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|------------|------------|-------|
| Job Number |            | Sheet |
| Job Title  |            |       |
| Client     |            |       |
| Calcs by   | Checked by | Date  |

Software Consultants (Pty) Ltd  
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Retaining Wall Design : Ver W3.0.03 - 06 Apr 2016

Title : Cantilever wall

### Input Data

C14



| Wall Dimensions |      |             |      | Unfactored Live Loads |   | General Parameters      |     | Design Parameters  |     |
|-----------------|------|-------------|------|-----------------------|---|-------------------------|-----|--------------------|-----|
| H1 (m)          | 1.8  | C (m)       | 0.3  | W (kN/m²)             | 0 | Soil frict $\phi$ (°)   | 25  | SF Overt.          | 1.5 |
| H2 (m)          | 0.7  | F (m)       | 0.00 | P (kN)                | 0 | Fill slope $\beta$ (°)  | 0   | SF Slip            | 1.5 |
| H3 (m)          | 0.15 | xf (m)      | 0.00 | xp (m)                | 0 | Wall frict $\delta$ (°) | 0   | ULS DL Factor      | 1.4 |
| Hw (m)          | 0    | At (m)      | 0.25 | L (kN/m)              | 0 | $\rho$ Conc kN/m³       | 25  | ULS LL Factor      | 1.6 |
| Hr (m)          | 0.36 | Ab (m)      | 0.25 | xl (m)                | 0 | $\rho$ Soil kN/m³       | 18  | Pmax (kPa)         | 250 |
| B (m)           | 0.00 | Cov wall mm | 50   | Lh (kN/m)             | 0 | fcu (MPa)               | 19  | Soil Poisson $\nu$ | 0.5 |
| D (m)           | 0.65 | Cov base mm | 50   | x (m)                 | 0 | fy (MPa)                | 450 | DLFac Slide/Ovt    | 0.9 |

Seepage not allowed

Active pressure applied on back of shear key for sliding

Theory : Coulomb

Wall type : Cantilever

### SEISMIC ANALYSIS SETTINGS:

Seismic Analysis ON/OFF:OFF

|                 |      |
|-----------------|------|
| Hor Accel. (g)  | 0.15 |
| Vert Accel. (g) | 0.01 |
| Include LL's    | Y    |

### VALUES OF PRESSURE COEFFICIENTS:

Active Pressure coefficient  $K_a$  :0.406

Passive Pressure coefficient  $K_p$  :2.464

Base frictional constant  $\mu$  :0.466

### FORCES ACTING ON THE WALL AT SLS:

All forces/moments are per m width

| Description                 | FORCES (kN ) and their LEVER ARMS (m ) |           |                     |           |
|-----------------------------|--|-----------|---------------------|-----------|
|                             | F Horizontal left (+)                  | Lever arm | F Vertical down (+) | Lever arm |
| Destabilizing forces:       |  |           |                     |           |
| Total Active pressure Pa    | 9.945                                  | 0.550     | 0.000               | 0.250     |
| Stabilizing forces:         |  |           |                     |           |
| Passive pressure on base Pp | -10.866                                | 0.233     |                     |           |
| Weight of the wall + base   |  |           | 16.125              | 0.261     |
| Weight of soil on the base  |  |           | 15.795              | 0.575     |

### EQUILIBRIUM CALCULATIONS AT SLS

All forces/moments are per m width

#### 1.Moment Equilibrium

Point of rotation: bottom front corner of base.

For Overturning moment  $M_o$  calculate as follows:

$$M_o = \text{Sum}(\text{hor. forces} \times \text{l.a.}) - \text{Sum}(\text{vert. forces} \times \text{l.a.})$$

For Stabilizing moment  $M_r$  calculate as follows:

$$M_r = -\text{Sum}(\text{hor. forces} \times \text{l.a.}) + \text{Sum}(\text{vert. forces} \times \text{l.a.})$$

where l.a. = lever arm of each force.

Stabilizing moment  $M_r$  : 15.83 kNm

Destabilizing moment  $M_o$  : 5.47 kNm

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Safety factor against overturning =  $M_r/M_o = 2.894$

2. Force Equilibrium at SLS

Sum of Vertical forces  $P_v$  : 31.92 kN  
Frictional resistance  $P_{fric}$  : 14.88 kN  
Passive Pressure on shear key : 0.00 kN  
Passive pressure on base : 10.87 kN  
=> Total Horiz. resistance  $F_r$  : 25.75 kN

Horizontal sliding force on wall  $F_{hw}$  : 9.94 kN  
Horizontal sliding force on shear key  $F_{ht}$  : 0.00 kN  
=> Total Horizontal sliding force  $F_h$  : 9.94 kN

Safety factor against overall sliding =  $F_r/F_h = 2.589$

**FORCES ACTING ON THE WALL AT ULS:**  
All forces/moments are per m width

| Description                    | FORCES (kN ) and their LEVER ARMS (m ) |           |                        |           |
|--------------------------------|--|-----------|------------------------|-----------|
|                                | F Horizontal<br>left (+)               | Lever arm | F Vertical<br>down (+) | Lever arm |
| Destabilizing forces:          |  |           |                        |           |
| Total Active pressure $P_a$    | 13.922                                 | 0.550     | 0.000                  | 0.250     |
| Stabilizing forces:            |  |           |                        |           |
| Passive pressure on base $P_p$ | -9.779                                 | 0.233     |                        |           |
| Weight of the wall + base      |  |           | 14.513                 | 0.261     |
| Weight of soil on the base     |  |           | 14.216                 | 0.575     |

**EQUILIBRIUM CALCULATIONS AT ULS**  
All forces/moments are per m width

1. Moment Equilibrium

Point of rotation: bottom front corner of base.

For Overturning moment  $M_o$  calculate as follows:  
 $M_o = \text{Sum}(\text{hor. forces} \times \text{l.a.}) - \text{Sum}(\text{vert. forces} \times \text{l.a.})$   
For Stabilizing moment  $M_r$  calculate as follows:  
 $M_r = -\text{Sum}(\text{hor. forces} \times \text{l.a.}) + \text{Sum}(\text{vert. forces} \times \text{l.a.})$   
where l.a. = lever arm of each force.

Stabilizing moment  $M_r$  : 14.24 kNm  
Destabilizing moment  $M_o$  : 7.66 kNm

Safety factor against overturning =  $M_r/M_o = 1.860$

2. Force Equilibrium at ULS

Sum of Vertical forces  $P_v$  : 28.73 kN  
Frictional resistance  $P_{fric}$  : 13.40 kN  
Passive Pressure on shear key : 0.00 kN  
Passive pressure on base : 9.78 kN  
=> Total Horiz. resistance  $F_r$  : 23.18 kN

Horizontal sliding force on wall  $F_{hw}$  : 13.92 kN  
Horizontal sliding force on shear key  $F_{ht}$  : 0.00 kN  
=> Total Horizontal sliding force  $F_h$  : 13.92 kN

Safety factor against overall sliding =  $F_r/F_h = 1.665$

**SOIL PRESSURES UNDER BASE AT SLS**

Maximum pressure : 65.15 kPa  
Minimum pressure : 5.79 kPa  
Maximum pressure occurs at left hand side of base

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# WALL MOMENTS (ULS) AND REINFORCEMENT TO BS8110 - 1997

| Position from<br>base top ( m ) | Moment<br>(kNm ) | Front Reinforcing<br>(mm <sup>2</sup> /m ) | Back Reinforcing<br>(mm <sup>2</sup> /m ) | Nominal (0.13%)<br>(mm <sup>2</sup> /m ) |
|---------------------------------|------------------|--|---|--|
| 0.00                            | 3.53             | 0.00                                       | 50.00                                     | 325.00                                   |
| 0.03                            | 3.40             | 0.00                                       | 48.09                                     | 325.00                                   |
| 0.06                            | 3.25             | 0.00                                       | 46.05                                     | 325.00                                   |
| 0.09                            | 3.10             | 0.00                                       | 43.91                                     | 325.00                                   |
| 0.12                            | 2.94             | 0.00                                       | 41.69                                     | 325.00                                   |
| 0.15                            | 2.78             | 0.00                                       | 39.41                                     | 325.00                                   |
| 0.18                            | 2.62             | 0.00                                       | 37.09                                     | 325.00                                   |
| 0.21                            | 2.45             | 0.00                                       | 34.75                                     | 325.00                                   |
| 0.24                            | 2.29             | 0.00                                       | 32.41                                     | 325.00                                   |
| 0.27                            | 2.12             | 0.00                                       | 30.08                                     | 325.00                                   |
| 0.30                            | 1.96             | 0.00                                       | 27.79                                     | 325.00                                   |
| 0.33                            | 1.81             | 0.00                                       | 25.56                                     | 325.00                                   |
| 0.36                            | 1.65             | 0.00                                       | 23.41                                     | 325.00                                   |
| 0.39                            | 1.51             | 0.00                                       | 21.35                                     | 325.00                                   |
| 0.42                            | 1.37             | 0.00                                       | 19.41                                     | 325.00                                   |
| 0.45                            | 1.24             | 0.00                                       | 17.59                                     | 325.00                                   |
| 0.48                            | 1.12             | 0.00                                       | 15.89                                     | 325.00                                   |
| 0.51                            | 1.01             | 0.00                                       | 14.30                                     | 325.00                                   |
| 0.54                            | 0.91             | 0.00                                       | 12.83                                     | 325.00                                   |
| 0.57                            | 0.81             | 0.00                                       | 11.45                                     | 325.00                                   |
| 0.60                            | 0.72             | 0.00                                       | 10.18                                     | 325.00                                   |
| 0.63                            | 0.64             | 0.00                                       | 9.01                                      | 325.00                                   |
| 0.66                            | 0.56             | 0.00                                       | 7.93                                      | 325.00                                   |
| 0.69                            | 0.49             | 0.00                                       | 6.94                                      | 325.00                                   |
| 0.72                            | 0.43             | 0.00                                       | 6.03                                      | 325.00                                   |
| 0.75                            | 0.37             | 0.00                                       | 5.21                                      | 325.00                                   |
| 0.78                            | 0.32             | 0.00                                       | 4.47                                      | 325.00                                   |
| 0.81                            | 0.27             | 0.00                                       | 3.80                                      | 325.00                                   |
| 0.84                            | 0.23             | 0.00                                       | 3.20                                      | 325.00                                   |
| 0.87                            | 0.19             | 0.00                                       | 2.67                                      | 325.00                                   |
| 0.90                            | 0.16             | 0.00                                       | 2.20                                      | 325.00                                   |
| 0.93                            | 0.13             | 0.00                                       | 1.79                                      | 325.00                                   |
| 0.96                            | 0.10             | 0.00                                       | 1.43                                      | 325.00                                   |
| 0.99                            | 0.08             | 0.00                                       | 1.13                                      | 325.00                                   |
| 1.02                            | 0.06             | 0.00                                       | 0.87                                      | 325.00                                   |
| 1.05                            | 0.05             | 0.00                                       | 0.65                                      | 325.00                                   |
| 1.08                            | 0.03             | 0.00                                       | 0.48                                      | 325.00                                   |
| 1.11                            | 0.02             | 0.00                                       | 0.33                                      | 325.00                                   |
| 1.14                            | 0.02             | 0.00                                       | 0.22                                      | 325.00                                   |
| 1.17                            | 0.01             | 0.00                                       | 0.14                                      | 325.00                                   |
| 1.20                            | 0.01             | 0.00                                       | 0.08                                      | 325.00                                   |
| 1.23                            | 0.00             | 0.00                                       | 0.04                                      | 325.00                                   |
| 1.26                            | 0.00             | 0.00                                       | 0.02                                      | 325.00                                   |
| 1.29                            | 0.00             | 0.00                                       | 0.01                                      | 325.00                                   |
| 1.32                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |
| 1.35                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |
| 1.38                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |
| 1.41                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |
| 1.44                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |
| 1.47                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |
| 1.50                            | 0.00             | 0.00                                       | 0.00                                      | 325.00                                   |

# BASE MOMENTS (ULS) AND REINFORCEMENT TO BS8110 - 1997

| Position from<br>left ( m ) | Moment<br>(kNm ) | Top Reinforcing<br>(mm <sup>2</sup> /m ) | Bot Reinforcing<br>(mm <sup>2</sup> /m ) | Nominal (0.13%)<br>(mm <sup>2</sup> /m ) |
|-----------------------------|------------------|--|--|--|
| 0.00                        | 0.00             | 0.00                                     | 0.00                                     | 390.00                                   |
| 0.02                        | -0.01            | 0.00                                     | 0.13                                     | 390.00                                   |
| 0.03                        | -0.05            | 0.00                                     | 0.00                                     | 390.00                                   |
| 0.05                        | -0.11            | 0.00                                     | 0.00                                     | 390.00                                   |
| 0.07                        | -0.19            | 0.00                                     | 0.00                                     | 390.00                                   |
| 0.09                        | -0.30            | 0.00                                     | 0.00                                     | 390.00                                   |

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| 0.10   | -0.43      | 0.00  | 0.00       | 390.00 |       |
| 0.12   | -0.59      | 0.00  | 0.00       | 390.00 |       |
| 0.14   | -0.60      | 0.00  | 0.00       | 390.00 |       |
| 0.16   | 3.51       | 0.00  | 0.00       | 390.00 |       |
| 0.17   | 3.21       | 0.00  | 0.00       | 390.00 |       |
| 0.19   | 3.06       | 0.00  | 0.00       | 390.00 |       |
| 0.21   | 2.91       | 0.00  | 0.00       | 390.00 |       |
| 0.23   | 2.77       | 0.00  | 0.00       | 390.00 |       |
| 0.24   | 2.63       | 29.43 | 0.00       | 390.00 |       |
| 0.26   | 2.49       | 27.90 | 0.00       | 390.00 |       |
| 0.28   | 2.36       | 26.42 | 0.00       | 390.00 |       |
| 0.29   | 2.23       | 24.97 | 0.00       | 390.00 |       |
| 0.31   | 2.10       | 23.56 | 0.00       | 390.00 |       |
| 0.33   | 1.98       | 22.20 | 0.00       | 390.00 |       |
| 0.35   | 1.86       | 20.87 | 0.00       | 390.00 |       |
| 0.36   | 1.75       | 19.59 | 0.00       | 390.00 |       |
| 0.38   | 1.64       | 18.34 | 0.00       | 390.00 |       |
| 0.40   | 1.53       | 17.14 | 0.00       | 390.00 |       |
| 0.42   | 1.43       | 15.98 | 0.00       | 390.00 |       |
| 0.43   | 1.33       | 14.86 | 0.00       | 390.00 |       |
| 0.45   | 1.23       | 13.78 | 0.00       | 390.00 |       |
| 0.47   | 1.14       | 12.74 | 0.00       | 390.00 |       |
| 0.48   | 1.05       | 11.74 | 0.00       | 390.00 |       |
| 0.50   | 0.96       | 10.78 | 0.00       | 390.00 |       |
| 0.52   | 0.88       | 9.87  | 0.00       | 390.00 |       |
| 0.54   | 0.80       | 8.99  | 0.00       | 390.00 |       |
| 0.55   | 0.73       | 8.15  | 0.00       | 390.00 |       |
| 0.57   | 0.66       | 7.36  | 0.00       | 390.00 |       |
| 0.59   | 0.59       | 6.60  | 0.00       | 390.00 |       |
| 0.61   | 0.53       | 5.89  | 0.00       | 390.00 |       |
| 0.62   | 0.47       | 5.22  | 0.00       | 390.00 |       |
| 0.64   | 0.41       | 4.59  | 0.00       | 390.00 |       |
| 0.66   | 0.36       | 4.00  | 0.00       | 390.00 |       |
| 0.68   | 0.31       | 3.44  | 0.00       | 390.00 |       |
| 0.69   | 0.26       | 2.94  | 0.00       | 390.00 |       |
| 0.71   | 0.22       | 2.47  | 0.00       | 390.00 |       |
| 0.73   | 0.18       | 2.04  | 0.00       | 390.00 |       |
| 0.74   | 0.15       | 1.65  | 0.00       | 390.00 |       |
| 0.76   | 0.12       | 1.30  | 0.00       | 390.00 |       |
| 0.78   | 0.09       | 1.00  | 0.00       | 390.00 |       |
| 0.80   | 0.07       | 0.73  | 0.00       | 390.00 |       |
| 0.81   | 0.05       | 0.51  | 0.00       | 390.00 |       |
| 0.83   | 0.03       | 0.33  | 0.00       | 390.00 |       |
| 0.85   | 0.02       | 0.18  | 0.00       | 390.00 |       |
| 0.87   | 0.01       | 0.08  | 0.00       | 390.00 |       |
| 0.88   | 0.00       | 0.02  | 0.00       | 390.00 |       |
| 0.90   | 0.00       | 0.00  | 0.00       | 390.00 |       |
| <b>SHEAR CHECK AT WALL-BASE JUNCTION TO BS8110 - 1997</b>  |            |       |            |        |       |
| Shear force at bottom of wall V = 8.9 kN   |            |       |            |        |       |
| Shear stress at bottom of wall v = 0.05 MPa OK   |            |       |            |        |       |
| Allowable shear stress vc = 0.40 MPa (based on Wall tensile reinf.)  |            |       |            |        |       |



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Base Bending Moments

