

MasterSeries – Composite Beam Design **Sample Output**

The following output is from the MasterBeam Composite Design program.

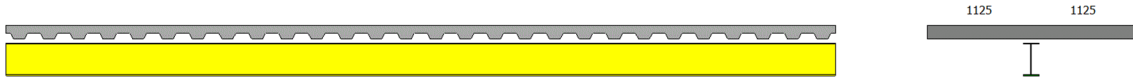
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<p>MasterSeries Sample Output</p> <p>3 Castle Street Carrickfergus County Antrim BT38 7BE</p> <p>Tel: 028 9036 5950</p>	<p>Job ref :My Project</p> <p>Sheet :Comp Beams / 2 -</p> <p>Made By : MOG</p> <p>Date : 21 June 2015/ Version 2017.11</p> <p>Checked : GHB</p> <p>Approved : ATW</p>
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UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM

Secondary beam



Summary of Design Data BS 5950-3.1 + A1:2010 (Symmetrical Beam)

Steel Section (51 kg/m)	356x171 UB 51 [S 355]Floor Area Supported 9 m Span, 2.5 m to LH Beam and 2.5 m to RH Beam (2.5 m Supported Directly)
Non-Continuous Multideck 60	Trough Spacing 323, Height 60, Average Width 150 in 1 mm thick
Concrete Slab	150 mm Thick @ 2350 kg/m ³ , Mod. Ratio 13.09, Gr 35 with 142 mm ² /m
Headed Stud Connector	19x98 mm (as welded) Placed @ 175 mm centres
Floor Loads (kN/m ²)	Live 7, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75
Self Weight Loads	Concrete Slab 2.717 kN/m ² , Steel Beam 0.5 kN/m
User Defined Values	Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area	90 x 2250 mm ² , b1= 1125 mm and b2= 1125 mm	
Steel Section Elastic Properties	ye 177.5 mm, A 64.9 cm ² , Ix 14139 cm ⁴ , Zt 797 cm ³ , Zb 797 cm ³	
Composite Section Elastic Properties	ye 128.5 mm, Ix 51670 cm ⁴ , Zs.t 24173 cm ³ , Zs.b 1381 cm ³ , Zc.t 52972 cm ³	
Headed Stud Connector	51 No. 19x98 mm, Qk 104 kN, Qp 83.2 kN, k 0.45, Pd 37.44	Welded

Ultimate Limit State (Final Stage)

Maximum Shear			
Support Reactions (kN)	200.97 kN each side	< 559.55 kN	OK
Check @ 4.5 m (Max. Moment)	M = 452.18 kN.m, Fv = 0 kN		
Shear Connection	No of shear connectors from nearest support 25 < 61.5	Partial	
Axial Resistance (kN)	Rc 3189.38 kN, Rs 2303.95 kN, Rq 936 kN	936 kN	
Degree of Shear Connection	Higher Ductility, Na/Np = 25 / 61.5 > 0.4	0.406	OK
Reduced Concrete Area	Area required to resist 936 kN	26.4x2250mm ²	
Moment Capacity	Plastic neutral axis in top flange @ 161 mm	524.07 kN.m	OK

Transverse Reinforcement

Max. No. of Shear Connectors (N)	Average minimum spacing 175 mm	5.71 per m	
Vp =N.4.D.tp.pyp	Min(5.71x4x19,1000)x1.0x280	121.60 kN	
Vr = fn(Asv,fy,Acv,fcu,Vp)	142, 460, 117000, 35, 121.6	290.17 kN	
V=N.Pd.Max(b1,b2)/(b1+b2)	5.71x37.4x1.13/(1.13+1.13)	106.97 kN	OK

Ultimate Limit State (Construction Stage)

Maximum Shear			
Support Reactions (kN)	62.59 kN each si	< 559.55 kN	OK
Check @ 4.5 m (Max. Moment)	M = 140.83 kN.m, Fv = 0 kN		
Moment Capacity	Plastic neutral axis in web @ 177.5 mm	318.08 kN.m	OK

Serviceability Limit State

Support Reactions (kN)			
Live Loads	90 kN each side		
Super Imposed Dead Load	5.63 kN each side		
Dead Load (Self Weight)	35.07 kN each side		
Maximum Deflection (Partial Connection All Loads)			
Live Loads	16.13 (23.76) mm @ 4.5 m < L / 360 = 25 mm	23.76 mm	OK
Super Imposed Dead Loads	1.01 (1.48) mm @ 4.5 m	1.48 mm	
Dead Loads (Self Weight)	22.97 mm @ 4.5 m	22.97 mm	
Maximum Steel Stress			
TOTAL (Tension)	Live 146.6, Super Dead 9.2, SW < 355	254.82 N/mm ²	OK
TOTAL (Compression)	Live 8.4, Super Dead 0.5, SW < 355	107.94 N/mm ²	OK
Maximum Concrete Stress	Live 3.82, Super Dead 0.24, SW < 17.5	4.06 N/mm ²	OK

Vibration Analysis (Partial Connection)

Beam Deflection	Including Partial Connection	10.15 mm	
Natural Frequency	18/√(10.15/1.1) = 5.93 > 4 Hz	5.93 Hz	OK

MasterSeries Sample Output

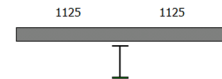
3 Castle Street
Carrickfergus
County Antrim BT38 7BE

Tel: 028 9036 5950

Job ref :My Project
Sheet :Comp Beams / 3 -
Made By :MOG
Date : 21 June 2015/ Version 2017.11
Checked : GHB
Approved : ATW

UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM

Secondary beam



Summary of Design Data EC4 - NA UK (Symmetrical Beam)

EuroCode National Annex	Using UK values, SCI P401, SCI P405
Steel Section (51 kg/m)	356x171 UB 51 [S 355]Floor Area Supported9 m Span, 2.5 m to LH Beam and 2.5 m to RH Beam (2.5 m Supported Directly)
Non-Continuous Multideck 60	Trough Spacing 323, Height 60, Average Width 150 in 1 mm thick
Concrete Slab	150 mm Thick @ 2350 kg/m ³ , Mod. Ratio 13.09, Gr C28/35 with 142 mm ² /m
Headed Stud Connector	19x98 mm (as welded) Placed @ 175 mm centres
Floor Loads (kN/m ²)	Live 7, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75
Self Weight Loads	Concrete Slab 2.717 kN/m ² , Steel Beam 0.5 kN/m
User Defined Values	Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area	90 x 2250 mm ² , b1= 1125 mm and b2= 1125 mm
Steel Section Elastic Properties	ye 177.5 mm, A 64.9 cm ² , Ix 14139 cm ⁴ , Zt 797 cm ³ , Zb 797 cm ³
Composite Section Elastic Properties	ye 128.5 mm, Ix 51670 cm ⁴ , Zs.t 24173 cm ³ , Zs.b 1381 cm ³ , Zc.t 52972 cm ³
Headed Stud Connector	51 No. 19x98 mm, Qk 99.57 kN, Qp 79.66 kN, k 0.7, Pd 55.76 Welded

Ultimate Limit State (Final Stage)

Maximum Shear			
Support Reactions (kN)	185.86 kN each side	< 587.37 kN	OK
Check @ 4.5 m (Max. Moment)	M = 418.19 kN.m, Fv = 0 kN		
Shear Connection	No of shear connectors from nearest support 25 < 41.3	Partial	
Axial Resistance (kN)	Rc 3213 kN, Rs 2303.95 kN, Rq 1394.01 kN	1394.01 kN	
Imposed/Total Load Ratio	M _{Imposed} / M _{Ult} = 319.6/418.2	0.764	
Load Classification	0.764 > 0.757 (derived from the 8 kN/m ² limit)therefore Very Heavy Loading - outside range of SCI P405		
Degree of Shear Connection	Higher Ductility, Na/Np = 25 / 41.3 > 0.52	0.605	OK
Reduced Concrete Area	Area required to resist 1394.01 kN	39x2250mm ²	
Moment Capacity	Plastic neutral axis in top flange @ 157.2 mm	582.08 kN.m	OK

Transverse Reinforcement

Vp = k _{phi} .1.1.D.tp.fyp.d/s	4x1.1x19x1.0x280/0.175	133.76 kN	
Vr = fn(Asv,fy,γs,θf, f _{ck} ,Vp)	142, 500, 1.15, 26.5, 28, 133.76	257.59 kN	
V ~ DF _d /~Dx.Max(b1,b2)/(b1+b2)	1394.01/4.5x1.13/(1.13+1.13)	154.89 kN	OK

Ultimate Limit State (Construction Stage)

Maximum Shear			
Support Reactions (kN)	56.49 kN each si	< 587.37 kN	OK
Check @ 4.5 m (Max. Moment)	M = 127.1 kN.m, Fv = 0 kN		
Moment Capacity	Plastic neutral axis in web @ 177.5 mm	318.08 kN.m	OK

Serviceability Limit State

Support Reactions (kN)			
Live Loads	90 kN each side		
Super Imposed Dead Load	5.63 kN each side		
Dead Load (Self Weight)	35.07 kN each side		
Maximum Deflection (Partial Connection All Loads)			
Live Loads	15.75 (20.70) mm @ 4.5 m < L / 360 = 25 mm	20.70 mm	OK
Super Imposed Dead Loads	0.98 (1.29) mm @ 4.5 m	1.29 mm	
Dead Loads (Self Weight)	22.42 mm @ 4.5 m	22.42 mm	
Maximum Steel Stress			
TOTAL (Tension)	Live 146.6, Super Dead 9.2, SW < 355	254.82 N/mm ²	OK
TOTAL (Compression)	Live 8.4, Super Dead 0.5, SW < 355	107.94 N/mm ²	OK
Maximum Concrete Stress	Live 3.82, Super Dead 0.24, SW < 17.5	4.06 N/mm ²	OK

Vibration Analysis (Partial Connection)

Beam Deflection	Including Partial Connection	9.5 mm	
Natural Frequency	18/√(9.50/1.1) = 6.13 > 4 Hz	6.13 Hz	OK

MasterSeries Sample Output

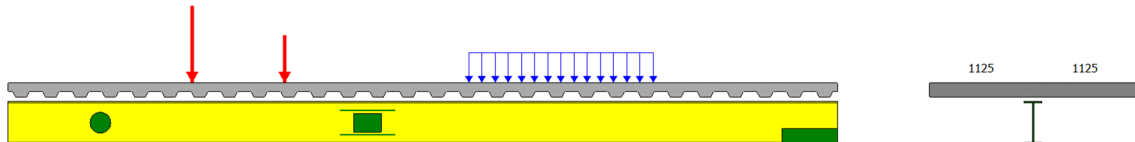
3 Castle Street
 Carrickfergus
 County Antrim BT38 7BE

 Tel: 028 9036 5950

Job ref :My Project
 Sheet :Comp Beams / 4 -
 Made By : MOG
 Date : 21 June 2015/ Version 2017.11
 Checked : GHB
 Approved : ATW

UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM WITH WEB OPENINGS

Secondary beam with additional loads and openings



Summary of Design Data EC4 - NA UK

EuroCode National Annex	Using UK values, SCI P405
Web Opening Design to	SCI P355
Steel Section (98 kg/m)	457x191 UB 98 [S 355] Floor Area Supported 9 m Span, 3 m to LH Beam and 3 m to RH Beam (3 m Supported Directly)
Non-Continuous Multideck 60 V2 (350)	Trough Spacing 323, Height 60, Average Width 150 in 1 mm thick
Concrete Slab	150 mm Thick @ 2350 kg/m ³ , Mod. Ratio 13.39, Gr C28/35 with 98 mm ² /m
Headed Stud Connector	19x98 mm (as welded) Placed One per Trough
Floor Loads (kN/m ²)	Live 6, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75
Self Weight Loads	Concrete Slab 2.717 kN/m ² , Steel Beam 0.965 kN/m
Additional Point Loads (kN)	Dead 5, Live 6 and Super Imposed Dead 2 @ 2 m
Additional Point Loads (kN)	Dead 4, Live 3 and Super Imposed Dead 1 @ 3 m
Additional Partial Loads (kN/m)	Dead 17, Live 15, Super Imposed Dead 9 between 5 and 7 m
User Defined Values	Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area	90 x 2250 mm ² , b1= 1125 mm and b2= 1125 mm
Steel Section Elastic Properties	ye 233.6 mm, A 125.3 cm ² , Ix 45730 cm ⁴ , Zt 1958 cm ³ , Zb 1958 cm ³
Composite Section Elastic Properties	ye 198.4 mm, Ix 125301 cm ⁴ , Zs.t 25890 cm ³ , Zs.b 2992 cm ³ , Zc.t 84567 cm ³
Headed Stud Connector	28 No. 19x98 mm, Qk 99.57 kN, Qp 79.66 kN, k 0.85, Pd 67.71 Welded

Ultimate Limit State (Final Stage)

Maximum Shear			
Support Reactions (kN)	LH Support 262.48 kN, RH Support 285.7	< 1113.81 kN	OK
Check @ 5.04 m (Max. Moment)	M = 668.82 kN.m, Fv = 2.36 kN		
Shear Connection	No of shear connectors from nearest support 12 < 47.5	Partial	
Axial Resistance (kN)	Rc 3213 kN, Rs 4321.47 kN, Rq 812.51 kN	812.51 kN	
Imposed/Total Load Ratio	M _{Imposed} / M _{Ult} = 463.9/668.8	0.694	
Load Classification	0.694 <= 0.7 therefore Normal Loading		
Degree of Shear Connection	Higher Ductility, Na/Np = 12 / 47.5 > 0.25	0.253	OK
Reduced Concrete Area	Area required to resist 812.51 kN	22.8x2250mm ²	
Moment Capacity	Plastic neutral axis in web @ 280.3 mm	1024.13 kN.m	OK
Check @ 2 m	M = 433.92 kN.m, Fv = 171.44 kN		
Shear Connection	No of shear connectors from nearest support 6 < 47.5	Partial	
Axial Resistance (kN)	Rc 3213 kN, Rs 4321.47 kN, Rq 406.26 kN	406.26 kN	
Reduced Concrete Area	Area required to resist 406.26 kN	11.4x2250mm ²	
Moment Capacity	Plastic neutral axis in web @ 332 mm	906.7 kN.m	OK
Check @ 3 m	M = 564.85 kN.m, Fv = 108.17 kN		
Shear Connection	No of shear connectors from nearest support 9 < 47.5	Partial	
Axial Resistance (kN)	Rc 3213 kN, Rs 4321.47 kN, Rq 609.38 kN	609.38 kN	
Reduced Concrete Area	Area required to resist 609.38 kN	17.1x2250mm ²	
Moment Capacity	Plastic neutral axis in web @ 306.1 mm	968.61 kN.m	OK

Transverse Reinforcement

Vp = k _{phi} .1.1.D.tp.fyp.d/s	4x1.1x19x1.0x350/0.323	90.59 kN	
Vr = fn(Asv.fy.γs.θf.fck.Vp)	98, 500, 1.15, 26.5, 28, 90.59	176.05 kN	
V = ~DFd/~Dx.Max(b1,b2)/(b1+b2)	812.51/3.96x1.13/(1.13+1.13)	102.59 kN	OK

Ultimate Limit State (Construction Stage)

Maximum Shear			
Support Reactions (kN)	LH Support 93.81 kN, RH Support 103.56	< 1113.81 kN	OK
Check @ 5.13 m (Max. Moment)	M = 244.72 kN.m, Fv = 0.74 kN		

MasterSeries Sample Output		Job ref	:My Project
3 Castle Street		Sheet	:Comp Beams / 5 -
Carrickfergus		Made By	: MOG
County Antrim BT38 7BE		Date	: 21 June 2015/ Version 2017.11
Tel: 028 9036 5950		Checked	: GHB
		Approved	: ATW
Moment Capacity	Plastic neutral axis in web @ 233.6 mm	770.18 kN.m	OK
Check @ 2 m	M = 156.65 kN.m, Fv = 62.85 kN		
Moment Capacity	Plastic neutral axis in web @ 233.6 mm	770.18 kN.m	OK
Check @ 3 m	M = 205.01 kN.m, Fv = 40.62 kN		
Moment Capacity	Plastic neutral axis in web @ 233.6 mm	770.18 kN.m	OK
Serviceability Limit State			
Support Reactions (kN)			
Live Loads	LH Support 111.17 kN, RH Support 116.83 kN		
Super Imposed Dead Load	LH Support 14.97 kN, RH Support 19.53 kN		
Dead Load (Self Weight)	LH Support 61.61 kN, RH Support 68.83 kN		
Maximum Deflection (Partial Connection All Loads)			
Live Loads	8.63 (11.81) mm @ 4.5 m < L / 360 = 25 mm	11.81 mm	OK
Additional due to Web Openings	Live load only, 0.148 mm	11.96 mm	OK
Super Imposed Dead Loads	1.48 (2.03) mm @ 4.68 m	2.03 mm	
Additional due to Web Openings	Super Dead load only, 0.025 mm	2.05 mm	
Dead Loads (Self Weight)	14.18 mm @ 4.59 m	14.18 mm	
Additional due to Web Openings	Dead load only, 0.178 mm	14.36 mm	
Maximum Steel Stress			
TOTAL (Tension)	Live 90.1, Super Dead 16.4, SW 83 < 345	190.20 N/mm ²	OK
TOTAL (Compression)	Live 10.4, Super Dead 1.9, SW 83 < 345	96.03 N/mm ²	OK
Maximum Concrete Stress	Live 3.19, Super Dead 0.58, SW < 17.5	3.77 N/mm ²	OK
Vibration Analysis (Partial Connection)			
Beam Deflection	Including Partial Connection	8.38 mm	
Natural Frequency	$18/\sqrt{(8.38/1.1)} = 6.52 > 4$ Hz	6.52 Hz	OK
UNSTIFFENED CIRCULAR OPENING @ 1 M			
Summary of Design Data			
Dimensions (mm)	Diameter 225, Top Distance 121, Bottom Distance 121, D 467		
Ultimate Limit State (Final Stage)			
General			
Applied Forces	M 239.72 kN.m @ 1 m, Fv 219.26 kN @ 0.949 m, To 311.34 kN		
Number of Shear Connectors	Total to start of opening (N1) 3, Over the opening (N2)0		
Composite Moment Capacity	$fyb.(D-Xet-Xeb) + N1.Pd.(Xet+ds-0.5dc) = 750.23$ kN.m	0.320	OK
Vierendeel Moment Capacity	Lower 64.008+Upper 67.674	131.682 kN.m	
Vierendeel Moment	Applied 22.2 kN.m, Capacity 131.682 kN.m	0.169	OK
Axial Force in Slab	Applied 203.128 kN, Capacity 2748.684 kN	0.074	OK
Shear Resistance in Slab	$b_w 417.8$ mm, $dc 90.0$ mm, $vc 0.90$ N/mm ²	34.003 kN	
Additional Live Load Deflection	Due to Bending 0.002 mm, Due to Shear 0.002 mm	0.004 mm	
Lower Web-Flange			
Section Properties and Mpb	$te 11.4$ mm, $ye 26.6$ mm, $yp 13.1$ mm	35.041 kN.m	
Axial Force Capacity fyb (kN)	Area 5065 mm ²	1747.553 kN	
Axial Force Applied T1 (kN)	$(M - \text{Min}(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)$	514.469 kN	OK
Shear Force and Capacity	Applied 92.794 kN, Capacity 318.325 kN	0.292	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	$te 11.4$ mm, $ye 26.6$ mm, $yp 13.1$ mm	34.947 kN.m	
Axial Force Capacity fyt (kN)	Area 5063 mm ²	1746.766 kN	
Axial Force Applied To (kN)	To 311.341 kN	311.341 kN	OK
Shear Force and Capacity	Applied 92.466 kN, Capacity 317.871 kN	0.291	OK
Web Post At end of Beam			
Horizontal Web Shear	$V_{Ed,average} 239.719$, $V_h 512.41$ / $V_{hr} 2015.308$ kN	0.254	OK
Web Post Axial Force	$do/t_w < 25$		OK
Web Post to right of opening			
Horizontal Web Shear	$V_{Ed,average} 136.705$, $V_h 764.38$ / $V_{hr} 5989.020$ kN	0.128	OK
Web Post Axial Force	$do/t_w < 25$		OK
Ultimate Limit State (Construction Stage)			
General			
Applied Forces	M 86.07 kN.m @ 1 m, Fv 79.11 kN @ 0.949 m, To 207.89 kN		
Vierendeel Moment Capacity	Lower 32.23+Upper 32.184	64.415 kN.m	
Vierendeel Moment	Applied 8.01 kN.m, Capacity 64.415 kN.m	0.124	OK
Lower Web-Flange			
Section Properties and Mpb	$te 11.4$ mm, $ye 26.6$ mm, $yp 13.1$ mm	35.041 kN.m	
Axial Force Capacity fyb (kN)	Area 5065 mm ²	1747.553 kN	
Axial Force Applied T1 (kN)	$(M - \text{Min}(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)$	207.888 kN	OK
Shear Force and Capacity	Applied 39.625 kN, Capacity 318.325 kN	0.124	OK

MasterSeries Sample Output

3 Castle Street
Carrickfergus
County Antrim BT38 7BE

Tel: 028 9036 5950

Job ref :My Project
Sheet :Comp Beams / 6 -
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Date : 21 June 2015/ Version 2017.11
Checked : GHB
Approved : ATW

Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 26.6 mm, yp 13.1 mm	34.947 kN.m	
Axial Force Capacity fyt (kN)	Area 5063 mm ²	1746.766 kN	
Axial Force Applied To (kN)	To 207.888 kN	207.888 kN	OK
Shear Force and Capacity	Applied 39.485 kN, Capacity 317.871 kN	0.124	OK
Web Post At end of Beam			
Horizontal Web Shear	V _{Ed,average} 86.066, Vh 207.888 / Vhr 2015.308 kN	0.103	OK
Web Post Axial Force	do/t _w < 25		OK
Web Post to right of opening			
Horizontal Web Shear	V _{Ed,average} 49.807, Vh 348.882 / Vhr 5989.020 kN	0.058	OK
Web Post Axial Force	do/t _w < 25		OK

STIFFENED RECTANGULAR OPENING @ 3.9 M**Summary of Design Data**

Dimensions (mm)	Width 300, Height 200, Top Distance 133, Bottom Distance 134, D 467		
2 No. Stiffeners (1 top & 1 bot)	Area 2000 mm ² each (p _y =345) positioned 10 mm from edge of opening		
Typical stiffener and weld arrangement			
Single Web Sided	100 mm wide x 20 mm thi, 1040 mm long, 6 fw all round [S 355]	Stiffener area specified is too large for single sided placement, 100 > lo/4	
Or Double Web Sided	85 mm wide x 12 mm thic 660 mm long, 6 fw all round [S 355]		
Important : Stiffeners and welds	must be designed by the engineer, using a compact stiffener section		

Ultimate Limit State (Final Stage)

General			
Applied Forces	M 634.09 kN.m @ 3.9 m, Fv 63.28 kN @ 3.75 m, To 585.51 kN		
Number of Shear Connectors	Total to start of opening (N1) 12, Over the opening (N2)0.93		
Composite Moment Capacity	fyb.(D-Xet-Xeb) + N1.Pd.(Xet+ds-0.5dc) = 763.16 kN.m	0.831	OK
Vierendeel Moment Capacity	Mvc 9.891+Lower 43.286+Upper 143.727	196.904 kN.m	
Vierendeel Moment	Applied 18.984 kN.m, Capacity 196.904 kN.m	0.096	OK
Axial Force in Slab	Applied 875.399 kN, Capacity 3213 kN	0.272	OK
Shear Resistance in Slab	b _w 417.8 mm, dc 90.0 mm, vc 1.00N/mm ²	37.596 kN	
Additional Live Load Deflection	Due to Bending 0.047 mm, Due to Shear 0.003 mm	0.051 mm	
Lower Web-Flange			
Section Properties and Mpb	te 11.4 mm, ye 52.8 mm, yp 18.4 mm	106.537 kN.m	
Axial Force Capacity fyb (kN)	Area 5085 mm ² , Reduced Stiffener 2000 mm ²	1754.436 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	1398.021 kN	OK
Shear Force and Capacity	Applied 12.977 kN, Capacity 322.299 kN	0.040	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 52.3 mm, yp 18.3 mm	105.165 kN.m	
Axial Force Capacity fyt (kN)	Area 5072 mm ² , Reduced Stiffener 2000 mm ²	1749.716 kN	
Axial Force Applied To (kN)	To 585.51 kN, T2=N2.Pd 62.888 kN	585.510 kN	OK
Shear Force and Capacity	Applied 12.707 kN, Capacity 319.574 kN	0.040	OK
Web Post to left of opening			
Horizontal Web Shear	V _{Ed,average} 136.705, Vh 830.681 / Vhr 5989.020 kN	0.139	OK
Web Post Axial Force	do/t _w < 20		OK
Web Post to right of opening			
Horizontal Web Shear	V _{Ed,average} 164.248, Vh 1739.975 / Vhr 9877.624 kN	0.176	OK
Web Post Axial Force	do/t _w < 20		OK

Ultimate Limit State (Construction Stage)

General			
Applied Forces	M 230.44 kN.m @ 3.9 m, Fv 25.89 kN @ 3.75 m, To 636.3 kN		
Vierendeel Moment Capacity	Lower 96.69+Upper 95.872	192.562 kN.m	
Vierendeel Moment	Applied 7.767 kN.m, Capacity 192.562 kN.m	0.040	OK
Lower Web-Flange			
Section Properties and Mpb	te 11.4 mm, ye 52.8 mm, yp 18.4 mm	106.537 kN.m	
Axial Force Capacity fyb (kN)	Area 5085 mm ² , Reduced Stiffener 2000 mm ²	1754.436 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	636.300 kN	OK
Shear Force and Capacity	Applied 13.081 kN, Capacity 322.299 kN	0.041	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 52.3 mm, yp 18.3 mm	105.165 kN.m	
Axial Force Capacity fyt (kN)	Area 5072 mm ² , Reduced Stiffener 2000 mm ²	1749.716 kN	
Axial Force Applied To (kN)	To 636.3 kN	636.300 kN	OK
Shear Force and Capacity	Applied 12.808 kN, Capacity 319.574 kN	0.040	OK
Web Post to left of opening			
Horizontal Web Shear	V _{Ed,average} 49.807, Vh 398.835 / Vhr 5989.020 kN	0.067	OK

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 Carrickfergus
 County Antrim BT38 7BE

 Tel: 028 9036 5950

Job ref :My Project
 Sheet :Comp Beams / 7 -
 Made By : MOG
 Date : 21 June 2015/ Version 2017.11
 Checked : GHB
 Approved : ATW

Web Post Axial Force	$d_o/t_w < 20$		OK
Web Post to right of opening			
Horizontal Web Shear	$V_{Ed,average} 60.1, V_h 796.56 / V_{hr} 9877.624 \text{ kN}$	0.081	OK
Web Post Axial Force	$d_o/t_w < 20$		OK

UNSTIFFENED BEAM NOTCH @ RIGHT HAND SUPPORT**Summary of Design Data**

Dimensions (mm) Width 600, Height 167, Top Distance 300, Bottom Distance 0, D 467

Ultimate Limit State (Final Stage)

General			
Applied Forces	M 83.66 kN.m @ 8.7 m, Fv 285.7 kN @ 9 m, To 0 kN		
Number of Shear Connectors	Total to start of opening (N1) 0, Over the opening (N2) 1.86		
Vierendeel Moment Capacity	Mvc 28.745+Upper 334.021	362.766 kN.m	
Vierendeel Moment	Applied 171.42 kN.m, Capacity 362.766 kN.m	0.473	OK
Axial Force in Slab	Applied 125.776 kN, Capacity 3213 kN	0.039	OK
Shear Resistance in Slab	$b_w 417.8 \text{ mm}, d_c 90.0 \text{ mm}, v_c 1.00 \text{ N/mm}^2$	37.596 kN	
Additional Live Load Deflection	Due to Bending 0.004 mm, Due to Shear 0.090 mm	0.094 mm	
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 78.5 mm, yp 18.1 mm	167.239 kN.m	
Axial Force Capacity fyt (kN)	Area 6975 mm ²	2406.527 kN	
Axial Force Applied T2-To (kN)	To 0 kN, T2=N2.Pd 125.776 kN	125.776 kN	OK
Shear Force and Capacity	Applied 248.105 kN, Capacity 698.784 kN	0.355	OK

Ultimate Limit State (Construction Stage)

General			
Applied Forces	M 30.37 kN.m @ 8.7 m, Fv 103.56 kN @ 9 m, To 0 kN		
Vierendeel Moment Capacity	Upper 167.239	167.239 kN.m	
Vierendeel Moment	Applied 62.133 kN.m, Capacity 167.239 kN.m	0.372	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 78.5 mm, yp 18.1 mm	167.239 kN.m	
Shear Force and Capacity	Applied 103.555 kN, Capacity 698.784 kN	0.148	OK

MasterSeries Sample Output

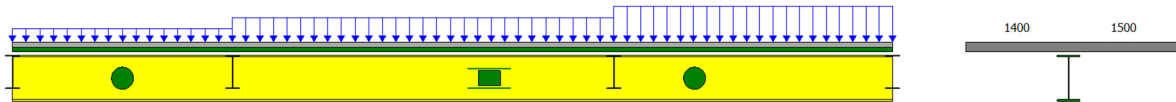
3 Castle Street
 Carrickfergus
 County Antrim BT38 7BE

 Tel: 028 9036 5950

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UNPROPPED COMPOSITE PRIMARY INTERNAL BEAM WITH WEB OPENINGS

Primary beam with additional loads and openings



Summary of Design Data EC4 - NA UK

EuroCode National Annex	Using UK values, SCI P405
Web Opening Design to	SCI P355
Steel Section (179 kg/m)	610x305 UB 179 [S 355]Floor Area Supported12 m Span, 3.5 m to LH Beam and 4 m to RH Beam
Non-Continuous Multideck 60 V2 (350)	Trough Spacing 323, Height 60, Average Width 150 in 1 mm thick
Concrete Slab	130 mm Thick @ 2350 kg/m ³ , Mod. Ratio 13.18, Gr C28/35 with 785 mm ² /m
Headed Stud Connector	19x98 mm (as welded) Placed @ 175 mm centre
Floor Loads (kN/m ²)	Live 6, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75
Self Weight Loads	Concrete Slab 2.256 kN/m ² , Steel Beam 1.756 kN/m
Transverse Beams and Floor Area	3.75 m x 4.1 m Floor Area + 2.469 kN Self Weight @ 3 m
Transverse Beams and Floor Area	3.75 m x 4.5 m Floor Area + 2.469 kN Self Weight @ 8.2 m
Additional Partial Loads (kN/m)	Dead 10, Live 7, Super Imposed Dead 6 between 0 and 3 m
Additional Partial Loads (kN/m)	Dead 17, Live 15, Super Imposed Dead 9 between 3 and 8.2 m
Additional Partial Loads (kN/m)	Dead 20, Live 20, Super Imposed Dead 20 between 8.2 and 12 m
User Defined Values	Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area	98 x 2900 mm ² , b1= 1400 mm and b2= 1500 mm
Steel Section Elastic Properties	ye 310.1 mm, A 228.1 cm ² , Ix 153044 cm ⁴ , Zt 4935 cm ³ , Zb 4935 cm ³
Composite Section Elastic Properties	ye 250.1 mm, Ix 324240 cm ⁴ , Zs.t 26989 cm ³ , Zs.b 6484 cm ³ , Zc.t 170844 cm ³
Headed Stud Connector	69 No. 19x98 mm, Qk 99.57 kN, Qp 79.66 kN, k 0.95, Pd 75.68 Welded

Ultimate Limit State (Final Stage)

Maximum Shear			
Support Reactions (kN)	LH Support 536.74 kN, RH Support 635.07	< 1877.24 kN	OK
Check @ 6.84 m (Max. Moment)	M = 1875.87 kN.m, Fv = 2.32 kN		
Shear Connection	No of shear connectors from nearest support 30 < 59.5	Partial	
Axial Resistance (kN)	Rc 4503.04 kN, Rs 7868.76 kN, Rq 2270.25 kN	2270.25 kN	
Imposed/Total Load Ratio	M _{Imposed} / M _{Ult} = 1278.0/1875.9	0.681	
Load Classification	0.681 <= 0.7 therefore Normal Loading		
Degree of Shear Connection	Na/Np = 30 / 59.5 > 0.28	0.504	OK
Reduced Concrete Area	Area required to resist 2270.25 kN	49.3x2900mm ²	
Moment Capacity	Plastic neutral axis in web @ 206.8 mm	2569.29 kN.m	OK
Check @ 3 m	M = 1463.08 kN.m, Fv = 438.65 kN		
Shear Connection	No of shear connectors from nearest support 17 < 59.5	Partial	
Axial Resistance (kN)	Rc 4503.04 kN, Rs 7868.76 kN, Rq 1286.48 kN	1286.48 kN	
Reduced Concrete Area	Area required to resist 1286.48 kN	28x2900mm ²	
Moment Capacity	Plastic neutral axis in web @ 307.9 mm	2354.17 kN.m	OK
Check @ 8.2 m	M = 1819.82 kN.m, Fv = 322.73 kN		
Shear Connection	No of shear connectors from nearest support 22 < 59.5	Partial	
Axial Resistance (kN)	Rc 4503.04 kN, Rs 7868.76 kN, Rq 1664.85 kN	1664.85 kN	
Reduced Concrete Area	Area required to resist 1664.85 kN	36.2x2900mm ²	
Moment Capacity	Plastic neutral axis in web @ 269 mm	2451.17 kN.m	OK

Transverse Reinforcement

Vr = fn(Asv, fy, ys, θf, fck)	785, 500, 1.15, 26.5, 28	236.30 kN	
V = ~DFd / ~Dx. Max(b1, b2) / (b1 + b2)	2270.25 / 5.16 x 1.5 / (1.4 + 1.5)	227.57 kN	OK

Ultimate Limit State (Construction Stage)

Maximum Shear			
Support Reactions (kN)	LH Support 202.35 kN, RH Support 227.53	< 1877.24 kN	OK
Check @ 6.48 m (Max. Moment)	M = 689.67 kN.m, Fv = 0.2 kN		
Moment Capacity	Plastic neutral axis in web @ 310.1 mm	1913.82 kN.m	OK

MasterSeries Sample Output

3 Castle Street
Carrickfergus
County Antrim BT38 7BE

Tel: 028 9036 5950

Job ref :My Project
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Check @ 3 m	M = 535.64 kN.m, Fv = 154.74 kN		
Moment Capacity	Plastic neutral axis in web @ 310.1 mm	1913.82 kN.m	OK
Check @ 8.2 m	M = 652.57 kN.m, Fv = 115.92 kN		
Moment Capacity	Plastic neutral axis in web @ 310.1 mm	1913.82 kN.m	OK

Lateral Torsional Buckling (Construction Stage)

Check between 0 and 3 m			
$C_1 = \text{fn}(M_1, M_2, \sim y)$	0.0, 535.6, 0.000	1.750	Not Loaded
$M_{cr} = \text{Fn}(C_1, L_e, I_z, I_t, I_w, E)$	1.750, 3.000, 11428, 340.1, 10.14, 210000	14501.42 kN.m	
$M_b = \text{fn}(\lambda_{LT}, C_{LT}, S_{xx}, p_y)$	0.363, 1.000, 5547.3, 345	1913.818 kN.m	OK
Check between 3 and 8.2 m			
$C_1 = \text{fn}(M_1, M_2, \sim y)$	535.6, 652.6, 0.821	1.090	Not Loaded
$M_{cr} = \text{Fn}(C_1, L_e, I_z, I_t, I_w, E)$	1.090, 5.200, 11428, 340.1, 10.14, 210000	3309.139 kN.m	
$M_b = \text{fn}(\lambda_{LT}, C_{LT}, S_{xx}, p_y)$	0.760, 0.805, 5547.3, 345	1541.292 kN.m	OK
Check between 8.2 and 12 m			
$C_1 = \text{fn}(M_1, M_2, \sim y)$	652.6, 0.0, 0.000	1.750	Not Loaded
$M_{cr} = \text{Fn}(C_1, L_e, I_z, I_t, I_w, E)$	1.750, 3.800, 11428, 340.1, 10.14, 210000	9321.376 kN.m	
$M_b = \text{fn}(\lambda_{LT}, C_{LT}, S_{xx}, p_y)$	0.453, 1.000, 5547.3, 345	1913.818 kN.m	OK

Serviceability Limit State

Support Reactions (kN)			
Live Loads	LH Support 190.13 kN, RH Support 210.62 kN		
Super Imposed Dead Load	LH Support 61.18 kN, RH Support 95.74 kN		
Dead Load (Self Weight)	LH Support 140.05 kN, RH Support 159.57 kN		
Maximum Deflection (Partial Connection All Loads)			
Live Loads	14.99 (17.15) mm @ 6 m < L / 360 = 33.3 mm	17.15 mm	OK
Additional due to Web Openings	Live load only, 0.109 mm	17.26 mm	OK
Super Imposed Dead Loads	5.03 (5.76) mm @ 6.12 m	5.76 mm	
Additional due to Web Openings	Super Dead load only, 0.037 mm	5.8 mm	
Dead Loads (Self Weight)	22.63 mm @ 6 m	22.63 mm	
Additional due to Web Openings	Dead load only, 0.144 mm	22.78 mm	
Maximum Steel Stress			
TOTAL (Tension)	Live 102.6, Super Dead 34.9, SW 96 < 345	234.41 N/mm ²	OK
TOTAL (Compression)	Live 24.6, Super Dead 8.4, SW 96 < 345	129.95 N/mm ²	OK
Maximum Concrete Stress	Live 3.89, Super Dead 1.33, SW < 17.5	5.22 N/mm ²	OK

Vibration Analysis (Partial Connection)

Beam Deflection	Including Partial Connection	18.15 mm	
Natural Frequency	$18/\sqrt{(18.15/1.1)} = 4.43 > 4 \text{ Hz}$	4.43 Hz	OK

UNSTIFFENED CIRCULAR OPENING @ 1.5 M**Summary of Design Data**

Dimensions (mm) Diameter 300, Top Distance 160, Bottom Distance 160, D 620

Ultimate Limit State (Final Stage)

General			
Applied Forces	M 768.33 kN.m @ 1.5 m, Fv 489.9 kN @ 1.433 m, To 636.86 kN		
Number of Shear Connectors	Total to start of opening (N1) 8, Over the opening (N2) 0.77		
Composite Moment Capacity	$\text{fyb} \cdot (D - \text{Xet} - \text{Xeb}) + N1 \cdot \text{Pd} \cdot (\text{Xet} + \text{ds} - 0.5\text{dc}) = 1879.36 \text{ kN.m}$	0.409	OK
Vierendeel Moment Capacity	$M_{vc} 7.397 + \text{Lower } 133.157 + \text{Upper } 150.325$	290.879 kN.m	
Vierendeel Moment	Applied 66.136 kN.m, Capacity 290.879 kN.m	0.227	OK
Axial Force in Slab	Applied 663.779 kN, Capacity 3933.373 kN	0.169	OK
Shear Resistance in Slab	$b_w 502.1 \text{ mm}, \text{dc } 70.0 \text{ mm}, \text{vc } 1.23 \text{ N/mm}^2$	43.342 kN	
Additional Live Load Deflection	Due to Bending 0.005 mm, Due to Shear 0.003 mm	0.008 mm	
Lower Web-Flange			
Section Properties and Mpb	te 14.1 mm, ye 31.8 mm, yp 15.3 mm	78.071 kN.m	
Axial Force Capacity fyb (kN)	Area 9385 mm ²	3237.867 kN	
Axial Force Applied T1 (kN)	$(M - \text{Min}(N1 \cdot \text{Pd}, \text{Fcd})(\text{Xet} + \text{ds} - 0.5\text{dc})) / (D - \text{Xeb} - \text{Xet})$	1242.261 kN	OK
Shear Force and Capacity	Applied 223.574 kN, Capacity 536.476 kN	0.417	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 14.1 mm, ye 31.7 mm, yp 15.3 mm	77.915 kN.m	
Axial Force Capacity fyt (kN)	Area 9382 mm ²	3236.894 kN	
Axial Force Applied To (kN)	To 636.86 kN, T2=N2.Pd 58.378 kN	636.860 kN	OK
Shear Force and Capacity	Applied 222.984 kN, Capacity 535.914 kN	0.416	OK
Web Post At end of Beam			
Horizontal Web Shear	$V_{Ed, \text{average}} 512.214, V_h 1232.427 / V_{hr} 3791.559 \text{ kN}$	0.325	OK
Web Post Axial Force	$d_o/t_w < 25$		OK

MasterSeries Sample Output 3 Castle Street Carrickfergus County Antrim BT38 7BE Tel: 028 9036 5950	Job ref :My Project Sheet :Comp Beams / 10 - Made By :MOG Date : 21 June 2015/ Version 2017.11 Checked : GHB Approved : ATW
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Web Post to right of opening				
Horizontal Web Shear	$V_{Ed,average}$ 252.411, V_h 1775.252 / V_{hr} 13200.050 kN		0.134	OK
Web Post Axial Force	$do/t_w < 25$			OK

Ultimate Limit State (Construction Stage)

General				
Applied Forces	M 285.68 kN.m @ 1.5 m, F_v 179.62 kN @ 1.433 m, T_o 513.13 kN			
Vierendeel Moment Capacity	Lower 72.424+Upper 72.348		144.773 kN.m	
Vierendeel Moment	Applied 24.248 kN.m, Capacity 144.773 kN.m		0.167	OK
Lower Web-Flange				
Section Properties and Mpb	te 14.1 mm, ye 31.8 mm, yp 15.3 mm		78.071 kN.m	
Axial Force Capacity f_{yb} (kN)	Area 9385 mm ²		3237.867 kN	
Axial Force Applied T1 (kN)	(M - Min($N_1.P_d, F_{cd}$)($X_{et}+ds-0.5dc$))/(D-Xeb-Xet)		513.127 kN	OK
Shear Force and Capacity	Applied 89.927 kN, Capacity 536.476 kN		0.168	OK
Upper Web-Flange (Compact)				
Section Properties and Mpt	te 14.1 mm, ye 31.7 mm, yp 15.3 mm		77.915 kN.m	
Axial Force Capacity f_{yt} (kN)	Area 9382 mm ²		3236.894 kN	
Axial Force Applied To (kN)	T_o 513.127 kN		513.127 kN	OK
Shear Force and Capacity	Applied 89.69 kN, Capacity 535.914 kN		0.167	OK
Web Post At end of Beam				
Horizontal Web Shear	$V_{Ed,average}$ 190.45, V_h 513.128 / V_{hr} 3791.559 kN		0.135	OK
Web Post Axial Force	$do/t_w < 25$			OK
Web Post to right of opening				
Horizontal Web Shear	$V_{Ed,average}$ 89.425, V_h 803.113 / V_{hr} 13200.050 kN		0.061	OK
Web Post Axial Force	$do/t_w < 25$			OK

STIFFENED RECTANGULAR OPENING @ 6.5 M

Summary of Design Data

Dimensions (mm)	Width 300, Height 200, Top Distance 210, Bottom Distance 210, D 620		
2 No. Stiffeners (1 top & 1 bot)	Area 2000 mm ² each ($p_y=345$) positioned 10 mm from edge of opening		
Typical stiffener and weld arrangement			
Single Web Sided	100 mm wide x 20 mm thi, 900 mm long, 7 fw all round [S 355]	Stiffener area specified is too large for single sided placement, $100 > l_o/4$	
Or Double Web Sided	85 mm wide x 12 mm thic 660 mm long, 6 fw all round [S 355]		
Important : Stiffeners and welds	must be designed by the engineer, using a compact stiffener section		

Ultimate Limit State (Final Stage)

General				
Applied Forces	M 1873.35 kN.m @ 6.5 m, F_v 95.26 kN @ 6.65 m, T_o 714.66 kN			
Number of Shear Connectors	Total to start of opening (N_1) 31, Over the opening (N_2)1.71			
Composite Moment Capacity	$f_{yb} \cdot (D-X_{et}-X_{eb}) + N_1.P_d \cdot (X_{et}+ds-0.5dc) = 2043.31$ kN.m		0.917	OK
Vierendeel Moment Capacity	M_{vc} 20.828+Lower 46.764+Upper 370.607		438.199 kN.m	
Vierendeel Moment	Applied 28.578 kN.m, Capacity 438.199 kN.m		0.065	OK
Axial Force in Slab	Applied 2475.656 kN, Capacity 4503.039 kN		0.550	OK
Shear Resistance in Slab	b_w 502.1 mm, dc 70.0 mm, vc 1.23N/mm ²		43.342 kN	
Additional Live Load Deflection	Due to Bending 0.080 mm, Due to Shear 0.000 mm		0.080 mm	
Lower Web-Flange				
Section Properties and Mpb	te 14.1 mm, ye 65.6 mm, yp 19.3 mm		229.296 kN.m	
Axial Force Capacity f_{yb} (kN)	Area 9879 mm ² , Reduced Stiffener 2000 mm ²		3408.124 kN	
Axial Force Applied T1 (kN)	(M - Min($N_1.P_d, F_{cd}$)($X_{et}+ds-0.5dc$))/(D-Xeb-Xet)		3060.590 kN	OK
Shear Force and Capacity	Applied 25.987 kN, Capacity 634.774 kN		0.041	OK
Upper Web-Flange (Compact)				
Section Properties and Mpt	te 14.1 mm, ye 65.6 mm, yp 19.3 mm		228.972 kN.m	
Axial Force Capacity f_{yt} (kN)	Area 9876 mm ² , Reduced Stiffener 2000 mm ²		3407.151 kN	
Axial Force Applied To (kN)	T_o 714.663 kN, $T_2=N_2.P_d$ 129.729 kN		714.663 kN	OK
Shear Force and Capacity	Applied 25.932 kN, Capacity 634.212 kN		0.041	OK
Web Post to left of opening				
Horizontal Web Shear	$V_{Ed,average}$ 252.411, V_h 1914.856 / V_{hr} 13200.050 kN		0.145	OK
Web Post Axial Force	$do/t_w < 20$			OK
Web Post to right of opening				
Horizontal Web Shear	$V_{Ed,average}$ 215.138, V_h 913.971 / V_{hr} 7021.298 kN		0.130	OK
Web Post Axial Force	$do/t_w < 20$			OK

Ultimate Limit State (Construction Stage)

General				
Applied Forces	M 689.67 kN.m @ 6.5 m, F_v 56.88 kN @ 6.65 m, T_o 1410.3 kN			

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Vierendeel Moment Capacity	Lower 190.432+Upper 190.264	380.696 kN.m	
Vierendeel Moment	Applied 17.065 kN.m, Capacity 380.696 kN.m	0.045	OK
Lower Web-Flange			
Section Properties and Mpb	te 14.1 mm, ye 65.6 mm, yp 19.3 mm	229.296 kN.m	
Axial Force Capacity fyb (kN)	Area 9879 mm ² , Reduced Stiffener 2000 mm ²	3408.124 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	1410.297 kN	OK
Shear Force and Capacity	Applied 28.472 kN, Capacity 634.774 kN	0.045	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 14.1 mm, ye 65.6 mm, yp 19.3 mm	228.972 kN.m	
Axial Force Capacity fyt (kN)	Area 9876 mm ² , Reduced Stiffener 2000 mm ²	3407.151 kN	
Axial Force Applied To (kN)	To 1410.297 kN	1410.297 kN	OK
Shear Force and Capacity	Applied 28.411 kN, Capacity 634.212 kN	0.045	OK
Web Post to left of opening			
Horizontal Web Shear	V _{Ed} .average 89.425, V _h 914.319 / V _{hr} 13200.050 kN	0.069	OK
Web Post Axial Force	do/t _w < 20		OK
Web Post to right of opening			
Horizontal Web Shear	V _{Ed} .average 74.267, V _h 425.231 / V _{hr} 7021.298 kN	0.061	OK
Web Post Axial Force	do/t _w < 20		OK

UNSTIFFENED CIRCULAR OPENING @ 9.3 M

Summary of Design Data

Dimensions (mm) Diameter 300, Top Distance 160, Bottom Distance 160, D 620

Ultimate Limit State (Final Stage)

General			
Applied Forces	M 1415.09 kN.m @ 9.3 m, Fv 418.69 kN @ 9.368 m, To 1148.28 kN		
Number of Shear Connectors	Total to start of opening (N1) 15, Over the opening (N2)0.77		
Composite Moment Capacity	fyb.(D-Xet-Xeb) + N1.Pd.(Xet+ds-0.5dc) = 1946.48 kN.m	0.727	OK
Vierendeel Moment Capacity	Mvc 7.397+Lower 78.487+Upper 137.191	223.075 kN.m	
Vierendeel Moment	Applied 56.524 kN.m, Capacity 223.075 kN.m	0.253	OK
Axial Force in Slab	Applied 1193.504 kN, Capacity 4399.197 kN	0.271	OK
Shear Resistance in Slab	b _w 502.1 mm, dc 70.0 mm, vc 1.23N/mm ²	43.342 kN	
Additional Live Load Deflection	Due to Bending 0.017 mm, Due to Shear 0.003 mm	0.020 mm	
Lower Web-Flange			
Section Properties and Mpb	te 14.1 mm, ye 31.8 mm, yp 15.3 mm	78.071 kN.m	
Axial Force Capacity fyb (kN)	Area 9385 mm ²	3237.867 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	2283.401 kN	OK
Shear Force and Capacity	Applied 187.924 kN, Capacity 536.476 kN	0.350	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 14.1 mm, ye 31.7 mm, yp 15.3 mm	77.915 kN.m	
Axial Force Capacity fyt (kN)	Area 9382 mm ²	3236.894 kN	
Axial Force Applied To (kN)	To 1148.275 kN, T2=N2.Pd 58.378 kN	1148.275 kN	OK
Shear Force and Capacity	Applied 187.428 kN, Capacity 535.914 kN	0.350	OK
Web Post At end of Beam			
Horizontal Web Shear	V _{Ed} .average 215.138, V _h 853.453 / V _{hr} 7021.298 kN	0.122	OK
Web Post Axial Force	do/t _w < 25		OK
Web Post At end of Beam			
Horizontal Web Shear	V _{Ed} .average 524.109, V _h 2276.013 / V _{hr} 7161.672 kN	0.318	OK
Web Post Axial Force	do/t _w < 25		OK

Ultimate Limit State (Construction Stage)

General			
Applied Forces	M 507.28 kN.m @ 9.3 m, Fv 150.21 kN @ 9.368 m, To 911.16 kN		
Vierendeel Moment Capacity	Lower 72.424+Upper 72.348	144.773 kN.m	
Vierendeel Moment	Applied 20.279 kN.m, Capacity 144.773 kN.m	0.140	OK
Lower Web-Flange			
Section Properties and Mpb	te 14.1 mm, ye 31.8 mm, yp 15.3 mm	78.071 kN.m	
Axial Force Capacity fyb (kN)	Area 9385 mm ²	3237.867 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	911.162 kN	OK
Shear Force and Capacity	Applied 75.206 kN, Capacity 536.476 kN	0.140	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 14.1 mm, ye 31.7 mm, yp 15.3 mm	77.915 kN.m	
Axial Force Capacity fyt (kN)	Area 9382 mm ²	3236.894 kN	
Axial Force Applied To (kN)	To 911.162 kN	911.162 kN	OK
Shear Force and Capacity	Applied 75.008 kN, Capacity 535.914 kN	0.140	OK
Web Post At end of Beam			

MasterSeries Sample Output

3 Castle Street
Carrickfergus
County Antrim BT38 7BE

Tel: 028 9036 5950

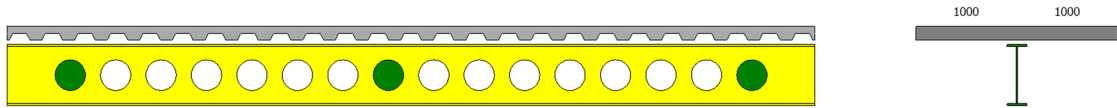
Job ref :My Project
Sheet :Comp Beams / 12 -
Made By :MOG
Date : 21 June 2015/ Version 2017.11
Checked : GHB
Approved : ATW

Horizontal Web Shear	$V_{Ed,average}$ 74.267, V_h 373.511 / V_{hr} 7021.298 kN	0.053	OK
Web Post Axial Force	$do/t_w < 25$		OK
Web Post At end of Beam			
Horizontal Web Shear	$V_{Ed,average}$ 187.882, V_h 911.158 / V_{hr} 7161.672 kN	0.127	OK
Web Post Axial Force	$do/t_w < 25$		OK

MasterSeries Sample Output 3 Castle Street Carrickfergus County Antrim BT38 7BE Tel: 028 9036 5950	Job ref :My Project Sheet :Comp Beams / 13 - Made By :MOG Date : 21 June 2015/ Version 2017.11 Checked : GHB Approved : ATW
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UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM WITH WEB OPENINGS

Cellform secondary beam



Summary of Design Data EC4 - NA UK (Symmetrical Beam)

EuroCode National Annex	Using UK values, SCI P405
Web Opening Design to	SCI P355
Steel Section (110 kg/m)	457x191 UB 98 (300@450) Cellular D 597 [S 355]Floor Area Supported8 m Span, 2.5 m to LH Beam and 2.5 m to RH Beam (2.5 m Supported Directly)
Non-Continuous Multideck 60 V2 (350)	Trough Spacing 323, Height 60, Average Width 150 in 1 mm thick
Concrete Slab	130 mm Thick @ 2350 kg/m ³ , Mod. Ratio 13.18, Gr C28/35 with 142 mm ² /m
Headed Stud Connector	19x98 mm (as welded) Placed One per Trough
Floor Loads (kN/m ²)	Live 6, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75
Self Weight Loads	Concrete Slab 2.256 kN/m ² , Steel Beam 1.079 kN/m
User Defined Values	Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area	70 x 2000 mm ² , b1= 1000 mm and b2= 1000 mm
Steel Section Elastic Properties	ye 298.6 mm, A 140.1 cm ² , Ix 80220 cm ⁴ , Zt 2687 cm ³ , Zb 2687 cm ³
Composite Section Elastic Properties	ye 258.8 mm, Ix 174218 cm ⁴ , Zs.t 13524 cm ³ , Zs.b 3720 cm ³ , Zc.t 88718 cm ³
Headed Stud Connector	25 No. 19x98 mm, Qk 99.57 kN, Qp 79.66 kN, k 0.85, Pd 67.71 Welded

Ultimate Limit State (Final Stage)

Maximum Shear			
Support Reactions (kN)	147.34 kN each si	< 1408.78 kN	OK
Check @ 4 m (Max. Moment)	M = 294.69 kN.m, Fv = 0 kN		
Shear Connection	No of shear connectors from nearest support 12 < 32.8	Partial	
Axial Resistance (kN)	Rc 2221.33 kN, Rs 4832.42 kN, Rq 812.51 kN	812.51 kN	
Imposed/Total Load Ratio	M _{Imposed} / M _{Ult} = 222.5/294.7	0.755	
Load Classification	0.755 > 0.7 therefore Heavy Loading		
Degree of Shear Connection	Higher Ductility, Na/Np = 12 / 32.8 > 0.25	0.366	OK
Reduced Concrete Area	Area required to resist 812.51 kN	25.6x2000mm ²	
Moment Capacity	Plastic neutral axis in web @ 325.3 mm	1354.78 kN.m	OK

Transverse Reinforcement

Vp = k _{phi} .1.1.D.tp.fyp,d/s	4x1.1x19x1.0x350/0.323	90.59 kN
Vr = fn(Asv,fy,γs,θf, f _{ck} ,Vp)	142, 500, 1.15, 26.5, 28, 90.59	214.42 kN
V ~ DF _a /~DX.Max(b1,b2)/(b1+b2)	812.51/4x1/(1+1)	101.56 kN OK

Ultimate Limit State (Construction Stage)

Maximum Shear			
Support Reactions (kN)	47.34 kN each si	< 1408.78 kN	OK
Check @ 4 m (Max. Moment)	M = 94.69 kN.m, Fv = 0 kN		
Moment Capacity	Plastic neutral axis in web @ 298.6 mm	1067.43 kN.m	OK

Serviceability Limit State

Support Reactions (kN)			
Live Loads	70 kN each side		
Super Imposed Dead Load	5 kN each side		
Dead Load (Self Weight)	28.88 kN each side		
Maximum Deflection (Partial Connection All Loads)			
Live Loads	2.55 (3.12) mm @ 4 m < L / 360 = 22.2 mm	3.12 mm	OK
Super Imposed Dead Loads	0.18 (0.22) mm @ 4 m	0.22 mm	
Dead Loads (Self Weight)	2.29 mm @ 4 m	2.29 mm	
Maximum Steel Stress			
TOTAL (Tension)	Live 37.6, Super Dead 2.7, SW 21 < 345	61.81 N/mm ²	OK
TOTAL (Compression)	Live 10.4, Super Dead 0.7, SW 21 < 345	32.58 N/mm ²	OK
Maximum Concrete Stress	Live 1.58, Super Dead 0.11, SW < 17.5	1.69 N/mm ²	OK

MasterSeries Sample Output

3 Castle Street
Carrickfergus
County Antrim BT38 7BE

Tel: 028 9036 5950

Job ref :My Project
Sheet :Comp Beams / 14 -
Made By : MOG
Date : 21 June 2015/ Version 2017.11
Checked : GHB
Approved : ATW

Vibration Analysis (Partial Connection)

Beam Deflection	Including Partial Connection	1.59 mm	
Natural Frequency	$18/\sqrt{(1.59/1.1)} = 14.99 > 4 \text{ Hz}$	14.99 Hz	OK

UNSTIFFENED CIRCULAR OPENING @ 0.625 M**Summary of Design Data**

Dimensions (mm) Diameter 300, Top Distance 149, Bottom Distance 148, D 597

Ultimate Limit State (Final Stage)

General

Applied Forces	M 84.9 kN.m @ 0.625 m, Fv 126.81 kN @ 0.558 m, To 0 kN		
Number of Shear Connectors	Total to start of opening (N1) 2, Over the opening (N2)0		
Composite Moment Capacity	$f_{yb} \cdot (D - X_{eb} + d_s - 0.5d_c) = 1289.12 \text{ kN.m}$	0.066	OK
Vierendeel Moment Capacity	Lower 52.371+Upper 52.645	105.016 kN.m	
Vierendeel Moment	Applied 17.119 kN.m, Capacity 105.016 kN.m	0.163	OK
Axial Force in Slab	Applied 135.419 kN, Capacity 1820.805 kN	0.074	OK
Shear Resistance in Slab	$b_w 387.8 \text{ mm}$, $d_c 70.0 \text{ mm}$, $v_c 0.69 \text{ N/mm}^2$	18.800 kN	
Additional Live Load Deflection	Due to Bending 0.000 mm, Due to Shear 0.000 mm	0.000 mm	
Lower Web-Flange			
Section Properties and Mpb	$t_e 11.4 \text{ mm}$, $y_e 34.4 \text{ mm}$, $y_p 14 \text{ mm}$	51.219 kN.m	
Axial Force Capacity f_{yb} (kN)	Area 5415 mm ²	1868.114 kN	
Axial Force Applied T1 (kN)	$X_c 5.2 \text{ mm}$, $M/(D - X_{eb} + e + 0.5X_c) = 84.9/690.1$	123.028 kN	OK
Shear Force and Capacity	Applied 53.668 kN, Capacity 387.931 kN	0.138	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	$t_e 11.4 \text{ mm}$, $y_e 34.7 \text{ mm}$, $y_p 14.1 \text{ mm}$	51.746 kN.m	
Shear Force and Capacity	Applied 54.34 kN, Capacity 389.966 kN	0.139	OK
Web Post At end of Beam			
Horizontal Web Shear	$V_{Ed, \text{average}} 135.833$, $V_h 128.616$ / $V_{hr} 1078.637 \text{ kN}$	0.119	OK
Web Post Axial Force	$\max(V_t, V_b) = \max(54.34, 53.67)$	54.34	
Local Web Buckling (Strut)	$d_o 300$, $s_o 475$, 66 , $p_c 239.4 \text{ N/mm}$, $P_c 409.368 \text{ kN}$	0.133	OK
Web Post to right of opening			
Horizontal Web Shear	$V_{Ed, \text{average}} 116.034$, $V_h 75.726$ / $V_{hr} 340.608 \text{ kN}$	0.222	OK
Web Post Axial Force	$V_h + M_{wEd}/(h_o/2)$, $M_{wEd} -2.18$	90.23	
Local Web Buckling (Strut)	$d_o 300$, $s_o 150$, 51 , $p_c 277.2 \text{ N/mm}$, $P_c 474.016 \text{ kN}$	0.190	OK

Ultimate Limit State (Construction Stage)

General

Applied Forces	M 27.28 kN.m @ 0.625 m, Fv 40.75 kN @ 0.558 m, To 51.67 kN		
Vierendeel Moment Capacity	Lower 52.371+Upper 52.645	105.016 kN.m	
Vierendeel Moment	Applied 5.501 kN.m, Capacity 105.016 kN.m	0.052	OK
Lower Web-Flange			
Section Properties and Mpb	$t_e 11.4 \text{ mm}$, $y_e 34.4 \text{ mm}$, $y_p 14 \text{ mm}$	51.219 kN.m	
Axial Force Capacity f_{yb} (kN)	Area 5415 mm ²	1868.114 kN	
Axial Force Applied T1 (kN)	$(M - \text{Min}(N1.P_d, F_{cd})(X_{et} + d_s - 0.5d_c))/(D - X_{eb} - X_{et})$	51.666 kN	OK
Shear Force and Capacity	Applied 20.246 kN, Capacity 387.931 kN	0.052	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	$t_e 11.4 \text{ mm}$, $y_e 34.7 \text{ mm}$, $y_p 14.1 \text{ mm}$	51.746 kN.m	
Axial Force Capacity f_{yt} (kN)	Area 5425 mm ²	1871.639 kN	
Axial Force Applied To (kN)	To 51.666 kN	51.666 kN	OK
Shear Force and Capacity	Applied 20.499 kN, Capacity 389.966 kN	0.053	OK
Web Post At end of Beam			
Horizontal Web Shear	$V_{Ed, \text{average}} 43.645$, $V_h 51.667$ / $V_{hr} 1078.637 \text{ kN}$	0.048	OK
Web Post Axial Force	$\max(V_t, V_b) = \max(20.5, 20.25)$	20.5	
Local Web Buckling (Strut)	$d_o 300$, $s_o 475$, 66 , $p_c 239.4 \text{ N/mm}$, $P_c 409.368 \text{ kN}$	0.050	OK
Web Post to right of opening			
Horizontal Web Shear	$V_{Ed, \text{average}} 37.283$, $V_h 31.777$ / $V_{hr} 340.608 \text{ kN}$	0.093	OK
Web Post Axial Force	$V_h + M_{wEd}/(h_o/2)$, $M_{wEd} 0.02$	31.93	
Local Web Buckling (Strut)	$d_o 300$, $s_o 150$, 51 , $p_c 277.2 \text{ N/mm}$, $P_c 474.016 \text{ kN}$	0.067	OK

UNSTIFFENED CIRCULAR OPENINGS @ 1.075 AND 6.925 M**Summary of Design Data**

Dimensions (mm) Diameter 300, Top Distance 149, Bottom Distance 148, D 597
Summary Maximum Unity Ratio for this Opening 0.191

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Job ref :My Project
Sheet :Comp Beams / 15 -
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Checked : GHB
Approved : ATW

UNSTIFFENED CIRCULAR OPENINGS @ 1.525 AND 6.475 M**Summary of Design Data**

Dimensions (mm)	Diameter 300, Top Distance 149, Bottom Distance 148, D 597	
Summary	Maximum Unity Ratio for this Opening	0.163

UNSTIFFENED CIRCULAR OPENINGS @ 1.975 AND 6.025 M**Summary of Design Data**

Dimensions (mm)	Diameter 300, Top Distance 149, Bottom Distance 148, D 597	
Summary	Maximum Unity Ratio for this Opening	0.185

UNSTIFFENED CIRCULAR OPENINGS @ 2.425 AND 5.575 M**Summary of Design Data**

Dimensions (mm)	Diameter 300, Top Distance 149, Bottom Distance 148, D 597	
Summary	Maximum Unity Ratio for this Opening	0.213

UNSTIFFENED CIRCULAR OPENINGS @ 2.875 AND 5.125 M**Summary of Design Data**

Dimensions (mm)	Diameter 300, Top Distance 149, Bottom Distance 148, D 597	
Summary	Maximum Unity Ratio for this Opening	0.274

UNSTIFFENED CIRCULAR OPENINGS @ 3.325 AND 4.675 M**Summary of Design Data**

Dimensions (mm)	Diameter 300, Top Distance 149, Bottom Distance 148, D 597	
Summary	Maximum Unity Ratio for this Opening	0.305

UNSTIFFENED CIRCULAR OPENINGS @ 3.775 AND 4.225 M**Summary of Design Data**

Dimensions (mm)	Diameter 300, Top Distance 149, Bottom Distance 148, D 597	
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Ultimate Limit State (Final Stage)

General

Applied Forces	M 293.76 kN.m @ 3.775 m, Fv 22.1 kN @ 3.708 m, To 0 kN		
Number of Shear Connectors	Total to start of opening (N1) 11, Over the opening (N2)0		
Composite Moment Capacity	fyb.(D-Xeb+ds-0.5dc) = 1272.06 kN.m	0.231	OK
Vierendeel Moment Capacity	Lower 52.371+Upper 52.645	105.016 kN.m	
Vierendeel Moment	Applied 2.984 kN.m, Capacity 105.016 kN.m	0.028	OK
Axial Force in Slab	Applied 744.802 kN, Capacity 2221.333 kN	0.335	OK
Shear Resistance in Slab	b _w 387.8 mm, dc 70.0 mm, vc 1.00N/mm ²	27.141 kN	
Additional Live Load Deflection	Due to Bending 0.000 mm, Due to Shear 0.000 mm	0.000 mm	
Lower Web-Flange			
Section Properties and Mpb	te 11.4 mm, ye 34.4 mm, yp 14 mm	51.219 kN.m	
Axial Force Capacity fyb (kN)	Area 5415 mm ²	1868.114 kN	
Axial Force Applied T1 (kN)	Xc 23.5 mm, M/(D-Xeb+e+0.5Xc) = 293.8/680.9	431.403 kN	OK
Shear Force and Capacity	Applied -2.504 kN, Capacity 387.931 kN	0.006	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 34.7 mm, yp 14.1 mm	51.746 kN.m	
Shear Force and Capacity	Applied 0 kN, Capacity 389.966 kN	0.000	OK
Web Post to right of opening			
Horizontal Web Shear	V _{Ed,average} 8.288, V _h 5.478 / V _{hr} 340.609 kN	0.016	OK
Web Post Axial Force	V _h + M _w Ed/(ho/2), M _w Ed -3.83	31.04	
Local Web Buckling (Strut)	do 300, so 150, 51, pc 277.2 N/mm, Pc 474.017 kN	0.065	OK

MasterSeries Sample Output

3 Castle Street
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Job ref :My Project
Sheet :Comp Beams / 16 -
Made By :MOG
Date : 21 June 2015/ Version 2017.11
Checked : GHB
Approved : ATW

Ultimate Limit State (Construction Stage)

General

Applied Forces	M 94.39 kN.m @ 3.775 m, Fv 11.84 kN @ 3.708 m, To 178.77 kN		
Vierendeel Moment Capacity	Lower 52.371+Upper 52.645	105.016 kN.m	
Vierendeel Moment	Applied 1.598 kN.m, Capacity 105.016 kN.m	0.015	OK
Lower Web-Flange			
Section Properties and Mpb	te 11.4 mm, ye 34.4 mm, yp 14 mm	51.219 kN.m	
Axial Force Capacity fyb (kN)	Area 5415 mm ²	1868.114 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	178.771 kN	OK
Shear Force and Capacity	Applied 5.881 kN, Capacity 387.931 kN	0.015	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 34.7 mm, yp 14.1 mm	51.746 kN.m	
Axial Force Capacity fyt (kN)	Area 5425 mm ²	1871.639 kN	
Axial Force Applied To (kN)	To 178.771 kN	178.771 kN	OK
Shear Force and Capacity	Applied 5.955 kN, Capacity 389.966 kN	0.015	OK
Web Post to right of opening			
Horizontal Web Shear	V _{Ed} .average 2.663, V _h 2.27 / V _{hr} 340.609 kN	0.007	OK
Web Post Axial Force	V _h + M _{WEd} /(ho/2), M _{WEd} 0	2.28	
Local Web Buckling (Strut)	do 300, so 150, 51, pc 277.2 N/mm, Pc 474.017 kN	0.005	OK

UNSTIFFENED CIRCULAR OPENING @ 7.375 M**Summary of Design Data**

Dimensions (mm) Diameter 300, Top Distance 149, Bottom Distance 148, D 597

Ultimate Limit State (Final Stage)

General

Applied Forces	M 84.89 kN.m @ 7.375 m, Fv 126.81 kN @ 7.443 m, To 0 kN		
Number of Shear Connectors	Total to start of opening (N1) 2, Over the opening (N2)0		
Composite Moment Capacity	fyb.(D-Xeb+ds-0.5dc) = 1289.12 kN.m	0.066	OK
Vierendeel Moment Capacity	Lower 52.371+Upper 52.645	105.016 kN.m	
Vierendeel Moment	Applied 17.119 kN.m, Capacity 105.016 kN.m	0.163	OK
Axial Force in Slab	Applied 135.419 kN, Capacity 1820.799 kN	0.074	OK
Shear Resistance in Slab	b _w 387.8 mm, dc 70.0 mm, vc 0.69N/mm ²	18.800 kN	
Additional Live Load Deflection	Due to Bending 0.000 mm, Due to Shear 0.000 mm	0.000 mm	
Lower Web-Flange			
Section Properties and Mpb	te 11.4 mm, ye 34.4 mm, yp 14 mm	51.219 kN.m	
Axial Force Capacity fyb (kN)	Area 5415 mm ²	1868.114 kN	
Axial Force Applied T1 (kN)	Xc 5.2 mm, M/(D-Xeb+e+0.5Xc) = 84.9/690.1	123.024 kN	OK
Shear Force and Capacity	Applied 53.668 kN, Capacity 387.931 kN	0.138	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 34.7 mm, yp 14.1 mm	51.746 kN.m	
Shear Force and Capacity	Applied 54.34 kN, Capacity 389.966 kN	0.139	OK
Web Post At end of Beam			
Horizontal Web Shear	V _{Ed} .average 135.833, V _h 128.608 / V _{hr} 1078.545 kN	0.119	OK
Web Post Axial Force	max(Vt,Vb) = max(54.34, 53.67)	54.34	
Local Web Buckling (Strut)	do 300, so 475, 66, pc 239.4 N/mm, Pc 409.368 kN	0.133	OK

Ultimate Limit State (Construction Stage)

General

Applied Forces	M 27.28 kN.m @ 7.375 m, Fv 40.75 kN @ 7.443 m, To 51.66 kN		
Vierendeel Moment Capacity	Lower 52.371+Upper 52.645	105.016 kN.m	
Vierendeel Moment	Applied 5.501 kN.m, Capacity 105.016 kN.m	0.052	OK
Lower Web-Flange			
Section Properties and Mpb	te 11.4 mm, ye 34.4 mm, yp 14 mm	51.219 kN.m	
Axial Force Capacity fyb (kN)	Area 5415 mm ²	1868.114 kN	
Axial Force Applied T1 (kN)	(M - Min(N1.Pd,Fcd)(Xet+ds-0.5dc))/(D-Xeb-Xet)	51.664 kN	OK
Shear Force and Capacity	Applied 20.246 kN, Capacity 387.931 kN	0.052	OK
Upper Web-Flange (Compact)			
Section Properties and Mpt	te 11.4 mm, ye 34.7 mm, yp 14.1 mm	51.746 kN.m	
Axial Force Capacity fyt (kN)	Area 5425 mm ²	1871.639 kN	
Axial Force Applied To (kN)	To 51.664 kN	51.664 kN	OK
Shear Force and Capacity	Applied 20.5 kN, Capacity 389.966 kN	0.053	OK
Web Post At end of Beam			
Horizontal Web Shear	V _{Ed} .average 43.645, V _h 51.663 / V _{hr} 1078.545 kN	0.048	OK
Web Post Axial Force	max(Vt,Vb) = max(20.5, 20.25)	20.5	
Local Web Buckling (Strut)	do 300, so 475, 66, pc 239.4 N/mm, Pc 409.368 kN	0.050	OK

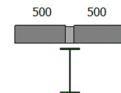
MasterSeries Sample Output

3 Castle Street
Carrickfergus
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Tel: 028 9036 5950

Job ref :My Project
Sheet :Comp Beams / 17 -
Made By :MOG
Date : 21 June 2015/ Version 2017.11
Checked : GHB
Approved : ATW

UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM Hollowcore slabs on secondary beam

**Summary of Design Data BS 5950-3.1 + A1:2010 (Symmetrical Beam)**

Steel Section (67 kg/m)	406x178 UB 67 [S 355]Floor Area Supported8 m Span, 2.5 m to LH Beam and 2.5 m to RH Beam (2.5 m Supported Directly)
Solid Slab	With 393 mm ² /m Bottom and 142 mm ² /m Top
Concrete Slab	150 mm Thick @ 2350 kg/m ³ , Mod. Ratio 13.38, Gr 35
Headed Stud Connector	19x98 mm (as welded) Placed @ 175 mm centres
Floor Loads (kN/m ²)	Live 6, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75
Self Weight Loads	Concrete Slab 2.685 kN/m ² , Steel Beam 0.657 kN/m
User Defined Values	Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area	150 x 1000 mm ² , b1= 500 mm and b2= 500 mm	See SCI P287
Steel Section Elastic Properties	ye 204.7 mm, A 85.5 cm ² , Ix 24334 cm ⁴ , Zt 1189 cm ³	
Composite Section Elastic Properties	ye 196.1 mm, Ix 64393 cm ⁴ , Zs.t 13983 cm ³ , Zs.b 1772 cm ³ , Zc.t 43947 cm ³	
Headed Stud Connector	46 No. 19x98 mm, Qk 104 kN, Qp 83.2 kN, k 1, Pd 83.2	Welded

Ultimate Limit State (Final Stage)

Maximum Shear			
Support Reactions (kN)	163.08 kN each si	< 767.38 kN	OK
Check @ 4 m (Max. Moment)	M = 326.15 kN.m, Fv = 0 kN		
Shear Connection	No of shear connectors from nearest support 23 < 28.4	Partial	
Axial Resistance (kN)	Rc 2362.5 kN, Rs 3036.67 kN, Rq 1913.6 kN	1913.6 kN	
Degree of Shear Connection	Na/Np = 23 / 28.4 > 0.44	0.81	OK
Reduced Concrete Area	Area required to resist 1913.6 kN	121.5x1000mm ²	
Moment Capacity	Plastic neutral axis in top flange @ 158.6 mm	781.22 kN.m	OK

Transverse Reinforcement

Max. No. of Shear Connectors (N)	Average minimum spacing 175 mm	5.71 per m	
Vr = fn(Asv,fy,Acv,fcu)	a-a plane 535, 460, 150000, 35	329.77 kN	
V=N.Pd.Max(b1,b2)/(b1+b2)	a-a plane 5.71x83.2x0.41/(0.5+0.5)	195.21 kN	OK
Vr = fn(Asv,b,fy,Acv,fcu)	b-b plane 786, 460, 234000, 35	498.79 kN	
V=N.Pd	b-b plane 5.71x83.2	475.43 kN	OK

Ultimate Limit State (Construction Stage)

Maximum Shear			
Support Reactions (kN)	56.08 kN each si	< 767.38 kN	OK
Top Flange Loading (factored)	Max. 52.396 kN, Min. 2.8 kN, Steel Beam 7.361 kN		
	Deck bearing 40 mm		
Check @ 4 m (Max. Moment)	M = 112.15 kN.m, Fv = 0 kN		
Moment Capacity	Plastic neutral axis in web @ 204.7 mm	477.83 kN.m	OK
m _{LT} .MA (Unrestraint)	0.925 x 112.153	103.741 kN.m	
Mb=fn(L,ryy,β _w ,u,v)	8 m, 4 cm, 1, 0.881, 0.75	119.014 kN.m	OK
Combined Torsion and Bending Check (Out of Balance Loads)			
Out of Balance Moments	Mx 62.557 kN.m, M _{out} 3.442 kN.m		
J, H, a, W _n	46.11 cm ⁴ , 0.5317 dm ⁶ , 1731 mm, 176.6 cm ²		
L _{ef} = 1.2 x L	1.2 x 8	9.6 m	
Mb=fn(L,ryy,β _w ,u,v)	9.6 m, 4 cm, 1, 0.881, 0.702	97.335 kN.m	
K _v = 1+0.5 m.Mx/Mb	1 + 0.5 • 0.925 • 62.56 / 97.34	1.297	
M _{yt} = M _{xb} • θ	62.56 • 66.17 • 10 ⁻³	4.139 kN.m	
σ _{byt} = M _{yt} / Z _y	4.139 / 153.0	27.05 N/mm ²	
σ _w = E • W _n • θ"	205 • 176.6 • 9.508 • 10 ⁻⁹	34.42 N/mm ²	
Modified Local Capacity Check	62.557/422.006 + (27.05 + 34.42) / 355	0.321	OK
Modified Buckling Check	62.557/97.335 + (27.05 + 34.42) • 1.297 / 355	0.867	OK

Serviceability Limit State

Support Reactions (kN)	
Live Loads	70 kN each side

MasterSeries Sample Output

3 Castle Street
 Carrickfergus
 County Antrim BT38 7BE

 Tel: 028 9036 5950

Job ref :My Project
 Sheet :Comp Beams / 18 -
 Made By :MOG
 Date : 21 June 2015/ Version 2017.11
 Checked : GHB
 Approved : ATW

Super Imposed Dead Load	5 kN each side		
Dead Load (Self Weight)	31.48 kN each side		
Maximum Deflection (Partial Connection All Loads)			
Live Loads	7.07 (7.73) mm @ 4 m < L / 360 = 22.2 mm	7.73 mm	OK
Super Imposed Dead Loads	0.51 (0.55) mm @ 4 m	0.55 mm	
Dead Loads (Self Weight)	8.41 mm @ 4 m	8.41 mm	
Maximum Steel Stress			
TOTAL (Tension)	Live 79, Super Dead 5.6, SW < 355	137.59 N/mm ²	OK
TOTAL (Compression)	Live 10, Super Dead 0.7, SW < 355	63.69 N/mm ²	OK
Maximum Concrete Stress	Live 3.19, Super Dead 0.23, SW < 17.5	3.41 N/mm ²	OK
Vibration Analysis (Partial Connection)			
Beam Deflection	Including Partial Connection	3.59 mm	
Natural Frequency	$18/\sqrt{(3.59)} = 9.49 > 4$ Hz	9.49 Hz	OK