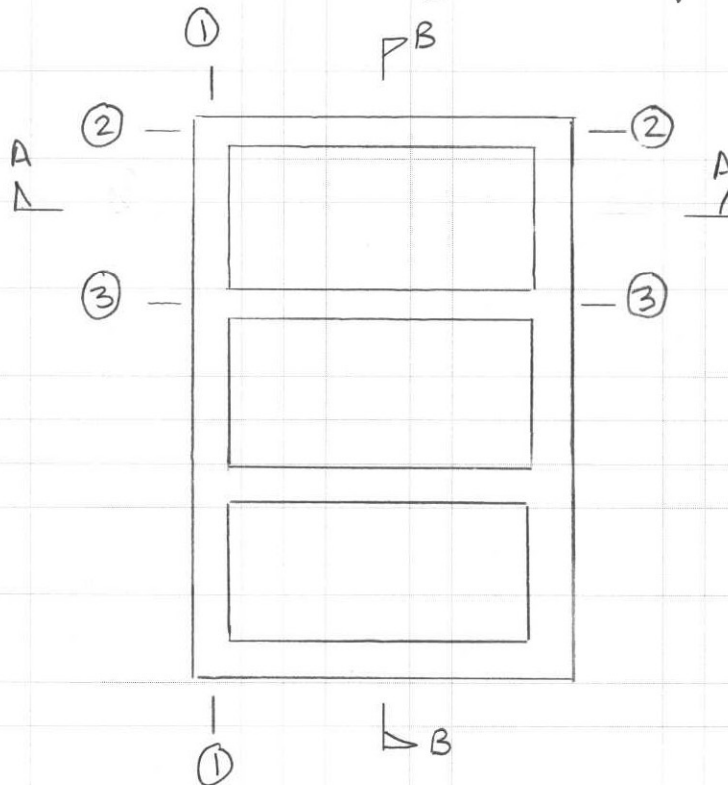
Project : Dakota House Garage

Calc Sheet No. : 3

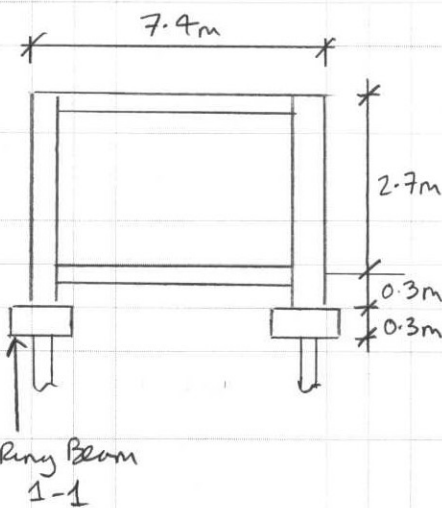
Ref :

Output :

Piled Ring Beam Design



Ring Beam ①-①



Dead Load ①-①

$$\text{Flat Roof} = 0.65 \cdot 7.4/2 = 2.41 \text{ kN/m}$$

$$\text{Cavity Wall} = 2.15(2.7+0.3) \cdot 2 = 12.9 \text{ kN/m}$$

$$\Sigma W_{DL} \text{ ①-①} = 15.31 \text{ kN/m}$$

Imposed Load ①-①

$$\text{Flat Roof} = 1.5 \cdot 7.4/2 = 5.55 \text{ kN/m}$$

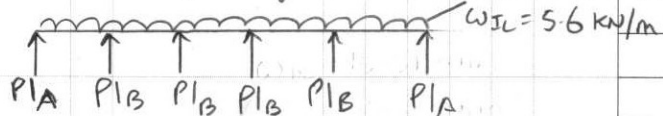
$$\Sigma W_{IL} \text{ ①-①} = 5.55 \text{ kN/m}$$

SECTION A-A

Tells Load diagram
Reactions = Pile Load

$$\begin{aligned} \text{Pile P1A} - R_{ADL} &= 20.6 \text{ kN} \\ - R_{AIL} &= 4.8 \text{ kN} \end{aligned}$$

Pile spacing $\approx 1.7 \text{ m}$



$$\begin{aligned} \text{Pile P1B} - R_{BDL} &= 41.2 \text{ kN} \\ - R_{BIL} &= 9.5 \text{ kN} \end{aligned}$$

Calculation Sheet

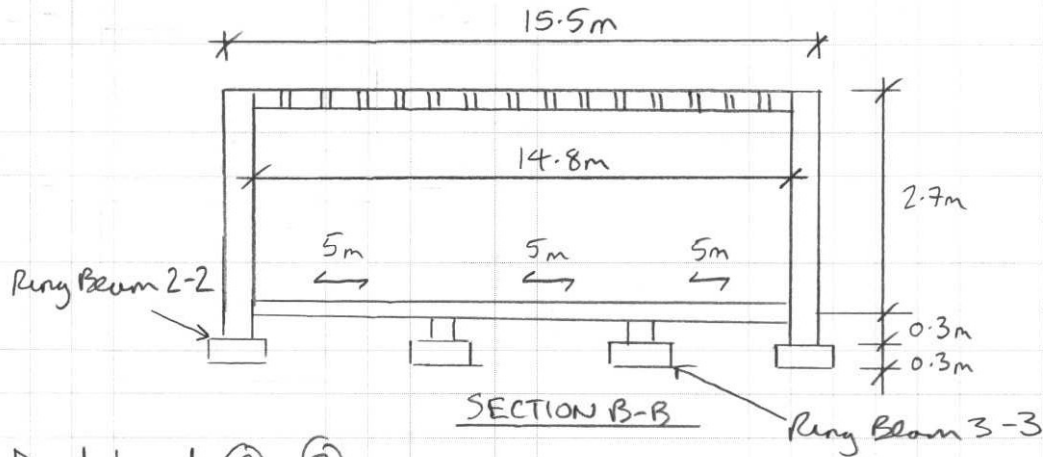
Project : Dakota House Garage

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Output :

Piled Ring Beam 2-2



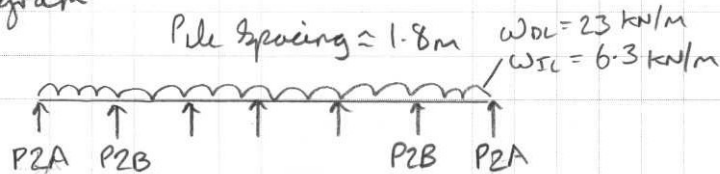
Dead Load ②-②

Flat Roof	= 0	
Cavity Wall	= $2.15 (2.7 + 0.3) \cdot 2$	= 12.9 kN/m
Suspended Floor	= $(3.04 + 20.0 \cdot 0.05) \cdot 5/2$	= 10.1 kN/m
$\Sigma WDL \text{ ②-②} =$		<u>23 kN/m</u>

Imposed Load ②-②

Flat Roof	= 0	
Suspended Floor	= $2.5 \cdot 5/2$	= 6.25 kN/m
$\Sigma WIL \text{ ②-②} =$		<u>6.25 kN/m</u>

Jedds Load diagram



Pile P2A :	$R_{ADL} = 29.6 \text{ kN}$	$R_{BDL} = 57.3 \text{ kN}$
	$R_{AIL} = 5.7 \text{ kN}$	$R_{BIL} = 11.3 \text{ kN}$

Calculation Sheet

Project : Dakota House Garage

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Output :

Piled Ring Beam 3-3

(see section B-B)

Dead Load 3-3

Flat Roof = 0

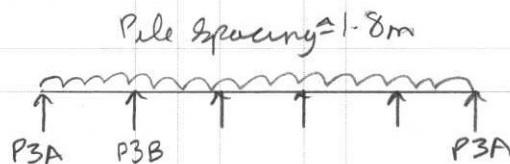
Suspended Floor = $(3.04 + 20.0 \cdot 0.05) \cdot 5 = 20.2 \text{ kN/m}$

$\Sigma W_{DL} \text{ (3)-(3)} = 20.2 \text{ kN/m}$

Imposed Load 3-3

Suspended Floor = $2.5 \cdot 5 = 12.5 \text{ kN/m}$

$\Sigma W_{IL} \text{ (3)-(3)} = 12.5 \text{ kN/m}$



Pile P3A: $R_{ADL} = 26.8 \text{ kN}$ $R_{BDL} = 53.7 \text{ kN}$
 $R_{AIL} = 11.7 \text{ kN}$ $R_{BIL} = 23.4 \text{ kN}$

Worst Case Pile Load

Design the pile with the worst pile load

- Junction with Ring Beam 1-1 and 3-3

$$\begin{aligned} \text{Nominal Pile Load} &= (P_{1B} + P_{3A})_{DL} + (P_{1B} + P_{3A})_{IL} \\ &= 41.2 + 26.8 + 9.5 + 11.7 \\ &= 89.2 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{Ultimate Pile Load} &= (P_{1B} + P_{3A})_{DL} \cdot 1.35 + (P_{1B} + P_{3A})_{IL} \cdot 1.5 \\ &= (41.2 + 26.8) \cdot 1.35 + (9.5 + 11.7) \cdot 1.5 \\ &= 91.8 + 31.8 \\ &= 123.6 \text{ kN} \end{aligned}$$

Calculation Sheet

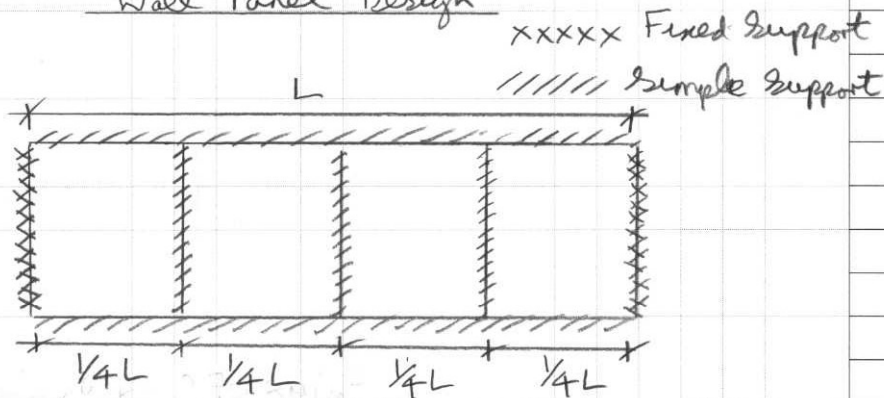
Project : Dakota House Garage

Calc Sheet No. : 6

Ref :

Output :

Wall Panel Design



Cavity Wall, $t_1 = 100 \text{ mm}$

$t_2 = 100 \text{ mm}$

$t_{\text{cavity}} = 150 \text{ mm}$

$\Sigma t_{\text{wall}} = 350 \text{ mm}$

Panel Length = $15500 / 4 = 3900 \text{ mm}$

Wind Load, $W_k = 0.75 \text{ kN/m}^2$

Vertical Loads - Inner Leaf -

Dead, $W_{DL} - \text{Roof} = 0.65 \cdot 7.4 / 2 = 2.41 \text{ kN/m}$

Imposed, $W_{IL} - \text{Roof} = 1.5 \cdot 7.4 / 2 = 5.55 \text{ kN/m}$

From Details: 4 Panels @ 3.9m Long

- End & Middle Panels OK

Wind Post Design

Wind Post provide simple support between individual panels.

Wind post height = 2.7m

Wind load, $W_k = 0.75 \text{ kN/m}^2$

Length of wall supported by wall, $L_w = 3.9 \text{ m}$

From Details: Require Angle - $150 \times 70 \times 6$

Grade 1-4301 (304) Stainless Steel

Calculation Sheet

Project : Dakota House

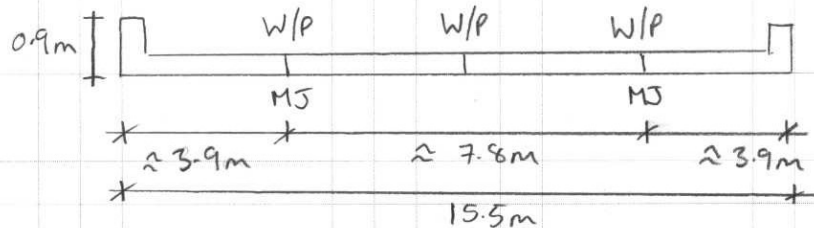
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Ref :

Output :

Movement Joints

External spacing in blockwork - 6 to 9m
Min distance from wall return = 1m



Lintel over garage door

Clear span = 5.6m

Effective span = 5.75m

Dead Load (Inner leaf)

$$\begin{aligned} \text{Cavity wall (Inner leaf)} &= 2.15 \times 0.6 = 1.29 \text{ kN/m} \\ \text{Parapet} &= 0.5 \text{ kN/m} \end{aligned}$$

$$\Sigma W_{DL} \text{ Inner} = \underline{\underline{1.79 \text{ kN/m}}}$$

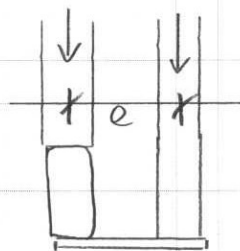
Dead Load (Outer leaf)

$$\text{Cavity wall outer leaf} = 2.15 \times 0.6 = 1.29 \text{ kN/m}$$

$$\Sigma W_{DL} \text{ Outer} = \underline{\underline{1.29 \text{ kN/m}}}$$

Imposed Load (Inner & Outer leaf) = 0

ΣW_{Inner} ΣW_{Outer}



$$\begin{aligned} \text{Load eccentricity Outer leaf} &= e \\ e &= 350 - 50 - 50 = 250 \text{ mm} \end{aligned}$$

From Tedds : Require 200x100x8 RHS

Calculation Sheet

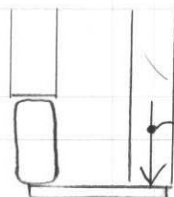
Project : Dakota House Elevation

Calc Sheet No. : 8

Ref :

Output :

Lintel cantilever plate



$$V = \sum W_{DL}(\text{outer}) = 1.3 \text{ kN/m}$$

$$e = 200 \text{ mm}$$

Governing factor = Deflection

Assume 6mm thick plate

$$\delta_{\text{cantilever}} = \frac{VL^3}{3EI} \quad \text{where } E_{\text{steel}} = 205 \text{ kN/mm}^2$$

$$I = \frac{bd^3}{12} = \frac{1000 \cdot 6^3}{12} = 18 \text{ E}3 \text{ mm}^4$$

$$\delta_{\text{actual}} = \frac{1.3 \text{ E}3 \cdot 200^3}{3 \cdot 205 \text{ E}3 \cdot 18 \text{ E}3} = 0.94 \text{ mm}$$

$$\delta_{\text{allowable}} = \frac{\text{span}}{180} = \frac{200}{180} = 1.11 \text{ mm}$$

$\therefore \delta_{\text{actual}} < \delta_{\text{allowable}} \therefore 6 \text{ mm plate OK in deflection}$

Bending Check

$$\text{For 6mm plate } Z = I/y = 18 \text{ E}3 / 6/2 = 6 \text{ E}3 \text{ mm}^3$$

$$\text{Design bending moment, } M_d = 1.3 \cdot 0.2 \cdot 1.35 = 0.351 \text{ kNm}$$

$$\text{Design bending stress, } \sigma_d = \frac{M_d}{Z} = \frac{0.351 \text{ E}6}{6 \text{ E}3} = 58.5 \text{ N/mm}^2$$

$$\text{Bending Resistance} = 275 \text{ N/mm}^2 > \text{Bending stress above}$$

$\therefore 6 \text{ mm Plate OK in bending}$

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Calcs for Ring Beam 1-1				Start page no./Revision 9	
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RC BEAM ANALYSIS & DESIGN (EN1992) RING BEAM 1-1

RC MEMBER ANALYSIS & DESIGN (EN1992-1-1:2004)

In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national annex

Tedds calculation version 3.3.11

Design summary

Span 1 moment design reinforcement (including crack requirements)

	Unit	Provided	Required	Utilisation	Result
Zone 1 top	-	-	--		Length of zone 0mmZone 1 top
Zone 1 bot	-	-	--		Length of zone 0mmZone 1 bot
Zone 2 top (-9.9 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 2 bot (4.9 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 3 top	-	-	--		Length of zone 0mmZone 3 top
Zone 3 bot	-	-	--		Length of zone 0mmZone 3 bot
Span to depth ratio		3.20	52.00	0.061	PASS

Span 1 shear design reinforcement

	Unit	Provided	Required	Utilisation	Result
Zone 1	-	-	-	-	Length of zone 0mm
Zone 2 (10.3 kN)	mm ² /m	628	543	0.864	PASS
Zone 3	-	-	-	-	Length of zone 0mm

Span 2 moment design reinforcement (including crack requirements)

	Unit	Provided	Required	Utilisation	Result
Zone 1 top	-	-	--		Length of zone 0mmZone 1 top
Zone 1 bot	-	-	--		Length of zone 0mmZone 1 bot
Zone 2 top (-9.9 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 2 bot (4.9 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 3 top	-	-	--		Length of zone 0mmZone 3 top
Zone 3 bot	-	-	--		Length of zone 0mmZone 3 bot
Span to depth ratio		3.20	52.00	0.061	PASS

Span 2 shear design reinforcement

	Unit	Provided	Required	Utilisation	Result
Zone 1	-	-	-	-	Length of zone 0mm
Zone 2 (10.3 kN)	mm ² /m	628	543	0.864	PASS
Zone 3	-	-	-	-	Length of zone 0mm

ANALYSIS

Tedds calculation version 1.0.38

Geometry

Geometry (m) - Concrete (C32 2500 Quartzite) - R 600x600



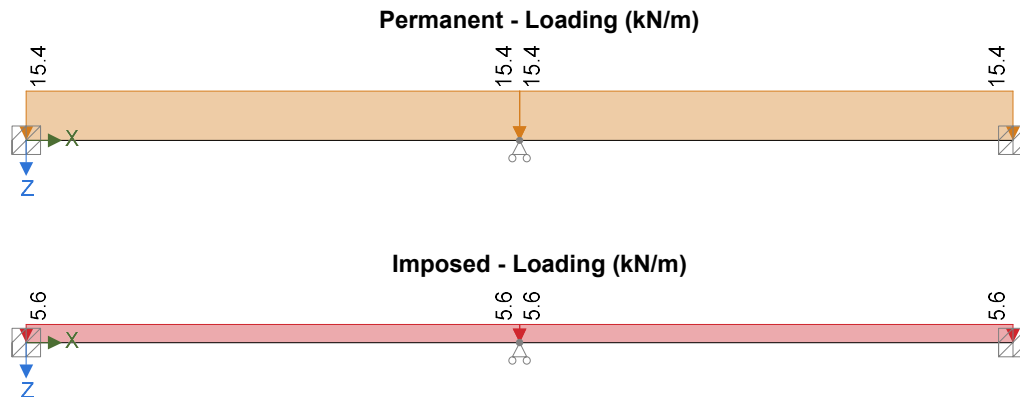
Span	Length (m)	Section	Start Support	End Support
1	1.7	R 600x600	Fixed	Roller Pin X
2	1.7	R 600x600	Roller Pin X	Fixed

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Span	Length (m)	Section	Start Support	End Support
R 600x600: Area 3600 cm ² , Inertia Major 1080000 cm ⁴ , Inertia Minor 1080000 cm ⁴ , Shear area parallel to Minor 3000 cm ² , Shear area parallel to Major = 3000 cm ²				
Concrete (C32 2500 Quartzite): Density 2500 kg/m ³ , Youngs 33.3457645 kN/mm ² , Shear 13.8940685 kN/mm ² , Thermal 0.00001 °C ⁻¹				

Loading

Self weight included



Load combination factors

Load combination	Self Weight	Permanent	Imposed
1.35G + 1.5Q + 1.5RQ (Strength)	1.35	1.35	1.50
1.0G + 1.0Q + 1.0RQ (Service)	1.00	1.00	1.00
1.0G + 1.0ψ ₂ Q (Quasi)	1.00	1.00	0.30

Member Loads

Member	Load case	Load Type	Orientation	Description
Beam	Permanent	UDL	GlobalZ	15.4 kN/m
Beam	Imposed	UDL	GlobalZ	5.6 kN/m

Results

Reactions

Load case: Self Weight

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	7.5	-2.1
2	0	15	0
3	0	7.5	2.1

Load case: Permanent

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	13.1	-3.7
2	0	26.2	0

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Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
3	0	13.1	3.7

Load case: Imposed

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	4.8	-1.3
2	0	9.5	0
3	0	4.8	1.3

Load combination: 1.35G + 1.5Q + 1.5RQ (Strength)

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	34.9	-9.9
2	0	69.9	0
3	0	34.9	9.9

Load combination: 1.0G + 1.0Q + 1.0RQ (Service)

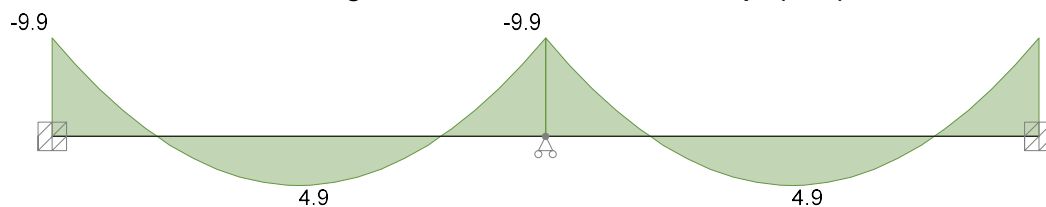
Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	25.4	-7.2
2	0	50.7	0
3	0	25.4	7.2

Load combination: 1.0G + 1.0 ψ_2 Q (Quasi)

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	22	-6.2
2	0	44	0
3	0	22	6.2

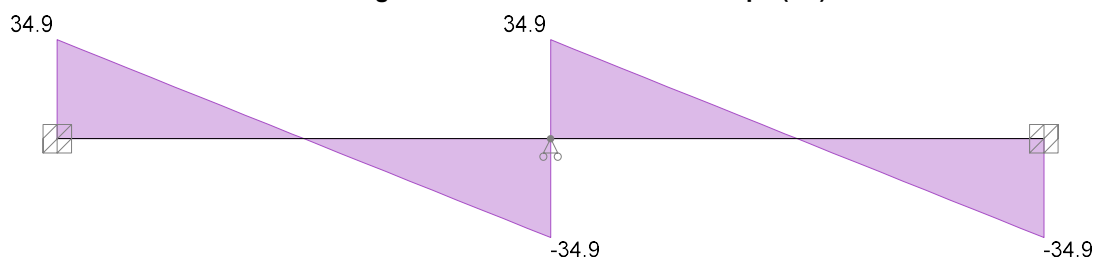
Forces

Strength combinations - Moment envelope (kNm)



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Strength combinations - Shear envelope (kN)



Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Beam	0	34.9 (max abs)		-9.9 (min)	
	0.85	0		4.9 (max)	
	1.7	34.9 (max abs)	-34.9	-9.9 (min)	

;

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

Concrete strength class; C32/40; Char. comp. cylinder strength; $f_{ck} = 32 \text{ N/mm}^2$
 Design comp conc. strength; $f_{c wd} = 21.3 \text{ N/mm}^2$; Maximum aggregate size; $h_{agg} = 20 \text{ mm}$

Reinforcement details

Char. yield strength of reinf.; $f_{yk} = 500 \text{ N/mm}^2$; Partial factor for reinf. steel; $\gamma_s = 1.15$
 Design yield strength of reinf.; $f_{yd} = 435 \text{ N/mm}^2$

Nominal cover to reinforcement

Nominal cover to top reinf; $c_{nom_t} = 50 \text{ mm}$; Nominal cover to bottom reinf; $c_{nom_b} = 50 \text{ mm}$
 Nominal cover to side reinf; $c_{nom_s} = 50 \text{ mm}$

Fire resistance

Standard fire resistance period; $R = 60 \text{ min}$; No. sides exposed to fire; 3
 Minimum width of beam; $b_{min} = 120 \text{ mm}$

Beam - Span 1

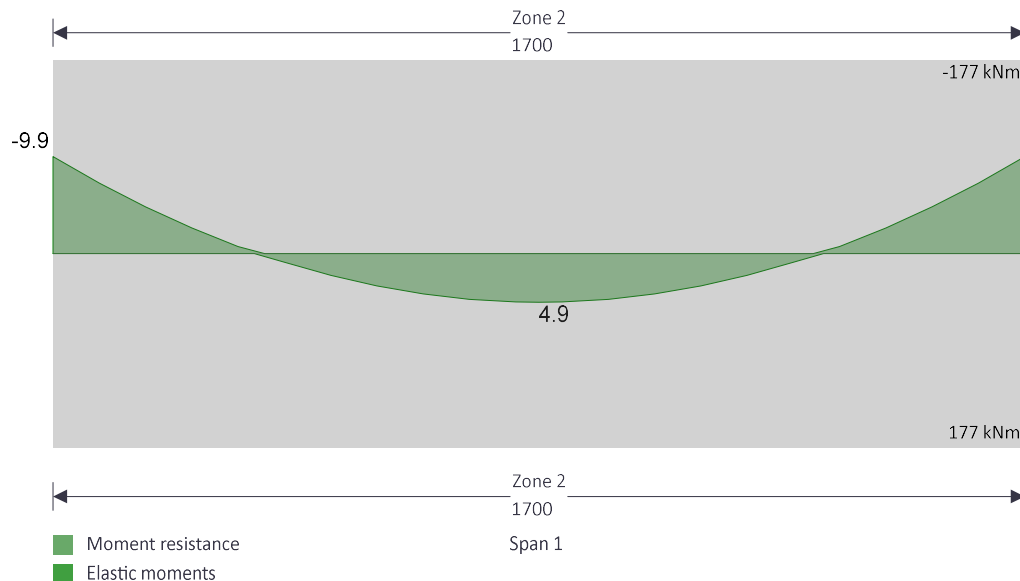
Rectangular section details

Section width; $b = 600 \text{ mm}$; Section depth; $h = 600 \text{ mm}$

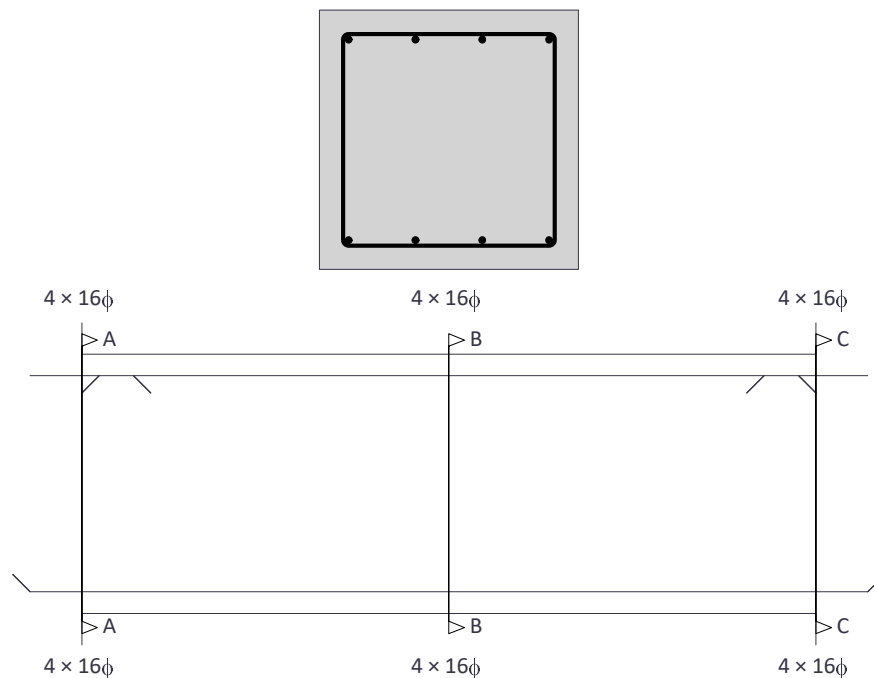
PASS - Minimum dimensions for fire resistance met

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Moment design



B - B



Zone 1 (0 mm - 0 mm) Negative moment - section 6.1

Design bending moment; $M = 9.9 \text{ kNm}$; Effective depth tension reinf.; $d = 534 \text{ mm}$
Area of tension reinf. req'd; $A_{s,req} = 45 \text{ mm}^2$; Area of tension reinf. prov; $A_{s,prov} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N); $A_{s,min} = 504 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400 \text{ mm}^2$

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{s,min} = 620 \text{ mm}^2$

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

Quasi-permanent moment; $M_{QP} = 6.2 \text{ kNm}$

Actual tension bar spacing; $s_{bar} = 156 \text{ mm}$;

Max bar spacing (Table 7.3N); $s_{bar,max} = 300 \text{ mm}$

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PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 140.0$ mm;

Min allow. top bar spacing; $S_{top,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $S_{bot} = 140.0$ mm;

Min allow. bottom bar spacing; $S_{bot,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (0 mm - 1700 mm) Positive moment - section 6.1

Design bending moment; $M = 4.9$ kNm;

Effective depth tension reinf.; $d = 534$ mm

Area of tension reinf. req'd; $A_{s,req} = 22$ mm²;

Area of tension reinf. prov; $A_{s,prov} = 804$ mm²

Min area of reinf. (exp.9.1N); $A_{s,min} = 504$ mm²;

Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm;

Min area reinf req'd (exp.7.1); $A_{sc,min} = 617$ mm²

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

Quasi-permanent moment; $M_{QP} = 3.1$ kNm

Actual tension bar spacing; $S_{bar} = 154.7$ mm;

Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $span_to_depth_{allow} = 52.000$;

Actual span to depth ratio; $span_to_depth_{actual} = 3.184$

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

Zone 2 (0 mm - 1700 mm) Negative moment - section 6.1

Design bending moment; $M = 9.9$ kNm;

Effective depth tension reinf.; $d = 532$ mm

Area of tension reinf. req'd; $A_{s,req} = 45$ mm²;

Area of tension reinf. prov; $A_{s,prov} = 804$ mm²

Min area of reinf. (exp.9.1N); $A_{s,min} = 502$ mm²;

Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm;

Min area reinf req'd (exp.7.1); $A_{sc,min} = 617$ mm²

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

Quasi-permanent moment; $M_{QP} = 6.2$ kNm

Actual tension bar spacing; $S_{bar} = 154.7$ mm;

Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $span_to_depth_{allow} = 52.000$;

Actual span to depth ratio; $span_to_depth_{actual} = 3.195$

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

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 138.7$ mm;

Min allow. top bar spacing; $S_{top,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

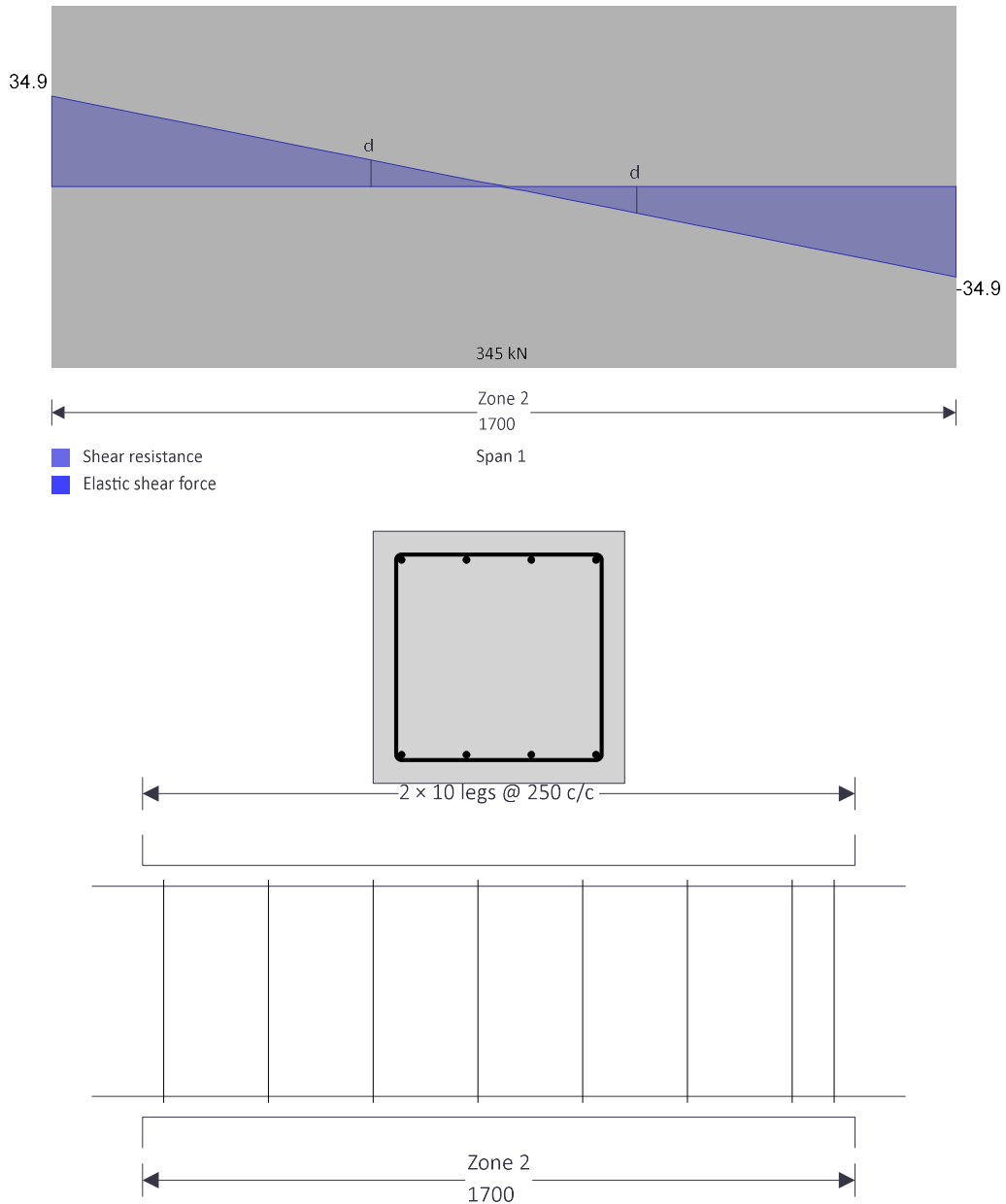
Bottom bar spacing; $S_{bot} = 138.7$ mm;

Min allow. bottom bar spacing; $S_{bot,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

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Calcs for Ring Beam 1-1				Start page no./Revision 15	
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Shear design



Angle of comp. shear strut; $\theta_{\max} = 45 \text{ deg};$

Compression chord coefficient; $\alpha_{cw} = 1.00;$

Strength reduction factor; $v_1 = 0.523$

Minimum area of shear reinf.; $A_{sv,\min} = 543 \text{ mm}^2/\text{m}$

Zone 2 (0 mm - 1700 mm) shear - section 6.2

Shear force at support; $V_{Ed,\max} = 10 \text{ kN};$

Max design shear resistance; $V_{Rd,\max} = 1692 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force; $V_{Ed} = 10 \text{ kN};$

Area shear reinf. req'd; $A_{sv,\text{req}} = 543 \text{ mm}^2/\text{m}$

Area of shear reinf prov.; $A_{sv,\text{prov}} = 628 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N; $s_{vl,\max} = 399 \text{ mm}$

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

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Beam - Span 2

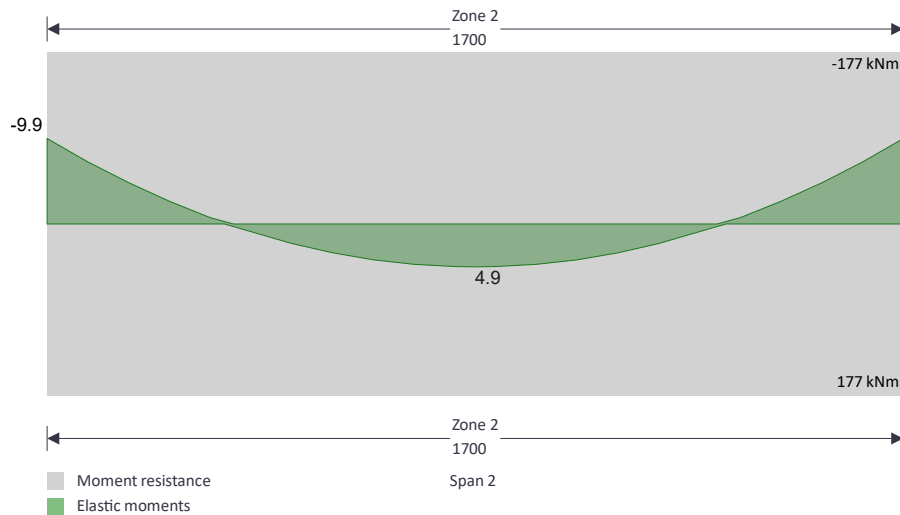
Rectangular section details

Section width; $b = 600$ mm;

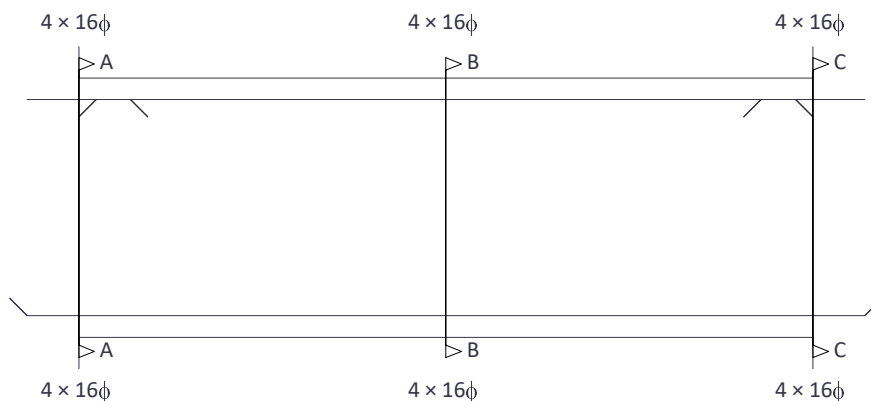
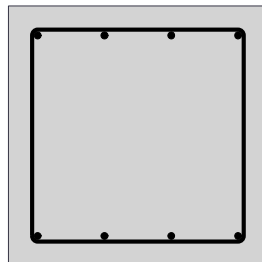
Section depth; $h = 600$ mm

PASS - Minimum dimensions for fire resistance met

Moment design



B - B



Zone 2 (0 mm - 1700 mm) Positive moment - section 6.1

Design bending moment; $M = 4.9$ kNm;

Effective depth tension reinf.; $d = 534$ mm

Area of tension reinf. req'd; $A_{s,req} = 22$ mm²;

Area of tension reinf. prov; $A_{s,prov} = 804$ mm²

Min area of reinf. (exp.9.1N); $A_{s,min} = 504$ mm²;

Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm;

Min area reinf req'd (exp.7.1); $A_{s,min} = 617$ mm²

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

Quasi-permanent moment; $M_{QP} = 3.1 \text{ kNm}$

Actual tension bar spacing; $S_{bar} = 154.7 \text{ mm}$; Max bar spacing (Table 7.3N); $S_{bar,max} = 300 \text{ mm}$

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $\text{span_to_depth}_{allow} = 52.000$; Actual span to depth ratio; $\text{span_to_depth}_{actual} = 3.184$

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

Zone 2 (0 mm - 1700 mm) Negative moment - section 6.1

Design bending moment; $M = 9.9 \text{ kNm}$; Effective depth tension reinf.; $d = 532 \text{ mm}$

Area of tension reinf. req'd; $A_{s,req} = 45 \text{ mm}^2$; Area of tension reinf. prov; $A_{s,prov} = 804 \text{ mm}^2$

Min area of reinf. (exp.9.1N); $A_{s,min} = 502 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400 \text{ mm}^2$

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{sc,min} = 617 \text{ mm}^2$

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

Quasi-permanent moment; $M_{QP} = 6.2 \text{ kNm}$

Actual tension bar spacing; $S_{bar} = 154.7 \text{ mm}$; Max bar spacing (Table 7.3N); $S_{bar,max} = 300 \text{ mm}$

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $\text{span_to_depth}_{allow} = 52.000$; Actual span to depth ratio; $\text{span_to_depth}_{actual} = 3.195$

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

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 138.7 \text{ mm}$; Min allow. top bar spacing; $S_{top,min} = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $S_{bot} = 138.7 \text{ mm}$; Min allow. bottom bar spacing; $S_{bot,min} = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (1700 mm - 1700 mm) Negative moment - section 6.1

Design bending moment; $M = 9.9 \text{ kNm}$; Effective depth tension reinf.; $d = 534 \text{ mm}$

Area of tension reinf. req'd; $A_{s,req} = 45 \text{ mm}^2$; Area of tension reinf. prov; $A_{s,prov} = 804 \text{ mm}^2$

Min area of reinf. (exp.9.1N); $A_{s,min} = 504 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400 \text{ mm}^2$

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{sc,min} = 620 \text{ mm}^2$

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

Quasi-permanent moment; $M_{QP} = 6.2 \text{ kNm}$

Actual tension bar spacing; $S_{bar} = 156 \text{ mm}$; Max bar spacing (Table 7.3N); $S_{bar,max} = 300 \text{ mm}$

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 140.0 \text{ mm}$; Min allow. top bar spacing; $S_{top,min} = 25.0 \text{ mm}$

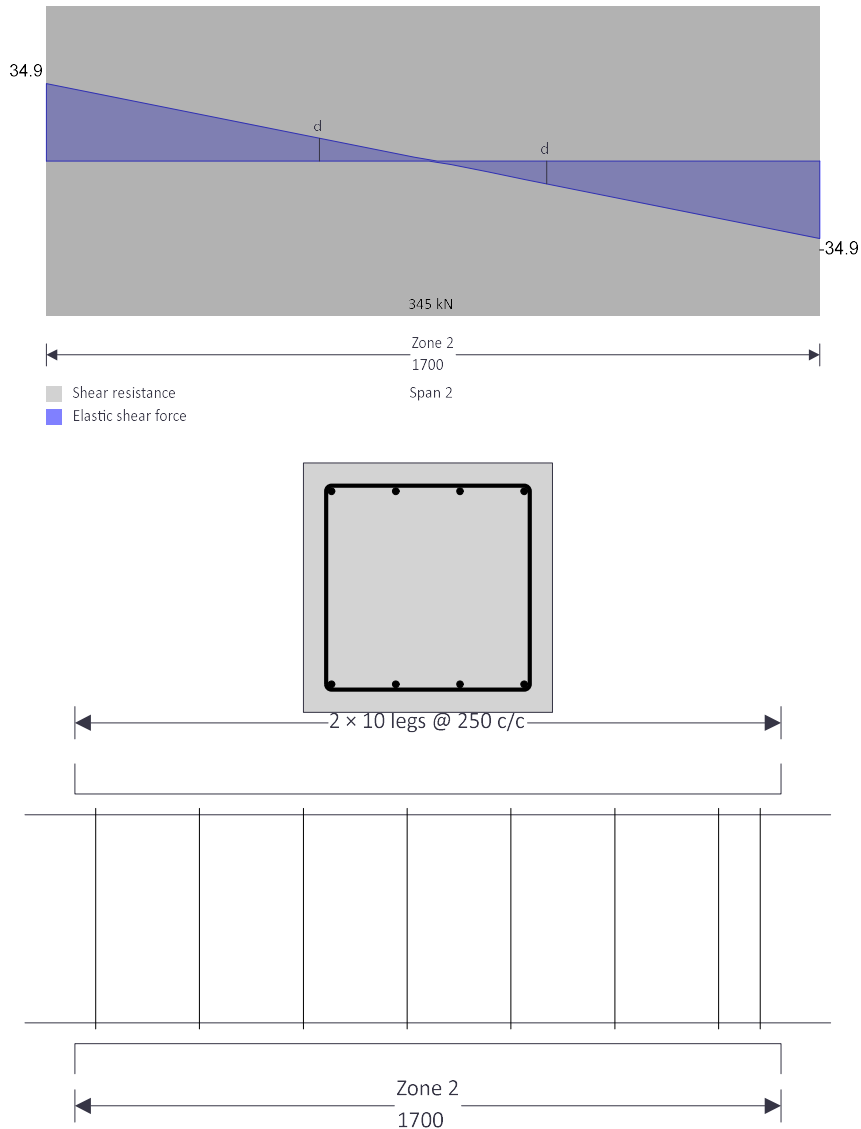
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $S_{bot} = 140.0 \text{ mm}$; Min allow. bottom bar spacing; $S_{bot,min} = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

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Shear design



Angle of comp. shear strut; $\theta_{\max} = 45 \text{ deg}$;

Compression chord coefficient; $\alpha_{cw} = 1.00$;

Strength reduction factor; $v_1 = 0.523$

Minimum area of shear reinf.; $A_{sv,\min} = 543 \text{ mm}^2/\text{m}$

Zone 2 (0 mm - 1700 mm) shear - section 6.2

Shear force at support; $V_{Ed,\max} = 10 \text{ kN}$;

Max design shear resistance; $V_{Rd,\max} = 1692 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force; $V_{Ed} = 10 \text{ kN}$;

Area shear reinf. req'd; $A_{sv,\text{req}} = 543 \text{ mm}^2/\text{m}$

Area of shear reinf prov.; $A_{sv,\text{prov}} = 628 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N; $s_{vl,\max} = 399 \text{ mm}$

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

NOTE: Crack control is in accordance with cl.7.3.3 which makes design assumptions detailed in Table 7.2N. For designs falling outside these parameters a more detailed crack check may be required.

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RC BEAM ANALYSIS & DESIGN (EN1992) RING BEAM 2-2

RC MEMBER ANALYSIS & DESIGN (EN1992-1-1:2004)

In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national annex

Tedds calculation version 3.3.11

Design summary

Span 1 moment design reinforcement (including crack requirements)

	Unit	Provided	Required	Utilisation	Result
Zone 1 top	-	-	--		Length of zone 0mmZone 1 top
Zone 1 bot	-	-	--		Length of zone 0mmZone 1 bot
Zone 2 top (-14.2 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 2 bot (7.1 kNm)	mm ²	804	618	0.768	PASS (crack width)
Zone 3 top	-	-	--		Length of zone 0mmZone 3 top
Zone 3 bot	-	-	--		Length of zone 0mmZone 3 bot
Span to depth ratio		3.61	52.00	0.069	PASS

Span 1 shear design reinforcement

	Unit	Provided	Required	Utilisation	Result
Zone 1	-	-	-	-	Length of zone 0mm
Zone 2 (15.7 kN)	mm ² /m	628	543	0.864	PASS
Zone 3	-	-	-	-	Length of zone 0mm

Span 2 moment design reinforcement (including crack requirements)

	Unit	Provided	Required	Utilisation	Result
Zone 1 top	-	-	--		Length of zone 0mmZone 1 top
Zone 1 bot	-	-	--		Length of zone 0mmZone 1 bot
Zone 2 top (-14.2 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 2 bot (7.1 kNm)	mm ²	804	618	0.768	PASS (crack width)
Zone 3 top	-	-	--		Length of zone 0mmZone 3 top
Zone 3 bot	-	-	--		Length of zone 0mmZone 3 bot
Span to depth ratio		3.61	52.00	0.069	PASS

Span 2 shear design reinforcement

	Unit	Provided	Required	Utilisation	Result
Zone 1	-	-	-	-	Length of zone 0mm
Zone 2 (15.7 kN)	mm ² /m	628	543	0.864	PASS
Zone 3	-	-	-	-	Length of zone 0mm

ANALYSIS

Tedds calculation version 1.0.38

Geometry

Geometry (m) - Concrete (C32 2500 Quartzite) - R 600x600



Span	Length (m)	Section	Start Support	End Support
1	1.8	R 600x600	Fixed	Roller Pin X
2	1.8	R 600x600	Roller Pin X	Fixed

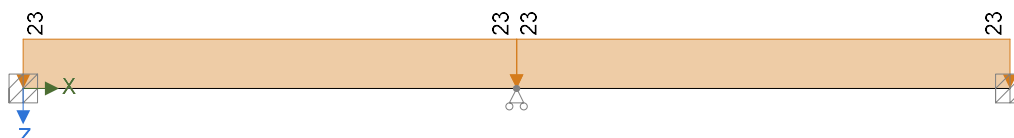
Project				Job no.	
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Calcs for				Start page no./Revision	
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Span	Length (m)	Section	Start Support	End Support
R 600x600: Area 3600 cm ² , Inertia Major 1080000 cm ⁴ , Inertia Minor 1080000 cm ⁴ , Shear area parallel to Minor 3000 cm ² , Shear area parallel to Major = 3000 cm ²				
Concrete (C32 2500 Quartzite): Density 2500 kg/m ³ , Youngs 33.3457645 kN/mm ² , Shear 13.8940685 kN/mm ² , Thermal 0.00001 °C ⁻¹				

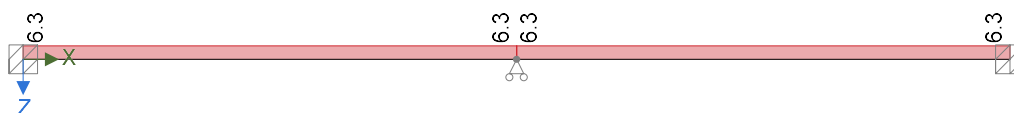
Loading

Self weight included

Permanent - Loading (kN/m)



Imposed - Loading (kN/m)



Load combination factors

Load combination	Self Weight	Permanent	Imposed
1.35G + 1.5Q + 1.5RQ (Strength)	1.35	1.35	1.50
1.0G + 1.0Q + 1.0RQ (Service)	1.00	1.00	1.00
1.0G + 1.0ψ ₂ Q (Quasi)	1.00	1.00	0.30

Member Loads

Member	Load case	Load Type	Orientation	Description
Beam	Permanent	UDL	GlobalZ	23 kN/m
Beam	Imposed	UDL	GlobalZ	6.3 kN/m

Results

Reactions

Load case: Self Weight

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	7.9	-2.4
2	0	15.9	0
3	0	7.9	2.4

Load case: Permanent

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	20.7	-6.2
2	0	41.4	0
3	0	20.7	6.2

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Load case: Imposed

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	5.7	-1.7
2	0	11.3	0
3	0	5.7	1.7

Load combination: 1.35G + 1.5Q + 1.5RQ (Strength)

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	47.2	-14.2
2	0	94.3	0
3	0	47.2	14.2

Load combination: 1.0G + 1.0Q + 1.0RQ (Service)

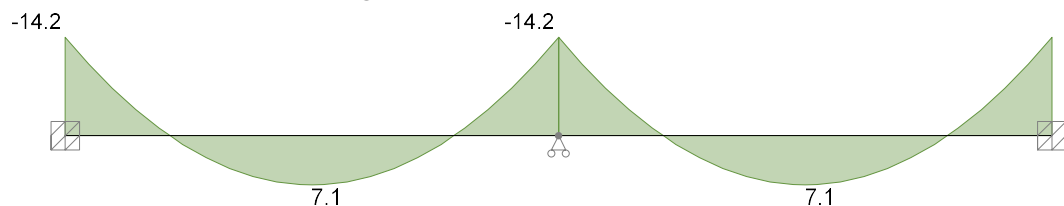
Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	34.3	-10.3
2	0	68.6	0
3	0	34.3	10.3

Load combination: 1.0G + 1.0 ψ_2 Q (Quasi)

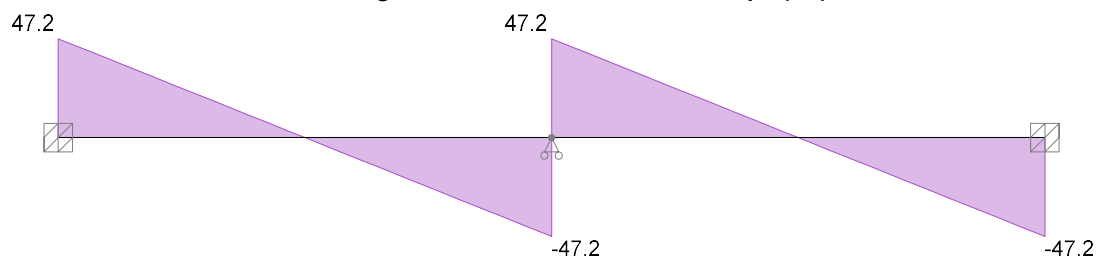
Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	30.3	-9.1
2	0	60.7	0
3	0	30.3	9.1

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



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Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Beam	0	47.2 (max abs)		-14.2 (min)	
	1.8	47.2 (max abs)	-47.2	-14.2 (min)	
	2.7	0		7.1 (max)	

;

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

Concrete strength class; C32/40; Char. comp. cylinder strength; $f_{ck} = 32 \text{ N/mm}^2$
 Design comp conc. strength; $f_{cwd} = 21.3 \text{ N/mm}^2$; Maximum aggregate size; $h_{agg} = 20 \text{ mm}$

Reinforcement details

Char. yield strength of reinf.; $f_{yk} = 500 \text{ N/mm}^2$; Partial factor for reinf. steel; $\gamma_s = 1.15$
 Design yield strength of reinf.; $f_{yd} = 435 \text{ N/mm}^2$

Nominal cover to reinforcement

Nominal cover to top reinf; $c_{nom_t} = 50 \text{ mm}$; Nominal cover to bottom reinf; $c_{nom_b} = 85 \text{ mm}$
 Nominal cover to side reinf; $c_{nom_s} = 50 \text{ mm}$

Fire resistance

Standard fire resistance period; $R = 60 \text{ min}$; No. sides exposed to fire; 3
 Minimum width of beam; $b_{min} = 120 \text{ mm}$

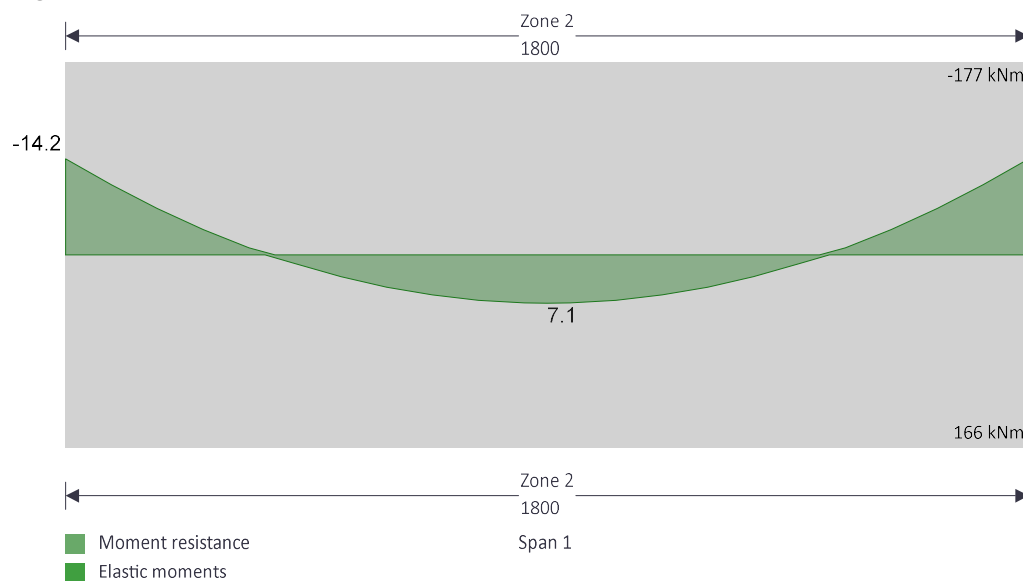
Beam - Span 1

Rectangular section details

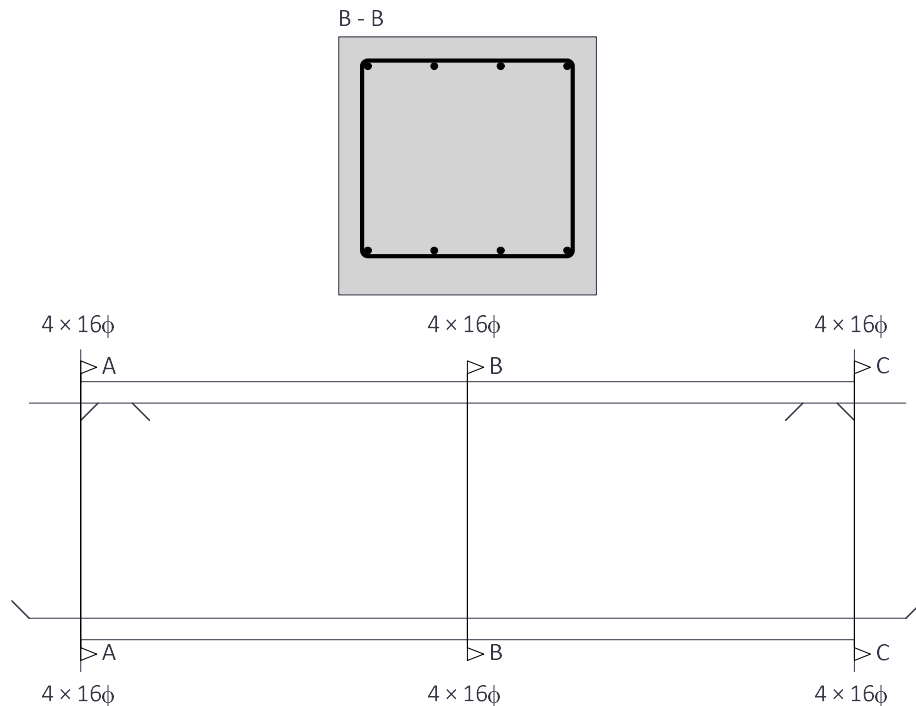
Section width; $b = 600 \text{ mm}$; Section depth; $h = 600 \text{ mm}$

PASS - Minimum dimensions for fire resistance met

Moment design



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Zone 1 (0 mm - 0 mm) Negative moment - section 6.1

Design bending moment; $M = 14.2 \text{ kNm}$; Effective depth tension reinf.; $d = 534 \text{ mm}$
Area of tension reinf. req'd; $A_{s, \text{req}} = 64 \text{ mm}^2$; Area of tension reinf. prov; $A_{s, \text{prov}} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N); $A_{s, \text{min}} = 504 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s, \text{max}} = 14400 \text{ mm}^2$

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{s, \text{c, min}} = 620 \text{ mm}^2$

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

Quasi-permanent moment; $M_{QP} = 9.1 \text{ kNm}$

Actual tension bar spacing; $s_{\text{bar}} = 156 \text{ mm}$; Max bar spacing (Table 7.3N); $s_{\text{bar, max}} = 300 \text{ mm}$

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $s_{\text{top}} = 140.0 \text{ mm}$; Min allow. top bar spacing; $s_{\text{top, min}} = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $s_{\text{bot}} = 140.0 \text{ mm}$; Min allow. bottom bar spacing; $s_{\text{bot, min}} = 25.0 \text{ mm}$

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (0 mm - 1800 mm) Positive moment - section 6.1

Design bending moment; $M = 7.1 \text{ kNm}$; Effective depth tension reinf.; $d = 499 \text{ mm}$
Area of tension reinf. req'd; $A_{s, \text{req}} = 34 \text{ mm}^2$; Area of tension reinf. prov; $A_{s, \text{prov}} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N); $A_{s, \text{min}} = 471 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s, \text{max}} = 14400 \text{ mm}^2$

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{s, \text{c, min}} = 618 \text{ mm}^2$

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

Quasi-permanent moment; $M_{QP} = 4.6 \text{ kNm}$

Actual tension bar spacing; $s_{\text{bar}} = 154.7 \text{ mm}$; Max bar spacing (Table 7.3N); $s_{\text{bar, max}} = 300 \text{ mm}$

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

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Deflection control - Section 7.4

Allow. span to depth ratio; $\text{span_to_depth}_{\text{allow}} = 52.000$; Actual span to depth ratio; $\text{span_to_depth}_{\text{actual}} = 3.607$
PASS - Actual span to depth ratio is within the allowable limit

Zone 2 (0 mm - 1800 mm) Negative moment - section 6.1

Design bending moment; $M = 14.2 \text{ kNm}$; Effective depth tension reinf.; $d = 532 \text{ mm}$
Area of tension reinf. req'd; $A_{s,\text{req}} = 64 \text{ mm}^2$; Area of tension reinf. prov; $A_{s,\text{prov}} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N); $A_{s,\text{min}} = 502 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s,\text{max}} = 14400 \text{ mm}^2$
PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{s,\text{c,min}} = 617 \text{ mm}^2$
PASS - Area of tension reinforcement provided exceeds minimum required for crack control
Quasi-permanent moment; $M_{\text{QP}} = 9.1 \text{ kNm}$
Actual tension bar spacing; $s_{\text{bar}} = 154.7 \text{ mm}$; Max bar spacing (Table 7.3N); $s_{\text{bar,max}} = 300 \text{ mm}$
PASS - Maximum bar spacing exceeds actual bar spacing for crack control

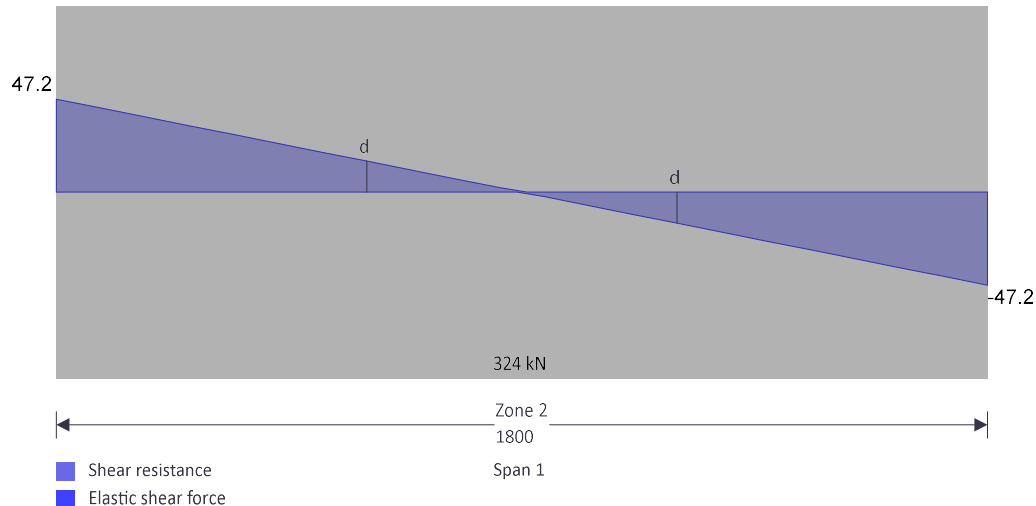
Deflection control - Section 7.4

Allow. span to depth ratio; $\text{span_to_depth}_{\text{allow}} = 52.000$; Actual span to depth ratio; $\text{span_to_depth}_{\text{actual}} = 3.383$
PASS - Actual span to depth ratio is within the allowable limit

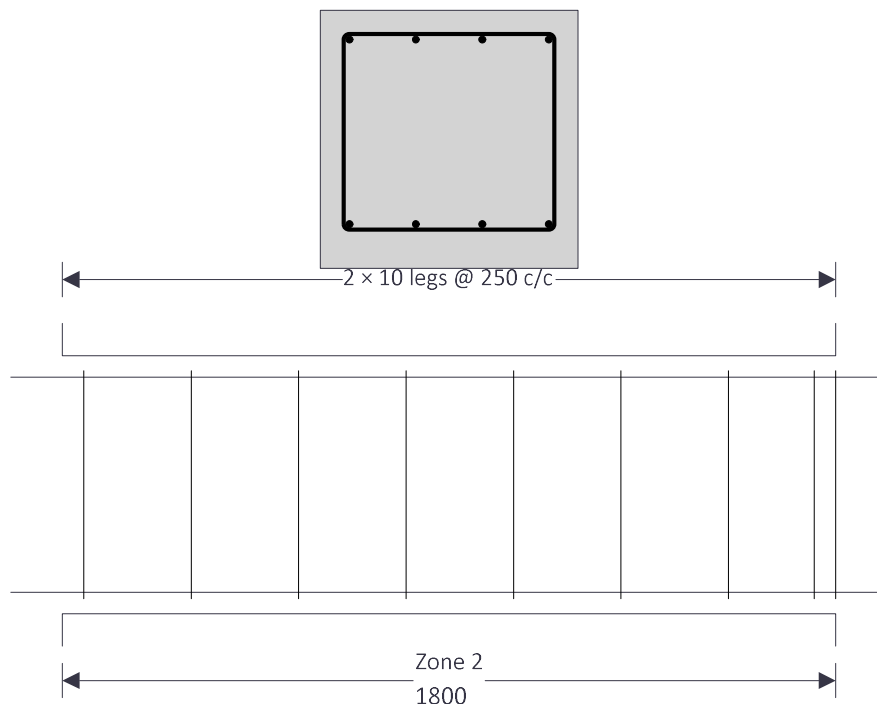
Minimum bar spacing (Section 8.2)

Top bar spacing; $s_{\text{top}} = 138.7 \text{ mm}$; Min allow. top bar spacing; $s_{\text{top,min}} = 25.0 \text{ mm}$
PASS - Actual bar spacing exceeds minimum allowable
Bottom bar spacing; $s_{\text{bot}} = 138.7 \text{ mm}$; Min allow. bottom bar spacing; $s_{\text{bot,min}} = 25.0 \text{ mm}$
PASS - Actual bar spacing exceeds minimum allowable

Shear design



Project Dakota House				Job no.	
Calcs for Ring Beam 2-2				Start page no./Revision 25	
Calcs by T	Calcs date 31/03/2025	Checked by	Checked date	Approved by	Approved date



Angle of comp. shear strut; $\theta_{\max} = 45 \text{ deg}$;

Compression chord coefficient; $\alpha_{cw} = 1.00$;

Strength reduction factor; $v_1 = 0.523$

Minimum area of shear reinf.; $A_{sv,\min} = 543 \text{ mm}^2/\text{m}$

Zone 2 (0 mm - 1800 mm) shear - section 6.2

Shear force at support; $V_{Ed,\max} = 16 \text{ kN}$;

Max design shear resistance; $V_{Rd,\max} = 1587 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force; $V_{Ed} = 16 \text{ kN}$;

Area shear reinf. req'd; $A_{sv,\text{req}} = 543 \text{ mm}^2/\text{m}$

Area of shear reinf prov.; $A_{sv,\text{prov}} = 628 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N; $s_{vl,\max} = 374 \text{ mm}$

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

Beam - Span 2

Rectangular section details

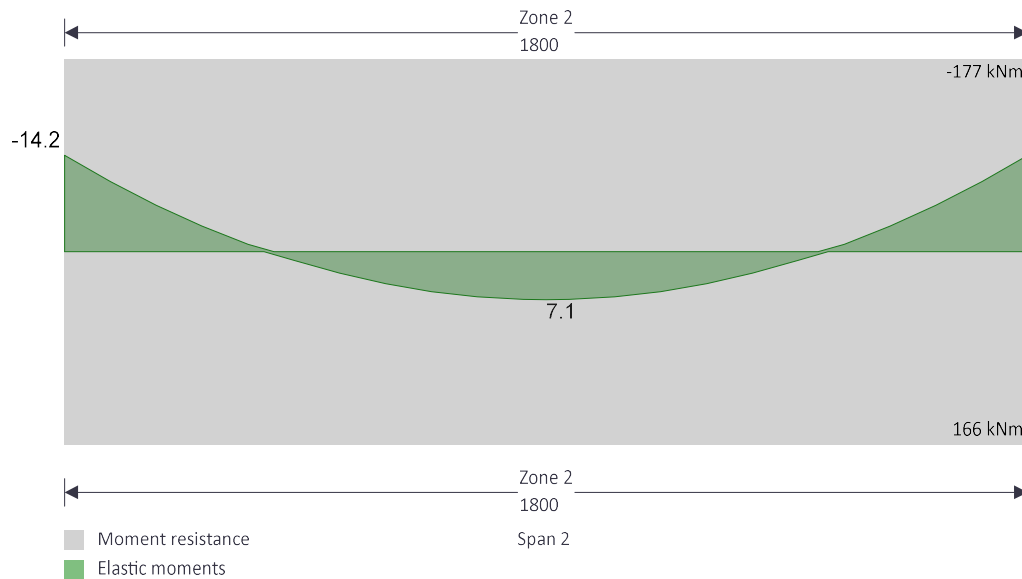
Section width; $b = 600 \text{ mm}$;

Section depth; $h = 600 \text{ mm}$

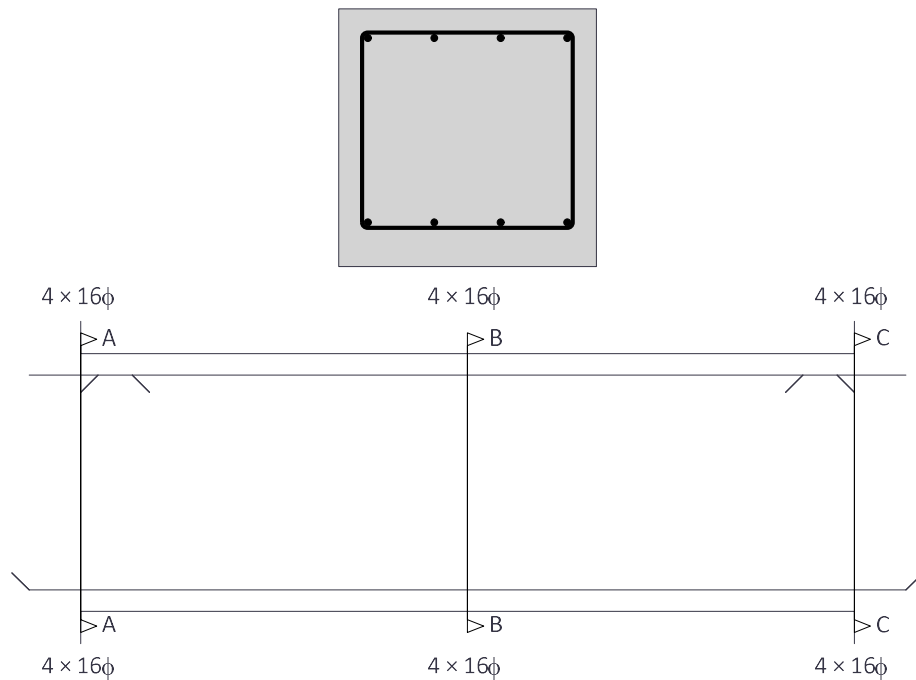
PASS - Minimum dimensions for fire resistance met

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Moment design



B - B



Zone 2 (0 mm - 1800 mm) Positive moment - section 6.1

Design bending moment; $M = 7.1 \text{ kNm}$; Effective depth tension reinf.; $d = 499 \text{ mm}$
Area of tension reinf. req'd; $A_{s,req} = 34 \text{ mm}^2$; Area of tension reinf. prov; $A_{s,prov} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N); $A_{s,min} = 471 \text{ mm}^2$; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400 \text{ mm}^2$

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30 \text{ mm}$; Min area reinf req'd (exp.7.1); $A_{s,min} = 618 \text{ mm}^2$

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

Quasi-permanent moment; $M_{QP} = 4.6 \text{ kNm}$

Actual tension bar spacing; $s_{bar} = 154.7 \text{ mm}$;

Max bar spacing (Table 7.3N); $s_{bar,max} = 300 \text{ mm}$

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PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $\text{span_to_depth}_{\text{allow}} = 52.000$; Actual span to depth ratio; $\text{span_to_depth}_{\text{actual}} = 3.607$
PASS - Actual span to depth ratio is within the allowable limit

Zone 2 (0 mm - 1800 mm) Negative moment - section 6.1

Design bending moment; $M = 14.2$ kNm; Effective depth tension reinf.; $d = 532$ mm
Area of tension reinf. req'd; $A_{s,\text{req}} = 64$ mm²; Area of tension reinf. prov; $A_{s,\text{prov}} = 804$ mm²
Min area of reinf. (exp.9.1N); $A_{s,\text{min}} = 502$ mm²; Max area reinf. (cl.9.2.1.1(3)); $A_{s,\text{max}} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm; Min area reinf req'd (exp.7.1); $A_{s,c,\text{min}} = 617$ mm²

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

Quasi-permanent moment; $M_{QP} = 9.1$ kNm

Actual tension bar spacing; $S_{\text{bar}} = 154.7$ mm; Max bar spacing (Table 7.3N); $S_{\text{bar},\text{max}} = 300$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $\text{span_to_depth}_{\text{allow}} = 52.000$; Actual span to depth ratio; $\text{span_to_depth}_{\text{actual}} = 3.383$
PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{\text{top}} = 138.7$ mm; Min allow. top bar spacing; $S_{\text{top},\text{min}} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $S_{\text{bot}} = 138.7$ mm; Min allow. bottom bar spacing; $S_{\text{bot},\text{min}} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (1800 mm - 1800 mm) Negative moment - section 6.1

Design bending moment; $M = 14.2$ kNm; Effective depth tension reinf.; $d = 534$ mm
Area of tension reinf. req'd; $A_{s,\text{req}} = 64$ mm²; Area of tension reinf. prov; $A_{s,\text{prov}} = 804$ mm²
Min area of reinf. (exp.9.1N); $A_{s,\text{min}} = 504$ mm²; Max area reinf. (cl.9.2.1.1(3)); $A_{s,\text{max}} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm; Min area reinf req'd (exp.7.1); $A_{s,c,\text{min}} = 620$ mm²

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

Quasi-permanent moment; $M_{QP} = 9.1$ kNm

Actual tension bar spacing; $S_{\text{bar}} = 156$ mm; Max bar spacing (Table 7.3N); $S_{\text{bar},\text{max}} = 300$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{\text{top}} = 140.0$ mm; Min allow. top bar spacing; $S_{\text{top},\text{min}} = 25.0$ mm

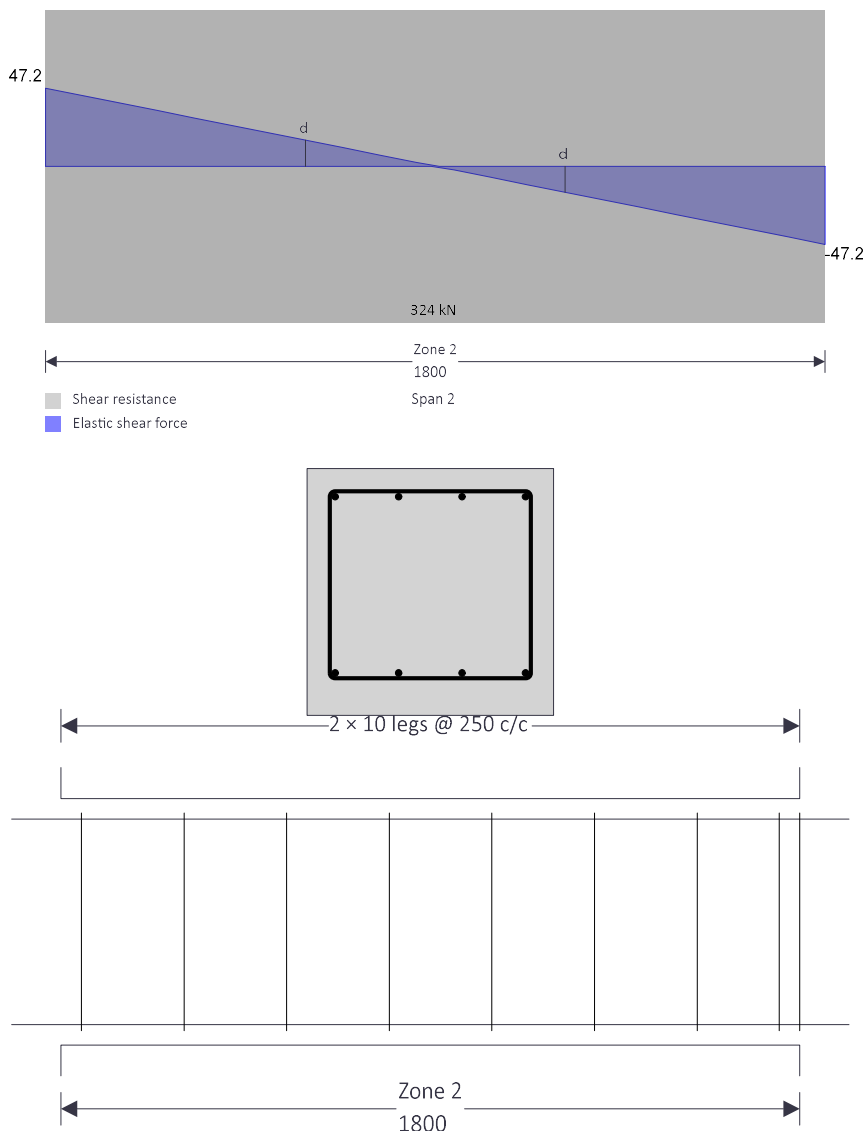
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $S_{\text{bot}} = 140.0$ mm; Min allow. bottom bar spacing; $S_{\text{bot},\text{min}} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

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Shear design



Angle of comp. shear strut; $\theta_{\max} = 45 \text{ deg}$;

Compression chord coefficient; $\alpha_{cw} = 1.00$;

Strength reduction factor; $v_1 = 0.523$

Minimum area of shear reinf.; $A_{sv,\min} = 543 \text{ mm}^2/\text{m}$

Zone 2 (0 mm - 1800 mm) shear - section 6.2

Shear force at support; $V_{Ed,\max} = 16 \text{ kN}$;

Max design shear resistance; $V_{Rd,\max} = 1587 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force; $V_{Ed} = 16 \text{ kN}$;

Area shear reinf. req'd; $A_{sv,\text{req}} = 543 \text{ mm}^2/\text{m}$

Area of shear reinf prov.; $A_{sv,\text{prov}} = 628 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N; $s_{vl,\max} = 374 \text{ mm}$

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

NOTE: Crack control is in accordance with cl.7.3.3 which makes design assumptions detailed in Table 7.2N. For designs falling outside these parameters a more detailed crack check may be required.

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RC BEAM ANALYSIS & DESIGN (EN1992) RING BEAM 3-3

RC MEMBER ANALYSIS & DESIGN (EN1992-1-1:2004)

In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national annex

Tedds calculation version 3.3.11

Design summary

Span 1 moment design reinforcement (including crack requirements)

	Unit	Provided	Required	Utilisation	Result
Zone 1 top	-	-	--		Length of zone 0mmZone 1 top
Zone 1 bot	-	-	--		Length of zone 0mmZone 1 bot
Zone 2 top (-16.1 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 2 bot (8.1 kNm)	mm ²	804	618	0.768	PASS (crack width)
Zone 3 top	-	-	--		Length of zone 0mmZone 3 top
Zone 3 bot	-	-	--		Length of zone 0mmZone 3 bot
Span to depth ratio		3.61	52.00	0.069	PASS

Span 1 shear design reinforcement

	Unit	Provided	Required	Utilisation	Result
Zone 1	-	-	-	-	Length of zone 0mm
Zone 2 (17.9 kN)	mm ² /m	628	543	0.864	PASS
Zone 3	-	-	-	-	Length of zone 0mm

Span 2 moment design reinforcement (including crack requirements)

	Unit	Provided	Required	Utilisation	Result
Zone 1 top	-	-	--		Length of zone 0mmZone 1 top
Zone 1 bot	-	-	--		Length of zone 0mmZone 1 bot
Zone 2 top (-16.1 kNm)	mm ²	804	617	0.767	PASS (crack width)
Zone 2 bot (8.1 kNm)	mm ²	804	618	0.768	PASS (crack width)
Zone 3 top	-	-	--		Length of zone 0mmZone 3 top
Zone 3 bot	-	-	--		Length of zone 0mmZone 3 bot
Span to depth ratio		3.61	52.00	0.069	PASS

Span 2 shear design reinforcement

	Unit	Provided	Required	Utilisation	Result
Zone 1	-	-	-	-	Length of zone 0mm
Zone 2 (17.9 kN)	mm ² /m	628	543	0.864	PASS
Zone 3	-	-	-	-	Length of zone 0mm

ANALYSIS

Tedds calculation version 1.0.38

Geometry

Geometry (m) - Concrete (C32 2500 Quartzite) - R 600x600



Span	Length (m)	Section	Start Support	End Support
1	1.8	R 600x600	Fixed	Roller Pin X
2	1.8	R 600x600	Roller Pin X	Fixed

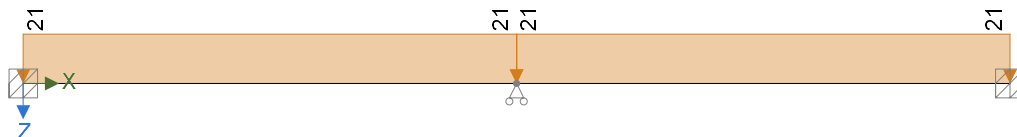
Project Dakota House				Job no.	
Calcs for Ring Beam 3-3				Start page no./Revision 30	
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Span	Length (m)	Section	Start Support	End Support
R 600x600: Area 3600 cm ² , Inertia Major 1080000 cm ⁴ , Inertia Minor 1080000 cm ⁴ , Shear area parallel to Minor 3000 cm ² , Shear area parallel to Major = 3000 cm ²				
Concrete (C32 2500 Quartzite): Density 2500 kg/m ³ , Youngs 33.3457645 kN/mm ² , Shear 13.8940685 kN/mm ² , Thermal 0.00001 °C ⁻¹				

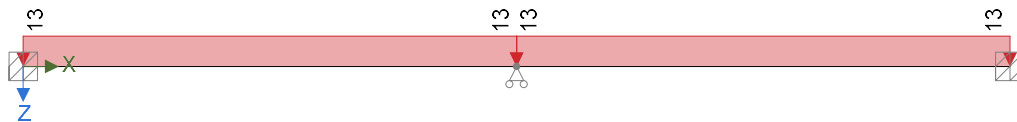
Loading

Self weight included

Permanent - Loading (kN/m)



Imposed - Loading (kN/m)



Load combination factors

Load combination	Self Weight	Permanent	Imposed
1.35G + 1.5Q + 1.5RQ (Strength)	1.35	1.35	1.50
1.0G + 1.0Q + 1.0RQ (Service)	1.00	1.00	1.00
1.0G + 1.0ψ ₂ Q (Quasi)	1.00	1.00	0.30

Member Loads

Member	Load case	Load Type	Orientation	Description
Beam	Permanent	UDL	GlobalZ	21 kN/m
Beam	Imposed	UDL	GlobalZ	13 kN/m

Results

Reactions

Load case: Self Weight

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	7.9	-2.4
2	0	15.9	0
3	0	7.9	2.4

Load case: Permanent

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	18.9	-5.7
2	0	37.8	0

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Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
3	0	18.9	5.7

Load case: Imposed

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	11.7	-3.5
2	0	23.4	0
3	0	11.7	3.5

Load combination: 1.35G + 1.5Q + 1.5RQ (Strength)

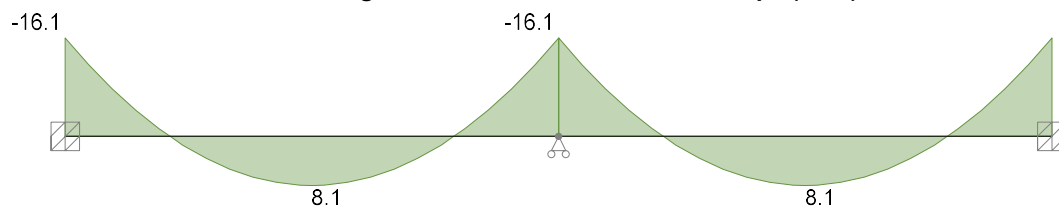
Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	53.8	-16.1
2	0	107.6	0
3	0	53.8	16.1

Load combination: 1.0G + 1.0Q + 1.0RQ (Service)

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	38.5	-11.6
2	0	77.1	0
3	0	38.5	11.6

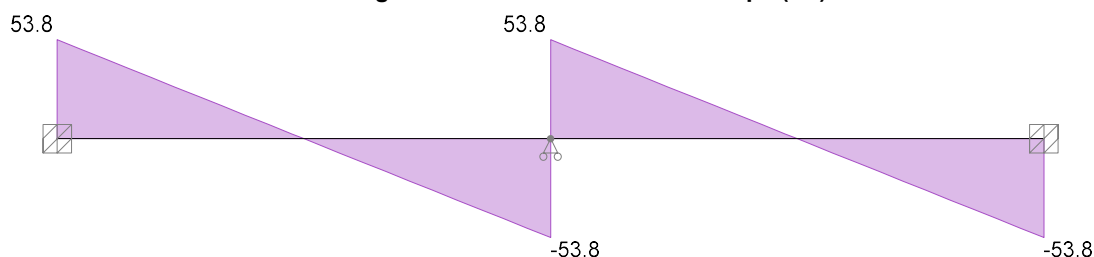
Load combination: 1.0G + 1.0 ψ_2 Q (Quasi)

Node	Force		Moment My (kNm)
	Fx (kN)	Fz (kN)	
1	0	30.4	-9.1
2	0	60.7	0
3	0	30.4	9.1

Forces
Strength combinations - Moment envelope (kNm)


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Strength combinations - Shear envelope (kN)



Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Beam	0	53.8 (max abs)		-16.1 (min)	
	1.8	53.8 (max abs)	-53.8	-16.1 (min)	
	2.7	0		8.1 (max)	

;

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

Concrete strength class; C32/40; Char. comp. cylinder strength; $f_{ck} = 32 \text{ N/mm}^2$
 Design comp conc. strength; $f_{cwd} = 21.3 \text{ N/mm}^2$; Maximum aggregate size; $h_{agg} = 20 \text{ mm}$

Reinforcement details

Char. yield strength of reinf.; $f_{yk} = 500 \text{ N/mm}^2$; Partial factor for reinf. steel; $\gamma_s = 1.15$
 Design yield strength of reinf.; $f_{yd} = 435 \text{ N/mm}^2$

Nominal cover to reinforcement

Nominal cover to top reinf; $c_{nom_t} = 50 \text{ mm}$; Nominal cover to bottom reinf; $c_{nom_b} = 85 \text{ mm}$
 Nominal cover to side reinf; $c_{nom_s} = 50 \text{ mm}$

Fire resistance

Standard fire resistance period; $R = 60 \text{ min}$; No. sides exposed to fire; 3
 Minimum width of beam; $b_{min} = 120 \text{ mm}$

Beam - Span 1

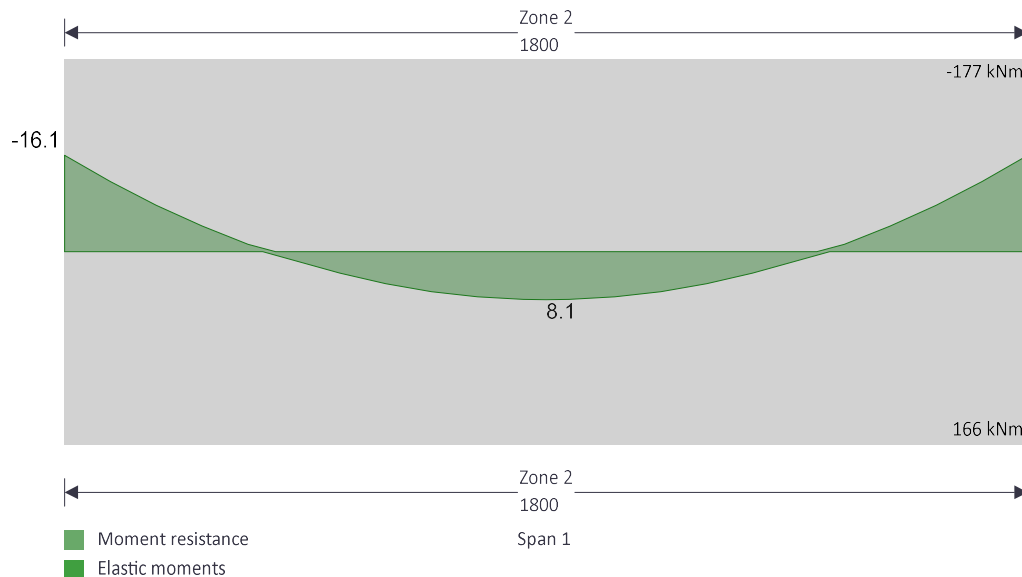
Rectangular section details

Section width; $b = 600 \text{ mm}$; Section depth; $h = 600 \text{ mm}$

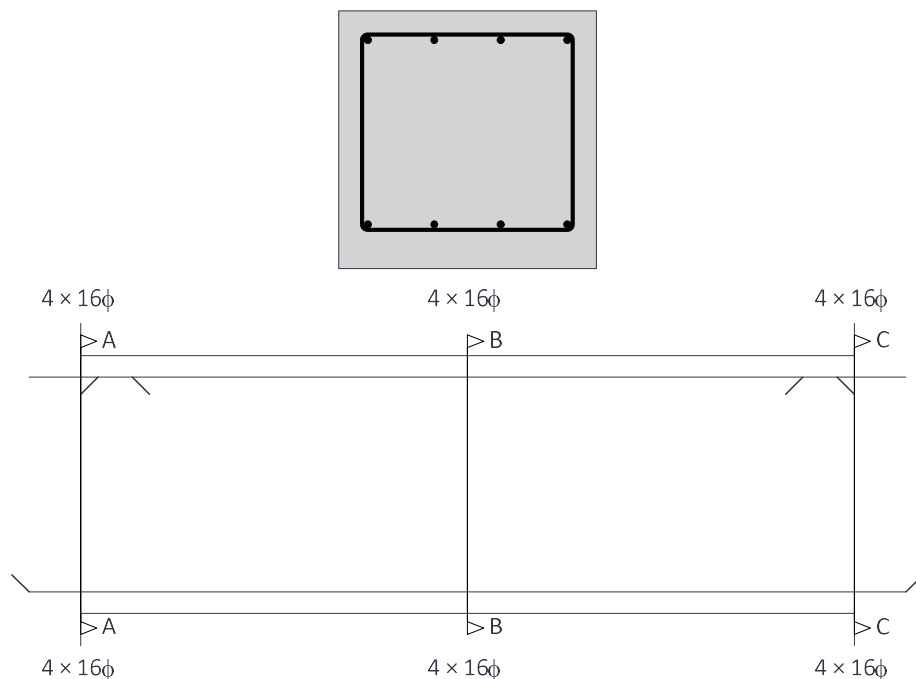
PASS - Minimum dimensions for fire resistance met

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Moment design



B - B



Zone 1 (0 mm - 0 mm) Negative moment - section 6.1

Design bending moment; $M = 16.1$ kNm; Effective depth tension reinf.; $d = 534$ mm
Area of tension reinf. req'd; $A_{s,req} = 73$ mm²; Area of tension reinf. prov; $A_{s,prov} = 804$ mm²
Min area of reinf. (exp.9.1N); $A_{s,min} = 504$ mm²; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm; Min area reinf req'd (exp.7.1); $A_{s,min} = 620$ mm²

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

Quasi-permanent moment; $M_{QP} = 9.1$ kNm

Actual tension bar spacing; $s_{bar} = 156$ mm;

Max bar spacing (Table 7.3N); $s_{bar,max} = 300$ mm

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PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 140.0$ mm;

Min allow. top bar spacing; $S_{top,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing; $S_{bot} = 140.0$ mm;

Min allow. bottom bar spacing; $S_{bot,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (0 mm - 1800 mm) Positive moment - section 6.1

Design bending moment; $M = 8.1$ kNm;

Effective depth tension reinf.; $d = 499$ mm

Area of tension reinf. req'd; $A_{s,req} = 39$ mm²;

Area of tension reinf. prov; $A_{s,prov} = 804$ mm²

Min area of reinf. (exp.9.1N); $A_{s,min} = 471$ mm²;

Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm;

Min area reinf req'd (exp.7.1); $A_{sc,min} = 618$ mm²

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

Quasi-permanent moment; $M_{QP} = 4.6$ kNm

Actual tension bar spacing; $S_{bar} = 154.7$ mm;

Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $span_to_depth_{allow} = 52.000$;

Actual span to depth ratio; $span_to_depth_{actual} = 3.607$

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

Zone 2 (0 mm - 1800 mm) Negative moment - section 6.1

Design bending moment; $M = 16.1$ kNm;

Effective depth tension reinf.; $d = 532$ mm

Area of tension reinf. req'd; $A_{s,req} = 73$ mm²;

Area of tension reinf. prov; $A_{s,prov} = 804$ mm²

Min area of reinf. (exp.9.1N); $A_{s,min} = 502$ mm²;

Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm;

Min area reinf req'd (exp.7.1); $A_{sc,min} = 617$ mm²

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

Quasi-permanent moment; $M_{QP} = 9.1$ kNm

Actual tension bar spacing; $S_{bar} = 154.7$ mm;

Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $span_to_depth_{allow} = 52.000$;

Actual span to depth ratio; $span_to_depth_{actual} = 3.383$

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

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 138.7$ mm;

Min allow. top bar spacing; $S_{top,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

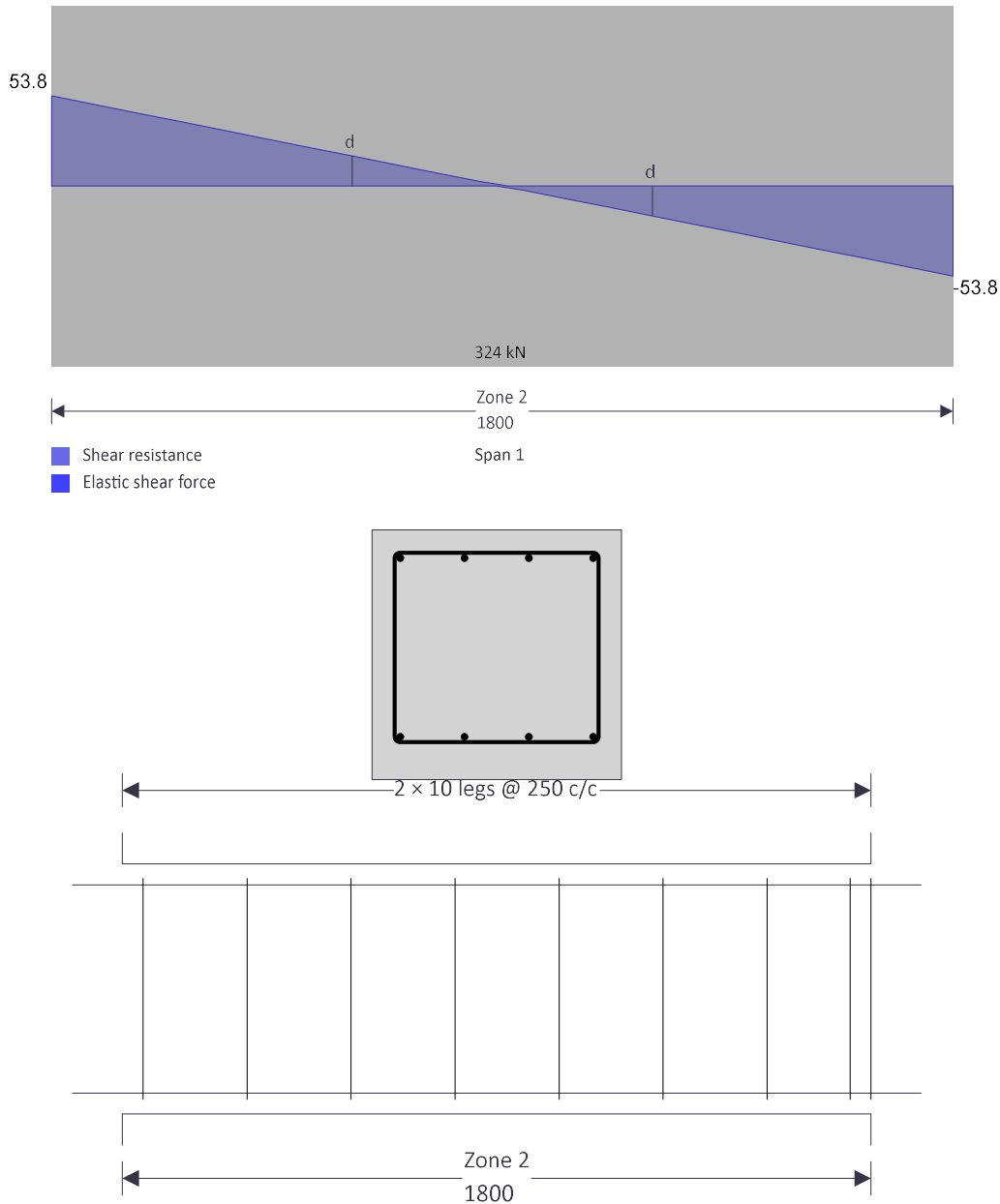
Bottom bar spacing; $S_{bot} = 138.7$ mm;

Min allow. bottom bar spacing; $S_{bot,min} = 25.0$ mm

PASS - Actual bar spacing exceeds minimum allowable

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Shear design



Angle of comp. shear strut; $\theta_{\max} = 45 \text{ deg};$

Compression chord coefficient; $\alpha_{cw} = 1.00;$

Strength reduction factor;

$v_1 = 0.523$

Minimum area of shear reinf.;

$A_{sv,\min} = 543 \text{ mm}^2/\text{m}$

Zone 2 (0 mm - 1800 mm) shear - section 6.2

Shear force at support; $V_{Ed,\max} = 18 \text{ kN};$

Max design shear resistance; $V_{Rd,\max} = 1587 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force; $V_{Ed} = 18 \text{ kN};$

Area shear reinf. req'd;

$A_{sv,\text{req}} = 543 \text{ mm}^2/\text{m}$

Area of shear reinf prov.; $A_{sv,\text{prov}} = 628 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp. 9.6N; $s_{vl,\max} = 374 \text{ mm}$

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

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Beam - Span 2

Rectangular section details

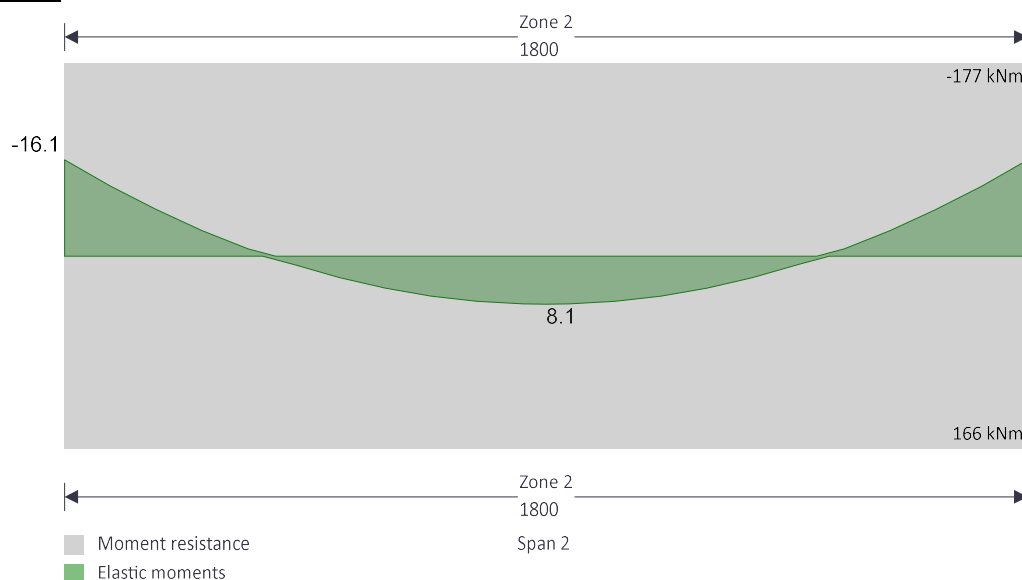
Section width; $b = 600$ mm;

Section depth;

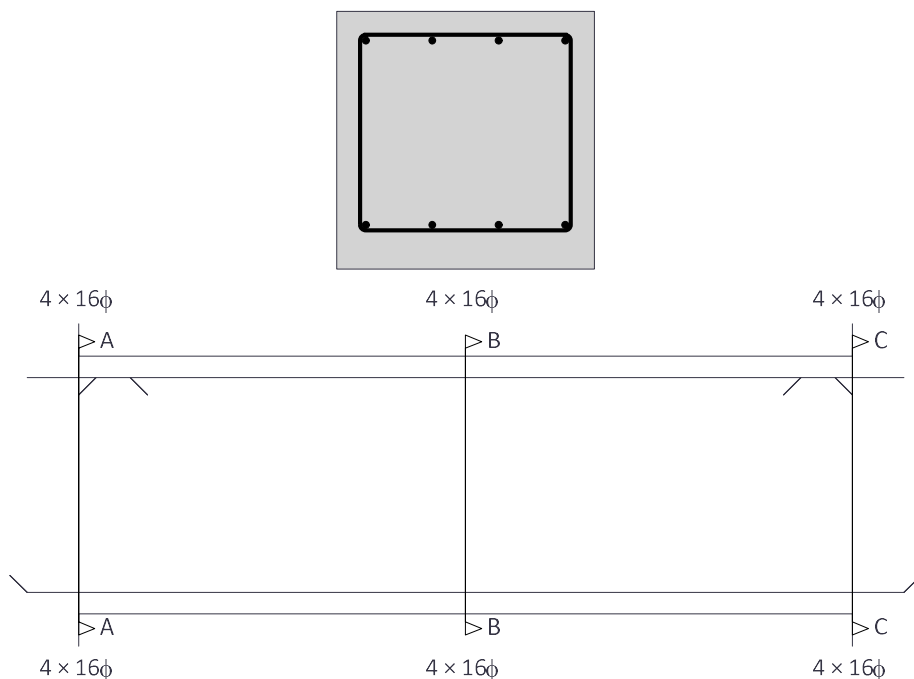
$h = 600$ mm

PASS - Minimum dimensions for fire resistance met

Moment design



B - B



Zone 2 (0 mm - 1800 mm) Positive moment - section 6.1

Design bending moment; $M = 8.1$ kNm;

Effective depth tension reinf.; $d = 499$ mm

Area of tension reinf. req'd; $A_{s,req} = 39$ mm²;

Area of tension reinf. prov; $A_{s,prov} = 804$ mm²

Min area of reinf. (exp.9.1N); $A_{s,min} = 471$ mm²;

Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²

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

Project Dakota House				Job no.	
Calcs for Ring Beam 3-3				Start page no./Revision 37	
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Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm; Min area reinf req'd (exp.7.1); $A_{sc,min} = 618$ mm²
PASS - Area of tension reinforcement provided exceeds minimum required for crack control
 Quasi-permanent moment; $M_{QP} = 4.6$ kNm
 Actual tension bar spacing; $S_{bar} = 154.7$ mm; Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm
PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $span_to_depth_{allow} = 52.000$; Actual span to depth ratio; $span_to_depth_{actual} = 3.607$
PASS - Actual span to depth ratio is within the allowable limit

Zone 2 (0 mm - 1800 mm) Negative moment - section 6.1

Design bending moment; $M = 16.1$ kNm; Effective depth tension reinf.; $d = 532$ mm
 Area of tension reinf. req'd; $A_{s,req} = 73$ mm²; Area of tension reinf. prov; $A_{s,prov} = 804$ mm²
 Min area of reinf. (exp.9.1N); $A_{s,min} = 502$ mm²; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²
PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width; $w_k = 0.30$ mm; Min area reinf req'd (exp.7.1); $A_{sc,min} = 617$ mm²
PASS - Area of tension reinforcement provided exceeds minimum required for crack control
 Quasi-permanent moment; $M_{QP} = 9.1$ kNm
 Actual tension bar spacing; $S_{bar} = 154.7$ mm; Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm
PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio; $span_to_depth_{allow} = 52.000$; Actual span to depth ratio; $span_to_depth_{actual} = 3.383$
PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 138.7$ mm; Min allow. top bar spacing; $S_{top,min} = 25.0$ mm
PASS - Actual bar spacing exceeds minimum allowable
 Bottom bar spacing; $S_{bot} = 138.7$ mm; Min allow. bottom bar spacing; $S_{bot,min} = 25.0$ mm
PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (1800 mm - 1800 mm) Negative moment - section 6.1

Design bending moment; $M = 16.1$ kNm; Effective depth tension reinf.; $d = 534$ mm
 Area of tension reinf. req'd; $A_{s,req} = 73$ mm²; Area of tension reinf. prov; $A_{s,prov} = 804$ mm²
 Min area of reinf. (exp.9.1N); $A_{s,min} = 504$ mm²; Max area reinf. (cl.9.2.1.1(3)); $A_{s,max} = 14400$ mm²
PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

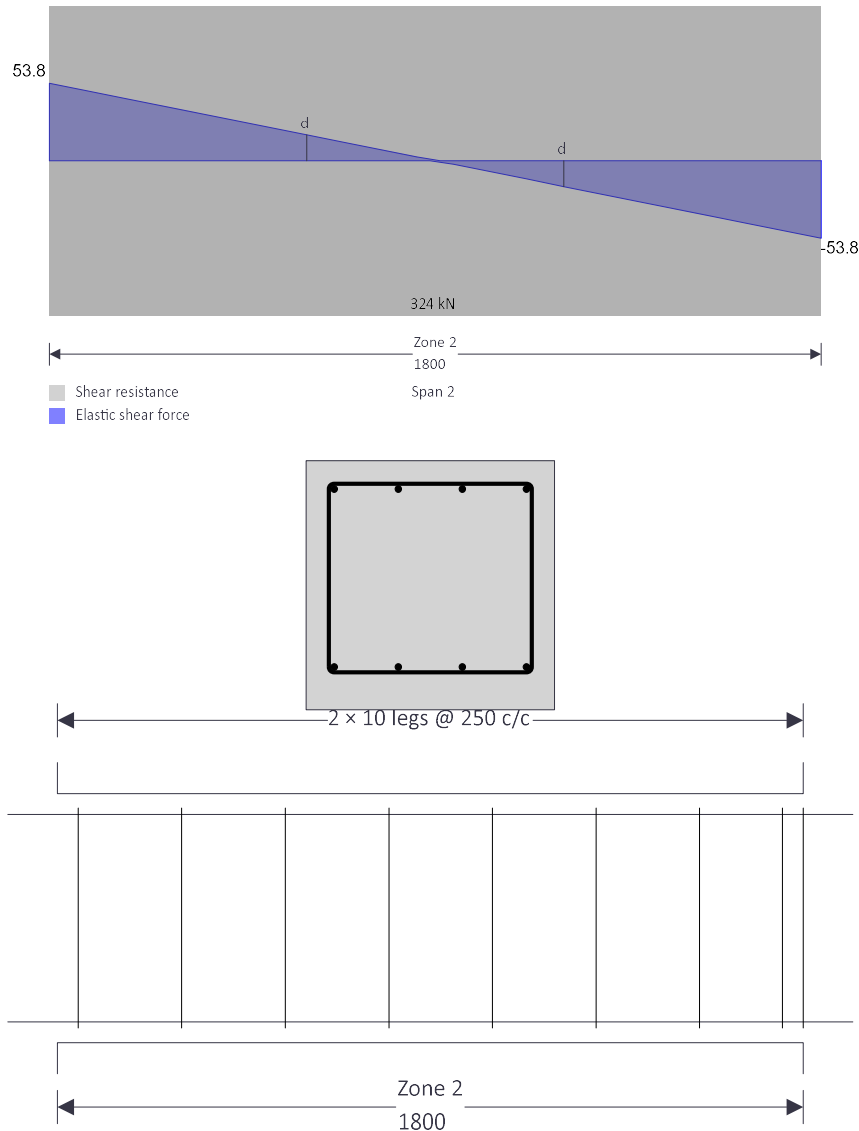
Maximum crack width; $w_k = 0.30$ mm; Min area reinf req'd (exp.7.1); $A_{sc,min} = 620$ mm²
PASS - Area of tension reinforcement provided exceeds minimum required for crack control
 Quasi-permanent moment; $M_{QP} = 9.1$ kNm
 Actual tension bar spacing; $S_{bar} = 156$ mm; Max bar spacing (Table 7.3N); $S_{bar,max} = 300$ mm
PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing; $S_{top} = 140.0$ mm; Min allow. top bar spacing; $S_{top,min} = 25.0$ mm
PASS - Actual bar spacing exceeds minimum allowable
 Bottom bar spacing; $S_{bot} = 140.0$ mm; Min allow. bottom bar spacing; $S_{bot,min} = 25.0$ mm
PASS - Actual bar spacing exceeds minimum allowable

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Ring Beam 3-3				38	
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Shear design



Angle of comp. shear strut; $\theta_{\max} = 45 \text{ deg}$;

Compression chord coefficient; $\alpha_{cw} = 1.00$;

Strength reduction factor; $v_1 = 0.523$

Minimum area of shear reinf.; $A_{sv,\min} = 543 \text{ mm}^2/\text{m}$

Zone 2 (0 mm - 1800 mm) shear - section 6.2

Shear force at support; $V_{Ed,\max} = 18 \text{ kN}$;

Max design shear resistance; $V_{Rd,\max} = 1587 \text{ kN}$

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force; $V_{Ed} = 18 \text{ kN}$;

Area shear reinf. req'd; $A_{sv,\text{req}} = 543 \text{ mm}^2/\text{m}$

Area of shear reinf prov.; $A_{sv,\text{prov}} = 628 \text{ mm}^2/\text{m}$

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N; $s_{vl,\max} = 374 \text{ mm}$

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

NOTE: Crack control is in accordance with cl.7.3.3 which makes design assumptions detailed in Table 7.2N. For designs falling outside these parameters a more detailed crack check may be required.

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MASONRY WALL PANEL DESIGN (EN1996)1

MASONRY WALL PANEL DESIGN

In accordance with EN1996-1-1:2005 + A1:2012 incorporating Corrigenda February 2006 and July 2009 and the UK national annex

Tedds calculation version 1.2.23

Summary table

	Allowable	Actual	Utilisation	
Slenderness ratio;	27;	21.4;	0.794;	PASS
Vertical loading on inner leaf;	103.839 kN/m;	14.846 kN/m;	0.143;	PASS
Height to thickness ratio;	68.091;	21.430;	0.315;	PASS
Design moment to outer leaf;	0.370 kNm/m;	0.340 kNm/m;	0.918;	PASS
Design moment to inner leaf;	0.370 kNm/m;	0.308 kNm/m;	0.831;	PASS

Masonry panel details

Unreinforced masonry wall without openings

Panel length; $L = 3900$ mm; Panel height; $h = 2700$ mm

Panel support conditions

Outer leaf; **All edges supported**

Inner leaf; **All edges supported**

Effective height of masonry walls - Section 5.5.1.2

Reduction factor; $\rho_2 = 1.000$; Effective height of wall; $h_{ef} = 2700$ mm

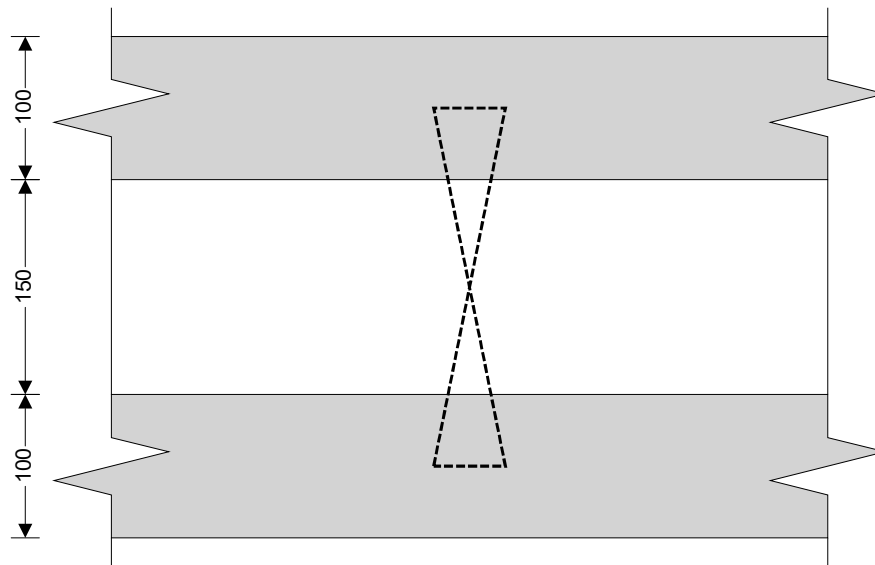


Cavity wall construction details

Outer leaf thickness; $t_1 = 100$ mm; Cavity thickness; $t_c = 150$ mm

Inner leaf thickness; $t_2 = 100$ mm; Effective wall thickness; $t_{ef} = 126$ mm

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Masonry outer leaf details

Masonry type;

Compressive strength;

Density of masonry;

Mortar type;

Comp.strength of mortar;

Char.comp.strength masonry;

Char.flex.str.parallel to bed;

Aggregate concrete - Group 1

$f_{c1} = 7.3 \text{ N/mm}^2$;

$\gamma_1 = 18 \text{ kN/m}^3$

Norm mean comp.strength;

$f_{b1} = 10.074 \text{ N/mm}^2$

M6 - General purpose mortar

$f_{m1} = 6 \text{ N/mm}^2$;

$f_{k1} = 6.468 \text{ N/mm}^2$

$f_{xk11} = 0.25 \text{ N/mm}^2$;

Compressive strength factor;

$K = 0.75$

Char.flex.str.perp.to bed;

$f_{xk21} = 0.6 \text{ N/mm}^2$

Masonry inner leaf details

Masonry type;

Compressive strength;

Density of masonry;

Mortar type;

Comp.strength of mortar;

Char.comp.strength masonry;

Char.flex.str.parallel to bed;

Aggregate concrete - Group 1

$f_{c2} = 7.3 \text{ N/mm}^2$;

$\gamma_2 = 18 \text{ kN/m}^3$

Norm mean comp.strength;

$f_{b2} = 10.074 \text{ N/mm}^2$

M6 - General purpose mortar

$f_{m2} = 6 \text{ N/mm}^2$;

$f_{k2} = 6.468 \text{ N/mm}^2$

$f_{xk12} = 0.25 \text{ N/mm}^2$;

Compressive strength factor;

$K = 0.75$

Char.flex.str.perp.to bed;

$f_{xk22} = 0.6 \text{ N/mm}^2$

Lateral loading details

Characteristic wind load on panel;

$W_k = 0.750 \text{ kN/m}^2$

Vertical loading details

Permanent load on top of inner leaf;

$G_{k2} = 2.4 \text{ kN/m}$;

Variable load on top of inner leaf;

$Q_{k2} = 5.55 \text{ kN/m}$;

Partial factors for material strength

Category of manufacture;

Category II;

Class of execution;

Class 2

Partial factor for compression; $\gamma_{Mc} = 3.00$;

Partial factor for tension;

$\gamma_{Mt} = 2.70$

Partial factor for shear;

$\gamma_{Mv} = 2.50$

Slenderness ratio of masonry walls - Section 5.5.1.4

Allowable slenderness ratio; $SR_{all} = 27$;

Slenderness ratio;

$SR = 21.4$

PASS - Slenderness ratio is less than maximum allowable

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Unreinforced masonry walls subjected to mainly vertical loading - Section 6.1

Partial safety factors for design loads

Partial factor for dead load; $\gamma_{FG} = 1.35$; Partial factor for imposed load; $\gamma_{FQ} = 1.5$
 Partial factor for wind load; $\gamma_{FW} = 0.75$

Considering inner leaf

Reduction factor for slenderness and eccentricity - Section 6.1.2.2

Vertical load at top of wall;	$N_{id2} = 11.565$ kN/m;	Moment at top of wall;	$M_{id2} = 0$ kNm/m
Eccentricity at top of wall;	$e_{t2} = 6$ mm;	Reduction factor at top of wall;	$\Phi_{t2} = 0.88$
Vertical load at mid wall;	$N_{md2} = 14.846$ kN/m;	Moment at mid wall;	$M_{md2} = 0$ kNm/m
Eccentricity at mid wall;	$e_{mk2} = 10.1$ mm;	Reduction factor at mid wall;	$\Phi_{m2} = 0.482$
		Reduction factor;	$\Phi_2 = 0.482$

Verification of unreinforced masonry walls subjected to mainly vertical loading - Section 6.1.2

Design value of vertical load; $N_{Ed2} = 14.846$ kN/m; Vertical resistance of wall; $N_{Rd2} = 103.839$ kN/m

PASS - Design vertical resistance exceeds applied design vertical load

Reduction factor for slenderness and eccentricity - Section 6.1.2.2

Vertical load at top of wall;	$N_{id1} = 0$ kN/m;	Moment at top of wall;	$M_{id1} = 0$ kNm/m
Eccentricity at top of wall;	$e_{t1} = 6$ mm;	Reduction factor at top of wall;	$\Phi_{t1} = 0.88$
Vertical load at mid wall;	$N_{md1} = 3.281$ kN/m;	Moment at mid wall;	$M_{md1} = 0$ kNm/m
Eccentricity at mid wall;	$e_{mk1} = 20.2$ mm;	Reduction factor at mid wall;	$\Phi_{m1} = 0.274$
		Reduction factor;	$\Phi_1 = 0.274$

Unreinforced masonry walls subjected to lateral loading - Section 6.3

Partial safety factors for design loads

Partial factor for dead load; $\gamma_{FG} = 1$; Partial factor for imposed load; $\gamma_{FQ} = 0$
 Partial factor for wind load; $\gamma_{FW} = 1.5$

Limiting height and length to thickness ratios for walls under the serviceability limit state - Annex F

Limiting h / t ratio; 68.091; Height to thickness ratio; 21.43 = **21.43**

PASS - Limiting height to thickness ratio is not exceeded

Design moments of resistance in panels

Self weight of wall;	$S_{wt1} = 2.43$ kN/m;	Design vertical comp.stress;	$\sigma_{d1} = 0.024$ N/mm ²
Des.flex.str.mas.parallel to bed;	$f_{xd11} = 0.093$ N/mm ² ;	App.flex.str.mas.parallel to bed;	$f_{xd11,app} = 0.117$ N/mm ²
Des.flex.str.mas.perp to bed;	$f_{xd21} = 0.222$ N/mm ² ;	Elastic section modulus;	$Z_1 = 1666667$ mm ³ /m
Mom.of resist parallel;	$M_{Rd11} = 0.195$ kNm/m;	Mom.of resist.perpendicular;	$M_{Rd21} = 0.37$ kNm/m
Self weight of wall;	$S_{wt2} = 2.43$ kN/m;	Design vertical comp.stress;	$\sigma_{d2} = 0.048$ N/mm ²
Des.flex.str.mas.parallel to bed;	$f_{xd12} = 0.093$ N/mm ² ;	App.flex.str.mas.parallel to bed;	$f_{xd12,app} = 0.141$ N/mm ²
Des.flex.str.mas.perp to bed;	$f_{xd22} = 0.222$ N/mm ² ;	Elastic section modulus;	$Z_2 = 1666667$ mm ³ /m
Mom.of resist parallel;	$M_{Rd12} = 0.235$ kNm/m;	Mom.of resist.perpendicular;	$M_{Rd22} = 0.37$ kNm/m

Calculate design wind load acting on each leaf

Outer leaf design wind load; $W_{k1} = 0.375$ kN/m²; Inner leaf design wind load; $W_{k2} = 0.375$ kN/m²

Design moment in panels

Design moment in wall; $M_{Ed1} = \gamma_{FW} \times \alpha_1 \times W_{k1} \times L^2 = 0.340$ kNm/m

PASS - Resistance moment exceeds design moment

Design moment in wall; $M_{Ed2} = \gamma_{FW} \times \alpha_2 \times W_{k2} \times L^2 = 0.308$ kNm/m

PASS - Resistance moment exceeds design moment

Project Dakota House				Job no.	
Calcs for Windpost Design				Start page no./Revision 42	
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WINDPOST DESIGN (EN1993)

WINDPOST DESIGN

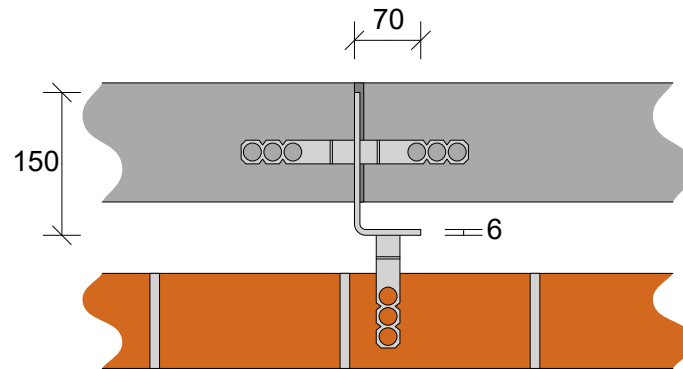
In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009

Tedds calculation version 1.0.01

Design summary

Overall design status; PASS
Overall design utilisation; 0.88

Description	Unit	Provided	Required	Utilisation	Result
Shear	kN	97.8	5.9	0.06	PASS
Bending moment	kNm	6.7	4.0	0.60	PASS
Deflection	mm	5.0	3.3	0.66	PASS
Max. wall ties spacing	mm	300	342	0.88	PASS



Section details

Section type; Angle (150x70x6)
Steel grade - Table 2.1, EN1993-1-4; 1.4301 (304) (Cold rolled strip)
Nominal thickness of element; $t_{nom} = t_{ss} = 6$ mm
Area; $A = 1284$ mm²
Second moment of area; $I_y = 308.4$ cm⁴
Elastic section modulus; $W_{el,y} = 31.9$ cm³
Distance to centroid; $c_y = 53$ mm

Material properties

Nominal yield strength; $f_y = 230$ N/mm²
Nominal ultimate tensile strength; $f_u = 540$ N/mm²
Modulus of elasticity; $E = 200000$ N/mm²

Partial factors - EN 1993-1-4 Table 5.1

Resistance of cross-sections; $\gamma_{M0} = 1.1$

Windpost design details

Height of windpost; $H_{post} = 2700$ mm
Spacing of windposts along masonry wall; $s_{post} = 3900$ mm
Windpost support type; Simply supported

Wind loading details

Partial factor for variable actions $\gamma_Q = 1.50$

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Unfactored wind pressure

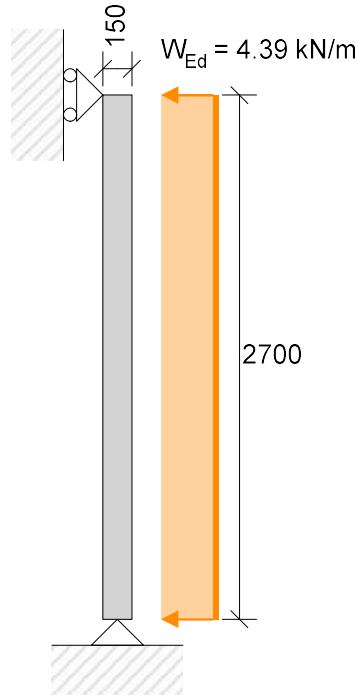
$$w = 0.75 \text{ kN/m}^2$$

Ultimate design load

$$W_{Ed} = 1.50 \times w \times s_{post} = 4.39 \text{ kN/m}$$

Service design load

$$W_{Ed,SLS} = w \times s_{post} = 2.93 \text{ kN/m}$$



Class section version 1.0.01

Classification of cross sections - Section 5.5

$$\varepsilon = \sqrt{(235 \text{ N/mm}^2 / f_y \times E / 210000 \text{ N/mm}^2)} = 0.99$$

Outstand flange in bending and compression- Table 5.2 (sheet 2 of 3)

Width of section;

$$c = h_{ss} = 150 \text{ mm}$$

$$\psi = -c_y / (b_{ss} - c_y) = -3.234$$

Buckling factor -EN1993-1-5 Table 4.2;

$$k_{\sigma} = 0.57 - 0.21 \times (\psi) + 0.07 \times (\psi)^2 = 1.981$$

$$c / t_{ss} = 25 = 25.3 \times \varepsilon \leq 21 \times \varepsilon \times \sqrt{(k_{\sigma})}; \quad \text{Class 3}$$

Outstand flange in compression- Table 5.2 (sheet 2 of 3)

Width of section;

$$c = b_{ss} = 70 \text{ mm}$$

$$c / t_{ss} = 11.7 = 11.8 \times \varepsilon \leq 14 \times \varepsilon; \quad \text{Class 3}$$

Section is class 3

Check design top of windpost

Check shear - Section 6.2.6

Height of web;

$$h_w = h_{ss} = 150 \text{ mm}$$

$$\eta = 1.200$$

Web slenderness;

$$h_w / t_{ss} = 25.00$$

Web slenderness limit - EN 1993-1-4 cl. 5.6.1;

$$56.2 \times \varepsilon / \eta = 46.20$$

$$h_w / t_{ss} \leq 56.2 \times \varepsilon / \eta - \text{Shear buckling resistance can be ignored}$$

Design shear force;

$$V_{Ed} = W_{Ed} \times H_{post} / 2 = 5.9 \text{ kN}$$

Shear area - cl. 6.2.6(3);

$$A_v = 0.9 \times h_{ss} \times t_{ss} = 810.0 \text{ mm}^2$$

Design shear resistance - exp. 6.18;

$$V_{c,Rd} = V_{Pl,Rd} = A_v \times (f_y / \sqrt{(3)}) / \gamma_{M0} = 97.8 \text{ kN}$$

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$$\text{abs}(V_{Ed}) / V_{c,Rd} = \mathbf{0.061}$$

PASS - Design shear resistance exceeds design shear force

Check design 1350 mm along windpost

Check bending moment - Section 6.2.5

Design bending moment;

$$M_{Ed} = W_{Ed} \times H_{post}^2 / 8 = \mathbf{4.0 \text{ kNm}}$$

Design bending resistance moment - eq. 6.14;

$$M_{c,Rd} = W_{el,y} \times f_y / \gamma_{M0} = \mathbf{6.7 \text{ kNm}}$$

$$\text{abs}(M_{Ed}) / M_{c,Rd} = \mathbf{0.599}$$

PASS - Design bending resistance exceeds design bending moment

Check deflection - Section 7.2.1

Maximum design service moment;

$$M_{Ed,ser,max} = W_{Ed,SLS} \times H_{post}^2 / 8 = \mathbf{2.7 \text{ kNm}}$$

Maximum design service stress;

$$\sigma_{Ed,ser,max} = \text{abs}(M_{Ed,ser,max}) / W_{el,y} = \mathbf{83.43 \text{ N/mm}^2}$$

Rolling direction;

Longitudinal

Ramberf Osgood coeff., EN 1993-1-4 Table 4.1;

$$n = \mathbf{6}$$

Secant modulus of elasticity;

$$E_{s,ser} = E / (1 + 0.002 \times E / \sigma_{Ed,ser,max} \times (\sigma_{Ed,ser,max} / f_y)^n) = \mathbf{197839.06 \text{ N/mm}^2}$$

Maximum deflection

$$\delta = 5 \times W_{Ed,SLS} \times H_{post}^4 / (384 \times E_{s,ser} \times I_y) = \mathbf{3.32 \text{ mm}}$$

Allowable deflection

$$\delta_{Allowable} = \min(H_{post} / 360, \delta_{lim}) = \mathbf{5.00 \text{ mm}}$$

$$\text{abs}(\delta) / \delta_{Allowable} = \mathbf{0.663}$$

PASS - Allowable deflection exceeds design deflection

Check wall ties - Section 6.5, EN 1996-1-1

Vertical centre to centre spacing

$$S_{ties} = \mathbf{300 \text{ mm}}$$

Brick tie capacity in tension and compression;

$$F_{k,Axial} = \mathbf{4.5 \text{ kN}}$$

Brick tie capacity in shear;

$$F_{k,Shear} = \mathbf{4.5 \text{ kN}}$$

Partial safety factor for wall ties - Table NA.1;

$$\gamma_M = \mathbf{3}$$

Min. number of ties per unit area - cl. NA.2.17;

$$n_{tmin} = \mathbf{2.5}$$

Req. number of ties per unit area - cl. 6.5(4);

$$n_t = \max(W_{Ed} \times 1 \text{ m} / (F_{k,Axial} / \gamma_M), n_{tmin}) = \mathbf{2.9}$$

Req. number of ties per unit area;

$$n_{t, shear} = W_{Ed} \times 1 \text{ m} / (2 \times F_{k,Shear} / \gamma_M) = \mathbf{1.5}$$

Maximum allowable wall tie spacing

$$S_{ties,max} = 1000 \text{ mm} / \max(n_t, n_{t, shear}) = \mathbf{341.88 \text{ mm}}$$

$$S_{ties} / S_{ties,max} = \mathbf{0.878}$$

PASS - Wall ties spacing does not exceeds maximum spacing

;

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Calcs for Beam Over Garage Door				Start page no./Revision 45	
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STEEL SIMPLE BEAM WITH TORSION ANALYSIS & DESIGN (SCI-P-057)

Analysis for simple beam with torsion to BS 5950 & SCI-P-057

TEDDS calculation version 1.0.02

Span length & partial factors for loading

Span (mm)	Factors for moments & forces			Factors for deflection		
	γ_{fd}	γ_{fi}	γ_{fw}	γ_{dd}	γ_{di}	γ_{dw}
5750	1.40	1.60	0.00	1.00	1.00	1.00

Loading data

Ref. #	Category	Type	Load kN/m	Position mm	Load kN/m	Position mm	Eccentricity mm
1	"Dead"	UDL	1.8	0	-	5750	0
2	"Dead"	UDL	1.3	0	-	5750	250

Analysis results - entire span

R_a kN (fac)	R_b kN (fac)	F_{vy} kN (fac)	M_x kNm (fac)	Sense	T_q kNm (fac)	Deflection: $\delta E I_x$ kNm ³	Direction
12.5	12.5	12.5	17.9	"Sagging"	2.62	44.12	"Down"

Unfactored support reactions

Support A; Dead load; **-8.9** kN; Live load; **0.0** kN; Wind load; **0.0** kN;
Support B; Dead load; **-8.9** kN; Live load; **0.0** kN; Wind load; **0.0** kN;

LTB segment results

Seg.	x_s mm	x_e mm	L_{LT} mm	M_{LT} kNm (fac)	M_{mLT2} kNm (fac)	M_{mLT3} kNm (fac)	M_{mLT4} kNm (fac)
1	0	5750	5750	17.9	13.5	17.9	13.5

Member design checks for simple beam with torsion to BS 5950 & SCI-P-057

Tedds calculation version 1.0.05

Summary

Span & restraint	L = 5750 mm	Torsion fixed & warping free each end.
Design load effects	$F_{vy} = 12.5$ kN; $M_x = 17.9$ kNm $T_q = 2.62$ kNm; torsion from uniformly distributed loads.	
Material	Grade = " S275 "	$p_y = 275$ N/mm ²
Section	" RHS 200x100x8.0 "	" Plastic "

Check;	Load;	Capacity;	Notes;	Result;
Deflection;	$\delta_{y_max} = 9.6$ mm;	$\delta_{lim} = 14.0$ mm;	Span / 360 or 14.0 mm;	Pass

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Twist angle	$\phi_{sls} = 0.05$ deg	$\phi_{lim} = 1.50$ deg	$T_{qu} = 1.87$ kNm	Pass
Shear;	$F_{vy} = 12.5$ kN;	$P_{vy} = 492.3$ kN;	Low shear;	Pass;
Moment;	$M_x = 17.9$ kNm;	$M_{cx} = 73.7$ kNm;	Serviceability governs;	Pass
LTB;	$\lambda = 208$;	$\lambda_{lim} = 340$;	LTB check not req'd; $L_{E_LT} = 8450$ mm;	Pass;
Overall buckling	Index; $i_b = 0.226$	Limit = 1.0	$\sigma_{byt} = 0$ N/mm ²	Pass
Local capacity	$\sigma_{bx} + \sigma_{byt}$ = 80 N/mm ²	$p_y = 275$ N/mm ²	$\sigma_{bx} = 80$ N/mm ² $\sigma_{byt} = 0$ N/mm ²	Pass
Combined shear stresses	$\tau = 11$ N/mm ²	$p_v = 165$ N/mm ²	$\tau_{bw} = 5$ N/mm ² $\tau_{vt} = 6$ N/mm ²	Pass

;;