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STRUCTURAL CALCULATION

For

(Basement Design)
(Planning Application)

26 Lynhurst Road
London
NW3

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Basement Design

Design consideration

Surcharge, Earth and Water

Loading

Surcharge

From BS 8002 1994 3.3.4.1
Surcharge q_1 = 10.00 kN/m²
Using 5.00 kN/m² for Build-up Earth → Garden
2.00 kN/m² for Internal House → Imposed

Earth Pressure

From Site Analytical Services LTd
Basement Impact Assessment +
Factual Report Ground Investigation

Soil:- Made ground overlaying the claygate member over clay formation

Bearing Pressure :- 74kN/m² at 3.00m increasing to 125 kN/m² at 4.0m
Using = 80.00 kN/m²

$\gamma = 18.50$; $\phi = 25°$

$$K_a = \frac{1-\sin 25}{1+\sin 25} = 0.40$$

Water Pressure

From site Analytical Services Ltd
Factual Ground Investigation Report

Water is found at about 4.50m below ground
Design is based on water pressure of two-third design RC Retaining water.

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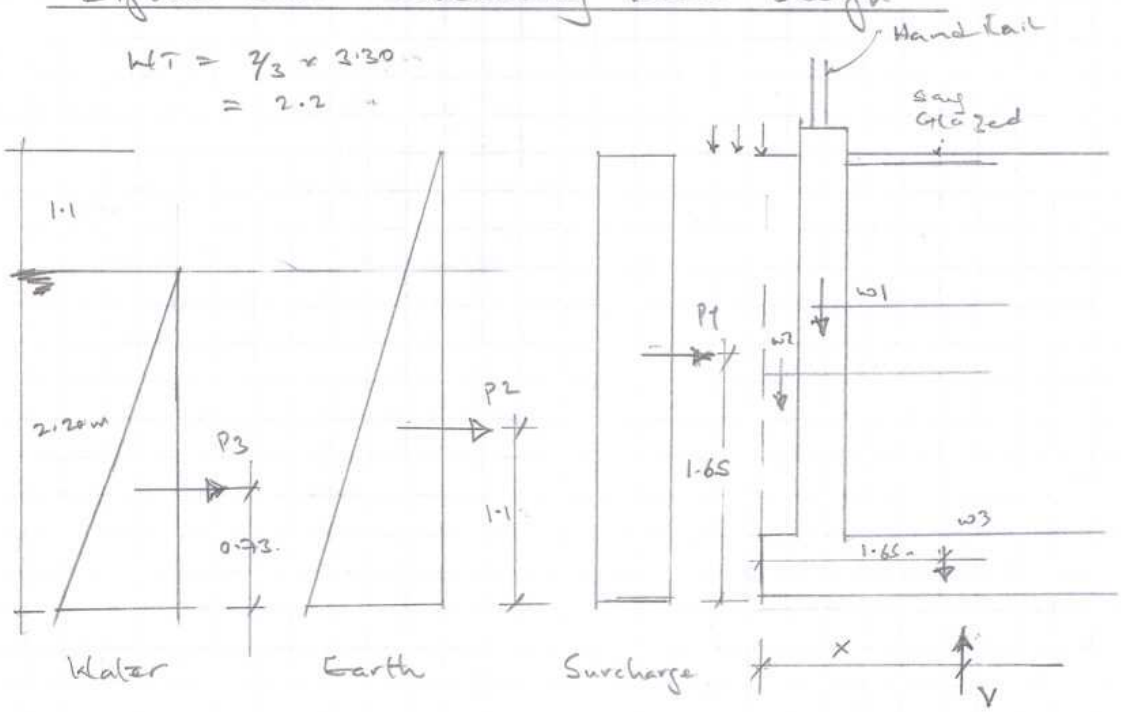
Light Well Retaining Wall Design



Load	DL	LL	DL + LL
Hand rail DL:- 1.00 kN/m² x Sag 1.50 m =	1.50		
Retaining wall DL:- 24 kN/m³ x 0.30m x 3.10m =	22.32		
* Glazed Floor DL:- Sag 1.50 kN/m² x Sag 1.00 m	1.50		
IL:- 2.50 kN/m² x 1.00 m		2.50	
Total W1	25.32 kN/m	2.50 kN/m	(SLS) 27.82 kN/m
Granular Material * DL: 20.00 kN/m³ x 0.20 x 2.95m =	11.80 kN/m		(SLS) 11.80 kN/m
Total W2			
Base slab DL:- 24 kN/m³ x 0.35 x Sag 3.00m =	25.20 kN/m		(SLS) 25.20 kN/m
Total W3			
Total V = W1 + W2 + W3 =			64.82 kN/m

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Base Pressure

	DL	LL	DL+LL
P1 Surcharge = 5.00 kN/m² × 0.4 × 3.30		6.60 kN/m	
P2 Earth = ½ × 0.40 × 18.5 × 3.30² =	40.293 kN/m		
P3 water = ½ × 9.81 × 2.20² =	23.70 kN/m		

Stability Check

Overturning

Overturning Moment @ Base = (6.60 × 1.65) + (40.293 × 1.10) + (23.70 × 0.73)
= 72.51 kNm

Stabilising Moment = (27.62 × 3.125) + (11.60 × 3.35) + (21.6 × 1.65)
= 162.10 kNm

F.O.S overturning = $\frac{162.10}{72.51}$ = 2.24 ∴ ok

Sliding

RC wall cannot slide as it is tied to (Part of) RC slab.

Bearing Pressure

Vx = (6.60 × 1.65) + (40.293 × 1.10) + (23.70 × 0.73) + (27.62 × 0.35)
+ (11.60 × 0.1) + (25.20 × 1.65) = 125.01 kNm

$x = \frac{125.01}{64.82} = 1.928 \Rightarrow \frac{3.30}{2} - 1.928 = -0.278$

Bearing Pressure @ max $= \frac{V}{A} \pm \frac{Ve}{Z}$

$= \frac{64.82}{3.00} \pm \frac{64.82 \times 6 \times (-0.278)}{3.0^2}$

= 33.62 kN/m² ∴ ok

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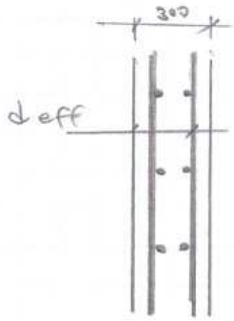
Reinforcement in Wall

BM @ Base = 72.51 kN m

BM_{ULT} = 72.51 × 1.4 = 101.514 kN m



Wall thickness = 300 mm

d eff = 300 − 35 − 16/2

= 257 mm

$$K = \frac{M}{bd^2 f_{cu}} \Rightarrow \frac{101.514 \times 10^6}{1000 \times 257^2 \times 35} = 0.044 < K'$$

$$z = d\left\{0.5\left[\sqrt{\left(0.25 - \frac{0.044}{0.90}\right)}\right]\right\} = 0.95\,d$$

$$A_s = \frac{101.514 \times 10^6}{0.95 \times 460 \times 0.95 \times 257} = 952\ mm^2/m$$

∴ PROVIDE H16 BARS @ 150 mm c/c (A_s = 1340 mm^2/m)

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Reinforcement in Base

$BM_{out} = 33.62\ kN/m^2 \times \frac{2.60^2}{2} \times 1.4 = 159.10\ kN\,m$

Base = 350 mm

$d_{eff} = 350 - 40 - 16/2 = 302$ mm

$K = \frac{159.10 \times 10^6}{1000 \times 302^2 \times 35} = 0.0498 < K'$

$z = d\left\{0.5 + \left[\sqrt{\left(0.25 - \frac{0.0498}{0.90}\right)}\right]\right\} = 0.94d < 0.95d$

$A_s = \frac{159.10 \times 10^6}{0.95 \times 460 \times 0.94 \times 302} = 1282$

∴ PROVIDE H16 BARS @ 150mm c/c ($A_s = 1340\ mm^2/m$)
TOP & BOTTOM + BOTH WAYS

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Base Slab Design (Basement)

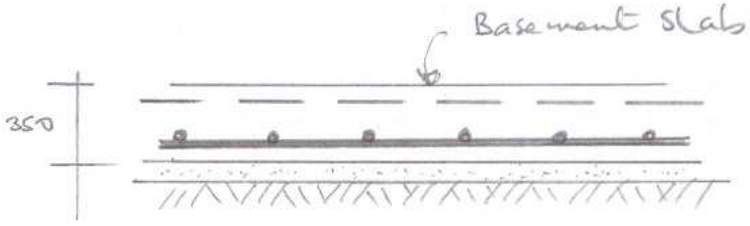
slab = 350 mm

Uplift force

$F = 2.20 \times 9.81 = 21.582$ kN/m

Factored $= 22.00 \times 1.4 = 30.80$ kN/m

$BM_{max} = \frac{31.00 \times 3.50^2}{8} = 47.50$ kN m



$d_{eff} = 350 - 40 - 8 = 302$ mm

$K = \frac{50.00 \times 10^6}{1000 \times 302^2 \times 35} = 0.0157$

$z = d\left\{0.5 + \left[\sqrt{\left(0.25 - \frac{0.0157}{0.9}\right)}\right]\right\} = 0.95d$

$A_s = \frac{50 \times 10^6}{0.95 \times 460 \times 0.95 \times 302} = 400$ mm²/m

∴ PROVIDE H12 BARS @ 150 mm c/c (754 mm²/m)

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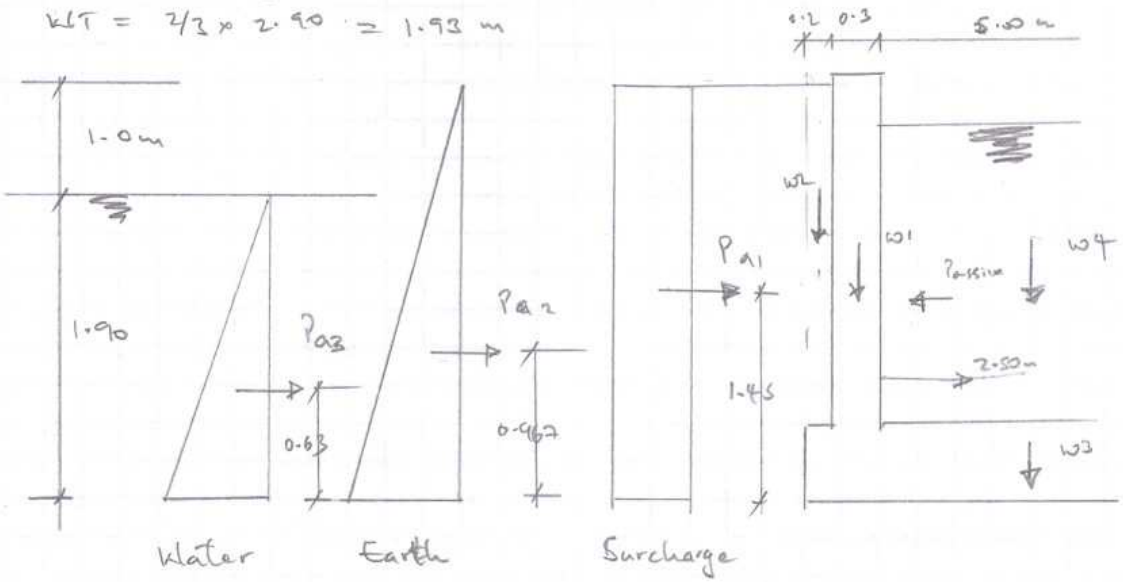
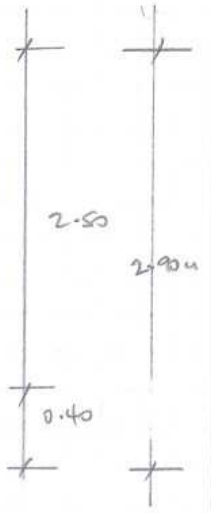
Swimming Pool Retaining Wall Design

KT = 2/3 × 2.90 = 1.93 m





Load	DL	LL	DL+LL
RC Retaining wall DL- 24kN/m³ × 0.30 × 2.50 m = Total W1	18.00 kN		18.00 kN/m
Granular W2 DL- 20kN/m³ × 0.20 × 2.5 Total W2	10.00 kN		10.00 kN/m
Base DL- 24 kN/m³ × 0.40m × 3.00 m Total W 3	28.80 kN		28.80 kN
* Swimming Pool (when full) W4 DL- 9.81 × 2.4 × 2.50 = Total W 4	58.86 kN		58.86 kN/m
Total V = With Swimming Pool water			56.80 kN/m
Without swimming Pool water			115.66 kN/m

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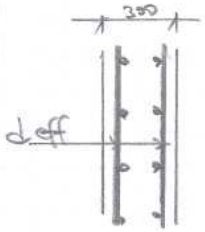
	DL	LL	DL+LL
P1 surcharge Base = 5.00 × 0.40 × 2.90 =		5.80 kN/m	
P2 Earth Pressure Base = ½ × 0.4 × 18.5 × 2.90² =	31.12 kN/m		
P3 Water Pressure Base = ½ × 9.81 × 1.90² =	17.71 kN/m		
Passive Pressure P4 = ½ × 9.81 × 2.60² =	28.25 kN/m		

Reinforcement in Wall (Swimming Pool)

BM@ Base = (5.80 × 1.45) + (31.12 × 0.967) + (17.71 × 0.63) = 49.66 kNm

BM ULT = 50 × 1.4 = 70.00 kNm (ULS)



wall thickness = 300 mm

deff = 300 − 35 − 6 = 257 mm

$$K = \frac{70.0 \times 10^6}{1000 \times 257^2 \times 35} = 0.030 < K'$$

$$z = d\left\{0.5 + \left[\sqrt{\left(0.25 - \frac{0.030}{0.90}\right)}\right]\right\} = 0.96d$$

$$A_s = \frac{70.00 \times 10^6}{0.96 \times 460 \times 0.95 \times 257} = 657 \text{ mm}^2/\text{m}$$

∴ PROVIDE H16 BARS @ 150 mm c/c (A_s = 1340 mm²/m)

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Stability check

Overturning

Overturning Moment @ Base = $(5.80 \times 1.45) + (31.12 \times 0.967) + (17.71 \times 0.63)$

= 49.66 kNm

Stabilising Moment = $(15.00 \times 2.65) + (10.00 \times 2.90) + (26.60 \times 1.50m)$

= 119.90 kNm

F.O.S Overturning = $\frac{119.90}{49.66}$ = 2.40 ∴ ok

Sliding
Wall cannot slide as it is tied to (Part of) RC slab.

Bearing Pressure

$V_x = (5.80 \times 1.45) + (31.12 \times 0.967) + (17.71 \times 0.63) + (15.00 \times 0.35) + (10.0 \times 0.1) + (26.60 \times 1.50) = 100.16$ kN/m

$X = \frac{100.16}{56.80} = 1.76 \Rightarrow \frac{3.00}{2} - 1.76 = -0.263$

Bearing Pressure $q_{max} = \frac{56.80}{3.0} \pm \frac{56.80 \times 6 \times (-0.263)}{3.0^2}$

= 28.90 kN/m² ∴ ok

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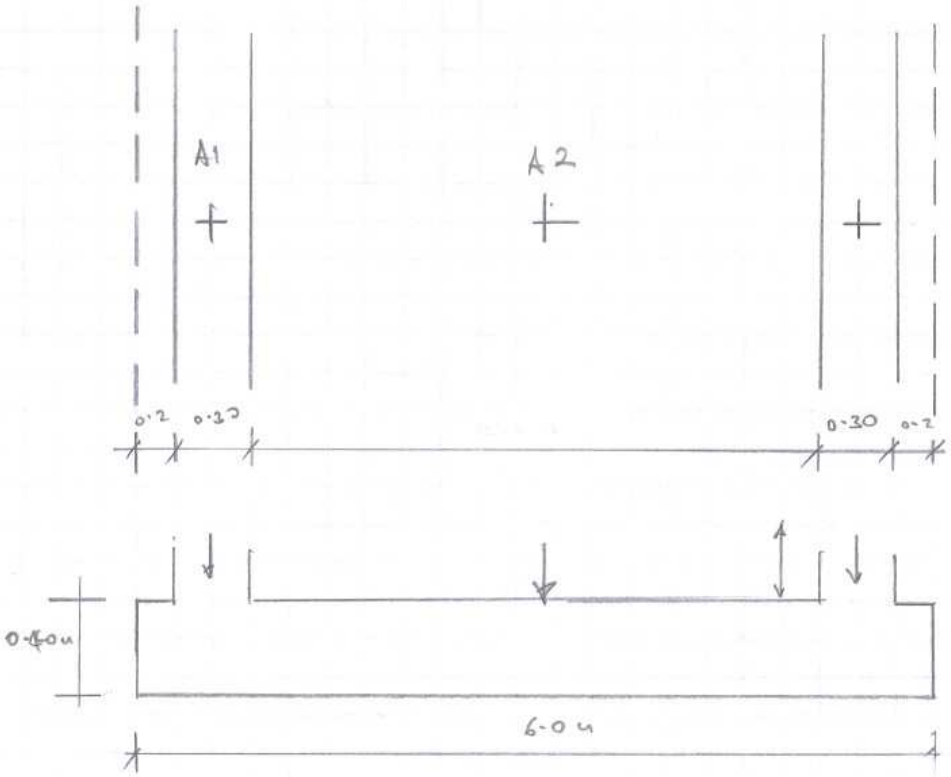
Base Design (With water in swimming Pool)



A1 = RC Retaining w = 15.00

A1 = " " 15.00

A2 = Swimming Pool water (9.81 × 5.0 × 2.50m) = 122.625

Base Slab S/w = 24 × 6.0 × 0.40 57.60

Granular : 20kN/m³ × 0.20 × 2.4m × 2m's = 23.04

Total UDL = 239.265 kN/m

Bearing Pressure = $\frac{250.00 \text{ kN/m}}{6.00 \text{m}}$

= 41.70 kN/m² ∴ OK

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Reinforcement in Base (Swimming Pool)

$$BM_{ULS} = 42.00 \times \frac{3.60^2}{2} \times 1.4$$

$$= 264.60 \text{ kNm}$$

Base thickness = 400 mm

d eff = $400 - 40 - 16/2 = 352$ mm

$$K = \frac{264.60 \times 10^6}{1000 \times 352^2 \times 35} = 0.061$$

$$z = d\left\{0.5 + \left[\sqrt{\left(0.25 - \frac{0.061}{0.9}\right)}\right]\right\} = 0.93d$$

$$A_s = \frac{264.60 \times 10^6}{0.95 \times 460 \times 0.93 \times 352}$$

$$= 1850 \text{ mm}^2/\text{m}$$

∴ PROVIDE H20 BARS @ 150 mm c/c ($2094 \text{ mm}^2/\text{m}$)
TOP & BOTTOM + BOTH WAYS