Elite Designers Ltd 12 Princeton Court 55 Felsham Road London SW15 1AZ 020 8785 4499	Project: **5 Highfield Grove, Highgate, London, SN6 6HN** Section: **Structural Calculations** Calc by: Date: **MD** **22/01/15**	Job Ref: **2014-207** Sheet No./Rev. **0** Check/App'd by: Date: **NJR** **22/01/15**

Structural Calculations - 5 Highfield Grove, Highgate London, SN6 6HN 4NJ

Project: Basement and full house refurbishment

The following calculations ascertain the structural integrity of the proposed alterations to the address above. Reference should be made to Elite Designers Ltd sketches for structural details and layout drawings.

Loadings from BS648 & BS6399 : Part 1 : 1984

Dead Loads

Ceiling + Services

Thermal Insulation $c_1 := 0.01 \cdot 10^3 \cdot newton \cdot m^{-2}$

Ceiling Joists $c_2 := 0.16 \cdot 10^3 \cdot newton \cdot m^{-2}$

Plaster Skim $c_3 := 0.03 \cdot 10^3 \cdot newton \cdot m^{-2}$

Plaster Board $c_4 := 0.11 \cdot 10^3 \cdot newton \cdot m^{-2}$

Services $c_5 := 0.20 \cdot 10^3 \cdot newton \cdot m^{-2}$

Total Ceiling Load $C1 := c_1 + c_2 + c_3 + c_4 + c_5 \quad C1 = 510\, m^{-2} \cdot newton$

Flat Roof

Asphalt 2 layers 19mm $r_3 := 0.41 \cdot 10^3 \cdot newton \cdot m^{-2}$

Joists with decking $r_4 := 0.25 \cdot 10^3 \cdot newton \cdot m^{-2}$

Total Ceiling Load $R_2 := r_3 + r_4 + C1 - c_2 \quad R_2 = 1.01 \times 10^3\, m^{-2} \cdot newton$

Roof 37deg Pitch

Slate Tiling $r_1 := 0.5 \cdot 10^3 \cdot newton \cdot m^{-2}$

Roof Rafters $r_2 := 0.16 \cdot 10^3 \cdot newton \cdot m^{-2}$

Total Roof Load $R_1 := r_1 + r_2 + C1 - c_2 \quad R_1 = 1.01 \times 10^3\, m^{-2} \cdot newton$

$R_3 := R_2 - r_2 \quad R_3 = 850\, m^{-2} \cdot newton$

Wall Loads

Stud, Lathe and Plaster $w_1 := 0.76 \cdot 10^3 \cdot newton \cdot m^{-2}$

Brick 300mm cavity $w_2 := 3.76 \cdot 10^3 \cdot newton \cdot m^{-2}$

Brick 9" solid $w_3 := 5.33 \cdot 10^3 \cdot newton \cdot m^{-2}$

Brick 13" solid $w_4 := 7.69 \cdot 10^3 \cdot newton \cdot m^{-2}$

Brick 4.5" solid $w_5 := 2.655 \cdot 10^3 \cdot newton \cdot m^{-2}$

New Stud Walls $w_6 := 0.5 \cdot 10^3 \cdot newton \cdot m^{-2}$

150mm Blockwork Wall $w_7 := 1.5 \cdot 10^3 \cdot newton \cdot m^{-2}$

Brick 6.3" solid $w_8 := 6.3 \cdot 10^3 \cdot newton \cdot m^{-2}$

Brick 13.75" solid $w_9 := 8.14 \cdot 10^3 \cdot newton \cdot m^{-2}$

Floor Loads

200x50 Joists With Decking $f_1 := 0.25 \cdot 10^3 \cdot newton \cdot m^{-2} + c_1 + c_3 + c_5$

$f_1 = 490\, m^{-2} \cdot newton$

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TR80+ Metal Decking - Ground, LGF & Basement Floors

Designed for Vehicle Load 2.5kN/m^2 to span < 3.75m

Density of Concrete	$\rho_c := 24 \cdot kN \cdot m^{-3}$	
Holorib Deck Depth	$h_{D80} := 0.14 \cdot m$	
Holorib Deck Weight	$w_{D80} := 0.123 \cdot kN \cdot m^{-2}$	
Volume of Concrete	$V_{CD80} := 0.098 \cdot m^3 \cdot m^{-2}$	
Holorib Dead Load	$DL_{D80} := w_{D80} + (V_{CD80} \cdot \rho_c)$	$DL_{D80} = 2.475\, m^{-2} \cdot kN$
80mm Screed	$scr_{80} := 0.08 \cdot m \cdot \rho_c$	$scr_{80} = 1.92\, m^{-2} \cdot kN$
Ceiling + Services	$s_v := 0.5 \cdot kN \cdot m^{-2}$	
Finishes	$s_f := 0.47 \cdot kN \cdot m^{-2}$	
Partitions	$s_p := 1.00 \cdot kN \cdot m^{-2}$	
Total Floor Load	$f_3 := DL_{D80} + scr_{80} + s_v + s_f + s_p$	$f_3 = 6.365\, m^{-2} \cdot kN$
Walk-on glazing	$f_4 := 1.2 \cdot kN \cdot m^{-2}$	

Imposed Loading

Floor Load Table 5 BS6399	$l_{fl} := 1.5 \cdot 10^3 \cdot newton \cdot m^{-2}$
Roof Load	$l_{rl} := 0.6 \cdot 10^3 \cdot newton \cdot m^{-2}$
Vehicle Load	$l_{vl} := 3.0 \cdot 10^3 \cdot newton \cdot m^{-2}$

Surcharge

Surcharge for r. wall	$S_w := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Safety Factors

Live Load Safety Factor γfl	$\gamma fl := 1.6$
Dead Load Safety Factor γfd	$\gamma fd := 1.4$

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DESIGN DATA

Heights

Height: New Basement 1	$h_1 := 2.70m$
Height: Basement 2	$h_2 := 2.50m$
Height: Ground floor	$h_3 := 3.00m$
Height: Existing wall for area 12	$h_4 := 4.50m$

Spans

Span for BEAM 1	$sp_1 := 2.0m$
Span for BEAM 2	$sp_2 := 2.500m$
Span Between BEAM 2 & BEAM 4	$sp_3 := 5.44m$
Span for BEAM 4 (between BEAM 3 & ret. wall)	$sp_4 := 5.35m$
Span Between retaining walls (Basement 2)	$sp_5 := 2.40m$
Span for BEAM 5	$sp_6 := 5.15m$
Span Between BEAM 5 & BEAM 7	$sp_7 := 6.70m$
Span for BEAM 7	$sp_8 := 6.70m$
Span Between BEAM 4 & retaining wall	$sp_9 := 2.50m$
Span Between r. walls for area 4	$sp_{10} := 1.40m$
Span Between r. walls for area 5	$sp_{11} := 3.00m$
Assumed existing 1st floor and roof span for area 9	$sp_{12} := 3.00m$
Span between BEAM7 & r.wall for area 11	$sp_{13} := 3.40m$
Span for area 13	$sp_{14} := 2.40m$
Span of extg floor and roof for area 12	$sp_{15} := 3.60m$

Lengths

BEAM 1 length	$L_1 := 1.75m$
BEAM 2 length	$L_2 := 2.05m$
BEAM 3 length	$L_3 := 7.50m$
BEAM 4 length	$L_4 := 7.50m$
BEAM 5 length	$L_5 := 2.95m$
BEAM 6 length	$L_6 := 3.50m$
BEAM 7 length	$L_7 := 4.05m$

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GROUND FLOOR LOADING

BEAM 1: Beam supporting ground Floor - Basement 1

Floor dead Load	$DL1_f := \frac{sp_1}{2} \cdot f_3$	$DL1_f = 6.4\,m^{-1} \cdot kN$
Total Dead Load	$DL1 := DL1_f$	$DL1 = 6.4\,m^{-1} \cdot kN$
Floor live Load	$LL1_f := \frac{sp_1}{2} \cdot l_{fl}$	$LL1_f = 1.5\,m^{-1} \cdot kN$
Total Live Load	$LL1 := LL1_f$	$LL1 = 1.5\,m^{-1} \cdot kN$

BEAM 2: Beam supporting ground Floor - Basement 1

Floor dead Load	$DL2_f := \frac{sp_2}{2} \cdot f_3$	$DL2_f = 8\,m^{-1} \cdot kN$
Total Dead Load	$DL2 := DL2_f$	$DL2 = 8\,m^{-1} \cdot kN$
Floor live Load	$LL2_f := \frac{sp_2}{2} \cdot l_{fl}$	$LL2_f = 1.875\,m^{-1} \cdot kN$
Total Live Load	$LL2 := LL2_f$	$LL2 = 1.9\,m^{-1} \cdot kN$

BEAM 3: Beam supporting ground Floor - Basement 1

Floor dead Load	$DL3_f := \frac{sp_3}{2} \cdot f_3$	$DL3_f = 17.3\,m^{-1} \cdot kN$
Total Dead Load	$DL3 := DL3_f$	$DL3 = 17.3\,m^{-1} \cdot kN$
Floor live Load	$LL3_f := \frac{sp_3}{2} \cdot l_{fl}$	$LL3_f = 4.08\,m^{-1} \cdot kN$
Total Live Load	$LL3 := LL3_f$	$LL3 = 4.1\,m^{-1} \cdot kN$

BEAM 4: Beam supporting ground Floor - Basement 1

Floor dead Load	$DL4_f := \frac{sp_4}{2} \cdot f_3$	$DL4_f = 17\,m^{-1} \cdot kN$
Total Dead Load	$DL4 := DL4_f$	$DL4 = 17\,m^{-1} \cdot kN$

Floor live Load	$LL4_f := \frac{sp_4}{2} \cdot l_{fl}$	$LL4_f = 4.012\,m^{-1} \cdot kN$
Total Live Load	$LL4 := LL4_f$	$LL4 = 4\,m^{-1} \cdot kN$

BEAM 5: Beam supporting ground Floor - Basement 2

Floor dead Load	$DL5_f := \frac{sp_6}{2} \cdot f_3$	$DL5_f = 16.4\,m^{-1} \cdot kN$
Total Dead Load	$DL5 := DL5_f$	$DL5 = 16.4\,m^{-1} \cdot kN$
Floor live Load	$LL5_f := \frac{sp_6}{2} \cdot l_{fl}$	$LL5_f = 3.863\,m^{-1} \cdot kN$
Total Live Load	$LL5 := LL5_f$	$LL5 = 3.9\,m^{-1} \cdot kN$

BEAM 6: Beam supporting ground Floor - Basement 2

Floor dead Load	$DL6_f := \frac{sp_7}{2} \cdot f_3$	$DL6_f = 21.3\,m^{-1} \cdot kN$
Total Dead Load	$DL6 := DL6_f$	$DL6 = 21.3\,m^{-1} \cdot kN$
Floor live Load	$LL6_f := \frac{sp_7}{2} \cdot l_{fl}$	$LL6_f = 5.025\,m^{-1} \cdot kN$
Total Live Load	$LL6 := LL6_f$	$LL6 = 5\,m^{-1} \cdot kN$

BEAM 7: Beam supporting ground Floor - Basement 2

Floor dead Load	$DL7_f := \frac{sp_8}{2} \cdot f_3$	$DL7_f = 21.3\,m^{-1} \cdot kN$
Total Dead Load	$DL7 := DL7_f$	$DL7 = 21.3\,m^{-1} \cdot kN$
Floor live Load	$LL7_f := \frac{sp_8}{2} \cdot l_{fl}$	$LL7_f = 5.025\,m^{-1} \cdot kN$
Total Live Load	$LL7 := LL6_f$	$LL7 = 5\,m^{-1} \cdot kN$

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RETAINING WALL LOADINGS

Retaining wall Area 1 (see attached drawing for location):

Area length $lw1 := 6.50m$

Wall height $H1_w := 2.7m$

Wall thickness $T1_w := 0.35m$

Base thickness $Bt1_w := 0.40m$

Base length $Bl1_w := 0.78m$

R. wall self weight $DLW1_w := \left(H1_w \cdot T1_w + Bt1_w \cdot Bl1_w\right) \cdot \rho_c$ $DLW1_w = 3.02 \times 10^4 \, m^{-1} \cdot newton$

Surcharge $S_{w1} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Reaction from BEAM 3 $DLR3_B := \left(L_3 \cdot DL3 \cdot 0.5\right)$ $DLR3_B = 6.49 \times 10^4 \cdot newton$

Floor Load $DLW1_f := \frac{sp_2}{2} \cdot f_3$ $DLW1_f = 7.96 \times 10^3 \, m^{-1} \cdot newton$

Total Dead Load $DLW1 := \frac{DLR3_B}{lw1} + DLW1_f \cdot 0.6$ $DLW1 := 14.85 \times 10^3 \, m^{-1} \, newton$

Reaction from BEAM 3 $LLR3_B := \left(L_3 \cdot LL3 \cdot 0.5\right)$ $LLR3_B = 1.53 \times 10^4 \cdot newton$

Floor live Load $LLW1_f := \frac{sp_2}{2} \cdot l_{fl}$ $LLW1_f = 1.875 \times 10^3 \, m^{-1} \cdot newton$

Total Live Load $LLW1 := \frac{LLR3_B}{lw1} + LLW1_f \cdot 0.6$ $LLW1 := 3.00 \times 10^3 \, m^{-1} \, newton$

Retaining wall Area 2 (see attached drawing for location):

Area length $lw2 := 5.8m$

Wall height $H2_w := 2.7m$

Wall thickness $T2_w := 0.35m$

Base thickness $Bt2_w := 0.40m$

Base length $Bl2_w := 0.78m$

R. wall self weight $DLW2_w := \left(H2_w \cdot T2_w + Bt2_w \cdot Bl2_w\right) \cdot \rho_c$ $DLW2_w = 3.02 \times 10^4\, m^{-1} \cdot newton$

Surcharge $S_{w2} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Reaction from BEAM 4 $DLR4_B := \left(L_4 \cdot DL4 \cdot 0.5\right)$ $DLR4_B = 6.38 \times 10^4 \cdot newton$

Floor Load $DLW2_f := \frac{sp_9}{2} \cdot f_3 \cdot 0.45$ $DLW2_f = 3.58 \times 10^3\, m^{-1} \cdot newton$

Total Dead Load $DLW2 := \frac{DLR4_B}{lw2} + DLW2_f$ $DLW2 = 1.5 \times 10^4\, m^{-1} \cdot newton$

Reaction from BEAM 3 $LLR4_B := \left(L_4 \cdot LL4 \cdot 0.5\right)$ $LLR4_B = 1.5 \times 10^4 \cdot newton$

Floor live Load $LLW2_f := \frac{sp_9}{2} \cdot l_{fl} \cdot 0.45$ $LLW2_f = 843.75\, m^{-1} \cdot newton$

Total Live Load $LLW2 := \frac{LLR4_B}{lw2} + LLW2_f$ $LLW2 := 3.15 \times 10^3\ m^{-1}\ newton$

Retaining wall Area 3 (see attached drawing for location):

Area length $lw3 := 5.25m$

Wall height $H3_w := 2.7m$

Wall thickness $T3_w := 0.35m$

Base thickness $Bt3_w := 0.40m$

Base length $Bl3_w := 0.78m$

R. wall self weight $DLW3_w := \left(H3_w \cdot T3_w + Bt3_w \cdot Bl3_w\right) \cdot \rho_c$ $DLW3_w = 3.02 \times 10^4\, m^{-1} \cdot newton$

Surcharge $S_{w3} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Floor Load $DLW3_f := \frac{sp_9}{2} \cdot f_3$

Total Dead Load $DLW3 := DLW3_f$ $DLW3 := 9.1 \times 10^3\ m^{-1}\ newton$

Floor live Load	$LLW3_f := \frac{sp_9}{2} \cdot l_{fl}$	
Total Live Load	$LLW3 := LLW3_f$	$LLW3 = 1.9 \times 10^3\ m^{-1} \cdot newton$

Retaining wall Area 4 (see attached drawing for location):

Area length	$lw4 := 6.0m$	
Wall height	$H4_w := 2.7m$	
Wall thickness	$T4_w := 0.35m$	
Base thickness	$Bt4_w := 0.40m$	
Base length	$Bl4_w := 0.78m$	
R. wall self weight	$DLW4_w := \left(H4_w \cdot T4_w + Bt4_w \cdot Bl4_w\right) \cdot \rho_c$	$DLW4_w = 3.02 \times 10^4\ m^{-1} \cdot newton$
Surcharge	$S_{w4} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$	
Reaction from BEAM 4	$DLR4_B := \left(L_4 \cdot DL4 \cdot 0.5\right)$	$DLR4_B = 6.38 \times 10^4 \cdot newton$
Floor Load	$DLW4_f := \frac{sp_{10}}{2} \cdot f_3 \cdot 0.5$	$DLW4_f = 2.23 \times 10^3\ m^{-1} \cdot newton$
Total Dead Load	$DLW4 := \frac{DLR4_B}{lw4} + \frac{DLW4_f}{2}$	$DLW4 = 1.2 \times 10^4\ m^{-1} \cdot newton$
Reaction from BEAM 3	$LLR4_B := \left(L_4 \cdot LL4 \cdot 0.5\right)$	$LLR4_B = 1.5 \times 10^4 \cdot newton$
Floor live Load	$LLW4_f := \frac{sp_{10}}{2} \cdot l_{fl} \cdot 0.5$	$LLW4_f = 525\ m^{-1} \cdot newton$
Total Live Load	$LLW4 := \frac{LLR4_B}{lw4} + \frac{LLW2_f}{2}$	$LLW4 = 2.7 \times 10^3\ m^{-1} \cdot newton$

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Retaining wall Area 5 (see attached drawing for location):

Area length	$lw5 := 6.70m$	
Wall height	$H5_w := 2.7m$	
Wall thickness	$T5_w := 0.35m$	
Base thickness	$Bt5_w := 0.40m$	
Base length	$Bl5_w := 0.78m$	
R. wall self weight	$DLW5_w := \left(H5_w \cdot T5_w + Bt5_w \cdot Bl5_w\right) \cdot \rho_c$	$DLW5_w = 3.02 \times 10^4\, m^{-1} \cdot newton$
Surcharge	$S_{w5} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$	
Floor Load	$DLW5_f := \frac{sp_{11}}{2} \cdot f_3$	$DLW5_f = 9.55 \times 10^3\, m^{-1} \cdot newton$
Total Dead Load	$DLW5 := DLW5_f$	$DLW5 := 11.6 \times 10^3\ m^{-1}\ newton$
Floor live Load	$LLW5_f := \frac{sp_{11}}{2} \cdot l_{fl}$	$LLW5_f = 2.25 \times 10^3\, m^{-1} \cdot newton$
Total Live Load	$LLW5 := LLW5_f$	$LLW5 := 2.4 \times 10^3\ m^{-1}\ newton$

Retaining wall Area 6 (see attached drawing for location):

Area length	$lw6 := 2.7m$	
Wall height	$H6_w := 2.7m$	
Wall thickness	$T6_w := 0.35m$	
Base thickness	$Bt6_w := 0.40m$	
Base length	$Bl6_w := 0.78m$	
R. wall self weight	$DLW6_w := \left(H6_w \cdot T6_w + Bt6_w \cdot Bl6_w\right) \cdot \rho_c$	$DLW6_w = 3.02 \times 10^4\, m^{-1} \cdot newton$
Surcharge	$S_{w6} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$	

Reaction from BEAM 3	$DLR3_B := (L_3 \cdot DL3 \cdot 0.5)$	$DLR3_B = 6.49 \times 10^4 \cdot newton$
Total Dead Load	$DLW6 := \frac{DLR3_B}{lw6}$	$DLW6 = 2.4 \times 10^4 \, m^{-1} \cdot newton$
Reaction from BEAM 3	$LLR3_B := (L_3 \cdot LL3 \cdot 0.5)$	$LLR3_B = 1.53 \times 10^4 \cdot newton$
Total Live Load	$LLW6 := \frac{LLR3_B}{lw6}$	$LW6 := 5.0 \times 10^3 \, m^{-1} \, newton$

Retaining wall Area 7 (see attached drawing for location):

Area length	$lw7 := 10.9m$	
Wall height	$H7_w := 2.7m$	
Wall thickness	$T7_w := 0.35m$	
Base thickness	$Bt7_w := 0.40m$	
Base length	$Bl7_w := 0.78m$	
R. wall self weight	$DLW7_w := (H7_w \cdot T7_w + Bt7_w \cdot Bl7_w) \cdot \rho_c$	$DLW7_w = 3.02 \times 10^4 \, m^{-1} \cdot newton$
Surcharge	$S_{w7} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$	
Reaction from BEAM 2	$DLR2_B := (L_2 \cdot DL2 \cdot 0.5)$	$DLR2_B = 8.16 \times 10^3 \cdot newton$
Reaction from BEAM 1	$DLR1_B := (L_1 \cdot DL1 \cdot 0.5)$	$DLR1_B = 5.57 \times 10^3 \cdot newton$
Floor Load	$DLW7_f := \frac{sp_1}{2} \cdot f_3$	$DLW7_f = 6.37 \times 10^3 \, m^{-1} \cdot newton$
Total Dead Load	$DLW7 := \frac{DLR2_B}{lw7} + DLW7_f + \frac{DLR1_B}{lw7}$	$DLW7 := 7.3 \times 10^3 \, m^{-1} \, newton$
Reaction from BEAM 2	$LLR2_B := (L_2 \cdot LL2 \cdot 0.5)$	$LLR2_B = 1.92 \times 10^3 \cdot newton$
Reaction from BEAM 1	$LLR1_B := (L_1 \cdot LL1 \cdot 0.5)$	$LLR1_B = 1.31 \times 10^3 \cdot newton$

Floor live Load $LLW7_f := \frac{sp_1}{2} \cdot l_{fl}$ $LLW7_f = 1.5 \times 10^3\, m^{-1} \cdot newton$

Total Live Load $LLW7 := \frac{LLR2_B}{lw7} + LLW7_f + \frac{LLR1_B}{lw7}$ $LW7 := 1.5 \times 10^3\, m^{-1}\, newton$

$LLW7 = 1.5 \times 10^3\, m^{-1} \cdot newton$

Retaining wall Area 8 (see attached drawing for location):

Area length $lw8 := 4.00m$

Wall height $H8_w := 2.7m$

Wall thickness $T8_w := 0.35m$

Base thickness $Bt8_w := 0.40m$

Base length $Bl8_w := 0.78m$

R. wall self weight $DLW8_w := \left(H8_w \cdot T8_w + Bt8_w \cdot Bl8_w\right) \cdot \rho_c$ $DLW8_w = 3.02 \times 10^4\, m^{-1} \cdot newton$

Surcharge $S_{w8} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Reaction from BEAM 2 $DLR2_B = 8.16 \times 10^3 \cdot newton$

Reaction from BEAM 1 $DLR1_B = 5.57 \times 10^3 \cdot newton$

Floor Load $DLW7_f = 6.37 \times 10^3\, m^{-1} \cdot newton$

$DL2_f = 8\, m^{-1} \cdot kN$

extg. ground floor $DLGF_f := \frac{sp_1}{2} \cdot f_1$ $DLGF_f = 0.5\, m^{-1} \cdot kN$

extg.roof $DLR_f := \frac{sp_1}{2} \cdot R_3$ $DLR_f = 0.9\, m^{-1} \cdot kN$

extg. brick wall $DL_{wall} := h_3 \cdot w_7$ $DL_{wall} = 4.5\, m^{-1} \cdot kN$

Total Dead Load $DLW8 := \frac{DLR2_B}{lw8} + DLW7_f + DL2_f + DL_{wall} + DLR_f + DLGF_f + \frac{DLR1_B}{lw8}$

$DLW8 = 2.4 \times 10^4\, m^{-1} \cdot newton$

Reaction from BEAM 2 $LLR2_B = 1.92 \times 10^3 \cdot newton$

Reaction from BEAM 1 $LLR1_B = 1.31 \times 10^3 \cdot newton$

Floor live Load $LLW7_f = 1.5 \times 10^3 \, m^{-1} \cdot newton$

$LL2_f = 1.875 \, m^{-1} \cdot kN$

extg. ground floor $LLGF_f := \frac{sp_1}{2} \cdot l_{fl}$ $LLGF_f = 1.5 \, m^{-1} \cdot kN$

extg.roof $LLR_f := \frac{sp_1}{2} \cdot l_{rl}$ $LLR_f = 0.6 \, m^{-1} \cdot kN$

Total Live Load $LLW8 := \frac{LLR2_B}{lw8} + LLW7_f + LL2_f + LLR_f + LLGF_f + \frac{LLR1_B}{lw8}$

$LLW8 = 3.6 \times 10^3 \, m^{-1} \cdot newton$

Retaining wall Area 9 (see attached drawing for location):

Area length $lw9 := 7.60m$

Wall height $H9_w := 2.7m$

Wall thickness $T9_w := 0.35m$

Base thickness $Bt9_w := 0.40m$

Base length $Bl9_w := 0.78m$

R. wall self weight $DLW9_w := \left(H9_w \cdot T9_w + Bt9_w \cdot Bl9_w\right) \cdot \rho_c$ $DLW9_w = 3.02 \times 10^4 \, m^{-1} \cdot newton$

Surcharge $S_{w9} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Floor Load $DLW9_f := \frac{sp_2}{2} \cdot f_3$ $DLW9_f = 7.96 \times 10^3 \, m^{-1} \cdot newton$

extg. ground floor $DLGF9_f := \frac{sp_{12}}{2} \cdot f_1$ $DLGF9_f = 0.7\,m^{-1} \cdot kN$

extg.roof $DLR9_f := \frac{sp_{12}}{2} \cdot R_3$ $DLR9_f = 1.3\,m^{-1} \cdot kN$

extg. brick wall $DL9_{wall} := h_3 \cdot w_3$ $DL9_{wall} = 16\,m^{-1} \cdot kN$

Total Dead Load $DLW9 := DLW9_f + DLR9_f + DL9_{wall} + DLR_f + DLGF9_f$

$DLW9 = 2.9 \times 10^4\,m^{-1} \cdot newton$

Floor Load $LLW9_f := \frac{sp_{12}}{2} \cdot l_{fl}$ $LLW9_f = 2.25 \times 10^3\,m^{-1} \cdot newton$

extg. ground floor $LLGF9_f := \frac{sp_{12}}{2} \cdot l_{fl}$ $LLGF9_f = 2.3\,m^{-1} \cdot kN$

extg.roof $LLR9_f := \frac{sp_1}{2} \cdot l_{rl}$ $LLR9_f = 0.6\,m^{-1} \cdot kN$

Total Live Load $LLW9 := LLW9_f + DLR9_f + DLGF9_f$

$LLW9 = 8.3 \times 10^3\,m^{-1} \cdot newton$

Retaining wall Area 10 (see attached drawing for location):

Area length $lw10 := 12.7m$

Wall height $H10_w := 1.0m$

Wall thickness $T10_w := 0.35m$

Base thickness $Bt10_w := 0.40m$

Base length $Bl10_w := 0.65m$

R. wall self weight $DLW10_w := \left(H10_w \cdot T10_w + Bt10_w \cdot Bl10_w\right) \cdot \rho_c$ $DLW10_w = 1.46 \times 10^4\,m^{-1} \cdot newton$

Surcharge $S_{w10} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Reaction from BEAM 5 $DLR5_B := (L_5 \cdot DL5 \cdot 0.5)$ $DLR5_B = 2.42 \times 10^4 \cdot newton$

Reaction from BEAM 6 $DLR6_B := (L_6 \cdot DL6 \cdot 0.5)$ $DLR6_B = 3.73 \times 10^4 \cdot newton$

Reaction from BEAM 7 $DLR7_B := (L_7 \cdot DL7 \cdot 0.5)$ $DLR7_B = 4.32 \times 10^4 \cdot newton$

Brick wall $DL10_{wall} := h_3 \cdot w_4$ $DL10_{wall} = 23.1\,m^{-1} \cdot kN$

Total Dead Load $DLW10 := \frac{(DLR5_B + DLR6_B + DLR7_B)}{lw10} + DL10_{wall}$

$DLW10 = 3.1 \times 10^4\,m^{-1} \cdot newton$

Reaction from BEAM 5 $LLR5_B := (L_5 \cdot LL5 \cdot 0.5)$ $LLR5_B = 5.7 \times 10^3 \cdot newton$

Reaction from BEAM 6 $LLR6_B := (L_6 \cdot LL6 \cdot 0.5)$ $LLR6_B = 8.79 \times 10^3 \cdot newton$

Reaction from BEAM 7 $LLR7_B := (L_7 \cdot LL7 \cdot 0.5)$ $LLR7_B = 1.02 \times 10^4 \cdot newton$

Total Live Load $LLW10 := \frac{(LLR5_B + LLR6_B + LLR7_B)}{lw10}$

$LLW10 = 3.1 \times 10^3\,m^{-1} \cdot newton$

Retaining wall Area 11 (see attached drawing for location):

Area length $lw11 := 5.10m$

Wall height $H11_w := 2.0m$

Wall thickness $T11_w := 0.35m$

Base thickness $Bt11_w := 0.40m$

Base length $Bl11_w := 0.65m$

R. wall self weight $DLW11_w := (H11_w \cdot T11_w + Bt11_w \cdot Bl11_w) \cdot \rho_c$ $DLW11_w = 2.3 \times 10^4\,m^{-1} \cdot newton$

Surcharge $S_{w11} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Floor Load	$DLW11_f := \frac{sp_{13}}{2} \cdot f_3$	$DLW11_f = 1.08 \times 10^4\, m^{-1} \cdot newton$
Total Dead Load	$DLW11 := DLW11_f$	$DLW11 = 1.2 \times 10^4\, m^{-1} \cdot newton$
Floor live Load	$LLW11_f := \frac{sp_{13}}{2} \cdot l_{fl}$	$LLW11_f = 2.55 \times 10^3\, m^{-1} \cdot newton$
Total Live Load	$LLW11 := LLW11_f$	$LLW11 = 2.6 \times 10^3\, m^{-1} \cdot newton$

Retaining wall Area 12 (see attached drawing for location):

Area length	$lw12 := 10.0m$	
Wall height	$H12_w := 2.0m$	
Wall thickness	$T12_w := 0.35m$	
Base thickness	$Bt12_w := 0.40m$	
Base length	$Bl12_w := 0.65m$	
R. wall self weight	$DLW12_w := \left(H12_w \cdot T12_w + Bt12_w \cdot Bl12_w\right) \cdot \rho_c$	$DLW12_w = 2.3 \times 10^4\, m^{-1} \cdot newton$
Surcharge	$S_{w12} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$	
Reaction from BEAM 5	$DLR5_B := \left(L_5 \cdot DL5 \cdot 0.5\right)$	$DLR5_B = 2.42 \times 10^4 \cdot newton$
Reaction from BEAM 6	$DLR6_B := \left(L_6 \cdot DL6 \cdot 0.5\right)$	$DLR6_B = 3.73 \times 10^4 \cdot newton$
Reaction from BEAM 7	$DLR7_B := \left(L_7 \cdot DL7 \cdot 0.5\right)$	$DLR7_B = 4.32 \times 10^4 \cdot newton$
Existing wall	$DL12_{wall} := h_4 \cdot w_4$	$DL12_{wall} = 34.6\, m^{-1} \cdot kN$
Extg. ground floor	$DLGF12_f := \frac{sp_{15}}{2} \cdot f_1$	$DLGF12_f = 0.9\, m^{-1} \cdot kN$
Extg.roof	$DLR12_f := \frac{sp_{15}}{2} \cdot R_3$	$DLR12_f = 1.5\, m^{-1} \cdot kN$

Total Dead Load $DLW12 := \frac{(DLR5_B + DLR6_B + DLR7_B)}{lw12} + DL12_{wall} + DLGF12_f + DLR12_f$

$DLW12 = 4.9 \times 10^4\, m^{-1} \cdot newton$

Reaction from BEAM 5 $LLR5_B := (L_5 \cdot LL5 \cdot 0.5)$ $LLR5_B = 5.7 \times 10^3 \cdot newton$

Reaction from BEAM 6 $LLR6_B := (L_6 \cdot LL6 \cdot 0.5)$ $LLR6_B = 8.79 \times 10^3 \cdot newton$

Reaction from BEAM 7 $LLR7_B := (L_7 \cdot LL7 \cdot 0.5)$ $LLR7_B = 1.02 \times 10^4 \cdot newton$

Extg. ground floor $LLGF12_f := \frac{sp_{15}}{2} \cdot l_{fl}$ $LLGF12_f = 2.7\, m^{-1} \cdot kN$

Extg.roof $LLR12_f := \frac{sp_{15}}{2} \cdot l_{rl}$ $LLR12_f = 1.1\, m^{-1} \cdot kN$

Total Live Load

$$LLW12 := \frac{(LLR5_B + LLR6_B + LLR7_B)}{lw12} + LLGF12_f + LLR12_f$$

$LLW12 = 7.5 \times 10^3\, m^{-1} \cdot newton$

Retaining wall Area 13 (see attached drawing for location):

Area length $lw13 := 19.50m$

Wall height $H13_w := 1.50m$

Wall thickness $T13_w := 0.35m$

Base thickness $Bt13_w := 0.40m$

Base length $Bl13_w := 0.62m$

R. wall self weight $DLW13_w := (H13_w \cdot T13_w + Bt13_w \cdot Bl13_w) \cdot \rho_c$ $DLW13_w = 1.86 \times 10^4\, m^{-1} \cdot newton$

Surcharge $S_{w13} := 10 \cdot 10^3 \cdot newton \cdot m^{-2}$

Floor Load $DLW13_f := \frac{sp_{14}}{2} \cdot f_3$ $DLW13_f = 7.64 \times 10^3\, m^{-1} \cdot newton$

Total Dead Load $DLW13 := DLW13_f$ $DLW13 = 9 \times 10^{3}\,m^{-1}\cdot newton$

Floor live Load $LLW13_f := \frac{sp_{14}}{2}\cdot l_{fl}$ $LLW13_f = 1.8 \times 10^{3}\,m^{-1}\cdot newton$

Total Live Load $LLW13 := LLW13_f$ $LLW13 = 1.8 \times 10^{3}\,m^{-1}\cdot newton$