

CALCULATION OF COMPOSITE BEAM PROPERTIES

Job Ref: -

Project: **VALIDATION**

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Title: **ELASTIC PROPERTIES**

Date: **30 DEC 06**

Data Entry

Elastic Properties

Plastic Design

Job Summary for Beam 02:

Factored Loads	M = 1000.00 kNm	R = 300.00 kN
Support to Design Section	Le = 5000.00 mm	
Slab Width	B = 2500.00 mm ✓	Be = 2500.00 mm ✓
Slab Depth	Ds = 150.00 mm ✓	Dp = 80.00 mm ✓
Connectors	Q = 64.00 kN ✓	s = 150.00 mm ✓
Beam Depth	D = 300.00 mm ✓	t = 8.00 mm ✓
Top Flange	B1 = 150.00 mm ✓	T1 = 12.00 mm ✓
Bottom Flange	B2 = 150.00 mm ✓	T2 = 12.00 mm ✓
Bottom Plate	B3 = 0.00 mm ✓	T3 = 0.00 mm ✓
Steel	Grade S355	Py = 355 N/mm2 ✓
		Es = 200 kN/mm2 ✓
Concrete	Grade C35	fcu = 35 N/mm2 ✓
	Ecs = 27.0 kN/mm2 ✓	Ecl = 9.0 kN/mm2 - (1/3).

Elastic Section Properties for Beam 02 based on Ec = 27.0 kN/mm2:

Element	Description	Area	y	Ay	Ay2	Io
1	Concrete	236.25	3.50	826.9	2,894.1	964.7
2	Top Flange	18.00	15.60	280.8	4,380.5	2.2
3	Web Concrete	22.08	30.00	662.4	19,872.0	1,401.6
4	Bottom Flange	18.00	44.40	799.2	35,484.5	2.2
5	Bottom Plate	0.00	45.00	0.0	0.0	0.0
Totals		294.33	8.73	2,569.3	62,631.0	2,370.6

Add warning for $g_{bar} < D_s - D_p$

None.

Depth to Neutral Axis	ybar = 8.73 cm ✓
Moment of Inertia	Ixx = 42,573.9 cm4 ✓
Modulus for Concrete	Zc = 36,127.1 cm3 ✓
Modulus for Top Flange	Zbt = 6,789.3 cm3 ✓
Modulus for Bottom Flange	Zbb = 1,173.8 cm3 ✓
Modulus for Bottom Plate	Zp = 1,173.8 cm3 ✓
Ay/I for Shear Studs	Ay/I = 0.0290 cm-1 check!

concrete units - Tension, not compression

$$q = \frac{V \times A_y}{I} \quad (\text{load per stud})$$

Elastic Section Properties for Beam 02 based on Ec = 9.0 kN/mm2:

Element	Description	Area	y	Ay	Ay2	Io
1	Concrete	78.75	3.50	275.6	964.7	321.6
2	Top Flange	18.00	15.60	280.8	4,380.5	2.2
3	Concrete	22.08	30.00	662.4	19,872.0	1,401.6
4	Bottom Flange	18.00	44.40	799.2	35,484.5	2.2
5	Bottom Plate	0.00	45.00	0.0	0.0	0.0
Totals		136.83	14.75	2,018.0	60,701.6	1,727.5

$$= \frac{V \times 236.25 \times 523}{42,573.9} = 0.029V$$

Depth to Neutral Axis	ybar = 14.75 cm
Moment of Inertia	Ixx = 32,666.5 cm4
Modulus for Concrete	Zc = 49,220.4 cm3
Modulus for Top Flange	Zbt = 129,840.5 cm3
Modulus for Bottom Flange	Zbb = 1,079.8 cm3
Modulus for Bottom Plate	Zp = 1,079.8 cm3
Ay/I for Shear Studs	Ay/I = 0.0271 cm-1 check!

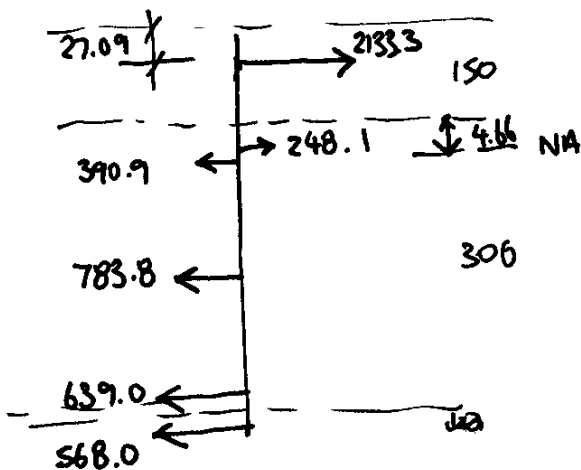
Only if NA below concrete Flange!

CALCULATION OF COMPOSITE BEAM PROPERTIES		Job Ref:
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Title:	PLASTIC CAPACITIES - CASE 1	Date: 30 DEC 06
	<u>Data Entry</u> <u>Elastic Properties</u> <u>Plastic Design</u>	
Job Summary for Beam 02:		
Factored Loads	M = 1000.00 kNm	R = 300.00 kN
Support to Design Section	Le = 5000.00 mm	
Slab Width	B = 2500.00 mm	Be = 2500.00 mm
Slab Depth	Ds = 150.00 mm	Dp = 80.00 mm
Connectors	Q = 64.00 kN	s = 150.00 mm
Beam Depth	D = 300.00 mm	t = 8.00 mm
Top Flange	B1 = 150.00 mm	T1 = 12.00 mm
Bottom Flange	B2 = 150.00 mm	T2 = 12.00 mm
Bottom Plate	B3 = 0.00 mm	T3 = 0.00 mm
Steel	Grade S355	Py = 355 N/mm2
		Es = 200 kN/mm2
Concrete	Grade C35	fcu = 35 N/mm2
	Ecs = 27.0 kN/mm2	Ecl = 9.0 kN/mm2
Element Capacities for Beam 02:		
Concrete Slab Capacity	Rc = 2,756.3 kN ✓	
Steel Beam Overall Capacity	Rs = 2,061.8 kN	
Steel Beam Top Flange Capacity	Rf1 = 639.0 kN ✓	
Steel Beam Web Capacity	Rw = 783.8 kN ✓	
Steel Beam Bottom Flange Capacity	Rf2 = 639.0 kN ✓	
Stiffener Plate Capacity	Rf3 = 0.0 kN ✓	
Shear Connector Capacity	Rq = 2,133.3 kN ✓	
Partial Interaction	103.5 Percent	
Plastic Moment Capacity for Beam 02:		
Neutral Axis	Neutral axis is located in slab	$\frac{52.36}{70} \times 2756.3 = 2061.7 \text{ kN} \checkmark$
Neutral Axis Depth	na = 52.36 mm	
Moment Capacity	Mc = 564.6 kNm	Add Working M > Mc.
V-Consult Limited Disclaimer: This computer program may contain errors - check results thoroughly!		

$$\text{Lever arm} = 150 + 150 - 52.36/2 = 273.82 \text{ mm}$$

$$M_c = 2061.8 \times 273.82 / 1000 = 564.6 \text{ kNm} \checkmark$$

CALCULATION OF COMPOSITE BEAM PROPERTIES		Job Ref: -
Project: VALIDATION		Page: 3 of 4
Title: PLASTIC CAPACITIES - CASE 2		Date: 30 DEC 06
<u>Data Entry</u>	<u>Elastic Properties</u>	<u>Plastic Design</u>
Job Summary for Beam 02:		
Factored Loads	M = 1000.00 kNm	R = 300.00 kN
Support to Design Section	Le = 5000.00 mm	
Slab Width	B = 2500.00 mm	Be = 2500.00 mm
Slab Depth	Ds = 150.00 mm	Dp = 80.00 mm
Connectors	Q = 64.00 kN	s = 150.00 mm
Beam Depth	D = 300.00 mm	t = 8.00 mm
Top Flange	B1 = 150.00 mm	T1 = 12.00 mm
Bottom Flange	B2 = 150.00 mm	T2 = 12.00 mm
Bottom Plate	B3 = 200.00 mm	T3 = 8.00 mm
Steel	Grade S355	Py = 355 N/mm2
		Es = 200 kN/mm2
Concrete	Grade C35	fcu = 35 N/mm2
	Ecs = 27.0 kN/mm2	Ecl = 9.0 kN/mm2
Element Capacities for Beam 02:		
Concrete Slab Capacity	Rc = 2,756.3 kN ✓	
Steel Beam Overall Capacity	Rs = 2,629.8 kN ✓	
Steel Beam Top Flange Capacity	Rf1 = 639.0 kN ✓	
Steel Beam Web Capacity	Rw = 783.8 kN ✓	
Steel Beam Bottom Flange Capacity	Rf2 = 639.0 kN ✓	
Stiffener Plate Capacity	Rf3 = 568.0 kN ✓	
Shear Connector Capacity	Rq = 2,133.3 kN ✓	
Partial Interaction	81.1 Percent ✓	
Plastic Moment Capacity for Beam 02:		
Neutral Axis	Neutral axis is located in top flange ✓	
Neutral Axis Depth	na = 154.66 mm ✓	
Moment Capacity	Mc = 743.0 kNm ✓	
V-Consult Limited Disclaimer: This computer program may contain errors - check results thoroughly!		

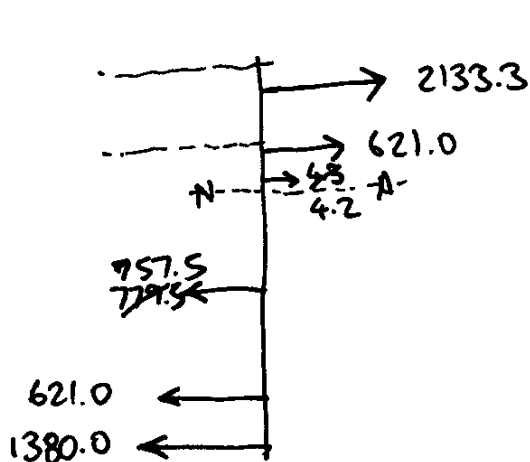


$$\begin{aligned}
 M_c &= 2133.3 \times 127.6 \\
 &+ 248.1 \times 2.33 \\
 &+ 390.9 \times 3.67 \\
 &+ 783.8 \times 145.3 \\
 &+ 639 \times 289.3 \\
 &+ 568.0 \times 299.3 \\
 &= 743.0 \text{ kNm } \checkmark
 \end{aligned}$$

1 of 1 2381.7 kN 2381.4 kN ✓

CALCULATION OF COMPOSITE BEAM PROPERTIES		Job Ref: -
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Title: PLASTIC CAPACITIES - CASE 3		Date: 30 DEC 06
<u>Data Entry</u>	<u>Elastic Properties</u>	<u>Plastic Design</u>
Job Summary for Beam 02:		
Factored Loads	M = 1000.00 kNm	R = 300.00 kN
Support to Design Section	Le = 5000.00 mm	
Slab Width	B = 2500.00 mm	Be = 2500.00 mm
Slab Depth	Ds = 150.00 mm	Dp = 80.00 mm
Connectors	Q = 64.00 kN	s = 150.00 mm
Beam Depth	D = 300.00 mm	t = 8.00 mm
Top Flange	B1 = 150.00 mm	T1 = 12.00 mm
Bottom Flange	B2 = 150.00 mm	T2 = 12.00 mm
Bottom Plate	B3 = 200.00 mm	T3 = 20.00 mm
Steel	Grade S355	Py = 345 N/mm2
		Es = 200 kN/mm2
Concrete	Grade C35	fcu = 35 N/mm2
	Ecs = 27.0 kN/mm2	Ecl = 9.0 kN/mm2
Element Capacities for Beam 02:		
Concrete Slab Capacity	Rc = 2,756.3 kN	✓
Steel Beam Overall Capacity	Rs = 3,383.8 kN	✓✓
Steel Beam Top Flange Capacity	Rf1 = 621.0 kN	✓
Steel Beam Web Capacity	Rw = 761.8 kN	✓
Steel Beam Bottom Flange Capacity	Rf2 = 621.0 kN	✓
Stiffener Plate Capacity	Rf3 = 1,380.0 kN	✓
Shear Connector Capacity	Rq = 2,133.3 kN	✓
Partial Interaction	77.4 Percent	✓
Plastic Moment Capacity for Beam 02:		
Neutral Axis	Neutral axis is located in web	
Neutral Axis Depth	na = 163.53 mm	✓
Moment Capacity	Mc = 983.0 kNm	

V-Consult Limited Disclaimer: This computer program may contain errors - check results thoroughly!



$$\begin{aligned}
 M_c &= 2133.3 \times 136.4 = \\
 &+ 621.0 \times 7.53 = \\
 &+ 757.5 \times 137.2 = \\
 &+ 621 \times 280.5 = \\
 &+ 1380 \times 296.5 = \\
 &= 982.4 \quad 983.0 \text{ kNm} \checkmark
 \end{aligned}$$

~~2780.5 kN~~
2758.5 ✓

~~2758.6~~
2758.5 ✓
1.53
274.47 } 276