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STRUCTURAL CALCULATIONS

FOR

WALKWAYS TO PLANT ROOMS REPLACEMENT BUILDING JE 0 056 TIDWORTH GARRISON

SJ/22002-20

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Project				Job Ref.	
Building JE 0 056 – Tidworth Garrison				22002-20	
Section				Sheet no./rev.	
Calculations – Replacement Walkways				1	
Calc. by	Date	Chk'd by	Date	App'd by	Date
SJJ	April 2023				

Consequence Class	Execution Class
CC2a	EXC2

Description

Following removal of concrete to the walkway side beams, it has been found that the beams and bolts are heavily corroded. These calculations are to determine the size of replacement beams and deck to the walkways to plant rooms only.

Loading

The walkways connect the main walkways to the first floor service rooms (cleaners and storage) and so are not heavily used. However as it is not known what the future usage may be a variable load of 5.0kN/m^2 has been used. This is higher than the 2.5kN/m^2 used for the main walkways.

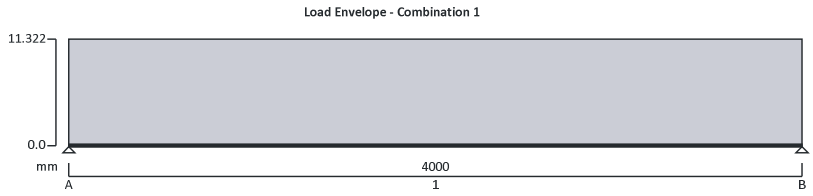
Walkway 0.15 x 25 x 1.43/2 + 0.30 x 0.20 x 25 = 4.2kN/m – permanent

5.0 x 1.43/2 = 3.6kN/m – variable

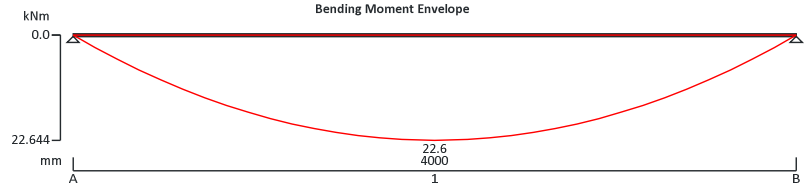
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14
(Library item – Steel beam design title)



Library item: Show beam analysis drawing



Library item: Show beam analysis drawing

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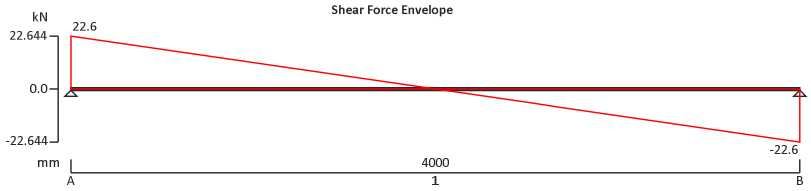
Project				Job Ref.	
Building JE 0 056 – Tidworth Garrison				22002-20	
Section				Sheet no./rev.	
Calculations – Replacement Walkways				2	
Calc. by	Date	Chk'd by	Date	App'd by	Date
SJJ	April 2023				



Library item: Show beam analysis drawing

Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Permanent self weight of beam × 1
	Walkway - Permanent full UDL 4.2 kN/m
	Walkway - Variable full UDL 3.6 kN/m

Load combinations

Load combination 1	Support A	Permanent × 1.35
		Variable × 1.50
		Permanent × 1.35
		Variable × 1.50
	Support B	Permanent × 1.35
		Variable × 1.50

Analysis results

Maximum moment;	M_{max} = **22.6** kNm;	M_{min} = **0** kNm
Maximum shear;	V_{max} = **22.6** kN;	V_{min} = **-22.6** kN
Deflection;	δ_{max} = **4.2** mm;	δ_{min} = **0** mm
Maximum reaction at support A;	R_{A_max} = **22.6** kN;	R_{A_min} = **22.6** kN
Unfactored permanent load reaction at support A;	$R_{A_Permanent}$ = **8.8** kN	
Unfactored variable load reaction at support A;	$R_{A_Variable}$ = **7.2** kN	
Maximum reaction at support B;	R_{B_max} = **22.6** kN;	R_{B_min} = **22.6** kN
Unfactored permanent load reaction at support B;	$R_{B_Permanent}$ = **8.8** kN	
Unfactored variable load reaction at support B;	$R_{B_Variable}$ = **7.2** kN	

Section details

Section type; **UKB 178x102x19 (Tata Steel Advance)**; Steel grade; **S275**

Library item: Section details summary

Section classification; **Class 1**

Library item: Classification summary

Check shear - Section 6.2.6

Library item: Design shear header summary

Design shear force; V_{Ed} = **23** kN; Design shear resistance; $V_{c,Rd}$ = **156.4** kN

Library item: Shear resistance plastic summary

PASS - Design shear resistance exceeds design shear force

Library item: General results output

Check bending moment - Section 6.2.5

Library item: Design bending header summary

Design bending moment; M_{Ed} = **22.6** kNm; Des.bending resist.moment; $M_{c,Rd}$ = **47.1** kNm

Library item: Design bending moment summary

PASS - Design bending resistance moment exceeds design bending moment

Library item: General results output

Check vertical deflection - Section 7.2.1

Consider deflection due to variable loads

Limiting deflection δ_{lim} = **11.1** mm; Maximum deflection; δ = **4.214** mm

Library item: Deflection summary

PASS - Maximum deflection does not exceed deflection limit

Maximum reaction from smaller beam is 22.6kN. Use 100 x 100 RSEA 10 and 100mm long and 2No. M16 bolts.

Replacement Deck

Span 1.4m c/c bearing

Load

Walkway 0.15 x 25 = 3.75kN/m^2 width – permanent

5.0kN/m^2 width – variable

M = (3.75 x 1.35 + 5.0 x 1.5) x 1.43^2 / 8 = 3.2kNm/m

V = (3.75 x 1.35 + 5.0 x 1.5) x 1.43/2 = 9.0kN

WALKWAY SLAB

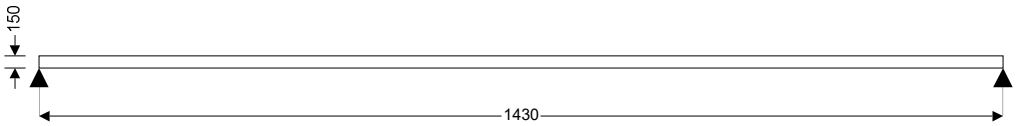
RC slab design in accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.22

Library item: Calc title

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Support 1					
Span 1					
Tension reinf.	mm^2/m	193	153	0.794	PASS
Tension bar spacing	mm	200	-883	-0.227	PASS
Allow. span-to-depth ratio		13.43	40.00	0.336	PASS
Support 2					
Cover					
Min cover bottom	mm	40	17	0.425	PASS



Library item - Show active sketch

Slab definition

Slab reference name;	**Walkway**
Overall slab depth;	h = **150** mm
Number of spans;	N_{spans} = **1**
First support;	**Simple**
Last support;	**Simple**
;	;;
Nominal cover to bottom reinforcement;	c_{nom_b} = **40** mm

Loading

Ratio of quasi-permanent to ultimate load;	r_q = **6.750**

Library item - Slab definition 1 way direct

Concrete properties

Concrete strength class;	C28/35
Characteristic cylinder strength;	f_{ck} = **28** N/mm^2
Partial factor (Table 2.1N);	γ_C = **1.50**
Compressive strength factor (cl. 3.1.6);	α_{cc} = **0.85**
Design compressive strength (cl. 3.1.6);	f_{cd} = **15.9** N/mm^2
Mean axial tensile strength (Table 3.1);	f_{ctm} = 0.30 N/mm^2 × (f_{ck} / 1 N/mm^2)$^{2/3}$ = **2.8** N/mm^2
Maximum aggregate size;	d_g = **20** mm

Reinforcement properties

Characteristic yield strength;	f_{yk} = **500** N/mm^2
Partial factor (Table 2.1N);	γ_S = **1.15**
Design yield strength (fig. 3.8);	f_{yd} = f_{yk} / γ_S = **434.8** N/mm^2

Library item - Material properties simplified

Concrete cover to reinforcement

Nominal cover to bottom reinforcement;	c_{nom_b} = **40** mm
Fire resistance period to bottom of slab;	R_{btm} = **30** min
Axis distance to bottom reinft (Table 5.8);	a_{fi_b} = **10** mm
Max bar diameter in bottom;	ϕ_{max_b} = **7** mm
Min. btm cover requirement with regard to bond;	c_{min,b_b} = ϕ_{max_b} = **7** mm
Reinforcement fabrication;	**Not subject to QA system**
Cover allowance for deviation;	Δc_{dev} = **10** mm
Min. required nominal cover to bottom reinft;	$c_{nom_b_min}$ = max(a_{fi_b} - ϕ_{max_b} / 2, c_{min,b_b} + Δc_{dev}) = **17.0** mm

PASS - There is sufficient cover to the bottom reinforcement

Library item - Cover 1 way B

Bending design checks

β = 1.0

Redistribution ratio;	β = **1.0**
Limiting value of K;	K' = 0.598 × β × β - 0.18 × β × β^{2} - 0.21 = **0.208**

Reinforcement design at midspan of span 1 (cl.6.1)

Length of span 1; l_1 = **1430** mm

Design bending moment; M_{p1} = **3.2** kNm/m

Reinforcement provided; **A193 mesh**;

Area provided; A_{sp1} = **193** mm²/m

Effective depth to tension reinforcement; $d_{p1} = h - c_{nom_b} - \phi_{p1} / 2$ = **106.5** mm

K factor; $K = M_{p1} / (b \times d_{p1}^2 \times f_{ck})$ = **0.010**

K < K' - Compression reinforcement is not required

Library item - K span 1 direct

Lever arm; $z = \min(0.95 \times d_{p1}, d_{p1} / 2 \cdot (1 + \sqrt{(1 - 3.53 \cdot K)}))$

z = **101.2** mm

Area of reinforcement required for bending; $A_{sp1_m} = M_{p1} / (f_{yd} \times z)$ = **73** mm²/m

Minimum area required; $A_{sp1_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{p1}$ = **153** mm²/m

Area of reinforcement required; $A_{sp1_req} = \max(A_{sp1_m}, A_{sp1_min})$ = **153** mm²/m

A_{scp1_req} = 0 mm²/m

PASS - Area of tension reinforcement provided is adequate (0.794)

Library item - As no comp reinf span 1

Library item - Spacing span 1

Shear design checks

Shear resistance constant (cl. 6.2.2); $C_{Rd,c}$ = 0.18 N/mm² / γ_C = **0.12** N/mm²

Library item - Shear design checks

Shear capacity check at support 1

; ;

_tmp.V_1 = if(_rcs.Method1=="Directly",getvar("V_1",1 kN/m), getvar("f_{v1}",0) × getvar("q",1 kN/m²) × l_1) = **9.0** kN/m

V_1 = _tmp.V_1 = **9.0** kN/m

Shear force; V_1 = ;**9.0**; kN/m

Reinforcement provided; **A193 mesh**;

Area provided; A_{sd1} = **193** mm²/m

Effective depth; $d_{d1} = h - c_{nom_b} - \phi_{d1} / 2$ = **106.5** mm

Effective depth factor (cl. 6.2.2); $k = \min(2.0, 1 + (200 \text{ mm} / d_{d1})^{0.5})$ = **2.000**

Reinforcement ratio; $\rho_l = \min(0.02, A_{sd1} / (b \times d_{d1}))$ = **0.0018**

Minimum shear resistance (Exp. 6.3N); $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \cdot k^{1.5} \cdot (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d1}$

V_{Rd,c_min} = **55.8** kN/m

Shear resistance (Exp. 6.2a); $V_{Rd,c1} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{d1})$

$V_{Rd,c1}$ = **55.8** kN/m

PASS - Shear capacity is adequate (0.161)

Library item - Shear 1 simple

Shear capacity check at support 2

Shear force; V_2 = **9.0** kN/m

Reinforcement provided; **A193 mesh**;

Area provided; A_{sd2} = **193** mm²/m

Effective depth; $d_{d2} = h - c_{nom_b} - \phi_{d2} / 2$ = **106.5** mm

Effective depth factor (cl. 6.2.2); $k = \min(2.0, 1 + (200 \text{ mm} / d_{d2})^{0.5})$ = **2.000**

Reinforcement ratio; $\rho_l = \min(0.02, A_{sd2} / (b \times d_{d2}))$ = **0.0018**

Minimum shear resistance (Exp. 6.3N); $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \cdot k^{1.5} \cdot (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d2}$

V_{Rd,c_min} = **55.8** kN/m

Shear resistance (Exp. 6.2a); $V_{Rd,c2} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{d2})$

$V_{Rd,c2}$ = **55.8** kN/m

PASS - Shear capacity is adequate (0.161)

Library item - Shear 2 simple

Deflection checks

Basic span-to-depth ratio deflection check span 1 (cl. 7.4.2)

Reference reinforcement ratio; $\rho_0 = (f_{ck} / 1\ N/mm^2)^{0.5} / 1000$ = **0.0053**

Required tension reinforcement ratio; $\rho = \max(0.0035, A_{sp1_m} / (b \times d_{p1}))$ = **0.0035**

Required compression reinforcement ratio; $\rho' = A_{scp1_req} / (b \times d_{p1})$ = **0.0000**

$K_\rho = if(N_{spans} > 1, K_{\rho,b}, K_{\rho,a})$ = **1.0**

Structural system factor (Table 7.4N); K_ρ = **1.0**

$ratio_{lim1_bas} = if(\rho <= \rho_0 , K_\rho \times [11 + 1.5 \times (f_{ck}/1\ N/mm^2)^{0.5} \times \rho_0/\rho \rho + 3.2 \times (f_{ck}/1\ N/mm^2)^{0.5} \times (\max(\rho_0/\rho,1) \rho - 1)^{1.5}], K_\rho \rho \times [11 + 1.5 \times (f_{ck}/1\ N/mm^2)^{0.5} \times \rho_0/(\rho - \rho') \rho + (f_{ck}/1\ N/mm^2)^{0.5} \times (\rho'/\rho_0)^{0.5} / 12])$ = **29.20**

Basic span-to-depth ratio limit; (Exp. 7.16a); $ratio_{lim1_bas} = K_\rho \rho [11 + 1.5 \rho (f_{ck}/1\ N/mm^2)^{0.5} \rho \rho_0/\rho + 3.2 \rho (f_{ck}/1\ N/mm^2)^{0.5} \rho (\rho_0/\rho - 1)^{1.5}]$

$ratio_{lim1_bas}$ = **29.20**

Modified span-to-depth ratio limit;

$ratio_{lim1} = \min(40 \rho K_\rho, \min(1.5, (500\ N/mm^2 / f_{yk}) \rho (A_{sp1} / A_{sp1_m})) \rho ratio_{lim1_bas})$ = **40.00**

Actual span-to-depth ratio; $ratio_{act1} = l_1 / d_{p1}$ = **13.43**

PASS - Span-to-depth ratio is acceptable (0.336)

Library item - Deflection span 1

Reinforcement summary

Midspan in span 1; **A193 mesh**

Library item - Reinft summary p1

Discontinuous support 1; **A193 mesh**

Library item - Reinft summary d1

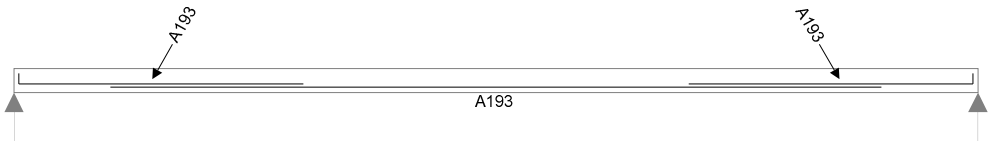
Discontinuous support 2; **A193 mesh**

Library item - Reinft summary d2

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.

Library item - Reinft sketch title



Library item - Show active sketch