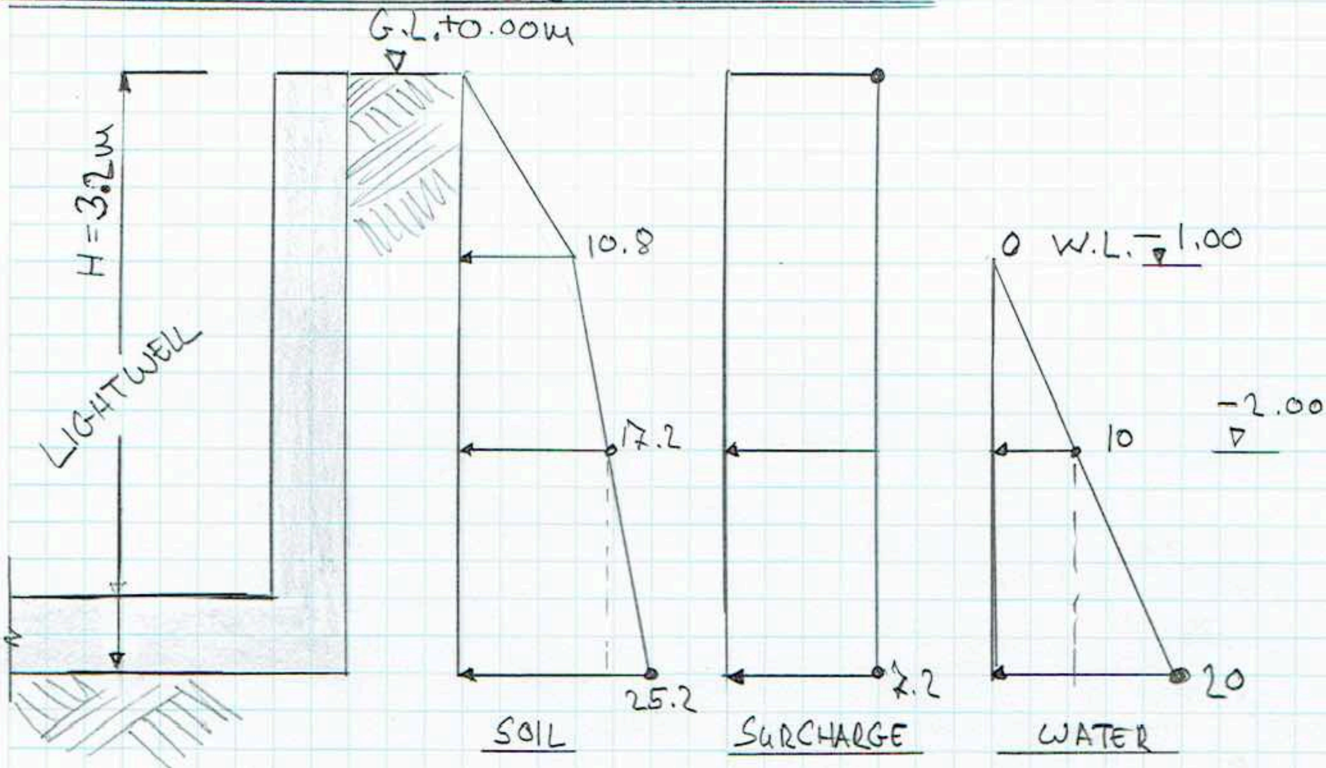
Project No. 1587	Sheet 1	Revision	27 GLADYS ROAD
Date 23.05.2017	Engineer KT	Checked	Project

RETAINING WALL DESIGN AT LIGHTWELL:

THE RETAINING WALL IS A CANTILEVER WITHOUT ANY PROPPING PROVIDED TO THE TOP.

DERIVATION OF HORIZONTAL LOADING:



SOIL:

$$\omega_{SOIL,1} = 0.6(18\,kN/m^3 \times 1m \times 1m) = \underline{10.8}\ kN/m$$

$$\omega_{SOIL2} = \omega_{SOIL,1} + \left[0.6(18\,kN/m^3 \times 2m \times 1m) \times \frac{2}{3}\right] = \underline{25.2}\,kN/m$$

SURCHARGE:

$$\omega_{SUR} = 0.6 \times 12\,kN/m^2 = \underline{7.2\,kN/m}$$

WATER:

$$\omega_{WATER} = 10\,kN/m^3 \times 2m = \underline{20\,kN/m}$$

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RETAINING WALL IS TO BE DESIGNED TO SPAN HORIZONTALLY AS AN RC SLAB.

WORST CASE DEAD LOAD ON RC WALL:

$$SOIL = 17.2 + \frac{(25.2 - 17.2) \times 1}{2} = \underline{\underline{21.2}}\ kN/m$$

$$WATER = 10 + \frac{(20 - 10) \times 1}{2} = \underline{\underline{15}}\ kN/m$$

WORST CASE LIVE LOAD ON RC WALL:

$$SURCHARGE = \underline{\underline{7.2}}\ kN/m$$

DESIGN:

FOR CALCULATION AND DESIGN REFER TO TEDDS PRINT-OUTS.

$$\omega_{ULS} = 1.4[21.2 + 15] + 1.6[7.2] = \underline{\underline{62.2}}\ kN/m$$

$$R = \frac{\omega L}{2} = \frac{62.2 \times 5}{2} = \underline{\underline{156}}\ kN$$

$$M = \frac{\omega L^2}{8} = \frac{62.2 \times 5^2}{8} = \underline{\underline{195}}\ kNm$$

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RC SLAB DESIGN (BS8110:PART1:1997)

TEDDS calculation version 1.0.04

CONCRETE SLAB DESIGN (CL 3.5.3 & 4)

SIMPLE ONE WAY SPANNING SLAB DEFINITION

Overall depth of slab $h = \mathbf{300}$ mm

Cover to tension reinforcement resisting sagging $c_b = \mathbf{50}$ mm

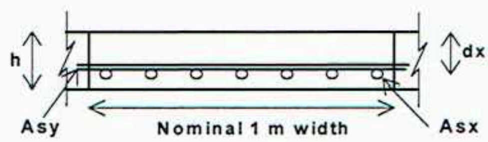
Trial bar diameter $D_{tryx} = \mathbf{25}$ mm

Depth to tension steel (resisting sagging)

$d_x = h - c_b - D_{tryx}/2 = \mathbf{237}$ mm

Characteristic strength of reinforcement $f_y = \mathbf{500}$ N/mm^2

Characteristic strength of concrete $f_{cu} = \mathbf{40}$ N/mm^2



One-way spanning slab
(simple)

ONE WAY SPANNING SLAB (CL 3.5.4)

MAXIMUM DESIGN MOMENTS IN SPAN

Design sagging moment (per m width of slab) $m_{sx} = \mathbf{195.0}$ kNm/m

CONCRETE SLAB DESIGN – SAGGING – OUTER LAYER OF STEEL (CL 3.5.4)

Design sagging moment (per m width of slab) $m_{sx} = \mathbf{195.0}$ kNm/m

Moment Redistribution Factor $\beta_{bx} = \mathbf{1.0}$

Area of reinforcement required

$K_x = abs(m_{sx}) / (d_x^2 \times f_{cu}) = \mathbf{0.086}$

$K'_x = \min (0.156 , (0.402 \times (\beta_{bx} - 0.4)) - (0.18 \times (\beta_{bx} - 0.4)^2)) = \mathbf{0.156}$

Outer compression steel not required to resist sagging

Slab requiring outer tension steel only - bars (sagging)

$z_x = \min ((0.95 \times d_x),(d_x \times (0.5+\sqrt{(0.25-K_x/0.9)}))) = \mathbf{212}$ mm

Neutral axis depth $x_x = (d_x - z_x) / 0.45 = \mathbf{57}$ mm

Area of tension steel required

$A_{sx\_req} = abs(m_{sx}) / (1/\gamma_{ms} \times f_y \times z_x) = \mathbf{2116}$ mm^2/m

Tension steel

Provide 25 dia bars @ 150 centres outer tension steel resisting sagging

$A_{sx\_prov} = A_{sx} = \mathbf{3270}$ mm^2/m

Area of outer tension steel provided sufficient to resist sagging

TRANSVERSE BOTTOM STEEL - INNER

Inner layer of transverse steel

Provide 12 dia bars @ 150 centres

$A_{sy\_prov} = A_{sy} =$ **754** mm^2/m

Check min and max areas of steel resisting sagging

Total area of concrete $A_c = h =$ **300000** mm^2/m

Minimum % reinforcement $k =$ **0.13** %

$A_{st\_min} = k \times A_c =$ **390** mm^2/m

$A_{st\_max} = 4\ \% \times A_c =$ **12000** mm^2/m

Steel defined:

Outer steel resisting sagging $A_{sx\_prov} =$ **3270** mm^2/m

Area of outer steel provided (sagging) OK

Inner steel resisting sagging $A_{sy\_prov} =$ **754** mm^2/m

Area of inner steel provided (sagging) OK

SHEAR RESISTANCE OF CONCRETE SLABS (CL 3.5.5)

Outer tension steel resisting sagging moments

Depth to tension steel from compression face $d_x =$ **237** mm

Area of tension reinforcement provided (per m width of slab) $A_{sx\_prov} =$ **3270** mm^2/m

Design ultimate shear force (per m width of slab) $V_x =$ **156** kN/m

Characteristic strength of concrete $f_{cu} =$ **40** N/mm^2

Applied shear stress

$v_x = V_x / d_x =$ **0.66** N/mm^2

Check shear stress to clause 3.5.5.2

$v_{allowable} = \min((0.8\ N^{1/2}/mm) \times \sqrt{(f_{cu})}, 5\ N/mm^2) =$ **5.00** N/mm^2

Shear stress - OK

Shear stresses to clause 3.5.5.3

Design shear stress

$f_{cu\_ratio} = \text{if}\ (f_{cu} > 40\ N/mm^2,\ 40/25,\ f_{cu}/(25\ N/mm^2)) =$ **1.600**

$v_{cx} = 0.79\ N/mm^2 \times \min(3, 100 \times A_{sx\_prov} / d_x)^{1/3} \times \max(0.67, (400\ mm / d_x)^{1/4}) / 1.25 \times f_{cu\_ratio}^{1/3}$

$v_{cx} =$ **0.94** N/mm^2

Applied shear stress

$v_x =$ **0.66** N/mm^2

No shear reinforcement required

CONCRETE SLAB DEFLECTION CHECK (CL 3.5.7)

Slab span length $l_x =$ **5.000** m

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Design ultimate moment in shorter span per m width m_{sx} = **195** kNm/m

Depth to outer tension steel d_x = **237** mm

Tension steel

Area of outer tension reinforcement provided A_{sx_prov} = **3270** mm^2/m

Area of tension reinforcement required A_{sx_req} = **2116** mm^2/m

Moment Redistribution Factor β_{bx} = **1.00**

Modification Factors

Basic span / effective depth ratio (Table 3.9) $ratio_{span\_depth}$ = **20**

The modification factor for spans in excess of 10m (ref. cl 3.4.6.4) has not been included.

$f_s = 2 \times f_y \times A_{sx\_req} / (3 \times A_{sx\_prov} \times \beta_{bx})$ = **215.7** N/mm^2

$factor_{tens} = \min(2, 0.55 + (477\ N/mm^2 - f_s) / (120 \times (0.9\ N/mm^2 + m_{sx} / d_x^2)))$ = **1.050**

Calculate Maximum Span

This is a simplified approach and further attention should be given where special circumstances exist. Refer to clauses 3.4.6.4 and 3.4.6.7.

Maximum span $l_{max} = ratio_{span\_depth} \times factor_{tens} \times d_x$ = **4.99** m

Check the actual beam span

Actual span/depth ratio l_x / d_x = **21.05**

Span depth limit $ratio_{span\_depth} \times factor_{tens}$ = **20.99**

Span/Depth ratio exceeds limit - check Fails

LOADING IS CONSERVATIVE, THEREFORE OK!

<u>**CHECK OF NOMINAL COVER (SAGGING) – (BS8110:PT 1, TABLE 3.4)**</u>

Slab thickness h = **300** mm

Effective depth to bottom outer tension reinforcement d_x = **237.5** mm

Diameter of tension reinforcement D_x = **25** mm

Diameter of links L_{diax} = **0** mm

Cover to outer tension reinforcement

$c_{tenx} = h - d_x - D_x / 2$ = **50.0** mm

Nominal cover to links steel

$c_{nomx} = c_{tenx} - L_{diax}$ = **50.0** mm

Permissable minimum nominal cover to all reinforcement (Table 3.4)

c_{min} = **50** mm

Cover over steel resisting sagging OK