Draft tender document - Stockbridge Meadows Boardwalk Replacement

Project overview

Currently there is a boardwalk from Stockbridge Meadows running to the river Mel as shown below.. This timber structure is unsound and as a consequence has been sealed off from the public until it is replaced.

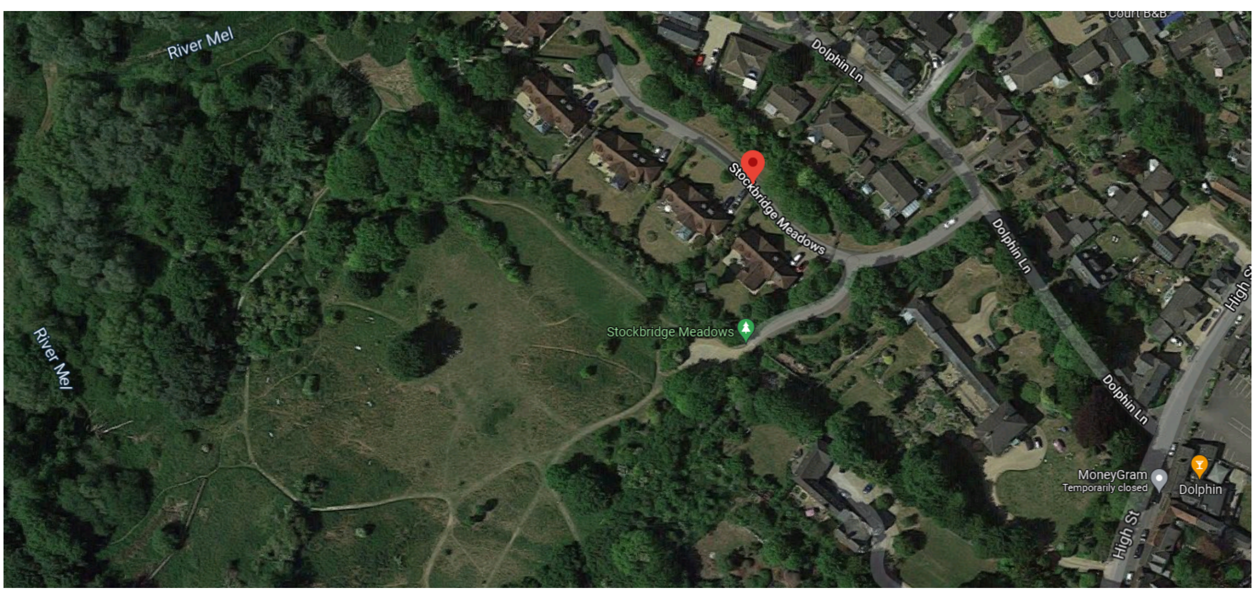
After a great deal of design and consultation we are seeking costing from relevant companies to complete the works to replace the boardwalk.

Please read this design brief and the tender requirements before submitting any pricing information.

Any quotation documents or questions should be addressed to the Parish council clerk via *parishclerk@melbournpc.co.uk* with the subject "boardwalk tender" or "boardwalk tender question" respectively.

Location

Stockbridge Meadows can be accessed off of the High Street via Dolphin Lane where there is a small car park to service visitors to the meadows.



Access is not restricted so those wishing to review the project are able to visit the location and view the existing boardwalk at any reasonable time.

Design Concept

Given its natural setting it is an absolute priority for the Parish council that the replacement boardwalk is in harmony with its surroundings, both in appearance and also in its effect on the environment through construction and once in use.

With this commitment to the environment in mind and having done the relevant ecological consultations, we have specified that the boardwalk should sit only slightly above ground level and be without handrails meaning that the structure has almost no visual impact on the green space as viewed from around the site.

Example of low level boardwalk without handrail.

Ensuring that the replacement boardwalk has a positive impact on the environment is most clearly seen in our choices for materials; opting for Grundomat piles for the foundation rather than a simple concrete pad foundation will limit both the short term disruption to habitats and the longer term dangers of concrete leaching. The use of recycled plastic for the boardwalk surface itself limits both the short term carbon footprint as well as the embedded carbon of the whole project given the longer serviceable period of recycled plastic when compared to timber or other materials.

Tender requirements

The parish council would welcome tenders from all qualified businesses who are prepared to provide pricing for, and can complete **all the project elements**. Unfortunately we will not be able to accept tenders from companies wishing to provide prices for only a selection of the requirements.

Prices should be based only on the design pack attached from Structural Engineers Cambridge, clarification on any details can be sought through the parish council. Companies who tender should be capable of providing both the practical and administrative elements of the project as they will be required to provide a plan to “self manage” under the guidance of the project engineer.

Tender should include pricing for all the below administrative elements:

- Provision to provide a project plan and specification that the appointed contractor will be held accountable to, the plan will be agreed with the parish council and the project engineer.
- Provision to produce a full health and safety risk assessment and anticipated costs of adhering to it must be included.
- Throughout the project the Parish council and project engineer must be able to communicate easily with the project & site managers provided by you. Anticipated costs for providing this must be included. Project management will be expected to provide budget information on a weekly or fortnightly basis and may be required to update the parish council or an appointed steering committee on a weekly or fortnightly basis on the general progress of the project.

Tender should include pricing for the below practical elements:

- All materials required for both infrastructure and H&S to complete the project, tools & equipment and materials to complete construction.
- Demolition and disposal of existing boardwalk
- Installation of Grundomat piles
- Installation of the boardwalk supporting structure
- Installation of the boardwalk surface
- Making good of the site and removal of all waste

Tenders should include the maximum amount of information possible and include a clear explanation of the various phases of the project, anticipated duration of each phase and a proposed payment structure. Any relevant industry credentials would also be appreciated.

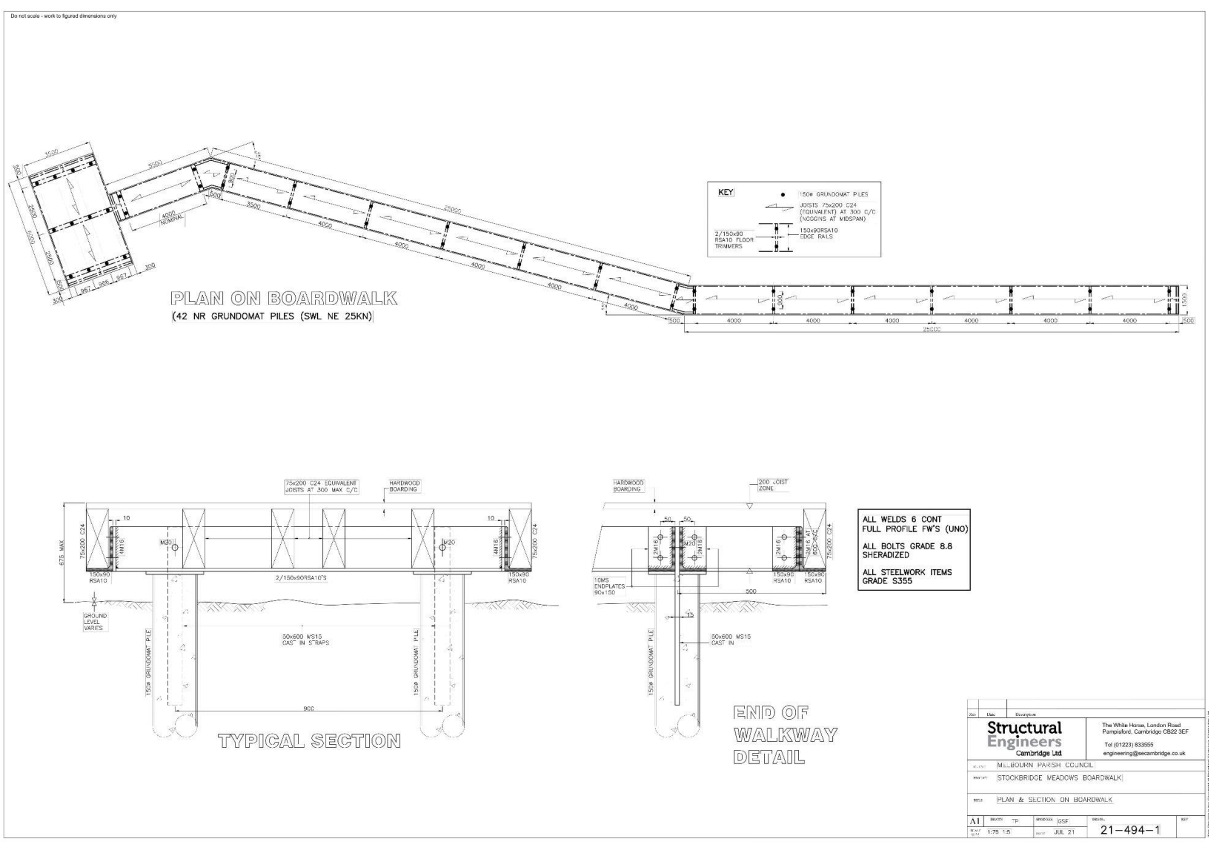
Site restrictions

The site for the boardwalk itself is not accessible via vehicle, as stated above there is a public car park which is accessible by road. This carpark could operate as a holding location for any works, but bidders must be clear that the build location itself is not accessible by vehicle. Any plans that involved vehicles going onto the meadows themselves would be very stringently reviewed for their impact on the habitat and if possible such plans should be avoided. Any plan that involved taking equipment into the reedbeds would be rejected.

The meadows are adjacent to a number of domestic residences and used frequently by the public so site hours would be restricted to 08:00-17:00 Mon - Fri.

Supporting Documents

Below are the supporting documents from the project engineer. Copies of these documents are available as PDFs on request.



Structural
Engineers
Cambridge Ltd

Calculations
for
STOCKBRIDGE MEADOWS
BOARDWALK
MELBOURN

21-494

August 2021

Structural Engineers Cambridge Ltd
The White Horse
London Road, Pampisford
Cambridge CB22 3EF

Structural Engineers Cambridge Limited
The White Horse, Pampisford, Cambridge CB22 3EF
Tel: (01223) 833555 Fax (01223) 833575
Email: engineering@secambridge.co.uk

Ref. No. D/1494
Date AUG 2021
Notes

General and Safety Notes

Building Regulations Approval

Most structural alterations will require Building Control approval and must be examined by a Building Inspector prior to concealing or covering structural members. It is the client's and contractor's responsibility to ensure that applications and inspections have been carried out.

Planning Permission

Planning permission may or may not be required in connection with the work described herein, and a suitably qualified architect or planning advisor should be consulted before commencement of work.

Party Wall Agreements

Structural alterations to a Party Wall, or excavations in the vicinity of a neighbour's property, will require the adjoining owner's consent under the Party Wall Act 1996. This will require a Party Wall Agreement to be made before commencement of the works. Advice may be obtained from the government Planning Portal www.planningportal.gov.uk or by contacting a Chartered Building Surveyor.

Safety

This information is provided in the expectation that those appointed to carry out the work are suitably qualified and experienced contractors. If there is any doubt about aspects of the specification, the engineer should be contacted before commencement of work on site. The work described should be capable of being carried out using the normal range of skills and equipment expected of a competent general contractor. If any operations are outside this norm a method statement or more detailed description of the procedure should be requested.

Excavations in excess of 1.2 metres deep or in unstable ground should not be entered by any person unless a system of shoring or ground support has been installed.

Any variation between the architect's drawings and specification and this information should be brought to the attention of the architect and engineer immediately.

Temporary Support

Installation of beams, lintels or other supporting structures should be undertaken only with the provision of suitable temporary support to the structure above. Attention should be paid to the nature of the supported loads (from the calculations) and the capacity of props, shores and needle beams as appropriate. If in doubt about the requirements, contact the engineer before commencement of work.

Dimensions etc.

The dimensions given in these documents are for design purposes only and should be checked on site for construction. Beam sizes are given for identification of the section and the span dimension is between centrelines of supports (i.e. neither the length of the beam nor the opening width).

Copyright

N.B. Dimensions given on pages of analysis are <u>not</u> for fabrication purposes.
The contractor is responsible for checking all dimensions for construction.

Structural Engineers Cambridge Ltd
The White Horse, Pampisford, Cambridge CB22 3EF
Tel: (01223) 833555 Email: engineering@secambridge.co.uk

Address STOCKBRIDGE MEADOWS BOARDWALK	Ref. No. 21494
	Page 1
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Calculation LOADINGS / JOISTS	Engr.

BS 6410
BS 6399

Decking 0·15
Joist 0·20
LL 5·00
= 5·35 kN/m²

Joists @ 300 c/c — BS 5268

Load/m 5·35 × 0·30 = 1·60 kN/m (✓)

Spanning 4·0 m

$M = 1·60 \times 4·0^2/8 = 3·20$ kN/m

$Z_{REQD} = \frac{3·20 \times 10^6}{7·5 \times 0·8 \times 1·10 \times 1·045}$ (K_2, K_8, K_7)

(C24 Grade)

$= 465 \times 10^3 mm^3$

$K_7 = \left(\frac{300}{200}\right)^{0·11} = 1·045$

$I_{REQD} = \frac{4·34 \times 1·60 \times 4·0^3 \times 10^9}{9900 \times 0·8}$ (K_2) — $\frac{4·34 f L^3}{E}$

$K_8 = 1·10$

$K_2 = 0·80$

$= 56·15 \times 10^6 mm^4$

75 × 200 C24 @ 300 c/c ($Z = 500 \times 10^3 mm^3$, $I = 50 \times 10^6 mm^4$)

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The White Horse, Pampisford, Cambridge CB22 3EF
Tel: (01223) 833555 Email: engineering@secambridge.co.uk

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Calculation	Engr. [signature]

Deflection = 0.003 × 4000 × $\frac{56.15}{50}$

= 13.50mm Acceptable!

Shear = $\frac{1.5 \times (1.60 \times 2) \times 10^3}{75 \times 200}$

$\frac{1.5V}{bd}$

= 0.32 N/mm²

Grade stress of 0.71 × 0.9 = 0.64 N/mm²

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Calculation PLATFORM TRIMMERS (RSA's)	Engr.

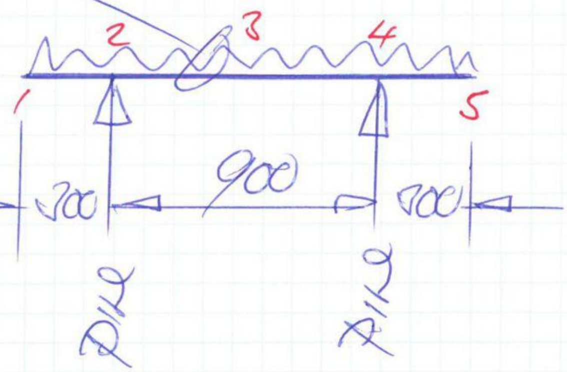
Loading

5.35 × 4.0 = 21.40

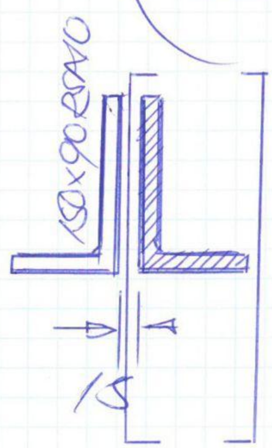
SW 0.35

21.75 kN/m

'LL' 20.00 kN/m



2/150×90RSA/O



Check for one half of loading effects.

21494.DAT

```
TABULATE DISPLACEMENTS FORCES REACTIONS
PRINT DATA RESULTS FROM 0
TYPE PLANE FRAME
METHOD ELASTIC NODES
NUMBER OF JOINTS 5
NUMBER OF MEMBERS 4
NUMBER OF SUPPORTS 2
NUMBER OF LOADINGS 1
NUMBER OF SEGMENTS 1
JOINT COORDINATES
1 0 0
2 0.30 0 S
3 0.75 0
4 1.20 0 S
5 1.50 0
JOINT RELEASES
2 MOMENT Z
4 MOMENT Z FORCE X
MEMBER INCIDENCES
1 THRU 4 CHAIN 1,2,3,4,5
CONSTANTS E 205E6 ALL G 79E6 ALL
MEMBER PROPERTIES
1 THRU 4 AX 2*23.2E-4 IZ 2*533E-8
LOADING
MEMBER LOADS
1 THRU 4 FORCE Y UNIFORM W -21.75
SOLVE
```

2/150x90x8UA10

LOADING
JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z ROTATION
1	0.000000000	0.000020155	-0.000055985
2	0.000000000	0.000000000	-0.000100773
3	0.000000000	-0.000039679	0.000000000
4	0.000000000	0.000000000	0.000100773
5	0.000000000	0.000020155	0.000055985

LOADING
MEMBER FORCES

MEMBER	JOINT	AXIAL FORCE	SHEAR FORCE	BENDING MOMENT
1	1	0.0000	0.0000	0.0000
	2	0.0000	6.5250	-0.9787
2	2	0.0000	9.7875	0.9787
	3	0.0000	0.0000	1.2234
3	3	0.0000	0.0000	-1.2234
	4	0.0000	9.7875	-0.9787
4	4	0.0000	6.5250	0.9787
	5	0.0000	0.0000	0.0000

LOADING

SUPPORT REACTIONS

JOINT	X FORCE	Y FORCE	Z MOMENT
2	0.0000	16.3125	0.0000
4	0.0000	16.3125	0.0000

EQUILIBRIUM CHECK	SUM OF FORCES	REACTION
FORCES IN DIRECTION X	0.0000	0.0000
FORCES IN DIRECTION Y	-32.6250	32.6250
MOMENTS ABOUT AXIS Z	-24.4688	24.4688

Design factors for one half of composite section

SERVICE EFFECTS

$M = \frac{2.20}{2} = 1.10$ Allow 1.15kNm

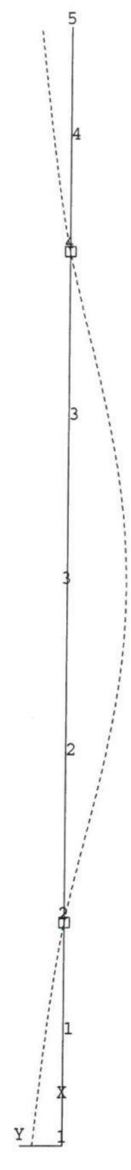
$V = \frac{9.80}{2} = 4.90$ Allow 5.00kN

Apply $\gamma_f = 1.6$

($M_{ult} = 1.85$kNm
V_{ult} 8.00kN)

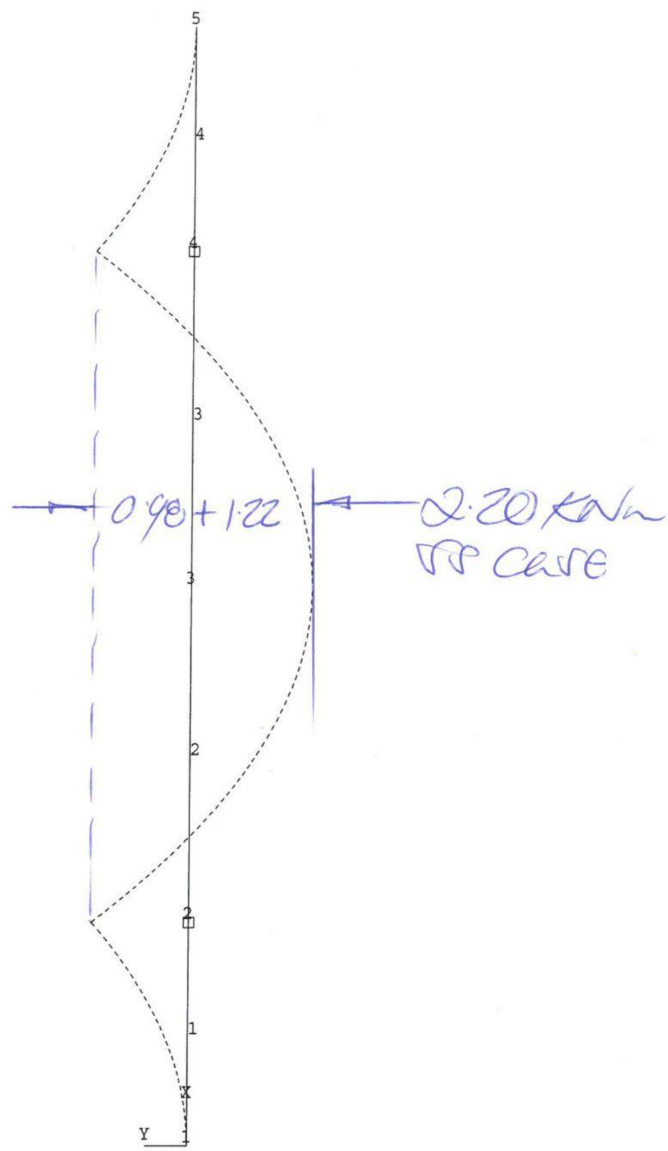
Structure scale 1 cm = 0.080 □ = supports

Deflectn scale 1 cm = 0.00004000000 1



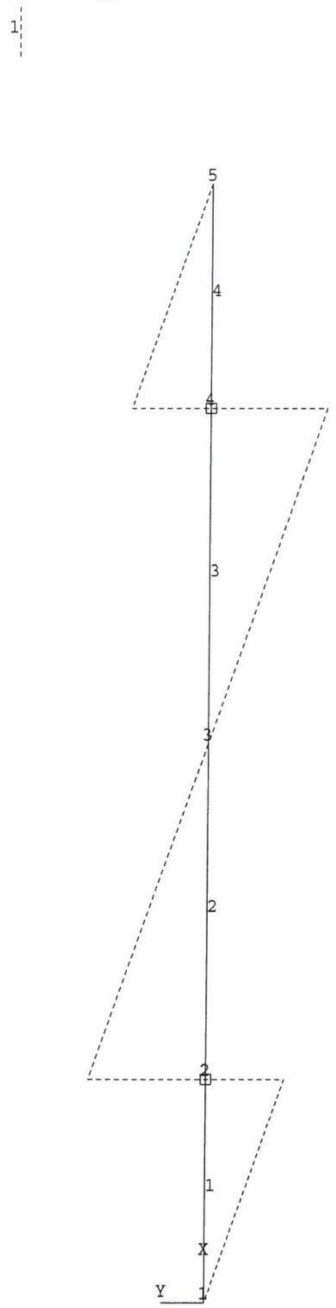
Structure scale 1 cm = 0.080 □ = supports

Moment Z scale 1 cm = 0.60 1



Structure scale 1 cm = 0.080 □ = supports

Force Y scale 1 cm = 5.00



Tekla Tedds	Project: STOCKBRIDGE MEADOWS BOARDWALK				Job no.: 21494	
	Calcs for: RSA PLATFORM TRIMMERS				Start page no./Revision: 9	
	Calcs by: GF	Calcs date: 17/08/2021	Checked by	Checked date	Approved by	Approved date

STEEL ANGLE DESIGN (BS5950-1:2000)

TEDDS calculation version 1.0.04

Element definition

Element being designed — **PLATFORM TRIMMERS**

Section — **RSA 150x90x10**

Steel grade — **S355**

Design strength (Table 9) — p_y = **355** N/mm^2

Angle properties

Gross area — A_g = **23.21** cm^2

Radius of gyration about v axis — r_v = **1.96** cm

Minimum section modulus about x axis — Z_{x_min} = **53.65** cm^3

Maximum section modulus about x axis — Z_{x_max} = **107.21** cm^3

Minimum section modulus about y axis — Z_{y_min} = **21.19** cm^3

Maximum section modulus about y axis — Z_{y_max} = **72.16** cm^3

Inertia about major axis — I_u = **594.6** cm^4

Inertia about minor axis — I_v = **89.1** cm^4

Design forces and moments

Shear force parallel to y-y axis — F_{vy} = **8.00** kN

Shear force parallel to x-x axis — F_{vx} = **0.00** kN

Axial force — F = **0.0 kN**

Maximum moment about x-x axis — M_x = **1.85** kNm

Maximum moment about y-y axis — M_y = **0.00** kNm

Section classification (Table 11)

Parameter epsilon — $\varepsilon = (275\ N/mm^2/p_y)^{0.5}$ = **0.880**

Ratio for leg dimension b — $ratio_b = b/t$ = **9.000**

Ratio for leg dimension d — $ratio_d = d/t$ = **15.000**

The section is Class 4 (slender) for bending

Reduced design strength in bending for Class 4 (slender) section (cl 3.6.5)

Maximum value of beta — $\beta = max(ratio_b, ratio_d)$ = **15.000**

Limiting value of β_3 for Class 3 section — $\beta_3 = 15 \times \varepsilon$ = **13.202**

Reduced design strength for bending — $p_{yr\_b} = (\beta_3/\beta)^2 \times p_y$ = **275.0** N/mm^2

Design for shear

For shear force parallel to y axis (cl. 4.2.3)

Shear area — $A_{vy} = 0.9 \times d \times t$ = **1350** mm^2

Shear capacity — $P_{vy} = 0.6 \times p_y \times A_{vy}$ = **287.55** kN

Shear capacity for 'low shear' — $P_{vy\_low} = 0.6 \times P_{vy}$ = **172.53** kN

PASS - The angle is in low shear parallel to y axis

Design for bending

The angle is not restrained against lateral torsional buckling

Moment capacities

Min moment capacity about x-x axis — $M_{cx\_min} = p_{yr\_b} \times Z_{x\_min}$ = **14.75** kNm

Max moment capacity about x-x axis — $M_{cx\_max} = p_{yr\_b} \times Z_{x\_max}$ = **29.48** kNm

PASS - The moment capacity about the x-x axis exceeds the applied moment

Design moments about principal axes

Angle between x-x and u-u axes — α = **19.9** deg

Resultant major (u-u) axis moment — $M_u = M_x \times \cos(\alpha) + M_y \times \sin(\alpha)$ = **1.74** kNm

Resultant minor (v-v) axis moment — $M_v = M_x \times \sin(\alpha) + M_y \times \cos(\alpha)$ = **0.63** kNm

Max major axis mt in segm't length governing M_b — $M_{LT} = M_u$ = **1.74** kNm

Equivalent uniform moment factor

EUM factor m_{LT} — m_{LT} = **1.000**

Major and minor axis section modulii

Distance from u-u axis to extreme fibre 1 — $u_1 = (d - c_x)\times\cos(\alpha) + c_y\times\sin(\alpha)$ = **101.0** mm

Distance from u-u axis to extreme fibre 2 — $u_2 = [d\times\cos(\alpha) + b\times\sin(\alpha)] - u_1$ = **70.7** mm

Maximum distance to extreme fibre — $u = \max(u_1, u_2)$ = **101.0** mm

Minimum major axis section modulus — $Z_u = I_u/u$ = **58.9** cm^3

Distance from v-v axis to extreme fibre 1 — $v_1 = (b-c_y)/\cos(\alpha) - [(c_x-t)+(b-c_y)\times\tan(\alpha)]\times\cos(\alpha)\times\tan(\alpha)$ = **51.8** mm

Distance from v-v axis to extreme fibre 2 — $v_2 = b\times\cos(\alpha) - v_1$ = **32.8** mm

Maximum distance to extreme fibre — $v = \max(v_1, v_2)$ = **51.8** mm

Minimum minor axis section modulus — $Z_v = I_v/v$ = **17.2** cm^3

Equivalent slenderness (B.2.9)

Unrestrained length for lateral torsional buckling — L_{v_b} = **900** mm

Slenderness wrt v-v axis — $\lambda_v = L_{v\_b}/r_v$ = **45.9**

Gamma factor — $\gamma_a = 1 - I_v/I_u$ = **0.850**

Phi factor — $\phi_a = [Z_u^2\times\gamma_a/(A\times J)]^{0.5}$ = **4.071**

The long leg is in compression at some point within the segment length, therefore:-

Monosymmetry index — ψ_a = **-9.030**

Nu factor — $\nu_a = 1/[(1+(4.5\times \psi_a /\lambda_v)^2)^{0.5}+(4.5\times \psi_a /\lambda_v)]^{0.5}$ = **1.490**

Equivalent slenderness — $\lambda_{LT} = 2.25 \times \nu_a \times (\phi_a\times\lambda_v)^{0.5}$ = **45.8**

Bending strength (B.2.1)

Limiting equivalent slenderness — $\lambda_{L0} = 0.4 \times (\pi^2 \times E/p_{yr\_b})^{0.5}$ = **34.3**

Robertson constant — a_{LT} = 7.0

Perry factor — $\eta_{LT} = \max(a_{LT} \times (\lambda_{LT}- \lambda_{L0})/1000, 0)$ = **0.081**

Euler buckling stress — $p_E = \pi^2 \times E/\lambda_{LT}^2$ = **962.9** N/mm^2

Factor phi — $\phi_{LT} = [p_{yr\_b} + (\eta_{LT}+1)\times p_E]/2$ = **657.8** N/mm^2

Bending strength — $p_b = p_E\times p_{yr\_b}/[\phi_{LT}+(\phi_{LT}^2 - p_E\times p_{yr\_b})^{0.5}]$ = **248.0** N/mm^2

Buckling resistance moment — $M_b = p_b \times Z_u$ = **14.61** kNm

Effective buckling resistance moment — $M_{beff} = M_b/m_{LT}$ = **14.61** kNm

PASS - Effective buckling resistance moment exceeds applied major axis moment

Minor axis bending resistance

Bending resistance — $M_{cv} = p_{yr\_b} \times Z_v$ = **4.73** kNm

PASS - Minor axis bending resistance moment exceeds applied minor axis moment

Equivalent uniform moment factors

EUM factor m_u — m_u = **1.000**

EUM factor m_v — m_v = **1.000**

Member buckling resistance (cl 4.8.3.3)

Equation 1 — $UF_1 = m_u\times M_u/(p_{yr\_b}\times Z_u) + m_v\times M_v/(p_{yr\_b}\times Z_v)$ = **0.240**

Equation 2 $UF_2 = m_{LT} \times M_{LT}/M_b + m_v \times M_v/(p_{yr\_b} \times Z_v)$ = **0.252**

PASS - Member buckling resistance is adequate

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The White Horse, Pampisford, Cambridge CB22 3EF
Tel: (01223) 833555 Email: engineering@secambridge.co.uk

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Calculation EDGE BEAM (RSA)	Engr.

Span ne 4.0m

(Supports edge timber.)

Load/m

5.35 x 0.35 = 1.90kN/m

$M = 1.90 \times 4.0^2/8 = 3.80$ kNm

$V = 1.90 \times 4.0/2 = 3.80$ kN

($M_{ult} = 5.70$ kNm
$V_{ult} = 5.70$ kN)

150x90 RSA 10

STEEL ANGLE DESIGN (BS5950-1:2000)

TEDDS calculation version 1.0.04

Element definition

Element being designed	**EDGE BEAM**
Section	**RSA 150x90x10**
Steel grade	**S355**
Design strength (Table 9)	p_y = **355** N/mm^2

Angle properties

Gross area	A_g = **23.21** cm^2
Radius of gyration about v axis	r_v = **1.96** cm
Minimum section modulus about x axis	Z_{x_min} = **53.65** cm^3
Maximum section modulus about x axis	Z_{x_max} = **107.21** cm^3
Minimum section modulus about y axis	Z_{y_min} = **21.19** cm^3
Maximum section modulus about y axis	Z_{y_max} = **72.16** cm^3
Inertia about major axis	I_u = **594.6** cm^4
Inertia about minor axis	I_v = **89.1** cm^4

Design forces and moments

Shear force parallel to y-y axis	F_{vy} = **5.70** kN
Shear force parallel to x-x axis	F_{vx} = **0.00** kN
Axial force	F = **0.0 kN**
Maximum moment about x-x axis	M_x = **5.70** kNm
Maximum moment about y-y axis	M_y = **0.00** kNm

Section classification (Table 11)

Parameter epsilon	$\varepsilon = (275\ \text{N/mm}^2/p_y)^{0.5}$ = **0.880**
Ratio for leg dimension b	$ratio_b = b/t$ = **9.000**
Ratio for leg dimension d	$ratio_d = d/t$ = **15.000**

The section is Class 4 (slender) for bending

Reduced design strength in bending for Class 4 (slender) section (cl 3.6.5)

Maximum value of beta	$\beta = \max(ratio_b, ratio_d)$ = **15.000**
Limiting value of β_3 for Class 3 section	$\beta_3 = 15 \times \varepsilon$ = **13.202**
Reduced design strength for bending	$p_{yr\_b} = (\beta_3/\beta)^2 \times p_y$ = **275.0** N/mm^2

Design for shear

For shear force parallel to y axis (cl. 4.2.3)

Shear area	$A_{vy} = 0.9 \times d \times t$ = **1350** mm^2
Shear capacity	$P_{vy} = 0.6 \times p_y \times A_{vy}$ = **287.55** kN
Shear capacity for 'low shear'	$P_{vy\_low} = 0.6 \times P_{vy}$ = **172.53** kN

PASS - The angle is in low shear parallel to y axis

Design for bending

The angle is not restrained against lateral torsional buckling

Moment capacities

Min moment capacity about x-x axis	$M_{cx\_min} = p_{yr\_b} \times Z_{x\_min}$ = **14.75** kNm
Max moment capacity about x-x axis	$M_{cx\_max} = p_{yr\_b} \times Z_{x\_max}$ = **29.48** kNm

PASS - The moment capacity about the x-x axis exceeds the applied moment

Design moments about principal axes

Angle between x-x and u-u axes — α = **19.9** deg

Resultant major (u-u) axis moment — $M_u = M_x \times \cos(\alpha) + M_y \times \sin(\alpha)$ = **5.36** kNm

Resultant minor (v-v) axis moment — $M_v = M_x \times \sin(\alpha) + M_y \times \cos(\alpha)$ = **1.94** kNm

Max major axis mt in segm't length governing M_b — $M_{LT} = M_u$ = **5.36** kNm

Equivalent uniform moment factor

EUM factor m_{LT} — m_{LT} = **1.000**

Major and minor axis section modulii

Distance from u-u axis to extreme fibre 1 — $u_1 = (d - c_x)\times\cos(\alpha) + c_y\times\sin(\alpha)$ = **101.0** mm

Distance from u-u axis to extreme fibre 2 — $u_2 = [d\times\cos(\alpha) + b\times\sin(\alpha)] - u_1$ = **70.7** mm

Maximum distance to extreme fibre — $u = \max(u_1, u_2)$ = **101.0** mm

Minimum major axis section modulus — $Z_u = I_u/u$ = **58.9** cm^3

Distance from v-v axis to extreme fibre 1 — $v_1 = (b-c_y)/\cos(\alpha) - [(c_x-t)+(b-c_y)\times\tan(\alpha)]\times\cos(\alpha)\times\tan(\alpha)$ = **51.8** mm

Distance from v-v axis to extreme fibre 2 — $v_2 = b\times\cos(\alpha) - v_1$ = **32.8** mm

Maximum distance to extreme fibre — $v = \max(v_1, v_2)$ = **51.8** mm

Minimum minor axis section modulus — $Z_v = I_v/v$ = **17.2** cm^3

Equivalent slenderness (B.2.9)

Unrestrained length for lateral torsional buckling — L_{v_b} = **4000** mm

Slenderness wrt v-v axis — $\lambda_v = L_{v\_b}/r_v$ = **204.2**

Gamma factor — $\gamma_a = 1 - I_v/I_u$ = **0.850**

Phi factor — $\phi_a = [Z_u^2\times\gamma_a/(A\times J)]^{0.5}$ = **4.071**

The long leg is in compression at some point within the segment length, therefore:-

Monosymmetry index — ψ_a = **-9.030**

Nu factor — $\nu_a = 1/[(1+(4.5\times\psi_a/\lambda_v)^2)^{0.5}+(4.5\times\psi_a/\lambda_v)]^{0.5}$ = **1.104**

Equivalent slenderness — $\lambda_{LT} = 2.25 \times \nu_a \times (\phi_a\times\lambda_v)^{0.5}$ = **71.6**

Bending strength (B.2.1)

Limiting equivalent slenderness — $\lambda_{L0} = 0.4 \times (\pi^2 \times E/p_{yr\_b})^{0.5}$ = **34.3**

Robertson constant — a_{LT} = 7.0

Perry factor — $\eta_{LT} = \max(a_{LT} \times (\lambda_{LT} - \lambda_{L0})/1000, 0)$ = **0.261**

Euler buckling stress — $p_E = \pi^2 \times E/\lambda_{LT}^2$ = **394.6** N/mm^2

Factor phi — $\phi_{LT} = [p_{yr\_b} + (\eta_{LT}+1)\times p_E]/2$ = **386.3** N/mm^2

Bending strength — $p_b = p_E\times p_{yr\_b}/[\phi_{LT}+(\phi_{LT}^2 - p_E\times p_{yr\_b})^{0.5}]$ = **184.5** N/mm^2

Buckling resistance moment — $M_b = p_b \times Z_u$ = **10.87** kNm

Effective buckling resistance moment — $M_{beff} = M_b/m_{LT}$ = **10.87** kNm

PASS - Effective buckling resistance moment exceeds applied major axis moment

Minor axis bending resistance

Bending resistance — $M_{cv} = p_{yr\_b} \times Z_v$ = **4.73** kNm

PASS - Minor axis bending resistance moment exceeds applied minor axis moment

Equivalent uniform moment factors

EUM factor m_u — m_u = **1.000**

EUM factor m_v — m_v = **1.000**

Member buckling resistance (cl 4.8.3.3)

Equation 1 — $UF_1 = m_u\times M_u/(p_{yr\_b}\times Z_u) + m_v\times M_v/(p_{yr\_b}\times Z_v)$ = **0.741**

Equation 2 $UF_2 = m_{LT} \times M_{LT}/M_b + m_v \times M_v/(p_{yr\_b} \times Z_v)$ = **0.903**

PASS - Member buckling resistance is adequate