RF 37

GRAMPIAN REGIONAL COUNCIL - DEPARTMENT OF ROADS

SUMMARY SHEET

Sheet No. 1 of 13 Sheets

Project: ROUTE ACTION - BRIDGE ASSESSMENTS Calculations by: [redacted]

Element of Project: C2E/20 CLODDACH BRIDGE. Checked by:

Job No.: Y6055 Date: 6.2.96

Design Requirements:

To assess bridge to DMRB Vol 3a, section 4, part 3 BD 21/93.

Computer Programs Used:

NONE.

Relevant Design Manuals, Reports, Method of Measurements:

DMRB Vol 3a, section 4

BS 5400 : Part 3 : 1982 including amendment N°2

40 tonne assessment loading. - failed

passed 7½ tonne assessment loading. + gp 1 FE.

Documents Referred to:

as above.

Scheme CLODDACH BRIDGE	Designed By	Checked By		Date	Sheet No. 2 of 13. sheets
Structure ASSESSMENT	[redacted]	Theory	Arithmetic	1.2.96	

SUMMARY

The calculations showed that the bridge was suitable for 7.5 tonne HA loading, however the accidental wheel load check for the equivalent loading failed. Due to the proximity of the edge of the carriageway to the 1st internal beam it was thought the accidental wheel loading check was over extreme, therefore the 7.5 tonne and group 1 FE assessment was considered adequate.

Scheme CLODDACH (NJ 202 534)	Designed By	Checked By		Date	Sheet No. 3 of 13 sheets
		Theory	Arithmetic		
Structure BRIDGE ASSESSMENT	[redacted]			1.2.96	

DESCRIPTION.

Cloddach bridge is a 3 span, simply supported, beam and jack arch structure. There are 7 beams at a distance of 700mm c/c, with condition factors of 0.8 for 2 outside beams on each arch and 0.9 for the 3 central beams. The jack arch has dimensions of 500 wide (say) and 135mm rise, from the external face of the bottom beam flange.

Carriageway width is 3.9m with a minimum clear width of 4.17m. Span dimensions are indicated -ver.

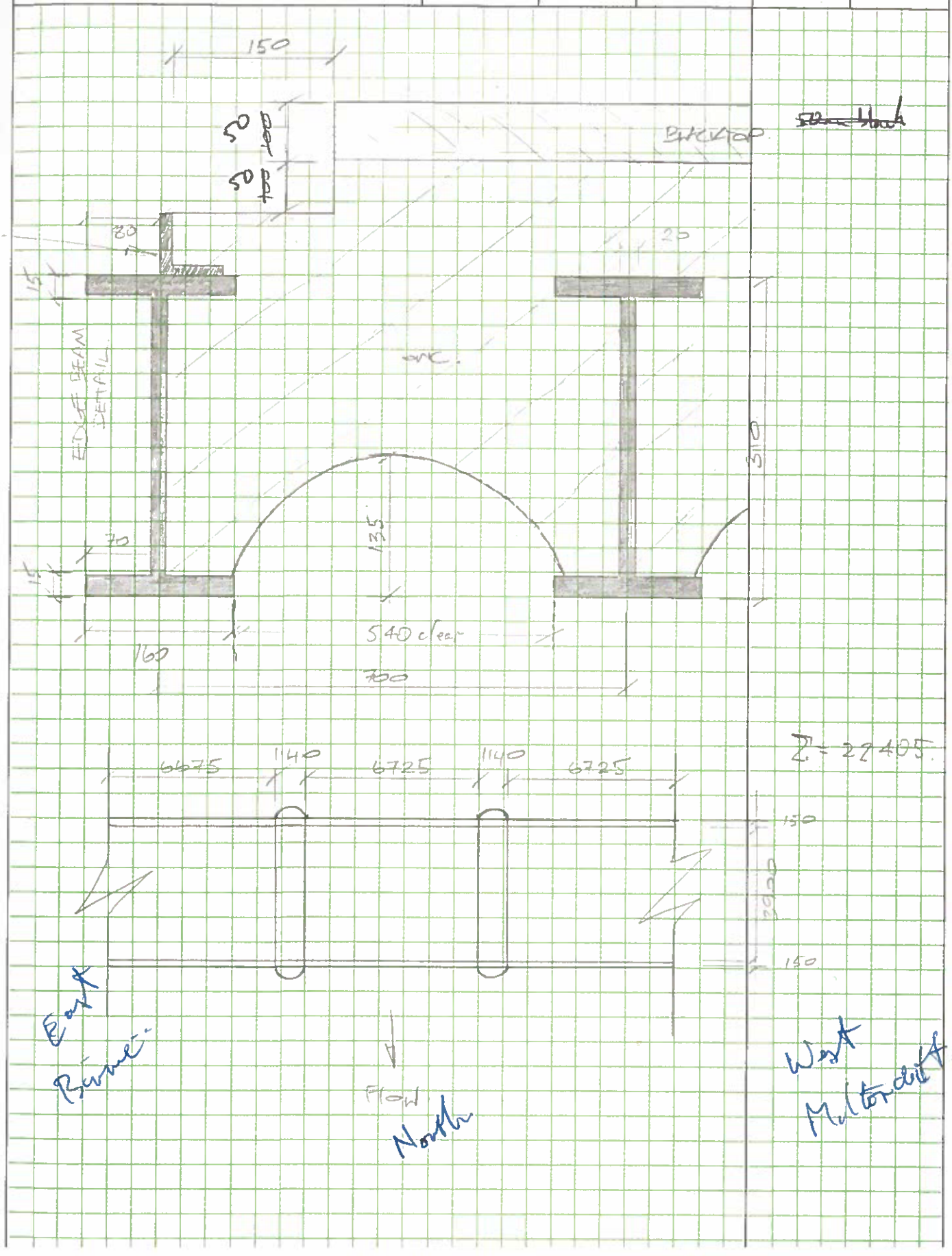
GRAMPIAN REGIONAL COUNCIL

DEPARTMENT OF ROADS

CALCULATION SHEET

Project	Calculations By	Checked By		Date	Sheet No. 4. of 13. Sheets
		Theory	Arithmetic		
Element N 1	[redacted]			1.2.96	

60 x 60 x 10 ANGLE



GRAMPIAN REGIONAL COUNCIL

DEPARTMENT OF ROADS

CALCULATION SHEET

Project	CLODACH (NS 202 584)	Calculations By	Checked By: Theory	Checked By: Arithmetic	Date	Sheet No. 5 of 13 Sheets
Element	ASSESSMENT	[redacted]			1.2.96	

INTERNAL MEMBER CHECK

NOMINAL DEAD LOAD.

SURFACING - 50mm blacktop + 50mm concrete

UDL = $\left[(0.05 \times 24) + (0.05 \times 23)\right] \times 0.7$

= 2.35 kN/m/beam 1.65

CONCRETE - Area = $(0.355 \times 0.7) - \frac{1}{2}(\pi \times 0.125^2) - (0.02 \times 0.28) - (0.15 \times 0.015)$

$= 0.249 - 0.029 - 0.006 - 0.002$

$= 0.212 m^2$

UDL = (0.212×23)

= 4.89 kN/m/beam

BEAM - Area = $2(0.15 \times 0.015) + (0.28 \times 0.02)$

$= 0.0104 m^2$

UDL = $0.0104 \times 78.5 = 0.82$ kN/m/beam

ASSESSMENT DEAD LOAD $\gamma_{f3} = 1.1$; γ_{fL} = variable

$[(0.84 \times 1.75) + (0.1 \times 1.2)] \times 1.1 = 2.68$ kN/m/beam

1.65 3.1

SURFACING : UDL = 2.35 x 1.1 x 1.75 = 4.52 kN/m/beam TABLE 3.1

4.6 5.82

CONCRETE : UDL = 4.89 x 1.1 x 1.15 = 6.19 kN/m/beam

STEEL BEAM : UDL = 0.82 x 1.1 x 1.05 = 0.95 kN/m/beam

2.68 5.82 9.45

TOTAL UDL = 4.52 + 6.19 + 0.95 = 11.66 kN/m/beam

2.7

TABLE 4.1

$(3h^2 + 4c^2)h/6c$

$(3 \times 120^2 + 4 \times 50^2) \times 110 / 6 \times 54$

$= 0.048 m^2$

Area $= 0.20 m^2$

4.6 kN/m

GRAMPIAN REGIONAL COUNCIL

DEPARTMENT OF ROADS

CALCULATION SHEET

Project	CLODDACH (NJ202 584)	Calculations By	Checked By		Date	Sheet No. 6. of 13 Sheets
Element	ASSESSMENT.	[redacted]	Theory	Arithmetic	1.2.96	

NOMINAL LIVE LOADS.

carriageway width = 3.9m ∴ 1 notional lane. Table 5/1

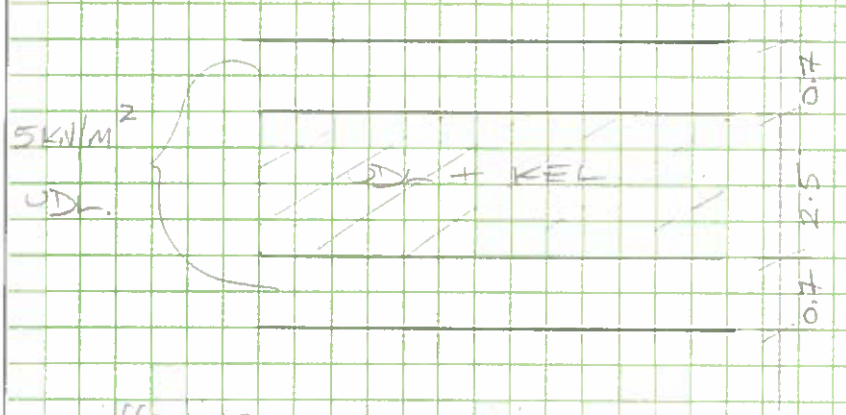
notional lane width = ~~3.65m~~ 2.5m

lane factor $\beta = 0.274 b_e \neq 1.0$. 4=40 5/2

$b_e = 3.65$ $= 0.274 \times ~~3.65~~\ 2.5$

$= 1.0$ 0.685

CARRIAGEWAY LOADING. 5.8



effective span. 6.5

$L_e = 6.725 + 2\left(\frac{1}{3} \times \frac{.310}{41}\right)$

$= 6.777m$.

HA LOADING 5.21

$W = 336\left(\frac{1}{6.777}\right)^{0.67} \times \beta. = 93.23 KN/M / ~~3.65m~~\ 2.5$ lane

~~26.10~~ left

UDL $= \frac{0.7}{~~3.65~~\ 2.5} \times 93.23 = ~~17.88~~ KN/M/beam$

~~37.6~~ Ref.

KEL $= \frac{0.7}{~~3.65~~\ 2.5} \times 120 = 23.01 KN/beam.$

GRAMPIAN REGIONAL COUNCIL

DEPARTMENT OF ROADS

CALCULATION SHEET

Project CLODDACH (NJ202 584)	Calculations By	Checked By: Theory	Checked By: Arithmetic	Date	Sheet No. 7 of 13 Sheets
Element ASSESSMENT.	[redacted]			1.2.96	

ASSESSMENT LIVE LOADS. $\gamma_{fL} = 1.5$; $\gamma_{fs} = 1.1$.

HA LOADING

UDL = ~~17.88~~ 26.60 × 1.1 × 1.5 = ~~47.4~~ 29.5 kN/M / beam

KEL = ~~22.01~~ 33.60 × 1.1 × 1.5 = 37.97 kN / beam ~~55.44kN~~

ASSESSEMENT DEAD LOAD MOMENT

$$M_{DL} = \frac{WL_e^2}{8} = \frac{(4.52 + 6.19 + 0.95) \times 6.78^2}{8}$$ 9.67

= 67.0 kNM / beam

54.25 kNm/beam

ASSESSMENT LIVE LOAD MOMENT

$$M_{LL} = \frac{W_{UDL} L_e^2}{8} + \frac{W_{KEL} L_e}{4}$$

$$= \frac{\text{~~47.4~~} \times 6.78^2}{8} + \frac{\text{~~55.44~~} \times 6.78}{4}$$

= ~~247.4~~ 102.74 + ~~93.0~~ 39.00

= 141.74 kNm / beam

~~341.4 kNm/beam~~

~~total~~ assessment moment

M_{ASS} = 67.0 + 141.74 = 208.74 kNm/beam

54.3 + ~~144~~ = ~~375.74 kNm/beam~~

196 kNm/beam

GRAMPIAN REGIONAL COUNCIL

DEPARTMENT OF ROADS

CALCULATION SHEET

Project	Calculations By	Checked By		Date	Sheet No. 8 of 13 Sheets
		Theory	Arithmetic		
Element ASSESSMENT.	[redacted]			1.2.96	

BS 5400: Pt 3 1982

BEAM RESISTANCE MOMENT

nominal yield stress $\sigma_y = 230 N/mm^2$

compact section check: 9.3.7.2.1

Web: $D \not> 28 t_w \sqrt{\frac{355}{\sigma_{yw}}}$

$\not> 28 \times 20 \times \sqrt{\frac{355}{230}}$

$\not> 695mm.$ $\therefore$ OK

Flange: $b_{fo} \not> 7 t_{fo} \sqrt{\frac{355}{230}}$ 9.3.7.3.1

$b_{fo} \approx 7t_2$.

$\not> 7 \times 15 \times \sqrt{\frac{355}{230}}$

$\not> 130mm.$ $\therefore$ OK.

Section is termed compact.

beams continuously restrained by deck. 9.6.6.1

$\therefore l_e = 0.$

slenderness $\lambda_{LT} = 0$ 9.7.2.

limiting compressive stress.

$\frac{\sigma_{li}}{\sigma_{yc}} = 1.0.$ $\therefore \sigma_{li} = 230 N/mm^2$ 9.8.1 Fig 10.

$M_D = \frac{Z_{xc} \sigma_{bc}}{\gamma_m \gamma_{f3}}$ where $\sigma_{bc} = \sigma_{li}$ 9.9.1.2.

GRAMPIAN REGIONAL COUNCIL

DEPARTMENT OF ROADS

CALCULATION SHEET

Project	CLODDACH (NJ 202 584)	Calculations By	Checked By: Theory	Checked By: Arithmetic	Date	Sheet No. 9 of 13 Sheets
Element	ASSESSMENT.	[redacted]			1.2.96	

Plastic Modulus.

$Z = \frac{I}{y}$ $\quad I_{xx} = \frac{160 \times 310^3}{12} - 2\left[\frac{70 \times 280^3}{12}\right]$

$= 397213333 - 256106667$

$= 141.11 \times 10^6 \text{ mm}^4$ ✓

$y = 155\text{mm}$.

$\therefore Z = \frac{141.11 \times 10^6}{155}$

$= 91.04 \times 10^4 \text{ mm}^3$.

$M_D = \frac{91.04 \times 10^4 \times 230}{1.2} \times 10^{-6} \times F_c$

$= 158.63 \times 0.8$

$= 126.90 \text{ KNm} < M_{ASS} (208.74 \text{ KNm})$

$\therefore$ Not OK - unsafe.

9.9.1.2

F_c = condition factor = 0.8.

REDUCTION FACTOR FOR HA

resistance moment for live load =

$139.6 - 54.25 = 85.35$

$126.90 - 67.0 = 59.90 \text{ KNm}$

resistance moment for live load

assessment moment for live load

$= \frac{59.90}{141.74} = 0.42$.

$\frac{85.35}{141.74} = 0.23$

equivalent to

Scheme	CLEDDACH (NJ 202 584)	Designed By	Checked By: Theory	Checked By: Arithmetic	Date	Sheet No. 10 of 13 sheets
Structure	ASSESSMENT	[redacted]			1.2.96	

SINGLE WHEEL LOADS.

for $K = 0.42$, $L_E = 6.78m$ } 7.5 tonnes. Group 2 FE

5.27

Maximum nominal single wheel load = 60kN. TABLE 5/4

assume effective pressure = $1.1 N/mm^2$ 5.28

$\therefore$ Area = $\frac{60000}{1.1} = 234 \times 234 mm$

load distribution: thro' blacktop 1:2. 6.7

thro' concrete 1:1

to NA of beam

$= 234 + 100 + 530 = 964 mm$

Design load

$= \frac{60000}{964} = 62.2 kN/m$ (69.4)

for 3 Tonne wheel load = 25kN

$\therefore M_{max} = 151 kNm/m$

$= 691 mm$

$\therefore$ Reqd load = 36.2kN/m.

964.

62.2 kN/m

A B

6780

30 kN 30kN.

$M_{MAX} = +(30 \times \frac{6.78}{2}) - (\frac{69.4}{62.2} \times 0.234 \times \frac{0.234}{2} \times \frac{1}{4})$

$= 101.7 - (0.43)$

$= 101.3 kNm$ (102.1) > 85.35.

$M_{MAX} = \left(125 \times \frac{6.777}{2}\right) - \left(36.2 \times \frac{0.151}{2} \times \frac{0.151}{4}\right)$

$= 42.2 kNm$

$\therefore$ OK.

$\therefore$ $M_{MAX} < M_D$ (126.9kNm)

$\therefore$ beam OK for single wheel load.

for Grp1 FE

GRAMPIAN REGIONAL COUNCIL

Department of Roads

DESIGN SHEET

Scheme	Designed By	Checked By		Date	Sheet No. 11 of 13 sheets
		Theory	Arithmetic		
Structure ASSESSMENT	[redacted]			1.2.96	

for $K = 0.54$, $L_e = 6.78m$. } 7.5 tonnes. Group 2 FE

Fig 5/2

NOMINAL ACCIDENTAL WHEEL LOADS.

Table 5/5

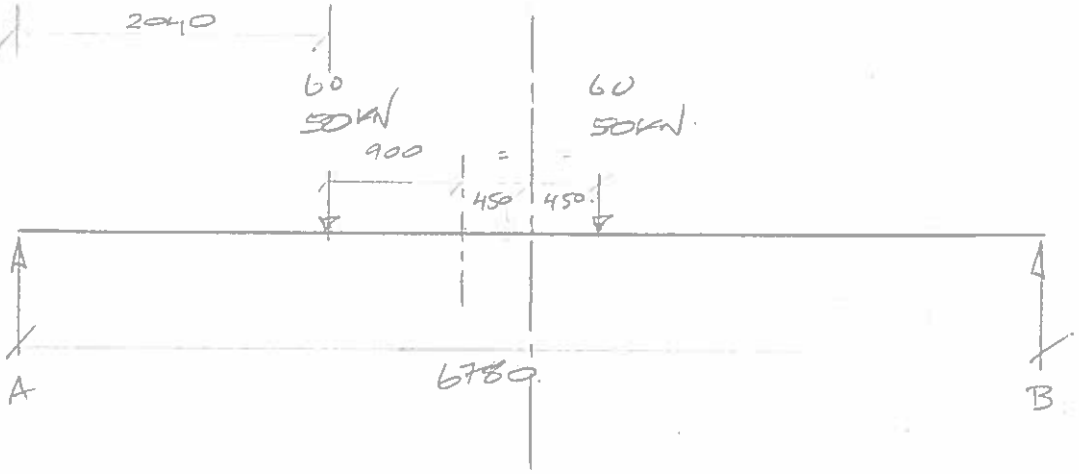
for above two groups

7.5 tonnes = W_1 = 50kN ✓

2 FE = W_1 = 30kN

Fw 3 / 1 Axle of 50kN.

25 / 25.



$\Sigma M_A = 0 +)$ $\quad 0 = +(2.04 \times 50) + (3.84 \times 50) - (6.78B)$

$\Leftrightarrow B = \dfrac{102 + 192}{6.78}$

$= 43.36kN$

$\therefore A = 100 - 43.36 = 56.64kN.$

21.7kN / 22.3kN

GRAMPIAN REGIONAL COUNCIL

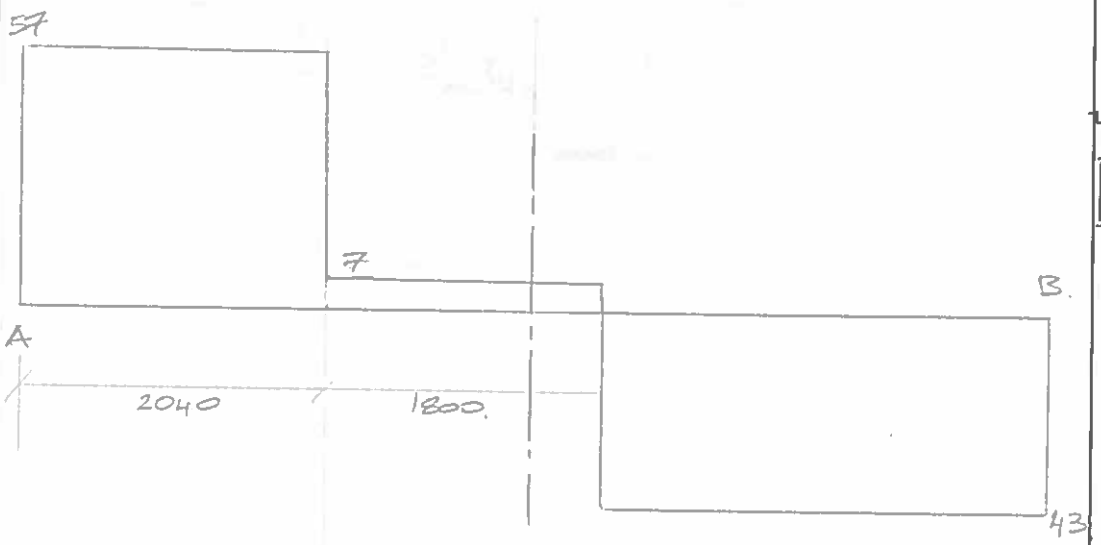
Form RF34

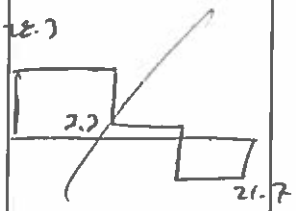
Department of Roads

DESIGN SHEET

Scheme	CLODDACH (NJ 202 584)	Designed By	Checked By: Theory	Checked By: Arithmetic	Date	Sheet No. 12 of 13 sheets
Structure	ASSESSMENT	[redacted]			1.2.96	

SF Diagram.





$M_{MAX} = (57 \times 2.04) + (7 \times 1.8) = 116.28 + 12.6.$

$= 128.88 \text{ kNm} <$

M_D (142.76).

∴ OK Bridge OK for accidental wheel loading.

SHEAR CHECK – assessment shear.

Shear due to dead load.

$V_{DL} = \frac{11.66 \times 6.777}{2} = 39.51 \text{ kN}$

Shear due to live load.

$V_{LL} = \frac{17.88 \times 6.777}{2} + 23.01 = 83.6 \text{ kN}$

$V_D + V_L = 39.51 + 83.6 = 123.11 \text{ kN}$

154.7 ~~85.35~~
63.67 <
∴ OK
fails 7½T
OK for 3T
& Grp 2 FE.

$\frac{9.45 \times 6.777}{2} = 32.02$

$\frac{26.1 \times 6.777}{2} + 32.6 = 122.04$

= 154.06 kN

GRAMPIAN REGIONAL COUNCIL

Department of Roads

DESIGN SHEET

Scheme CLODDACH	Designed By	Checked By: Theory	Checked By: Arithmetic	Date	Sheet No. 13, of 13 sheets
Structure ASSESSMENT	[redacted]			5.2.96	

Shear resistance. 9.9.2.1.

$$V_D = \left[\frac{t_w (d_w - \not{d_h})}{\gamma_m \not{\gamma_{f3}}}\right] \tau_l$$

in loading

$$= \frac{t_w d_w}{\gamma_m} \tau_l$$

$t_w = 10$ $d_w = 310$ $\gamma_m = 1.2$

$$= \frac{10 \times 310}{1.2} \tau_l$$

$$= 2583.33\, \tau_l$$

$$\lambda_1 = \frac{d_{wc}}{t_w} \sqrt{\frac{\sigma_{yw}}{355}}$$

$$= \frac{305 - (2 \times 15)}{10} \sqrt{\frac{230}{355}}$$

$$= 22.14$$

Fig 11 - 17

$$\frac{\tau_l}{\tau_y} = 1.0$$

$$\therefore \tau_l = \tau_y = \frac{\sigma_{yw}}{\sqrt{3}} = \frac{230}{\sqrt{3}} = 132.8 N/mm^2$$

$$\therefore V_D = 2583.33 \times 132.8 \times 10^{-3} = 343.07 kN. > V_{ASS} (123.11 kN)$$

VIEW LOOKING EAST

VIEW LOOKING NORTH

CORRODED EDGE BEAM

BRIDGE PIERS AND DECK

DAMAGED PILASTER

AS ABOVE

SPALLING OF CONCRETE ON PIER

SEATING ANGLE

JACK ARCH SOFFIT

AS ABOVE

ASSESSMENT SUMMARY

BRIDGE NAME: CLODDACH

ROUTE No: C2E

STRUCTURE REFERENCE No: C2E/20

GRID REFERENCE: NJ 202 584

COUNCIL: THE MORAY COUNCIL

DOCUMENTS IN ASSESSMENT FOLDER		
DATE	WHO	WHAT
6/2/96	[redacted]	Assessment Calculations
		Photographs & Negatives.

SUMMARY OF ASSESSMENT		
DATE	WHO	SUMMARY DETAILS - ASSESSED LOAD(S), CRITICAL PART(S), TECH MEMO, + COMMENT
6/2/96	[redacted]	7½ Tonne + Group 1 F.E. Loading —
		Steel Beams Critical.