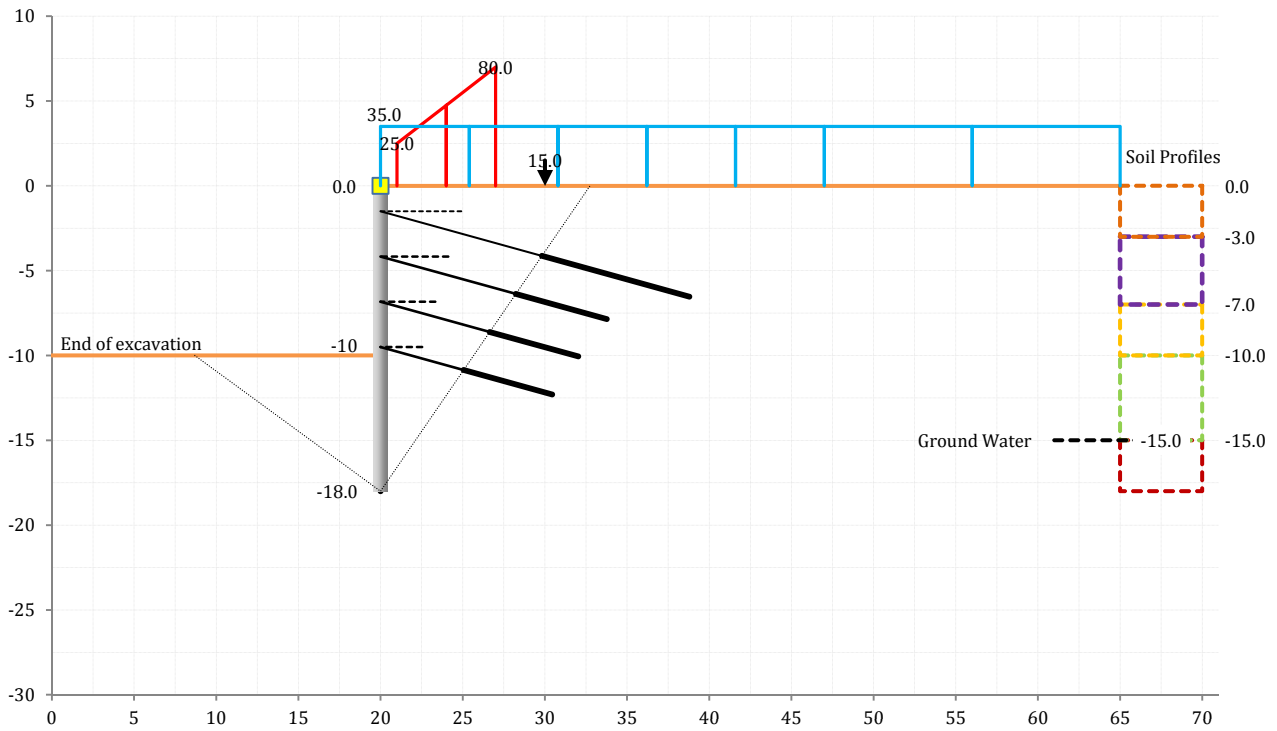


# ANCHORED PILED RETAINING WALL



## SOIL PROFILE

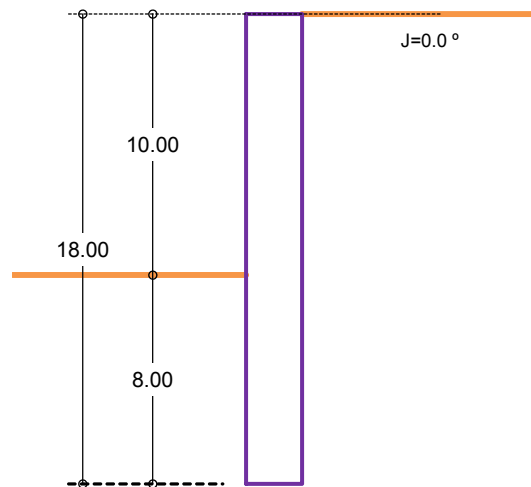
| LAYER      | S.E. (M) | c (KN/M <sup>3</sup> ) | φ (°) | C' (KN/M <sup>2</sup> ) | KA       | KP         | H (M) |
|------------|----------|------------------------|-------|-------------------------|----------|------------|-------|
| SOIL1      | -3       | 20                     | 25    | 5                       | 0.405859 | 2.46391281 | 3     |
| SOIL2      | -7       | 20                     | 5     | 95                      | 0.839663 | 1.19095424 | 4     |
| SOIL3      | -10      | 20                     | 32    | 0                       | 0.307259 | 3.2545883  | 3     |
| SOIL4      | -15      | 20                     | 11    | 100                     | 0.67953  | 1.47160434 | 5     |
| STIFF SOIL | -18      | 18.2                   | 24    | 150                     | 0.42173  | 2.37118411 | 3     |

GROUND WATER ELEVATION : -15 M

## WALL AND PILE PROPERTIES

### SECTION

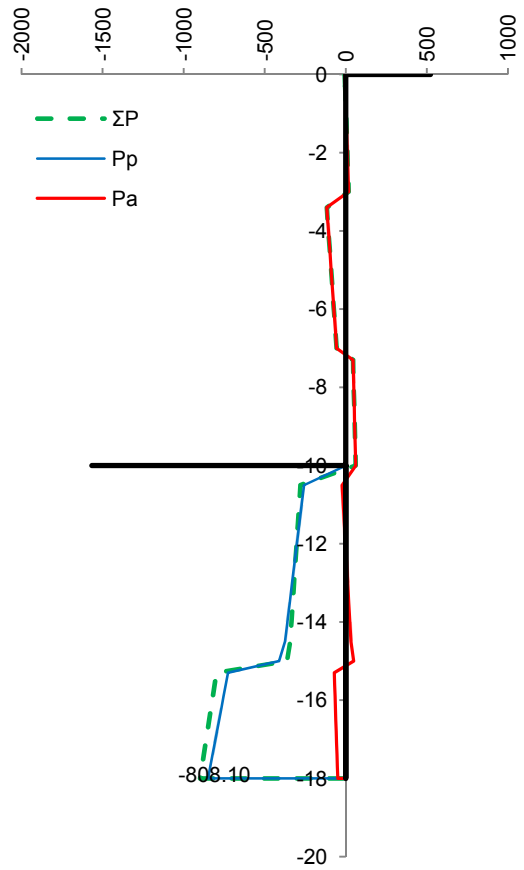
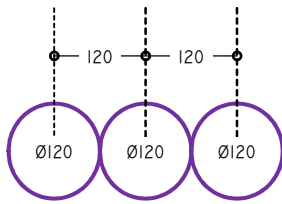
H = 10 M  
 D = 8 M  
 J = 0 °  
 EP = 2E+08 KN/M<sup>2</sup>  
 HPILE = 18 M



# ANCHORED PILED RETAINING WALL

## PILE PLAN

A = 120 CM  
 R = 120 CM  
 Ix = 0.10179 M<sup>4</sup>  
 AP = 1.13097 M<sup>2</sup>

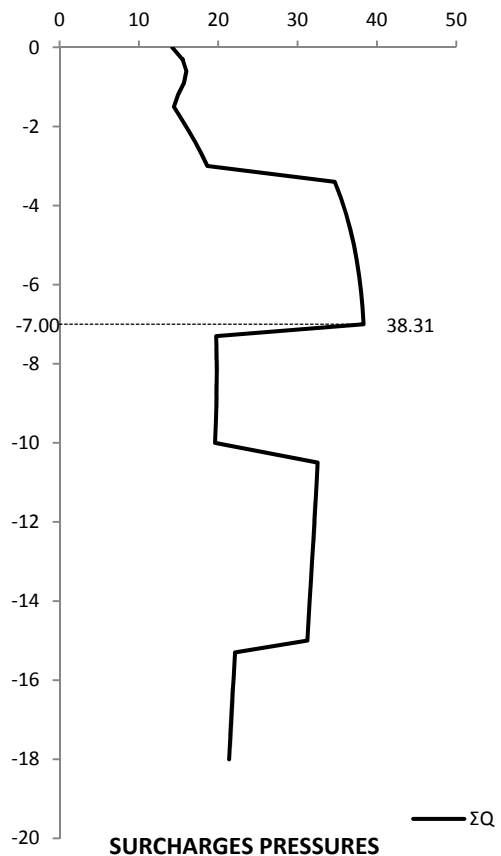


## SURCHARGES

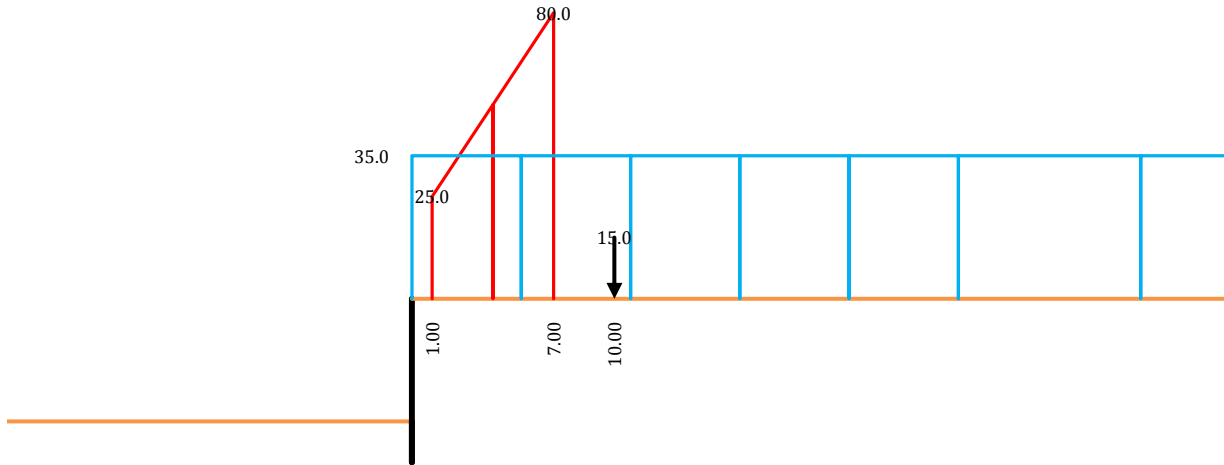
| UNI.LOAD | QU (KN/M <sup>2</sup> ) |
|----------|-------------------------|
| 1        | 35                      |

| STRIP LOAD | Q1 (KN/M <sup>2</sup> ) | Q2 (KN/M <sup>2</sup> ) | X1 > 0.00 | X2 < 19.80 |
|------------|-------------------------|-------------------------|-----------|------------|
| 1          | 25                      | 80                      | 1         | 7          |
| 2          | 0                       | 0                       | 0         | 0          |
| 3          | 0                       | 0                       | 0         | 0          |

| LINE LOAD | QL (KN/M) | 19.8 |
|-----------|-----------|------|
| 1         | 15        | 10   |
| 2         | 0         | 0    |
| 3         | 0         | 0    |

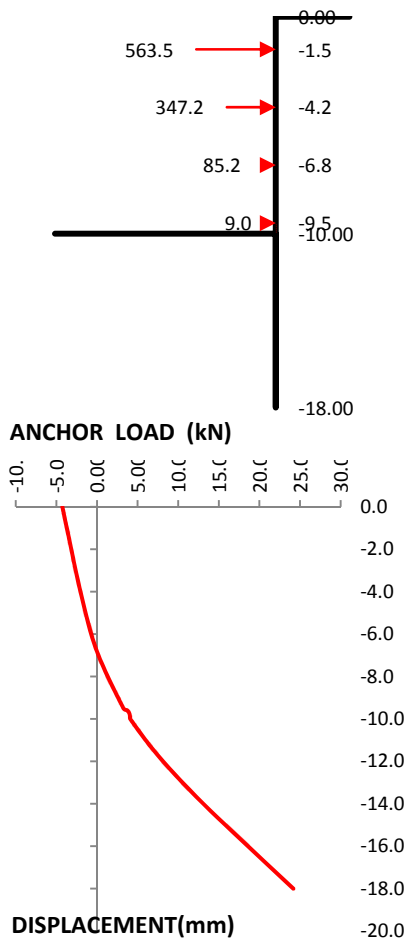


# ANCHORED PILED RETAINING WALL



## ANCHORAGES

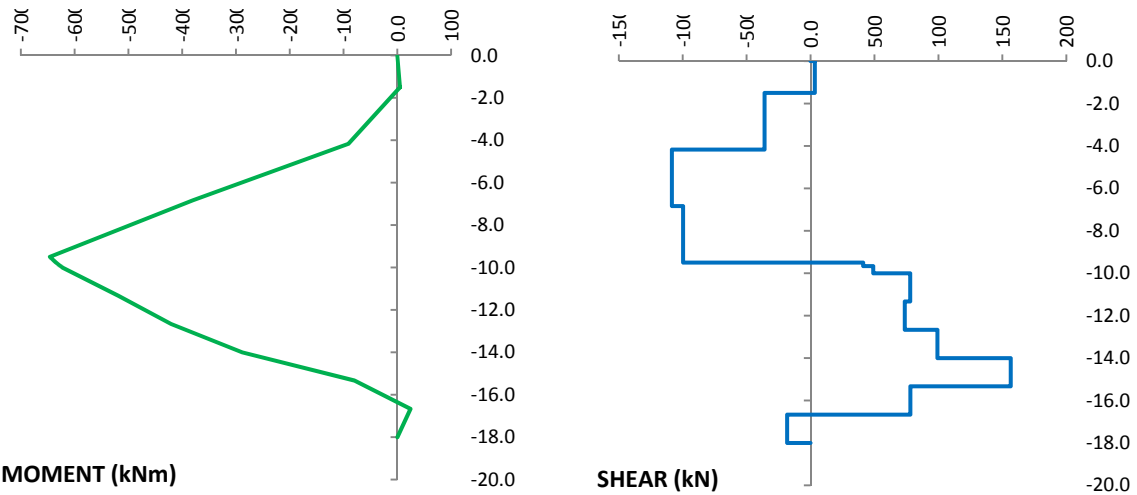
H = 10 M  
 # ANCHORS = 4  
 H (I) = 1.5 M  
 H (N) = 0.5 M  
 H (2,3,...,N-1) = 2.66667 M



| Z (M)    | R (kN)      | Ä (MM)   | M (kNM)   | V (kN)   |
|----------|-------------|----------|-----------|----------|
| 0        | 1.90781E-11 | -4.26116 | 1.273E-11 | 0        |
| -1.5     | 563.5041997 | -3.43718 | 50.841568 | 33.8944  |
| -4.16667 | 347.2188802 | -1.9286  | -909.8959 | -360.277 |
| -6.83333 | 85.22133868 | 0.01027  | -3802.239 | -1084.63 |
| -9.5     | 8.985709959 | 3.26368  | -6460.694 | -996.921 |
| -9.58333 | 0           | 3.67958  | -6426.445 | 410.989  |
| -9.66667 | 0           | 3.88753  | -6392.196 | 410.989  |
| -9.75    | 0           | 3.9915   | -6351.341 | 490.258  |
| -9.83333 | 0           | 4.04349  | -6310.486 | 490.258  |
| -9.91667 | 0           | 4.06948  | -6269.632 | 490.258  |
| -10      | -455.336526 | 4.09548  | -6228.777 | 490.258  |
| -11.3333 | -746.809734 | 6.67376  | -5189.221 | 779.667  |
| -12.6667 | -1092.73473 | 9.70603  | -4206.251 | 737.228  |
| -14      | -1483.37309 | 13.1007  | -2883.138 | 992.335  |
| -15.3333 | -1905.29641 | 16.736   | -795.8664 | 1565.45  |
| -16.6667 | -2340.85858 | 20.456   | 244.26521 | 780.099  |
| -18      | -2596.74419 | 24.1734  | 5.821E-11 | -183.199 |
| MAX      | 2596.744186 | 24.1734  | 6460.6942 | 1565.45  |

| ANCHOR | ELEV.    | I (°) | LU.(M)  |
|--------|----------|-------|---------|
| 1      | -1.5     | 15    | 10.1661 |
| 2      | -4.16667 | 15    | 8.52307 |
| 3      | -6.83333 | 15    | 6.88007 |
| 4      | -9.5     | 15    | 5.23707 |
| 5      |          | 15    | 0       |
| 6      |          | 0     | 0       |
| 7      |          | 0     | 0       |
| 8      |          | 0     | 0       |
| 9      |          | 0     | 0       |

# ANCHORED PILED RETAINING WALL



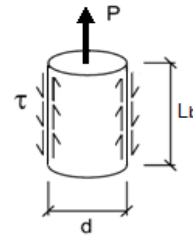
## ANCHOR DESIGN

SF = 1.5  
 T = 200 kN/M2  
 PP = 350 kN (PROJECT LOAD)

P : ANCHOR LOAD  
 LB : LOAD TRANSFER LENGTH  
 D : DIAMETER OF GROUT ANNULUS  
 T : WORKING BOND STRESS  
 SF : SAFETY FACTOR  
 $\delta = 3.14$

$LB = P \cdot SF / [ \delta \cdot D \cdot T ]$

TABLE-I



| STR.DIA. (IN) | APS (MM2) | FPU (N/MM2) | 0.60 .FPU.APS |
|---------------|-----------|-------------|---------------|
| 0.6           | 182.4     | 1863.0      | 203.9         |

| ANC. | D (MM) | PULT (kN) | LB.(M)  | SELECT LB   | L       | STRANDS |
|------|--------|-----------|---------|-------------|---------|---------|
| 1    | 150    | 583.382   | 9.28482 | 9.28482047  | 19.4509 | 3       |
| 2    | 150    | 359.467   | 5.7211  | 5.721101933 | 14.2442 | 2       |
| 3    | 150    | 88.2276   | 5.57042 | 5.570423008 | 12.4505 | 2       |
| 4    | 150    | 9.30269   | 5.57042 | 5.570423008 | 10.8075 | 2       |
| 5    | 150    | 0         | 0       | 0           | 0       | 0       |
| 6    | 150    | 0         | 0       | 0           | 0       | 0       |
| 7    | 150    | 0         | 0       | 0           | 0       | 0       |
| 8    | 150    | 0         | 0       | 0           | 0       | 0       |
| 9    | 150    | 0         | 0       | 0           | 0       | 0       |

TABLE-I

| SOIL / ROCK TYPE EMPIRICAL BOND STRESS VALUE [ T ] | kN/M2       |
|--|-------------|
| COHESIVE SOIL                                      | 100         |
| SAND   | 150         |
| GRAVEL   | 200         |
| WEATHERED MARL, CHALK, SOFT SHALES                 | 150 - 800   |
| SOFT LIMESTONE, SLATES, HARD SHALES, SANDSTONE     | 800 - 1700  |
| DOLOMITE LIMESTONE                                 | 1400 - 2100 |
| GRANITE, BASALT                                    | 1700 - 3100 |

# ANCHORED PILED RETAINING WALL

## D CHECK

$$D_{CALC.} = P_v \cdot SF / [ A_{PH} \cdot T ]$$

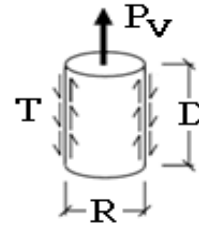
$P_v$  : UPLIFT LOAD

$D$  : LOAD TRANSFER LENGTH

$R$  : DIAMETER OF PILE

$T$  : WORKING BOND STRESS                      TABLE-I

$SF$  : SAFETY FACTOR



$SF =$

$T =$                       100 kN/m<sup>2</sup>                      MATERIAL >>

| NAME | PV.FEM  | PSEL.   |       |
|------|---------|---------|-------|
| ANC1 | 379.367 | 246.697 | 0     |
| ANC2 | 233.757 | 227.601 | 0     |
| ANC3 | 57.3733 | 227.601 | 0     |
| ANC4 | 6.04943 | 227.601 | 0     |
| ANC5 | 0       | 0       | 0     |
| ANC6 | 0       | 0       | 0     |
| ANC7 | 0       | 0       | 0     |
| ANC8 | 0       | 0       | 0     |
| ANC9 | 0       | 0       | 0     |
|      |         |         | 929.5 |

$D_{SEL} =$                       8.00 M

$R =$                       1.20 M

$A_{PH} =$                       30.16 m<sup>2</sup>

$D_{CALC.} =$                       0.92 M                       $D_{SEL} > D_{CALC}$

OK

### HEAD BEAM MATERIAL :

CONCRETE                       $F_{CD-HBEAM} =$                       23300 kN/m<sup>2</sup>

$F_{CDT-HBEAM} =$                       1340 kN/m<sup>2</sup>

STEEL                       $F_{YD-HBEAM} =$                       365000 kN/m<sup>2</sup>

### PILE MATERIAL :

CONCRETE                       $F_{CD-PILE} =$                       33300 kN/m<sup>2</sup>

$F_{CTD-PILE} =$                       2231.1 kN/m<sup>2</sup>

STEEL                       $F_{YD-PILE} =$                       435000 kN/m<sup>2</sup>

### STRUT BEAM MATERIAL :

CONCRETE                       $F_{CD-SBEAM} =$                       20000 kN/m<sup>2</sup>

$F_{CDT-SBEAM} =$                       1340 kN/m<sup>2</sup>

STEEL                       $F_{YD-SBEAM} =$                       365000 kN/m<sup>2</sup>

ANCHORED PILED RETAINING WALL

PILE HEAD BEAM REINFORCEMENT CONCRETE CALCULATIONS

LONGITUDINAL REINFORCEMENT

BBEAM = 140 CM  
 HBEAM = 100 CM  
 D' = 7.5 CM  
 D = 92.5 CM  
 ACB = 0.21 M<sup>2</sup>

RMAX = 929.5 KN/M  
 MD = 487.987 KNM  
 MD = 0.02057  
 ÑM = 0.1295

TOP/BOTTOM OF THE BEAM

CALC. ASB = 90.9958 CM<sup>2</sup>  
 SELECT ASB = 17.8128 CM<sup>2</sup>

TOP : 18Ø26 OK

BOTTOM : 18Ø26 OK

TRANSVERSE REINFORCEMENT

$V_D = V_{MAX} \cdot 1.5$   
 $V_{MAX} = 232.375 \text{ KN/M}$   
 $V_D = 348.562 \text{ KN}$

$V_{CR} = 0.65 \cdot F_{CTD} \cdot A_C$   
 $F_{CTD} = 1340 \text{ KN/M}^2$   
 $V_{CR} = 182.91 \text{ KN}$

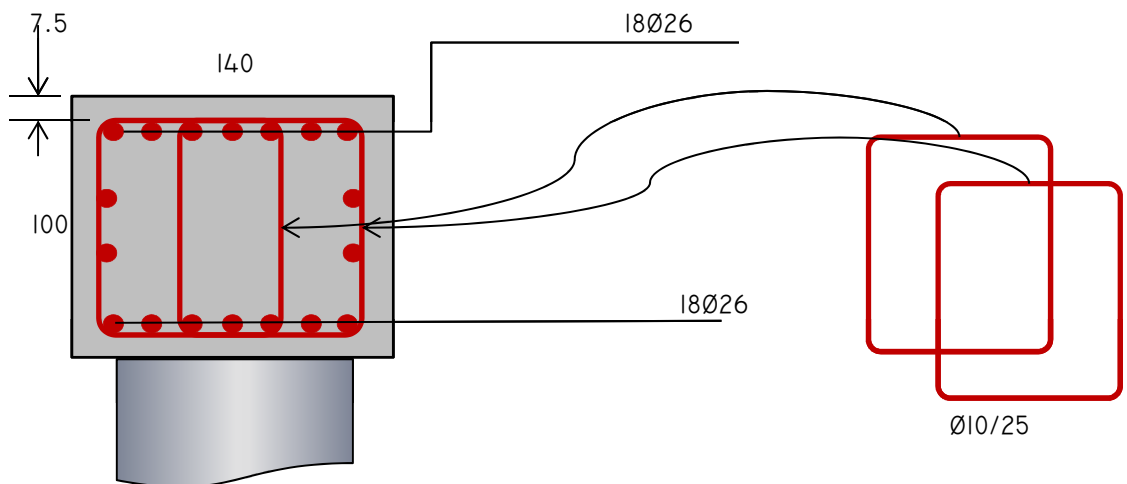
$V_c = 0.80 \cdot V_{CR}$   
 $V_c = 146.328 \text{ KN}$

$V_{WS} = A_{SW} \cdot D \cdot F_{YWD} / S$   
 $V_{WS} = 229.336 \text{ KN}$

$V_{D'} = V_{WS} + V_c$   
 $V_{D'} = 375.664 \text{ KN}$

$V_{D'} > V_D (?)$  OK

Ø10/25



# ANCHORED PILED RETAINING WALL

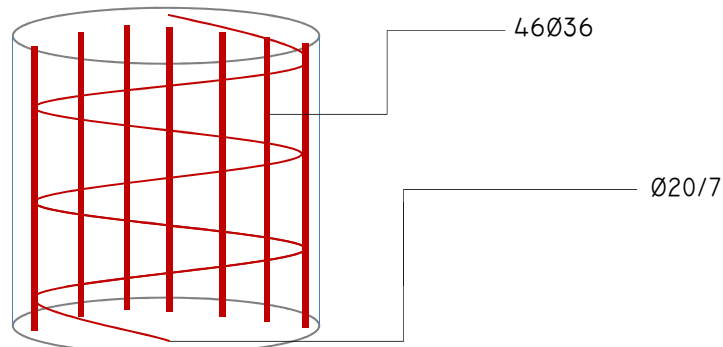
## PILE REINFORCEMENT CONCRETE CALCULATIONS

### LONGITUDINAL REINFORCEMENT

|  |             |                 |         |                   |   |
|--|-------------|-----------------|---------|-------------------|---|
| $D_{PL} = D_{PL} - D'_{PL}$                    |             | $D_{PL} =$      | 120.0   | CM                |   |
|  |             | $D'_{PL} =$     | 5.0     | CM                |   |
|  |             | $D_{PL} =$      | 115.0   | CM                |   |
| $M_D = M_{P_{MAX}} \times 1.5$                 |             |                 |         |                   |   |
| $M_{P_{MAX}} = M_{MAX} + M_{FAILURE}$          |             | $M_{P_{MAX}} =$ | 7048.1  | KNM/M             |   |
|  |             | $A =$           | 1.20    | M                 |   |
|  |             | $M_D =$         | 12686.5 | KNM               |   |
| $M_D = M_D / (0.85 F_{CD} A_c D)$              |             |                 |         |                   |   |
| $P = M_{AX} (P_M ; M_D)$                       |             |                 |         |                   |   |
|  |             | $A_{CP} =$      | 1.131   | M <sup>2</sup>    |   |
|  |             | $F_{CD} =$      | 33300   | KN/M <sup>2</sup> |   |
|  |             | $M_D =$         | 0.330   |                   |   |
|  |             | $\rho_M =$      | 0.623   |                   |   |
| $A_s = \bar{n} A_c / (F_{YD} / (0.85 F_{CD}))$ |             | $F_{YD} =$      | 435000  | KN/M <sup>2</sup> |   |
|  | CALCULATION | $A_{SC} =$      | 458.6   | CM <sup>2</sup>   |   |
|  | SELECTION   | $A_{SS} =$      | 468.2   | CM <sup>2</sup>   | 46Ø36 <span style="border: 1px solid black; padding: 2px; color: green; font-weight: bold;">OK</span> |
|  |             | $\rho_B =$      | 0.041   |                   |   |
|  |             | $M_B =$         | 13199.6 | KNM               |   |

### TRANSVERSE REINFORCEMENT

|  |  |                 |        |                   |   |
|--|--|-----------------|--------|-------------------|---|
| $V_D = V_{P_{MAX}} \times 1.5$         |  |                 |        |                   |   |
| $V_{P_{MAX}} = V_{MAX} + V_{FAIL.ANC}$ |  | $V_{P_{MAX}} =$ | 2307.4 | KN/M              |   |
|  |  | $V_D =$         | 4153.3 | KN                |   |
| $V_{CR} = 0.65 F_{CTD} A_c$            |  |                 |        |                   |   |
|  |  | $F_{CTD} =$     | 2231.1 | KN/M <sup>2</sup> |   |
|  |  | $V_{CR} =$      | 1640.2 | KN                |   |
| $V_c = 0.80 V_{CR}$                    |  | $V_c =$         | 1312.1 | KN                |   |
| $V_{WS} = A_{SW} D F_{YWD} / S$        |  |                 |        |                   |   |
|  |  | $V_{WS} =$      | 3276.2 | KN                |   |
| $V_{D'} = V_{WS} + V_c$                |  | $V_{D'} =$      | 4588.4 | KN                | $V_{D'} > V_D (?)$  |
|  |  |                 |        |                   | Ø20/7 <span style="border: 1px solid black; padding: 2px; color: green; font-weight: bold;">OK</span> |



# ANCHORED PILED RETAINING WALL

## BEAM REINFORCEMENT CONCRETE CALCULATIONS

### LONGITUDINAL REINFORCEMENT

$$D_{PL} = D_{PL} - D'_{PL}$$

|              |       |                |
|--------------|-------|----------------|
| $B_{BEAM} =$ | 35.0  | CM             |
| $H_{BEAM} =$ | 60.0  | CM             |
| $D' =$       | 3     | CM             |
| $D =$        | 32    | CM             |
| $A_{CB} =$   | 0.210 | M <sup>2</sup> |

|             |        |      |
|-------------|--------|------|
| $2S =$      | 2.1    | M    |
| $R_{MAX} =$ | 2596.7 | KN/M |
| $Q_D =$     | 463.7  | KN/M |

$$Q_D = Q_{ULT} = R_{MAX} / (2S \cdot H_{23})$$

$$M_D = M_{MAX} = V_{MAX} S - Q_{ULT} S/2$$

|         |       |     |
|---------|-------|-----|
| $M_D =$ | 267.8 | KNM |
|---------|-------|-----|

$$MD = MD / (0.85 F_{CD} B D^2)$$

|            |       |
|------------|-------|
| $M_D =$    | 0.154 |
| $\rho_M =$ | 0.077 |

$$A_s = \rho_M B D / (F_{YD} / (0.85 F_{CD}))$$

|                        |             |            |      |                 |      |                                 |
|------------------------|-------------|------------|------|-----------------|------|---------------------------------|
|                        | CALCULATION | $A_{SB} =$ | 19.2 | CM <sup>2</sup> |      |                                 |
| SIDE OF THE PILE       | SELECTION   | $A_{SB} =$ | 29.5 | CM <sup>2</sup> | 6Ø25 | <input type="text" value="OK"/> |
|                        | CALCULATION | $A_{SB} =$ | 12.8 | CM <sup>2</sup> |      |                                 |
| SIDE OF THE EXCAVATION | SELECTION   | $A_{SB} =$ | 19.6 | CM <sup>2</sup> | 4Ø25 | <input type="text" value="OK"/> |

### TRANSVERSE REINFORCEMENT

$$V_D = V_{MAX} A 1.5$$

|             |       |      |
|-------------|-------|------|
| $V_{MAX} =$ | 486.9 | KN/M |
| $V_D =$     | 876.4 | KN   |

$$V_{CR} = 0.65 F_{CTD} A_c$$

|             |        |                   |
|-------------|--------|-------------------|
| $F_{CTD} =$ | 1340.0 | KN/M <sup>2</sup> |
| $V_{CR} =$  | 182.9  | KN                |

$$V_C = 0.80 V_{CR}$$

|         |       |    |
|---------|-------|----|
| $V_C =$ | 146.3 | KN |
|---------|-------|----|

$$V_{WS} = A_{SW} D F_{YWD} / S$$

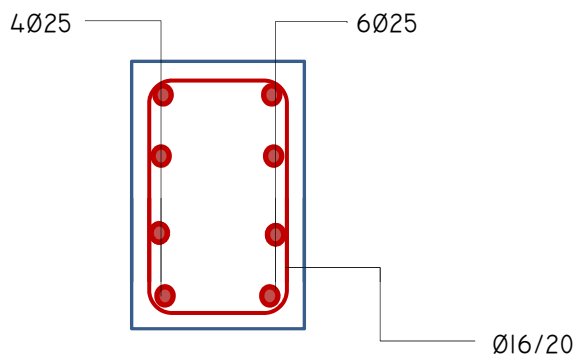
|            |       |    |
|------------|-------|----|
| $V_{WS} =$ | 733.9 | KN |
|------------|-------|----|

$$V_{D'} = V_{WS} + V_C$$

|            |       |    |
|------------|-------|----|
| $V_{D'} =$ | 880.2 | KN |
|------------|-------|----|

$V_{D'} > V_D$  (?)

|        |                                 |
|--------|---------------------------------|
| Ø16/20 | <input type="text" value="OK"/> |
|--------|---------------------------------|





# ANCHORED PILED RETAINING WALL

## QUANTITIES

WALL LENGTH : 85.5 M.

| WL    | A    | HPILE | TP=WL/A | TL=TP.HPILE |
|-------|------|-------|---------|-------------|
| M     | M    | M     | #       | M.          |
| 85.50 | 1.20 | 18.0  | 71      | 1282.5      |

| BARS         | BAR NUMB. | BAR DIA. | UNIT B.L. | UNIT B.W. | BW     | TOTAL BW      |
|--------------|-----------|----------|-----------|-----------|--------|---------------|
| 0            | #         | MM       | M         | KG/M      | KG     | KG            |
| PILE LONG.   | 46        | Ø36      | 20.10     | 7.99      | 526385 | <b>592705</b> |
| PILE TRANS.  | 15        | Ø20      | 4.06      | 2.47      | 47443  |               |
| HEAD BEAM L. | 36        | Ø26      | 1.00      | 4.17      | 12828  |               |
| HEAD BEAM T. | 8         | Ø10      | 3.68      | 0.62      | 1553   |               |
| STRUT BEAM L | 6         | Ø25      | 1.00      | 3.85      | 1977   |               |
| STRUT BEAM L | 4         | Ø25      | 1.00      | 3.85      | 1318   |               |
| STRUT BEAM T | 5         | Ø16      | 1.78      | 1.58      | 1201   |               |

| CONCRETE   | NUMBERS | LENGTH | AREA | VOLUME  | TOTAL CV    |
|------------|---------|--------|------|---------|-------------|
| 0          | #       | M      | M2   | M3      | M3          |
| PILE       | 71      | 18     | 1.13 | 1450.47 | <b>1644</b> |
| HEAD BEAM  | 1       | 85.5   | 1.40 | 119.70  |             |
| STRUT BEAM | 4       | 85.5   | 0.21 | 71.82   |             |

| STR. DIA | STR. DIA | UNIT W. |
|----------|----------|---------|
| IN       | MM       | KG/M    |
| 0.60''   | 1.524    | 1.1     |

| FIXED L. | F.L. DIA. | GROUT       |
|----------|-----------|-------------|
| M        | M         | M3          |
| 9.28     | 0.15      | 13.45       |
| 5.72     | 0.15      | 8.29        |
| 5.57     | 0.15      | 8.07        |
| 5.57     | 0.15      | 8.07        |
| 0.00     | 0.15      | 0.00        |
| 0.00     | 0.15      | 0.00        |
| 0.00     | 0.15      | 0.00        |
| 0.00     | 0.15      | 0.00        |
| 0.00     | 0.15      | 0.00        |
| 0.00     | 0.15      | 0.00        |
|          |           | <b>37.9</b> |

| ANCHOR   | ANC.NUMB. | FULL L. | TOTAL         | STRANDS | TOT. STR. L.   | TOT. STR. W.   |
|----------|-----------|---------|---------------|---------|----------------|----------------|
| 0        | #         | M       | M             | #       | M              | KG             |
| 1        | 82        | 19.45   | 1594.97       | 3       | 4784.92        | 5263.41        |
| 2        | 82        | 14.24   | 1168.02       | 2       | 2336.04        | 2569.65        |
| 3        | 82        | 12.45   | 1020.94       | 2       | 2041.88        | 2246.07        |
| 4        | 82        | 10.81   | 886.21        | 2       | 1772.43        | 1949.67        |
| 5        | 0         | 0.00    | 0.00          | 0       | 0.00           | 0.00           |
| 6        | 0         | 0.00    | 0.00          | 0       | 0.00           | 0.00           |
| 7        | 0         | 0.00    | 0.00          | 0       | 0.00           | 0.00           |
| 8        | 0         | 0.00    | 0.00          | 0       | 0.00           | 0.00           |
| 9        | 0         | 0.00    | 0.00          | 0       | 0.00           | 0.00           |
| TOTALS : |           |         | <b>4670.2</b> |         | <b>10935.3</b> | <b>12028.8</b> |