Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	SUMMARY. 1.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		26 Jul-00	1 of

Code ref	Calculations	Remarks/output	Checked by Initls and date

1. PLASTIC MOMENT CAPACITIES OF STEEL BEAMS COMPOSITE WITH JACK ARCH CONCRETE HAVE BEEN CALCULATED.

2. MAX. LIVE LOAD SHEAR STRESS HAS BEEN APPLIED TO COMPOSITE SECTION AND LOCAL BOND STRESS IS WITHIN CODE REQUIREMENTS. THEREFORE, PLASTIC CAPACITY OF COMPOSITE SECTIONS APPLIES.

3. ORTHOGONAL GRILLAGE HAS BEEN SET UP IN C:\INTEGER\DATA\CLODDACH1.xgd. GRILLAGE HAS TRANSVERSE MEMBER RELEASES FOR TORSION ONLY IN TRANSVERSE DIRECTION - NO FLEXURE SUSTAINED BY MASS CONCRETE JACK ARCHES - NO TRANSVERSE REINFORCEMENT.

4. INNER BEAM CAPACITY = 193 kNm.
MAX ULS MOMENT = 278 kNm.
C = 0.623
Use BD21/97, FIG 5/4 Lp:
Low HGV traffic flow, Poor road surface.

for K ≤ 0.623,
Assessment Live Loading = 17 tonnes.

No allowance made for corrosion of the 7 steel beams on each span.

Trial holes required to determine concrete characteristic strength and confirm 9" x 7" Inner beams.

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	SUMMARY 2.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		26 Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date
5.	No labour available from DLO until holidays over. Works Order issued. Liaise with John McGhee for availability of specialist cover from DLO. TTRO required for closure. DLO organising this also [redacted] 26/7/00.		
	3 no Cores Taken and inner beam depth confirmed as 9" - 10/8/00 - Work carried out by DLO. - AHF.		

Project	Part of structure/scheme and status	Job ref
Cloddach Bridge	Re-Assessment	

Department	Telephone No	Service	Calculations by	Checked by	Date	Calc sheet no
		Roads	[redacted]		24/05//2000	of

Code ref	Calculations	Remarks/output	Checked by Inits & date
	RESULTS of CLASSIFIED COUNT 50 to 60 per day ∴ Use Figure 5/4 of 21/97		
21/97	cl. 5.29 21/97		
	Flexure K = 0.54 from sht 11 of 13 of Previous 1996 Assessment		
	c'way width = 3.9 m ∴ 1 Notional lane		
	L_e = 6.777 m b_L = 3.9 m = $\bar{a}$		
	∴ New AF = $\frac{3.9}{2.5}$ = 1.56		
	∴ K_{NEW} = K × AF = 0.54 × 1.56 = 0.842.	(F_{cm} = 1.0)	
21/97	clause 3.18 F_{cm} = 0.8. Engineering judgement means that because the seven bridge beams are corroded and the uncorroded section sizes have been used in determining resistance R*, then the conversion factor F_{cm} must be used.		
	∴ $K_{NEW} \times F_{cm}$ = 0.842 × 0.8 = 0.673		
21/97	FIG 5/4, Assessment Live loading flexure = 17 tonnes gvw		
	∴ Weight Restriction = 17 tonnes g v w.		

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	APPLIED LOADING.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date

DETERMINATION OF SUPER STRESS LOAD CASES.

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	APPLIED LOADING.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date

Determine weight of concrete in deck
Use 23 kN/m³ as density - no reinf.
Average depth of concrete = 332 mm

× 23 kN/m³ = 7.636 kN/m² Nom.

Edge members of grillage carry ½ a bay of concrete transversely = 350 m.m.
and one bay longitudinally = 677 m.m

∴ 0.35 × 0.677 × 7.636 = 1.8 kN.
or 2.672 kN/m along longit. member.

Internal grillage member:

carries one bay of concrete = 0.700 m.

∴ SWt = 0.7 × 7.636 = 5.345 kN/m.
longitudinally

Apply these u.d.l's to the seven longit. members to act in flexure - ensures little transverse distribution due to torsional restraints only transversely.

Check
Estimated total SWT concrete

= 7.636 kN/m² × 6.772 m span × 4.2 m width

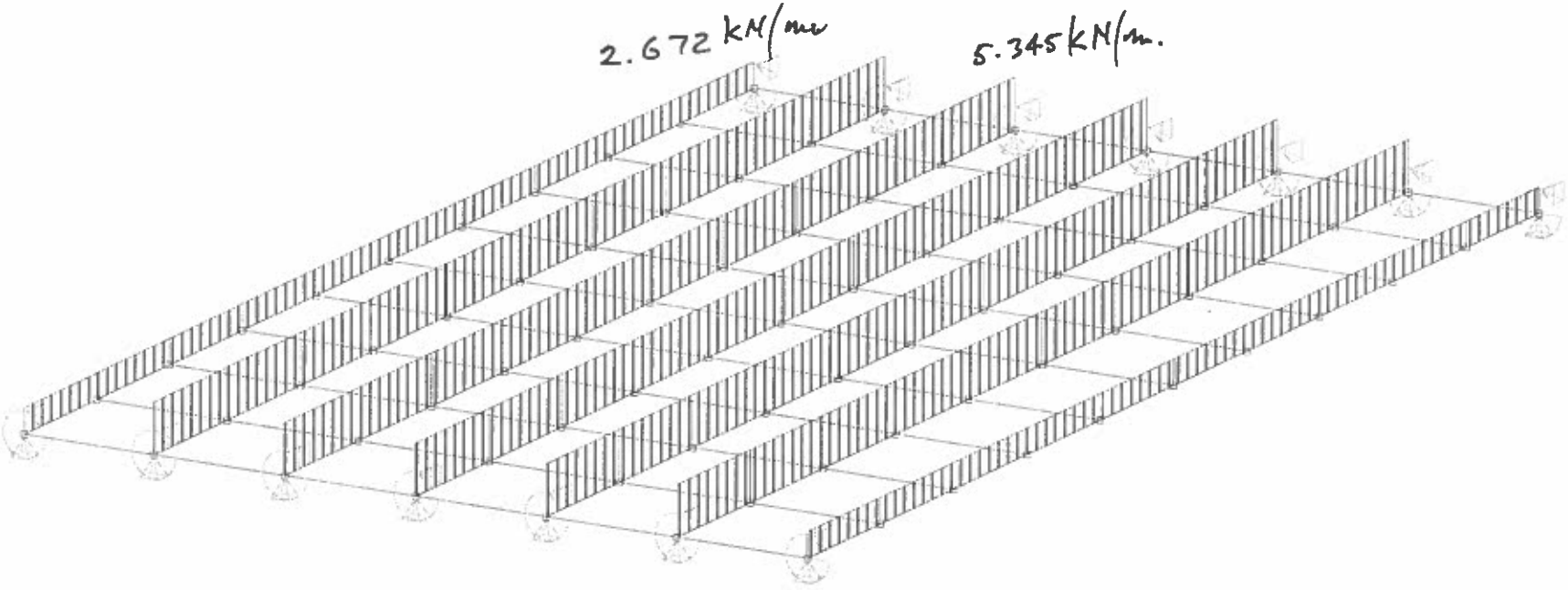
= 217 kN (≈ 22 tonnes).

= Sum of support rxNS for B2 ✓

Self Wt of Steel Beams: B1 Superstruc

Use SWt function of S/Struc and Non-composite Steel Areas.

SELF WEIGHT CONCRETE
Structure 1:32
Point loads 1 mm = 1.000 kN
Distributed loads 1 mm = 0.668 kN/m

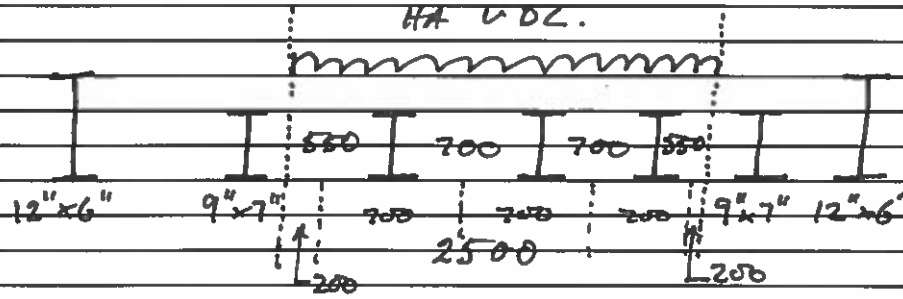


Joint No	Load case	MX (kN.m)	MY (kN.m)	FZ (kN)
1	B2	0.000	0.000	9.057
11	B2	0.000	0.000	9.059
12	B2	0.000	0.000	18.117
22	B2	0.000	0.000	18.122
23	B2	0.000	0.000	18.117
33	B2	0.000	0.000	18.122
34	B2	0.000	0.000	18.117
44	B2	0.000	0.000	18.122
45	B2	0.000	0.000	18.117
55	B2	0.000	0.000	18.122
56	B2	0.000	0.000	18.117
66	B2	0.000	0.000	18.122
67	B2	0.000	0.000	9.057
77	B2	0.000	0.000	9.059

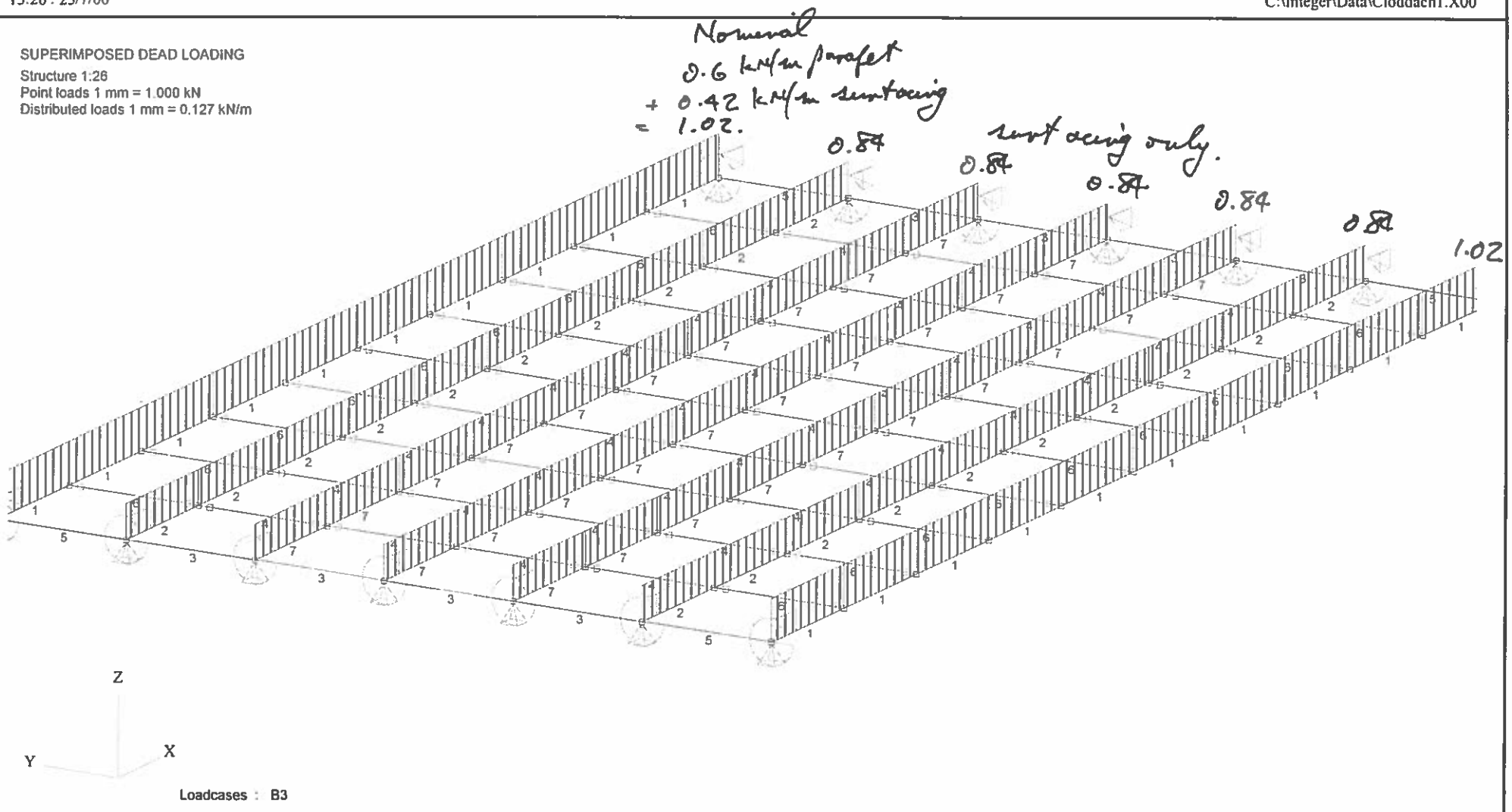
217 kN.

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	SDL + HA Loading.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		25-Jul-00	of

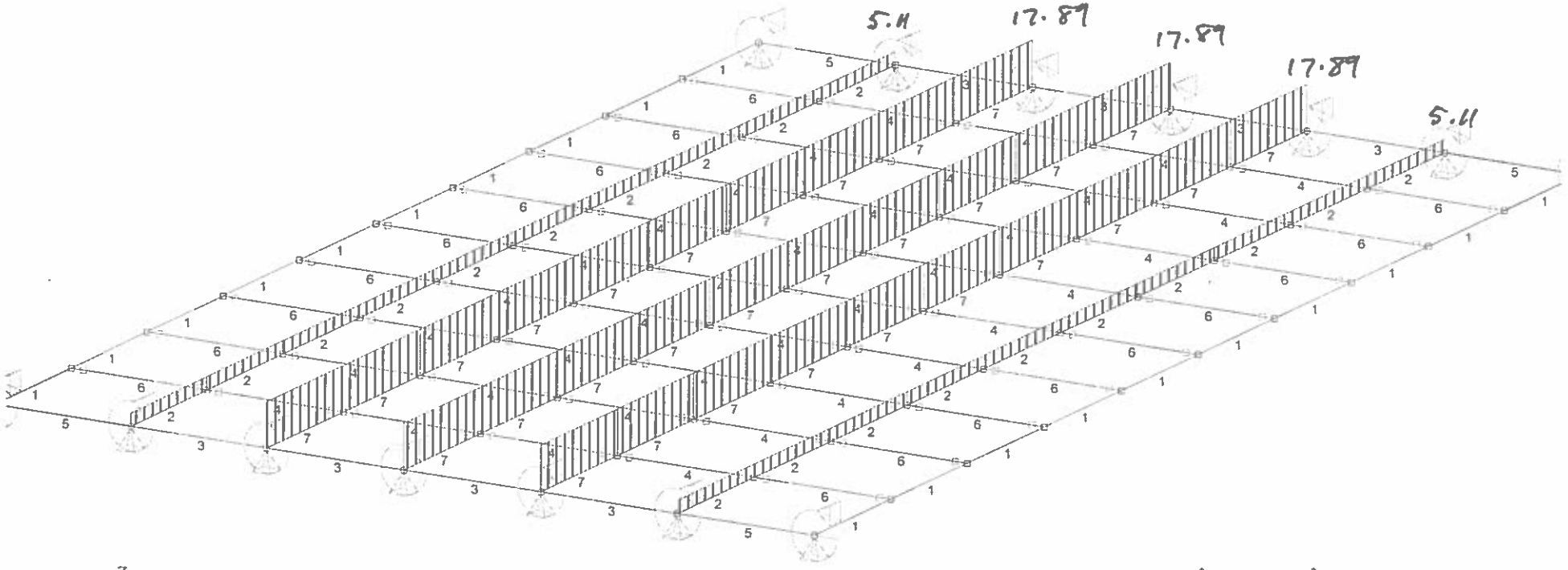
Code ref	Calculations	Remarks/output	Checked by Initls and date
BD21	BLACKTOP $\gamma_{f1} = 1.75$ $\gamma_{f3} = 1.1$		
	Thickness of surfacing = 50 mm		
	Density = 24 kN/m³		
	∴ Loading = 1.2 kN/m².	SDC	
	Edge beams with 350 mm bays = 0.42 kN/m	0.42 kN/m	
	Inner grillage beams, 700 mm bays = 0.84 kN/m.	0.84 kN/m.	
	Check Total Nominal SDC Load = 24 kN/m³ × 50 mm × 6.77 m span × 4.2 m width		
	= 34 kN ≈ 3½ tonnes.		
	∴ ULS SDL = 34 × 1.75 × 1.1 = 65.7 kN (6½ tonnes)		
	Parapet SDC – assume 0.6 kN/m nominal. on edge beams – no distribution to inner beams.		
	HA LOADING $W = 336\left(\frac{1}{6.77}\right)^{0.67}$		
	W = 93.3 kN/m per 3.65 m lane.		
	HA udl = 93.3 kN/m.		
	AF = $\frac{3.65}{2.5}$ = 1.46		
	∴ Adjusted HA = $\frac{93.3}{1.46}$ = 63.9 kN/m per 2.5 m lane width.		
	= 25.56 kN/m² over worst 2.5 m width.		
		HA Loading.	
	∴ 3 Inner beams take 25.56 kN/m² × 0.7m =	17.89 kN/m	
	2 1st Inner beams take 25.56 kN/m² × 0.2m =	5.11 kN/m	

SUPERIMPOSED DEAD LOADING
Structure 1:26
Point loads 1 mm = 1.000 kN
Distributed loads 1 mm = 0.127 kN/m



NOMINAL HA LOADING
Structure 1:26
Point loads 1 mm = 1.000 kN
Distributed loads 1 mm = 2.236 kN/m

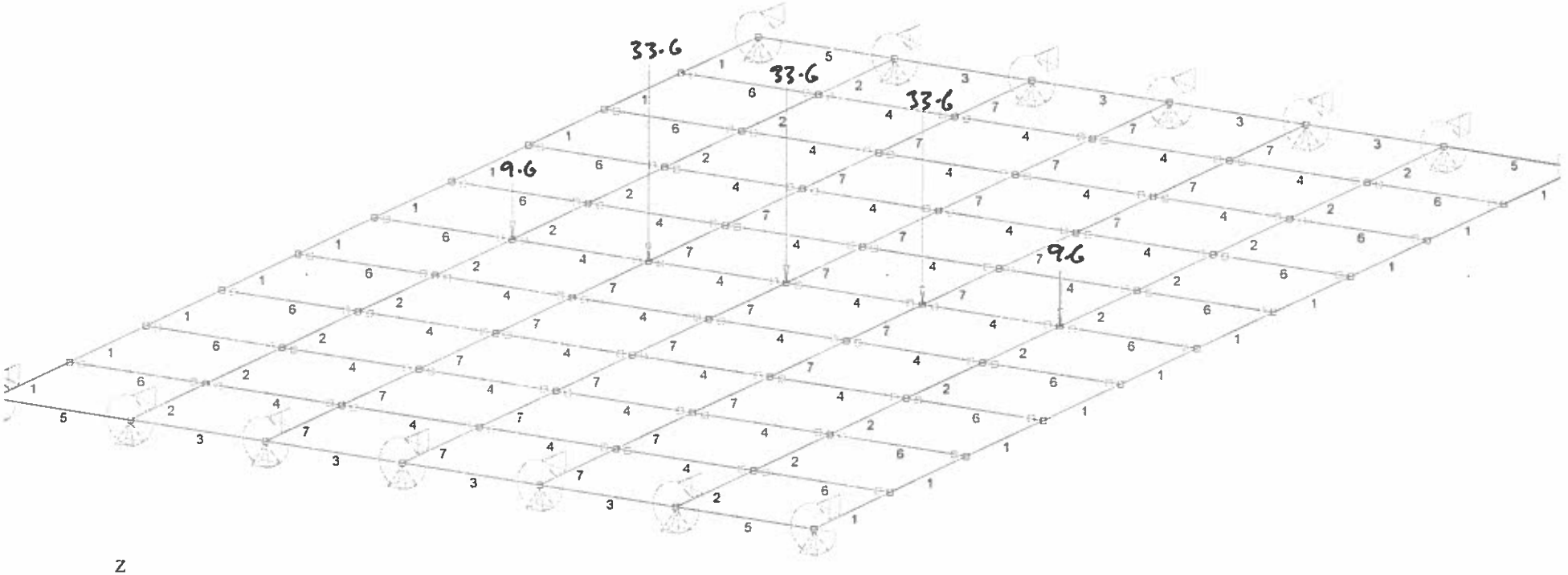
Nom HA



Central Location of Lane

Loadcases : B4

NOMINAL HA KEL LOADING AT MIDSPAN
Structure 1:26
Point loads 1 mm = 1.000 kN



Loadcases : B5

Basic Loadcase 3 : Nom Surfacing & parapets (Contd)
Data last edited at 12:04 on 10/7/00

Units : P(kN) , (kN.m) W(kN/m) , (kN.m/m) D(mm) R(deg) t(deg C) L (m)

Entry No	Load type	Joint/ member	Axes	Act.	P,D,W,Wa R,L,t,F,e	Wb	L,La (m)	Lb (m)
279	MU	59	G	FZ	-0.840		0.000	0.678
280	MU	60	G	FZ	-0.840		0.000	0.678

Basic Loadcase 4 : Nom HA Loading
Data last edited at 12:04 on 10/7/00

Units : P(kN) , (kN.m) W(kN/m) , (kN.m/m) D(mm) R(deg) t(deg C) L (m)

Entry No	Load type	Joint/ member	Axes	Act.	P,D,W,Wa R,L,t,F,e	Wb	L,La (m)	Lb (m)
281	MU	21	G	FZ	-17.890		0.000	0.677
282	MU	22	G	FZ	-17.890		0.000	0.677
283	MU	23	G	FZ	-17.890		0.000	0.677
284	MU	24	G	FZ	-17.890		0.000	0.677
285	MU	25	G	FZ	-17.890		0.000	0.677
286	MU	26	G	FZ	-17.890		0.000	0.677
287	MU	27	G	FZ	-17.890		0.000	0.677
288	MU	28	G	FZ	-17.890		0.000	0.677
289	MU	29	G	FZ	-17.890		0.000	0.677
290	MU	30	G	FZ	-17.890		0.000	0.677
291	MU	31	G	FZ	-17.890		0.000	0.677
292	MU	32	G	FZ	-17.890		0.000	0.677
293	MU	33	G	FZ	-17.890		0.000	0.677
294	MU	34	G	FZ	-17.890		0.000	0.677
295	MU	35	G	FZ	-17.890		0.000	0.677
296	MU	36	G	FZ	-17.890		0.000	0.677
297	MU	37	G	FZ	-17.890		0.000	0.677
298	MU	38	G	FZ	-17.890		0.000	0.677
299	MU	39	G	FZ	-17.890		0.000	0.677
300	MU	40	G	FZ	-17.890		0.000	0.677
301	MU	41	G	FZ	-17.890		0.000	0.677
302	MU	42	G	FZ	-17.890		0.000	0.677
303	MU	43	G	FZ	-17.890		0.000	0.677
304	MU	44	G	FZ	-17.890		0.000	0.677
305	MU	45	G	FZ	-17.890		0.000	0.677
306	MU	46	G	FZ	-17.890		0.000	0.677
307	MU	47	G	FZ	-17.890		0.000	0.677
308	MU	48	G	FZ	-17.890		0.000	0.677
309	MU	49	G	FZ	-17.890		0.000	0.677
310	MU	50	G	FZ	-17.890		0.000	0.677
311	MU	11	G	FZ	-5.110		0.000	0.677
312	MU	12	G	FZ	-5.110		0.000	0.677
313	MU	13	G	FZ	-5.110		0.000	0.677
314	MU	14	G	FZ	-5.110		0.000	0.677
315	MU	15	G	FZ	-5.110		0.000	0.677
316	MU	16	G	FZ	-5.110		0.000	0.677
317	MU	17	G	FZ	-5.110		0.000	0.677
318	MU	18	G	FZ	-5.110		0.000	0.677
319	MU	19	G	FZ	-5.110		0.000	0.677
320	MU	20	G	FZ	-5.110		0.000	0.677
321	MU	51	G	FZ	-5.110		0.000	0.677
322	MU	52	G	FZ	-5.110		0.000	0.677
323	MU	53	G	FZ	-5.110		0.000	0.677
324	MU	54	G	FZ	-5.110		0.000	0.677
325	MU	55	G	FZ	-5.110		0.000	0.677
326	MU	56	G	FZ	-5.110		0.000	0.677

Basic Loadcase 4 : Nom HA Loading (Contd)
Data last edited at 12:04 on 10/7/00

Units : P(kN) , (kN.m) W(kN/m) , (kN.m/m) D(mm) R(deg) t(deg C) L (m)

Entry No	Load type	Joint/ member	Axes	Act.	P,D,W,Wa R,L,t,F,e	Wb	L,La (m)	Lb (m)
327	MU	57	G	FZ	-5.110		0.000	0.677
328	MU	58	G	FZ	-5.110		0.000	0.677
329	MU	59	G	FZ	-5.110		0.000	0.677
330	MU	60	G	FZ	-5.110		0.000	0.677

Basic Loadcase 5 : Nom KEL midspan
Data last edited at 12:04 on 10/7/00

Units : P(kN) , (kN.m) W(kN/m) , (kN.m/m) D(mm) R(deg) t(deg C) L (m)

Entry No	Load type	Joint/ member	Axes	Act.	P,D,W,Wa R,L,t,F,e	Wb	L,La (m)	Lb (m)
332	J	17		FZ	-9.600			
333	J	28		FZ	-33.600			
334	J	39		FZ	-33.600			
335	J	50		FZ	-33.600			
336	J	61		FZ	-9.600			

Basic Loadcase 6 : Nom KEL supports
Data last edited at 12:04 on 10/7/00

Units : P(kN) , (kN.m) W(kN/m) , (kN.m/m) D(mm) R(deg) t(deg C) L (m)

Entry No	Load type	Joint/ member	Axes	Act.	P,D,W,Wa R,L,t,F,e	Wb	L,La (m)	Lb (m)
337	J	13		FZ	-9.600			
338	J	24		FZ	-33.600			
339	J	35		FZ	-33.600			
340	J	46		FZ	-33.600			
341	J	57		FZ	-9.600			

Combination Loadcase 1 : ULS Load Combination 1
Data last edited at 12:04 on 10/7/00

Entry no	Loadcase reference	Load Factor
1	B1	1.155
2	B2	1.265
3	B3	1.925
4	B4	1.650
5	B5	1.650

Combination Loadcase 2 : ULS Live Load only
Data last edited at 12:04 on 10/7/00

Entry no	Loadcase reference	Load Factor
6	B4	1.650
7	B5	1.650

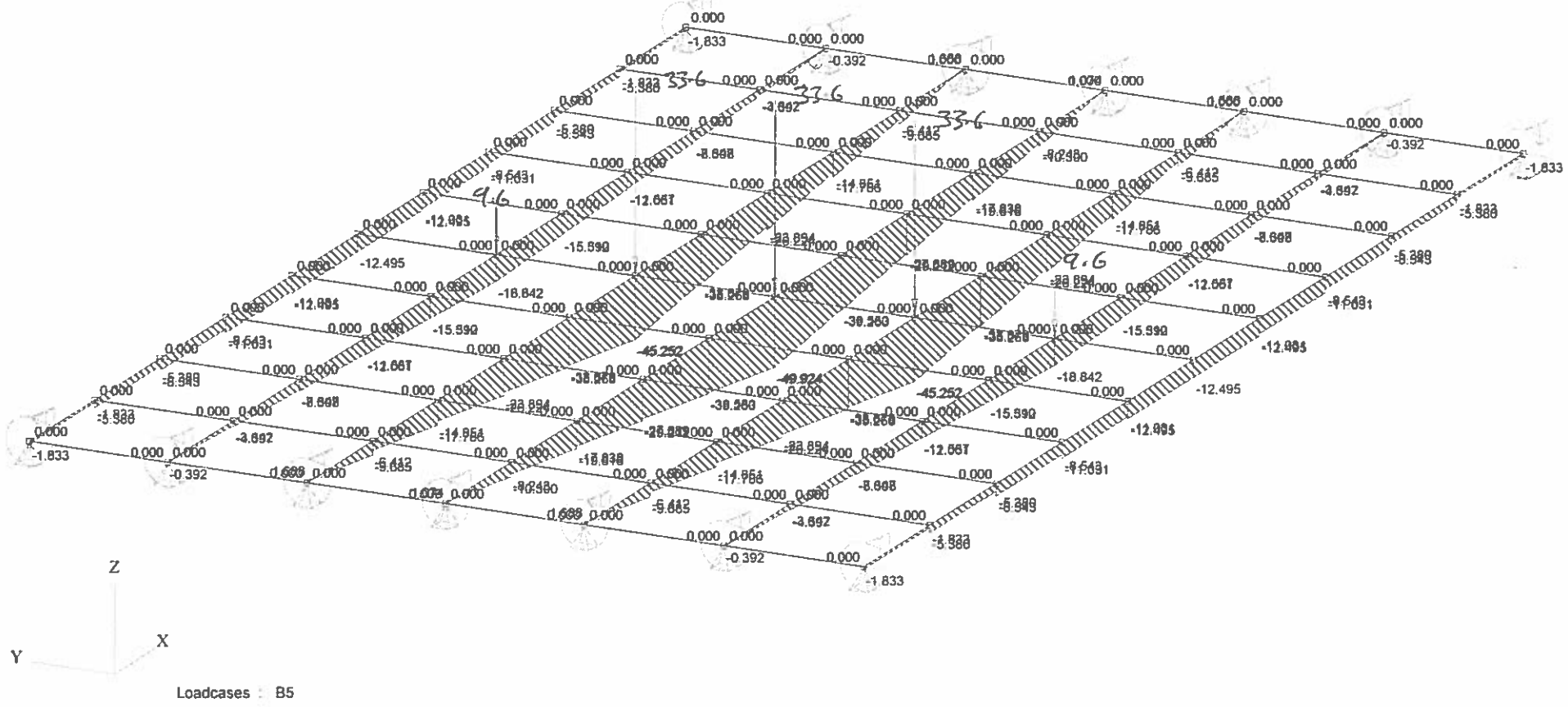
Combination Loadcase 3 : SLS Live Load Max Moment
Data last edited at 12:04 on 10/7/00

Entry no	Loadcase reference	Load Factor
8	B4	1.200
9	B5	1.200

Combination Loadcase 4 : SLS Live Load Max Shear
Data last edited at 12:04 on 10/7/00

Entry no	Loadcase reference	Load Factor
10	B4	1.200
11	B6	1.200

BMD DUE TO MIDSPAN KEL
Structure 1.28
Point loads 1 mm = 1.000 kN
Distributed loads 1 mm = 2.000 kN/m
Moments 1 mm = 4.160 kN.m

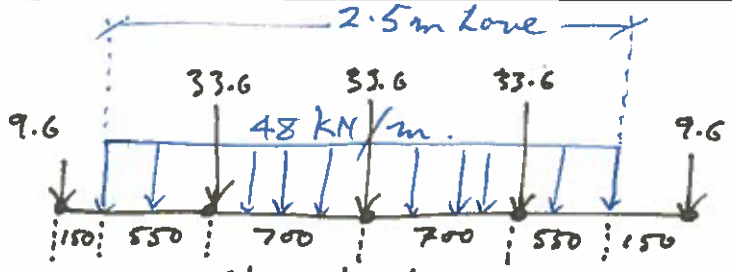


Loadcases : B5

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	NOM. HA KEL MIDSPAM.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		25-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date



120 kN Nom. kel

B5 Superstress Basic Load Case.

Combination 1

		γ_{f1}	γ_{f3}	Σ
B1 Steel SWt	Nom	1.05	1.1	1.15
B2 Concrete SWt	Nom	1.15	1.1	1.265
B3 Surfacing SWt	Nom	1.75	1.1	1.925
B4 HA ual	Nom	1.5	1.1	1.65
B5 HA kel	Nom	1.5	1.1	1.65.

Find maximum shear by applying kel near supports in order to determine shear flow then max. local bond stress acc. to BDG1/96. cl. 8.5.1.

BDG1/96/8.5.1

Use SLS Load Combination C4 in SuperStress:

Nom HA Loading × γ_{f3} 1.2 ✱

Nom HA kel × γ_{f3} 1.2 ✱

Webs of Steel beams take all DL + SDL shear. Concrete takes LL shear to bond stress only based upon LL.

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE		.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date

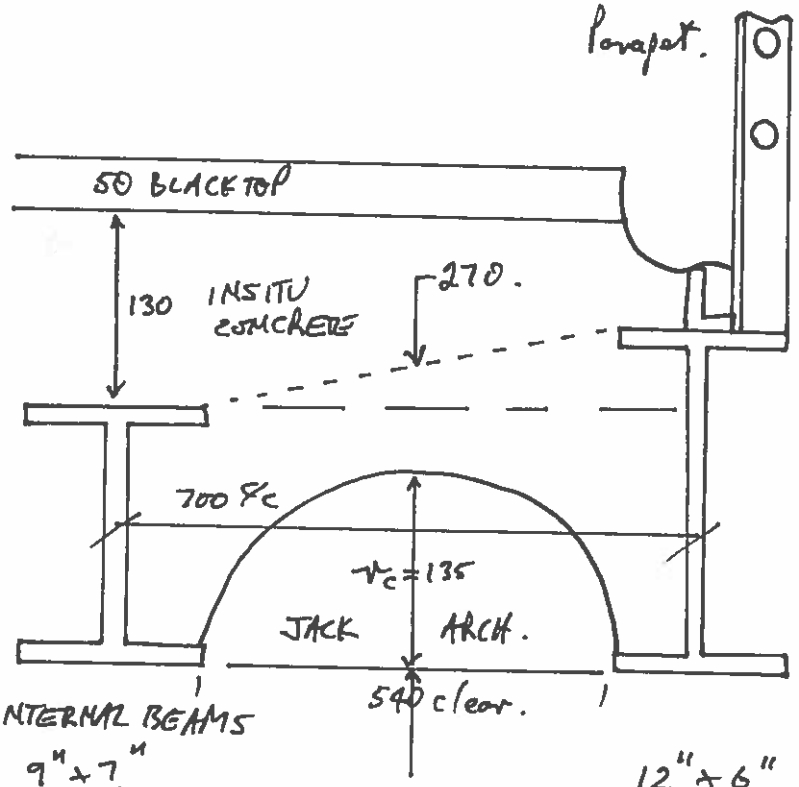
GRILLAGE

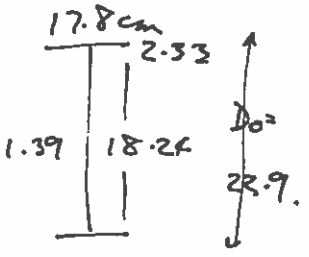
CONSTRUCTION.

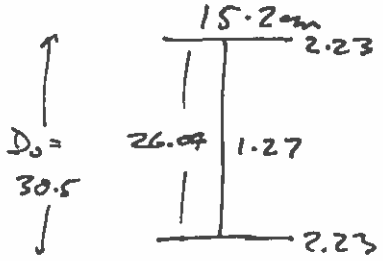
Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	EDGE JACK ARCH DETAILS.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Units and date







$\Sigma k B C^3 = 166.3 cm^4$ $\quad \Sigma k B C^3 = 130 cm^4$

$$\alpha_{es} = \frac{E_s}{E_c} = \frac{205}{24.05} = \underline{8.52.}$$

BD44

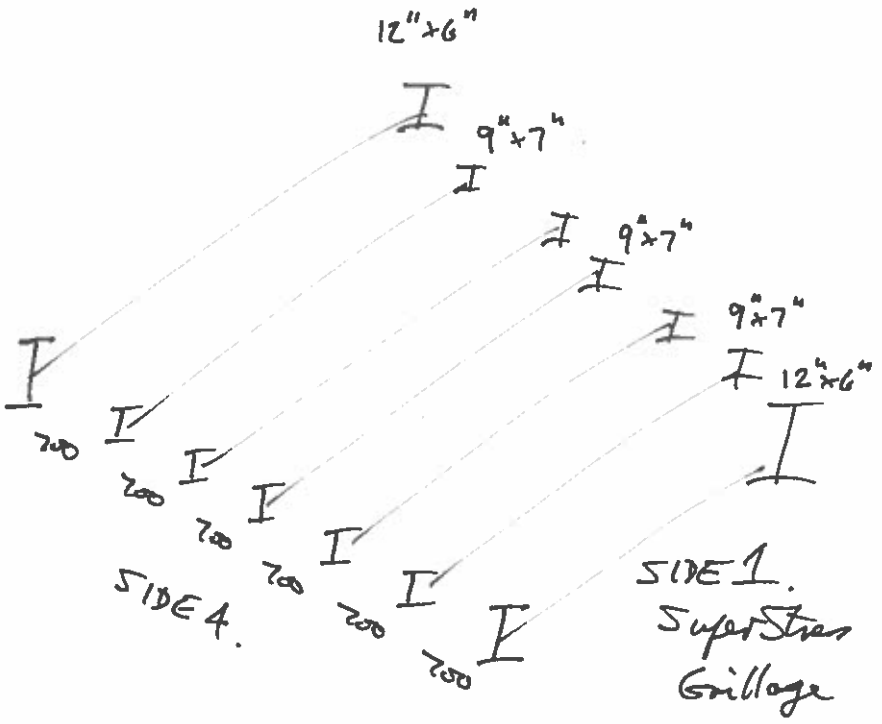
$E_c = 20 + 0.27 f_{cu}$, assume $f_{cu} = 15 N/mm^2$

$= 24.05 kN/mm^2$

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	Superstress Grillage Constr.	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date



Ratio of transverse grillage beams & longitudinal beams = 1.5 : 1 and total no. of transverse beams to be odd.

So 7 longit. beams ⇒ 11 transverse beams.

Width deck = 4.2m. Span = 6.772 m.

∴ Span/width Ratio = 1.61.

∴ 11 ok.

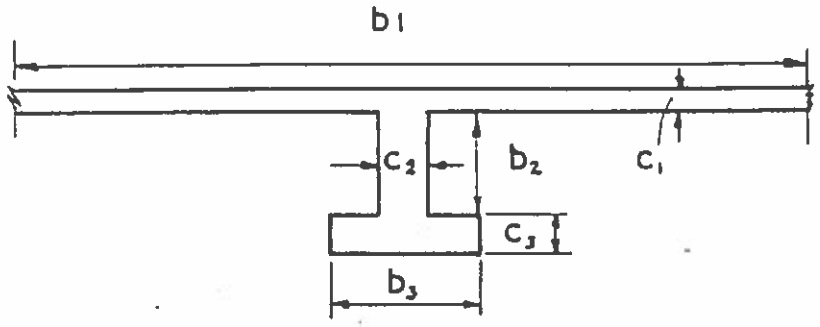
∴ 10 transverse BAYS @ 0.6772 m.

& 6 longit. BAYS @ 0.700 m.

FREE TORSION

(All Sections Free to Warp)

I OPEN GRILLAGE



Torsional stiffness = $G \xi k_1 bc^3$

Shear stress $T = kc\Theta G$

$$\Theta = \frac{Mt}{G \xi k_1 bc^3}$$

$$T = \frac{Mt\,c}{\xi k_2 bc^3}$$

SYMBOLS

$k, k_1, \& k_2$. Constants given below.

b is greater dimension of part considered.

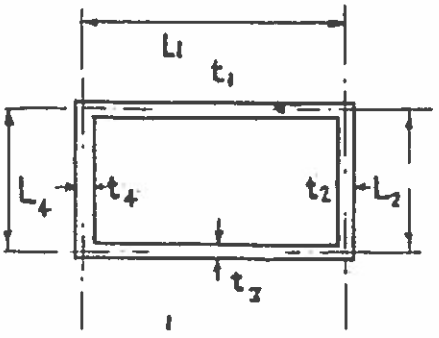
c is lesser dimension of part considered.

Θ = Twist per unit length

Mt = Torque

b/c	1.0	1.2	1.5	2.0	2.5	3	4	5	10	∞
k	0.675	.759	.848	.930	.968	.985	.997	.999	1.00	1.00
k_1	.1406	.166	.196	.229	.249	.263	.281	.291	.312	.333
k_2	.208	.219	.231	.246	.258	.267	.282	.291	.312	.333

II THIN WALLED CLOSED BOX



Torsional Stiffness $4A^2G/\xi\, L/t$.

A = Mean of areas enclosed by inner & outer boundaries

Shear Stress $T = 2G\Theta A / t \xi\, L/t$

$$\Theta = \frac{Mt \xi L/t}{4A^2G}$$

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	EDGE TRANSVERSE STIFFENERS.	.

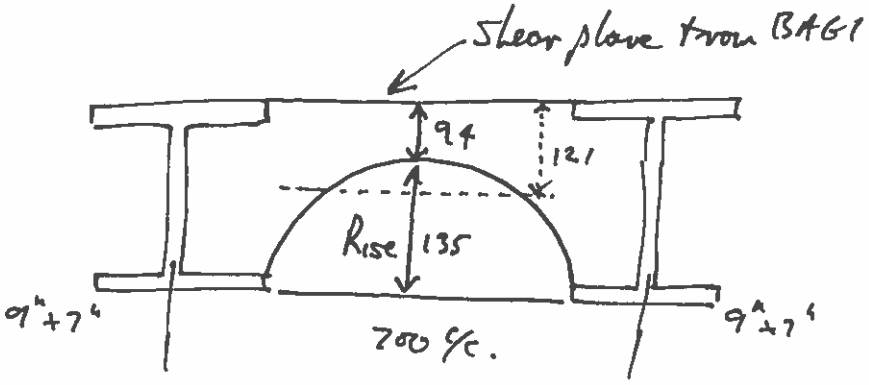
Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date
BA61 8.14	Torsional stiffness to be based upon vertical distance between flanges of steel beams: different heights of steel beams, therefore average ht. of concrete taken to be 135 mm.		
	∴ Diaphragm $J = \frac{33.8 \times 16.2^3}{6 \times 8.52} = 2811\ cm^4$	2811 cm^4	
	$A = \frac{33.8 \times 16.2}{8.52} = 64.2\ cm^2$	64.2 cm^2	
	Span $J = \frac{67.7 \times 16.2^3}{6 \times 8.52} = 5630\ cm^4$	5630 cm^4	
	$A = 128.7\ cm^2$	128.7 cm^2	
	J is represented by I_x in Superstress.		
	I_{NA} " " " I_y " " .		
	Use nominal $I_y = 0.01\ cm^4$ so pure torsion and no flexure in transverse elements. Insert member releases transversely to ensure no transverse bending moments are possible.		

Project	Part of structure/scheme and status	Job ref
CLODDACH BRIDGE	FOUR INNER TRANSVERSE JACK ARCHES.	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date



Depth of concrete to use = $94 + \frac{1}{5} + 135$

$= 121$ mm.

∴ Diaphragm Jack Arch $J = \frac{33.8 \times 12.1^3}{6 + 8.52_{dec}} = 1171\ cm^4$ — 1171 cm^4

$A = \frac{33.8 \times 12.1}{8.52} = 48\ cm^2$ — 48 cm^2

& Span Jack Arch $J = \frac{67.7 \times 12.1^3}{6 + 8.52} = 2346\ cm^4$ — 2346 cm^4

$A = \frac{67.7 \times 12.1}{8.52} = 96\ cm^2$ — 96 cm^2.

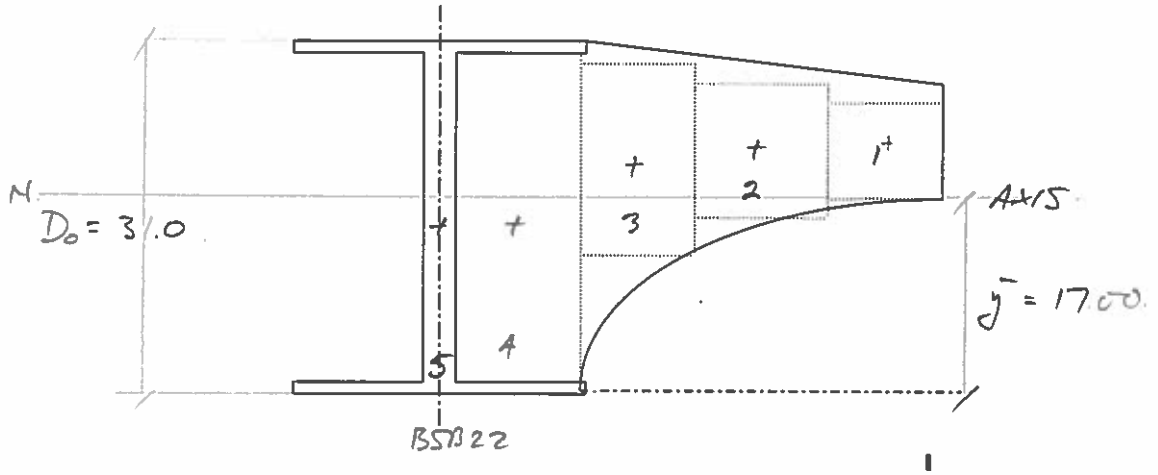
Determine Composite Longitudinal Member Inertias or Second Moments of Area = I_y in Superstruc.

Use Steel Areas only for A_x in Superstruc so A_x can be used for steel self-weight.

Project	Part of structure/scheme and status	Job ref
CLODDACH	Gross Section Elastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24/7/00.	of

Code ref	Calculations	Remarks/output	Checked by Initials and date
BA 61/96	LONGITUDINAL EDGE MEMBER OF GALLERY.		



	Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)	h (cm)	Ah^2 (cm^4)	Icg (cm^4)	I_{NA} (cm^4)
	1	9.00	13.50	0.117	23.85	14.22	339.04	-6.85	667.59	215.90	883.49
	2	9.00	18.60	0.117	20.70	19.59	405.43	-3.70	268.55	564.66	833.21
	3	9.00	23.70	0.117	17.55	24.96	437.98	-0.55	7.63	1168.13	1175.76
	4	6.50	26.60	0.117	15.50	20.23	313.55	1.50	45.34	1192.79	1238.13
BSB 22	5	---	31.00	1.00	15.50	102.50	1588.75	1.50	229.74	15633.00	15862.74
		composite area =				181.49	3084.75			19993.32

Height to NA = $\Sigma A\psi/\Sigma A$ = 17.00

= I_y in Superstress

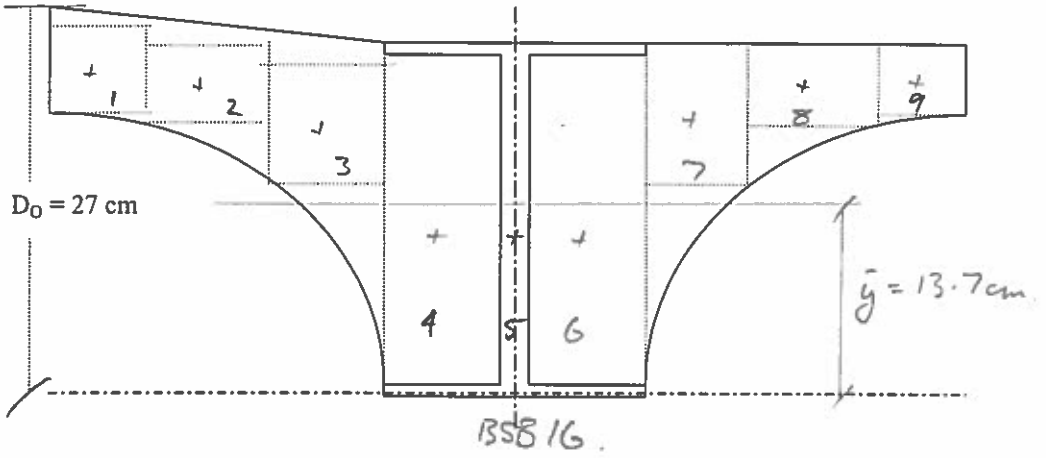
Area steel = 102.5 cm^2 → 5/5bars.

S/STRESS: COMPOSITE LONGITUDINAL EDGE BEAM. INPUT

Project	Part of structure/scheme and status	Job ref
CLODDACH	Gross Section Elastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		24/7/06	of

Code ref	Calculations	Remarks/output	Checked by Inits and date
BA 61/96	LONGITUDINAL 1ST INNER BEAMS FOR GRILLAGE.		



D = 27 cm

Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)	h (cm)	Ah^2 (cm^4)	Icg (cm^4)	I_{NA} (cm^4)
1	9.00	9.40	0.117	22.30	9.90	220.73	-8.57	726.70	72.88	799.58
2	9.00	13.90	0.117	20.05	14.64	293.47	-6.32	584.32	235.66	819.99
3	9.00	18.40	0.117	17.80	19.38	344.88	-4.07	320.69	546.64	867.33
4	8.20	18.24	0.117	11.45	17.50	200.37	2.28	91.10	485.17	576.27
BSB 16 5	—	22.90	1.00	11.45	110.60	1266.37	2.28	575.76	9560.00	10135.76
6	8.20	18.24	0.117	11.45	17.50	200.37	2.28	91.10	485.17	576.27
7	9.00	18.40	0.117	13.70	19.38	265.44	0.03	0.02	546.64	546.66
8	9.00	13.90	0.117	15.95	14.64	233.46	-2.22	72.03	235.66	307.69
9	9.00	9.40	0.117	18.20	9.90	180.15	-4.47	197.63	72.88	270.51
					composite area. 233.42	3205.22				14900.06

Height to NA = $\Sigma A\psi/\Sigma A$ = 13.73

= I_y in Superstress

Area steel = 110.6 cm^2 → 5/Stress

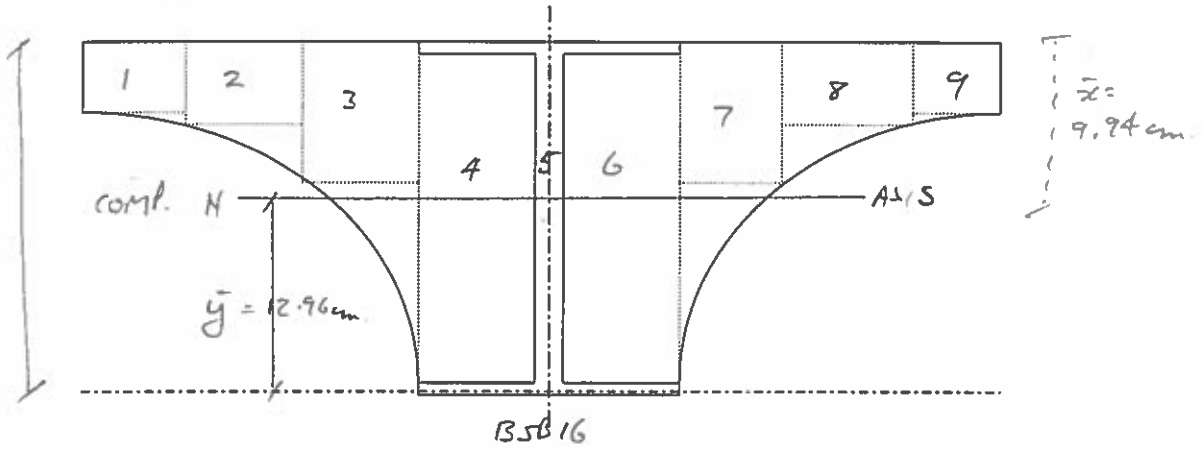
SUPERSTRESS: COMPOSITE LONGITUDINAL 1ST INNER BEAM

INPUT

Project	Part of structure/scheme and status	Job ref
CLODDACH	Gross Section Elastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		29/7/00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date
BA 61/96	LONGITUDINAL INNER BEAMS FOR GRILLAGE		



	Ref	B (cm)	D (cm)	M	y (cm)	A (cm²)	Ay (cm³)	h (cm)	Ah² (cm⁴)	Icg (cm⁴)	I_{NA} (cm⁴)
	1	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
	2	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	3	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	4	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
BSB 16	5	---	22.90	1.00	11.45	110.60	1266.37	1.51	252.30	9560.00	9812.30
	6	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
	7	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	8	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	9	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
						233.42	3025.19				13399.18

Height to NA = $\Sigma A\psi/\Sigma A$ = 12.96

= I_y cm

S/Stress.

Area steel = 110.6 cm² → S/Stress.

S/STRESS : COMPOSITE INTERMIT BEAMS INPUT

Moray Council

ASSESSMENT BD21/97
CLODDACH BRIDGE

Page : 1
Made by : [redacted]
Date : 3/6/00
Job No. :
Checked by :

13:49 : 5/6/00

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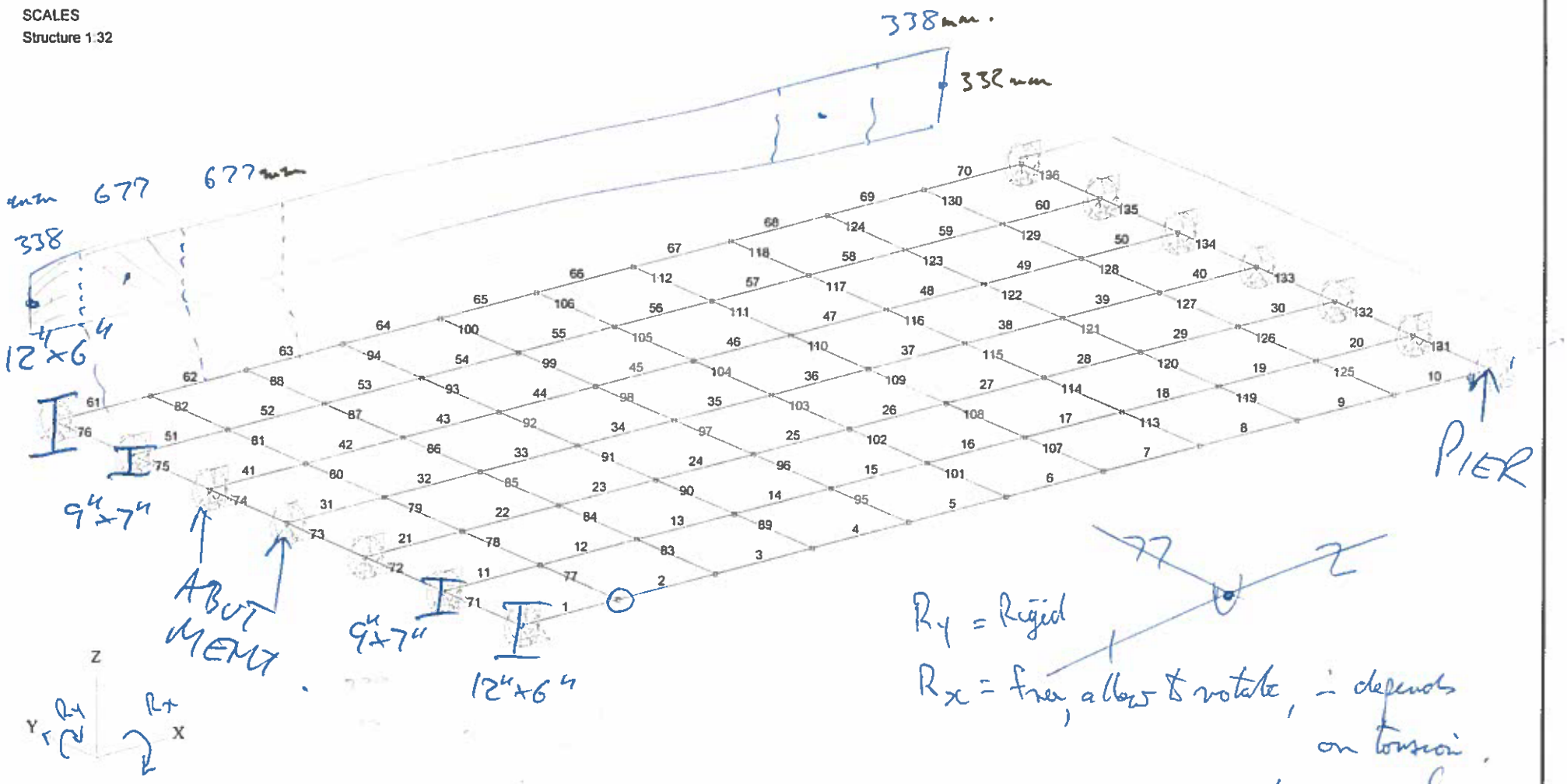
SCALES
Structure 1:32



Sections
Data last edited at 15:34 on 4/7/00

Section 1 : COMP LONG EDGE : General

Ax = 102.45 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 130.00 cm4	Iy = 19993.32 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

Section 2 : COMP 1ST INNER LONG INT : General

Ax = 110.06 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 166.26 cm4	Iy = 14900.06 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

Section 3 : INNER TRANS END DIAPHR : General

Ax = 48.00 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 1171.00 cm4	Iy = 0.01 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

Section 4 : INNER TRANS JACK ARCH : General

Ax = 96.00 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 2346.00 cm4	Iy = 0.01 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

Section 5 : EDGE TRANS DIAPHR : General

Ax = 64.20 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 2811.00 cm4	Iy = 0.01 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

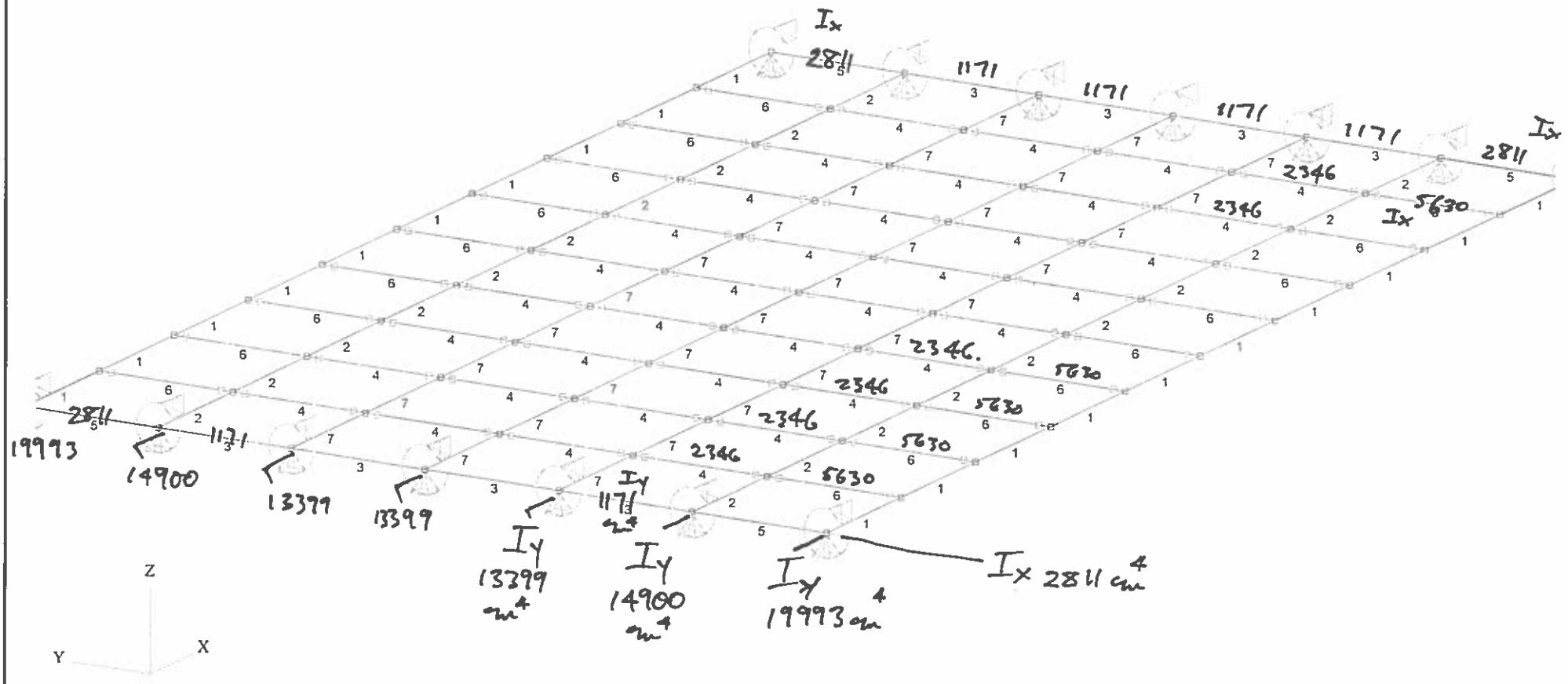
Section 6 : EDGE TRANS JACK ARCH : General

Ax = 128.70 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 5630.00 cm4	Iy = 0.01 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

Section 7 : COMP INTERNAL BEAMS : General

Ax = 110.06 cm2	Az = 0.00 cm2	Ay = 0.00 cm2
Ix = 0.01 cm4	Iy = 13399.18 cm4	Iz = 0.00 cm4
	Cz = 0.0 mm	Cy = 0.0 mm

SECTION NUMBERS
Structure 1:26



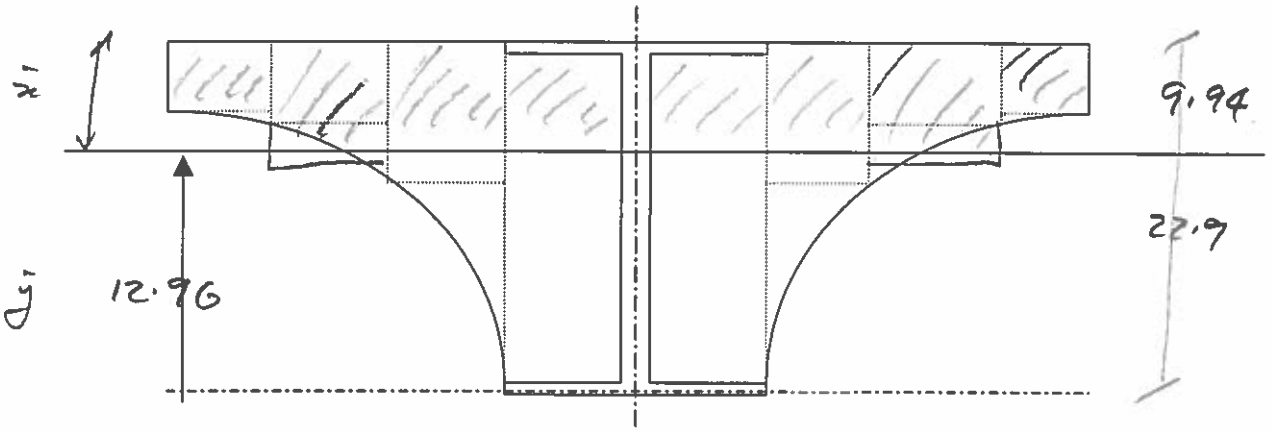
integer

Project	Part of structure/scheme and status	Job ref
CLODDACH	Gross Section Elastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]			of

Code ref	Calculations	Remarks/output	Checked by Initls and date

BA 61/96



	Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)	h (cm)	Ah^2 (cm^4)	Icg (cm^4)	I_{NA} (cm^4)
	1	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
	2	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	3	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	4	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
BSB 16	5	---	22.90	1.00	11.45	110.60	1266.37	1.51	252.30	9560.00	9812.30
	6	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
	7	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	8	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	9	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
						233.42	3025.19				13399.18

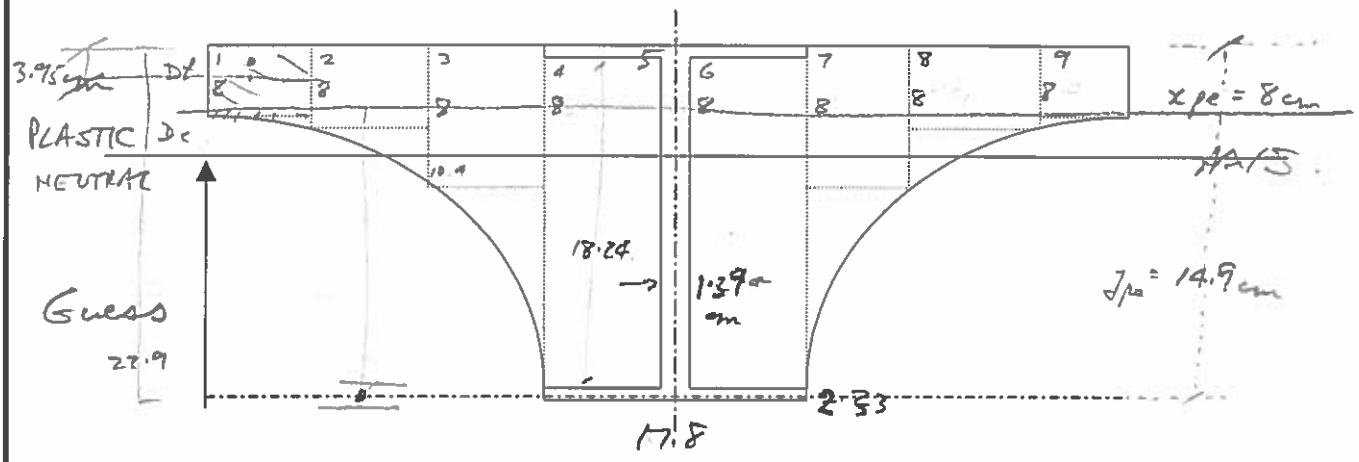
Height to NA = ΣAy/ΣA = 12.96 cm.

Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)	h (cm)	Ah^2 (cm^4)	Icg (cm^4)	I_{NA} (cm^4)
1	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
2	9.00	12.96	0.117	16.42	13.65	224.09	-3.46	163.33	191.03	354.36
3	9.00	12.96	0.117	16.42	13.65	224.09	-3.46	163.33	191.03	354.36
4	8.20	12.96	0.117	11.45	12.43	142.37	1.51	28.36	174.05	202.41
		22.90								
6	8.20	12.96	0.117	11.45	12.43	142.37	1.51	28.36	174.05	202.41
7	9.00	12.96	0.117	16.42	13.65	224.09	-3.46	163.33	191.03	354.36
8	9.00	12.96	0.117	16.42	13.65	224.09	-3.46	163.33	191.03	354.36
9	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63

Project	Part of structure/scheme and status	Job ref
CLODDACH	Gross Section Elastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]			of

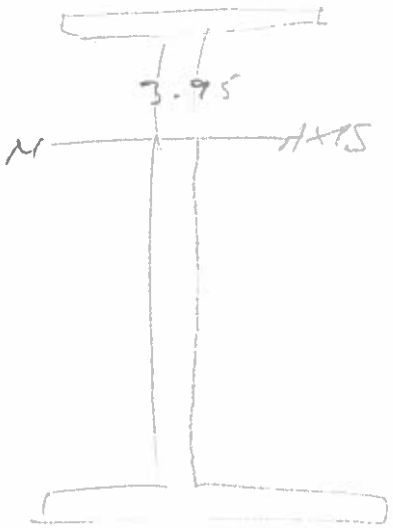
Code ref	Calculations	Remarks/output	Checked by Initls and date
BA 61/96			

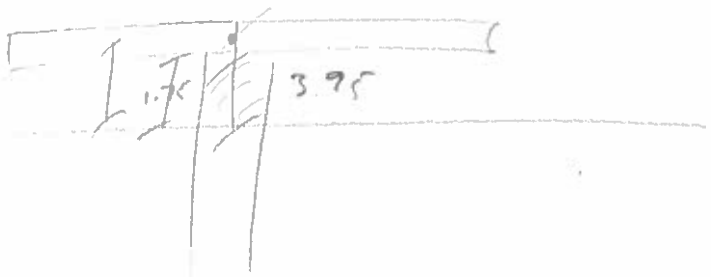


	Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)	h (cm)	Ah^2 (cm^4)	Icg (cm^4)	I_{NA} (cm^4)
	1	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
	2	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	3	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	4	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
BSB 16	5	---	22.90	1.00	11.45	110.60	1266.37	1.51	252.30	9560.00	9812.30
	6	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
	7	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	8	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	9	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
						233.42	3025.19				13399.18
	Height to NA = $\Sigma A\psi/\Sigma A$ =					12.96		-13.41			

$N/mm^2 \times A\,cm^2 = kN$

$N/mm^2 \times \frac{100A\,mm^2}{1000} = N$



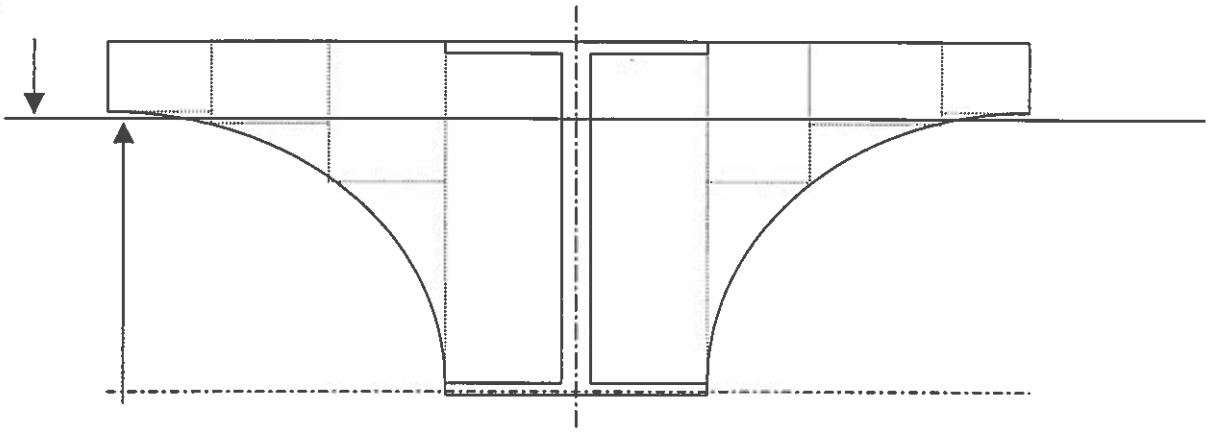


Project	Part of structure/scheme and status	Job ref
CLODDACH	Gross Section Elastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]			of

Code ref	Calculations	Remarks/output	Checked by (initials and date)
BA 61/96			

5.3.1



	Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)	h (cm)	Ah^2 (cm^4)	Icg (cm^4)	I_{NA} (cm^4)
	1	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
	2	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	3	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	4	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
BSB 16	5	---	22.90	1.00	11.45	110.60	1266.37	1.51	252.30	9560.00	9812.30
	6	8.20	18.24	0.117	11.45	17.50	200.37	1.51	39.92	485.17	525.09
	7	9.00	18.40	0.117	13.70	19.38	265.44	-0.74	10.60	546.64	557.24
	8	9.00	13.90	0.117	15.95	14.64	233.46	-2.99	130.82	235.66	366.49
	9	9.00	9.40	0.117	18.20	9.90	180.15	-5.24	271.74	72.88	344.63
						233.42	3025.19				13399.18 = I

Height to NA = ΣAy/ΣA = **12.96** **= Y BAR** **X BAR =** **9.94** **CM**

COMPOSITE

	Ref	B (cm)	D (cm)	M	y (cm)	A (cm^2)	Ay (cm^3)
	1	9.00	9.40	0.117	4.97	9.90	49.19
	2	9.00	9.94	0.117	4.97	10.47	52.02
	3	9.00	9.94	0.117	4.97	10.47	52.02
	4	8.20	9.94	0.117	4.97	9.54	47.39
BSB 16	5		22.90				
	6	8.20	9.94	0.117	4.97	9.54	47.39
	7	9.00	9.94	0.117	4.97	10.47	52.02
	8	9.00	9.94	0.117	4.97	10.47	52.02
	9	9.00	9.40	0.117	4.97	9.90	49.19
	Transformed area of concrete in compression =					**80.73**	**401.24** = $A\bar{y}$

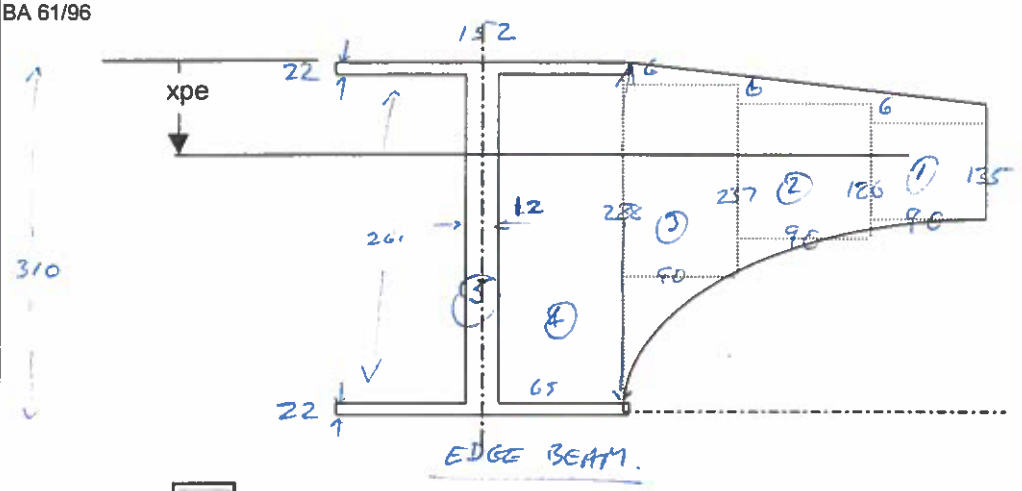
Both for $e = \frac{V A\bar{y}}{I}$ CALC.

Bath EDGE BEAMS – COMPOSITE

Project	Part of structure/scheme and status	Job ref
CLODDACH	Cracked Section Plastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]			of

Code ref	Calculations	Remarks/output	Checked by Initials and date
BA 61/96			



xpe = 128 mm ITERATION.

Compres	Ref	B	D	A	fs/fcu	γ_m	f_s/γ_m or $0.67f_{cu}/\gamma_{mc}$	P	Lever Arm	Moment
		mm	mm	mm^2	/mm^		N/mm^2	kN	m	kNm
	1	90	110	9900	20	1.50	8.93	88.4	0.055	4.86
	2	90	116	10440	20	1.50	8.93	93.3	0.058	5.41
	3	90	122	10980	20	1.50	8.93	98.1	0.061	5.98
	4	90	106	9540	20	1.50	8.93	85.2	0.053	4.52
BSB 22	5 fl	152	22	3344	230	1.05	219.05	732.5	0.117	85.70
BSB 22	5 web	12	106	1272	230	1.05	219.05	278.6	0.053	14.77
								1376.1		**121.24**

Tension	Ref	B	D	A	fs/fcu	γ_m	f_s/γ_m or $0.67f_{cu}/\gamma_{mc}$	P	Lever Arm	Moment
		mm	mm	mm^2	/mm^		N/mm^2	kN	m	kNm
	1	90	-11	-990	20	1.50	8.93	-8.8	0.013	-0.11
	2	90	46	4140	20	1.50	8.93	37.0	0.035	1.29
	3	90	103	9270	20	1.50	8.93	82.8	0.058	4.76
	4	90	138	12420	20	1.50	8.93	111.0	0.080	8.88
BSB 22	5 web	12	160	1920	230	1.05	219.05	420.6	0.080	33.65
BSB 22	5 fl	152	22	3344	230	1.05	219.05	732.5	0.086	62.63
								1374.97		111.10
								Plastic Moment Capacity =		**232.34**

Project		Part of structure/scheme and status			Job ref
CLODDACH		BSB 22 PROPS AND EFF SHEAR PERIMETER			.
Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		11-Jul-00	of

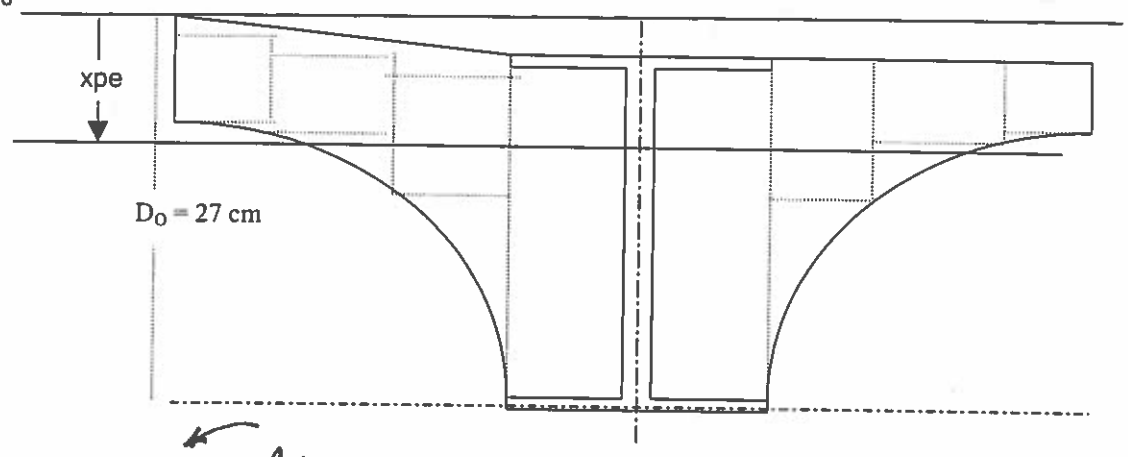
Code ref	Calculations	Remarks/output	Checked by Initials and date
	152 22 f l $x_1 = \frac{152}{2} - 11 = 65$ 305 web web ht = 305 − 2×22 = 261 12 22 f l		
BA61/96			
14.1	Effective Perimeter for shear transfer under composite action is 65 + 261 + 65 = 391 MM		
	AREA OF TOP FLANGE = 152 × 22		
	AREA OF WEB = 261 × 12		

1ST INNER BEAMS – COMPOSITE

Project	Part of structure/scheme and status	Job ref
CLODDACH	Cracked Section Plastic Properties	

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		11/07/00	of

Code ref	Calculations	Remarks/output	Checked by / Initls and date
BA 61/96			



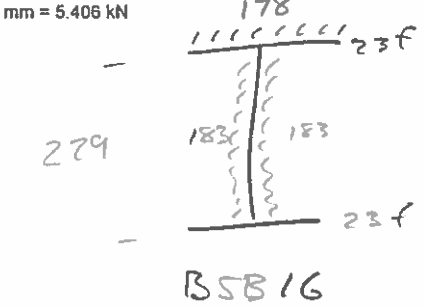
xpe = 118 mm Iteration

Compres	Ref	B	D	A	fs/fcu	γ_m	f_s/γ_m or $0.67f_{cu}/\gamma_{mc}$	P	Lever Arm	Moment
		mm	mm	mm^2	/mm^		N/mm^2	kN	m	kNm
	1	90	104	9360	20	1.50	8.93	83.6	0.045	3.76
	2	90	91	8190	20	1.50	8.93	73.2	0.032	2.34
	3	90	77	6930	20	1.50	8.93	61.9	0.018	1.11
	4	90	55	4950	20	1.50	8.93	44.2	-0.004	-0.18
BSB 16	5 fl	178	22	3916	230	1.05	219.05	857.8	0.066	56.61
BSB 16	5 web	14	55	765	230	1.05	219.05	167.5	0.028	4.61
	6	90	55	4950	20	1.50	8.93	44.2	0.028	1.22
	7	90	77	6930	20	1.50	8.93	61.9	0.039	2.38
	8	90	77	6930	20	1.50	8.93	61.9	0.039	2.38
	9	90	77	6930	20	1.50	8.93	61.9	0.039	2.38
								1518.1		**76.63**

Tension	Ref	B	D	A	fs/fcu	γ_m	f_s/γ_m or $0.67f_{cu}/\gamma_{mc}$	P	Lever Arm	Moment
		mm	mm	mm^2	/mm^		N/mm^2	kN	m	kNm
	1	90	31	2790	20	1.50	8.93	24.9	0.016	0.39
	2	90	75	6750	20	1.50	8.93	60.3	0.038	2.26
	3	90	121	10890	20	1.50	8.93	97.3	0.061	5.89
	4	90	67	6030	20	1.50	8.93	53.9	0.034	1.80
BSB 16	5 web	14	67	938	230	1.05	219.05	205.5	0.034	6.88
BSB 16	5 fl	178	22	3916	230	1.05	219.05	857.8	0.071	60.47
	6	90	67	6030	20	1.50	8.93	53.9	0.067	3.61
	7	90	107	9630	20	1.50	8.93	86.0	0.054	4.60
	8	90	62	5580	20	1.50	8.93	49.8	0.031	1.55
	9	90	17	1530	20	1.50	8.93	13.7	0.009	0.12
								1503.05		**87.57**
								Plastic Moment Capacity =		**164.20**

ULS SHEAR FORCE DIAGRAM
Structure 1:28
Forces 1 mm = 5.406 kN

Effective Perimeter BA 61/96 14.1



BSB16

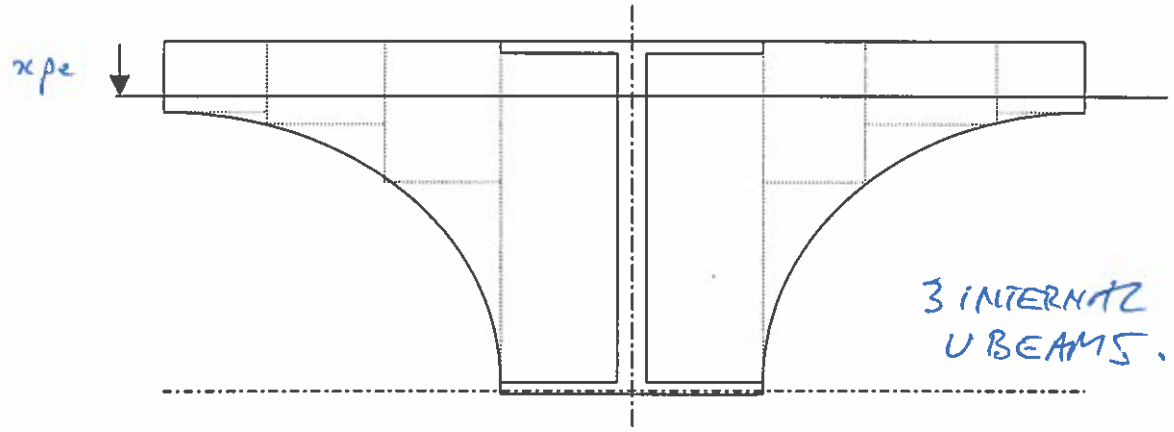
Σ = 544 mm
= 54.4 cm.

integer

3 INTERNAL BEAMS – COMPOSITE

	Project		Part of structure/scheme and status			Job ref
	CLODDACH		Cracked Section Plastic Properties			
	Department	Service	Calculations by	Checked by	Date	Calc sheet no
	Environmental Svcs	Roads	[redacted]			of
Code ref	Calculations			Remarks/output		Checked by initials and date

BA 61/96



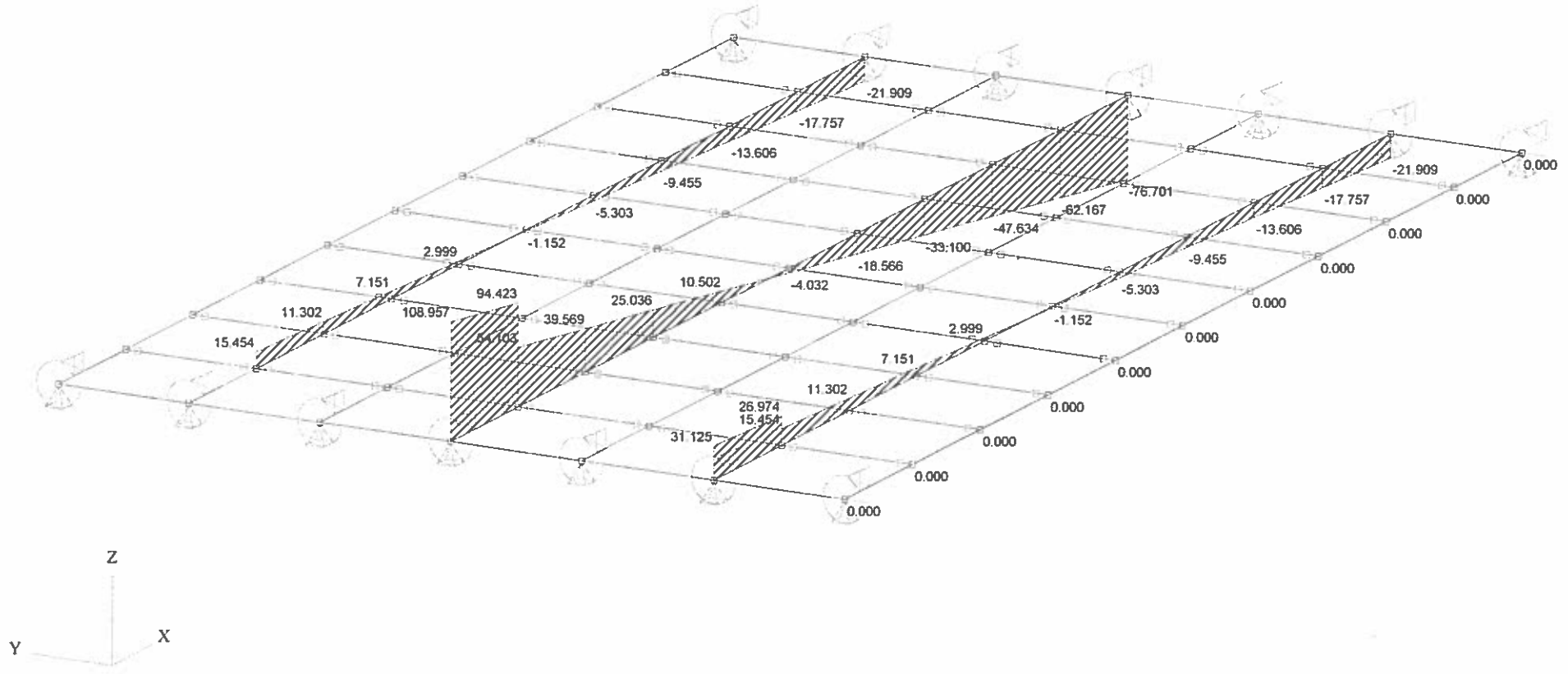
x_{pe} = 5.00 cm PLASTIC NEUTRAL AXIS BY ITERATION.

Comp	Ref	B	D	A	f_s/f_{cu}	γ_m	f_s/γ_m or $0.67f_{cu}/\gamma_{mc}$	P(kN)	La (mm)	M (kNm)
	1	9.00	5	45	20	1.5	8.93	40	25	1.0
	2	9.00	5	45	20	1.5	8.93	40	25	1.0
	3	9.00	5	45	20	1.5	8.93	40	25	1.0
	4	8.20	5	41	20	1.5	8.93	37	25	0.9
BSB 16	5 fl	17.80	2.2	39.16	230	1.05	219.05	858	39.0	33.5
BSB 16	5 we	1.39	2.8	3.892	230	1.05	219.05	85	14.0	1.2
	6	8.20	5	41	20	1.5	8.93	37	25	0.9
	7	9.00	5	45	20	1.5	8.93	40	25	1.0
	8	9.00	5	45	20	1.5	8.93	40	25	1.0
	9	9.00	5	45	20	1.5	8.93	40	25	1.0
								1257		**42.5**

Tension	Ref	B	D	A	f_s/f_{cu}	γ_m	f_s/γ_m or $0.67f_{cu}/\gamma_{mc}$	P (kN)	La (mm)	M (kNm)
	1	9.00	4.4	39.6	0	1.5	0.00	0		
	2	9.00	8.9	80.1	0	1.5	0.00	0		
	3	9.00	13.4	120.6	0	1.5	0.00	0		
	4	8.20	13.24	108.6	0	1.5	0.00	0		
BSB 16	5 fl	17.80	2.2	39.16	230	1.05	219.05	858	143.4	123.0
BSB 16	5 we	1.39	13.24	18.4	230	1.05	219.05	403	66.2	26.7
	6	8.20	13.24	108.6	0	1.5	0.00	0		
	7	9.00	13.4	120.6	0	1.5	0.00	0		
	8	9.00	8.9	80.1	0	1.5	0.00	0		
	9	9.00	4.4	39.6	0	1.5	0.00	0		
								1261		**149.7**

Plastic moment capacity = **192.2** kNm

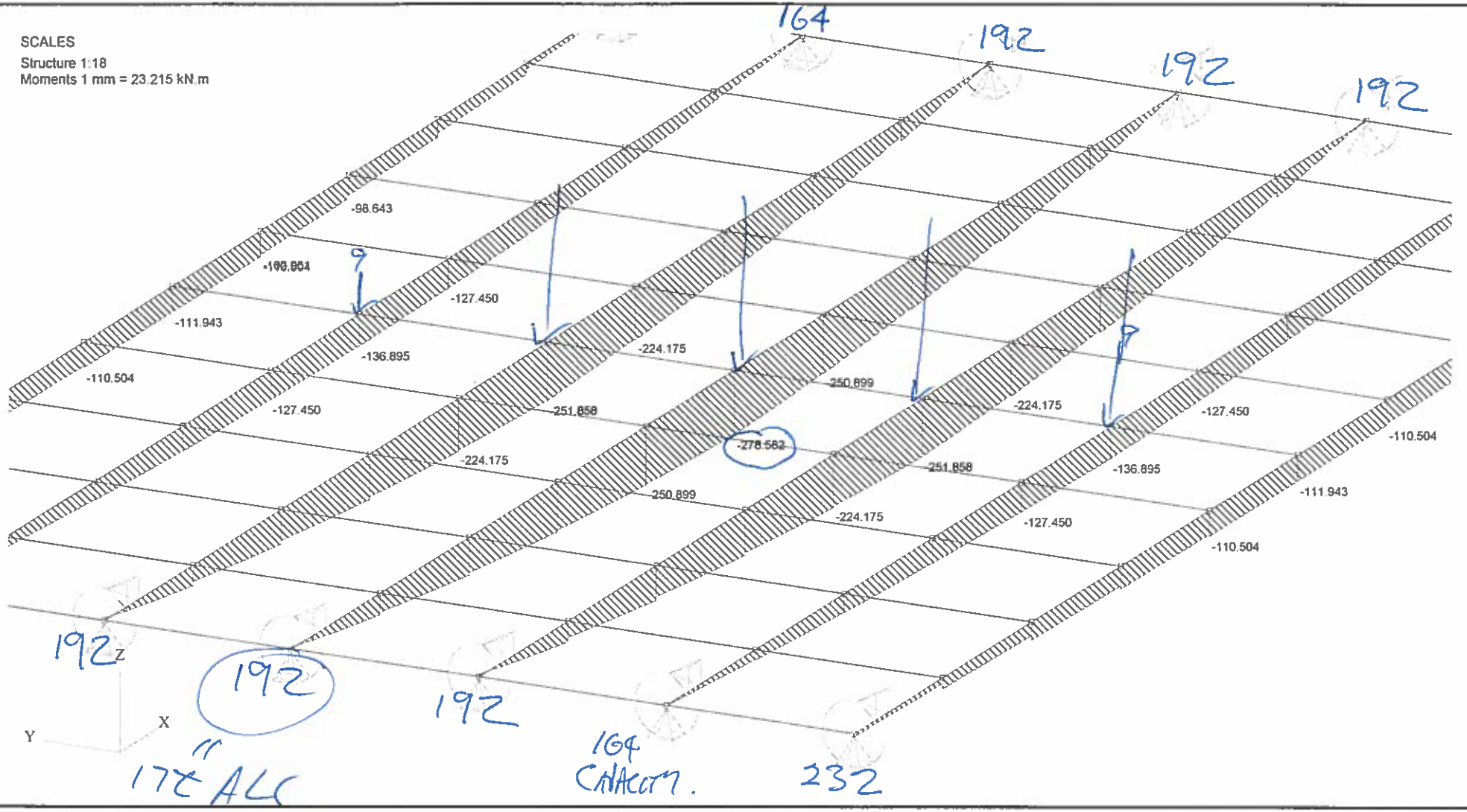
SLS LOAD COMBINATION C4 MAX SHEAR
Structure 1:29
Forces 1 mm = 5.406 kN



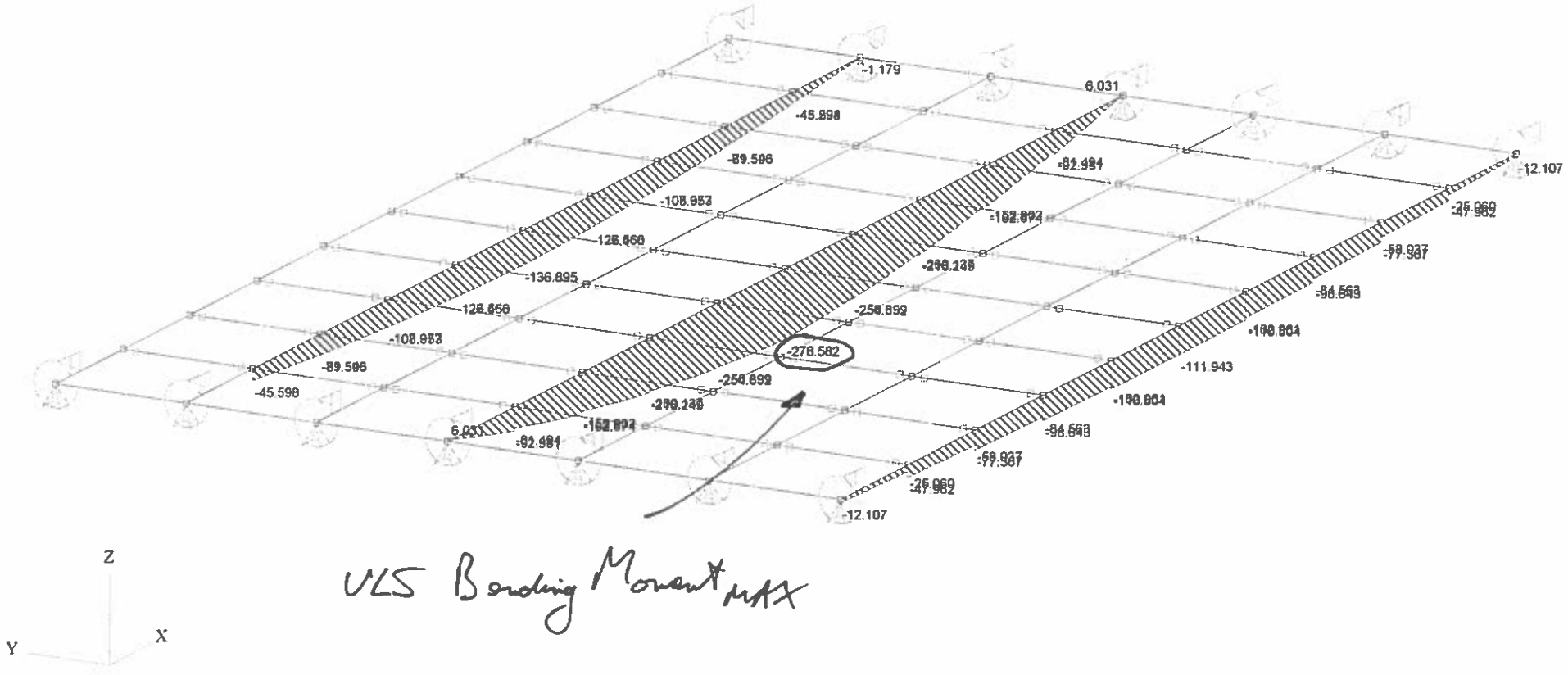
Project	Part of structure/scheme and status	Job ref
CLODDACH	LONGITUDINAL SHEAR FLOW	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		10-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date
BD61/96			
8.5.1	SLS Longitudinal Shear.		
	Assume SLS (DL + SDL) is carried by webs of UBeams in shear resistance.		
	SLS Live Load shear is to be carried by interaction between steel beam and concrete in composite action. Generate 2 Superstress SLS Live Load Combination load cases, one with KEL at midspan and second with KEL at joints immediate to the supports.		
	C3 : SLS Live Load Only, kel Midspan $V_{max} = 92kN$		
	C4 : SLS Live Load Only, kel near supports $V_{max} = 109kN$.		
	Longitudinal Shear Flow $q = \frac{VA_y}{I}$		
	$\therefore q = 109kN \times \frac{401.24\ cm^3}{13399.18\ cm^4}$		
	$= 3.26\ kN/cm$		
	$= 0.326\ kN/mm.$		
	Permitted Perimeter = 544 mm (both webs + top flange)		
	$\therefore$ Local bond stress = $\frac{q\,\gamma_{f3}}{\text{Perimeter}}$		
	$= \frac{0.326 \times 1.1}{544} = 0.659\ N/mm^2$		
	$< 0.7\ N/mm^2$		
	Therefore Local Bond Stress achieved at SLS so composite action ok.		



ULS LOAD COMBINATION 1
Structure 1:29
Moments 1 mm = 23.215 kN.m



ULS Bending Moment MAX

Project	Part of structure/scheme and status	Job ref
CLODDACH	ULS APPLIED MOMENTS	.

Department	Service	Calculations by	Checked by	Date	Calc sheet no
Environmental Svcs	Roads	[redacted]		10-Jul-00	of

Code ref	Calculations	Remarks/output	Checked by Initls and date
BD21/97	MAX APPLIED ULS BENDING MOMENT		
	= 278·6 kNm AT JOINT 39, C1.		
	PLASTIC MOMENT CAPACITY = 193 kNm.		
	ULS LIVE LOAD ONLY = 227·5 kNm.		
	ULS DL + SDL = 51·1 kNm.		
	∴ LIVE LOAD CAPACITY = 193 − 51·1 = 141·9 kNm.		
5.28	∴ C = 141·9 / 227·5 = 0·623		
	From FIG 5/4 : Lp : K ≤ 0·623 & span 6·7m.		
	⇒ ALC = 17 Tonnes (exactly).		
	Note No Condition Factor due to corrosion of individual beams has been applied to Moment of Resistance of beams in order to Reduce them.		

Structure Name:	Cloddach Bridge
Structure No.:	C2E/20
Grid Ref:	NJ 202 584
Date:	21/02/2001

Assessment Certificate

1. STRUCTURE IDENTIFIER

1.1 Structure Reference No — C2E/20

1.2 Structure Name — CLODDACH BRIDGE

2. ASSESSMENT

We certify that reasonable professional skills and care have been used in the assessment of the above structure with a view to securing that:

2.1 It has been assessed in accordance with:

The Approval in Principle Form TA1 — Dated 31/07/2000

2.2 The unique numbers of the drawings used for the assessment are: — 5/C2E/20/1/1

2.3 The assessed capacity of the structure is as follows : — **7.5 Tonnes Gross Vehicle Weight**

Signed ..[redacted]

Name [redacted]
Qualifications. Engineer, The Moray Council

Date 21/02/2001

3. This Certificate is accepted by Structures Section.

Signed [redacted]
Name

Qualifications Senior Engineer, Structures

Date 6/3/01