SCI TEDDS MODULES

Steel Knowledge

SCI — Resistance of Composite Slabs to Concentrated Loads implements a new calculation procedure produced by SCI (and published in SCI Advisory Desk notes AD 450 & AD 477), which calculates the reinforcement required in a composite slab subject to one or more concentrated loads. The procedure allows for optimisation of the effective widths of the slab assumed to support the concentrated load, finding the best compromise between longitudinal and transverse requirements. The process may also be used to justify existing transverse reinforcement provision when an 'unexpected' load, such as that from a MEWP or similar vehicle, is applied.

CALCULATION DETAILS

Calculation Version: **1.0.00**

Project Name:	**Demo**	Design Standard:	**Eurocode**
Client:	**SCI Tedds Modules**	Analysis Date & Time:	**24/01/2024 - 10:34**
Project Reference:	**Sample**	Prepared By:	**ABC**
Location:	**Sample Floor**	Checked By:	**DEF**

SUMMARY OF RESULTS

Longitudinal Bending Moment Check ($M_{Rd} > M_{Ed}$)	**Vertical Shear Check** ($V_{Rd} > V_{Ed}$);	**Transverse Bending Moment Check** ($M_{t,Rd} > M_{t,Ed}$);	**Required Area of Transverse Reinforcement** ($A_{s,t,req}$);
Pass	**Pass**;	**Pass**;	**207 mm²/m**;

INPUT SUMMARY

DEFAULT PARTIAL FACTORS

Permanent Actions	γ_G = **1.35**
Variable Actions	γ_Q = **1.50**
Reduction Factor for Permanent Actions	ξ = **0.925**
Resistance of Cross-Sections	γ_{M0} = **1.00**
Longitudinal Shear Resistance of a Composite Slab	γ_{vs} = **1.25**
Concrete Material Strength	γ_c = **1.50**
Reinforcing Steel Material Strength	γ_s = **1.15**

OTHER DEFAULT FACTORS

Coefficient for Long Term Effects on Concrete α_{cc} = **1.00**
Weight Increase Factor for Rebar Overlap $f_{overlap}$ = **1.15**
Stress Distribution Factor α = **0.85**

USER INPUTS

Slab Geometry

Slab Span L = **3.50** m
Slab Width L_t = **10.00** m
Slab Depth h = **150** mm
Screed Depth h_f = **0** mm
Bearing Length at a Support b_{sup} = **50** mm

Steel Decking Properties

Thickness t_{nom} = **0.90** mm
Thickness of Galvanising Coating t_{galv} = **0.040** mm
Steel Strength $f_{yp,k}$ = **350** N/mm^2
Profile Height h_p = **80** mm
Elastic Neutral Axis Height e = **44** mm
Plastic Neutral Axis Height e_p = **31** mm
Trough Pitch b_s = **300** mm
Soffit Width b_b = **120** mm
Crest Width b_r = **150** mm
Longitudinal Shear Strength $\tau_{u,Rk}$ = **0.1800** N/mm^2
Area of Concrete $A_{c,prof}$ = **35595** mm^2/m
Gross Cross-Sectional Area $A_{p,gross}$ = **1259** mm^2/m
Effective Cross-Sectional Area $A_{p,eff}$ = **941** mm^2/m
Deck Density ρ_{deck} = **79** kN/m^3
Sagging Bending Resistance $m_{Rd,s}$ = **7** kNm/m

Concrete Properties

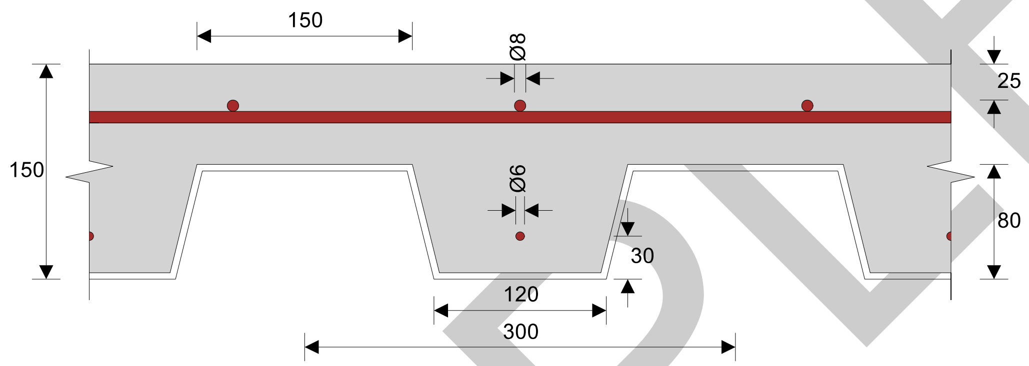
Characteristic Cylinder Strength f_{ck} = **25** N/mm^2
Dry Density ρ_{dry} = **24** kN/m^3

Mesh Reinforcement Properties

No. Layers mesh_layers = **1**
Mesh Bar Diameter d_{mesh} = **8** mm
Mesh Area $A_{mesh,single}$ = **252** mm^2/m
Mesh Cover c_{mesh} = **25** mm
Yield Strength $f_{yk,mesh}$ = **500** N/mm^2
Density ρ_{mesh} = **79** kN/m^3

Bar Reinforcement Properties

No. of Bars in Rib	bar_no = **1**
Bar Diameter	d_{bar} = **6** mm
Axis Distance from Soffit	y_{bar} = **30** mm
Yield Strength	$f_{yk,bar}$ = **500** N/mm^2
Density	ρ_{bar} = **79** kN/m^3



(All dimensions in mm)

LOAD INPUTS

Uniformly Distributed Load (UDL)

Services	w_{serv} = **0.50** kN/m^2
Finishes	w_{finish} = **0.70** kN/m^2
Screed	w_{screed} = **0.20** kN/m^2
Imposed	w_{imp} = **1.00** kN/m^2
Partitions	w_{part} =**0.50** kN/m^2

Concentrated Loads Set

Loads A1 and A2

Magnitude of Load	W_A = **5.00** kN
Bearing Width	b_A = **0.100** m
Bearing width	a_A = **0.100** m

Loads B1 and B2

Magnitude of Load	W_B = **5.00** kN
Bearing Width	b_B = **0.100** m
Bearing Width	a_B = **0.100** m

Distance Between Loads

Distance A to B	d_{AB} = **1.000** m
Distance 1 to 2	d_{12} = **0.600** m

ANALYSIS RESULTS

SECTION AND MATERIAL PROPERTIES

Slab Geometry

Effective Span — $L_{eff,comp} = MIN(L, L - 2 \times b_{sup} + (h - e)) =$ **3.50** m

Concrete Properties

Depth of Concrete Above Decking — $h_c = h - h_p =$ **70.0** mm

Total Area of Concrete — $A_c = A_{c,prof} + h_c =$ **105595.0** mm²/m

Design Cylinder Strength — $f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_c =$ **17** N/mm²

Concrete Self-Weight (Dry) — $w_{conc,dry} = \rho_{dry} \times A_c =$ **2.53** kN/m²

Mesh Reinforcement Properties

Design Yield Strength of Mesh — $f_{yd,mesh} = f_{yk,mesh} / \gamma_s =$ **435** N/mm²

Cross-Sectional Area of Mesh — $A_{mesh} = mesh\_layers \times A_{mesh,single} =$ **252.0** mm²/m

Distance from Transverse Reinforcement

Centreline to Top of Slab — $d_s = c_{mesh} + 1.5 \times d_{mesh} =$ **37.0** mm

Mesh Reinforcement Self-Weight — $w_{mesh} = f_{overlap} \times \rho_{mesh} \times 2 \times A_{mesh} =$ **0.05** kN/m²

Bar Reinforcement Properties

Area of Single Bar — $A_{bar,single} = (pi / 4) \times d_{bar}^2 =$ **28** mm²

Cross-Sectional Area of Bars — $A_{bar} = bar\_no \times A_{bar,single} / b_s =$ **94** mm²/m

Design Yield Strength of Bars — $f_{yd,bar} = f_{yk,bar} / \gamma_s =$ **435** N/mm²

Bar Reinforcement Self-Weight — $w_{bar} = f_{overlap} \times \rho_{bar} \times A_{bar} =$ **0.01** kN/m²

Steel Decking Properties

Design Core Thickness — $t = t_{nom} - t_{galv} =$ **0.86** mm

Design Steel Strength of Deck — $f_{yp,d} = f_{yp,k} / \gamma_{M0} =$ **350** N/mm²

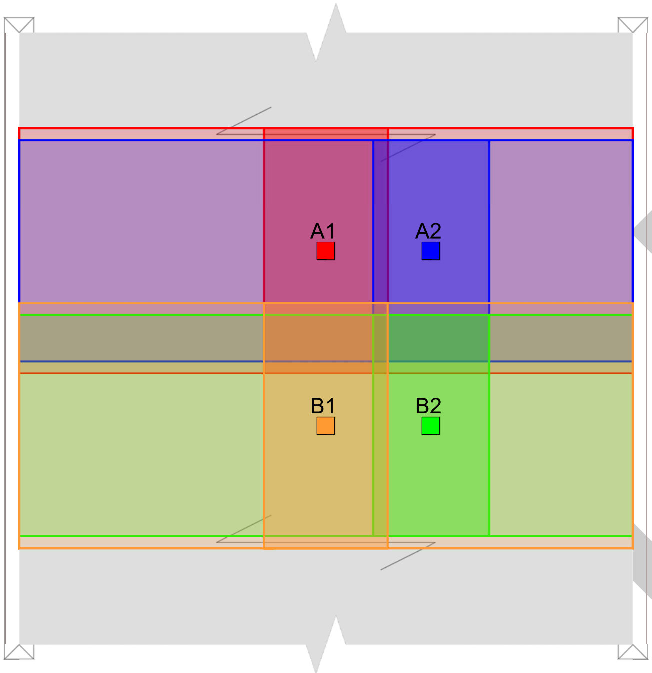
Design Longitudinal Shear Strength — $\tau_{u,Rd} = \tau_{u,Rk} / \gamma_{vs} =$ **0.144** N/mm²

Design Sagging Bending Resistance — $m_{Rd,s} =$ **6.68** kNm/m

Elastic Neutral Axis of Deck and Bar — $e_{comb} = (A_{p,eff} \times e + A_{bar} \times y_{bar}) / (A_{p,eff} + A_{bar}) =$ **42.7** mm

Decking Self-Weight — $w_{deck} = \rho_{deck} \times A_{p,gross} =$ **0.10** kN/m²

SKETCH OF SLAB AND LOADS SET AT CRITICAL LOCATION



UNIFORMLY DISTRIBUTED LOADS

Area loads

Superimposed Permanent Load $w_{superimp} = w_{serv} + w_{finish} + w_{screed} = \mathbf{1.40}$ kN/m^2

Variable Load $w_{var} = w_{imp} + w_{part} = \mathbf{1.50}$ kN/m^2

Load Combinations

Loading Category _load_cat = **"A"**

ψ Factors $\psi_0 = \mathbf{0.700}$

$\psi_1 = \mathbf{0.500}$

Permanent Load $g_{k,comp,ULS} = w_{deck} + w_{mesh} + w_{bar} + w_{conc,dry} + w_{pond,dry} + w_{superimp} = \mathbf{4.09}$ kN/m^2

Variable Load $q_{k,comp,ULS} = w_{var} = \mathbf{1.50}$ kN/m^2

Ultimate Limit State

Eq. (6.10a) $w_{comp,ULS,610a} = \gamma_G \times g_{k,comp,ULS} + \gamma_Q \times \psi_0 \times q_{k,comp,ULS} = \mathbf{7.09}$ kN/m^2

Eq. (610b) $w_{comp,ULS,610b} = \xi \times \gamma_G \times g_{k,comp,ULS} + \gamma_Q \times q_{k,comp,ULS} = \mathbf{7.36}$ kN/m^2

ULS Load $w_{comp,ULS} = \mathrm{MAX}(w_{comp,ULS,610a}, w_{comp,ULS,610b}) = \mathbf{7.36}$ kN/m^2

CONCENTRATED LOADS DETAILS

Concentrated Load A1

Ultimate Limit State

Eq. (6.10a) $w_{conc,610a} = \gamma_Q \times \psi_0 \times W_A =$ **5.250 kN**

Eq. (6.10b) $w_{conc,610b} = \gamma_Q \times W_A =$ **7.500 kN**

ULS Load $w_{conc,ULS} = MAX(w_{conc,ULS,610a}, w_{conc,ULS,610b}) =$ **7.500 kN**

Stiff Bearing Widths

Bearing Width Transverse to Span **b_m = 0.240** m

Bearing Width Along Span **a_m = 0.240** m

Effective Widths

Effective Width Transverse to Span b_{em} = **1.402** m

Effective Width Along Span a_{em} = **0.707** m

Concentrated Load A2

Ultimate Limit State

Eq. (6.10a) $w_{conc,610a} = \gamma_Q \times \psi_0 \times W_A =$ **5.250 kN**

Eq. (6.10b) $w_{conc,610b} = \gamma_Q \times W_A =$ **7.500 kN**

ULS Load $w_{conc,ULS} = MAX(w_{conc,ULS,610a}, w_{conc,ULS,610b}) =$ **7.500 kN**

Stiff Bearing Widths

Bearing Width Transverse to Span **b_m = 0.240** m

Bearing Width Along Span **a_m = 0.240** m

Effective Widths

Effective Width Transverse to Span b_{em} = **1.266** m

Effective Width Along Span a_{em} = **0.662** m

Concentrated Load B2

Ultimate Limit State

Eq. (6.10a) $w_{conc,610a} = \gamma_Q \times \psi_0 \times W_B =$ **5.250 kN**

Eq. (6.10b) $w_{conc,610b} = \gamma_Q \times W_B =$ **7.500 kN**

ULS Load $w_{conc,ULS} = MAX(w_{conc,ULS,610a}, w_{conc,ULS,610b}) =$ **7.500 kN**

Stiff Bearing Widths

Bearing Width Transverse to Span **b_m = 0.240** m

Bearing Width Along Span **a_m = 0.240** m

Effective Widths

Effective Width Transverse to Span b_{em} = **1.266** m

Effective Width Along Span a_{em} = **0.662** m

Concentrated Load B1

Ultimate Limit State

Eq. (6.10a) $w_{conc,610a} = \gamma_Q \times \psi_0 \times W_B =$ **5.250 kN**

Eq. (6.10b) $w_{conc,610b} = \gamma_Q \times W_B =$ **7.500 kN**

ULS Load $w_{conc,ULS} = MAX(w_{conc,ULS,610a}, w_{conc,ULS,610b}) =$ **7.500 kN**

Stiff Bearing Widths

Bearing Width Transverse to Span **b_m = 0.240** m

Bearing Width Along Span **a_m = 0.240** m

Effective Widths

Effective Width Transverse to Span b_{em} = **1.402** m

Effective Width Along Span a_{em} = **0.707** m

VERTICAL SHEAR RESISTANCE

The calculation of the vertical shear resistance per metre width of the composite slab neglects any contribution from the bars in the troughs in accordance with standard practice.

Effective Depth $d_p = h - e =$ **106** mm

$C_{Rd,c} = 0.18 / \gamma_c =$ **0.12**

$k = MIN(1 + \sqrt{((200 \times 1\ mm) / d_p)}, 2.0) =$ **2.0**

Width of Cross-Section in Tensile Area $b_w = (1\ m / b_s) \times (b_b + (b_s - b_r)) / 2 =$ **450** mm

Area of Tensile Reinforcement $A_{sl} = A_{p,eff} =$ **941** mm^2/m

$\rho_l = MIN(A_{sl} / (b_w \times d_p) \times 1\ m, 0.02) =$ **0.02**

$v_{min} = 0.035 \times k^{3/2} \times (f_{ck})^{1/2} = 0.495$ N/mm^2

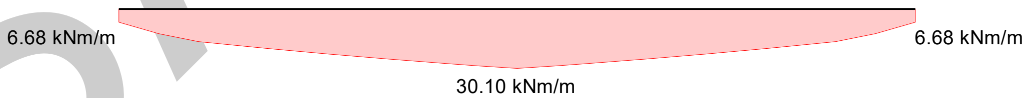
Vertical Shear Resistance **$v_{Rd,c,1} = (C_{Rd,c} \times k \times (100 \times \rho_l \times f_{ck,nd})^{1/3}) \times b_w \times d_p = 42.0$ kN/m**

$v_{Rd,c,2} = v_{min} \times b_w \times d_p = 23.6$ kN/m

$v_{Rd,comp} = MAX(v_{Rd,c,1}, v_{Rd,c,2}) =$ **42.0** kN/m

LONGITUDINAL BENDING RESISTANCE

The calculation of the longitudinal bending resistance per metre width of the composite slab allows for the partial shear connection between the deck and the concrete. As a result of this, the bending resistance of the composite slab varies along the span, being minimum at the end supports and maximum at midspan, as shown in the following diagram.



LONGITUDINAL BENDING MOMENT DIAGRAM

$M_{Ed,Lx,max}$ = 16.65 kNm/m

TRANSVERSE BENDING RESISTANCE

Normal Force in Mesh Reinforcement $F_s = A_{mesh,single} \times f_{yd,mesh}$ = **109.57** kN/m

Plastic Neutral Axis of Concrete Above Deck $Z_{pl} = \min(d_s, F_s / (0.85 \times f_{cd}))$ = **7.7** mm

Transverse Bending Resistance $m_{Rd,comp,t} = F_s \times (d_s – Z_{pl} / 2)$ = **3.63** kNm/m