



Project: CONCRETE SLEEPER DESIGN (5kPa AND 10kPa SURCHARGE)	Page: 1
CONCRETE STRENGTH N40 GRADE CONCRETE	Ref: 7349
Client: SUNSET SLEEPERS	Designed: AFC
	Date: OCT 2018

NOTE: "d_o" AND "d" VALUES BASED ON THE FOLLOWING CLIENT ADVICE:

- 80 SLEEPER d = d_o = 39
- 100 SLEEPER d = d_o = 59

CONCRETE SLEEPER DESIGN

1.0 MAX BENDING MOMENT

1.1 200 x 80 THICK SLEEPER

CONCRETE STRENGTH = 40MPa
REINFORCEMENT = 2-12mm BARS CENTRAL

$$M^* = \phi M_L = \phi A_{st} f_{sy} d \left[\frac{1 - 0.6 A_{st} f_{sy}}{l d f_c} \right]$$

$$= 0.8 \times 226 \times 10^{-6} \times 500 \times 10^3 \times 39 \times 10^3 \left[1 - \frac{0.6 \times 226 \times 10^{-6} \times 500 \times 10^3}{200 \times 10^{-3} \times 39 \times 10^{-3} \times 40 \times 10^3} \right]$$

$$40 \text{ MPa} \leq 3.53 \left[1 - \frac{67.8}{312} \right] = \underline{2.76 \text{ kN-m}}$$

1.2 200 x 100 THICK SLEEPER

CONCRETE STRENGTH = 40MPa
REINFORCEMENT = 2-12mm BARS CENTRAL

$$M^* \leq 0.8 \times 226 \times 10^{-6} \times 500 \times 10^3 \times 59 \times 10^{-3} \left[1 - \frac{0.6 \times 226 \times 10^{-6} \times 500 \times 10^3}{200 \times 10^{-3} \times 39 \times 10^{-3} \times 40 \times 10^3} \right]$$

$$40 \text{ kPa} \leq 5.33 \left[1 - \frac{67.8}{475} \right] = \underline{4.57 \text{ kN-m}}$$

2.0 MAX SHEAR

2.1 200x80 THICK SLEEPER

CONCRETE STRENGTH = 40MPa
REINFORCEMENT = 2-12mm BARS CENTRAL

$$V^* \leq 0.5 \phi V_{lc} \\ \leq 0.5 \times 0.7 \times \beta_1 \beta_2 \beta_3 L_v d_o f_{ev} \left(\frac{A_{st}}{L_v d_o} \right)^{1/3}$$



Project: CONCRETE SLEEPER DESIGN (5kPa AND 10kPa SURCHARGE)	Page: 2
CONCRETE STRENGTH N40 GRADE CONCRETE	Ref: 7349
	Designed: AFC
Client: SUNSET SLEEPERS	Date: OCT 2018

WHERE $\beta_1 = 1.1 (1.6 - d_o/1000) \geq 1.1$
 $= 1.1 (1.6 - 39/1000) = 1.72 > 1.1$ OK!

$\beta_2 = 1$ $l_w = 200 \times 10^{-3}$ $f_{ev} = 3.42$

$\beta_3 = 1$ $d_o = 39 \times 10^{-3}$ $\Delta_{st} = 226 \times 10^{-6}$

$$V^* \leq 0.5 \times 0.7 \times 1.72 \times 1 \times 1 \times 200 \times 10^{-3} \times 39 \times 10^{-3} \times 3.42 \times 10^3 \left(\frac{226 \times 10^{-6}}{0.2 \times 0.39} \right)^{1/3}$$
$$\leq \underline{4.93 \text{ kN}}$$

2.2 200x100 THICK SLEEPER

CONCRETE STRENGTH = 40 MPa
REINFORCEMENT = 2-12mm BARS CENTRAL

$$V^* \leq 0.5 \phi V_{cc}$$

$\beta_1 = 1.1 (1.6 - 59/1000) = 1.695 > 1.1$ OK!

$\beta_2 = 1$ $l_w = 200 \times 10^{-3}$ $f_{ev} = 3.42$

$\beta_3 = 1$ $d_o = 59 \times 10^{-3}$ $\Delta_{st} = 226 \times 10^{-6}$

$$\leq 0.5 \times 0.7 \times 1.695 \times 1 \times 1 \times 200 \times 10^{-3} \times 59 \times 10^{-3} \times 3.42 \times 10^3 \left(\frac{226 \times 10^{-6}}{0.2 \times 0.59} \right)^{1/3}$$
$$\leq \underline{6.40 \text{ kN}}$$



Project: CONCRETE SLEEPER DESIGN (5kPa AND 10kPa SURCHARGE)	Page: 3
CONCRETE STRENGTH N40 GRADE CONCRETE	Ref: 7349
Client: SUNSET SLEEPERS	Designed: AFC
	Date: OCT 2018

3.0 MAX RETAINED HEIGHT

3.1 200x80 THICK x 1800 LONG SLEEPER

$M^* \leq 2.76 \text{ kN-m}$, $V^* = 4.93 \text{ kN}$
ALLOWABLE LOAD AT BASE OF WALL

$$\Rightarrow M^* = \frac{wl^2}{8} ; w = \frac{8M}{l^2} = \frac{8 \times 2.76}{1.8^2} = 6.81 \text{ kN-m}$$

$$\text{OR } \Rightarrow V^* = \frac{wL}{2} ; w = \frac{2V}{L} = \frac{2 \times 4.93}{1.8} = 5.48 \text{ kN-m}$$

∴ SHEAR DESIGN CASE GOVERNS

$$\text{PRESSURE AT BASE} = \frac{5.48 \text{ kN-m}}{0.2 \text{ m}} = 27.4 \text{ kPa}$$

MAX RETAINED HEIGHT 5kPa SURCHARGE \Rightarrow

$$27.4 = 1.5 \times 5.0 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$24.775 = 8.584$$

$$H = 2.888 \text{ m} = \underline{2888 \text{ mm}}$$

MAX RETAINED HEIGHT 10kPa SURCHARGE

$$27.4 = 1.5 \times 10 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$22.15 = 8.584$$

$$H = 2.582 \text{ m} = \underline{2582 \text{ mm}}$$

3.2 200x80 THICK x 2000 LONG SLEEPER

ALLOWABLE LOAD AT BASE OF WALL

$$\Rightarrow M^* = \frac{wl^2}{8} ; w = \frac{8M}{l^2} = \frac{8 \times 2.76}{2^2} = 5.52 \text{ kN-m}$$

$$\text{OR } \Rightarrow V^* = \frac{wL}{2} ; w = \frac{2V}{L} = \frac{2 \times 4.93}{2} = 4.93 \text{ kN-m}$$

∴ SHEAR DESIGN CASE GOVERNS

$$\text{PRESSURE AT BASE} = \frac{4.93}{0.2} = 24.65 \text{ kPa}$$



Project: CONCRETE SLEEPER DESIGN (5kPa AND 10kPa SURCHARGE)	Page: 4
CONCRETE STRENGTH N40 GRADE CONCRETE	Ref: 7349
Client: SUNSET SLEEPERS	Designed: AFC
	Date: OCT 2018

MAX RETAINED HEIGHT 5kPa SURCHARGE ⇒

$$24.65 = 1.5 \times 5.0 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$22.025 = 8.58H$$

$$H = 2.567 \text{ m} = \underline{2567 \text{ mm}}$$

MAX RETAINED HEIGHT 10kPa SURCHARGE ⇒

$$24.65 = 1.5 \times 10 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$19.40 = 8.58H$$

$$H = 2.261 \text{ m} = \underline{2261 \text{ mm}}$$

3.3 200x80 THICK x 2400 LONG SLEEPER

ALLOWABLE LOAD AT BASE OF WALL

$$\Rightarrow M^* = \frac{Wl^2}{8}; W = \frac{BM}{l^2} = \frac{8 \times 2.76}{2.4^2} = 3.833 \text{ kN-m}$$

$$\text{OR } \Rightarrow V^* = \frac{WL}{2}; W = \frac{2V}{L} = \frac{2 \times 4.93}{2.4} = 4.108 \text{ kN-m}$$

∴ BENDING MOMENT DESIGN CASE GOVERNS

$$\text{PRESSURE AT BASE} = \frac{3.833}{0.2} = 19.165 \text{ kPa}$$

MAX RETAINED HEIGHT 5kPa SURCHARGE ⇒

$$19.165 = 1.5 \times 5.0 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$16.54 = 8.58H$$

$$H = 1.928 \text{ m} = \underline{1928 \text{ mm}}$$

MAX RETAINED HEIGHT 10kPa SURCHARGE ⇒

$$19.165 = 1.5 \times 10 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$13.915 = 8.58H$$

$$H = 1.622 \text{ m} = \underline{1622 \text{ mm}}$$



Project: CONCRETE SLEEPER DESIGN (5kPa AND 10kPa SURCHARGE)	Page: 5
CONCRETE STRENGTH N40 GRADE CONCRETE	Ref: 7349
	Designed: AFC
Client: SUNSET SLEEPERS	Date: OCT 2018

3.4 200 x 100 THICK x 1800 LONG SLEEPER

$$M^* \leq 4.57 \text{ kN-m}, \quad V^* \leq 6.40 \text{ kN}$$

ALLOWABLE LOAD AT BASE OF WALL

$$\Rightarrow M^* = \frac{Wl^2}{8}; \quad W = \frac{8M}{l^2} = \frac{8 \times 4.57}{1.8^2} = 11.284 \text{ kN-m}$$

$$\text{OR } \Rightarrow V^* = \frac{WL}{2}; \quad W = \frac{2V}{L} = \frac{2 \times 6.40}{1.8} = 7.11 \text{ kN-m}$$

∴ SHEAR DESIGN CASE GOVERNS

$$\text{PRESSURE AT BASE} = \frac{7.11}{0.2} = 35.55 \text{ kPa}$$

MAX RETAINED HEIGHT 5kPa SURCHARGE \Rightarrow

$$\begin{aligned} 35.55 &= 1.5 \times 5.0 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35H \\ 32.925 &= 8.58H \\ H &= 3.837 \text{ m} = \underline{\underline{3837 \text{ mm}}} \end{aligned}$$

MAX RETAINED HEIGHT 10kPa SURCHARGE \Rightarrow

$$\begin{aligned} 35.55 &= 1.5 \times 10 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H \\ 30.30 &= 8.58H \\ H &= 3.531 \text{ m} = \underline{\underline{3531 \text{ mm}}} \end{aligned}$$

3.5 200 x 100 THICK x 2000 LONG SLEEPER

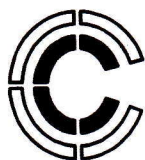
ALLOWABLE LOAD AT BASE OF WALL

$$\Rightarrow M^* = \frac{Wl^2}{8}; \quad W = \frac{8M}{l^2} = \frac{8 \times 4.57}{2^2} = 9.14 \text{ kN-m}$$

$$\text{OR } \Rightarrow V^* = \frac{WL}{2}; \quad V = \frac{2V}{L} = \frac{2 \times 6.40}{2} = 6.40 \text{ kN-m}$$

∴ SHEAR DESIGN CASE GOVERNS

$$\text{PRESSURE AT BASE} = \frac{6.40}{0.2} = 32 \text{ kPa.}$$



Project: CONCRETE SLEEPER DESIGN (5kPa AND 10kPa SURCHARGE)	Page: 6
CONCRETE STRENGTH N40 GRADE CONCRETE	Ref: 7349
Client: SUNSET SLEEPERS	Designed: AFL
	Date: OCT 2018

MAX RETAINED HEIGHT 5kPa SURCHARGE ⇒

$$32.00 = 1.5 \times 5.0 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$29.375 = 8.58H$$

$$H = 3.424 \text{ m} = \underline{\underline{3424 \text{ mm}}}$$

MAX RETAINED HEIGHT 10kPa SURCHARGE ⇒

$$32.00 = 1.5 \times 10 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$26.75 = 8.58H$$

$$H = 3.118 \text{ m} = \underline{\underline{3118 \text{ mm}}}$$

3.6 200x100 THICK x 2400 LONG SLEEPER

ALLOWABLE LOAD AT BASE OF WALL

$$\Rightarrow M^* = \frac{wL^2}{8} ; W = \frac{8M}{L^2} = \frac{8 \times 4.57}{2.4^2} = 6.372 \text{ kN-m}$$

$$\text{OR } \Rightarrow V^* = \frac{wL}{2} ; W = \frac{2V}{L} = \frac{2 \times 6.40}{2.4} = 6.40 \text{ kN-m}$$

∴ BENDING MOMENT DESIGN CASE GOVERNS

$$\text{PRESSURE AT BASE} = \frac{6.372}{0.2} = 31.86 \text{ kPa}$$

MAX RETAINED HEIGHT 5kPa SURCHARGE ⇒

$$31.86 = 1.5 \times 5.0 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$29.235 = 8.58H$$

$$H = 3.407 \text{ m} = \underline{\underline{3407 \text{ mm}}}$$

MAX RETAINED HEIGHT 10kPa SURCHARGE ⇒

$$31.86 = 1.5 \times 10 \text{ kPa} \times 0.35 + 1.25 \times 19.62 \times 0.35 \times H$$

$$26.61 = 8.58H$$

$$H = 3.101 \text{ m} = \underline{\underline{3101 \text{ mm}}}$$