**MasterSeries – Composite SlimFloor Beam Design**

**Sample Output**

The following output is from the MasterBeam Composite SlimFloor Design program.

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4 Built Up SlimFloor Beam
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UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM
UC SlimFloor Beam

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

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<td>Using UK values, SCI P405</td>
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<td>Steel Section (161 kg/m)</td>
<td>254x254 UC 89 + 456.3x20 B Plate 160.59 [S 355]Floor Area Supported 9 m Span, 5 m to LH Beam and 5 m to RH Beam (5 m Supported Directly)</td>
</tr>
<tr>
<td>Non-Continuous SD 225 (SlimFloor)</td>
<td>Trough Spacing 600, Height 225, Average Width 174 in 1 mm thick</td>
</tr>
<tr>
<td>Concrete Slab</td>
<td>400 mm Thick @ 2350 kg/m³, Mod. Ratio 10, Gr C25/30 with 193 mm²/m³</td>
</tr>
<tr>
<td>Rib Pattern</td>
<td>Bond force per unit length = [2(B+T+r+d)] where ( f_{bd} = 0.6 \text{ N/mm}^2 ]</td>
</tr>
<tr>
<td>Floor Loads (kN/m²)</td>
<td>Live 3, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75</td>
</tr>
<tr>
<td>Self Weight Loads</td>
<td>Concrete Slab 5.538 kN/m², Steel Beam 1.575 kN/m</td>
</tr>
<tr>
<td>User Defined Values</td>
<td>Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits</td>
</tr>
</tbody>
</table>

Section Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Effective Area</td>
<td>95 x 1125 mm², b1 = 563 mm and b2 = 563 mm</td>
</tr>
<tr>
<td>Steel Section Elastic Properties</td>
<td>ye 192.7 mm, A 204.6 cm², Ix 24227 cm⁴, Zw 1257 cm³, Zb 2765 cm³</td>
</tr>
<tr>
<td>Composite Section Elastic Properties</td>
<td>ye 242.7 mm, Ix 85866 cm⁴, Zs.t 9151 cm³, Zs.b 5320 cm³, Zc.t 38847 cm³</td>
</tr>
</tbody>
</table>

Ultimate Limit State (Final Stage)

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Shear</td>
<td>319.32 kN each si</td>
</tr>
<tr>
<td>Plate Loading (factored)</td>
<td>Max. 310.456 kN, Min. 310.456 kN, Steel Beam 17.723 kN</td>
</tr>
<tr>
<td>Transverse Plate Bending</td>
<td>310.456x62.5/1000, ( M_o = 310.5 \text{ kN.m} )</td>
</tr>
<tr>
<td>Von Mises Criterion</td>
<td>Trans. Str. 21.6 N/mm², Per. Longitudinal Str. = 333.7 N/mm²</td>
</tr>
<tr>
<td>Check @ 4.5 m (Max. Moment)</td>
<td>( M = 718.46 \text{ kN.m}, F_v = 0 \text{ kN} )</td>
</tr>
<tr>
<td>Shear Connection</td>
<td>Bond developed over half span 1334.2 kN &lt; 1518.8</td>
</tr>
<tr>
<td>Axial Resistance (kN)</td>
<td>Rc 1518.84 kN, Rs 6954.68 kN, Fsb 1334.21 kN</td>
</tr>
<tr>
<td>Degree of Shear Connection</td>
<td>Fsb/Rc = 1334 / 1518.8 &gt; 0.83</td>
</tr>
<tr>
<td>Reduced Concrete Area</td>
<td>Area required to resist 1334.21 kN</td>
</tr>
<tr>
<td>Moment Capacity</td>
<td>Plastic neutral axis in bottom flange @ 387.8 mm</td>
</tr>
</tbody>
</table>

Transverse Reinforcement

\[ V_r = f_n(A_s/v_y) \frac{f_y}{f_y} \]
\[ V = V_f = V_c = \frac{d}{dx} \max(b_1,b_2)/(b_1+b_2) \]

Ultimate Limit State (Construction Stage)

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Shear</td>
<td>201.59 kN each si</td>
</tr>
<tr>
<td>Plate Loading (factored)</td>
<td>Max. 154.639 kN, Min. 6.075 kN, Steel Beam 17.723 kN</td>
</tr>
<tr>
<td>Transverse Plate Bending</td>
<td>154.639x62.5/1000, ( M_o = 310.5 \text{ kN.m} )</td>
</tr>
<tr>
<td>Check @ 4.5 m (Max. Moment)</td>
<td>Trans. Str. 10.7 N/mm², Per. Longitudinal Str. = 20692, 224.0, 1.357, 210000,</td>
</tr>
<tr>
<td>Moment Capacity</td>
<td>Plastic neutral axis in bottom flange @ 256 mm</td>
</tr>
<tr>
<td>( C_i = \text{Fn(Moment Distribution)} )</td>
<td>(Unrestrained) - Uniform Load</td>
</tr>
<tr>
<td>( M_o = \text{Fn(C_i,L_o,b_i,b_i,E)} )</td>
<td>1.127</td>
</tr>
<tr>
<td>( M_b = \text{Fn(C_i,Z_o,C_i,Z_i)} )</td>
<td>0.454, -12.2, 0.525, -96.3</td>
</tr>
<tr>
<td>( M_b = \text{Fn}(A_s,C_i,S_{xx,p},py) )</td>
<td>0.746, 0.871, 1559, 345</td>
</tr>
</tbody>
</table>

Combined Torsion and Bending Check

\( \text{Out of Balance Loads} \)
\( \text{Out of Balance} \)
\( J, H, a, W_o \)
\( \text{Local Torsion} \)

<table>
<thead>
<tr>
<th>Property</th>
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</tr>
</thead>
<tbody>
<tr>
<td>J, H, a, W_o</td>
<td>224.0 cm⁴, 1.357 dm⁴, 1255 mm, 284.7 cm²</td>
</tr>
<tr>
<td>( L_f )</td>
<td>1 x 9</td>
</tr>
<tr>
<td>( M_o = \text{Fn}(C_i,L_o,b_i,b_i,E) )</td>
<td>1.127, 9.000, 20692, 224.0, 1.357, 210000,</td>
</tr>
<tr>
<td>( M_b = \text{Fn}(A_s,C_i,S_{xx,p},py) )</td>
<td>0.454, -12.2, 0.525, -96.3</td>
</tr>
<tr>
<td>( M_{out} = M_{in} )</td>
<td>986.283 kN.m</td>
</tr>
<tr>
<td>( M_{out} = E \times \theta )</td>
<td>121 \times 284.7 \times 16.43 \times 10^6</td>
</tr>
<tr>
<td>( M_{out} = E \times \theta )</td>
<td>210 \times 284.7 \times 16.43 \times 10^6</td>
</tr>
<tr>
<td>( M_{out} = E \times \theta )</td>
<td>210 \times 2427 \times 10^6 \times 16.43 \times 10^9</td>
</tr>
</tbody>
</table>

Job ref : My Project  
Sheet : Slim Floor / 2 -  
Made By : GHB  
Date : 21 June 2015/ Version 2017.11  
Checked : MOG  
Approved : ATW
Torsion Buckling

\[ k = k_w \times k_{bw} \times k_d \]

\[ M_{n,p,b} + M_{n,ld,b} + M_{n,ld,p} \]

\[ (200.741/433.67)^2 + 30.158/312.88 + 18.602/98.017 \]

\[ 0.662 \times 0.904 \times 1.263 \]

\[ 0.755 \times 18.602/98.017 \]

Serviceability Limit State

Support Reactions (kN)

- Live Loads: 90 kN each side
- Super Imposed Dead Load: 11.25 kN each side
- Dead Load (Self Weight): 136.2 kN each side

Maximum Deflection (Partial Connection All Loads)

- Live Loads: 9.47 (16.71) mm @ 4.5 m < L / 360 = 25 mm
- Super Imposed Dead Loads: 1.18 (2.09) mm @ 4.5 m
- Dead Loads (Self Weight): 50.82 mm @ 4.5 m

Maximum Steel Stress

- TOTAL (Tension): 38.1, Super Dead 4.8, SW 110 < 345
- TOTAL (Compression): 22.1, Super Dead 2.8, SW 243 < 345

Maximum Concrete Stress

- Live 5.21, Super Dead 0.65, SW < 15

Vibration Analysis (Partial Connection)

- Beam Deflection: Including Partial Connection
- Natural Frequency: 18/√(18.10/1.1) = 4.44 > 4 Hz
Summary of Design Data EC4 - NA UK (Symmetrical Beam)

EuroCode National Annex: Using UK values, SCI P405
Steel Section (101 kg/m): 200x15 T + 350x20 B + 240x10 W 24 r 101.22 [S 355]Floor Area Supported 6 m Span, 6 m to LH Beam and 6 m to RH Beam (6 m Supported Directly)
Non-Continuous SD 225 (SlimFloor): Trough Spacing 600, Height 225, Average Width 174 in 1 mm thick
Concrete Slab: 400 mm Thick @ 2350 kg/m³, Mod. Ratio 10, Gr C25/30 with 252 mm²/m Rib Pattern

Floor Loads (kN/m²):
- Live 2, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75

Self Weight Loads:
- Concrete Slab 5.538 kN/m², Steel Beam 0.993 kN/m

Additional Point Loads (kN):
- Dead 10 @ 2 and 4 m
- Additional Partial Loads (kN/m):
  - Dead 5, Live 6, Super Imposed Dead 7 between 0 and 2 m
  - Dead 15, Live 12, Super Imposed Dead 17 between 2 and 4 m
  - Dead 5, Live 6, Super Imposed Dead 7 between 4 and 6 m

User Defined Values:
- Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties:
- Concrete Effective Area: 90 x 750 mm², b₁= 375 mm and b₂= 375 mm
- Steel Section Elastic Properties: ye 175.9 mm, A 128.9 cm², Iₓ 16381 cm⁴, Zₜ 931 cm³, Zₑ 1653 cm³
- Composite Section Elastic Properties: ye 243.7 mm, Iₓ 56006 cm⁴, Zₑ.t 6105 cm³, Zₑ.b 3417 cm³, Zₑ.c 24723 cm³

Ultimate Limit State (Final Stage):
- Maximum Shear Support Reactions (kN): 343.59 kN each si < 547.76 kN OK
- Bottom Flange Loading (factored):
  - Max. 221.365 kN, Min. 221.365 kN, Steel Beam 7.447 kN
  - Deck bearing 75 mm
  - Transverse Bottom Flange Bending:
    - 221.365x137.5/1000, Mₚ 207 kN.m
    - 30.438 kN.m
  - Von Mises Criterion:
    - Trans. Str. 50.7 N/mm², Per. Longitudinal Str. = 316.8 N/mm²
  - Check @ 3 m (Max. Moment):
    - M = 555.63 kN.m, Fv = 0 kN
  - Shear Connection:
    - Bond developed over half span 810 kN < 956.3 Partial
  - Axial Resistance (kN):
    - Rc 956.25 kN, Rs 4251.22 kN, Fsb 810 kN 810 kN
  - Degree of Shear Connection:
    - Fsb/Rc = 810 / 956.3 > 0.66 OK
  - Reduced Concrete Area:
    - Area required to resist 810 kN 76.2x750mm²
  - Moment Capacity:
    - Plastic neutral axis in web @ 334 mm 655.81 kN.m

Transverse Reinforcement:
- Vₛ = fn(Aₛv, fy, γₛ, θf, fck, a) a-a plane 252, 500, 1.15, 26.5, 25 219.75 kN
- Vₛ = Dₚ/Fₒ̄,Dₓ Max(b₁,b₂)/(b₁+b₂) a-a plane 80/2x0.28/(0.38+0.38) 202.50 kN OK

Ultimate Limit State (Construction Stage):
- Maximum Shear Support Reactions (kN): 204.89 kN each si < 547.76 kN OK
- Bottom Flange Loading (factored):
  - Max. 123.711 kN, Min. 4.86 kN, Steel Beam 7.447 kN
  - Deck bearing 75 mm
  - Transverse Bottom Flange Bending:
    - 123.711x137.5/1000, Mₚ 207 kN.m
    - 17.01 kN.m
  - Von Mises Criterion:
    - Trans. Str. 28.4 N/mm², Per. Longitudinal Str. = 330 N/mm²
  - Check @ 3 m (Max. Moment):
    - M = 327.59 kN.m
  - Moment Capacity:
    - Plastic neutral axis in bottom flange @ 256.9 mm 398.48 kN.m

Moment Capacity
- Mb = fn(γ₁,Lₓ,Lₜ,E₁, Lₜ,E₂) (Unrestraint) - Uniform Load 1.127
- Mb = fn(Lₓ,Cₓ, Zₓ,y) 1.127, 6.000, 8154, 149.8, 0.5817, 210000, 752.391 kN.m
- Mb = fn(Lₓ,Cₓ, Zₓ,y) 0.728, 0.881, 1155, 345 351.005 kN.m OK
Combined Torsion and Bending Check (Out of Balance Loads)

Out of Balance Moments

\[ M_x = 102.014 \text{kN.m}, \quad M_{bd} = 16.342 \text{kN.m} \]

\[ J, H, a, W_n \]

\[ 149.8 \text{cm}^4, \quad 0.5817 \text{dm}^3, \quad 1005 \text{mm}, \quad 225.9 \text{cm}^2 \]

\[ L_f = 1 \times L \]

\[ 1 \times 6 \quad \text{m} \]

\[ M_u = \text{fn}(C_2, L, I, J, a, E) \]

\[ 1.127, \quad 6.000, \quad 8154, \quad 149.8, \quad 0.5817, \quad 210000, \quad C_2, Z_e, C_3, Z) \]

\[ 0.454, \quad -14.1, \quad 0.525, \quad -97.1 \quad \text{752.391 kN.m} \]

\[ M_b = \text{fn}(\lambda, L, C, S_{x,y}) \]

\[ 0.728, \quad 0.881, \quad 1155, \quad 345 \quad \text{351.005 kN.m} \]

\[ \sigma_{w} = E \cdot W_n \cdot \theta'' \]

\[ 210 \times 225.9 \times 20.24 \times 10^{-9} \quad \text{96.03 N/mm²} \]

\[ M_{w,Ed} = E \cdot I_{tf} \cdot \theta'' \cdot e_{sf} \]

\[ 210 \times 1000.0 \times 10^{-4} \times 20.24 \times 10^{-9} \times 225.89 \quad \text{9.60 kN.m} \]

\[ (M_{h,Ed} / M_{bd})^2 + (M_{z,Ed} / M_{bd}) + 1 = 0.338 \quad \text{OK} \]

\[ \text{Torsion Buckling} \]

\[ k = k_w \times k_{zw} \times k_6 \]

\[ 0.663 \times 0.949 \times 1.157 = 0.728 \quad \text{OK} \]

\[ M_{h,Ed} / M_{bd} + C_{mw} \cdot M_{z,Ed} / M_{bd} + k \cdot M_{w,Ed} / M_{bd} \]

\[ 0.474 \quad \text{OK} \]

Check at 2 m

\[ M = 291.19 \text{kN.m}, \quad Fv = 86.3 \text{kN} \]

Serviceability Limit State

Support Reactions (kN)

| Live Loads | 78 kN each side |
| Super Imposed Dead Load | 40 kN each side |

Maximum Deflection (Partial Connection All Loads)

| Live Loads | 3.88 (6.69) mm @ 3 m < L / 360 = 16.7 mm |
| Super Imposed Dead Loads | 2.16 (3.73) mm @ 3 m |

Maximum Steel Stress

| TOTAL (Tension) | Live 36, Super Dead 20.5, SW 137 < 345 |
| TOTAL (Compression) | Live 20.1, Super Dead 11.5, SW 243 < 345 |

Maximum Concrete Stress

| Live 4.97, Super Dead 2.83, SW < 15 |

Vibration Analysis (Partial Connection)

| Beam Deflection | Including Partial Connection |
| Natural Frequency | 18/√(11.58/1.1) = 5.55 > 4 Hz |

OK
UNPROPPED COMPOSITE SECONDARY INTERNAL BEAM

ASB Slimfloor beam with hollowcore units

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

EuroCode National Annex
Using UK values

Steel Section (100 kg/m)
280 ASB 100 [S 355]Floor Area Supported 8 m Span, 3 m to LH Beam and 3 m to RH Beam (3 m Supported Directly)

Solid Slab
With 393 mm²/m Bottom and 0 mm²/m Top

Concrete Slab
400 mm Thick @ 2350 kg/m³, Mod. Ratio 15.36, Gr C28/35

Headed Stud Connector
19x95 mm (as welded) Placed @ 250 mm centres in pairs

Floor Loads (kN/m²)
Live 5, Partitions 1, Services 0.5, Deck/Mesh 0.2, Construction 0.75

Self-Weight Loads
Concrete Slab 8.449 kN/m², Steel Beam 0.984 kN/m²

User Defined Values
Combinations, Deck/Mesh, Construction Load, Vibration and Deflection Limits

Section Properties

Concrete Effective Area
133 x 2000 mm², b₁ = 1000 mm and b₂ = 1000 mm

Steel Section Elastic Properties
ye 159.9 mm, A 127.8 cm², Ix 15506 cm⁴, Zt 995 cm³, Zb 1291 cm³

Composite Section Elastic Properties
ye 163.9 mm, lx 56753 cm³, Zs.t 23799 cm³, Zs.b 2256 cm³, Zc.t 53307 cm³

Headed Stud Connector
64 No. 19x95 mm, Qk 99.57 kN, Qp 79.66 kN, k 1, Pd 79.66 kN

Ultimate Limit State (Final Stage)

Maximum Shear
Support Reactions (kN)
250.15 kN each si
Bottom Flange Loading (factored)
Max. 245.229 kN, Min. 245.229 kN, Steel Beam 9.84 kN
Deck bearing 75 mm

Transverse Bottom Flange Bending
245.229x109.5/1000, Mₚ 181.76 kN.m

Von Mises Criterion
M = 500.3 kN.m, Fv = 0 kN

Check @ 4 m (Max. Moment)
Shear Connection
No of shear connectors from nearest support 32 < 53

Axial Resistance (kN)
Rc = 4220.53 kN, Rs = 4318.37 kN, Rq = 2549.06 kN

Degree of Shear Connection
Na/Np = 32 / 53 > 0.58

Reduced Concrete Area
Area required to resist 2549.06 kN

M = 309.74 kN.m, Fv = 0 kN

Moment Capacity
Plastic neutral axis in web @ 183.1 mm

463.957 kN.m.

Ultimate Limit State (Construction Stage)

Maximum Shear
Support Reactions (kN)
154.87 kN each si
Bottom Flange Loading (factored)
Max. 119.142 kN, Min. 119.142 kN, Steel Beam 9.84 kN
Deck bearing 75 mm

Transverse Bottom Flange Bending
119.142x109.5/1000, Mₚ 181.76 kN.m

Von Mises Criterion
M = 309.74 kN.m, Fv = 0 kN

Check @ 4 m (Max. Moment)
Shear Connection
No of shear connectors from nearest support 32 < 53

Axial Resistance (kN)
Rc = 4220.53 kN, Rs = 4318.37 kN, Rq = 2549.06 kN

Degree of Shear Connection
Na/Np = 32 / 53 > 0.58

Moment Capacity
Plastic neutral axis in top flange @ 152.6 mm

884.07 kN.m.

Combined Torsion and Bending Check (Out of Balance Loads)
Out of Balance Moments
Mₓ = 309.74 kN.m, Mᵧ = 2549.06 kN.m
Lₓ = 1 x 8
Lᵧ = 1 x 8

M = 309.74 kN.m, Fv = 0 kN

Moment Capacity
Plastic neutral axis in top flange @ 152.6 mm

119.162 kN.m.

Job ref: My Project
Sheet: Slim Floor / 6 -
Made By: GHB
Date: 21 June 2015/ Version 2017.11
Checked: MOG
Approved: ATW
MasterSeries Sample Output

3 Castle Street
Carrickfergus
County Antrim BT38 7BE

Tel: 028 9036 5950

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

σw = E . Wn . 9''  
Mw,Ed = E . JEd . 9'' . σw  
Local Torsion  
(Mt,Ed/Mt,Ed)² + (Mt,Ed/Mt,Ed) +  
Mw,Ed/Mw,Ed  
Torsion Buckling  
k = kw . kw . kw  
Mw,Ed/Mw,Ed + Cw . Mw,Ed/Mw,Ed +  
k . Mw,Ed/Mw,Ed  
48.47 N/mm²  
4.38 kN.m  
0.360  
OK

Serviceability Limit State

Support Reactions (kN)
Live Loads 72 kN each side
Super Imposed Dead Load 6 kN each side
Dead Load (Self Weight) 107.72 kN each side

Maximum Deflection (Partial Connection All Loads)
Live Loads 8.05 (10.60) mm @ 4 m < L / 360 = 22.2 mm  
Super Imposed Dead Loads 0.67 (0.88) mm @ 4 m  
Dead Loads (Self Weight) 44.11 mm @ 4 m  

Maximum Steel Stress
TOTAL (Tension) Live 63.8, Super Dead 5.3, SW 166 < 345  
TOTAL (Compression) Live 6.1, Super Dead 0.5, SW 216 < 345  
Maximum Concrete Stress Live 2.7, Super Dead 0.23, SW < 17.5  

Vibration Analysis (Partial Connection)
Beam Deflection Including Partial Connection 13.99 mm
Natural Frequency 18/√(13.99/1.1) = 5.05 > 4 Hz  
5.05 Hz  
OK