



Retain The Earth
Concrete Products & Sleepers

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**STRUCTURAL CALCULATIONS & DETAILS FOR CONCRETE
SLEEPERS FOR RETAINING WALLS**

ENGINEERING SPECIFICATIONS

Produced by
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DATE: 15th June 2021

SITE: VARIOUS

CLIENT: Retain The Earth Pty Ltd

REFERENCE NO. 210631

60mpa Concrete Strength

Lelio Bibbo
Consulting Engineers Pty Ltd

STRUCTURAL CALCULATIONS

JOB No. 210623

DESIGN: DGH

DATE: June 2021

PROPOSED CONSTRUCTION: Concrete Sleepers for Retaining Walls

SITE: Various

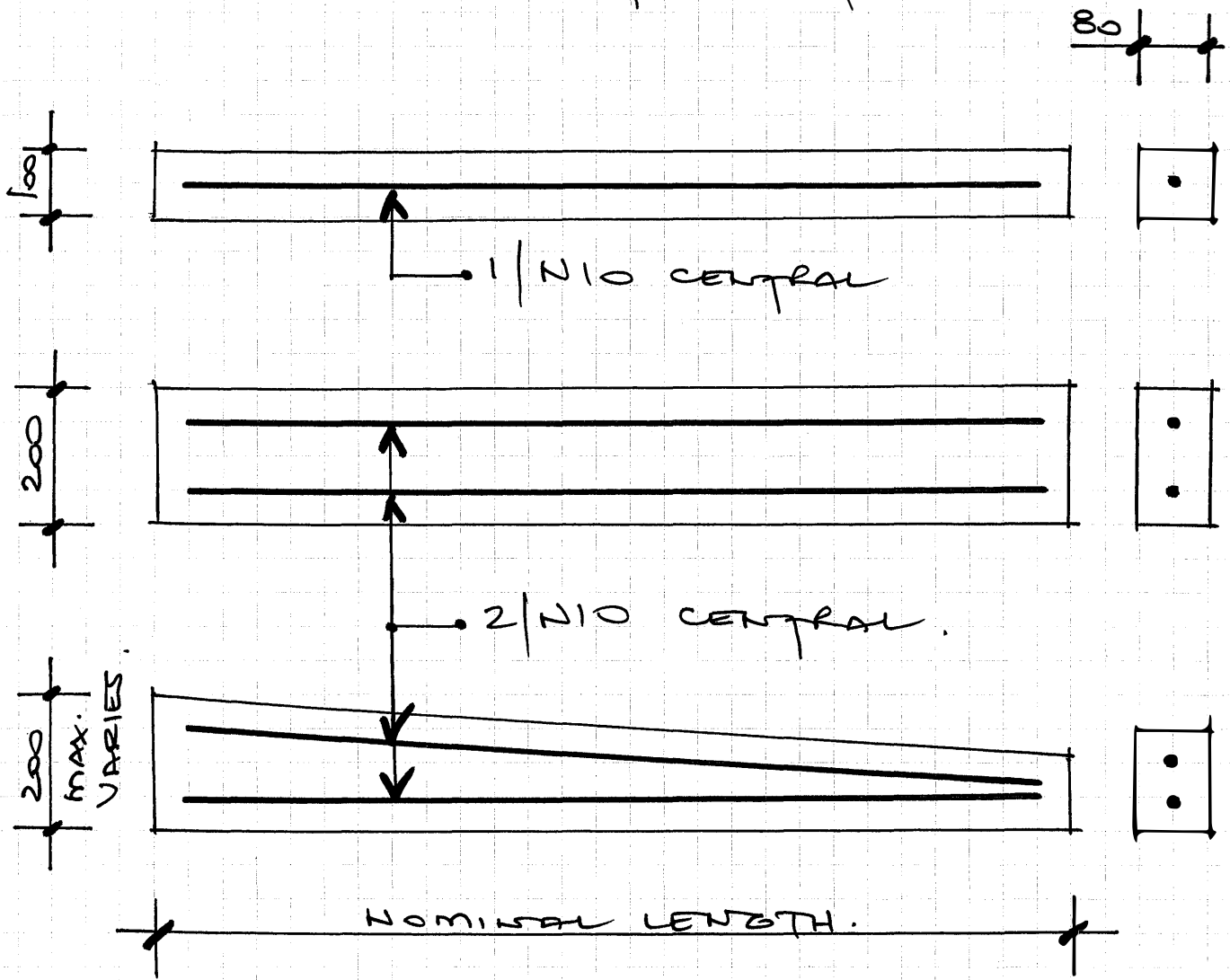
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RETAIN THE EARTH P/L
WALL SLEEPERS.

80 mm THICK CONCRETE SLEEPER

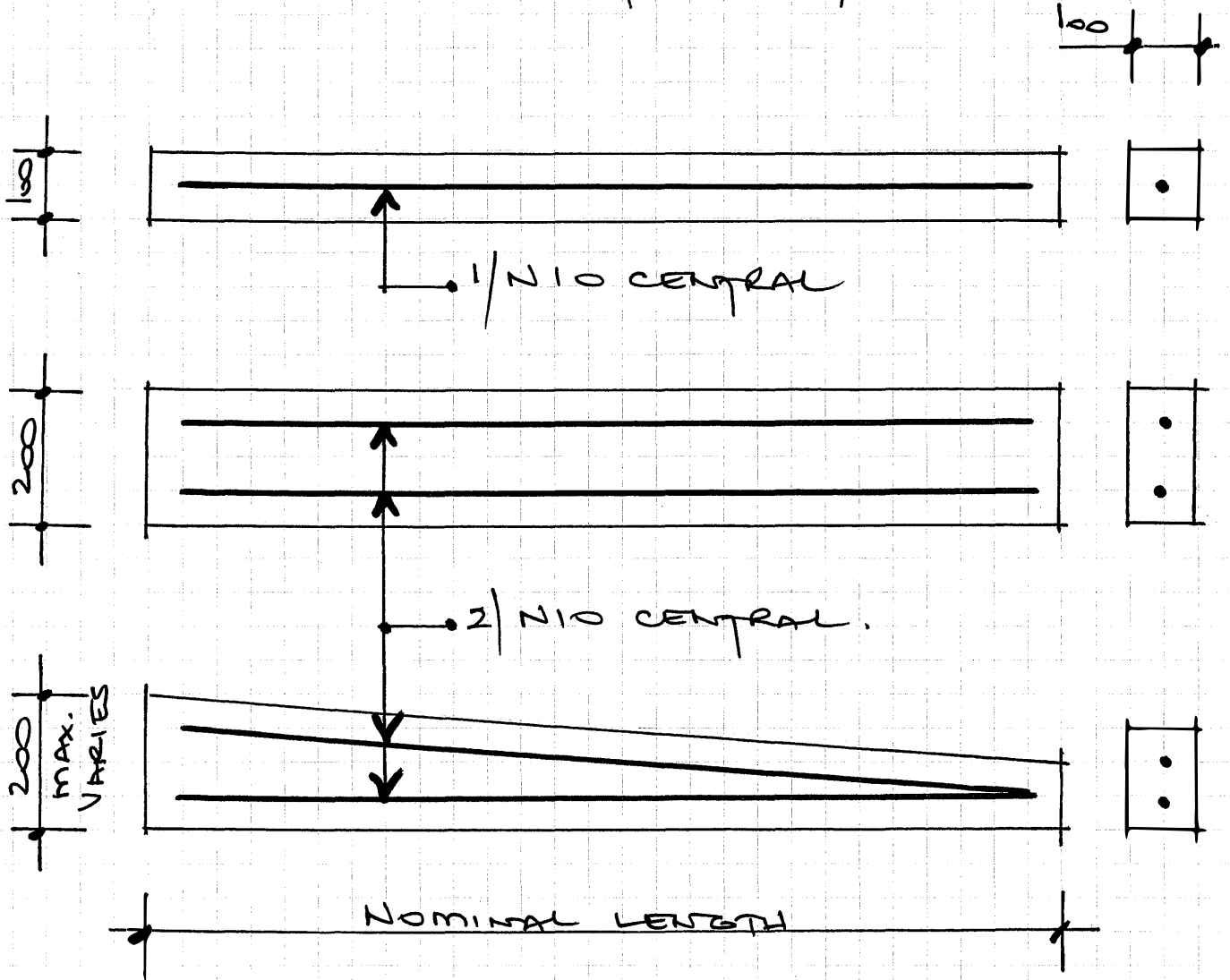


NOMINAL LENGTH (m)	MAX. RETAINED HEIGHT (m)
2.0	2.0
2.4	1.20

NOTES:

1. CONCRETE STRENGTH $f'c = 60 \text{ MPa}$
2. STEEL GRADE 'N' $f_{sy} = 500 \text{ MPa}$
3. RETAINING WALLS DRAINED.
4. ALL CONCRETE WORKS TO AS3600.

100mm THICK CONCRETE SLEEPER.



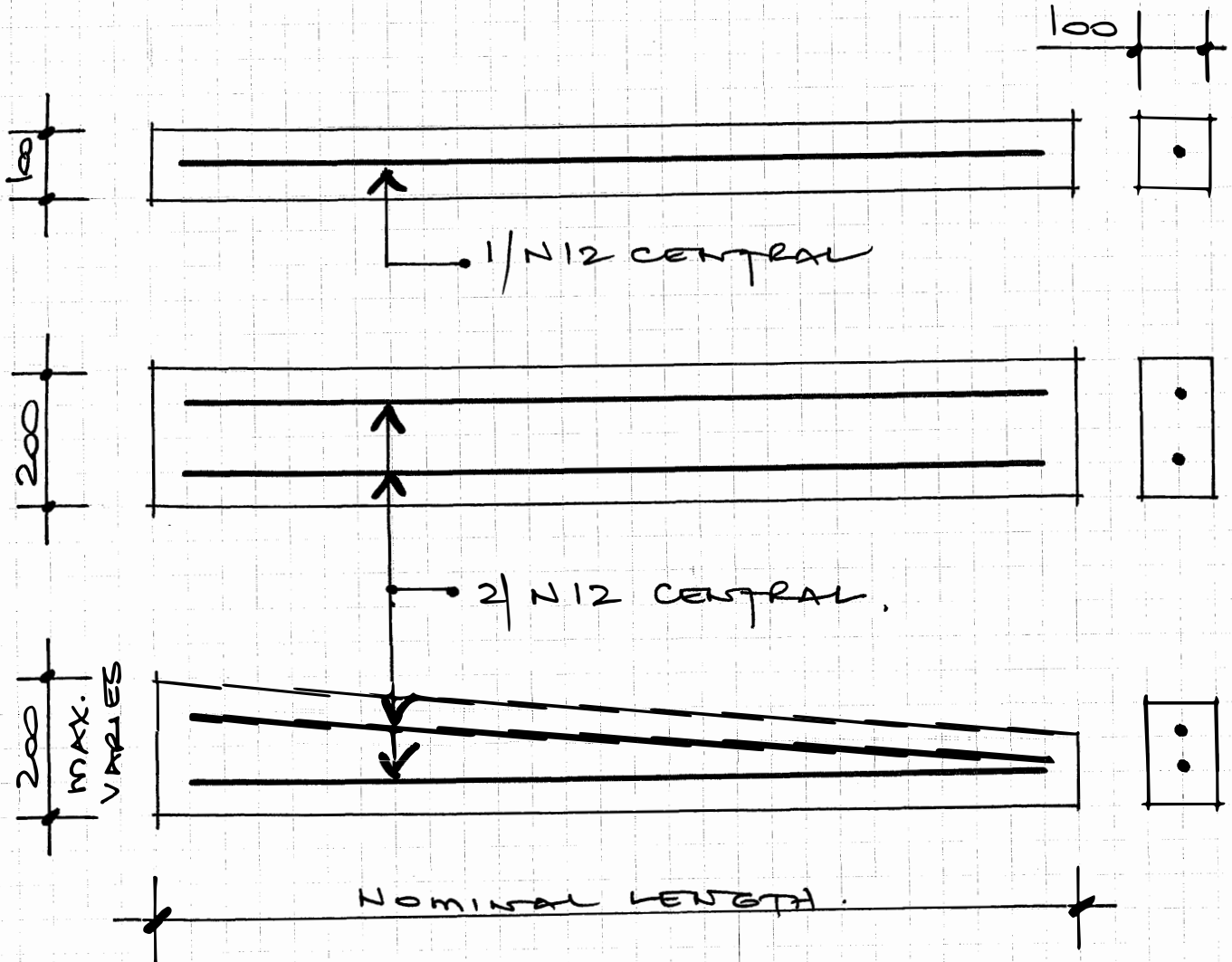
NOMINAL LENGTH (m)	MAX. RETAINED HEIGHT (m)
2.0	2.6
2.4	1.8

NOTES:

1. CONCRETE STRENGTH
 $f_c = 60 \text{ MPa}$,
2. STEEL GRADE 'N'
 $f_{sy} = 500 \text{ MPa}$
3. RETAINING WALLS
DRAINED.
4. ALL CONCRETE
WORKS TO
AS 3600.

RETAIN THE EARTH P/L
WALL SLEEPERS

100 mm THICK CONCRETE SLEEPER



NOMINAL LENGTH (m)	MAX. RETAINED HEIGHT (m)
2.0	3.0
2.4	2.4

NOTES:

1. CONCRETE STRENGTH
 $f_{lc} = 60 \text{ MPa}$
2. STEEL GRADE 'N'
 $f_{sy} = 500 \text{ MPa}$
3. RETAINING WALLS
DRAINED.
4. ALL CONCRETE
WORKS TO
AS 3600.

LATERAL PRESSURES DUE TO SOIL, WATER & SURCHARGE

Density of Soil = 19.0 kN/m³.

Density of Water = 9.8 kN/m³.

Depth to Water Table = 3.0 m.

Submerged Density of Soil = 9.2 kN/m³.

Soil Friction Angle, θ = 32 Degrees

Modified Soil Friction Angle, θ' = 25.1 Degrees

Active Pressure Coefficient, K_a = 0.404

Total Surcharge Load = 5.00 kN/m².

Depth Increment for Calculation = 0.20 m.

- ① 80 SLEEPER N10-100%
- ② 100 SLEEPER N10-100%
- ③ 100 SLEEPER N12-100%

Summary

Depth m.	Soil Pressure kPa.	Water Pressure kPa.	Surcharge Pressure kPa.	Total Pressure kPa.	Design Pressure 1.25G+1.5C	Service Pressure G+0.6Q	Span=2m. Moment M*	Span=2m. Moment Ms	Span=2m. Shear V*	Span=2.4m. Moment M*	Span=2.4m. Moment Ms	Span=2.4m. Shear V*
0.00	0.00	0.00	2.02	2.02	3.03	1.21	1.52	0.61	3.03	2.18	0.87	3.64
0.20	1.54	0.00	2.02	3.56	4.95	2.75	2.48	1.37	4.95	3.56	1.98	5.94
0.40	3.07	0.00	2.02	5.09	6.87	4.28	3.44	2.14	6.87	4.95	3.08	8.24
0.60	4.61	0.00	2.02	6.63	8.79	5.82	4.40	2.91	8.79	6.33	4.19	10.55
0.80	6.14	0.00	2.02	8.16	10.71	7.36	5.35	3.68	10.71	7.71	5.30	12.85
1.00	7.68	0.00	2.02	9.70	12.63	8.89	6.31	4.45	12.63	9.09	6.40	15.16
1.20	9.21	0.00	2.02	11.24	14.55	10.43	7.27	5.21	14.55	10.48	7.51	17.46
1.40	10.75	0.00	2.02	12.77	16.47	11.96	8.23	5.98	16.47	11.86	8.61	19.76
1.60	12.29	0.00	2.02	14.31	18.39	13.50	9.19	6.75	18.39	13.24	9.72	22.07
1.80	13.82	0.00	2.02	15.84	20.31	15.03	10.15	7.52	20.31	14.62	10.82	24.37
2.00	15.36	0.00	2.02	17.38	22.23	16.57	11.11	8.28	22.23	16.00	11.93	26.67
2.20	16.89	0.00	2.02	18.91	24.15	18.11	12.07	9.05	24.15	17.39	13.04	28.98
2.40	18.43	0.00	2.02	20.45	26.07	19.64	13.03	9.82	26.07	18.77	14.14	31.28
2.60	19.96	0.00	2.02	21.99	27.99	21.18	13.99	10.59	27.99	20.15	15.25	33.58
2.80	21.50	0.00	2.02	23.52	29.91	22.71	14.95	11.36	29.91	21.53	16.35	35.89
3.00	23.04	0.00	2.02	25.06	31.83	24.25	15.91	12.12	31.83	22.91	17.46	38.19

WALL SLEEPERSSLEEPERS FOR RETAINING WALLS

DENSITY OF SOIL $\gamma = 19 \text{ kN/m}^3$

SOIL FRICTION ANGLE $\phi = 32^\circ$ GRANULAR BACKFILL

SURCHARGE LOAD, $q = 5.0 \text{ kPa}$.

$$\phi' = \tan^{-1}(0.75 \tan \phi) = 25.11^\circ$$

$$K_a = 0.404$$

SOIL PRESSURE $p_a = K_a \cdot \gamma \cdot H$

FOR $H = 1.2 \text{ m}$ $p_a = 0.404 \times 19 \times 1.2 = 9.21 \text{ kPa}$

$H = 2.4 \text{ m}$ $p_a = 0.404 \times 19 \times 2.4 = 18.42 \text{ kPa}$

SURCHARGE PRESSURE $p_q = K_a \cdot q$
 $= 0.404 \times 5.0 = 2.02 \text{ kPa}$

DESIGN ACTIONS $H = 1.2 \text{ m}$.

$1.25G + 1.5Q, W^* = (1.25 \times 9.21) + (1.50 \times 2.02) = 14.52 \text{ kPa}$

$W_s = 9.21 + (0.6 \times 2.02) = 10.42 \text{ kPa}$

SPAN = 2.0 m.

$M^* = 14.52 \times 2.0^2/8 = 7.27 \text{ kNm/m width}$

$V^* = 14.52 \times 2.0/2 = 14.52 \text{ kN/m}$ "

$M_s = 10.42 \times 2.0^2/8 = 5.21 \text{ kNm/m}$ "

SPAN = 2.4 m.

$M^* = 14.52 \times 2.4^2/8 = 10.47 \text{ kNm/m width}$

$V^* = 14.52 \times 2.4/2 = 17.45 \text{ kN/m}$ "

$M_s = 10.42 \times 2.4^2/8 = 7.50 \text{ kNm/m}$ "

DESIGN ACTIONS. $H = 2.4m$.

$$1.25G + 1.5Q, w^* = (1.25 \times 18.42) + (1.5 \times 2.02) = \underline{26.06} \text{ kPa}$$

$$w_s = 18.42 + (0.6 \times 2.02) = \underline{19.63} \text{ kPa}$$

span = 2.0m.

$$m^* = 26.06 \times 2.0^2 / 8 = \underline{13.03} \text{ kNm}$$

$$U^* = 26.06 \times 2.0 / 2 = \underline{26.06} \text{ kN}$$

$$m_s = 19.63 \times 2.0^2 / 8 = \underline{9.82} \text{ kNm}$$

ALL PER
METRE
WIDTH.

span = 2.4m.

$$m^* = 26.06 \times 2.4^2 / 8 = \underline{18.76} \text{ kNm}$$

$$U^* = 26.06 \times 2.4 / 2 = \underline{31.27} \text{ kN}$$

$$m_s = 19.63 \times 2.4^2 / 8 = \underline{14.13} \text{ kNm}$$

LATERAL PRESSURES DUE TO SOIL, WATER & SURCHARGE

3
B6H
210631
15.6.21

- Density of Soil = 19.0 kN/m³.
- Density of Water = 9.8 kN/m³.
- Depth to Water Table = 3.0 m.
- Submerged Density of Soil = 9.2 kN/m³.
- Soil Friction Angle, θ = 32 Degrees
- Modified Soil Friction Angle, θ' = 25.1 Degrees
- Active Pressure Coefficient, K_a = 0.404
- Total Surcharge Load = 5.00 kN/m².
- Depth Increment for Calculation = 0.20 m.

Depth m.	Soil Pressure kPa.	Water Pressure kPa.	Surcharge Pressure kPa.	Total Pressure kPa.
0.00	0.00	0.00	2.02	2.02
0.20	1.54	0.00	2.02	3.56
0.40	3.07	0.00	2.02	5.09
0.60	4.61	0.00	2.02	6.63
0.80	6.14	0.00	2.02	8.16
1.00	7.68	0.00	2.02	9.70
1.20	9.21	0.00	2.02	11.24
1.40	10.75	0.00	2.02	12.77
1.60	12.29	0.00	2.02	14.31
1.80	13.82	0.00	2.02	15.84
2.00	15.36	0.00	2.02	17.38
2.20	16.89	0.00	2.02	18.91
2.40	18.43	0.00	2.02	20.45
2.60	19.96	0.00	2.02	21.99
2.80	21.50	0.00	2.02	23.52
3.00	23.04	0.00	2.02	25.06

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REINFORCED CONCRETE BEAM DESIGN TO AS3600.

4
DGH
210631
15/06/2021

$b_v =$	1000 mm.	
$b_{eff} =$	1000 mm.	
$D =$	80 mm.	
$d =$	40 mm.	80 SLEEPER
$f_{sy} =$	500 MPa.	
$F'_c =$	60 MPa.	
Design Moment, $M^* =$	11.30 kN.m.	BENDING CAPACITY
$A_{st} \text{ required} =$	783 mm ² .	
Design shear, $V^* =$	38.19 kN.	
$A_{st} \text{ provided} =$	785 mm ² .	N10 @ 100%
$d_v =$	57.60	
Epsilon $x =$	0.00075	
$k_v =$	0.189	
$V_{uc} =$	84.20 kN.	
$0.75 \times V_{uc} =$	63.15 kN.	
$V_{u.min} =$	108.20 kN.	
$s \text{ (max. allowed)} =$	60 mm.	
$s \text{ (chosen)} =$	0 mm.	
$f_{sy.lig} =$	500 MPa.	
$A_{sv.min} =$	0 mm ² .	
Required $V_{us} =$	-33.28 kN.	
$A_{sv} \text{ (strength)} =$	0 mm ² . Use This Value	

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REINFORCED CONCRETE BEAM DESIGN TO AS3600.

5
DGH
210631
15/06/2021

bv = 1000 mm.
beff = 1000 mm.
D = 100 mm.
d = 50 mm.
fsy = 500 MPa.
F'c = 60 MPa.
Design Moment, M* = 14.45 kN.m.
Ast required = 784 mm².
Design shear, V* = 38.19 kN.
Ast provided = 785 mm².
dv = 72.00
Epsilon x = 0.00076
kv = 0.187
Vuc = 104.19 kN.
0.75 x Vuc = 78.14 kN.
Vu.min = 134.19 kN.
s (max. allowed) = 75 mm.
s (chosen) = 0 mm.
fsy.lig = 500 MPa.
Asv.min = 0 mm².
Required Vus = -53.27 kN.
Asv (strength) = 0 mm². Use This Value

100 SLABER.

BENDING
CAPACITY

N10@100 c/c

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REINFORCED CONCRETE BEAM DESIGN TO AS3600.

6
DGH
210631
15/06/2021

bv =	1000 mm.	
beff =	1000 mm.	
D =	100 mm.	
d =	50 mm.	100 SLAGER
fsy =	500 MPa.	
F'c =	60 MPa.	
Design Moment, M* =	20.00 kN.m.	BENDING CAPACITY
Ast required =	1127 mm ² .	
Design shear, V* =	38.19 kN.	
Ast provided =	1130 mm ² .	N12 - 100%
dv =	72.00	
Epsilon x =	0.00070	
kv =	0.195	
Vuc =	108.90 kN.	
0.75 x Vuc =	81.67 kN.	
Vu.min =	138.90 kN.	
s (max. allowed) =	75 mm.	
s (chosen) =	0 mm.	
fsy.lig =	500 MPa.	
Asv.min =	0 mm ² .	
Required Vus =	-57.98 kN.	
Asv (strength) =	0 mm ² . Use This Value	

REINFORCED CONCRETE SLAB DESIGN TO AS3600. (Crack Width Check)

7
DGH
210631
15/06/2021

b = 1000 mm.

D = 80 mm.

d = 40 mm.

fsy = 500 MPa.

F'c = 60 MPa.

80 SLABER

Design Moment, M* = 11.3 kN.m.

Ast required = 783 mm². *****

Ast provided = 785 mm² — *N10-100 ye*

Bar Spacing, s = 100 mm.

Bar Diameter, db = 10 mm.

Working Moment, M = 8.48 kN.m *****

dn = 80 mm.

Es = 200000 MPa.

Concrete Density, Rho = 2400 Kg/m³.

Long Term Ec = 17400 MPa.

Modular Ratio, n = 15.0

Steel Ratio, p = 0.0196 n.p = 0.2944

k = 0.527

k.d = 21.10 mm.

j = 0.824

Steel Stress, fs = 328 MPa. *****

Stress Limit, Fs = 335 MPa. Table 8.6.2.2 (A) - AS3600

Average Strain, Em = 0.0048878

Minimum Cover, C.min = 35 mm.

Ct = 59.0 mm. To Main Steel

Crack Width, W.max = 0.477 mm.

REINFORCED CONCRETE SLAB DESIGN TO AS3600. (Crack Width Check)

8
DGH
210631
15/06/2021

b = 1000 mm.
D = 100 mm.
d = 50 mm.
fsy = 500 MPa.
F'c = 60 MPa.

100 sleeper

Design Moment, M* = 14.45 kN.m.

Ast required = 784 mm². *****

Ast provided = **785 mm²**. *N10-100/c*

Bar Spacing, s = 100 mm.

Bar Diameter, db = 10 mm.

Working Moment, M = 10.69 kN.m *****

dn = 100 mm.

Es = 200000 MPa.

Concrete Density, Rho = 2400 Kg/m³.

Long Term Ec = 17400 MPa.

Modular Ratio, n = 15.0

Steel Ratio, p = 0.0157 n.p = 0.2355

k = 0.490

k.d = 24.50 mm.

j = 0.837

Steel Stress, fs = 326 MPa. *****

Stress Limit, Fs = 335 MPa. Table 8.6.2.2 (A) - AS3600

Average Strain, Em = 0.0045458

Minimum Cover, C.min = 45 mm.

Ct = 65.7 mm. To Main Steel

Crack Width, W.max = 0.579 mm.

REINFORCED CONCRETE SLAB DESIGN TO AS3600. (Crack Width Check)

9
DGH
210631
15/06/2021

b =	1000 mm.	
D =	100 mm.	
d =	50 mm.	100 super
fsy =	500 MPa.	
F'c =	60 MPa.	
Design Moment, M* =	20 kN.m.	
Ast required =	1127 mm ² .	*****
Ast provided =	1130 mm ² .	N 12, 100 ye
Bar Spacing, s =	100 mm.	
Bar Diameter, db =	12 mm.	
Working Moment, M =	14.4 kN.m	*****
dn =	100 mm.	
Es =	200000 MPa.	
Concrete Density, Rho =	2400 Kg/m ³ .	
Long Term Ec =	17400 MPa.	
Modular Ratio, n =	15.0	
Steel Ratio, p =	0.0226	n.p = 0.3390
k =	0.551	
k.d =	27.57 mm.	
j =	0.816	
Steel Stress, fs =	312 MPa.	*****
Stress Limit, Fs =	335 MPa.	Table 8.6.2.2 (A) - AS3600
Average Strain, Em =	0.0048439	
Minimum Cover, C.min =	44 mm.	
Ct =	64.7 mm.	To Main Steel
Crack Width, W.max =	0.598 mm.	