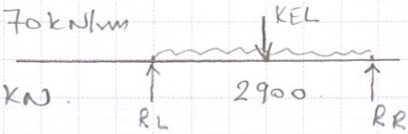
Reference		

ii) HA UDL = 70kN/m
+
HA KEL = 198kN.



$\therefore M_{max}(mid) = 70 \times 2.9^2 \times 0.125 + 198 \times 2.9 \times 0.25 =$ **+217.1 kNm.**

$R_L = R_R = 1.45 \times 70 + 0.5 \times 198 =$ **200.5 kN.**

$M_{2.04m} = 200.5 \times 2.04 - 70 \times 2.04^2 \times 0.5 - 198(2.04 - 1.45) =$ **+146.5 kNm.**

$\therefore M_D^+ = 217.1 + 3.1 =$ **220.2 kNm.** ($M^- = 20.7$).

$V_L^{max} = 200.5 + 25.5 =$ **226 kN.**

$V_R^{max} = 200.5 + 4.1 =$ **204.6 kN.**

AFTER INSPECTION, A CONDITION FACTOR OF 0.95 IS ADOPTED IN THIS ASSESSMENT.

FOR SECTION PROPERTIES REFER TO 'TEDDS' BEAM CHECK PAGES 'TB/1&2' ATTACHED.

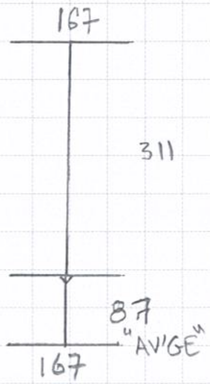
FROM TEDDS, SHEAR CAPACITY = 238 × 0.95 = **226.1 kN ∴ OK.**

CONSIDER BUCKLING MOMENT CAPACITY AS

$116.2 \times 0.95 =$ **110.4 kNm** $<< M_D^+$

∴ SECTION IS INADEQUATE WITHOUT THE WELDED T-SECTION.

SECTION PROPERTIES FOR COMPOUND SECTION:



(MIDSPAN)

TEDDS:
$A_{UB} = 6840 mm^2$.
$I_{xx} = 11687.8 \times 10^4 mm^4$

$A_T(EST) \simeq 2600 mm^2$
$I_{xx}(EST) \simeq$

Tekla Tedds GHDLivigunn	Project: Oughtibridge Mills, Sheffield				Job no.: LS1611	
	Calcs for: Transverse Beam Check (ignore T section)				Start page no./Revision: TB/ 1	
	Calcs by: BST	Calcs date: 29/06/2016	Checked by	Checked date	Approved by	Approved date

HISTORICAL SECTION DESIGN

Try Universal Beams To BS4 1962 12x6.5x36

For 1959 MS Rolled 1.50in or less

SECTION PROPERTY DATA - I SECTIONS - METRIC UNITS

D = **310.9** mm	B = **166.9** mm	A = **68.4** cm^2
Mass = **53.6** kg/m	t = **7.9** mm	T = **13.7** mm
I_{xx} = **11687.8** cm^4	Z_{xx} = **752.2** cm^3	r_{xx} = **13.2** cm
I_{yy} = **986.5** cm^4	Z_{yy} = **118.0** cm^3	r_{yy} = **3.8** cm

STRESS DATA - METRIC UNITS

p_{bc} = **162** N/mm^2	p_{bt} = **162** N/mm^2
p_t = **147** N/mm^2	p_q = **108** N/mm^2

SHEAR CAPACITY

F_{vy} = **226.0** kN

$A_v = k_s \times t \times D$ = **2203** mm^2

$P_{vy} = p_q \times A_v$ = **238** kN

Utilisation ratio abs(F_{vy})/P_{vy} = **0.949**

PASS - Shear check

MOMENT CAPACITY - FULLY RESTRAINED

M_x = **220.2** kNm

$M_{cx} = \min(p_{bc} \times Z_{xx}, p_{bt} \times Z_{xx})$ = **122.0** kNm

FAIL - Bending check

(SEE Pg #12)

LTB CHECKS - BS449 1948

M_x = **220.2** kNm

Effective length $L_{eyy} = k_{yy} \times L_{yy}$ = **2900** mm

Slenderness $l_{yy} = L_{eyy} / r_{yy}$ = **76**

PASS - L/r ratio <= 300

$M_b = p_b \times Z_{xx}$ = **116.2** kNm

FAIL - Lat. tors. buckling check

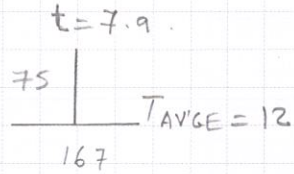
(SEE Pg #12)

DEFLECTION

Maximum deflection $\delta = \max(\text{abs}(\delta_{max}), \text{abs}(\delta_{min}))$ = **10.0** mm

Reference

T-SECTION:



$A_t = 75 \times 7.9 = 592.5\ mm^2$.
$A_T = 167 \times 12 = 2004\ mm^2$.

$\Sigma A_T = 2596.5\ mm^2$.

$\bar{y} = (592.5 \times 49.5 + 2004 \times 6) \div 2596.5 = 15.92\ mm$.

$\therefore I_{xx} = (7.9 \times 75^3/12 + 592.5 \times 33.6^2) + (167 \times 12^3/12 + 2004 \times 9.92^2) = 117 \times 10^4\ mm^4$.

UB + T-SECTION:

$\Sigma A = 6840 + 2596.5 = 9436.5\ mm^2$.

$\bar{y} = (6840 \times 242.5 + 2596.5 \times 15.92) \div \Sigma A = 180.1\ mm$.

$\therefore I_{xx(TOT)} = 11687.8 \times 10^4 + 117 \times 10^4 + 6840 \times 62.4^2 + 2596.5 \times 164.18^2 = 214.7 \times 10^6\ mm^4$.

$\therefore Z_{xx(B)} = I_{xx} \div 180.1 = 1.1920 \times 10^6\ mm^3$.

$\therefore M_b = P_b \times Z_{xx(B)} = 154.5 \times 1.1920 = 184\ KNm$

MODIFIED $M_b = 0.95 \times 184 = 174.8\ KNm$

$\therefore$ THIS IS LESS THAN $M_D^+ = 220.2\ KNm$. $(R = 0.79) < 1.0$

$\Rightarrow$ REDUCE LIVE LOAD.

$\therefore M_D^+$ DUE TO LIVE LOAD $= 174.8 - 3.1 = 171.7\ KNm$

LIVE LOAD RATIO $= 171.7 \div 217.1 = 0.79$

BD21/01 FROM FIG. 5.2 FOR A LOADED L = 24.3 m

& ASSUMING AN H_p^* CLASS:

THE BEAM'S LOAD CARRYING CAPACITY = 26 TONNES.

* IF Hg IS ADOPTED THEN ALL ≤ 38 TONNES.

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HOWEVER, IF HM IS ADOPTED THEN

AN ALL OF $\frac{38+26}{2}$ = 32 TONNES IS OK.

RESULT: TRANSVERSE BEAMS ARE ADEQUATE FOR LIVELOADS IN THE RANGE OF (26 → 32) TONNES IN ACCORDANCE WITH BD21/01.

Reference

d) RIVETED LATTICE TRUSS GIRDER - TO BE ASSESSED AT ELASTIC STRESS LIMIT STATE:

FROM DIMENSIONAL SURVEY DWG № 03:

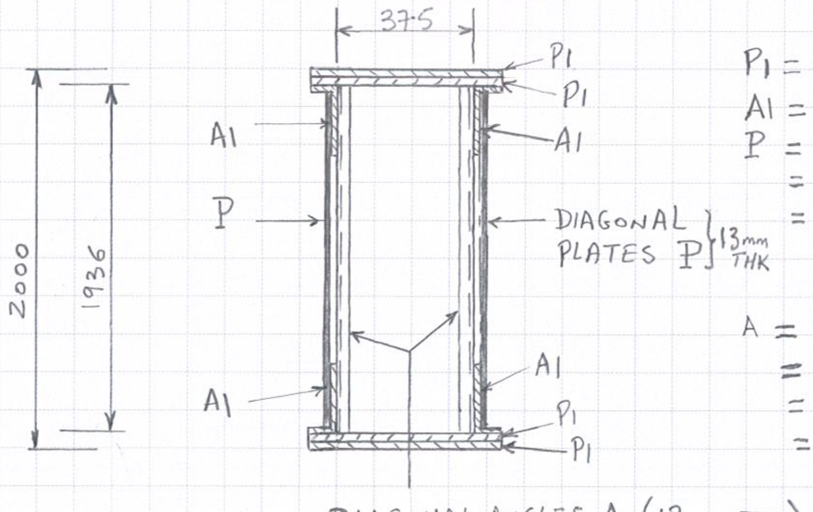
TRUSS SPAN (C/C OF BEARING STONES) =
22817 − 915 = 21902 ÷ 10^3 = **22 m SAY**

BY INSPECTION OF DWG № 02:

NORTH TRUSS SUPPORTS A LARGER DECK AREA THAN THE SOUTH TRUSS + PARAPET POSTS & 'ARMCO' BARRIERS.

AS THE ASSESSMENT LIVE LOADS ARE MUCH GREATER THAN DEAD LOADS, THE NORTH TRUSS SHALL BE ASSESSED ONLY - CONSERVATIVE FOR SOUTH TRUSS.

TRUSS PROPERTIES:



P1 = 500 x 16 (mm^2)
A1 = 178 x 76 x 13 (mm^3)
P = 178 x 13 (A-A), 4 №
= 140 x 13 (C-C), 4 №
= 102 x 13 (E-E), 4 №

A = 178 x 76 x 13 (B-B), 4 №
= 127 x 76 x 13 (D-D), 4 №
= 102 x 76 x 13 (F-F), 4 №
= 89 x 89 x 13 (G-G), 2 №

TYPICAL TRUSS X-SECTION

Reference

FLANGE PLATE, P1:

$A_s = 500 \times 16 = \underline{8000}\ mm^2.$

$\therefore \Sigma A_s = 4 \times 8000 = \underline{32000 mm^2}$

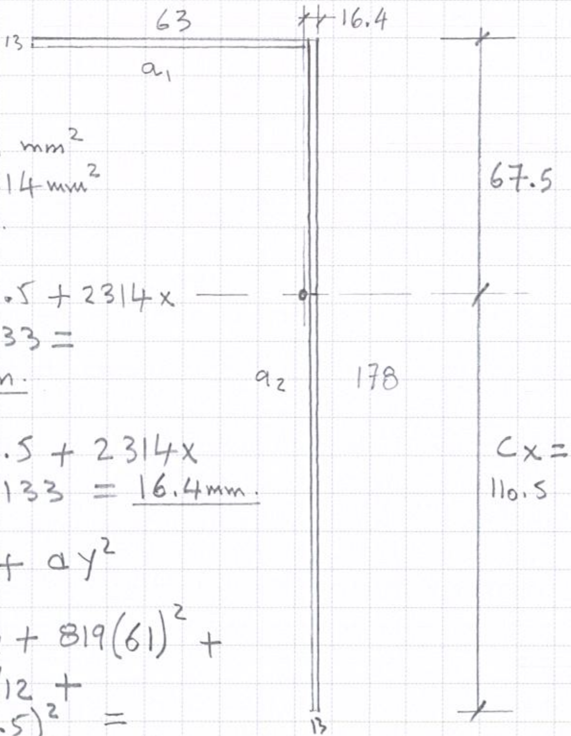
$I_{xx} = 500 \times 16^3 / 12 = \underline{170\,667}\ mm^4$ & $r_{xx} = \underline{4.62\ mm}.$

$I_{yy} = 16 \times 500^3 / 12 = \underline{166.67 \times 10^6}\ mm^4$ & $r_{yy} = \underline{144.3 mm}$

FLANGE ANGLE, A1:

$A_s = 178 \times 13 + 63 \times 13 = \underline{3133}\ mm^2.$

$\therefore \Sigma A_s = 4 \times 3133 = \underline{12532\ mm^2}$



$a_1 = 63 \times 13 = 819\ mm^2$
$a_2 = 178 \times 13 = 2314\ mm^2$
$A_s = 3133\ mm^2.$

$\therefore C_x = (819 \times 171.5 + 2314 \times 89) \div 3133 = \underline{110.5\ mm}.$

$C_y = (819 \times 44.5 + 2314 \times 6.5) \div 3133 = \underline{16.4 mm}.$

$\therefore I = bd^3/12 + ay^2$

$I_{xx} = 63 \times 13^3/12 + 819(61)^2 + 13 \times 178^3/12 + 2314 \times (21.5)^2 = \underline{10.24 \times 10^6\ mm^4}$

$I_{yy} = 13 \times 63^3/12 + 819\,(28.1)^2 + 178 \times 13^3/12 + 2314 \times (9.9)^2 = \underline{1.177 \times 10^6}\ mm^4$

$r_{xx} = (10.24 \times 10^6 \div 3133)^{0.5} = \underline{57.2}\ mm.$

$r_{yy} = (1.177 \times 10^6 \div 3133)^{0.5} = \underline{19.4}\ mm.$

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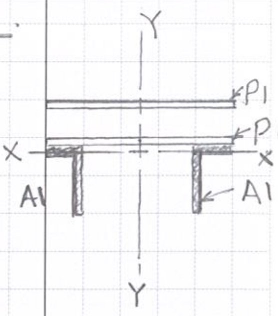
	COMPOUND FLANGE :	
	$\Sigma A_F = 2 \times 8000 + 2 \times 3133 = \underline{22266 \text{ mm}^2}$.	
	$C_X = (8000 \times 202 + 8000 \times 186 + 2 \times 3133 \times 110.5) \div 22266 = \underline{170.5 \text{ mm}}$	
	$I_{XX} = 170667 + 8000 \times 31.5^2 + 170667 + 8000 \times 15.5^2 + 3133 \times 60^2 \times 2 + 2 \times 10.24 \times 10^6 = \underline{53.24 \times 10^6} \text{ mm}^4$.	
	$\therefore r_{XX} = (I_{XX} \div 22266)^{0.5} = \underline{48.9 \text{ mm}}$.	MAKE UP OF FLANGE (T+B)
	$I_{YY} = 2 \times 166.67 \times 10^6 + 1.177 \times 10^6 \times 2 + 2 \times 3133 \times 190.4^2 = 562.85 \times 10^6 \text{ mm}^4$	
	$\therefore r_{YY} = (I_{YY} \div 22266)^{0.5} = \underline{159 \text{ mm}}$.	
	CONSIDER COMPRESSION FLANGE :	
	UNRESTRAINED LENGTH $\simeq$ 3100 mm (TYP).	
	SLENDERNESS $\lambda_X = 3100 \div 48.9 =$	$\underline{63.4}$.
	$\therefore$ BUCKLING STRESS (BS449-1948) $\geq$ (P_b)	157 N/mm²
	CONSIDER LATTICE GIRDER :	
	FOR SECTION PROPERTIES IGNORE DIAGONAL MEMBERS - CONSERVATIVE.	
Pg # 14.	$\Sigma A_s = 2 \times 22266 = \underline{44532 \text{ mm}^2}$.	
	$I_{XX} = 2(53.24 \times 10^6 + 22266 \times 960.5^2) =$	$\underline{4.119 \times 10^{10}} \text{ mm}^4$.
	$\therefore r_{XX} = (I_{XX} \div \Sigma A_s)^{0.5} = \underline{961.74 \text{ mm}}$.	
	$I_{YY} = 562.85 \times 10^6 \times 2 = \underline{1125.7 \times 10^6} \text{ mm}^4$.	
	$\therefore r_{YY} = (I_{YY} \div \Sigma A_s)^{0.5} = \underline{159 \text{ mm}}$.	
BS449-2	SLENDERNESS $\lambda_Y = 3100 \div 159 =$	$\underline{19.5}$
	$\therefore P_b \geq \underline{157 \text{ N/mm}^2}$ GOVERNS.	

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$\therefore Z_x = (4.119 \times 10^{10} \div 10^3) = \underline{4.119 \times 10^7}$ mm^3.

$\therefore$ BUCKLING MOMENT CAPACITY =

$4.119 \times 10^7 \times 157 \times 10^{-6}$ = $\underline{6467 \text{ KNm}}$.

LOADS:

DECK + BEAMS = $(0.77 \times 0.924 + 0.90 + \frac{0.71}{3.1}) \times 1.10 (\gamma_{f3}) = 2.20 \therefore \underline{3.10 \text{ KN/m}^2 (SLS)}$ CONSERVATIVE.

$\therefore$ LINE D.L @ TRANS' BEAMS = 3.1×3.1 = $\underline{11.43 \text{ KN/m}}$ (SLS)

PARAPET POST = $0.54 \times 2.3 = \underline{1.25 \text{ KN}}$ (SLS).

PARAPET RAILS = $(0.37 \times 3.1) \times 3 = \underline{3.45 \text{KN}}$ (SLS).

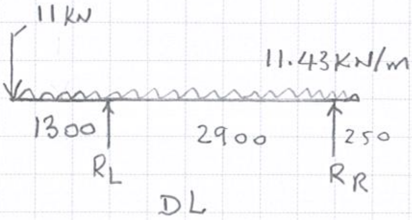
DRAIN CHANNEL & PLATES = $77 \times (0.24 \times 0.012 + 0.078 \times 0.012 + 0.14 \times 0.010 + 2 \times 0.16 \times 0.01) 3.1 + 77 \times 0.16 \times 0.255 \times 0.02 = \underline{4.1 \text{KN}}$ (SLS)

SAFETY BARRIES + MESH = $(3 \times 0.5) \times 1.10 = \underline{1.65 \text{KN}}$ (SLS)

$\therefore \Sigma$ PARAPET LOAD = $1.25 + 3.45 + 4.1 + 1.65 = 10.45$ + BOLTS/ETC = $\underline{11 \text{ KN}}$ (SLS)

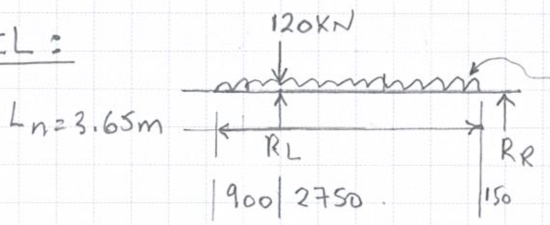
TRANSVERSE DECK LAYOUT:

i) DL:



$R_L = (11 \times 4.2 + 11.43 \times 4.2^2 \times 0.5 - 11.43 \times 0.25^2 \times 0.5) \div 2.9 = 50.57$ + STIFFS/ETC = $\underline{51 \text{KN}}$.

ii) IL:



HA UDL = $10.85 \times 1.1 \times 3.1 = \underline{37 \text{ KN/m}}$ (SLS)

HA KEL IS APPLIED AT THE CRITICAL LOCATIONS FOR BENDING + SHEAR:

$R_L \text{(MOM)} = (120 \times \overset{\gamma_{f3}}{1.1}) + (37 \times 3.65 \times 1.975 \div 2.9) = \underline{224 \text{ kN (SLS)}}$.

$\therefore \Sigma R_L$ (NEAR MIDSPAN) $= 51 + \overset{132}{}\overset{92}{224} =$ <u>275 kN (SLS)</u>

(OTHERS EXCEPT BEARINGS) $= 51 + 92 =$ <u>143 kN (SLS)</u>

(AT BEARINGS) $= 27 + 48 =$ <u>75 kN (SLS)</u>

R_L (SHEAR) $= 51 + 224 =$ <u>275 kN (SLS)</u>
APPLIED NEAR A BEARING

(OTHERS) = <u>143 kN (SLS)</u>

(AT BEARINGS) = <u>75 kN (SLS)</u>.

<u>TRUSS S.WT:</u>

FLANGES $= 2 \times (77 \times 22266 \times 10^{-6} \times 1.1) =$ <u>3.77 kN/m (SLS)</u>

DIAGONAL PLATES $= 2.5 \times 77 \times 1.1 (0.178 \times 0.013 \times 4 + 0.14 \times 0.013 \times 4 + 0.102 \times 0.013 \times 4) \div 22 =$ <u>0.21 kN/m (SLS)</u>

DIAGONAL ANGLES $= 2.5 \times 77 \times 1.1 (3133 \times 10^{-6} \times 4 + 3.73 \times 25.4^2 \times 10^{-6} \times 4 + 3.23 \times 25.4^2 \times 10^{-6} \times 4 + 3.23 \times 25.4^2 \times 10^{-6} \times 2) \div 22 =$ <u>0.334 kN/m (SLS)</u>

$\therefore$ S.WT = <u>4.313 kN/m</u>

<u>TRUSS ANALYSIS - SIMPLIFIED APPROACH</u>

MEMBER FORCES ARE DETERMINED USING HAND CALCS (NO COMPUTER MODELLING IS USED). THIS SIMPLIFIED APPROACH CONSIDERS TOP & BOTTOM COMPOUND FLANGES TO BE SUBJECT TO COMPRESSION & TENSION RESPECTIVELY. DIAGONAL ANGLES ARE GENERALLY ASSESSED AS COMPRESSION MEMBERS WHILST DIAGONAL PLATES ARE ASSESSED AS TENSION MEMBERS.

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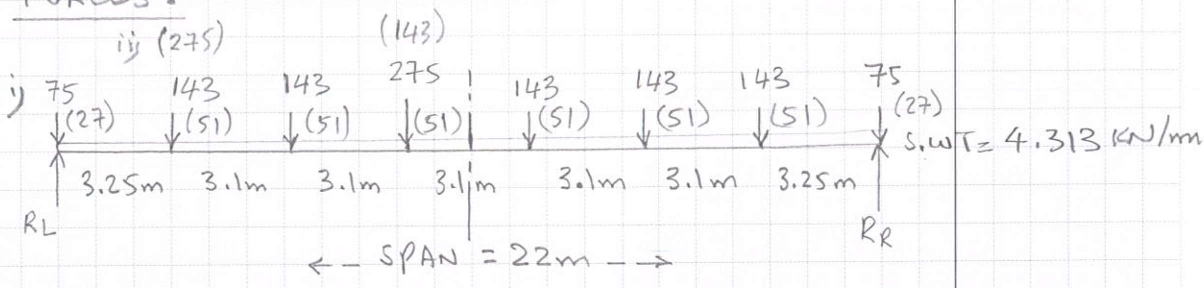
FORCES:

i) M_{max}:



$R_{L_{TOT}} = 75 + 143 \times 3 + 11 \times 4.313 + (132 \times 12.55 \div 22) =$ **626.75 kN.**

& $R_{L(D)} = 27 + 51 \times 3 + 11 \times 4.313 =$ **227.5 kN.**

∴ $M_{max}(TOTAL) = 626.75 \times 9.45 - 75 \times 9.45 - 143(3.1 + 6.2) - 4.313 \times 9.45^2 \times 0.5 =$ **3691.6 kNm**

& $M_{mid}(TOTAL) = (626.75 - 75) \times 11 - 143 \times 7.75 - 143 \times 4.65 - 275 \times 1.55 - 4.313 \times 11^2 \times 0.5 =$ **3608.9 kNm.**

$M_{max}(D) = (227.5 - 27) \times 9.45 - 51(3.1 + 6.2) - 4.313 \times 9.45^2 \times 0.5 =$ **1227.8 kNm**

∴ $M_{max}(LIVE) = 3691.6 - 1227.8 =$ **2463.8 kNm.**

ii) V_{max}:

$R_{L(TOT)} = 75 + 143 \times 3 + 11 \times 4.313 + (132 \times 18.75 \div 22) =$ **663.95 kN.**

$R_L(LIVE) = 663.95 - 227.5 =$ **436.45 kN.**

FLANGE COMPRESSION:

$C_{TOT} = 3691.6 \div 1.921 = $ **1921.7 kN.**

∴ COMPRESSIVE STRESS $= 1921.7 \times 10^3 \div 0.90 (CF) \times 222.66 = 95.9 < 157\ N/mm^2$ ∴ OK.

FLANGE TENSION (BS449):

TENSILE CAP $= 22266 \times 162 \times 10^{-3} = 3607\ kN$

$C_F = 0.9 \Rightarrow$ RATIO $= \dfrac{1921.7}{0.9 \times 3607} = 0.59 < 1.0$ ∴ OK.

SHEAR:

$V = 275000 \div 2 \times 178 \times 13 = 59.4 < 99\ N/mm^2$ ∴ OK.

GHD LIVIGUNN

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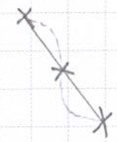
DIAGONAL ANGLES (B-B):

C_{TOT} / PAIR = (663.95 (ii) − 75) × 2.5 ÷ 2 = 736.2 KN

= 368.1 × 2 (EACH ANGLE × 2)



BUCKLING LENGTH = $0.85 \times \frac{2500}{2}$ = 1062.5 mm.

∴ λ_y = 1062.5 ÷ 19.4 = 54.8 < 300 ∴ OK.

∴ C_o = 3133 × 158 × 10^{-3} = 495 KN. (990 KN / PAIR)

∴ % = 495 ÷ 368.1 = 1.344 > 1.0 ∴ OK.

CHECK DEAD EFFECTS:

C_D / PAIR = (227.5 − 27) × 2.5 ÷ 2 = 250.63 KN.

= (125.3 × 2) KN.

∴ C_{LIVE} = 495 − 125.3 = 369.7 KN.

∴ R_L (LIVE) = 369.7 × 2 ÷ 2.5 = 295.75 KN / ANGLE.

APPLIED R_L (LIVE) DUE TO FULL HA ALL =

(663.95 − 227.5) = 436.45 ÷ 2 = 218.2 KN / ANGLE.

(C_F = 1.0) ∴ RATIO = 369.70 ÷ 218.2 = 1.694 > 1.0 ∴ OK

DIAGONAL ANGLES (D-D): r_{min} = 16.25 mm (TABLE) ∴ P_b = 157

C_T / PAIR = (626.75 (i) − 75 − 143 (394.7) − 3.25 × 4.313) × 2.5

÷ 2 = 493.4 = (246.7 × 2) KN.

∴ C_o / ANGLE = 378 > C_T = 246.7 KN ∴ OK (1.53)

DIAGONAL ANGLES (F-F): r_{min} = 16 mm ∴ P_b = 157.

C_T / PAIR = (394.7 − 143 (238.3) − 3.1 × 4.313) × 2.5 ÷ 2 = 297.95 KN.

= (148.9 × 2) KN.

∴ C_o / ANGLE = 327 > C_T = 148.9 KN ∴ OK. (2.2)

Reference

DIAGONAL ANGLES (G-G) - TENSION

$T_0 = -2084 \times 162 \; 10^{-3} = -338$ KN/ANGLE.

(ii)

T_T / PAIR = (663.95 − 75 − 275 − 2×143 − 9.45×4.313)× 2.5÷2 = −16 KN = (−8×2) KN

∴ To/ANGLE > 8 KN ∴ OK.

DIAGONAL PLATES (A-A):

RESTRAINING FORCE = 2.5% × 368.1 = 9.20 KN.

TENSILE CAP = 0.178 × 0.013 × 162 × 10^3 = 375 KN ∴ OK.

LIVE LOAD CAPACITY:

BD21/01 BY INSPECTION, DIAGONAL ANGLES HAVE THE LEAST LOAD RATIO OF 1.344 > 1.0

∴ FROM FIG 5.5 (HEAVY TRAFFIC + MED. SURFACE) THE EQUIVALENT ALL ≥ 40 TONNES.

RESULT: LATTICE TRUSS IS DEEMED ADEQUATE FOR A LIVE 'ALL OF 40 TONNES' IN ACCORDANCE WITH BD21/01.

THE TRUSS CAPACITY IS GOVERNED BY THE DIAGONAL COMPRESSION ANGLES CLOSE TO THE BEARING SUPPORTS.

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Ms K Stafeckis
Commercial Estates Group
No1 Leeds
26 Whitehall Road
Leeds
LS12 1BE

10th March 2017

Ref: C6485E/GH/7785

Dear Karen

Re: Oughtibridge Mills, Sheffield - Stockpile Testing

1.0 Introduction

Sirius Geotechnical Ltd (Sirius) were commissioned by Commercial Estates Group (CEG), to undertake an investigation of stockpiled materials located on land at Oughtibridge Mill, Oughtibridge, Sheffield ('the site'). It is understood that the site is proposed for redevelopment for a residential end use.

The investigation works are intended to assist with initial assessment of the recently stockpiled materials for either re-use or disposal consideration.

This letter report presents the factual information obtained from this investigation, along with the results of the laboratory testing.

The comments and opinions presented in this letter report are based on the ground conditions encountered by this investigation. There may be other conditions prevailing which have not been revealed by this investigation and which have not been taken into account by this report. Responsibility cannot be accepted for any conditions not revealed by this investigation.

Any diagram or opinion on the possible configuration of strata, contamination or other spatially variable features between or beyond investigation positions is conjectural and given for guidance only. Confirmation of ground conditions between exploratory holes should be undertaken if deemed necessary.

This letter report has been written for the sole use of CEG. No other third party may rely upon or reproduce the contents of this report without the written approval of Sirius. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk and the authors do not owe them any Duty of Care or Skill.

2.0 Site Description

The site is irregular in shape, with approximate dimensions of 900m in length and 200m in width, and comprises a number of existing and recently demolished structures and features associated with the former Oughtibridge Paper Mill. The southern boundary of the site runs approximately northwest-southeast, parallel to Langsett Road North. The River Don runs through the site, bisecting it into two portions. The site is bordered by woodland to the north and east, Main Road / Langsett Road North to the south and residential properties and a public house to the north / northwest.

The stockpile is located along the eastern site boundary, adjacent to (and partly impinging into), an area of off-site woodland, and is known to have only recently been placed (i.e. approximately within the last 12 months). The stockpile does not appear to have been sufficiently bladed / sealed, which appears to have allowed some surface water ingress. The source of the stockpile materials is unknown.

The stockpile location within the site is shown on Drawing No. C6485E/02 included within Appendix A. Photographs of the stockpile are included within Appendix F of this report.

3.0 Stockpile Volume

The stockpile was surveyed on 9th February 2017 by Stamford Geomatics Ltd, on behalf of Sirius.

The dimensions and volume of the stockpile, as taken from the survey drawing and associated calculations are c.5m-7m in height, 85m in length, c.25m-40m in width and 8,132m^3 in volume. Copies of the survey drawing and volume calculations, as provided by Stamford Geomatics Ltd, are included within Appendix C of this letter report.

4.0 Fieldwork

Fieldworks forming this ground investigation were undertaken on 7th February 2017 and comprised the mechanical excavation of fourteen trial pits (STP1 - STP14) using a JCB 3CX into the stockpile to a maximum depth/ distance of approximately 3.0m. The stockpile materials were considered too unstable to allow excavation into the centre of the stockpile.

The works were supervised by a Geoenvironmental Engineer and an SSSTS (Site Supervisor Safety Training Scheme) trained supervisor.

Exploratory hole locations are shown on Drawing No. C6485E/02 in Appendix A of this letter report.

Strata Description

Strata descriptions were logged in accordance with Eurocode 7. Detailed descriptions of strata made during investigation works, together with samples recovered, are presented on the Engineer's records in Appendix B.

Laboratory Testing

Geotechnical laboratory testing on selected samples was carried out under subcontract by Professional Soils Laboratory (PSL), a UKAS-accredited laboratory.

Selected soil samples were tested for a range of potential contaminants under subcontract with Derwentside Environmental Testing Services (DETS), a UKAS and MCERTS-accredited laboratory.

The results of laboratory analysis, as received from the laboratory, are presented in Appendix D of this report.

5.0 Stockpile Conditions

Cohesive made ground, comprising variably firm, to very stiff consistency, high plasticity, light brown-grey sandy gravelly clay with low cobble and boulder content, was typically recorded during the investigation forming the majority of the stockpile. The gravel, cobble and boulder contents were principally found to include brick, concrete, sandstone and mudstone, with occasional wood, plastic, tile, glass, re-bar, metal and asphalt fragments. Roots and rootlets were noted within several of the trial hole excavations. Waste plastic and carpet materials, in addition to paint fragments, were recorded within stockpile materials excavated within STP02.

Stockpile materials were found to vary slightly within STP01 located within the northern area of the stockpile. Soils within trial hole excavation STP01 were found to comprise firm light grey sandy gravelly clays to a depth of 0.3m, underlain by stiff red-orange brown sandy gravelly clays, in turn underlain by firm blue-grey sandy gravelly clay, with low ash content.

Perched water was not encountered during the investigation, however soils were recorded to be damp / wet on occasion. The damp / wet soils were found to be lead to instability within a number of trial holes during excavation.

Copies of all exploratory hole logs are included within Appendix B of this letter report.

Visual/olfactory Evidence of Contamination

During our works, there was no olfactory or visual evidence of hydrocarbon or similar contamination.

Asbestos has not been observed at the surface of, or within trial excavations into the stockpile, but the presence of such materials in light of the uncontrolled deposition of this material cannot be precluded and a watching brief should be maintained during any further works.

6.0 Material Properties

Water soluble sulphate (SO_4^{2-}) analyses recorded from nine samples taken in the cohesive made ground soils recorded concentrations of between 77mg/l and 1600mg/l, together with pH conditions of between 6.9 and 9.8. These results indicate a design sulphate class of DS-2 and an ACEC class of AC-2, in accordance with BRE Special Digest 1 (2005) for the design of buried concrete on brownfield land, assuming mobile groundwater conditions.

Atterberg limit determinations undertaken on four samples of the cohesive made ground revealed liquid limits of between 50% and 53%, plastic limits of between 24% and 25% and plasticity indices of between 26% and 28%. This data indicates the material tested to be clay of high plasticity.

The Consistency Index (Ic) of the samples tested returned highly variable Ic values of between 0.70 and 1.19 (indicating firm, to very stiff consistency clay).

Compaction tests were undertaken, using a 2.5kg rammer, on six selected samples of the cohesive made ground soils. The compaction tests were undertaken at a range of moisture contents to determine the optimum moisture content and dry density relationship for the samples. Table 1 overleaf indicates the salient compaction results. Classification of soils is based on grading, in accordance with Highways Agency (HA) publication “Specification for Highway Works Series 600, Earthworks”.

Table 1: Summary of Earthworks Test Results

Trial Pit (STP)	Sample Depth (m)	HA Soil Class	Optimum Moisture content (%)	Maximum Dry Density (Mg/m3)	Optimum moisture content range (95% relative compaction/ <5% air voids		Natural moisture content (%)	Comments on natural moisture content
					Lower (%)	Upper (%)		
1	0.7	2C	16	1.81	15	20	19	OK
2	0.5	2C	16	1.78	16	20	19	OK
3	0.5	2C	19	1.72	18	23	27	Too wet
6	0.5	2C	22	1.61	22	28	33	Too wet
8	0.5	2C	19	1.71	18	23	25	Too wet
12	0.5	2C	17	1.76	16	22	23	OK
13	0.5	2C	n/r	n/r	n/r	n/r	n/r	n/r
14	0.5	2C	n/r	n/r	n/r	n/r	n/r	n/r

The moisture contents recorded within the three samples tested were typically found to be wetter than the theoretical effective compaction range to enable 95% relative compaction and less than 5% air voids. In this instance, in order to achieve effective compaction such soils would therefore require drying.

Particle size distribution (PSD) testing was undertaken on eight samples of the cohesive made ground in order to confirm the field descriptions and enable categorisation of the fill material for compaction. The PSD results indicated the cohesive made ground to typically comprise sandy gravelly clay in accordance with BS EN ISO 14688:2002 and 2004 and BS EN ISO 14689:2003. Based on the laboratory test results undertaken to date, the disturbed samples of cohesive made ground soils, have been classified as "stoney cohesive material 2C" in accordance with Highways Agency (HA) publication "Specification for Highway Works Series 600, Earthworks".

7.0 Chemical Testing

The laboratory test data for the soils sampled from the stockpile were reviewed for completeness and consistency. Those determinands that represent potential contaminants of concern were subject to further evaluation.

For each potential contaminant of concern, analytical data for soil samples were evaluated against the relevant Generic Assessment Criterion (GAC), taking account of the Soil Organic Matter (SOM) content. For this site, measured values were compared to GACs derived for a residential with gardens end use. Source data for all GACs are provided in Appendix E.

If any samples recorded contaminant concentrations that exceeded that GAC, then consideration was given to the applicability of statistical data evaluation in line with the methods described for the Planning Scenario in CL:AIRE & CIEH "Guidance on Comparing Soil Contamination Data with a Critical Concentration", May 2008.

Soil Analyses

Table 2 presents a summary of the analytical results obtained as part of the investigation, and their evaluation against the applicable GACs. Table 2 also summarises the statistical analysis of each determinand where applicable.

Table 2 Summary of Total Soil Concentrations

Determinand	No. of Samples Tested	Range of Results (mg/kg unless specified)	US95	GAC (1% SOM)	No. of Samples >GAC	Samples Exceeding GAC
Metals						
Inorganic Arsenic	5	6.6 - 11	NA	37	0	
Cadmium	5	0.4 - 4.1	NA	11	0	
Chromium (III)	5	20 - 28	NA	910	0	
Lead	5	37 - 98	NA	200	0	
Inorganic Mercury	5	0.06 - 0.14	NA	40	0	
Selenium	5	<0.5 - 0.7	NA	250	0	
Copper	5	31 - 72	NA	200	0	
Nickel	5	16 - 34	NA	180	0	
Zinc	5	93 - 510	NA	450	1	STP08
Inorganics						
pH	9	6.9 - 9.8	NA	<5 or >9	2	STP01 and STP12

Determinand	**No. of Samples Tested**	**Range of Results (mg/kg unless specified)**	**US95**	**GAC (1% SOM)**	**No. of Samples >GAC**	**Samples Exceeding GAC**
Total Sulphate	5	600 - 1200	NA	2400	0	
Water Sol. Sulphate	9	77 - 1600mg/l	NA	500mg/l	2	STP02 and STP07
Speciated PAH						
Acenaphthene	5	<0.1 - 0.8	NA	200	0	
Anthracene	5	<0.1 - 1.3	NA	2300	0	
Acenaphthylene	5	<0.1	NA	170	0	
Benzo(a)anthracene	5	<0.1 - 2.3	NA	*b(a)p**	0	
Benzo(b)fluoranthene	5	<0.1 - 1.5	NA	*b(a)p**	0	
Benzo(k)fluoranthene	5	<0.1 - 1.1	NA	*b(a)p**	0	
Benzo(g,h,i)perylene	5	<0.1 - 1.3	NA	*b(a)p**	0	
Benzo(a)pyrene	5	<0.1 - 2.2	1.48	2.1	1	STP02
Chrysene	5	<0.1 - 2.5	NA	*b(a)p**	0	
Dibenzo(a,h)anthracene	5	<0.1	NA	*b(a)p**	0	
Fluoranthene	5	<0.1 - 6.1	NA	280	0	
Fluorene	5	<0.1 - 0.9	NA	170	0	
Indeno(1,2,3-cd)pyrene	5	<0.1 - 1.2	NA	*b(a)p**	0	
Naphthalene	5	<0.1 - 0.1	NA	1.0	0	
Pyrene	5	<0.1 - 5.2	NA	620	0	
Phenanthrene	5	<0.1 - 5.3	NA	95	0	
Speciated TPH						
Aliphatic EC 5-6	5	<0.01	NA	24	0	
Aliphatic EC >6-8	5	<0.01	NA	53	0	
Aliphatic EC >8-10	5	<0.01	NA	13	0	
Aliphatic EC >10-12	5	<1.5	NA	62	0	
Aliphatic EC >12-16	5	<1.2	NA	510	0	
Aliphatic EC >16-35	5	<4.9	NA	41000	0	
Aromatic EC 5-7	5	<0.01	NA	53	0	
Aromatic EC >7-8	5	<0.01	NA	100	0	
Aromatic EC >8-10	5	<0.01	NA	20	0	
Aromatic EC >10-12	5	<0.9	NA	63	0	
Aromatic EC >12-16	5	<0.5 - 0.7	NA	140	0	
Aromatic EC >16-21	5	<0.6 - 3.3	NA	260	0	
Aromatic EC >21-35	5	<1.4 - 2.7	NA	1100	0	
Benzene	5	<0.01	NA	0.063	0	
Toluene	5	<0.01	NA	100	0	
Ethylbenzene	5	<0.01	NA	26	0	
Xylenes (total)	5	<0.01	NA	28	0	

Determinand	No. of Samples Tested	Range of Results (mg/kg unless specified)	US95	GAC (1% SOM)	No. of Samples >GAC	Samples Exceeding GAC
MTBE	5	<0.01	NA	31	0	
Others						
Phenol	5	<0.3	NA	110	0	
TOC	5	1.1 - 1.8	NA	3 w/w%	0	
Loss on Ignition	5	4.3 - 6.6%	NA	10%	0	
Asbestos	5	NAD	NA	Fibres present	0	

Table based on a Residential with Gardens end use (with consumption of homegrown produce). US95 - 95th percentile estimate of the mean value; GAC - Stage 1 generic assessment criterion. * Assessed using benzo(a)pyrene as a surrogate marker, except where stated in text. NAD – No Asbestos Detected. NA - not applicable.

Metals

A concentration of zinc was recorded marginally in exceedance of the relevant GAC in one sample of cohesive made ground.

For residential with plant uptake end-use the GAC applied to zinc is based on potential phytotoxic effects and has been set at the maximum allowable concentration for sewage sludge – amended soils presented in the "Sludge (Use in Agriculture) Regulations". The equivalent GAC value for zinc with respect of human health protection in this land use is 3,700mg/kg, based on the LQM-CIEH "S4UL" value. Consequently, the risk to human health from the elevated levels of zinc is considered to be low.

Statistical analysis was not possible in this instance because of the limited, skewed dataset.

No other metals / metalloids exceeded the relevant GACs.

Inorganics

Water-soluble sulphate concentrations exceeded the relevant GACs within two samples of cohesive made ground soils tested. These are not considered as contaminants of concern for human health, although elevated concentrations can have implications for the specification of buried concrete required for proposed structures, which is discussed within Section 6.

Two slightly elevated pH values have been recorded within the cohesive made ground, which may have the potential to cause minor skin irritation. The maximum pH value was 9.8, which is not considered to pose a potentially unacceptable risk during normal site occupancy and use. Exposure of construction workers during enabling works will be greater and can be mitigated through the use of appropriate personal protective equipment (PPE) and good hygiene practices.

No other inorganics exceeded the relevant GACs.

Organics

Benzo(a)pyrene was encountered within one sample of cohesive made ground at a concentration of 2.2mg/kg, marginally exceeding the relevant Stage 1 GAC of 2.1mg/kg. Statistical analysis of the relevant data indicates the corresponding US95 value of 1.48mg/kg for benzo(a)pyrene to be below the Stage 1 GAC. In addition, none of the samples were found to be in exceedance of the Stage 2 GAC of 4.9mg/kg. On this basis, the risk to site end users is considered to be low, not requiring further consideration.

No other organics exceeded the relevant GACs.

Asbestos

No asbestos fibres were detected within the samples tested.

8.0 Conclusions and Recommendations

The materials tested are considered chemically suitable for use as general fill for the proposed development at the site. However, due to the presence of man-made materials such as concrete, metal, timber, etc., the material is not considered to be textually suitable for use in a clean cover layer or growing medium. In addition, the materials are not suitable for a higher performance requirement, for example, such as fill to structures, granular working platforms or as a capping layer below adoptable highways.

Any of the stockpiled materials excavated as part of the preparatory / enabling works, proposed for use on site as general fill, should be processed / screened (as required) to remove oversized materials or any other unsuitable material for example organic materials, timber and items such as carpeting etc. All stockpiled materials, if to be re-used in the works, should have a maximum particle size of 125mm. Oversized hard material should be crushed to generate a suitably graded material for re-use within the works, or alternatively removed from site.

All unsuitable material, including, but not limited to, metal, steel reinforcement, rags, plastic, timber or degradable material should be removed prior to re-use.

The laboratory testing undertaken as part of this investigation was intended to allow an initial assessment of the materials present be made, for either re-use or for disposal off-site. Additional testing, at specific frequencies specified within the Remediation Strategy for the site (report reference C6485/RS, dated July 2016), are likely to be necessary subject to the intended proposals for the stockpiled material.

Should the soils be exported for re-use on another site, then this would need to be undertaken under a CL:AIRE Development Industry Code of Practice Materials Management Plan (MMP); the MMP will need to be declared to CL:AIRE prior to commencement of earthworks.

Vigilance should be maintained during any works associated with the stockpile for currently unknown hotspots of contamination. If any unexpected areas of noxious, odorous, brightly coloured, fibrous, liquid or other suspect contamination are encountered, then these are to be reported and advice sought from a suitably qualified consultant.

It is possible that areas of more significant contamination not previously identified may be encountered within the stockpile during any proposed works. If any areas of potential contamination are encountered, further advice should be sought from a suitably qualified consultant.

Contamination may pose a short-term (acute) or long-term (chronic) risk to workers during construction and maintenance. The potential risks must be specifically assessed as part of the health and safety evaluation for the works to be performed in accordance with prevailing legislation. Site practices must conform to the specific legislative requirements and follow appropriate guidance (e.g., HSE, 1991; CIRIA, 1996).

The classification criteria of soils for disposal are determined by the receiving landfill site. It is therefore recommended that the laboratory test results obtained as part of this investigation are forwarded to appropriate landfill sites in order to confirm the waste classification of any material to be removed from site.

Materials for off-site disposal shall be sampled and analysed, by the relevant contractor, at a frequency sufficient to allow the material to be adequately categorised.

Any materials removed from site should be undertaken in accordance with current Duty of Care requirements and the EA Technical Guidance Document WM3, dated 2015. The waste may also be subject to Waste Acceptance Criteria (WAC) testing. In light of the new regulations it is recommended that discussion with landfill operators takes place at an early stage. A transfer note shall be completed, signed and retained by all parties involved. The transfer note shall state the volume of waste, the nature of the material and statement of its chemical composition. The waste transfer notes shall be kept by the contractor for a period of at least two years.

It is hoped that this report is adequate for your present needs. However, should you require any further information please do not hesitate to contact the office.

Should you have any questions regarding this letter report, please do not hesitate to call.

Yours sincerely

G. Halliday.

Gemma Halliday
Principal Engineer
For and on behalf of Sirius Geotechnical Ltd

Enc.:

Appendix A	Drawings
Appendix B	Exploratory Hole Logs
Appendix C	Volume Calculations
Appendix D	Laboratory Test Results
Appendix E	Sirius Generic Assessment Criteria
Appendix F	Photographs

APPENDIX A

DRAWINGS