

Structural Calculations
Design Stage July 2022

FOR

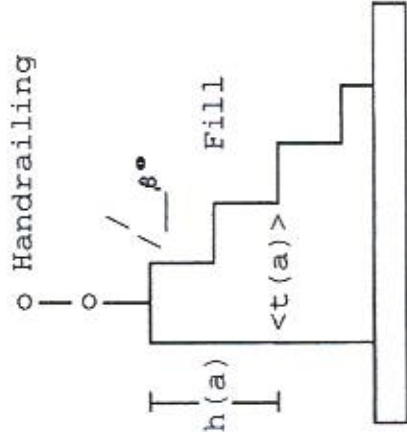
RETAINING WALL

AT

26 PENTWYN
BAGLAN ROAD, BAGLAN

Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.
Location: Wall on grid line A/1-2



Steps are numbered down from the top.
h(a) is height at step a (from top)
t(a) is thickness at step a

Soil details

Weight/unit volume of soil & wall $w_e=18 \text{ kN/m}^3$
Internal angle of friction $\phi=35^\circ$
Angle of backfill $\beta=0^\circ$
Active soil pressure is applicable.
Sine angle of internal friction $\text{sp}=\text{SIN}(\text{RAD}(\phi))=0.5736$
Active pressure coefficient $\text{ce}=(1-\text{sp})/(1+\text{sp})$
 $= (1-0.5736)/(1+0.5736)$
 $= 0.271$

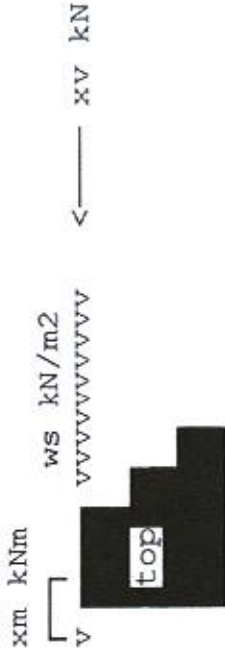
Masonry details

Mortar designation to Table 1 $\text{mortar}=3$
Masonry type (1=clay 2=cal silicate 3=conc brick 4=block)
 $\text{typ}(1)=4$
Concrete Blocks Dimensions
Height $\text{hb}=215 \text{ mm}$
Least horiz dimension $\text{ld}=100 \text{ mm}$
ratio height/least horiz dim $\text{rb}=\text{hb}/\text{ld}=215/100=2.15$
Compressive strength of blocks $\text{po}=7.3 \text{ N/mm}^2$

Characteristic flexural strength for bed failure and leaf greater than
250mm thick - Table 3 $fb(a)=TABLE\ 3.71\ for\ po=7.3,\ mortar=3$
 $=0.1586\ N/mm^2$

Partial safety factor material $\gamma_{mm}=3.5$

External loading



Applied moment at top of wall $xm=0\ kNm$
Applied shear at top of wall $xv=0\ kN$
Weight/unit area of surcharge $ws=1.5\ kN/m^2$
Load factor external loads at top $\gamma_{max}=1.6$
Load factor surcharge $\gamma_{as}=1.6$
Load factor earth pressure $\gamma_{ae}=1.4$
Load factor self weight $\gamma_{af}=0.9$

Wall design

Number of steps proposed in wall $steps=4$

Step 1 Typical Analysis which is repeated for each step

Proposed height at step $h(1)=0.325\ m$
Proposed thickness at step $t(1)=0.325\ m$
Moment at height h earth $me=ce*we*h(a)^3/6=0.271*18*0.325^3/6$
 $=0.02791\ kNm$
surcharge $ms=ce*ws*h(a)^2/2=0.271*1.5*0.325^2/2$
 $=0.02147\ kNm$
Ultimate moment at height h $mu=me*\gamma_{ae}+ms*\gamma_{as}+(xm+xv*h(a))$
 $*\gamma_{max}$
 $=0.02791*1.4+0.02147*1.6+(0+0$
 $*0.325)*1.6$
 $=0.07342$

Section modulus at thickness t
Weight/unit area at depth h

$$\begin{aligned} z &= t(a)^2/6 = 0.325^2/6 = 0.0176 \text{ m}^3 \\ g_d &= (w_s + w_e * h(a)) * \gamma_{maf}/1000 \\ &= (1.5 + 18 * 0.325) * 0.9/1000 \\ &= 0.006615 \text{ N/mm}^2 \end{aligned}$$

Moment of resistance

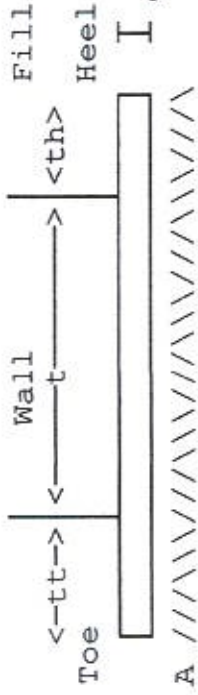
$$\begin{aligned} m_r &= (f_b(1)/\gamma_{mam} + g_d) * z * 1000 \\ &= (0.1586/3.5 + 0.006615) * 0.0176 * 1000 \\ &= 0.914 \text{ kNm} \end{aligned}$$

Applied moment less than moment of resistance (0.07342 <= 0.914)
therefore section is satisfactory.

Step 1
width 0.325 m
height 0.325 m

Step height (m)	Step thickness (m)	Ultimate Moments (kNm) Resistance Applied
0.325	0.325	0.914 0.07342
0.775	0.45	1.998 0.7251
1.45	0.675	5.327 4.154
2	0.9	10.67 10.41

Stability and bearing check



Width of toe
Width of heel
Thickness of wall
Height of wall
Width of base

$$\begin{aligned} t_t &= 0.25 \text{ m} \\ t_h &= 0.25 \text{ m} \\ t &= 0.9 \text{ m} \\ h &= 2 \text{ m} \\ t_b &= t + t_t + t_h = 0.9 + 0.25 + 0.25 \\ &= 1.4 \end{aligned}$$

Depth of base
Overall depth
Weight of fill and wall

$$\begin{aligned} d_b &= 0.30 \text{ m} \\ o_d &= h + d_b = 2 + 0.3 = 2.3 \text{ m} \\ w_f &= w_e * (t + t_h) * h = 18 * (0.9 + 0.25) * 2 \\ &= 41.4 \text{ kN} \end{aligned}$$

Eccentricity from A

$$\begin{aligned} e_f &= t_t + (t + t_h) / 2 = 0.25 + (0.9 + 0.25) / 2 \\ &= 0.825 \text{ m} \end{aligned}$$

Weight of base
Earth horizontal force

$$\begin{aligned}wb &= tb * db * 24 = 1.4 * 0.3 * 24 = 10.08 \text{ kN} \\sfe &= ce * we * od^2 / 2 = 0.271 * 18 * 2.3^2 / 2 \\&= 12.9 \text{ kN}\end{aligned}$$

Moment due to earth pressure
Surcharge horizontal force

$$\begin{aligned}me &= sfe * od / 3 = 12.9 * 2.3 / 3 = 9.891 \text{ kNm} \\sfs &= ws * ce * od = 1.5 * 0.271 * 2.3 \\&= 0.9349 \text{ kN}\end{aligned}$$

Moment due to surcharge

$$\begin{aligned}ms &= sfs * od / 2 = 0.9349 * 2.3 / 2 \\&= 1.075 \text{ kNm}\end{aligned}$$

Wall shear

Horizontal shear force

$$\begin{aligned}usf &= (sfe * gammae) + (sfs * gamma_s) \\&= (12.9 * 1.4) + (0.9349 * 1.6) \\&= 19.56 \text{ kN}\end{aligned}$$

Shear stress at bottom of wall

$$\begin{aligned}uss &= usf / (t * steps) * 1000 \\&= 19.56 / (0.9 * 1000) \\&= 0.02173 \text{ N/mm}^2\end{aligned}$$

Weight at bottom of step 1

$$\begin{aligned}uwt &= t(a) * we * h(a) * gamma_f \\&= 0.325 * 18 * 0.325 * 0.9 \\&= 1.711 \text{ kN}\end{aligned}$$

Weight at bottom of step 2

$$\begin{aligned}uwt &= uwt + (t(a) * we * h(a) * gamma_f) \\&= 1.711 + (0.45 * 18 * 0.775 * 0.9) \\&= 7.361 \text{ kN}\end{aligned}$$

Weight at bottom of step 3

$$\begin{aligned}uwt &= uwt + (t(a) * we * h(a) * gamma_f) \\&= 7.361 + (0.675 * 18 * 1.45 * 0.9) \\&= 23.22 \text{ kN}\end{aligned}$$

Weight at bottom of step 4

$$\begin{aligned}uwt &= uwt + (t(a) * we * h(a) * gamma_f) \\&= 23.22 + (0.9 * 18 * 2 * 0.9) \\&= 52.38 \text{ kN}\end{aligned}$$

Weight per. unit area

$$\begin{aligned}ga &= uwt / (t * steps) * 1000 \\&= 52.38 / (0.9 * 1000) \\&= 0.0582 \text{ N/mm}^2\end{aligned}$$

Permissible shear stress

$$\begin{aligned}fv &= 0.15 + 0.6 * ga = 0.15 + 0.6 * 0.0582 \\&= 0.1849 \text{ N/mm}^2\end{aligned}$$

Applied shear less than shear resistance (0.02173 <= 0.1849)
therefore section is satisfactory.

Overturning

Overturning moment about A

$$\begin{aligned} \text{om} &= \text{me} + \text{ms} + (\text{xm} + \text{xv} * \text{od}) \\ &= 9.891 + 1.075 + (0 + 0 * 2.3) \\ &= 10.97 \text{ kNm} \end{aligned}$$

Restoring moment abt A fill/wall base surcharge

$$\begin{aligned} \text{rmf} &= \text{wf} * \text{ef} = 41.4 * 0.825 = 34.15 \text{ kNm} \\ \text{rmb} &= \text{wb} * \text{tb} / 2 = 10.08 * 1.4 / 2 = 7.056 \text{ kNm} \\ \text{rms} &= \text{ws} * (\text{t} + \text{th}) * \text{ef} = 1.5 * (0.9 + 0.25) * 0.825 \\ &= 1.423 \end{aligned}$$

total

$$\begin{aligned} \text{rm} &= \text{rmf} + \text{rmb} + \text{rms} = 34.15 + 7.056 + 1.423 \\ &= 42.63 \end{aligned}$$

Factor of safety

$$\text{fso} = \text{rm} / \text{om} = 42.63 / 10.97 = 3.888$$

Sliding (passive resistance ignored)

Sliding force

$$\begin{aligned} \text{sf} &= \text{sfe} + \text{sfs} + \text{xv} = 12.9 + 0.9349 + 0 \\ &= 13.84 \end{aligned}$$

Details of bearing stratas angle of friction cohesion

$$\begin{aligned} \text{phib} &= 40^\circ \\ \text{cu} &= 0 \text{ kN/m}^2 \\ \text{cf} &= \text{TAN}(\text{RAD}(\text{phib} * 2 / 3)) \\ &= \text{TAN}(\text{RAD}(40 * 2 / 3)) \\ &= 0.5022 \end{aligned}$$

Coefficient of friction

Resisting force

$$\begin{aligned} \text{fill} \quad \text{rff} &= \text{wf} * \text{cf} = 41.4 * 0.5022 = 20.79 \text{ kN} \\ \text{base} \quad \text{rfb} &= \text{wb} * \text{cf} + \text{tb} * \text{cu} / 2 \\ &= 10.08 * 0.5022 + 1.4 * 0 / 2 \\ &= 5.062 \text{ kN} \end{aligned}$$

surcharge

$$\begin{aligned} \text{rfs} &= \text{ws} * (\text{t} + \text{th}) * \text{cf} \\ &= 1.5 * (0.9 + 0.25) * 0.5022 \\ &= 0.8663 \text{ kN} \end{aligned}$$

total

$$\begin{aligned} \text{rf} &= \text{rff} + \text{rfb} + \text{rfs} = 20.79 + 5.062 + 0.8663 \\ &= 26.72 \text{ kN} \end{aligned}$$

Factor of safety

$$\text{fss} = \text{rf} / \text{sf} = 26.72 / 13.84 = 1.931$$

Bearing pressure

Weight of surcharge

$$\begin{aligned} \text{sw} &= \text{ws} * (\text{t} + \text{th}) = 1.5 * (0.9 + 0.25) \\ &= 1.725 \text{ kN} \end{aligned}$$

Moments about centre of base

$$\begin{aligned} \text{m} &= \text{om} + (\text{wf} + \text{sw}) * (\text{tb} / 2 - \text{ef}) \\ &= 10.97 + (41.4 + 1.725) * (1.4 / 2 - 0.825) \\ &= 5.576 \text{ kNm} \end{aligned}$$

Proposed Retaining wall at:
26 Pentwyn, Baglan Road
Baglan
Port Talbot

Page: 6
Made by:
Date: 08.07.22
Ref No:

Section modulus of base
Total weight

$$\begin{aligned} z_b &= t_b^2/6 = 1.4^2/6 = 0.3267 \text{ m}^3 \\ t_w &= w_f + s_w + w_b = 41.4 + 1.725 + 10.08 \\ &= 53.21 \text{ kN} \end{aligned}$$

Pressure due to weight
Pressure due to moment (+/-)
Maximum pressure
Minimum pressure

$$\begin{aligned} p_w &= t_w/t_b = 53.21/1.4 = 38 \text{ kN/m}^2 \\ p_m &= m/z_b = 5.576/0.3267 = 17.07 \text{ kN/m}^2 \\ p_{\max} &= p_w + p_m = 38 + 17.07 = 55.07 \text{ kN/m}^2 \\ p_{\min} &= p_w - p_m = 38 - 17.07 = 20.93 \text{ kN/m}^2 \end{aligned}$$

Summary of stability check

Factor of safety overturning
Factor of safety sliding
Maximum base pressure

$$\begin{aligned} &3.888 \\ &1.931 \\ &55.07 \text{ kN/m}^2 \end{aligned}$$

DESIGN SUMMARY Wall height 2 m
Wall design
Step height Step thickness
(m) (m)

Ultimate Moments (kNm)
Resistance Applied

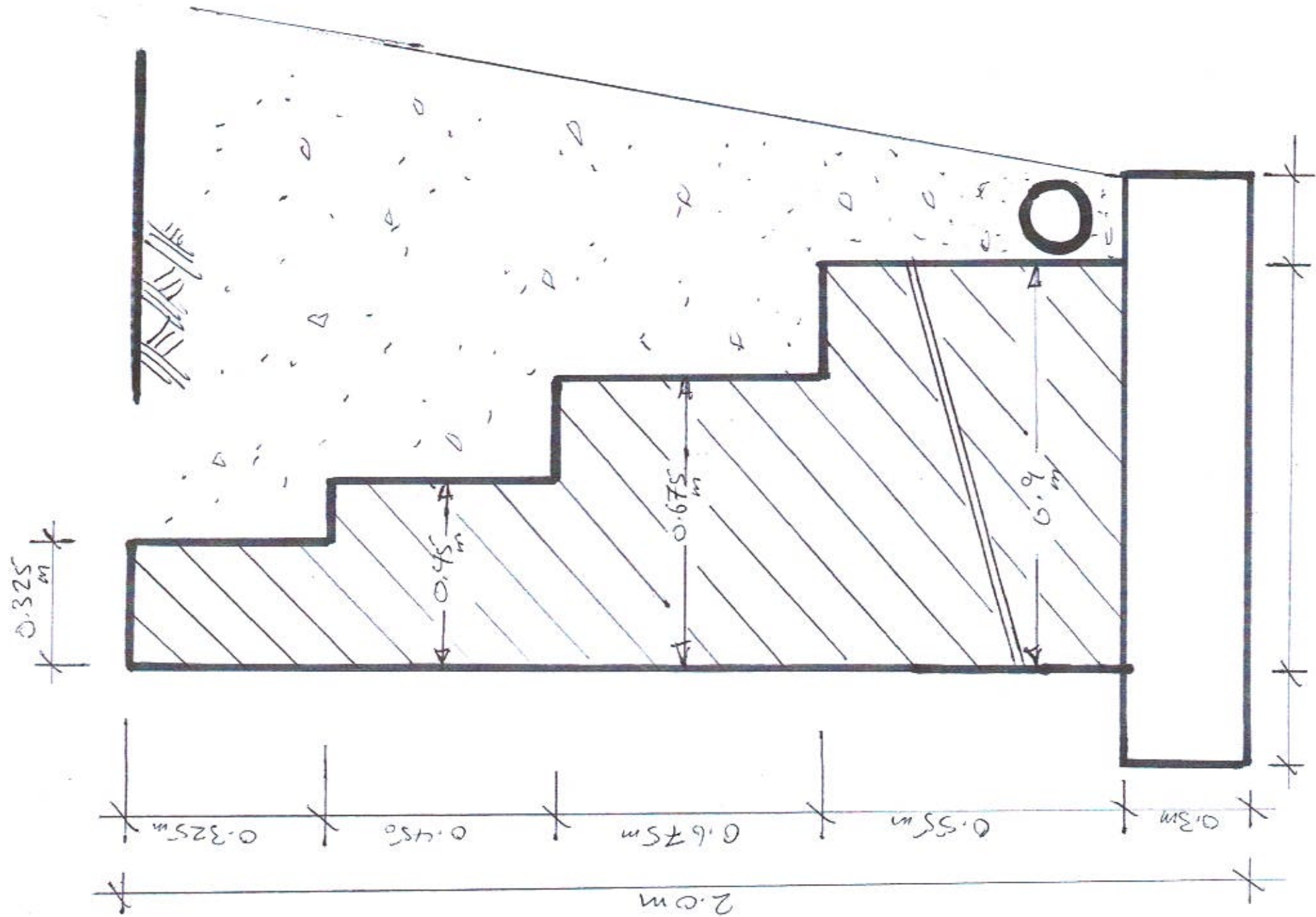
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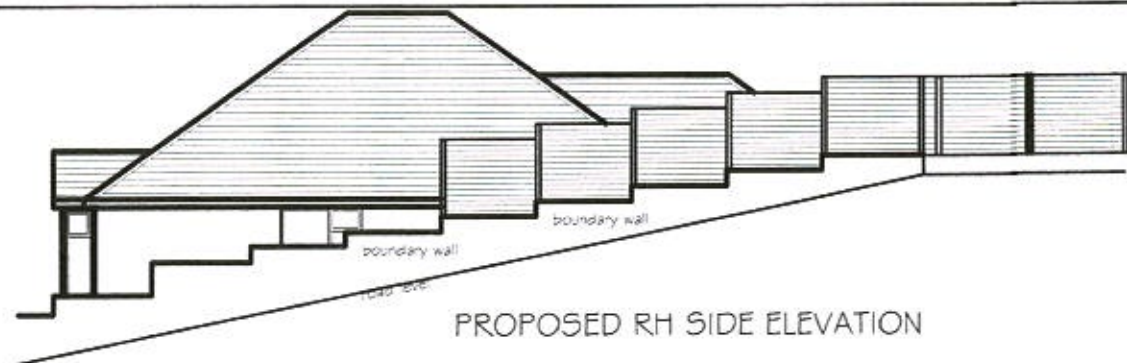
$$\begin{aligned} &3.888 \\ &1.931 \\ &55.07 \text{ kN/m}^2 \end{aligned}$$

THIS IS AN UPDATE AND NEEDS YOUR OWN L.NAM FILE.





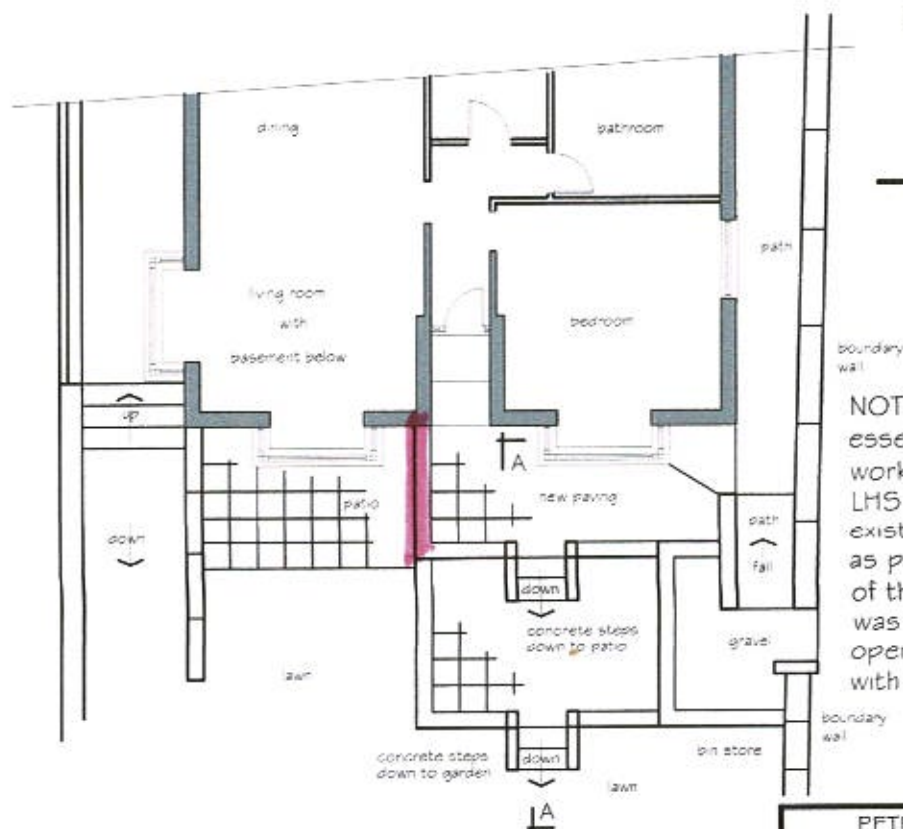
PROPOSED FRONT ELEVATION



PROPOSED RH SIDE ELEVATION

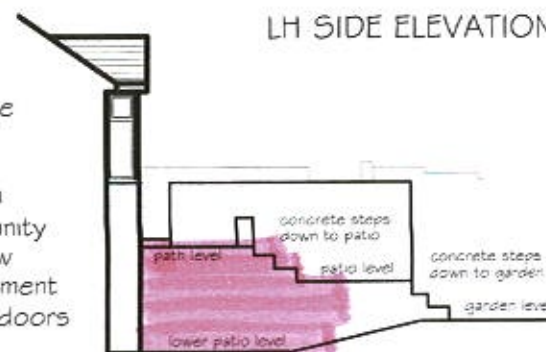


LH SIDE ELEVATION - no changes



PROPOSED PART FLOOR PLAN

NOTE
essential structural repair
works were undertaken to the
LHS front wall below the
existing bay window.
as part of the reconstruction
of this front wall the opportunity
was taken to construct a new
opening to the existing basement
with the installation of patio doors



CROSS SECTION A-A ON PATIO AREAS

Revision A 12.03.22
construction note added
for the new basement level
patio doors

PETER JONES
TALBOT DESIGN SERVICES
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project title
New patio doors to basement
and new hard landscaping at
26 Fentwyn Baglan Road

drawing title
proposed elevations
and hard landscaping

date
January 2022
scale
1:100
drawing no
26 PR - 04 rev A