

# **TUBULAR KING PILE FOUNDATION SYSTEM**

**- Robust and Resilient Foundation System with High Cost Efficiency -**

## **Design Case Study**

# **APPENDICES**

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# **APPENDIX A**

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
 Licensed from GEOSOLVE | Job No. 1504  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Made by : HGC  
 Tubular King File Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :

Units: kN,m

## INPUT DATA

### SOIL PROFILE

| Stratum no. | Elevation of top of stratum | Active side         | Soil types          | Passive side |
|-------------|-----------------------------|---------------------|---------------------|--------------|
| 1           | 7.00                        | 1 Fill              | 1 Fill              |              |
| 2           | 0.00                        | 2 Medium Dense Sand | 2 Medium Dense Sand |              |
| 3           | -5.00                       | 3 Stiff Clay (Und)  | 3 Stiff Clay (Und)  |              |

### SOIL PROPERTIES

| Soil type       | density  | Bulk Young's Modulus | At rest coeff. | Consol. state. | Active limit | Passive limit | Cohesion |
|-----------------|----------|----------------------|----------------|----------------|--------------|---------------|----------|
| No. Description | kN/m3    | Eh, kN/m2            | Ko             | NC/OC          | Ka           | Kp            | kN/m2    |
| (Datum elev.)   |          | (dEh/dy)             | (dKo/dy)       | (Nu)           | (Kac)        | (Kpc)         | (dc/dy)  |
| 1 Fill          | 18.00a   | 10000                | 0.500          | OC             | 0.198        | 8.432         |          |
| ( 5.00 )        | 19.00b   | ( 5000 )             |                | (0.300)        | (0.000)      | ( 0.000 )     |          |
| 2 Medium De..   | 18.00a   | 25000                | 0.430          | OC             | 0.227        | 6.670         |          |
| ( 0.00 )        | 19.00b   | ( 5000 )             |                | (0.300)        | (0.000)      | ( 0.000 )     |          |
| 3 Stiff Cla..   | 20.00    | 100000               | 1.500          | OC             | 1.000        | 1.000         | 100.0u   |
| ( -5.00 )       | ( 7000 ) |                      | (0.490)        | (2.000)        | ( 2.000 )    | ( 7.000 )     |          |
| 4 Stiff Cla..   | 20.00    | 80000                | 1.500          | OC             | 0.444        | 2.488         | 10.00d   |
| ( -5.00 )       | ( 5600 ) |                      | (0.200)        | (1.529)        | ( 4.088 )    |               |          |

Note: (a) and (b) are Bulk Densities above and below the water table

### Additional soil parameters associated with Ka and Kp

| Soil type           | parameters for Ka   |             |             | parameters for Kp   |             |             |
|---------------------|---------------------|-------------|-------------|---------------------|-------------|-------------|
|                     | Soil friction angle | Wall coeff. | Back- angle | Soil friction angle | Wall coeff. | Back- angle |
| 1 Fill              | 38.00               | 0.667       | 0.00        | 38.00               | 0.667       | 0.00        |
| 2 Medium Dense Sand | 35.00               | 0.667       | 0.00        | 35.00               | 0.667       | 0.00        |
| 3 Stiff Clay (Und)  | 0.00                | 0.000       | 0.00        | 0.00                | 0.000       | 0.00        |
| 4 Stiff Clay (Dra)  | 20.00               | 0.500       | 0.00        | 20.00               | 0.500       | 0.00        |

### GROUND WATER CONDITIONS

Density of water = 9.807 kN/m3

|                               | Active side | Passive side |
|-------------------------------|-------------|--------------|
| Initial water table elevation | -0.50       | -0.50        |

Automatic water pressure balancing at toe of wall : No

| Active side  |             |              |       | Passive side |              |       |        |
|--------------|-------------|--------------|-------|--------------|--------------|-------|--------|
| Water press. | Point Elev. | Piezo Water  |       | Point Elev.  | Piezo Water  |       |        |
| no.          | no.         | elev. press. |       | no.          | elev. press. |       |        |
|              | m           | m            | kN/m2 |              | m            | m     | kN/m2  |
| 1            | 1           | 0.00         | 0.0   | 1            | -0.50        | -0.50 | 0.0 MC |
| 2            | 1           | 0.50         | 0.50  | 1            | -0.50        | -0.50 | 0.0 WC |

### WALL PROPERTIES

Type of structure = Fully Embedded Wall  
 Elevation of toe of wall = -14.00  
 Maximum finite element length = 1.20 m  
 Youngs modulus of wall E = 2.1000E+08 kN/m2  
 Moment of inertia of wall I = 2.1085E-03 m4/m run  
 E.I = 442785 kN.m2/m run  
 Yield Moment of wall = Not defined



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

## HORIZONTAL and MOMENT LOADS/RESTRAINTS

| Load no. | Elevation | Horizontal load<br>kN/m run | Moment load<br>kN.m/m run | Moment restraint<br>kN.m/m/rad | Partial factor/<br>Category |
|----------|-----------|-----------------------------|---------------------------|--------------------------------|-----------------------------|
| 1        | 7.00      | 166.7                       | 0                         | 0                              | 1.00 Var                    |

## SURCHARGE LOADS

| Surch-<br>arge<br>no. | Distance<br>Elev. | Length<br>from wall | Width<br>parallel<br>to wall | perpend.<br>to wall | Surcharge<br>kN/m2 | Equiv. soil<br>type | Partial<br>factor/<br>Category |
|-----------------------|-------------------|---------------------|------------------------------|---------------------|--------------------|---------------------|--------------------------------|
| 1                     | 7.00              | 0.00 (A)            | 1000.00                      | 2.00                | 5.00 =             | N/A                 | 1.00 Var                       |
| 2                     | 7.00              | 2.00 (A)            | 1000.00                      | 20.00               | 20.00 =            | N/A                 | 1.00 Var                       |

Note: A = Active side, P = Passive side  
Limit State Categories P/U = Permanent Unfavourable  
P/F = Permanent Favourable  
Var = Variable (unfavourable)

## CONSTRUCTION STAGES

| Construction stage no. | Stage description                                                                                                                                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Excavate to elevation 0.00 on ACTIVE side<br>Toe of berm at elevation 7.00<br>Width of top of berm = 2.00<br>Width of toe of berm = 12.50                |
| 2                      | Excavate to elevation 0.00 on PASSIVE side                                                                                                               |
| 3                      | Change EI of wall to 4.6265E+06 kN.m2/m run<br>From elevation 7.00 to 0.00<br>Yield moment not defined<br>Reset wall displacements to zero at this stage |
| 4                      | Fill to elevation 7.00 on ACTIVE side with soil type 1                                                                                                   |
| 5                      | Apply surcharge no.1 at elevation 7.00<br>No analysis at this stage                                                                                      |
| 6                      | Apply surcharge no.2 at elevation 7.00                                                                                                                   |
| 7                      | Apply water pressure profile no.1 ( Mod. Conserv. )                                                                                                      |
| 8                      | Change properties of soil type 3 to soil type 4<br>Ko pressures will be reset                                                                            |
| 9                      | Change EI of wall to 2.3133E+06 kN.m2/m run<br>From elevation 7.00 to 0.00<br>Yield moment not defined<br>Allow wall to relax with new modulus value     |
| 10                     | Apply load no.1 at elevation 7.00                                                                                                                        |

## FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: Serviceability Limit State  
All loads and soil strengths are unfactored

Stability analysis:  
Method of analysis - Strength Factor method  
Factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:  
Minimum equivalent fluid density = 5.00 kN/m3  
Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:  
Method - Subgrade reaction model using Influence Coefficients  
Open Tension Crack analysis? - No  
Non-linear Modulus Parameter (L) = 0 m

Boundary conditions:  
Length of wall (normal to plane of analysis) = 1000.00 m

Width of excavation on active side of wall = 20.00 m  
Width of excavation on passive side of wall = 20.00 m

Distance to rigid boundary on active side = 20.00 m  
Distance to rigid boundary on passive side = 20.00 m

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

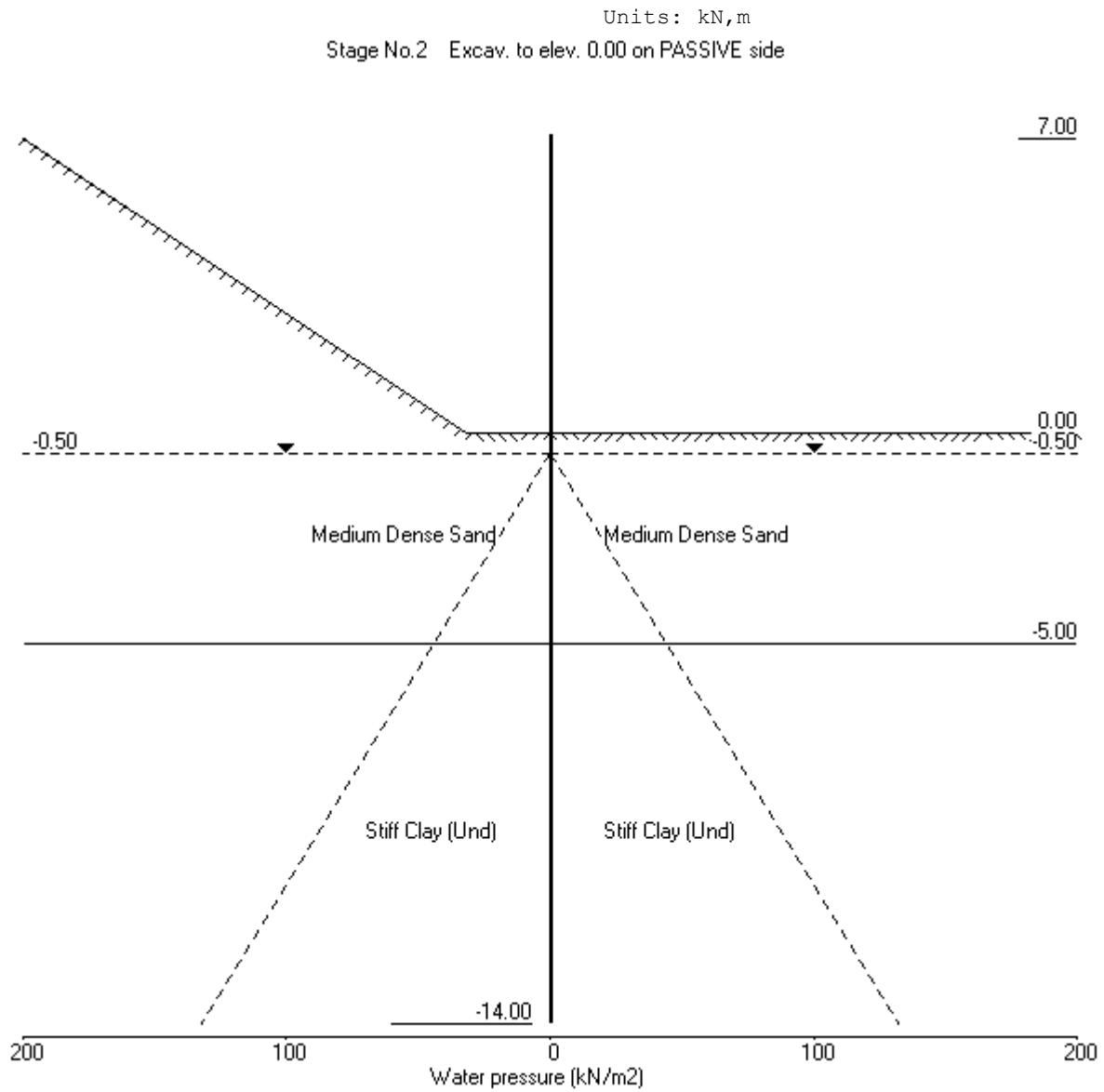
## OUTPUT OPTIONS

| Stage no. | Stage description                      | Displacement<br>Bending mom.<br>Shear force | Active,<br>Passive | Graph.<br>output<br>pressures |
|-----------|----------------------------------------|---------------------------------------------|--------------------|-------------------------------|
| 1         | Excav. to elev. 0.00 on ACTIVE side    | No                                          | No                 | No                            |
| 2         | Excav. to elev. 0.00 on PASSIVE side   | No                                          | No                 | No                            |
| 3         | Change EI of wall to 4.6265E+06kN.m2/m | No                                          | No                 | No                            |
| 4         | Fill to elev. 7.00 on ACTIVE side      | Yes                                         | Yes                | Yes                           |
| 5         | Apply surcharge no.1 at elev. 7.00     | No                                          | No                 | No                            |
| 6         | Apply surcharge no.2 at elev. 7.00     | No                                          | No                 | No                            |
| 7         | Apply water pressure profile no.1      | Yes                                         | Yes                | Yes                           |
| 8         | Change soil type 3 to soil type 4      | No                                          | No                 | No                            |
| 9         | Change EI of wall to 2.3133E+06kN.m2/m | No                                          | No                 | No                            |
| 10        | Apply load no.1 at elev. 7.00          | No                                          | No                 | No                            |
| *         | Summary output                         | Yes                                         | -                  | Yes                           |

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# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

|                                                                    |                 |
|--------------------------------------------------------------------|-----------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                  | Sheet No.       |
| Licensed from GEOSOLVE                                             | Job No. 1504    |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_SLS | Made by : HGC   |
| Tubular King Pile Foundation                                       | Date:16-09-2015 |
| D1000-14 @ 2500                                                    | Checked :       |



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
 | Job No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
 Tubular King File Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :  
 -----

Units: kN,m

Stage No. 2 Excavate to elevation 0.00 on PASSIVE side

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|                    |                |                                       |
|--------------------|----------------|---------------------------------------|
|                    | FoS for toe    | Toe elev. for                         |
|                    | elev. = -14.00 | FoS = 1.000                           |
|                    | -----          | -----                                 |
| Stage --- G.L. --- | Strut          | Factor Moment                         |
| No. Act. Pass.     | Elev.          | of equilib.                           |
|                    |                | Safety at elev.                       |
| 2                  | 0.00           | 0.00                                  |
|                    | Cant.          | Conditions not suitable for FoS calc. |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq Influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
 Passive side 20.00 from wall

### Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 0.00                | -0.018       | -1.46E-03          | 0.0              | -0.0                  |                   | 442785             |
| 2        | 5.90    | 0.00                | -0.016       | -1.46E-03          | 0.0              | 0.0                   |                   | 442785             |
| 3        | 4.80    | 0.00                | -0.014       | -1.46E-03          | 0.0              | 0.0                   |                   | 442785             |
| 4        | 3.60    | 0.00                | -0.013       | -1.46E-03          | 0.0              | 0.0                   |                   | 442785             |
| 5        | 2.40    | 0.00                | -0.011       | -1.46E-03          | 0.0              | 0.0                   |                   | 442785             |
| 6        | 1.20    | 0.00                | -0.009       | -1.46E-03          | 0.0              | 0.0                   |                   | 442785             |
| 7        | 0.00    | 0.00                | -0.007       | -1.46E-03          | 0.0              | 0.0                   |                   | 442785             |
| 8        | -0.50   | -49.85              | -0.007       | -1.46E-03          | -12.5            | 2.5                   |                   | 442785             |
| 9        | -1.45   | -0.68               | -0.005       | -1.42E-03          | -36.5            | -39.7                 |                   | 442785             |
| 10       | -2.40   | 7.95                | -0.004       | -1.30E-03          | -33.0            | -74.1                 |                   | 442785             |
| 11       | -3.60   | 13.85               | -0.002       | -1.04E-03          | -19.9            | -113.9                |                   | 442785             |
| 12       | -4.30   | 15.02               | -0.002       | -8.60E-04          | -9.8             | -123.8                |                   | 442785             |
| 13       | -5.00   | 13.26               | -0.001       | -6.62E-04          | 0.1              | -126.6                |                   | 442785             |
|          |         | 36.76               | -0.001       | -6.62E-04          | 0.1              | -126.6                |                   |                    |
| 14       | -6.10   | 12.21               | -0.001       | -3.76E-04          | 27.0             | -104.3                |                   | 442785             |
| 15       | -7.20   | -2.78               | -0.000       | -1.63E-04          | 32.2             | -67.2                 |                   | 442785             |
| 16       | -8.40   | -9.32               | -0.000       | -3.08E-05          | 24.9             | -30.5                 |                   | 442785             |
| 17       | -9.60   | -9.23               | -0.000       | 2.04E-05           | 13.8             | -7.3                  |                   | 442785             |
| 18       | -10.80  | -6.19               | -0.000       | 2.68E-05           | 4.6              | 2.6                   |                   | 442785             |
| 19       | -12.00  | -2.55               | -0.000       | 1.84E-05           | -0.7             | 3.6                   |                   | 442785             |
| 20       | -13.00  | 0.35                | -0.000       | 1.25E-05           | -1.8             | 1.6                   |                   | 442785             |
| 21       | -14.00  | 3.24                | -0.000       | 1.07E-05           | -0.0             | -0.0                  |                   | ---                |

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.2 Excavate to elevation 0.00 on PASSIVE side

| Node<br>no. | Y<br>coord | ----- ACTIVE side -----  |                        |                          |                           |                            | Total<br>earth<br>pressure<br>kN/m2 | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|-------------|------------|--------------------------|------------------------|--------------------------|---------------------------|----------------------------|-------------------------------------|--------------------------------------|
|             |            | Water<br>press.<br>kN/m2 | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 |                                     |                                      |
| 1           | 7.00       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 2           | 5.90       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 3           | 4.80       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 4           | 3.60       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 5           | 2.40       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 6           | 1.20       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 7           | 0.00       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
|             |            | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 6779                                 |
| 8           | -0.50      | 0.00                     | 9.00                   | 2.04                     | 60.04                     | 5.09                       | 5.09                                | 7457                                 |
| 9           | -1.45      | 9.32                     | 17.75                  | 4.03                     | 118.42                    | 44.57                      | 53.88                               | 8745                                 |
| 10          | -2.40      | 18.63                    | 26.56                  | 6.03                     | 177.14                    | 43.52                      | 62.15                               | 10033                                |
| 11          | -3.60      | 30.40                    | 37.80                  | 8.58                     | 252.12                    | 39.99                      | 70.39                               | 11660                                |
| 12          | -4.30      | 37.26                    | 44.44                  | 10.08                    | 296.40                    | 37.67                      | 74.93                               | 12609                                |
| 13          | -5.00      | 44.13                    | 51.15                  | 11.61                    | 341.15                    | 35.75                      | 79.88                               | 13558                                |
|             |            | Total>                   | 95.28                  | 25.00m                   | 295.30                    | 224.06                     | 224.06                              | 35291                                |
| 14          | -6.10      | Total>                   | 117.86                 | 30.50m                   | 333.28                    | 236.15                     | 236.15                              | 38008                                |
| 15          | -7.20      | Total>                   | 140.65                 | 36.00m                   | 371.48                    | 255.48                     | 255.48                              | 40726                                |
| 16          | -8.40      | Total>                   | 165.76                 | 42.00m                   | 413.38                    | 283.29                     | 283.29                              | 43690                                |
| 17          | -9.60      | Total>                   | 191.10                 | 48.00m                   | 455.53                    | 315.31                     | 315.31                              | 46655                                |
| 18          | -10.80     | Total>                   | 216.68                 | 54.00m                   | 497.91                    | 349.07                     | 349.07                              | 49619                                |
| 19          | -12.00     | Total>                   | 242.46                 | 60.00m                   | 540.49                    | 383.13                     | 383.13                              | 52584                                |
| 20          | -13.00     | Total>                   | 264.08                 | 65.00m                   | 576.11                    | 411.42                     | 411.42                              | 55054                                |
| 21          | -14.00     | Total>                   | 285.80                 | 70.00m                   | 611.84                    | 439.72                     | 439.72                              | 57524                                |

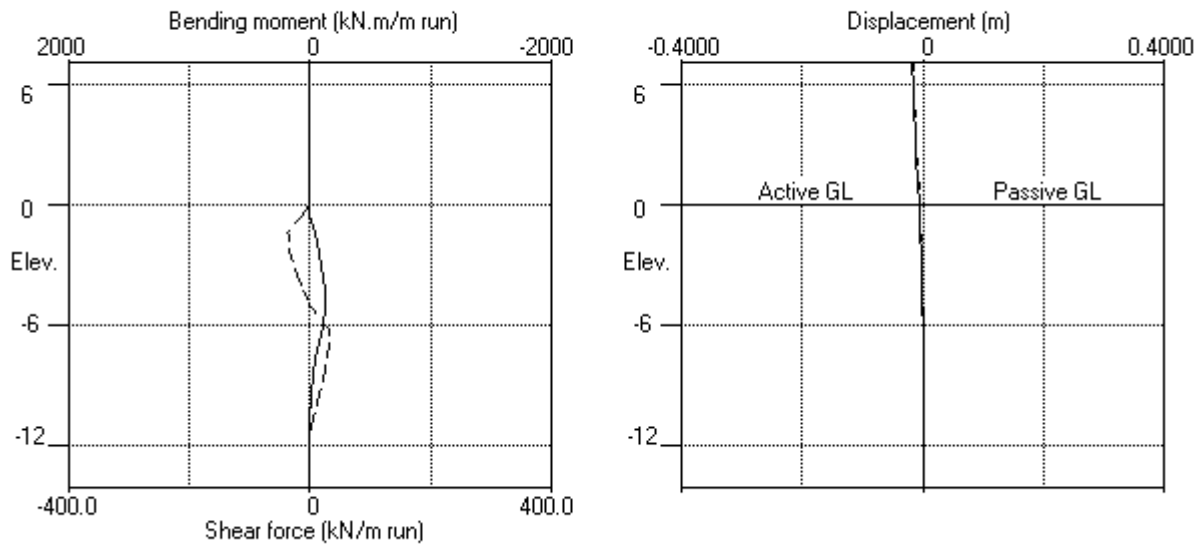
| Node<br>no. | Y<br>coord | ----- PASSIVE side ----- |                        |                          |                           |                            | Total<br>earth<br>pressure<br>kN/m2 | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|-------------|------------|--------------------------|------------------------|--------------------------|---------------------------|----------------------------|-------------------------------------|--------------------------------------|
|             |            | Water<br>press.<br>kN/m2 | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 |                                     |                                      |
| 1           | 7.00       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 2           | 5.90       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 3           | 4.80       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 4           | 3.60       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 5           | 2.40       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 6           | 1.20       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 7           | 0.00       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
|             |            | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 6779                                 |
| 8           | -0.50      | 0.00                     | 9.00                   | 2.04                     | 60.04                     | 54.94                      | 54.94                               | 7457                                 |
| 9           | -1.45      | 9.32                     | 17.75                  | 4.03                     | 118.42                    | 45.25                      | 54.57                               | 8745                                 |
| 10          | -2.40      | 18.63                    | 26.56                  | 6.03                     | 177.14                    | 35.57                      | 54.20                               | 10033                                |
| 11          | -3.60      | 30.40                    | 37.80                  | 8.58                     | 252.12                    | 26.14                      | 56.54                               | 11660                                |
| 12          | -4.30      | 37.26                    | 44.44                  | 10.08                    | 296.40                    | 22.65                      | 59.91                               | 12609                                |
| 13          | -5.00      | 44.13                    | 51.15                  | 11.61                    | 341.15                    | 22.49                      | 66.61                               | 13558                                |
|             |            | Total>                   | 95.28                  | 25.00m                   | 295.30                    | 187.31                     | 187.31                              | 35291                                |
| 14          | -6.10      | Total>                   | 117.86                 | 30.50m                   | 333.28                    | 223.93                     | 223.93                              | 38008                                |
| 15          | -7.20      | Total>                   | 140.65                 | 36.00m                   | 371.48                    | 258.26                     | 258.26                              | 40726                                |
| 16          | -8.40      | Total>                   | 165.76                 | 42.00m                   | 413.38                    | 292.61                     | 292.61                              | 43690                                |
| 17          | -9.60      | Total>                   | 191.10                 | 48.00m                   | 455.53                    | 324.54                     | 324.54                              | 46655                                |
| 18          | -10.80     | Total>                   | 216.68                 | 54.00m                   | 497.91                    | 355.26                     | 355.26                              | 49619                                |
| 19          | -12.00     | Total>                   | 242.46                 | 60.00m                   | 540.49                    | 385.68                     | 385.68                              | 52584                                |
| 20          | -13.00     | Total>                   | 264.08                 | 65.00m                   | 576.11                    | 411.07                     | 411.07                              | 55054                                |
| 21          | -14.00     | Total>                   | 285.80                 | 70.00m                   | 611.84                    | 436.47                     | 436.47                              | 57524                                |

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

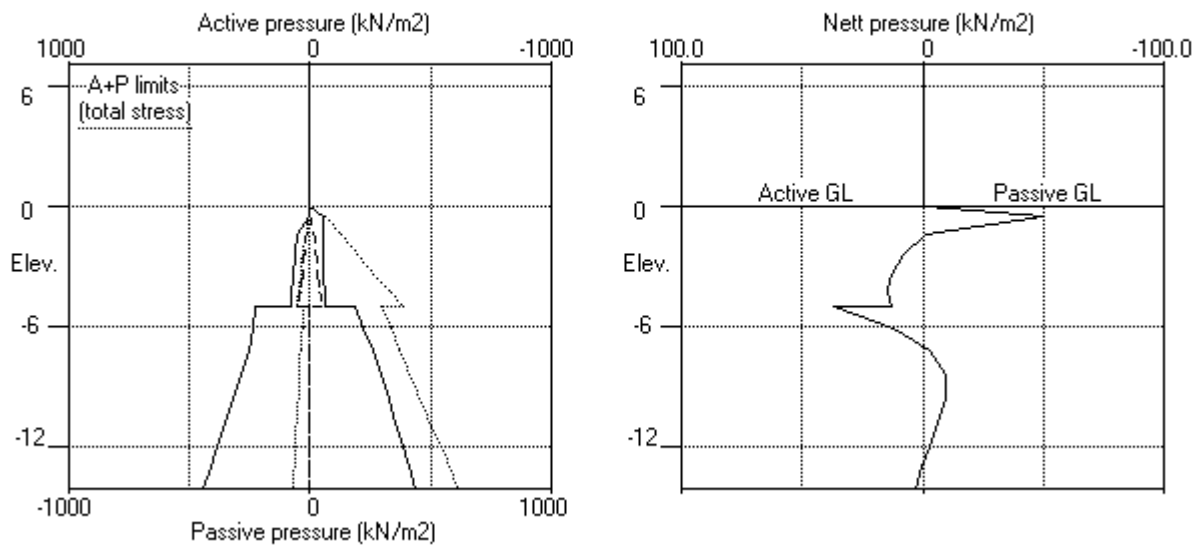
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.2 Excav. to elev. 0.00 on PASSIVE side



Stage No.2 Excav. to elev. 0.00 on PASSIVE side



APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49

Sheet No. 1504

Licensed from GEOSOLVE

Made by : HGC

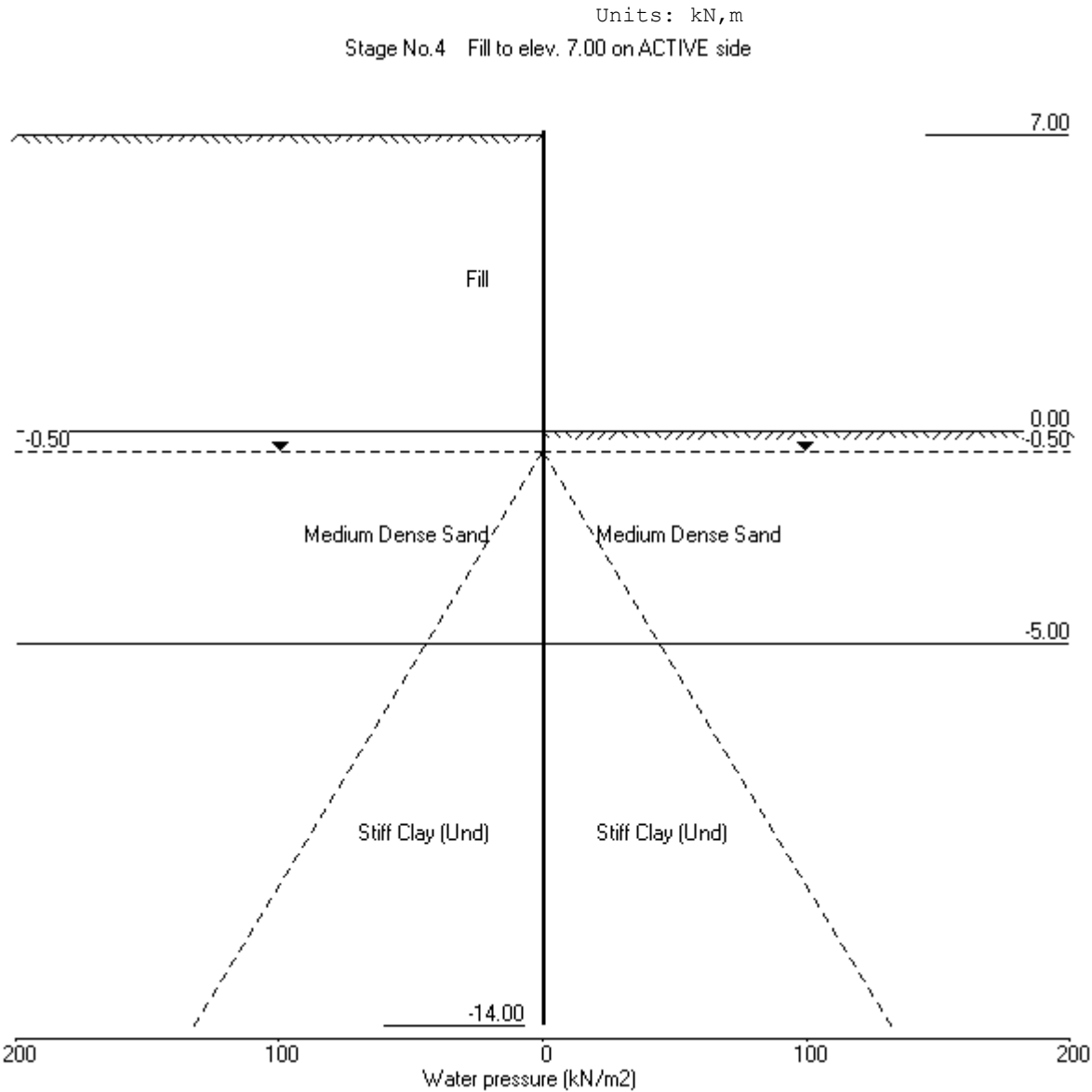
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Tubular King Pile Foundation

Date:16-09-2015

D1000-14 @ 2500

Checked :



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
 Licensed from GEOSOLVE | Job No. 1504  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Made by : HGC  
 Tubular King File Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :  
 -----

Units: kN,m

Stage No. 4 Fill to elevation 7.00 on ACTIVE side with soil type 1

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|       |              |       |        |                |  |               |        |
|-------|--------------|-------|--------|----------------|--|---------------|--------|
|       |              |       |        | FoS for toe    |  | Toe elev. for |        |
|       |              |       |        | elev. = -14.00 |  | FoS = 1.000   |        |
|       |              |       |        | -----          |  | -----         |        |
| Stage | --- G.L. --- | Strut | Factor | Moment         |  | Toe           | Wall   |
| No.   | Act. Pass.   | Elev. | of     | equilib.       |  | elev.         | Penetr |
|       |              |       | Safety | at elev.       |  | -ation        |        |
| 4     | 7.00 0.00    | Cant. | 2.013  | -12.27         |  | -4.13         | 4.13   |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq Influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
 Passive side 20.00 from wall

### Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m <sup>2</sup> | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m <sup>2</sup> /m |
|----------|---------|---------------------------------|--------------|--------------------|------------------|-----------------------|-------------------|---------------------------------|
| 1        | 7.00    | 0.00                            | 0.052        | 4.92E-03           | 0.0              | -0.0                  |                   | 4626512                         |
| 2        | 5.90    | 3.91                            | 0.047        | 4.92E-03           | 2.2              | 0.8                   |                   | 4626512                         |
| 3        | 4.80    | 7.82                            | 0.042        | 4.92E-03           | 8.6              | 6.3                   |                   | 4626512                         |
| 4        | 3.60    | 12.09                           | 0.036        | 4.91E-03           | 20.6             | 23.3                  |                   | 4626512                         |
| 5        | 2.40    | 16.36                           | 0.030        | 4.90E-03           | 37.6             | 57.7                  |                   | 4626512                         |
| 6        | 1.20    | 20.63                           | 0.024        | 4.88E-03           | 59.8             | 115.6                 |                   | 4626512                         |
| 7        | 0.00    | 24.89                           | 0.018        | 4.84E-03           | 87.1             | 203.3                 |                   | 442785                          |
|          |         | 28.59                           | 0.018        | 4.84E-03           | 87.1             | 203.3                 |                   |                                 |
| 8        | -0.50   | -29.40                          | 0.016        | 4.58E-03           | 86.9             | 252.6                 |                   | 442785                          |
| 9        | -1.45   | -72.56                          | 0.012        | 3.94E-03           | 38.5             | 308.1                 |                   | 442785                          |
| 10       | -2.40   | -56.72                          | 0.008        | 3.14E-03           | -22.9            | 323.5                 |                   | 442785                          |
| 11       | -3.60   | -17.72                          | 0.005        | 2.11E-03           | -67.6            | 249.2                 |                   | 442785                          |
| 12       | -4.30   | -0.40                           | 0.004        | 1.57E-03           | -73.9            | 198.2                 |                   | 442785                          |
| 13       | -5.00   | 10.57                           | 0.003        | 1.10E-03           | -70.4            | 146.8                 |                   | 442785                          |
|          |         | 7.94                            | 0.003        | 1.10E-03           | -70.4            | 146.8                 |                   |                                 |
| 14       | -6.10   | 20.07                           | 0.002        | 5.41E-04           | -54.9            | 74.1                  |                   | 442785                          |
| 15       | -7.20   | 19.45                           | 0.002        | 2.04E-04           | -33.2            | 25.6                  |                   | 442785                          |
| 16       | -8.40   | 12.98                           | 0.002        | 3.83E-05           | -13.8            | -0.5                  |                   | 442785                          |
| 17       | -9.60   | 6.22                            | 0.001        | -1.53E-06          | -2.2             | -8.0                  |                   | 442785                          |
| 18       | -10.80  | 1.58                            | 0.001        | 1.16E-05           | 2.4              | -6.5                  |                   | 442785                          |
| 19       | -12.00  | -0.80                           | 0.001        | 3.28E-05           | 2.9              | -2.9                  |                   | 442785                          |
| 20       | -13.00  | -1.62                           | 0.001        | 4.26E-05           | 1.7              | -0.6                  |                   | 442785                          |
| 21       | -14.00  | -1.79                           | 0.001        | 4.51E-05           | 0.0              | -0.0                  |                   | ---                             |



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.4 Fill to elevation 7.00 on ACTIVE side with soil type 1

| Node no. | Y coord | ----- ACTIVE side ----- |            |              |               |                | Total earth pressure | Soil stiffness coeff. |
|----------|---------|-------------------------|------------|--------------|---------------|----------------|----------------------|-----------------------|
|          |         | Water press.            | Vertic -al | Active limit | Passive limit | Earth pressure |                      |                       |
|          |         | kN/m2                   | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2                | kN/m3                 |
| 1        | 7.00    | 0.00                    | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 2        | 5.90    | 0.00                    | 19.80      | 3.91         | 166.95        | 3.91           | 3.91a                | 771                   |
| 3        | 4.80    | 0.00                    | 39.60      | 7.82         | 333.90        | 7.82           | 7.82a                | 1543                  |
| 4        | 3.60    | 0.00                    | 61.20      | 12.09        | 516.03        | 12.09          | 12.09a               | 2384                  |
| 5        | 2.40    | 0.00                    | 82.80      | 16.36        | 698.15        | 16.36          | 16.36a               | 3225                  |
| 6        | 1.20    | 0.00                    | 104.40     | 20.63        | 880.28        | 20.63          | 20.63a               | 4067                  |
| 7        | 0.00    | 0.00                    | 126.00     | 24.89        | 1062.41       | 24.89          | 24.89a               | 4908                  |
|          |         | 0.00                    | 126.00     | 28.59        | 840.42        | 28.59          | 28.59a               | 3506                  |
| 8        | -0.50   | 0.00                    | 135.00     | 30.63        | 900.45        | 30.63          | 30.63a               | 3856                  |
| 9        | -1.45   | 9.32                    | 143.73     | 32.62        | 958.70        | 45.86          | 55.18                | 4522                  |
| 10       | -2.40   | 18.63                   | 152.47     | 34.60        | 1016.95       | 54.54          | 73.17                | 5189                  |
| 11       | -3.60   | 30.40                   | 163.50     | 37.10        | 1090.54       | 62.93          | 93.33                | 6030                  |
| 12       | -4.30   | 37.26                   | 169.94     | 38.56        | 1133.46       | 66.40          | 103.66               | 6521                  |
| 13       | -5.00   | 44.13                   | 176.37     | 40.02        | 1176.39       | 69.01          | 113.14               | 7012                  |
|          |         | Total>                  | 220.50     | 60.00m       | 420.52        | 289.19         | 289.19               | 18965                 |
| 14       | -6.10   | Total>                  | 242.50     | 65.50m       | 457.92        | 314.49         | 314.49               | 20425                 |
| 15       | -7.20   | Total>                  | 264.50     | 71.00m       | 495.32        | 338.67         | 338.67               | 21886                 |
| 16       | -8.40   | Total>                  | 288.50     | 77.00m       | 536.12        | 365.83         | 365.83               | 23479                 |
| 17       | -9.60   | Total>                  | 312.50     | 83.00m       | 576.93        | 394.50         | 394.50               | 25072                 |
| 18       | -10.80  | Total>                  | 336.50     | 89.00m       | 617.73        | 424.47         | 424.47               | 26665                 |
| 19       | -12.00  | Total>                  | 360.50     | 95.00m       | 658.53        | 455.22         | 455.22               | 28258                 |
| 20       | -13.00  | Total>                  | 380.50     | 100.00m      | 692.53        | 481.15         | 481.15               | 29586                 |
| 21       | -14.00  | Total>                  | 400.50     | 105.00m      | 726.53        | 507.27         | 507.27               | 30913                 |

| Node no. | Y coord | ----- PASSIVE side ----- |            |              |               |                | Total earth pressure | Soil stiffness coeff. |
|----------|---------|--------------------------|------------|--------------|---------------|----------------|----------------------|-----------------------|
|          |         | Water press.             | Vertic -al | Active limit | Passive limit | Earth pressure |                      |                       |
|          |         | kN/m2                    | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2                | kN/m3                 |
| 1        | 7.00    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 2        | 5.90    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 3        | 4.80    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 4        | 3.60    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 5        | 2.40    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 6        | 1.20    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
| 7        | 0.00    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0                   |
|          |         | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 6180                  |
| 8        | -0.50   | 0.00                     | 9.00       | 2.04         | 60.04         | 60.04          | 60.04p               | 6798                  |
| 9        | -1.45   | 9.32                     | 17.75      | 4.03         | 118.42        | 118.42         | 127.74p              | 7972                  |
| 10       | -2.40   | 18.63                    | 26.56      | 6.03         | 177.14        | 111.26         | 129.89               | 9146                  |
| 11       | -3.60   | 30.40                    | 37.80      | 8.58         | 252.12        | 80.65          | 111.05               | 10629                 |
| 12       | -4.30   | 37.26                    | 44.44      | 10.08        | 296.40        | 66.80          | 104.07               | 11494                 |
| 13       | -5.00   | 44.13                    | 51.15      | 11.61        | 341.15        | 58.45          | 102.58               | 12359                 |
|          |         | Total>                   | 95.28      | 25.00m       | 295.30        | 281.25         | 281.25               | 32286                 |
| 14       | -6.10   | Total>                   | 117.86     | 30.50m       | 333.28        | 294.42         | 294.42               | 34773                 |
| 15       | -7.20   | Total>                   | 140.65     | 36.00m       | 371.48        | 319.22         | 319.22               | 37259                 |
| 16       | -8.40   | Total>                   | 165.76     | 42.00m       | 413.38        | 352.85         | 352.85               | 39971                 |
| 17       | -9.60   | Total>                   | 191.10     | 48.00m       | 455.53        | 388.28         | 388.28               | 42683                 |
| 18       | -10.80  | Total>                   | 216.68     | 54.00m       | 497.91        | 422.89         | 422.89               | 45395                 |
| 19       | -12.00  | Total>                   | 242.46     | 60.00m       | 540.49        | 456.02         | 456.02               | 48107                 |
| 20       | -13.00  | Total>                   | 264.08     | 65.00m       | 576.11        | 482.77         | 482.77               | 50367                 |
| 21       | -14.00  | Total>                   | 285.80     | 70.00m       | 611.84        | 509.06         | 509.06               | 52627                 |

APPENDIX A-1. WALLAP run ID: TKPF \_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

|                                                      |                 |
|------------------------------------------------------|-----------------|
| Run ID. TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_SLS | Sheet No.       |
| Tubular King Pile Foundation                         | Date:16-09-2015 |
| D1000-14 @ 2500                                      | Checked :       |

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(continued)

Stage No.4    Fill to elevation 7.00 on ACTIVE side with soil type 1

Note:        30.63a    Soil pressure at active limit

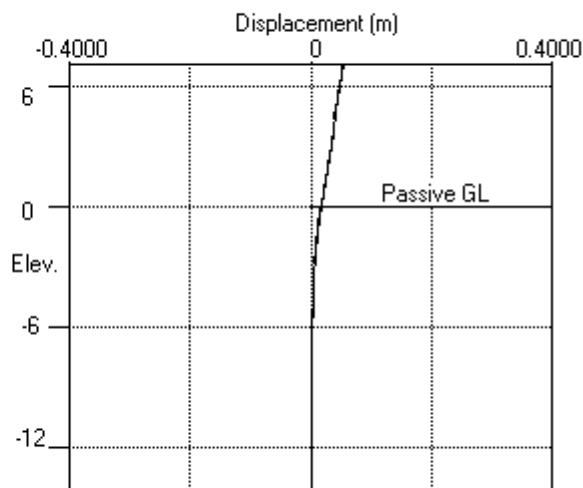
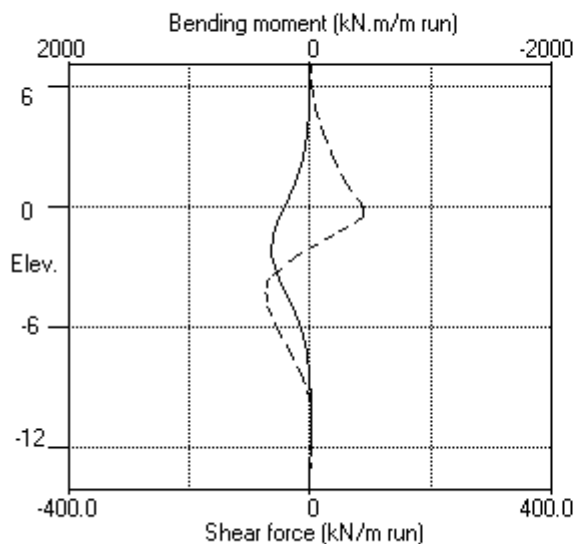
             127.74p    Soil pressure at passive limit

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

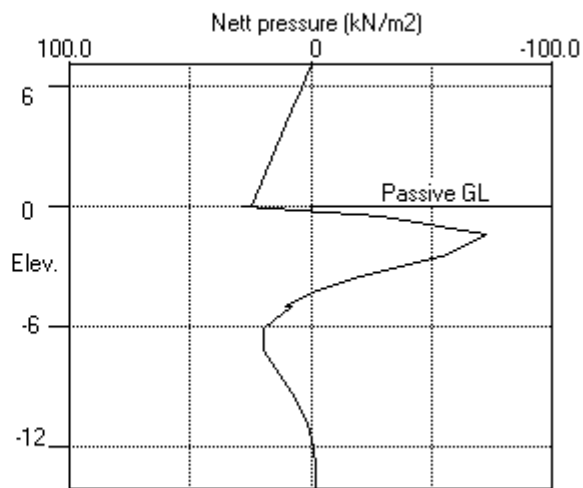
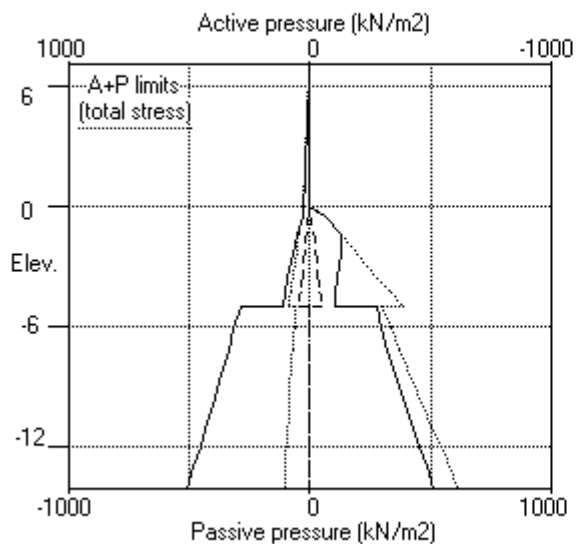
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.4 Fill to elev. 7.00 on ACTIVE side

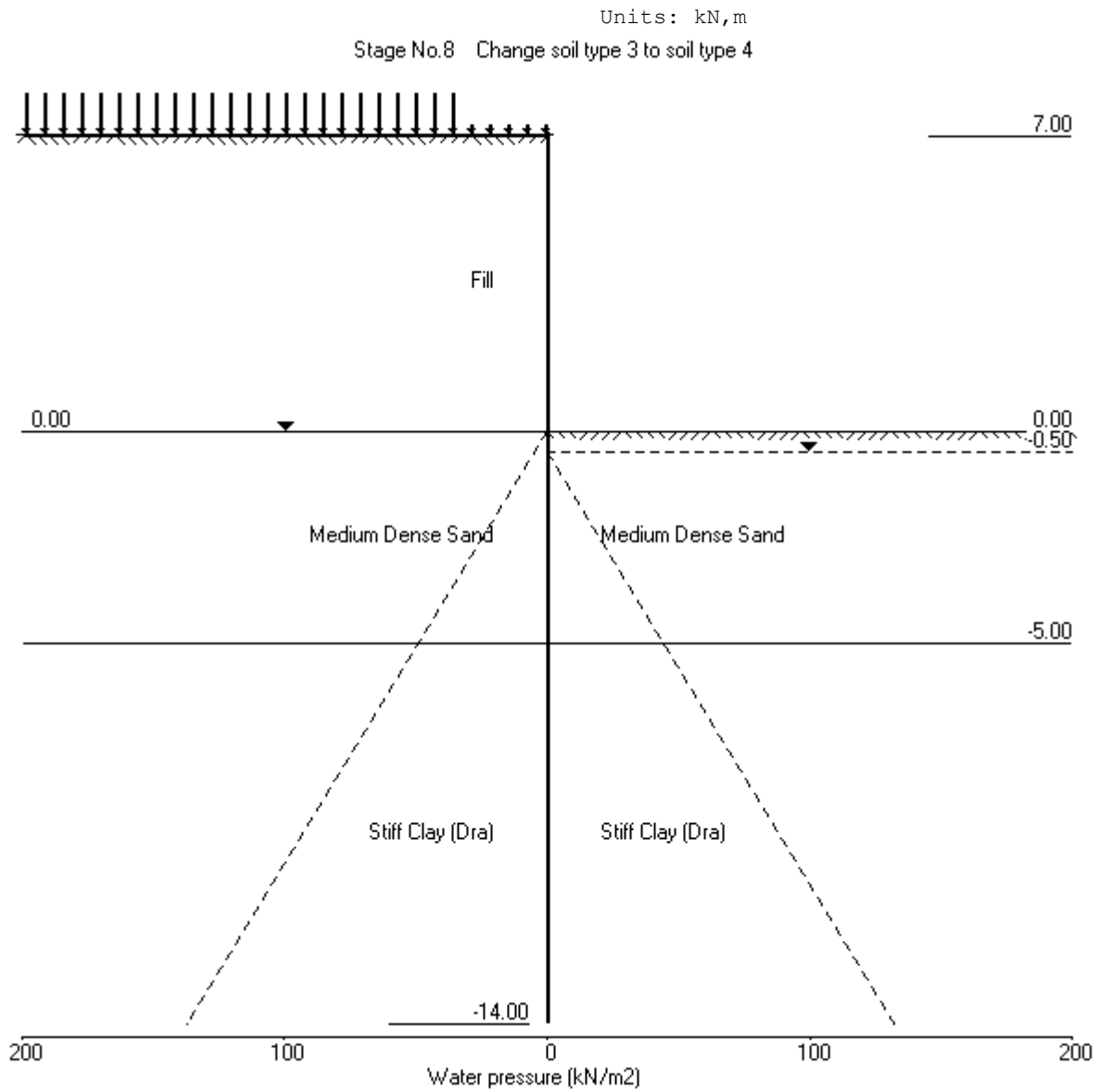


Stage No.4 Fill to elev. 7.00 on ACTIVE side



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
 | Job No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
 Tubular King File Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :  
 -----

Units: kN,m

Stage No. 8 Change properties of soil type 3 to soil type 4  
 Ko pressures will be reset

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|       |              |       |        |                 |        |               |        |
|-------|--------------|-------|--------|-----------------|--------|---------------|--------|
|       |              |       |        | FoS for toe     |        | Toe elev. for |        |
|       |              |       |        | elev. = -14.00  |        | FoS = 1.000   |        |
|       |              |       |        | -----           |        | -----         |        |
| Stage | --- G.L. --- | Strut | Factor | Moment          |        | Toe           | Wall   |
| No.   | Act.         | Pass. | Elev.  | of equil.       |        | elev.         | Penetr |
|       |              |       |        | Safety at elev. |        |               | -ation |
| 8     | 7.00         | 0.00  | Cant.  | 1.545           | -12.90 | -4.59         | 4.59   |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq Influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
 Passive side 20.00 from wall

### Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m <sup>2</sup> | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m <sup>2</sup> /m |
|----------|---------|---------------------------------|--------------|--------------------|------------------|-----------------------|-------------------|---------------------------------|
| 1        | 7.00    | 2.14                            | 0.063        | 5.63E-03           | 0.0              | -0.0                  |                   | 4626512                         |
| 2        | 5.90    | 7.01                            | 0.057        | 5.63E-03           | 5.0              | 1.9                   |                   | 4626512                         |
| 3        | 4.80    | 11.80                           | 0.051        | 5.62E-03           | 15.4             | 12.5                  |                   | 4626512                         |
| 4        | 3.60    | 15.23                           | 0.044        | 5.62E-03           | 31.6             | 40.6                  |                   | 4626512                         |
| 5        | 2.40    | 18.83                           | 0.037        | 5.60E-03           | 52.0             | 90.6                  |                   | 4626512                         |
| 6        | 1.20    | 23.34                           | 0.031        | 5.57E-03           | 77.3             | 167.7                 |                   | 4626512                         |
| 7        | 0.00    | 27.77                           | 0.024        | 5.51E-03           | 108.0            | 278.4                 |                   | 442785                          |
|          |         | 31.90                           | 0.024        | 5.51E-03           | 108.0            | 278.4                 |                   |                                 |
| 8        | -0.50   | -22.13                          | 0.021        | 5.16E-03           | 110.4            | 338.7                 |                   | 442785                          |
| 9        | -1.45   | -78.44                          | 0.017        | 4.31E-03           | 62.7             | 419.8                 |                   | 442785                          |
| 10       | -2.40   | -97.08                          | 0.013        | 3.25E-03           | -20.7            | 455.9                 |                   | 442785                          |
| 11       | -3.60   | -60.12                          | 0.010        | 1.89E-03           | -115.0           | 355.3                 |                   | 442785                          |
| 12       | -4.30   | -45.90                          | 0.009        | 1.22E-03           | -152.1           | 260.7                 |                   | 442785                          |
| 13       | -5.00   | -39.36                          | 0.008        | 7.05E-04           | -182.0           | 143.3                 |                   | 442785                          |
|          |         | 83.20                           | 0.008        | 7.05E-04           | -182.0           | 143.3                 |                   |                                 |
| 14       | -6.10   | 62.94                           | 0.008        | 2.53E-04           | -101.6           | -10.3                 |                   | 442785                          |
| 15       | -7.20   | 44.24                           | 0.008        | 1.62E-04           | -42.6            | -87.8                 |                   | 442785                          |
| 16       | -8.40   | 26.60                           | 0.007        | 2.97E-04           | -0.1             | -109.7                |                   | 442785                          |
| 17       | -9.60   | 12.06                           | 0.007        | 5.21E-04           | 23.1             | -92.9                 |                   | 442785                          |
| 18       | -10.80  | 0.31                            | 0.006        | 7.20E-04           | 30.5             | -59.2                 |                   | 442785                          |
| 19       | -12.00  | -9.27                           | 0.005        | 8.44E-04           | 25.1             | -25.9                 |                   | 442785                          |
| 20       | -13.00  | -16.08                          | 0.004        | 8.88E-04           | 12.4             | -7.8                  |                   | 442785                          |
| 21       | -14.00  | -8.80                           | 0.003        | 8.99E-04           | 0.0              | 0.0                   |                   | ---                             |

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.8 Change properties of soil type 3 to soil type 4  
Ko pressures will be reset

| Node<br>no. | Y<br>coord | ----- ACTIVE side -----        |                        |                          |                           |                            |                            |                              |
|-------------|------------|--------------------------------|------------------------|--------------------------|---------------------------|----------------------------|----------------------------|------------------------------|
|             |            | ----- Effective stresses ----- |                        |                          |                           |                            | Total                      | Soil                         |
|             |            | Water<br>press.<br>kN/m2       | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 | earth<br>pressure<br>kN/m2 | stiffness<br>coeff.<br>kN/m3 |
| 1           | 7.00       | 0.00                           | 5.00                   | 0.99                     | 42.16                     | 2.14                       | 2.14                       | 0.0                          |
| 2           | 5.90       | 0.00                           | 25.57                  | 5.05                     | 215.59                    | 7.01                       | 7.01                       | 1478                         |
| 3           | 4.80       | 0.00                           | 47.79                  | 9.44                     | 402.98                    | 11.80                      | 11.80                      | 2956                         |
| 4           | 3.60       | 0.00                           | 71.92                  | 14.21                    | 606.40                    | 15.23                      | 15.23                      | 4568                         |
| 5           | 2.40       | 0.00                           | 95.32                  | 18.83                    | 803.70                    | 18.83                      | 18.83a                     | 2300                         |
| 6           | 1.20       | 0.00                           | 118.14                 | 23.34                    | 996.16                    | 23.34                      | 23.34a                     | 2900                         |
| 7           | 0.00       | 0.00                           | 140.58                 | 27.77                    | 1185.31                   | 27.77                      | 27.77a                     | 3499                         |
|             |            | 0.00                           | 140.58                 | 31.90                    | 937.64                    | 31.90                      | 31.90a                     | 2500                         |
| 8           | -0.50      | 4.90                           | 145.44                 | 33.00                    | 970.05                    | 33.00                      | 37.91a                     | 2750                         |
| 9           | -1.45      | 14.22                          | 154.56                 | 35.07                    | 1030.93                   | 35.07                      | 49.29a                     | 3225                         |
| 10          | -2.40      | 23.54                          | 163.58                 | 37.12                    | 1091.06                   | 38.25                      | 61.78                      | 3699                         |
| 11          | -3.60      | 35.30                          | 174.84                 | 39.68                    | 1166.16                   | 44.39                      | 79.70                      | 4299                         |
| 12          | -4.30      | 42.17                          | 181.35                 | 41.15                    | 1209.62                   | 45.68                      | 87.85                      | 4649                         |
| 13          | -5.00      | 49.03                          | 187.84                 | 42.62                    | 1252.86                   | 45.55                      | 94.58                      | 4999                         |
|             |            | 49.03                          | 187.84                 | 68.02                    | 508.22                    | 246.43                     | 295.46                     | 7203                         |
| 14          | -6.10      | 59.82                          | 199.07                 | 73.00                    | 536.16                    | 255.53                     | 315.35                     | 7758                         |
| 15          | -7.20      | 70.61                          | 210.24                 | 77.96                    | 563.96                    | 266.70                     | 337.30                     | 8312                         |
| 16          | -8.40      | 82.38                          | 222.38                 | 83.34                    | 594.16                    | 282.23                     | 364.61                     | 8918                         |
| 17          | -9.60      | 94.14                          | 234.47                 | 88.70                    | 624.24                    | 301.48                     | 395.63                     | 9523                         |
| 18          | -10.80     | 105.91                         | 246.53                 | 94.05                    | 654.24                    | 324.09                     | 430.00                     | 10128                        |
| 19          | -12.00     | 117.68                         | 258.55                 | 99.38                    | 684.17                    | 349.37                     | 467.05                     | 10733                        |
| 20          | -13.00     | 127.49                         | 268.56                 | 103.82                   | 709.06                    | 371.95                     | 499.44                     | 11237                        |
| 21          | -14.00     | 137.29                         | 278.56                 | 108.25                   | 733.93                    | 395.56                     | 532.85                     | 11741                        |

| Node<br>no. | Y<br>coord | ----- PASSIVE side -----       |                        |                          |                           |                            |                            |                              |
|-------------|------------|--------------------------------|------------------------|--------------------------|---------------------------|----------------------------|----------------------------|------------------------------|
|             |            | ----- Effective stresses ----- |                        |                          |                           |                            | Total                      | Soil                         |
|             |            | Water<br>press.<br>kN/m2       | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 | earth<br>pressure<br>kN/m2 | stiffness<br>coeff.<br>kN/m3 |
| 1           | 7.00       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
| 2           | 5.90       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
| 3           | 4.80       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
| 4           | 3.60       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
| 5           | 2.40       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
| 6           | 1.20       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
| 7           | 0.00       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 0.0                          |
|             |            | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                       | 2500                         |
| 8           | -0.50      | 0.00                           | 9.00                   | 2.04                     | 60.04                     | 60.04                      | 60.04p                     | 2750                         |
| 9           | -1.45      | 9.32                           | 17.75                  | 4.03                     | 118.42                    | 118.42                     | 127.74p                    | 3225                         |
| 10          | -2.40      | 18.63                          | 26.56                  | 6.03                     | 177.14                    | 140.23                     | 158.86                     | 3699                         |
| 11          | -3.60      | 30.40                          | 37.80                  | 8.58                     | 252.12                    | 109.41                     | 139.81                     | 4299                         |
| 12          | -4.30      | 37.26                          | 44.44                  | 10.08                    | 296.40                    | 96.48                      | 133.75                     | 4649                         |
| 13          | -5.00      | 44.13                          | 51.15                  | 11.61                    | 341.15                    | 89.81                      | 133.94                     | 4999                         |
|             |            | 44.13                          | 51.15                  | 7.40                     | 168.14                    | 168.14                     | 212.27p                    | 7203                         |
| 14          | -6.10      | 54.92                          | 62.95                  | 12.63                    | 197.49                    | 197.49                     | 252.41p                    | 7758                         |
| 15          | -7.20      | 65.70                          | 74.95                  | 17.95                    | 227.36                    | 227.36                     | 293.06p                    | 8312                         |
| 16          | -8.40      | 77.47                          | 88.29                  | 23.87                    | 260.54                    | 260.54                     | 338.01p                    | 8918                         |
| 17          | -9.60      | 89.24                          | 101.86                 | 29.89                    | 294.32                    | 294.32                     | 383.56p                    | 9523                         |
| 18          | -10.80     | 101.01                         | 115.67                 | 36.01                    | 328.68                    | 328.68                     | 429.68p                    | 10128                        |
| 19          | -12.00     | 112.78                         | 129.69                 | 42.23                    | 363.54                    | 363.54                     | 476.32p                    | 10733                        |
| 20          | -13.00     | 122.58                         | 141.50                 | 47.47                    | 392.93                    | 392.93                     | 515.51p                    | 11237                        |
| 21          | -14.00     | 132.39                         | 153.42                 | 52.75                    | 422.58                    | 409.27                     | 541.66                     | 11741                        |

APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

|                                                      |                 |
|------------------------------------------------------|-----------------|
| Run ID. TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_SLS | Sheet No.       |
| Tubular King Pile Foundation                         | Date:16-09-2015 |
| D1000-14 @ 2500                                      | Checked :       |

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(continued)

Stage No.8    Change properties of soil type 3 to soil type 4  
                    Ko pressures will be reset

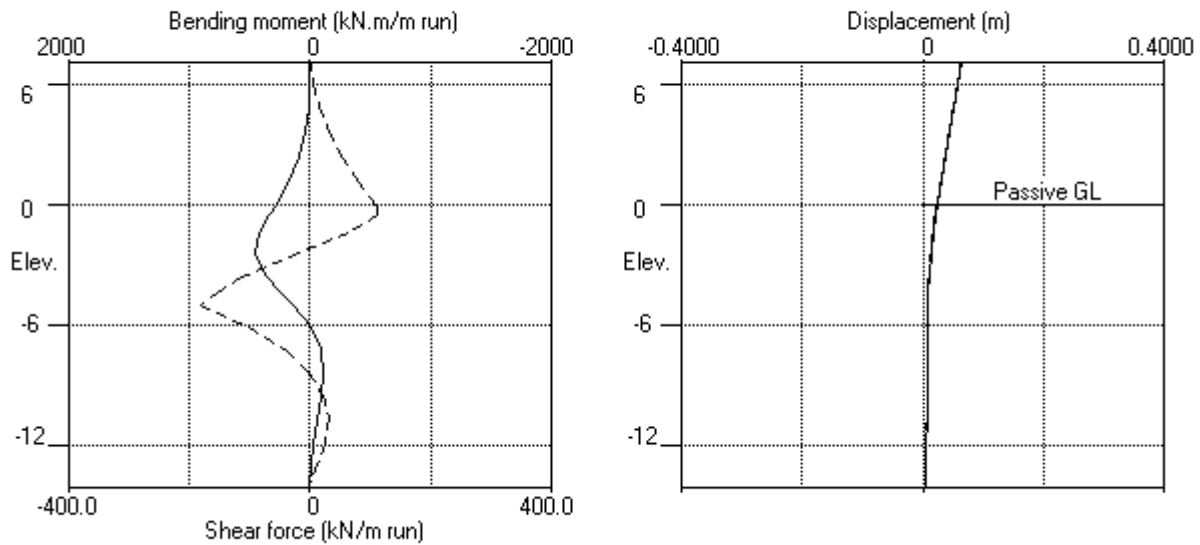
Note:        49.29a    Soil pressure at active limit  
              515.51p    Soil pressure at passive limit

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

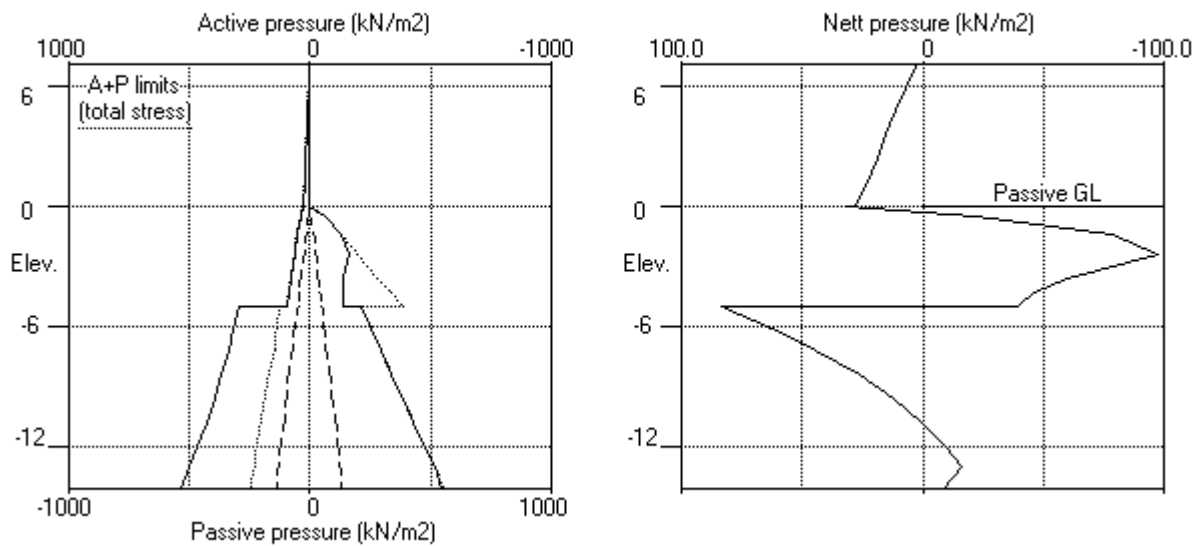
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.8 Change soil type 3 to soil type 4



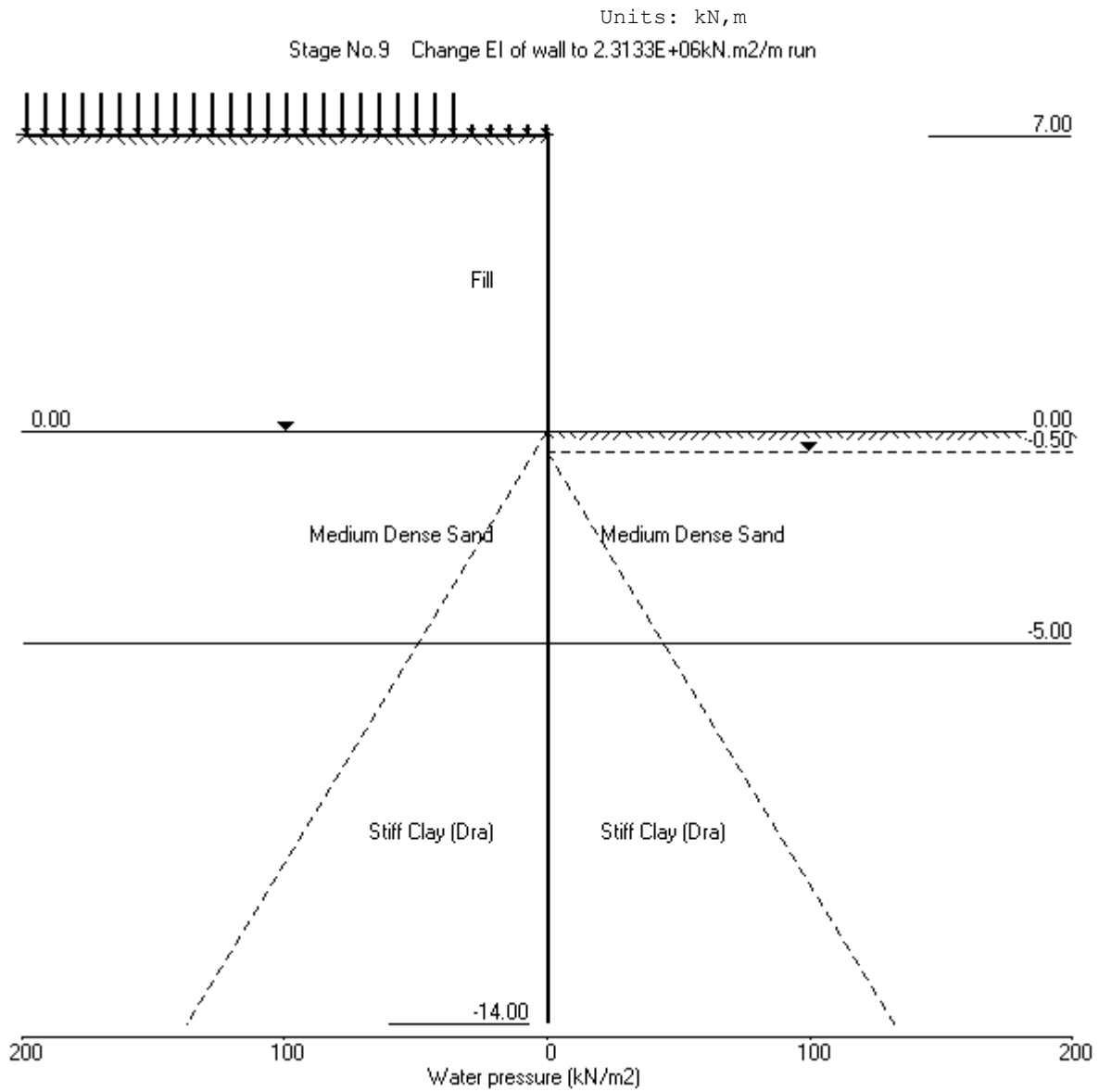
Stage No.8 Change soil type 3 to soil type 4





# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 9 Change EI of wall to 2.3133E+06 kN.m2/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|       |      |          |                 |                         |
|-------|------|----------|-----------------|-------------------------|
|       |      |          | FoS for toe     | Toe elev. for           |
|       |      |          | elev. = -14.00  | FoS = 1.000             |
| Stage | ---  | G.L. --- | Strut           | Factor Moment           |
| No.   | Act. | Pass.    | Elev.           | of equilib.             |
|       |      |          | Safety at elev. | -ation                  |
| 9     | 7.00 | 0.00     | Cant.           | 1.545 -12.90 -4.59 4.59 |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 2.14                | 0.064        | 5.70E-03           | 0.0              | -0.0                  |                   | 2313256            |
| 2        | 5.90    | 6.69                | 0.057        | 5.70E-03           | 4.9              | 1.9                   |                   | 2313256            |
| 3        | 4.80    | 11.41               | 0.051        | 5.70E-03           | 14.8             | 12.3                  |                   | 2313256            |
| 4        | 3.60    | 15.00               | 0.044        | 5.69E-03           | 30.7             | 39.7                  |                   | 2313256            |
| 5        | 2.40    | 18.94               | 0.037        | 5.65E-03           | 51.0             | 88.9                  |                   | 2313256            |
| 6        | 1.20    | 23.73               | 0.031        | 5.59E-03           | 76.6             | 165.2                 |                   | 2313256            |
| 7        | 0.00    | 28.20               | 0.024        | 5.47E-03           | 107.8            | 275.5                 |                   | 442785             |
|          |         | 32.21               | 0.024        | 5.47E-03           | 107.8            | 274.1                 |                   |                    |
| 8        | -0.50   | -21.36              | 0.021        | 5.13E-03           | 110.5            | 334.3                 |                   | 442785             |
| 9        | -1.45   | -78.04              | 0.017        | 4.29E-03           | 63.3             | 415.7                 |                   | 442785             |
| 10       | -2.40   | -97.01              | 0.013        | 3.23E-03           | -19.9            | 452.6                 |                   | 442785             |
| 11       | -3.60   | -60.22              | 0.010        | 1.89E-03           | -114.2           | 353.0                 |                   | 442785             |
| 12       | -4.30   | -46.05              | 0.009        | 1.21E-03           | -151.4           | 259.0                 |                   | 442785             |
| 13       | -5.00   | -39.55              | 0.008        | 7.04E-04           | -181.4           | 142.1                 |                   | 442785             |
|          |         | 83.06               | 0.008        | 7.04E-04           | -181.4           | 142.1                 |                   |                    |
| 14       | -6.10   | 62.80               | 0.008        | 2.55E-04           | -101.1           | -10.9                 |                   | 442785             |
| 15       | -7.20   | 44.11               | 0.008        | 1.65E-04           | -42.3            | -88.0                 |                   | 442785             |
| 16       | -8.40   | 26.50               | 0.007        | 3.00E-04           | 0.0              | -109.6                |                   | 442785             |
| 17       | -9.60   | 11.99               | 0.007        | 5.23E-04           | 23.1             | -92.7                 |                   | 442785             |
| 18       | -10.80  | 0.27                | 0.006        | 7.22E-04           | 30.5             | -59.0                 |                   | 442785             |
| 19       | -12.00  | -9.29               | 0.005        | 8.45E-04           | 25.1             | -25.8                 |                   | 442785             |
| 20       | -13.00  | -16.08              | 0.004        | 8.89E-04           | 12.4             | -7.7                  |                   | 442785             |
| 21       | -14.00  | -8.66               | 0.003        | 8.99E-04           | 0.0              | 0.0                   |                   | ---                |

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.9 Change EI of wall to 2.3133E+06 kN.m2/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

| Node<br>no. | Y<br>coord | ----- ACTIVE side -----  |                        |                          |                           |                            |                                     | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|-------------|------------|--------------------------|------------------------|--------------------------|---------------------------|----------------------------|-------------------------------------|--------------------------------------|
|             |            | Water<br>press.<br>kN/m2 | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 | Total<br>earth<br>pressure<br>kN/m2 |                                      |
| 1           | 7.00       | 0.00                     | 5.00                   | 0.99                     | 42.16                     | 2.14                       | 2.14                                | 0.0                                  |
| 2           | 5.90       | 0.00                     | 25.57                  | 5.05                     | 215.59                    | 6.69                       | 6.69                                | 1448                                 |
| 3           | 4.80       | 0.00                     | 47.79                  | 9.44                     | 402.98                    | 11.41                      | 11.41                               | 2896                                 |
| 4           | 3.60       | 0.00                     | 71.92                  | 14.21                    | 606.40                    | 15.00                      | 15.00                               | 4475                                 |
| 5           | 2.40       | 0.00                     | 95.32                  | 18.83                    | 803.70                    | 18.94                      | 18.94                               | 4573                                 |
| 6           | 1.20       | 0.00                     | 118.14                 | 23.34                    | 996.16                    | 23.73                      | 23.73                               | 5765                                 |
| 7           | 0.00       | 0.00                     | 140.58                 | 27.77                    | 1185.31                   | 28.20                      | 28.20                               | 6958                                 |
|             |            | 0.00                     | 140.58                 | 31.90                    | 937.64                    | 32.21                      | 32.21                               | 4970                                 |
| 8           | -0.50      | 4.90                     | 145.44                 | 33.00                    | 970.05                    | 33.25                      | 38.15                               | 5467                                 |
| 9           | -1.45      | 14.22                    | 154.56                 | 35.07                    | 1030.93                   | 35.20                      | 49.42                               | 6412                                 |
| 10          | -2.40      | 23.54                    | 163.58                 | 37.12                    | 1091.06                   | 38.27                      | 61.80                               | 7356                                 |
| 11          | -3.60      | 35.30                    | 174.84                 | 39.68                    | 1166.16                   | 44.34                      | 79.65                               | 5811                                 |
| 12          | -4.30      | 42.17                    | 181.35                 | 41.15                    | 1209.62                   | 45.60                      | 87.77                               | 6284                                 |
| 13          | -5.00      | 49.03                    | 187.84                 | 42.62                    | 1252.86                   | 45.46                      | 94.49                               | 6757                                 |
|             |            | 49.03                    | 187.84                 | 68.02                    | 508.22                    | 246.30                     | 295.33                              | 9858                                 |
| 14          | -6.10      | 59.82                    | 199.07                 | 73.00                    | 536.16                    | 255.39                     | 315.21                              | 10617                                |
| 15          | -7.20      | 70.61                    | 210.24                 | 77.96                    | 563.96                    | 266.57                     | 337.17                              | 11376                                |
| 16          | -8.40      | 82.38                    | 222.38                 | 83.34                    | 594.16                    | 282.13                     | 364.51                              | 12204                                |
| 17          | -9.60      | 94.14                    | 234.47                 | 88.70                    | 624.24                    | 301.41                     | 395.55                              | 13032                                |
| 18          | -10.80     | 105.91                   | 246.53                 | 94.05                    | 654.24                    | 324.04                     | 429.95                              | 13860                                |
| 19          | -12.00     | 117.68                   | 258.55                 | 99.38                    | 684.17                    | 349.35                     | 467.03                              | 14689                                |
| 20          | -13.00     | 127.49                   | 268.56                 | 103.82                   | 709.06                    | 371.94                     | 499.43                              | 15379                                |
| 21          | -14.00     | 137.29                   | 278.56                 | 108.25                   | 733.93                    | 395.63                     | 532.93                              | 128043                               |

| Node<br>no. | Y<br>coord | ----- PASSIVE side ----- |                        |                          |                           |                            |                                     | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|-------------|------------|--------------------------|------------------------|--------------------------|---------------------------|----------------------------|-------------------------------------|--------------------------------------|
|             |            | Water<br>press.<br>kN/m2 | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 | Total<br>earth<br>pressure<br>kN/m2 |                                      |
| 1           | 7.00       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 2           | 5.90       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 3           | 4.80       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 4           | 3.60       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 5           | 2.40       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 6           | 1.20       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
| 7           | 0.00       | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 0.0                                  |
|             |            | 0.00                     | 0.00                   | 0.00                     | 0.00                      | 0.00                       | 0.00                                | 10527                                |
| 8           | -0.50      | 0.00                     | 9.00                   | 2.04                     | 60.04                     | 59.52                      | 59.52                               | 11579                                |
| 9           | -1.45      | 9.32                     | 17.75                  | 4.03                     | 118.42                    | 118.15                     | 127.46                              | 13579                                |
| 10          | -2.40      | 18.63                    | 26.56                  | 6.03                     | 177.14                    | 140.18                     | 158.81                              | 15580                                |
| 11          | -3.60      | 30.40                    | 37.80                  | 8.58                     | 252.12                    | 109.46                     | 139.86                              | 5811                                 |
| 12          | -4.30      | 37.26                    | 44.44                  | 10.08                    | 296.40                    | 96.56                      | 133.82                              | 6284                                 |
| 13          | -5.00      | 44.13                    | 51.15                  | 11.61                    | 341.15                    | 89.90                      | 134.03                              | 6757                                 |
|             |            | 44.13                    | 51.15                  | 7.40                     | 168.14                    | 168.14                     | 212.27p                             | 9858                                 |
| 14          | -6.10      | 54.92                    | 62.95                  | 12.63                    | 197.49                    | 197.49                     | 252.41p                             | 10617                                |
| 15          | -7.20      | 65.70                    | 74.95                  | 17.95                    | 227.36                    | 227.36                     | 293.06p                             | 11376                                |
| 16          | -8.40      | 77.47                    | 88.29                  | 23.87                    | 260.54                    | 260.54                     | 338.01p                             | 12204                                |
| 17          | -9.60      | 89.24                    | 101.86                 | 29.89                    | 294.32                    | 294.32                     | 383.56p                             | 13032                                |
| 18          | -10.80     | 101.01                   | 115.67                 | 36.01                    | 328.68                    | 328.68                     | 429.68p                             | 13860                                |
| 19          | -12.00     | 112.78                   | 129.69                 | 42.23                    | 363.54                    | 363.54                     | 476.32p                             | 14689                                |
| 20          | -13.00     | 122.58                   | 141.50                 | 47.47                    | 392.93                    | 392.93                     | 515.51p                             | 15379                                |

## APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Sheet No.  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :

(continued)

Stage No.9 Change EI of wall to 2.3133E+06 kN.m2/m run  
 From elevation 7.00 to 0.00  
 Yield moment not defined  
 Allow wall to relax with new modulus value

| Node no. | Y coord | ----- PASSIVE side ----- |            |              |               |                | Total earth pressure | Soil stiffness |
|----------|---------|--------------------------|------------|--------------|---------------|----------------|----------------------|----------------|
|          |         | Water press.             | Vertic -al | Active limit | Passive limit | Earth pressure |                      |                |
|          |         | kN/m2                    | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2                | kN/m3          |
| 21       | -14.00  | 132.39                   | 153.42     | 52.75        | 422.58        | 409.20         | 541.58               | 128043         |

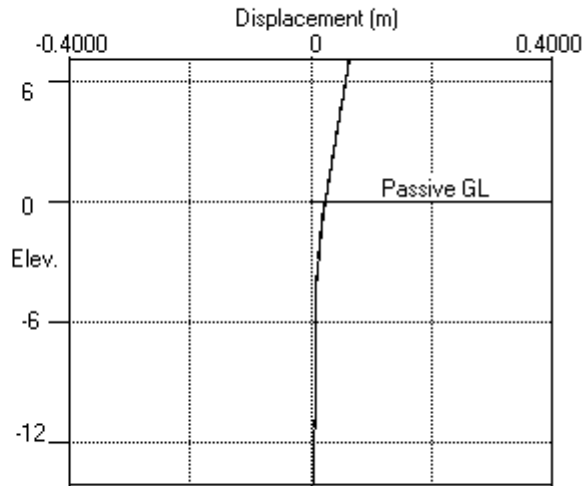
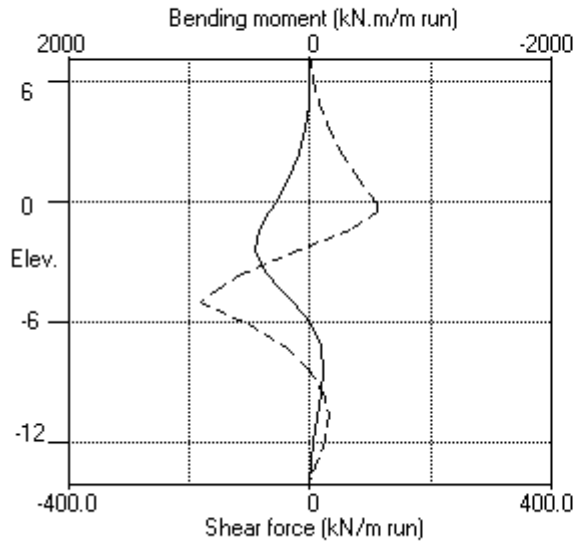
Note: 12.34a Soil pressure at active limit  
 515.51p Soil pressure at passive limit

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

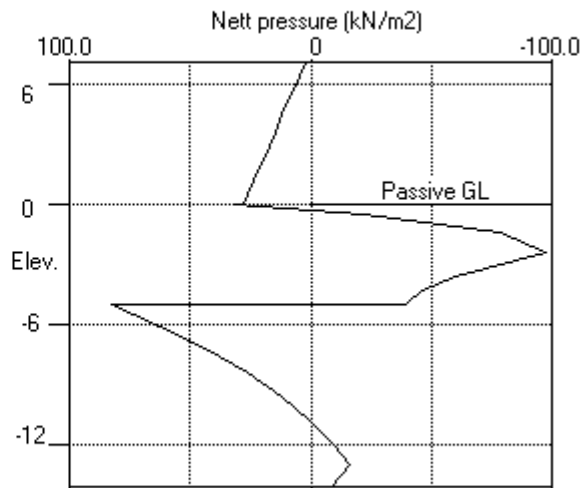
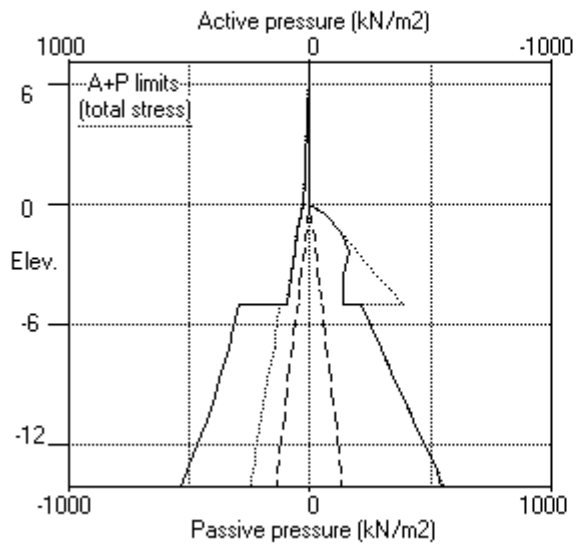
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.9 Change EI of wall to 2.3133E+06kN.m2/m run



Stage No.9 Change EI of wall to 2.3133E+06kN.m2/m run



# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King Pile Foundation | Date: 16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

## Summary of results

### LIMIT STATE PARAMETERS

Limit State: Serviceability Limit State  
All loads and soil strengths are unfactored

### STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|       |              |       | FoS for toe                             |                                       | Toe elev. for |              |
|-------|--------------|-------|-----------------------------------------|---------------------------------------|---------------|--------------|
|       |              |       | elev. = -14.00                          |                                       | FoS = 1.000   |              |
|       |              |       | -----                                   |                                       | -----         |              |
| Stage | --- G.L. --- |       | Strut                                   | Factor                                | Moment        | Toe Wall     |
| No.   | Act.         | Pass. | Elev.                                   | of                                    | equilib.      | elev. Penetr |
|       |              |       | Safety at elev.                         |                                       | -ation        |              |
| 1     | 0.00         | 7.00  | Wall tending to move from right to left |                                       |               |              |
| 2     | 0.00         | 0.00  | Cant.                                   | Conditions not suitable for FoS calc. |               |              |
| 3     | 0.00         | 0.00  | No analysis at this stage               |                                       |               |              |
| 4     | 7.00         | 0.00  | Cant.                                   | 2.013                                 | -12.27        | -4.13 4.13   |
| 5     | 7.00         | 0.00  | No analysis at this stage               |                                       |               |              |
| 6     | 7.00         | 0.00  | Cant.                                   | 1.862                                 | -12.33        | -4.49 4.49   |
| 7     | 7.00         | 0.00  | Cant.                                   | 1.843                                 | -12.32        | -4.59 4.59   |
| 8     | 7.00         | 0.00  | Cant.                                   | 1.545                                 | -12.90        | -4.59 4.59   |
| 9     | 7.00         | 0.00  | Cant.                                   | 1.545                                 | -12.90        | -4.59 4.59   |
| 10    | 7.00         | 0.00  | Cant.                                   | 1.269                                 | -12.42        | -9.06 9.06   |

Note: To obtain a Factor of Safety for the case of wall failing from  
right to left you should reverse the data (Ctrl+K) and re-analyse.

# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

## Summary of results

### BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

#### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

#### Limit State: Serviceability Limit State

Calculated Bending Moments and Strut Forces have been multiplied by a factor of 1.35 to obtain values for structural design.

### Bending moment, shear force and displacement envelopes

| Node no. | Y coord | Displacement |       | Bending moment |      |          |      | Shear force |      |          |      |
|----------|---------|--------------|-------|----------------|------|----------|------|-------------|------|----------|------|
|          |         |              |       | Calculated     |      | Factored |      | Calculated  |      | Factored |      |
|          |         | max.         | min.  | max.           | min. | max.     | min. | max.        | min. | max.     | min. |
|          |         | m            | m     | kN.m/m         |      | kN.m/m   |      | kN/m        | kN/m | kN/m     | kN/m |
| 1        | 7.00    | 0.345        | 0.000 | 0              | -0   | 0        | -0   | 167         | 0    | 225      | 0    |
| 2        | 5.90    | 0.309        | 0.000 | 185            | -1   | 250      | -1   | 171         | -2   | 230      | -3   |
| 3        | 4.80    | 0.273        | 0.000 | 377            | -6   | 508      | -9   | 179         | -9   | 241      | -12  |
| 4        | 3.60    | 0.235        | 0.000 | 599            | -23  | 809      | -31  | 193         | -21  | 260      | -28  |
| 5        | 2.40    | 0.196        | 0.000 | 843            | -58  | 1138     | -78  | 213         | -38  | 287      | -51  |
| 6        | 1.20    | 0.159        | 0.000 | 1113           | -116 | 1502     | -156 | 238         | -60  | 321      | -81  |
| 7        | 0.00    | 0.121        | 0.000 | 1416           | -203 | 1912     | -274 | 269         | -87  | 363      | -118 |
| 8        | -0.50   | 0.107        | 0.000 | 1555           | -248 | 2100     | -335 | 271         | -87  | 366      | -117 |
| 9        | -1.45   | 0.081        | 0.000 | 1789           | -325 | 2415     | -439 | 223         | -46  | 301      | -62  |
| 10       | -2.40   | 0.059        | 0.000 | 1972           | -343 | 2662     | -463 | 122         | -33  | 164      | -45  |
| 11       | -3.60   | 0.037        | 0.000 | 1989           | -315 | 2685     | -426 | 44          | -115 | 60       | -155 |
| 12       | -4.30   | 0.027        | 0.000 | 1875           | -278 | 2532     | -375 | 57          | -244 | 77       | -329 |
| 13       | -5.00   | 0.020        | 0.000 | 1660           | -235 | 2241     | -317 | 62          | -394 | 83       | -532 |
| 14       | -6.10   | 0.012        | 0.000 | 1203           | -153 | 1624     | -206 | 71          | -400 | 96       | -540 |
| 15       | -7.20   | 0.008        | 0.000 | 772            | -88  | 1043     | -119 | 56          | -358 | 76       | -483 |
| 16       | -8.40   | 0.007        | 0.000 | 380            | -110 | 513      | -148 | 33          | -268 | 44       | -362 |
| 17       | -9.60   | 0.007        | 0.000 | 123            | -93  | 166      | -125 | 23          | -158 | 31       | -213 |
| 18       | -10.80  | 0.006        | 0.000 | 8              | -59  | 10       | -80  | 30          | -63  | 41       | -85  |
| 19       | -12.00  | 0.005        | 0.000 | 5              | -34  | 7        | -46  | 25          | -3   | 34       | -4   |
| 20       | -13.00  | 0.004        | 0.000 | 2              | -22  | 2        | -30  | 18          | -3   | 24       | -4   |
| 21       | -14.00  | 0.003        | 0.000 | 0              | -0   | 0        | -0   | 0           | -0   | 0        | -0   |

### Maximum and minimum bending moment and shear force at each stage

| Stage no. | Bending moment               |            |            |            | Shear force |            |            |            |
|-----------|------------------------------|------------|------------|------------|-------------|------------|------------|------------|
|           | Calculated                   |            | Factored   |            | Calculated  |            | Factored   |            |
|           | max. elev.                   | min. elev. | max. elev. | min. elev. | max. elev.  | min. elev. | max. elev. | min. elev. |
|           | kN.m/m                       | kN.m/m     | kN.m/m     | kN.m/m     | kN/m        | kN/m       | kN/m       | kN/m       |
| 1         | 8 -10.80                     | -343 -2.40 | 10 -463    | 71 -6.10   | -87 0.00    | 96 -118    |            |            |
| 2         | 4 -12.00                     | -127 -5.00 | 5 -171     | 32 -7.20   | -36 -1.45   | 43 -49     |            |            |
| 3         | No calculation at this stage |            |            |            |             |            |            |            |
| 4         | 323 -2.40                    | -8 -9.60   | 437 -11    | 87 0.00    | -74 -4.30   | 118 -100   |            |            |
| 5         | No calculation at this stage |            |            |            |             |            |            |            |
| 6         | 407 -2.40                    | -9 -10.80  | 550 -12    | 103 -0.50  | -88 -4.30   | 140 -118   |            |            |
| 7         | 414 -2.40                    | -9 -10.80  | 558 -12    | 104 -0.50  | -87 -4.30   | 141 -117   |            |            |
| 8         | 456 -2.40                    | -110 -8.40 | 615 -148   | 110 -0.50  | -182 -5.00  | 149 -246   |            |            |
| 9         | 453 -2.40                    | -110 -8.40 | 611 -148   | 110 -0.50  | -181 -5.00  | 149 -245   |            |            |
| 10        | 1989 -3.60                   | -34 -12.00 | 2685 -46   | 271 -0.50  | -400 -6.10  | 366 -540   |            |            |

## APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS | Sheet No.  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :

### Summary of results (continued)

#### Maximum and minimum displacement at each stage

| Stage | Displacement                                                                |       |              |       | Stage description                          |
|-------|-----------------------------------------------------------------------------|-------|--------------|-------|--------------------------------------------|
| no.   | maximum<br>m                                                                | elev. | minimum<br>m | elev. |                                            |
| 1     | 0.000                                                                       | 7.00  | -0.051       | 7.00  | Excav. to elev. 0.00 on ACTIVE side        |
| 2     | 0.000                                                                       | 7.00  | -0.018       | 7.00  | Excav. to elev. 0.00 on PASSIVE side       |
| 3     | Wall displacements reset to zero Change EI of wall to 4.6265E+06kN.m2/m run |       |              |       |                                            |
| 4     | 0.052                                                                       | 7.00  | 0.000        | 7.00  | Fill to elev. 7.00 on ACTIVE side          |
| 5     | No calculation at this stage Apply surcharge no.1 at elev. 7.00             |       |              |       |                                            |
| 6     | 0.063                                                                       | 7.00  | 0.000        | 7.00  | Apply surcharge no.2 at elev. 7.00         |
| 7     | 0.065                                                                       | 7.00  | 0.000        | 7.00  | Apply water pressure profile no.1          |
| 8     | 0.063                                                                       | 7.00  | 0.000        | 7.00  | Change soil type 3 to soil type 4          |
| 9     | 0.064                                                                       | 7.00  | 0.000        | 7.00  | Change EI of wall to 2.3133E+06kN.m2/m run |
| 10    | 0.345                                                                       | 7.00  | 0.000        | 7.00  | Apply load no.1 at elev. 7.00              |

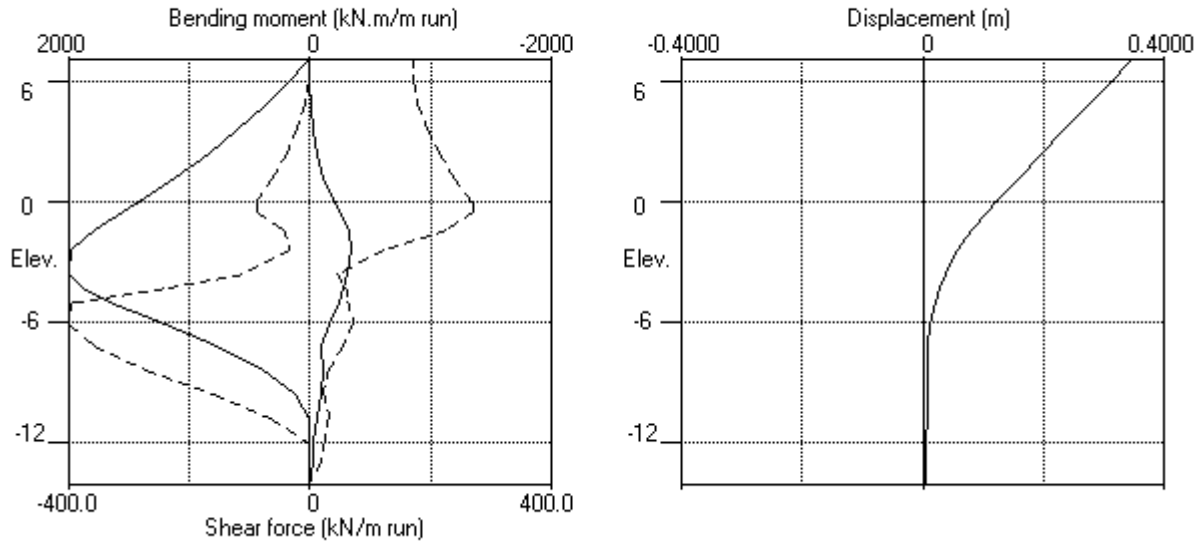


# APPENDIX A-1. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_SLS

|                                                                    |                  |
|--------------------------------------------------------------------|------------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                  | Sheet No.        |
| Licensed from GEOSOLVE                                             | Job No. 1504     |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_SLS | Made by : HGC    |
| Tubular King Pile Foundation                                       | Date: 16-09-2015 |
| D1000-14 @ 2500                                                    | Checked :        |

Units: kN,m

Bending moment, shear force, displacement envelopes



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

## INPUT DATA

### SOIL PROFILE

| Stratum no. | Elevation of top of stratum | Active side         | Soil types          | Passive side |
|-------------|-----------------------------|---------------------|---------------------|--------------|
| 1           | 7.00                        | 1 Fill              | 1 Fill              |              |
| 2           | 0.00                        | 2 Medium Dense Sand | 2 Medium Dense Sand |              |
| 3           | -5.00                       | 3 Stiff Clay (Und)  | 3 Stiff Clay (Und)  |              |

### SOIL PROPERTIES (Unfactored SLS soil strengths)

| Soil type       | density  | Young's Modulus | At rest coeff. | Consol. state. | Active limit | Passive limit | Cohesion |
|-----------------|----------|-----------------|----------------|----------------|--------------|---------------|----------|
| No. Description | kN/m3    | Eh, kN/m2       | Ko             | NC/OC          | Ka           | Kp            | kN/m2    |
| (Datum elev.)   |          | (dEh/dy)        | (dKo/dy)       | (Nu)           | (Kac)        | (Kpc)         | (dc/dy)  |
| 1 Fill          | 18.00a   | 10000           | 0.500          | OC             | 0.198        | 8.432         |          |
| ( 5.00 )        | 19.00b   | ( 5000 )        |                | (0.300)        | (0.000)      | ( 0.000 )     |          |
| 2 Medium De..   | 18.00a   | 25000           | 0.430          | OC             | 0.227        | 6.670         |          |
| ( 0.00 )        | 19.00b   | ( 5000 )        |                | (0.300)        | (0.000)      | ( 0.000 )     |          |
| 3 Stiff Cla..   | 20.00    | 100000          | 1.500          | OC             | 1.000        | 1.000         | 100.0u   |
| ( -5.00 )       | ( 7000 ) |                 | (0.490)        | (2.000)        | ( 2.000 )    | ( 7.000 )     |          |
| 4 Stiff Cla..   | 20.00    | 80000           | 1.500          | OC             | 0.444        | 2.488         | 10.00d   |
| ( -5.00 )       | ( 5600 ) |                 | (0.200)        | (1.529)        | ( 4.088 )    |               |          |

Note: (a) and (b) are Bulk Densities above and below the water table

### Additional soil parameters associated with Ka and Kp

| Soil type           | parameters for Ka |       |                | parameters for Kp |       |       |
|---------------------|-------------------|-------|----------------|-------------------|-------|-------|
|                     | Soil              | Wall  | Back-          | Soil              | Wall  | Back- |
| friction angle      | adhesion coeff.   | fill  | friction angle | adhesion coeff.   | fill  |       |
| 1 Fill              | 38.00             | 0.667 | 0.00           | 38.00             | 0.667 | 0.00  |
| 2 Medium Dense Sand | 35.00             | 0.667 | 0.00           | 35.00             | 0.667 | 0.00  |
| 3 Stiff Clay (Und)  | 0.00              | 0.000 | 0.00           | 0.00              | 0.000 | 0.00  |
| 4 Stiff Clay (Dra)  | 20.00             | 0.500 | 0.00           | 20.00             | 0.500 | 0.00  |

### GROUND WATER CONDITIONS

Density of water = 9.807 kN/m3

|                               | Active side | Passive side |
|-------------------------------|-------------|--------------|
| Initial water table elevation | -0.50       | -0.50        |

Automatic water pressure balancing at toe of wall : No

| Active side  |             |              |       | Passive side |              |       |        |
|--------------|-------------|--------------|-------|--------------|--------------|-------|--------|
| Water press. | Point Elev. | Piezo Water  |       | Point Elev.  | Piezo Water  |       |        |
| no.          | no.         | elev. press. |       | no.          | elev. press. |       |        |
|              | m           | m            | kN/m2 |              | m            | m     | kN/m2  |
| 1            | 1           | 0.00         | 0.0   | 1            | -0.50        | -0.50 | 0.0 MC |
| 2            | 1           | 0.50         | 0.50  | 1            | -0.50        | -0.50 | 0.0 WC |

### WALL PROPERTIES

Type of structure = Fully Embedded Wall  
Elevation of toe of wall = -14.00  
Maximum finite element length = 1.20 m  
Youngs modulus of wall E = 2.1000E+08 kN/m2  
Moment of inertia of wall I = 2.1085E-03 m4/m run  
E.I = 442785 kN.m2/m run  
Yield Moment of wall = Not defined

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

### HORIZONTAL and MOMENT LOADS/RESTRAINTS

| Load no. | Elevation | Horizontal load<br>kN/m run | Moment load<br>kN.m/m run | Moment restraint<br>kN.m/m/rad | Partial factor/<br>Category |
|----------|-----------|-----------------------------|---------------------------|--------------------------------|-----------------------------|
| 1        | 7.00      | 166.7                       | 0                         | 0                              | 1.10 Var                    |

### SURCHARGE LOADS

| Surch-<br>arge<br>no. | Distance<br>Elev. | Length<br>from wall | Width<br>parallel<br>to wall | perpend.<br>to wall | Surcharge<br>kN/m2 | Equiv. soil<br>type | Partial<br>factor/<br>Category |
|-----------------------|-------------------|---------------------|------------------------------|---------------------|--------------------|---------------------|--------------------------------|
| 1                     | 7.00              | 0.00 (A)            | 1000.00                      | 2.00                | 5.00 =             | N/A                 | 1.10 Var                       |
| 2                     | 7.00              | 2.00 (A)            | 1000.00                      | 20.00               | 20.00 =            | N/A                 | 1.10 Var                       |

Note: A = Active side, P = Passive side

Limit State Categories P/U = Permanent Unfavourable

P/F = Permanent Favourable

Var = Variable (unfavourable)

### CONSTRUCTION STAGES

| Construction stage no. | Stage description                                                                                                                                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Excavate to elevation 0.00 on ACTIVE side<br>Toe of berm at elevation 7.00<br>Width of top of berm = 2.00<br>Width of toe of berm = 12.50                |
| 2                      | Excavate to elevation 0.00 on PASSIVE side                                                                                                               |
| 3                      | Change EI of wall to 4.6265E+06 kN.m2/m run<br>From elevation 7.00 to 0.00<br>Yield moment not defined<br>Reset wall displacements to zero at this stage |
| 4                      | Fill to elevation 7.00 on ACTIVE side with soil type 1                                                                                                   |
| 5                      | Apply surcharge no.1 at elevation 7.00<br>No analysis at this stage                                                                                      |
| 6                      | Apply surcharge no.2 at elevation 7.00                                                                                                                   |
| 7                      | Apply water pressure profile no.1 ( Mod. Conserv. )                                                                                                      |
| 8                      | Excavate to elevation -0.50 on PASSIVE side                                                                                                              |
| 9                      | Change properties of soil type 3 to soil type 4<br>Ko pressures will be reset                                                                            |
| 10                     | Change EI of wall to 2.3133E+06 kN.m2/m run<br>From elevation 7.00 to 0.00<br>Yield moment not defined<br>Allow wall to relax with new modulus value     |
| 11                     | Apply load no.1 at elevation 7.00                                                                                                                        |

### FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: ULS DA1 Combination 1

Water pressures : Moderately Conservative

Partial factor on C' = 1.000

Partial factor on Phi' = 1.000

Partial factor on Cu = 1.000

Partial factor on Soil Modulus = 1.000

Partial factor on Permanent Unfavourable loads = 1.000

Partial factor on Permanent Favourable loads = 1.000

Partial factor on Permanent Variable loads = 1.100

Design factor on calculated Bending Moments = 1.350

Parameters for undrained strata:

Minimum equivalent fluid density = 5.00 kN/m3

Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:

Method - Subgrade reaction model using Influence Coefficients

Open Tension Crack analysis? - No

Non-linear Modulus Parameter (L) = 0 m

Boundary conditions:

Length of wall (normal to plane of analysis) = 1000.00 m

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Width of excavation on active side of wall = 20.00 m  
Width of excavation on passive side of wall = 20.00 m

Distance to rigid boundary on active side = 20.00 m  
Distance to rigid boundary on passive side = 20.00 m

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

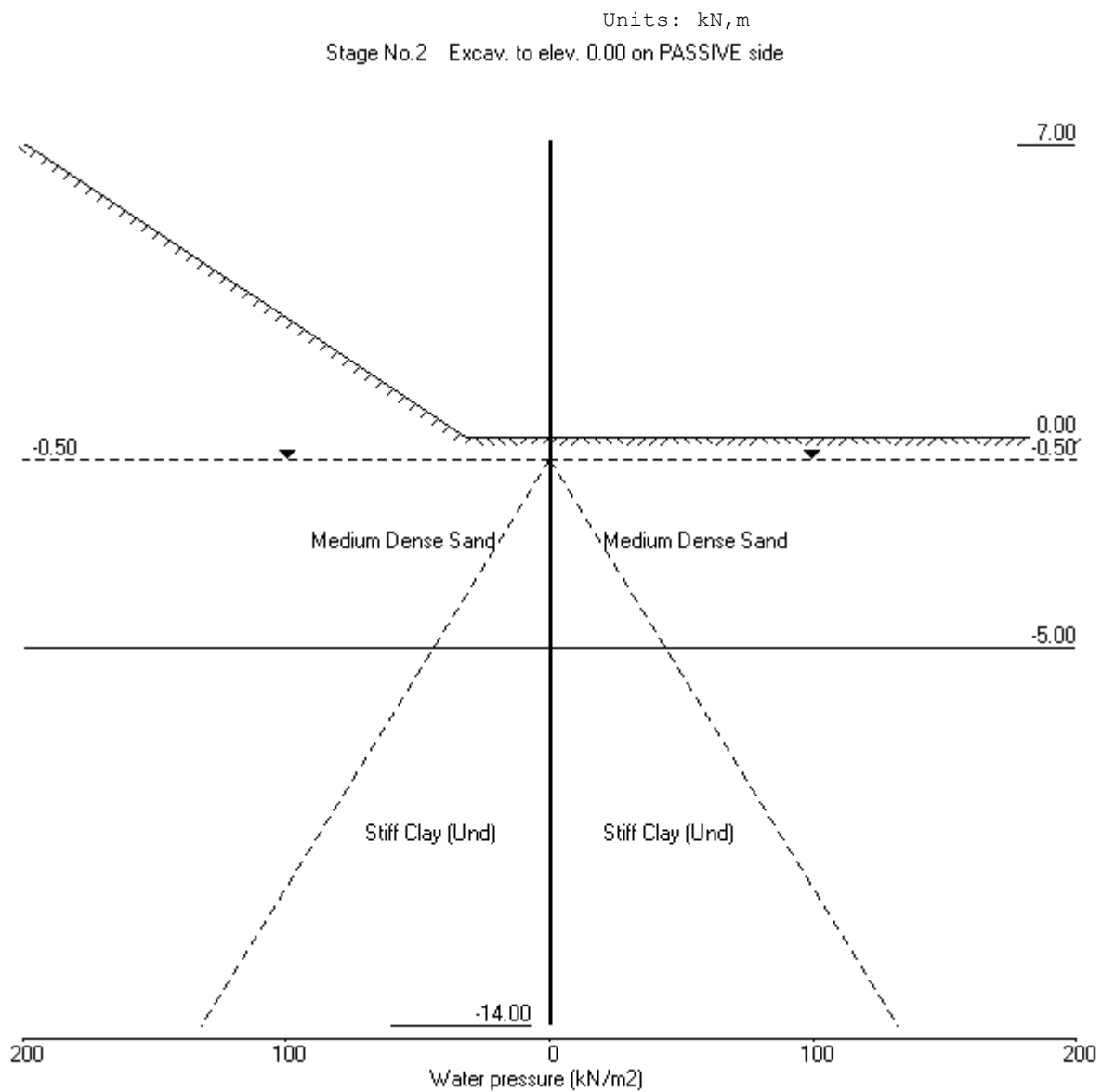
### OUTPUT OPTIONS

| Stage no. | Stage description                      | Displacement<br>Bending mom.<br>Shear force | Active,<br>Passive | Graph.<br>output<br>pressures |
|-----------|----------------------------------------|---------------------------------------------|--------------------|-------------------------------|
| 1         | Excav. to elev. 0.00 on ACTIVE side    | No                                          | No                 | No                            |
| 2         | Excav. to elev. 0.00 on PASSIVE side   | No                                          | No                 | No                            |
| 3         | Change EI of wall to 4.6265E+06kN.m2/m | No                                          | No                 | No                            |
| 4         | Fill to elev. 7.00 on ACTIVE side      | Yes                                         | Yes                | Yes                           |
| 5         | Apply surcharge no.1 at elev. 7.00     | No                                          | No                 | No                            |
| 6         | Apply surcharge no.2 at elev. 7.00     | No                                          | No                 | No                            |
| 7         | Apply water pressure profile no.1      | Yes                                         | Yes                | Yes                           |
| 8         | Excav. to elev. -0.50 on PASSIVE side  | No                                          | No                 | No                            |
| 9         | Change soil type 3 to soil type 4      | No                                          | No                 | No                            |
| 10        | Change EI of wall to 2.3133E+06kN.m2/m | No                                          | No                 | No                            |
| 11        | Apply load no.1 at elev. 7.00          | No                                          | No                 | No                            |
| *         | Summary output                         | Yes                                         | -                  | Yes                           |

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# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

|                                                                     |                  |
|---------------------------------------------------------------------|------------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                   | Sheet No.        |
| Licensed from GEOSOLVE                                              | Job No. 1504     |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS1 | Made by : HGC    |
| Tubular King Pile Foundation                                        | Date: 16-09-2015 |
| D1000-14 @ 2500                                                     | Checked :        |



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
 Tubular King File Foundation | Date: 16-09-2015  
 D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No. 2 Excavate to elevation 0.00 on PASSIVE side

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
 Subgrade reaction model - Boussinesq Influence coefficients  
 Soil deformations are elastic until the active or passive limit is reached  
 Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
 Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

| Node no. | Y coord | Nett pressure<br>kN/m2 | Wall disp.<br>m | Wall rotation<br>rad. | Shear force<br>kN/m | Bending moment<br>kN.m/m | Strut forces<br>kN/m | EI of wall<br>kN.m2/m |
|----------|---------|------------------------|-----------------|-----------------------|---------------------|--------------------------|----------------------|-----------------------|
| 1        | 7.00    | 0.00                   | -0.018          | -1.46E-03             | 0.0                 | 0.0                      |                      | 442785                |
| 2        | 5.90    | 0.00                   | -0.016          | -1.46E-03             | 0.0                 | -0.0                     |                      | 442785                |
| 3        | 4.80    | 0.00                   | -0.014          | -1.46E-03             | 0.0                 | 0.0                      |                      | 442785                |
| 4        | 3.60    | 0.00                   | -0.013          | -1.46E-03             | 0.0                 | 0.0                      |                      | 442785                |
| 5        | 2.40    | 0.00                   | -0.011          | -1.46E-03             | 0.0                 | 0.0                      |                      | 442785                |
| 6        | 1.20    | 0.00                   | -0.009          | -1.46E-03             | 0.0                 | 0.0                      |                      | 442785                |
| 7        | 0.00    | 0.00                   | -0.007          | -1.46E-03             | 0.0                 | 0.0                      |                      | 442785                |
| 8        | -0.50   | -49.85                 | -0.007          | -1.46E-03             | -12.5               | 2.5                      |                      | 442785                |
| 9        | -1.45   | -0.68                  | -0.005          | -1.42E-03             | -36.5               | -39.7                    |                      | 442785                |
| 10       | -2.40   | 7.95                   | -0.004          | -1.30E-03             | -33.0               | -74.1                    |                      | 442785                |
| 11       | -3.60   | 13.85                  | -0.002          | -1.04E-03             | -19.9               | -113.9                   |                      | 442785                |
| 12       | -4.30   | 15.02                  | -0.002          | -8.60E-04             | -9.8                | -123.8                   |                      | 442785                |
| 13       | -5.00   | 13.26                  | -0.001          | -6.62E-04             | 0.1                 | -126.6                   |                      | 442785                |
|          |         | 36.76                  | -0.001          | -6.62E-04             | 0.1                 | -126.6                   |                      |                       |
| 14       | -6.10   | 12.21                  | -0.001          | -3.76E-04             | 27.0                | -104.3                   |                      | 442785                |
| 15       | -7.20   | -2.78                  | -0.000          | -1.63E-04             | 32.2                | -67.2                    |                      | 442785                |
| 16       | -8.40   | -9.32                  | -0.000          | -3.08E-05             | 24.9                | -30.5                    |                      | 442785                |
| 17       | -9.60   | -9.23                  | -0.000          | 2.04E-05              | 13.8                | -7.3                     |                      | 442785                |
| 18       | -10.80  | -6.19                  | -0.000          | 2.68E-05              | 4.6                 | 2.6                      |                      | 442785                |
| 19       | -12.00  | -2.55                  | -0.000          | 1.84E-05              | -0.7                | 3.6                      |                      | 442785                |
| 20       | -13.00  | 0.35                   | -0.000          | 1.25E-05              | -1.8                | 1.6                      |                      | 442785                |
| 21       | -14.00  | 3.24                   | -0.000          | 1.07E-05              | -0.0                | 0.0                      |                      | ---                   |

| Node no. | Y coord | ----- ACTIVE side -----        |            |              |               |                |             |           |
|----------|---------|--------------------------------|------------|--------------|---------------|----------------|-------------|-----------|
|          |         | ----- Effective stresses ----- |            |              |               |                | Total earth | Soil      |
|          |         | Water press.                   | Vertic -al | Active limit | Passive limit | Earth pressure | pressure    | stiffness |
|          |         | kN/m2                          | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2       | coeff.    |
|          |         |                                |            |              |               |                |             | kN/m3     |
| 1        | 7.00    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
| 2        | 5.90    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
| 3        | 4.80    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
| 4        | 3.60    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
| 5        | 2.40    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
| 6        | 1.20    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
| 7        | 0.00    | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 0.0       |
|          |         | 0.00                           | 0.00       | 0.00         | 0.00          | 0.00           | 0.00        | 6779      |
| 8        | -0.50   | 0.00                           | 9.00       | 2.04         | 60.04         | 5.09           | 5.09        | 7457      |
| 9        | -1.45   | 9.32                           | 17.75      | 4.03         | 118.42        | 44.57          | 53.88       | 8745      |
| 10       | -2.40   | 18.63                          | 26.56      | 6.03         | 177.15        | 43.52          | 62.15       | 10033     |
| 11       | -3.60   | 30.40                          | 37.80      | 8.58         | 252.13        | 39.99          | 70.39       | 11660     |
| 12       | -4.30   | 37.26                          | 44.44      | 10.08        | 296.41        | 37.67          | 74.93       | 12609     |

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.2 Excavate to elevation 0.00 on PASSIVE side

| Node |         | ----- ACTIVE side -----        |        |        |         |          |          |           |
|------|---------|--------------------------------|--------|--------|---------|----------|----------|-----------|
| no.  | Y coord | ----- Effective stresses ----- |        |        |         |          | Total    | Soil      |
|      |         | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|      |         | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|      |         | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 13   | -5.00   | 44.13                          | 51.15  | 11.61  | 341.16  | 35.75    | 79.88    | 13558     |
|      |         | Total>                         | 95.28  | 25.00m | 295.31  | 224.06   | 224.06   | 35291     |
| 14   | -6.10   | Total>                         | 117.86 | 30.50m | 333.30  | 236.15   | 236.15   | 38008     |
| 15   | -7.20   | Total>                         | 140.65 | 36.00m | 371.49  | 255.49   | 255.49   | 40725     |
| 16   | -8.40   | Total>                         | 165.76 | 42.00m | 413.40  | 283.29   | 283.29   | 43690     |
| 17   | -9.60   | Total>                         | 191.10 | 48.00m | 455.55  | 315.31   | 315.31   | 46654     |
| 18   | -10.80  | Total>                         | 216.68 | 54.00m | 497.93  | 349.07   | 349.07   | 49619     |
| 19   | -12.00  | Total>                         | 242.46 | 60.00m | 540.52  | 383.13   | 383.13   | 52583     |
| 20   | -13.00  | Total>                         | 264.08 | 65.00m | 576.14  | 411.42   | 411.42   | 55053     |
| 21   | -14.00  | Total>                         | 285.80 | 70.00m | 611.87  | 439.71   | 439.71   | 57524     |

| Node |         | ----- PASSIVE side -----       |        |        |         |          |          |           |
|------|---------|--------------------------------|--------|--------|---------|----------|----------|-----------|
| no.  | Y coord | ----- Effective stresses ----- |        |        |         |          | Total    | Soil      |
|      |         | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|      |         | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|      |         | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 1    | 7.00    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 2    | 5.90    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 3    | 4.80    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 4    | 3.60    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 5    | 2.40    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 6    | 1.20    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 7    | 0.00    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
|      |         | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 6779      |
| 8    | -0.50   | 0.00                           | 9.00   | 2.04   | 60.04   | 54.94    | 54.94    | 7457      |
| 9    | -1.45   | 9.32                           | 17.75  | 4.03   | 118.42  | 45.25    | 54.56    | 8745      |
| 10   | -2.40   | 18.63                          | 26.56  | 6.03   | 177.15  | 35.57    | 54.20    | 10033     |
| 11   | -3.60   | 30.40                          | 37.80  | 8.58   | 252.13  | 26.14    | 56.54    | 11660     |
| 12   | -4.30   | 37.26                          | 44.44  | 10.08  | 296.41  | 22.65    | 59.91    | 12609     |
| 13   | -5.00   | 44.13                          | 51.15  | 11.61  | 341.16  | 22.49    | 66.62    | 13558     |
|      |         | Total>                         | 95.28  | 25.00m | 295.31  | 187.31   | 187.31   | 35291     |
| 14   | -6.10   | Total>                         | 117.86 | 30.50m | 333.30  | 223.94   | 223.94   | 38008     |
| 15   | -7.20   | Total>                         | 140.65 | 36.00m | 371.49  | 258.26   | 258.26   | 40725     |
| 16   | -8.40   | Total>                         | 165.76 | 42.00m | 413.40  | 292.61   | 292.61   | 43690     |
| 17   | -9.60   | Total>                         | 191.10 | 48.00m | 455.55  | 324.54   | 324.54   | 46654     |
| 18   | -10.80  | Total>                         | 216.68 | 54.00m | 497.93  | 355.26   | 355.26   | 49619     |
| 19   | -12.00  | Total>                         | 242.46 | 60.00m | 540.52  | 385.68   | 385.68   | 52583     |
| 20   | -13.00  | Total>                         | 264.08 | 65.00m | 576.14  | 411.07   | 411.07   | 55053     |
| 21   | -14.00  | Total>                         | 285.80 | 70.00m | 611.87  | 436.47   | 436.47   | 57524     |



## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

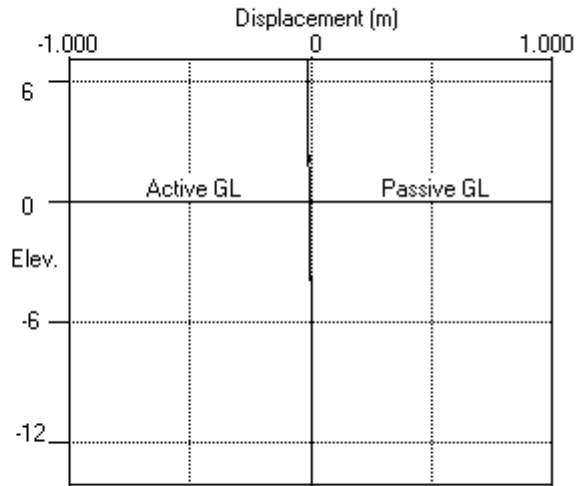
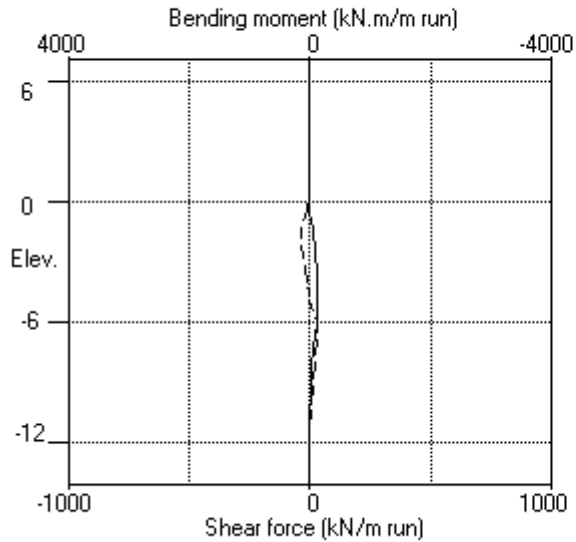
Program: WALLAP Version 6.05 Revision A45.B58.R49  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
 Tubular King Pile Foundation  
 D1000-14 @ 2500

| Sheet No.  
 | Job No. 1504  
 | Made by : HGC  
 | Date: 16-09-2015  
 | Checked :

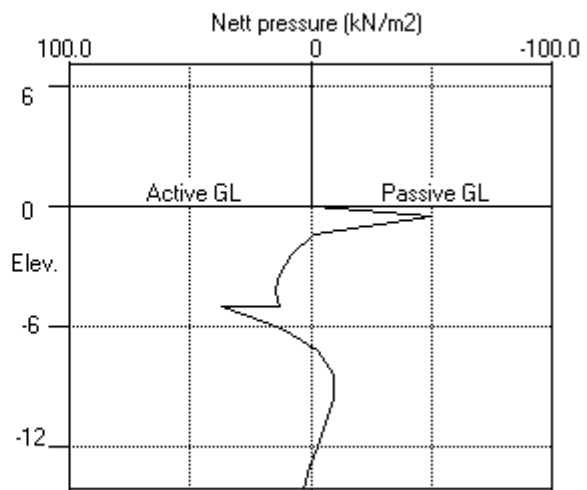
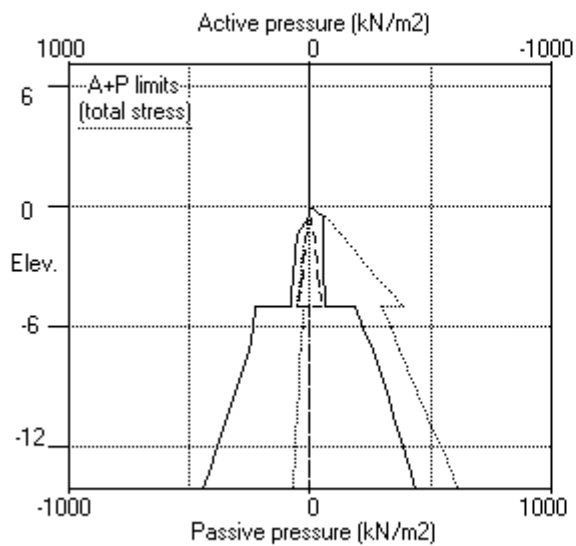
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Units: kN,m

Stage No.2 Excav. to elev. 0.00 on PASSIVE side



Stage No.2 Excav. to elev. 0.00 on PASSIVE side



APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49

| Sheet No. 1504

Licensed from GEOSOLVE

| Made by : HGC

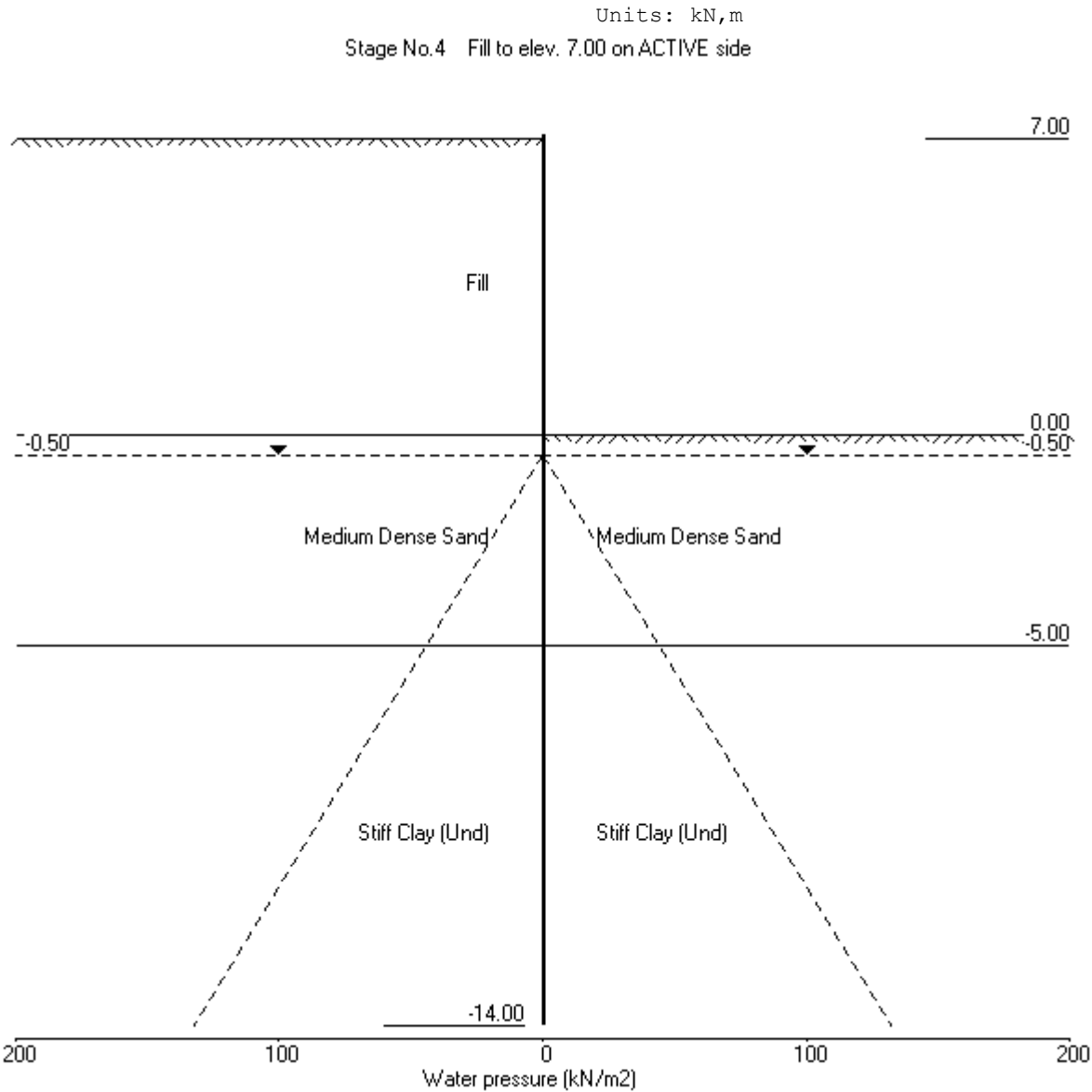
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Tubular King Pile Foundation

| Date: 16-09-2015

D1000-14 @ 2500

| Checked :



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King File Foundation | Date: 16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No. 4 Fill to elevation 7.00 on ACTIVE side with soil type 1

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 0.00                | 0.052        | 4.92E-03           | 0.0              | 0.0                   |                   | 4626512            |
| 2        | 5.90    | 3.91                | 0.047        | 4.92E-03           | 2.2              | 0.8                   |                   | 4626512            |
| 3        | 4.80    | 7.82                | 0.042        | 4.92E-03           | 8.6              | 6.3                   |                   | 4626512            |
| 4        | 3.60    | 12.09               | 0.036        | 4.91E-03           | 20.6             | 23.3                  |                   | 4626512            |
| 5        | 2.40    | 16.36               | 0.030        | 4.90E-03           | 37.6             | 57.7                  |                   | 4626512            |
| 6        | 1.20    | 20.62               | 0.024        | 4.88E-03           | 59.8             | 115.6                 |                   | 4626512            |
| 7        | 0.00    | 24.89               | 0.018        | 4.84E-03           | 87.1             | 203.3                 |                   | 442785             |
|          |         | 28.59               | 0.018        | 4.84E-03           | 87.1             | 203.3                 |                   |                    |
| 8        | -0.50   | -29.40              | 0.016        | 4.58E-03           | 86.9             | 252.6                 |                   | 442785             |
| 9        | -1.45   | -72.56              | 0.012        | 3.94E-03           | 38.5             | 308.1                 |                   | 442785             |
| 10       | -2.40   | -56.71              | 0.008        | 3.14E-03           | -22.9            | 323.5                 |                   | 442785             |
| 11       | -3.60   | -17.71              | 0.005        | 2.11E-03           | -67.6            | 249.2                 |                   | 442785             |
| 12       | -4.30   | -0.40               | 0.004        | 1.57E-03           | -73.9            | 198.2                 |                   | 442785             |
| 13       | -5.00   | 10.57               | 0.003        | 1.10E-03           | -70.4            | 146.8                 |                   | 442785             |
|          |         | 7.94                | 0.003        | 1.10E-03           | -70.4            | 146.8                 |                   |                    |
| 14       | -6.10   | 20.07               | 0.002        | 5.41E-04           | -54.9            | 74.1                  |                   | 442785             |
| 15       | -7.20   | 19.45               | 0.002        | 2.04E-04           | -33.2            | 25.6                  |                   | 442785             |
| 16       | -8.40   | 12.98               | 0.002        | 3.83E-05           | -13.8            | -0.5                  |                   | 442785             |
| 17       | -9.60   | 6.22                | 0.001        | -1.52E-06          | -2.2             | -8.0                  |                   | 442785             |
| 18       | -10.80  | 1.58                | 0.001        | 1.17E-05           | 2.4              | -6.5                  |                   | 442785             |
| 19       | -12.00  | -0.80               | 0.001        | 3.28E-05           | 2.9              | -2.9                  |                   | 442785             |
| 20       | -13.00  | -1.62               | 0.001        | 4.26E-05           | 1.7              | -0.6                  |                   | 442785             |
| 21       | -14.00  | -1.79               | 0.001        | 4.51E-05           | 0.0              | 0.0                   |                   | ---                |

| Node no. | Y coord | ----- ACTIVE side ----- |            |              |               |                | Total          | Soil      |
|----------|---------|-------------------------|------------|--------------|---------------|----------------|----------------|-----------|
|          |         | Water press.            | Vertic -al | Active limit | Passive limit | Earth pressure | earth pressure | stiffness |
|          |         | kN/m2                   | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2          | coeff.    |
| 1        | 7.00    | 0.00                    | 0.00       | 0.00         | 0.00          | 0.00           | 0.00           | 0.0       |
| 2        | 5.90    | 0.00                    | 19.80      | 3.91         | 166.95        | 3.91           | 3.91a          | 771       |
| 3        | 4.80    | 0.00                    | 39.60      | 7.82         | 333.90        | 7.82           | 7.82a          | 1543      |
| 4        | 3.60    | 0.00                    | 61.20      | 12.09        | 516.03        | 12.09          | 12.09a         | 2384      |
| 5        | 2.40    | 0.00                    | 82.80      | 16.36        | 698.16        | 16.36          | 16.36a         | 3225      |
| 6        | 1.20    | 0.00                    | 104.40     | 20.62        | 880.28        | 20.62          | 20.62a         | 4067      |
| 7        | 0.00    | 0.00                    | 126.00     | 24.89        | 1062.41       | 24.89          | 24.89a         | 4908      |
|          |         | 0.00                    | 126.00     | 28.59        | 840.43        | 28.59          | 28.59a         | 3506      |
| 8        | -0.50   | 0.00                    | 135.00     | 30.63        | 900.46        | 30.63          | 30.63a         | 3856      |
| 9        | -1.45   | 9.32                    | 143.73     | 32.62        | 958.71        | 45.86          | 55.18          | 4522      |

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.4 Fill to elevation 7.00 on ACTIVE side with soil type 1

| Node Y ----- ACTIVE side ----- |        |                                |        |         |         |          |          |           |
|--------------------------------|--------|--------------------------------|--------|---------|---------|----------|----------|-----------|
| no.                            | coord  | ----- Effective stresses ----- |        |         |         | Total    | Soil     |           |
|                                |        | Water                          | Vertic | Active  | Passive | Earth    | earth    | stiffness |
|                                |        | press.                         | -al    | limit   | limit   | pressure | pressure | coeff.    |
|                                |        | kN/m2                          | kN/m2  | kN/m2   | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 10                             | -2.40  | 18.63                          | 152.47 | 34.60   | 1016.97 | 54.54    | 73.17    | 5189      |
| 11                             | -3.60  | 30.40                          | 163.50 | 37.10   | 1090.55 | 62.93    | 93.33    | 6030      |
| 12                             | -4.30  | 37.26                          | 169.94 | 38.56   | 1133.48 | 66.40    | 103.66   | 6521      |
| 13                             | -5.00  | 44.13                          | 176.37 | 40.02   | 1176.40 | 69.01    | 113.14   | 7012      |
|                                |        | Total>                         | 220.50 | 60.00m  | 420.56  | 289.19   | 289.19   | 18965     |
| 14                             | -6.10  | Total>                         | 242.50 | 65.50m  | 457.96  | 314.49   | 314.49   | 20425     |
| 15                             | -7.20  | Total>                         | 264.50 | 71.00m  | 495.36  | 338.67   | 338.67   | 21886     |
| 16                             | -8.40  | Total>                         | 288.50 | 77.00m  | 536.17  | 365.83   | 365.83   | 23479     |
| 17                             | -9.60  | Total>                         | 312.50 | 83.00m  | 576.97  | 394.50   | 394.50   | 25072     |
| 18                             | -10.80 | Total>                         | 336.50 | 89.00m  | 617.78  | 424.47   | 424.47   | 26665     |
| 19                             | -12.00 | Total>                         | 360.50 | 95.00m  | 658.58  | 455.22   | 455.22   | 28258     |
| 20                             | -13.00 | Total>                         | 380.50 | 100.00m | 692.58  | 481.15   | 481.15   | 29586     |
| 21                             | -14.00 | Total>                         | 400.50 | 105.00m | 726.59  | 507.27   | 507.27   | 30913     |

| Node Y ----- PASSIVE side ----- |        |                                |        |        |         |          |          |           |
|---------------------------------|--------|--------------------------------|--------|--------|---------|----------|----------|-----------|
| no.                             | coord  | ----- Effective stresses ----- |        |        |         | Total    | Soil     |           |
|                                 |        | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|                                 |        | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|                                 |        | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 1                               | 7.00   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 2                               | 5.90   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 3                               | 4.80   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 4                               | 3.60   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 5                               | 2.40   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 6                               | 1.20   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 7                               | 0.00   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
|                                 |        | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 6180      |
| 8                               | -0.50  | 0.00                           | 9.00   | 2.04   | 60.04   | 60.04    | 60.04p   | 6798      |
| 9                               | -1.45  | 9.32                           | 17.75  | 4.03   | 118.42  | 118.42   | 127.74p  | 7972      |
| 10                              | -2.40  | 18.63                          | 26.56  | 6.03   | 177.15  | 111.25   | 129.89   | 9146      |
| 11                              | -3.60  | 30.40                          | 37.80  | 8.58   | 252.13  | 80.65    | 111.05   | 10629     |
| 12                              | -4.30  | 37.26                          | 44.44  | 10.08  | 296.41  | 66.80    | 104.07   | 11494     |
| 13                              | -5.00  | 44.13                          | 51.15  | 11.61  | 341.16  | 58.45    | 102.58   | 12359     |
|                                 |        | Total>                         | 95.28  | 25.00m | 295.31  | 281.25   | 281.25   | 32286     |
| 14                              | -6.10  | Total>                         | 117.86 | 30.50m | 333.30  | 294.42   | 294.42   | 34772     |
| 15                              | -7.20  | Total>                         | 140.65 | 36.00m | 371.49  | 319.22   | 319.22   | 37258     |
| 16                              | -8.40  | Total>                         | 165.76 | 42.00m | 413.40  | 352.85   | 352.85   | 39970     |
| 17                              | -9.60  | Total>                         | 191.10 | 48.00m | 455.55  | 388.28   | 388.28   | 42683     |
| 18                              | -10.80 | Total>                         | 216.68 | 54.00m | 497.93  | 422.89   | 422.89   | 45395     |
| 19                              | -12.00 | Total>                         | 242.46 | 60.00m | 540.52  | 456.02   | 456.02   | 48107     |
| 20                              | -13.00 | Total>                         | 264.08 | 65.00m | 576.14  | 482.77   | 482.77   | 50367     |
| 21                              | -14.00 | Total>                         | 285.80 | 70.00m | 611.87  | 509.06   | 509.06   | 52627     |

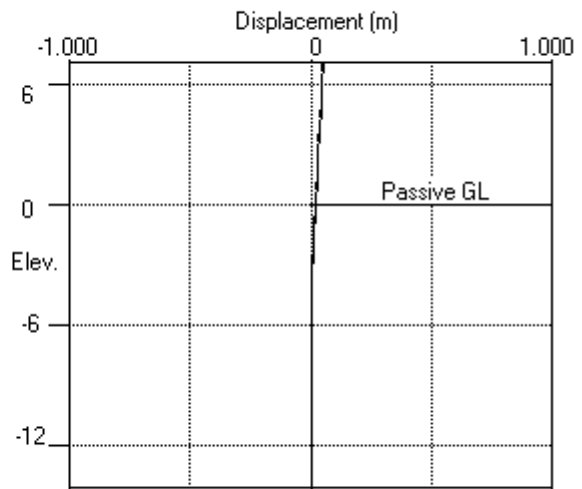
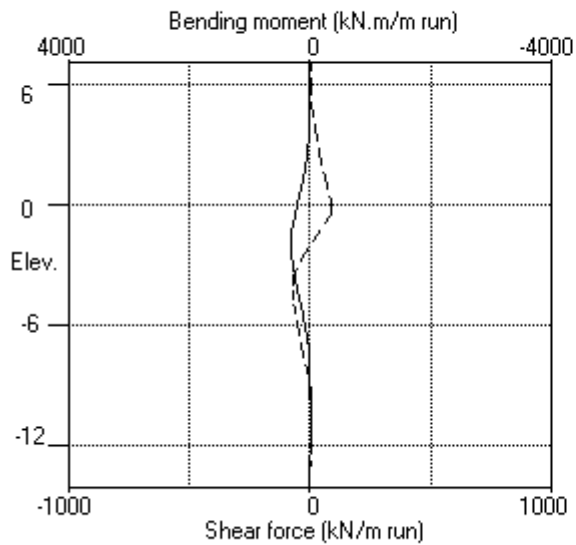
Note: 30.63a Soil pressure at active limit  
127.74p Soil pressure at passive limit

# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

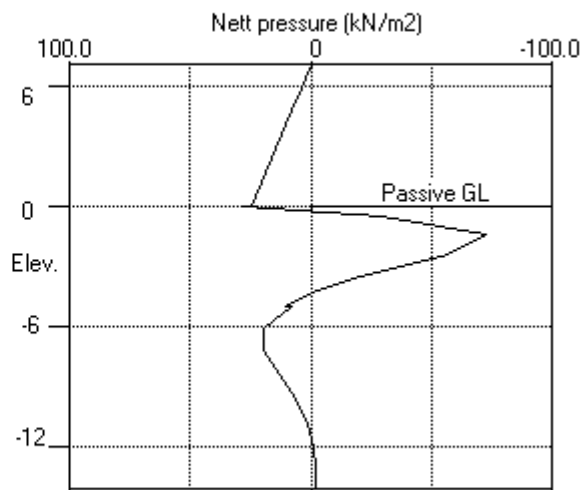
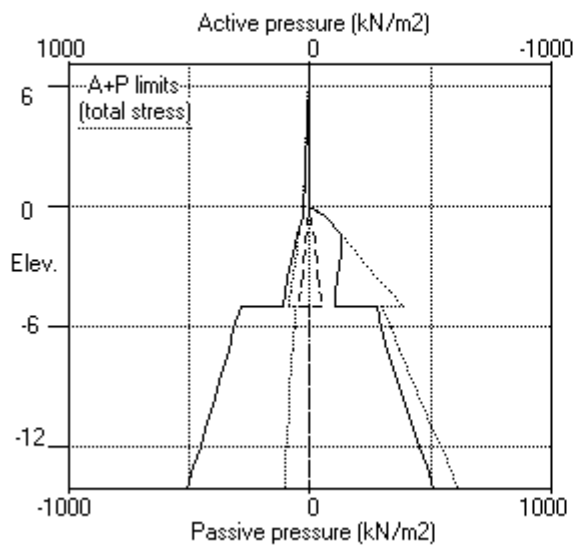
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.4 Fill to elev. 7.00 on ACTIVE side

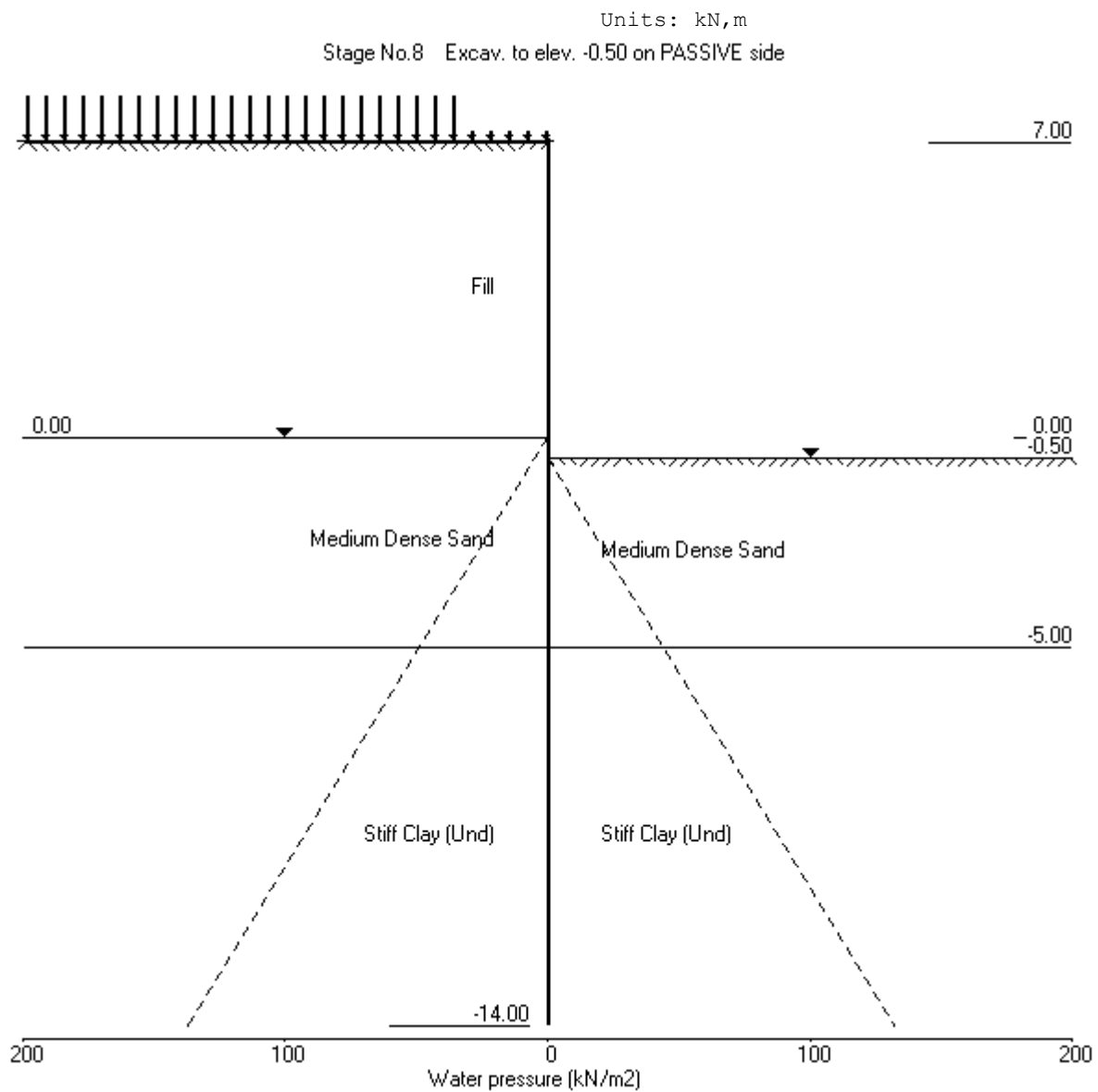


Stage No.4 Fill to elev. 7.00 on ACTIVE side



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

|                                                                     |                  |
|---------------------------------------------------------------------|------------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                   | Sheet No.        |
| Licensed from GEOSOLVE                                              | Job No. 1504     |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS1 | Made by : HGC    |
| Tubular King Pile Foundation                                        | Date: 16-09-2015 |
| D1000-14 @ 2500                                                     | Checked :        |



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King File Foundation | Date: 16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 8 Excavate to elevation -0.50 on PASSIVE side

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 2.36                | 0.104        | 9.34E-03           | 0.0              | 0.0                   |                   | 4626512            |
| 2        | 5.90    | 5.17                | 0.093        | 9.34E-03           | 4.1              | 2.0                   |                   | 4626512            |
| 3        | 4.80    | 9.60                | 0.083        | 9.34E-03           | 12.3             | 10.6                  |                   | 4626512            |
| 4        | 3.60    | 14.42               | 0.072        | 9.34E-03           | 26.7             | 33.3                  |                   | 4626512            |
| 5        | 2.40    | 19.08               | 0.061        | 9.32E-03           | 46.8             | 76.9                  |                   | 4626512            |
| 6        | 1.20    | 23.61               | 0.050        | 9.29E-03           | 72.4             | 147.8                 |                   | 4626512            |
| 7        | 0.00    | 28.06               | 0.038        | 9.24E-03           | 103.4            | 252.7                 |                   | 442785             |
|          |         | 32.23               | 0.038        | 9.24E-03           | 103.4            | 252.7                 |                   |                    |
| 8        | -0.50   | 38.24               | 0.034        | 8.92E-03           | 121.0            | 313.3                 |                   | 442785             |
| 9        | -1.45   | -17.97              | 0.026        | 8.08E-03           | 130.6            | 431.8                 |                   | 442785             |
| 10       | -2.40   | -74.46              | 0.019        | 6.91E-03           | 86.7             | 551.0                 |                   | 442785             |
| 11       | -3.60   | -95.68              | 0.011        | 5.11E-03           | -15.4            | 590.9                 |                   | 442785             |
| 12       | -4.30   | -60.82              | 0.008        | 4.01E-03           | -70.1            | 559.0                 |                   | 442785             |
| 13       | -5.00   | -27.44              | 0.006        | 2.98E-03           | -101.0           | 495.4                 |                   | 442785             |
|          |         | -30.63              | 0.006        | 2.98E-03           | -101.0           | 495.4                 |                   |                    |
| 14       | -6.10   | -15.73              | 0.003        | 1.62E-03           | -126.5           | 363.0                 |                   | 442785             |
| 15       | -7.20   | 24.68               | 0.002        | 6.93E-04           | -121.6           | 219.6                 |                   | 442785             |
| 16       | -8.40   | 37.77               | 0.002        | 1.39E-04           | -84.1            | 91.2                  |                   | 442785             |
| 17       | -9.60   | 31.56               | 0.002        | -5.84E-05          | -42.5            | 17.1                  |                   | 442785             |
| 18       | -10.80  | 19.15               | 0.002        | -7.22E-05          | -12.1            | -11.7                 |                   | 442785             |
| 19       | -12.00  | 7.78                | 0.002        | -3.05E-05          | 4.1              | -12.9                 |                   | 442785             |
| 20       | -13.00  | -2.39               | 0.002        | -4.27E-06          | 6.7              | -5.2                  |                   | 442785             |
| 21       | -14.00  | -11.10              | 0.002        | 3.45E-06           | 0.0              | 0.0                   |                   | ---                |

| Node no. | Y coord | ----- ACTIVE side ----- |                  |                    |                     |                      |  | Total earth pressure | Soil stiffness |
|----------|---------|-------------------------|------------------|--------------------|---------------------|----------------------|--|----------------------|----------------|
|          |         | Water press. kN/m2      | Vertic -al kN/m2 | Active limit kN/m2 | Passive limit kN/m2 | Earth pressure kN/m2 |  | pressure kN/m2       | coeff. kN/m3   |
| 1        | 7.00    | 0.00                    | 5.50             | 1.09               | 46.38               | 2.36                 |  | 2.36                 | 0.0            |
| 2        | 5.90    | 0.00                    | 26.15            | 5.17               | 220.45              | 5.17                 |  | 5.17a                | 723            |
| 3        | 4.80    | 0.00                    | 48.61            | 9.60               | 409.89              | 9.60                 |  | 9.60a                | 1446           |
| 4        | 3.60    | 0.00                    | 72.99            | 14.42              | 615.45              | 14.42                |  | 14.42a               | 2234           |
| 5        | 2.40    | 0.00                    | 96.57            | 19.08              | 814.26              | 19.08                |  | 19.08a               | 3023           |
| 6        | 1.20    | 0.00                    | 119.52           | 23.61              | 1007.75             | 23.61                |  | 23.61a               | 3811           |
| 7        | 0.00    | 0.00                    | 142.03           | 28.06              | 1197.61             | 28.06                |  | 28.06a               | 4600           |
|          |         | 0.00                    | 142.03           | 32.23              | 947.38              | 32.23                |  | 32.23a               | 3286           |
| 8        | -0.50   | 4.90                    | 146.92           | 33.34              | 979.97              | 33.34                |  | 38.24a               | 3614           |
| 9        | -1.45   | 14.22                   | 156.09           | 35.42              | 1041.11             | 35.42                |  | 49.64a               | 4239           |

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.8 Excavate to elevation -0.50 on PASSIVE side

| Node |         | ----- ACTIVE side -----        |        |         |         |          |          |           |
|------|---------|--------------------------------|--------|---------|---------|----------|----------|-----------|
| no.  | Y coord | ----- Effective stresses ----- |        |         |         |          | Total    | Soil      |
|      |         | Water                          | Vertic | Active  | Passive | Earth    | earth    | stiffness |
|      |         | press.                         | -al    | limit   | limit   | pressure | pressure | coeff.    |
|      |         | kN/m2                          | kN/m2  | kN/m2   | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 10   | -2.40   | 23.54                          | 165.13 | 37.47   | 1101.42 | 37.47    | 61.01a   | 4863      |
| 11   | -3.60   | 35.30                          | 176.41 | 40.03   | 1176.68 | 40.03    | 75.34a   | 5652      |
| 12   | -4.30   | 42.17                          | 182.94 | 41.51   | 1220.19 | 45.15    | 87.32    | 6112      |
| 13   | -5.00   | 49.03                          | 189.42 | 42.98   | 1263.46 | 55.81    | 104.84   | 6572      |
|      |         | Total>                         | 238.46 | 60.00m  | 438.51  | 255.51   | 255.51   | 17891     |
| 14   | -6.10   | Total>                         | 260.48 | 65.50m  | 475.94  | 308.35   | 308.35   | 19268     |
| 15   | -7.20   | Total>                         | 282.43 | 71.00m  | 513.30  | 348.36   | 348.36   | 20646     |
| 16   | -8.40   | Total>                         | 306.33 | 77.00m  | 554.00  | 383.93   | 383.93   | 35677     |
| 17   | -9.60   | Total>                         | 330.17 | 83.00m  | 594.65  | 412.98   | 412.98   | 38098     |
| 18   | -10.80  | Total>                         | 353.98 | 89.00m  | 635.26  | 439.23   | 439.23   | 40519     |
| 19   | -12.00  | Total>                         | 377.76 | 95.00m  | 675.84  | 465.57   | 465.57   | 74323     |
| 20   | -13.00  | Total>                         | 397.55 | 100.00m | 709.64  | 486.86   | 486.86   | 77815     |
| 21   | -14.00  | Total>                         | 417.33 | 105.00m | 743.42  | 508.73   | 508.73   | 81306     |

| Node |         | ----- PASSIVE side -----       |        |        |         |          |          |           |
|------|---------|--------------------------------|--------|--------|---------|----------|----------|-----------|
| no.  | Y coord | ----- Effective stresses ----- |        |        |         |          | Total    | Soil      |
|      |         | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|      |         | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|      |         | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 1    | 7.00    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 2    | 5.90    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 3    | 4.80    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 4    | 3.60    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 5    | 2.40    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 6    | 1.20    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 7    | 0.00    | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
| 8    | -0.50   | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 0.0       |
|      |         | 0.00                           | 0.00   | 0.00   | 0.00    | 0.00     | 0.00     | 6480      |
| 9    | -1.45   | 9.32                           | 8.74   | 1.98   | 58.30   | 58.30    | 67.61p   | 7599      |
| 10   | -2.40   | 18.63                          | 17.52  | 3.97   | 116.83  | 116.83   | 135.47p  | 8718      |
| 11   | -3.60   | 30.40                          | 28.71  | 6.51   | 191.48  | 140.62   | 171.02   | 10132     |
| 12   | -4.30   | 37.26                          | 35.31  | 8.01   | 235.53  | 110.87   | 148.14   | 10957     |
| 13   | -5.00   | 44.13                          | 41.99  | 9.53   | 280.05  | 88.15    | 132.28   | 11782     |
|      |         | Total>                         | 86.12  | 22.50m | 286.14  | 286.14   | 286.14p  | 30839     |
| 14   | -6.10   | Total>                         | 108.65 | 28.00m | 324.08  | 324.08   | 324.08p  | 33214     |
| 15   | -7.20   | Total>                         | 131.40 | 33.50m | 362.23  | 323.68   | 323.68   | 35589     |
| 16   | -8.40   | Total>                         | 156.47 | 39.50m | 404.11  | 346.16   | 346.16   | 35677     |
| 17   | -9.60   | Total>                         | 181.80 | 45.50m | 446.25  | 381.43   | 381.43   | 38098     |
| 18   | -10.80  | Total>                         | 207.39 | 51.50m | 488.64  | 420.07   | 420.07   | 40519     |
| 19   | -12.00  | Total>                         | 233.21 | 57.50m | 531.26  | 457.80   | 457.80   | 74323     |
| 20   | -13.00  | Total>                         | 254.88 | 62.50m | 566.94  | 489.26   | 489.26   | 77815     |
| 21   | -14.00  | Total>                         | 276.68 | 67.50m | 602.74  | 519.83   | 519.83   | 81306     |

Note: 75.34a Soil pressure at active limit  
324.08p Soil pressure at passive limit



## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

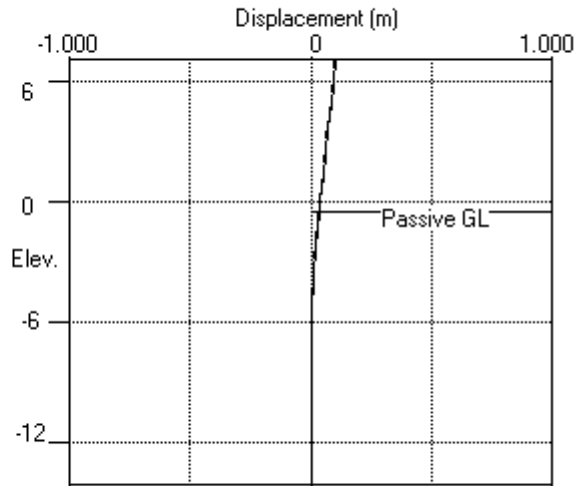
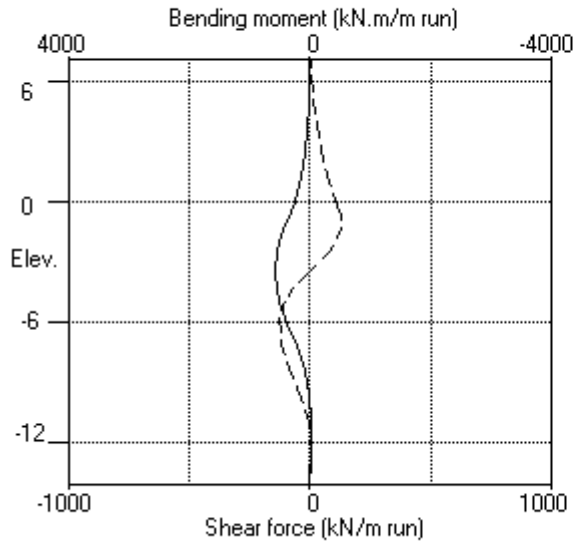
Program: WALLAP Version 6.05 Revision A45.B58.R49  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
 Tubular King Pile Foundation  
 D1000-14 @ 2500

| Sheet No.  
 | Job No. 1504  
 | Made by : HGC  
 | Date: 16-09-2015  
 | Checked :

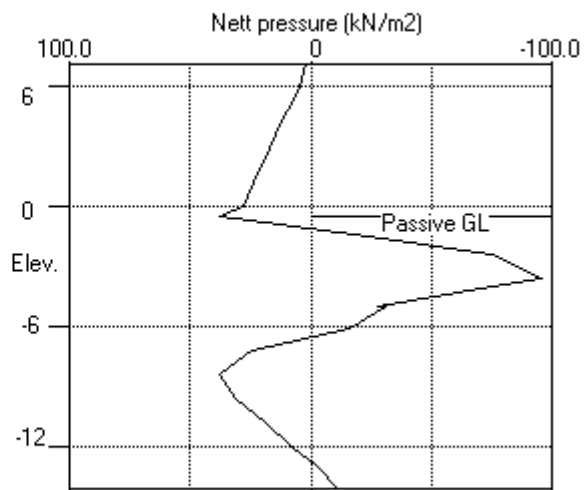
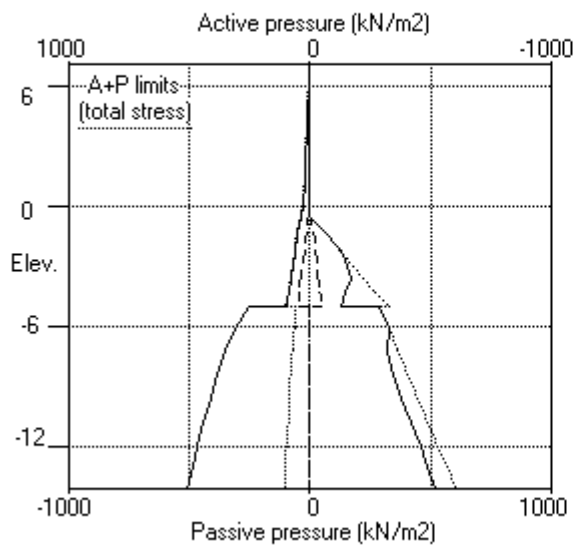
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Units: kN,m

Stage No.8 Excav. to elev. -0.50 on PASSIVE side

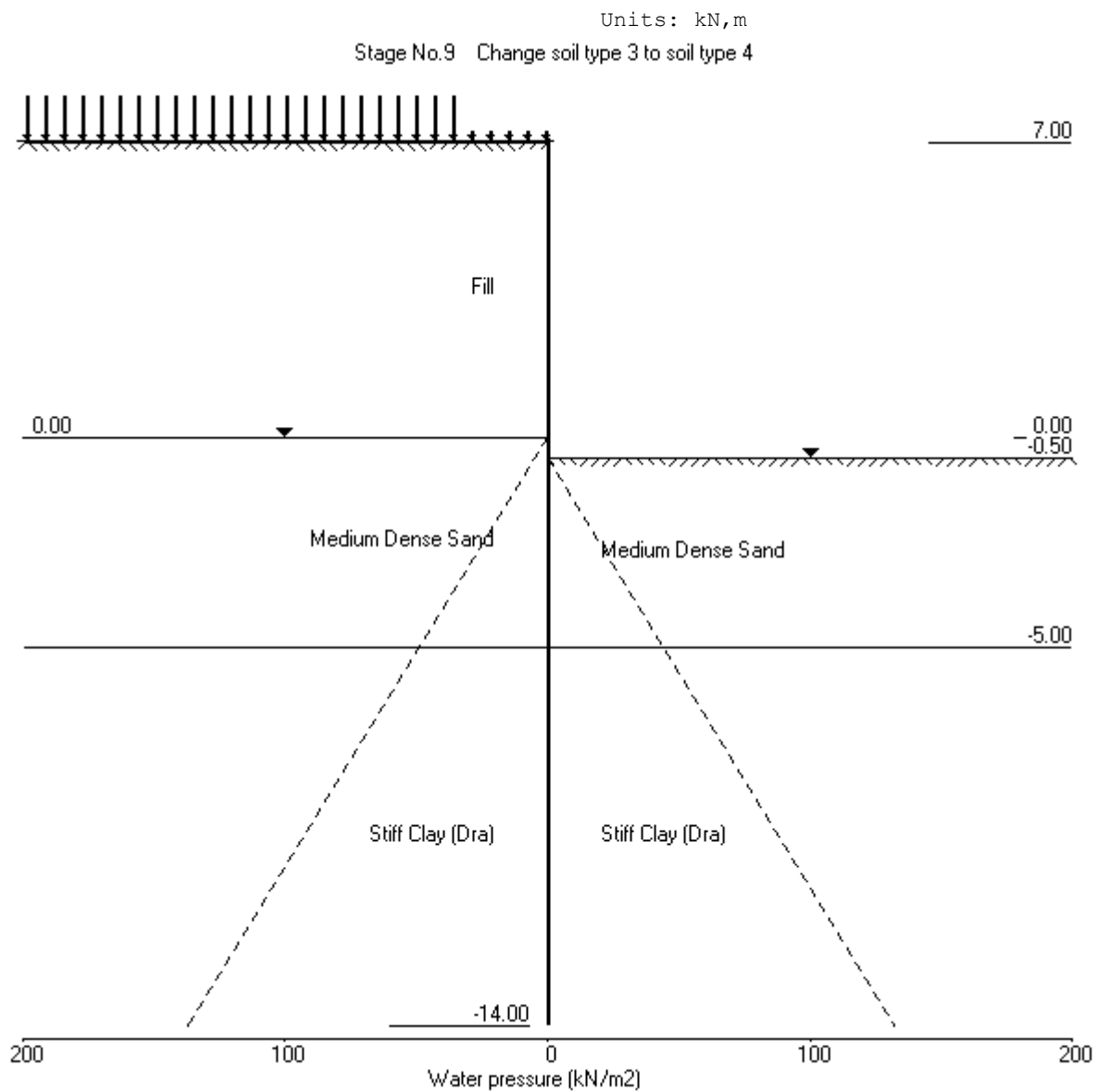


Stage No.8 Excav. to elev. -0.50 on PASSIVE side



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No. 9 Change properties of soil type 3 to soil type 4  
Ko pressures will be reset

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DAL Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure<br>kN/m2 | Wall disp.<br>m | Wall rotation<br>rad. | Shear force<br>kN/m | Bending moment<br>kN.m/m | Strut forces<br>kN/m | EI of wall<br>kN.m2/m |
|----------|---------|------------------------|-----------------|-----------------------|---------------------|--------------------------|----------------------|-----------------------|
| 1        | 7.00    | 2.36                   | 0.114           | 9.20E-03              | 0.0                 | 0.0                      |                      | 4626512               |
| 2        | 5.90    | 5.17                   | 0.104           | 9.20E-03              | 4.1                 | 2.0                      |                      | 4626512               |
| 3        | 4.80    | 9.60                   | 0.094           | 9.20E-03              | 12.3                | 10.6                     |                      | 4626512               |
| 4        | 3.60    | 14.42                  | 0.083           | 9.19E-03              | 26.7                | 33.3                     |                      | 4626512               |
| 5        | 2.40    | 19.08                  | 0.072           | 9.18E-03              | 46.8                | 76.9                     |                      | 4626512               |
| 6        | 1.20    | 23.61                  | 0.061           | 9.15E-03              | 72.4                | 147.8                    |                      | 4626512               |
| 7        | 0.00    | 28.06                  | 0.050           | 9.10E-03              | 103.4               | 252.7                    |                      | 442785                |
|          |         | 32.23                  | 0.050           | 9.10E-03              | 103.4               | 252.7                    |                      |                       |
| 8        | -0.50   | 38.24                  | 0.045           | 8.78E-03              | 121.0               | 313.3                    |                      | 442785                |
| 9        | -1.45   | -17.97                 | 0.037           | 7.94E-03              | 130.6               | 431.8                    |                      | 442785                |
| 10       | -2.40   | -74.46                 | 0.030           | 6.76E-03              | 86.7                | 551.0                    |                      | 442785                |
| 11       | -3.60   | -144.36                | 0.023           | 4.96E-03              | -44.6               | 590.9                    |                      | 442785                |
| 12       | -4.30   | -117.52                | 0.020           | 3.89E-03              | -136.2              | 526.4                    |                      | 442785                |
| 13       | -5.00   | -97.59                 | 0.018           | 2.96E-03              | -211.5              | 401.9                    |                      | 442785                |
|          |         | 74.55                  | 0.018           | 2.96E-03              | -211.5              | 401.9                    |                      |                       |
| 14       | -6.10   | 57.68                  | 0.015           | 1.92E-03              | -138.8              | 206.0                    |                      | 442785                |
| 15       | -7.20   | 42.89                  | 0.013           | 1.34E-03              | -83.5               | 82.8                     |                      | 442785                |
| 16       | -8.40   | 29.46                  | 0.012           | 1.09E-03              | -40.1               | 6.5                      |                      | 442785                |
| 17       | -9.60   | 18.36                  | 0.011           | 1.06E-03              | -11.4               | -23.0                    |                      | 442785                |
| 18       | -10.80  | 8.92                   | 0.009           | 1.12E-03              | 5.0                 | -24.8                    |                      | 442785                |
| 19       | -12.00  | 0.65                   | 0.008           | 1.18E-03              | 10.7                | -14.2                    |                      | 442785                |
| 20       | -13.00  | -5.53                  | 0.007           | 1.21E-03              | 8.3                 | -4.2                     |                      | 442785                |
| 21       | -14.00  | -11.05                 | 0.006           | 1.21E-03              | 0.0                 | 0.0                      |                      | ---                   |

| Node no. | Y coord | ----- ACTIVE side ----- |                     |                       |                        |                         |                               |                                   |
|----------|---------|-------------------------|---------------------|-----------------------|------------------------|-------------------------|-------------------------------|-----------------------------------|
|          |         | Water press.<br>kN/m2   | Vertic -al<br>kN/m2 | Active limit<br>kN/m2 | Passive limit<br>kN/m2 | Earth pressure<br>kN/m2 | Total earth pressure<br>kN/m2 | Soil stiffness<br>coeff.<br>kN/m3 |
| 1        | 7.00    | 0.00                    | 5.50                | 1.09                  | 46.38                  | 2.36                    | 2.36                          | 0.0                               |
| 2        | 5.90    | 0.00                    | 26.15               | 5.17                  | 220.45                 | 5.17                    | 5.17a                         | 448                               |
| 3        | 4.80    | 0.00                    | 48.61               | 9.60                  | 409.89                 | 9.60                    | 9.60a                         | 895                               |
| 4        | 3.60    | 0.00                    | 72.99               | 14.42                 | 615.45                 | 14.42                   | 14.42a                        | 1383                              |
| 5        | 2.40    | 0.00                    | 96.57               | 19.08                 | 814.26                 | 19.08                   | 19.08a                        | 1872                              |
| 6        | 1.20    | 0.00                    | 119.52              | 23.61                 | 1007.75                | 23.61                   | 23.61a                        | 2360                              |
| 7        | 0.00    | 0.00                    | 142.03              | 28.06                 | 1197.61                | 28.06                   | 28.06a                        | 2848                              |
|          |         | 0.00                    | 142.03              | 32.23                 | 947.38                 | 32.23                   | 32.23a                        | 2035                              |
| 8        | -0.50   | 4.90                    | 146.92              | 33.34                 | 979.97                 | 33.34                   | 38.24a                        | 2238                              |

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1 | Sheet No.  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :

(continued)

Stage No.9 Change properties of soil type 3 to soil type 4  
 Ko pressures will be reset

| Node<br>no. | Y<br>coord | ----- ACTIVE side -----        |              |                |                |                   |                                     |                                      |
|-------------|------------|--------------------------------|--------------|----------------|----------------|-------------------|-------------------------------------|--------------------------------------|
|             |            | ----- Effective stresses ----- |              |                |                |                   | Total<br>earth<br>pressure<br>kN/m2 | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|             |            | Water                          | Vertic       | Active         | Passive        | Earth             |                                     |                                      |
|             |            | press.<br>kN/m2                | -al<br>kN/m2 | limit<br>kN/m2 | limit<br>kN/m2 | pressure<br>kN/m2 |                                     |                                      |
| 9           | -1.45      | 14.22                          | 156.09       | 35.42          | 1041.11        | 35.42             | 49.64a                              | 2625                                 |
| 10          | -2.40      | 23.54                          | 165.13       | 37.47          | 1101.42        | 37.47             | 61.01a                              | 3011                                 |
| 11          | -3.60      | 35.30                          | 176.41       | 40.03          | 1176.68        | 40.03             | 75.34a                              | 3499                                 |
| 12          | -4.30      | 42.17                          | 182.94       | 41.51          | 1220.19        | 41.51             | 83.68a                              | 3784                                 |
| 13          | -5.00      | 49.03                          | 189.42       | 42.98          | 1263.46        | 42.98             | 92.02a                              | 4069                                 |
|             |            | 49.03                          | 189.42       | 68.72          | 512.17         | 214.99            | 264.02                              | 5739                                 |
| 14          | -6.10      | 59.82                          | 200.66       | 73.70          | 540.12         | 227.34            | 287.16                              | 6180                                 |
| 15          | -7.20      | 70.61                          | 211.83       | 78.66          | 567.91         | 242.31            | 312.91                              | 6622                                 |
| 16          | -8.40      | 82.38                          | 223.95       | 84.04          | 598.08         | 261.98            | 344.35                              | 7104                                 |
| 17          | -9.60      | 94.14                          | 236.03       | 89.39          | 628.13         | 284.64            | 378.78                              | 7586                                 |
| 18          | -10.80     | 105.91                         | 248.07       | 94.73          | 658.08         | 309.58            | 415.49                              | 8068                                 |
| 19          | -12.00     | 117.68                         | 260.08       | 100.06         | 687.96         | 336.27            | 453.95                              | 8551                                 |
| 20          | -13.00     | 127.49                         | 270.07       | 104.49         | 712.81         | 359.62            | 487.10                              | 8952                                 |
| 21          | -14.00     | 137.29                         | 280.04       | 108.91         | 737.63         | 383.91            | 521.21                              | 9354                                 |

| Node<br>no. | Y<br>coord | ----- PASSIVE side -----       |                        |                          |                           |                                     |                            | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|-------------|------------|--------------------------------|------------------------|--------------------------|---------------------------|-------------------------------------|----------------------------|--------------------------------------|
|             |            | ----- Effective stresses ----- |                        |                          |                           | Total<br>earth<br>pressure<br>kN/m2 |                            |                                      |
|             |            | Water<br>press.<br>kN/m2       | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 |                                     | Earth<br>pressure<br>kN/m2 |                                      |
| 1           | 7.00       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 2           | 5.90       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 3           | 4.80       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 4           | 3.60       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 5           | 2.40       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 6           | 1.20       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 7           | 0.00       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 8           | -0.50      | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
|             |            | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 2617                                 |
| 9           | -1.45      | 9.32                           | 8.74                   | 1.98                     | 58.30                     | 58.30                               | 67.61p                     | 3069                                 |
| 10          | -2.40      | 18.63                          | 17.52                  | 3.97                     | 116.83                    | 116.83                              | 135.47p                    | 3521                                 |
| 11          | -3.60      | 30.40                          | 28.71                  | 6.51                     | 191.48                    | 189.30                              | 219.70                     | 4091                                 |
| 12          | -4.30      | 37.26                          | 35.31                  | 8.01                     | 235.53                    | 163.94                              | 201.20                     | 4424                                 |
| 13          | -5.00      | 44.13                          | 41.99                  | 9.53                     | 280.05                    | 145.47                              | 189.60                     | 4758                                 |
|             |            | 44.13                          | 41.99                  | 3.33                     | 145.34                    | 145.34                              | 189.47p                    | 6832                                 |
| 14          | -6.10      | 54.92                          | 53.73                  | 8.54                     | 174.57                    | 174.57                              | 229.49p                    | 7358                                 |
| 15          | -7.20      | 65.70                          | 65.69                  | 13.85                    | 204.32                    | 204.32                              | 270.03p                    | 7884                                 |
| 16          | -8.40      | 77.47                          | 78.99                  | 19.75                    | 237.42                    | 237.42                              | 314.89p                    | 8458                                 |
| 17          | -9.60      | 89.24                          | 92.56                  | 25.76                    | 271.18                    | 271.18                              | 360.42p                    | 9032                                 |
| 18          | -10.80     | 101.01                         | 106.38                 | 31.89                    | 305.56                    | 305.56                              | 406.57p                    | 9606                                 |
| 19          | -12.00     | 112.78                         | 120.43                 | 38.12                    | 340.53                    | 340.53                              | 453.30p                    | 10180                                |
| 20          | -13.00     | 122.58                         | 132.30                 | 43.39                    | 370.05                    | 370.05                              | 492.63p                    | 10658                                |
| 21          | -14.00     | 132.39                         | 144.29                 | 48.70                    | 399.87                    | 399.87                              | 532.26p                    | 11136                                |

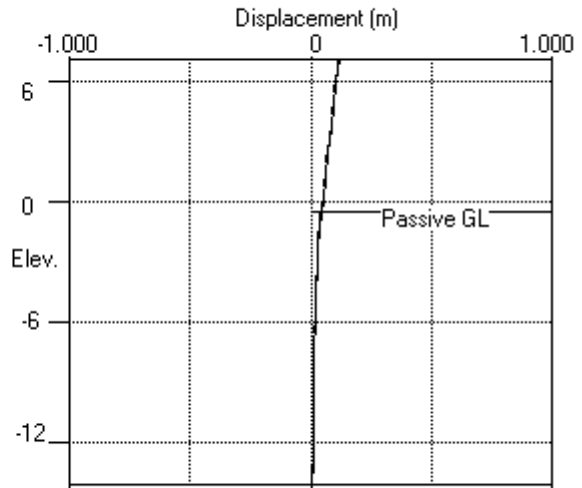
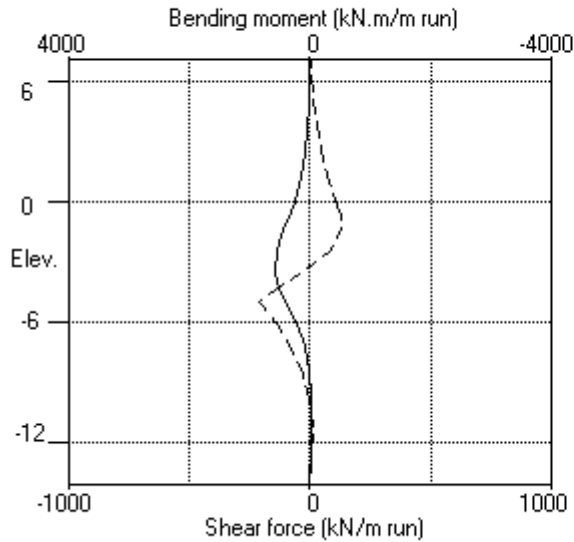
Note: 92.02a Soil pressure at active limit  
 532.26p Soil pressure at passive limit

# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

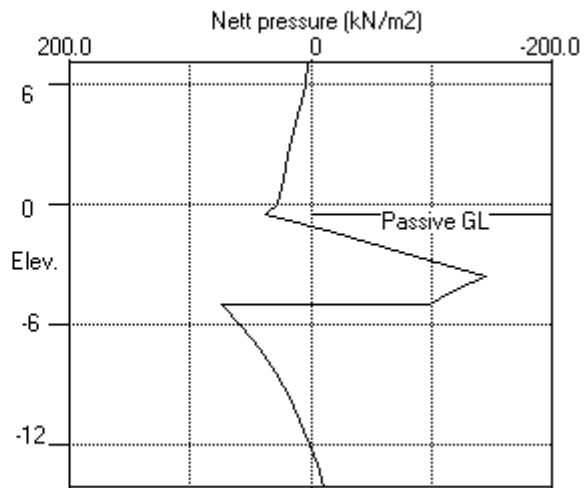
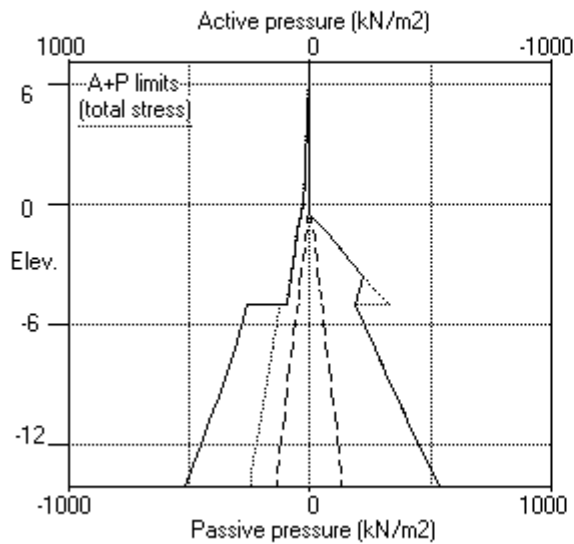
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.9 Change soil type 3 to soil type 4

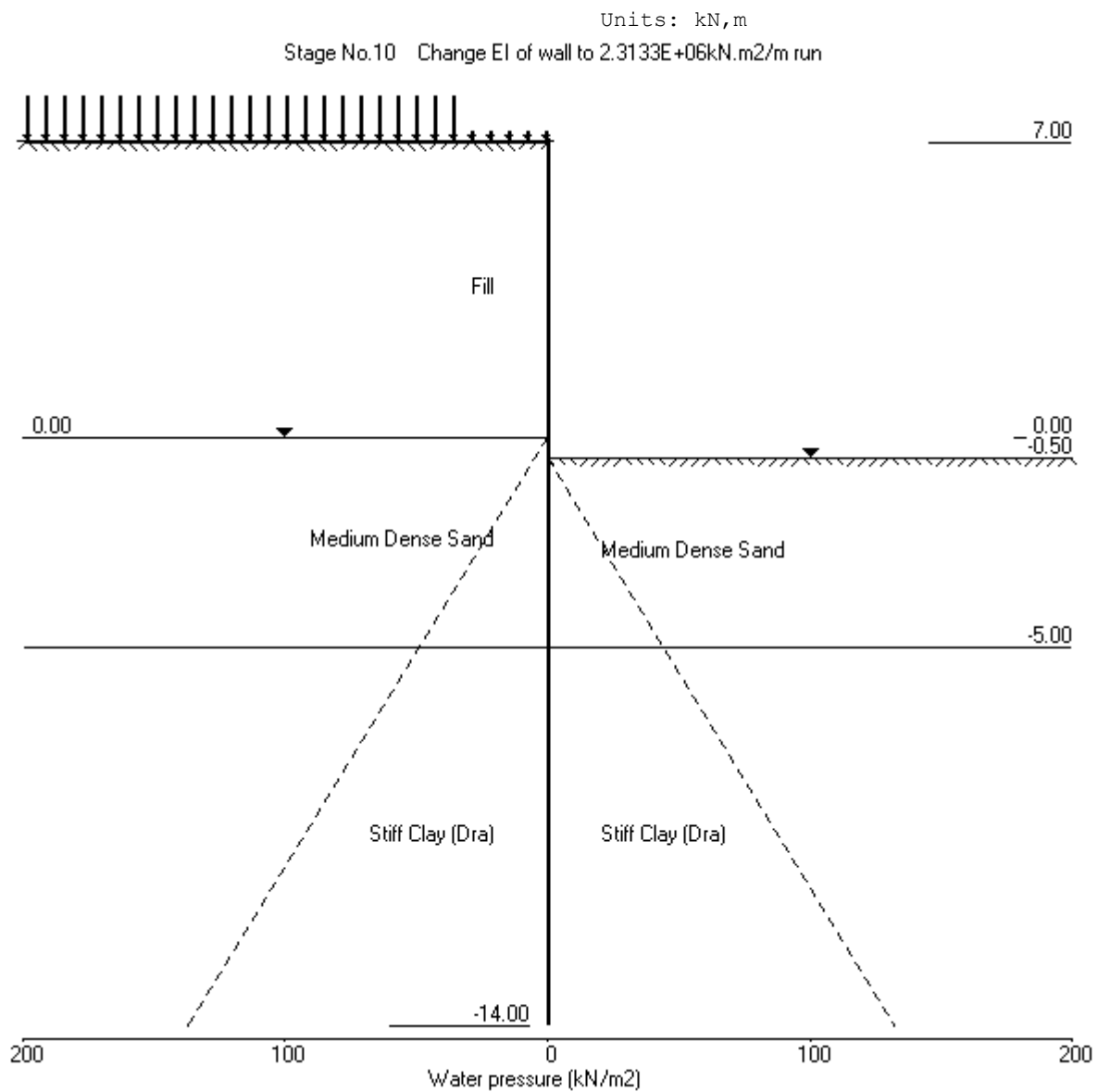


Stage No.9 Change soil type 3 to soil type 4



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 10 Change EI of wall to 2.3133E+06 kN.m2/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces are to be multiplied by a factor of 1.35 to obtain values for structural design. See summary for factored values.

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 2.36                | 0.115        | 9.30E-03           | 0.0              | 0.0                   |                   | 2313256            |
| 2        | 5.90    | 5.17                | 0.104        | 9.30E-03           | 4.1              | 2.0                   |                   | 2313256            |
| 3        | 4.80    | 9.60                | 0.094        | 9.30E-03           | 12.3             | 10.6                  |                   | 2313256            |
| 4        | 3.60    | 14.42               | 0.083        | 9.29E-03           | 26.7             | 33.3                  |                   | 2313256            |
| 5        | 2.40    | 19.08               | 0.072        | 9.26E-03           | 46.8             | 76.9                  |                   | 2313256            |
| 6        | 1.20    | 23.61               | 0.061        | 9.20E-03           | 72.4             | 147.8                 |                   | 2313256            |
| 7        | 0.00    | 28.06               | 0.050        | 9.10E-03           | 103.4            | 252.7                 |                   | 442785             |
|          |         | 32.23               | 0.050        | 9.10E-03           | 103.4            | 252.7                 |                   |                    |
| 8        | -0.50   | 38.24               | 0.045        | 8.78E-03           | 121.0            | 313.3                 |                   | 442785             |
| 9        | -1.45   | -17.97              | 0.037        | 7.94E-03           | 130.6            | 431.8                 |                   | 442785             |
| 10       | -2.40   | -74.46              | 0.030        | 6.76E-03           | 86.7             | 551.0                 |                   | 442785             |
| 11       | -3.60   | -144.36             | 0.023        | 4.96E-03           | -44.6            | 590.9                 |                   | 442785             |
| 12       | -4.30   | -117.52             | 0.020        | 3.89E-03           | -136.2           | 526.4                 |                   | 442785             |
| 13       | -5.00   | -97.59              | 0.018        | 2.96E-03           | -211.5           | 401.9                 |                   | 442785             |
|          |         | 74.55               | 0.018        | 2.96E-03           | -211.5           | 401.9                 |                   |                    |
| 14       | -6.10   | 57.68               | 0.015        | 1.92E-03           | -138.8           | 206.0                 |                   | 442785             |
| 15       | -7.20   | 42.89               | 0.013        | 1.34E-03           | -83.5            | 82.8                  |                   | 442785             |
| 16       | -8.40   | 29.46               | 0.012        | 1.09E-03           | -40.1            | 6.5                   |                   | 442785             |
| 17       | -9.60   | 18.36               | 0.011        | 1.06E-03           | -11.4            | -23.0                 |                   | 442785             |
| 18       | -10.80  | 8.92                | 0.009        | 1.12E-03           | 5.0              | -24.8                 |                   | 442785             |
| 19       | -12.00  | 0.65                | 0.008        | 1.18E-03           | 10.7             | -14.2                 |                   | 442785             |
| 20       | -13.00  | -5.53               | 0.007        | 1.21E-03           | 8.3              | -4.2                  |                   | 442785             |
| 21       | -14.00  | -11.05              | 0.006        | 1.21E-03           | 0.0              | 0.0                   |                   | ---                |

| Node no. | Y coord | ----- ACTIVE side -----        |        |        |         |          |          |           |
|----------|---------|--------------------------------|--------|--------|---------|----------|----------|-----------|
|          |         | ----- Effective stresses ----- |        |        |         | Total    | Soil     |           |
|          |         | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|          |         | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|          |         | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 1        | 7.00    | 0.00                           | 5.50   | 1.09   | 46.38   | 2.36     | 2.36     | 0.0       |
| 2        | 5.90    | 0.00                           | 26.15  | 5.17   | 220.45  | 5.17     | 5.17a    | 1154      |
| 3        | 4.80    | 0.00                           | 48.61  | 9.60   | 409.89  | 9.60     | 9.60a    | 2308      |
| 4        | 3.60    | 0.00                           | 72.99  | 14.42  | 615.45  | 14.42    | 14.42a   | 3567      |
| 5        | 2.40    | 0.00                           | 96.57  | 19.08  | 814.26  | 19.08    | 19.08a   | 4826      |
| 6        | 1.20    | 0.00                           | 119.52 | 23.61  | 1007.75 | 23.61    | 23.61a   | 6085      |
| 7        | 0.00    | 0.00                           | 142.03 | 28.06  | 1197.61 | 28.06    | 28.06a   | 12114     |
|          |         | 0.00                           | 142.03 | 32.23  | 947.38  | 32.23    | 32.23a   | 8653      |

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.10 Change EI of wall to 2.3133E+06 kN.m<sup>2</sup>/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

| Node no. | Y coord | ----- ACTIVE side -----        |                   |                   |                   |                      |                   |
|----------|---------|--------------------------------|-------------------|-------------------|-------------------|----------------------|-------------------|
|          |         | ----- Effective stresses ----- |                   |                   |                   | Total earth pressure | Soil stiffness    |
|          |         | Water press.                   | Vertic -al        | Active limit      | Passive limit     | Earth pressure       | coeff.            |
|          |         | kN/m <sup>2</sup>              | kN/m <sup>2</sup> | kN/m <sup>2</sup> | kN/m <sup>2</sup> | kN/m <sup>2</sup>    | kN/m <sup>3</sup> |
| 8        | -0.50   | 4.90                           | 146.92            | 33.34             | 979.97            | 33.34                | 9518              |
| 9        | -1.45   | 14.22                          | 156.09            | 35.42             | 1041.11           | 35.42                | 11162             |
| 10       | -2.40   | 23.54                          | 165.13            | 37.47             | 1101.42           | 37.47                | 12806             |
| 11       | -3.60   | 35.30                          | 176.41            | 40.03             | 1176.68           | 40.03                | 14883             |
| 12       | -4.30   | 42.17                          | 182.94            | 41.51             | 1220.19           | 41.51                | 6251              |
| 13       | -5.00   | 49.03                          | 189.42            | 42.98             | 1263.46           | 42.98                | 6722              |
|          |         | 49.03                          | 189.42            | 68.72             | 512.17            | 214.99               | 9806              |
| 14       | -6.10   | 59.82                          | 200.66            | 73.70             | 540.12            | 227.34               | 10561             |
| 15       | -7.20   | 70.61                          | 211.83            | 78.66             | 567.91            | 242.31               | 11316             |
| 16       | -8.40   | 82.38                          | 223.95            | 84.04             | 598.08            | 261.98               | 12139             |
| 17       | -9.60   | 94.14                          | 236.03            | 89.39             | 628.13            | 284.64               | 12963             |
| 18       | -10.80  | 105.91                         | 248.07            | 94.73             | 658.08            | 309.58               | 13787             |
| 19       | -12.00  | 117.68                         | 260.08            | 100.06            | 687.96            | 336.27               | 14610             |
| 20       | -13.00  | 127.49                         | 270.07            | 104.49            | 712.81            | 359.62               | 15297             |
| 21       | -14.00  | 137.29                         | 280.04            | 108.91            | 737.63            | 383.91               | 255480            |

| Node no. | Y coord | ----- PASSIVE side -----       |                   |                   |                   |                      |                   |
|----------|---------|--------------------------------|-------------------|-------------------|-------------------|----------------------|-------------------|
|          |         | ----- Effective stresses ----- |                   |                   |                   | Total earth pressure | Soil stiffness    |
|          |         | Water press.                   | Vertic -al        | Active limit      | Passive limit     | Earth pressure       | coeff.            |
|          |         | kN/m <sup>2</sup>              | kN/m <sup>2</sup> | kN/m <sup>2</sup> | kN/m <sup>2</sup> | kN/m <sup>2</sup>    | kN/m <sup>3</sup> |
| 1        | 7.00    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 2        | 5.90    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 3        | 4.80    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 4        | 3.60    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 5        | 2.40    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 6        | 1.20    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 7        | 0.00    | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
| 8        | -0.50   | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 0.0               |
|          |         | 0.00                           | 0.00              | 0.00              | 0.00              | 0.00                 | 10350             |
| 9        | -1.45   | 9.32                           | 8.74              | 1.98              | 58.30             | 58.30                | 12138             |
| 10       | -2.40   | 18.63                          | 17.52             | 3.97              | 116.83            | 116.83               | 13926             |
| 11       | -3.60   | 30.40                          | 28.71             | 6.51              | 191.48            | 189.30               | 16184             |
| 12       | -4.30   | 37.26                          | 35.31             | 8.01              | 235.53            | 163.94               | 6251              |
| 13       | -5.00   | 44.13                          | 41.99             | 9.53              | 280.05            | 145.47               | 6722              |
|          |         | 44.13                          | 41.99             | 3.33              | 145.34            | 145.34               | 9806              |
| 14       | -6.10   | 54.92                          | 53.73             | 8.54              | 174.57            | 174.57               | 10561             |
| 15       | -7.20   | 65.70                          | 65.69             | 13.85             | 204.32            | 204.32               | 11316             |
| 16       | -8.40   | 77.47                          | 78.99             | 19.75             | 237.42            | 237.42               | 12139             |
| 17       | -9.60   | 89.24                          | 92.56             | 25.76             | 271.18            | 271.18               | 12963             |
| 18       | -10.80  | 101.01                         | 106.38            | 31.89             | 305.56            | 305.56               | 13787             |
| 19       | -12.00  | 112.78                         | 120.43            | 38.12             | 340.53            | 340.53               | 14610             |
| 20       | -13.00  | 122.58                         | 132.30            | 43.39             | 370.05            | 370.05               | 15297             |
| 21       | -14.00  | 132.39                         | 144.29            | 48.70             | 399.87            | 399.87               | 255480            |

Note: 92.02a Soil pressure at active limit  
532.26p Soil pressure at passive limit



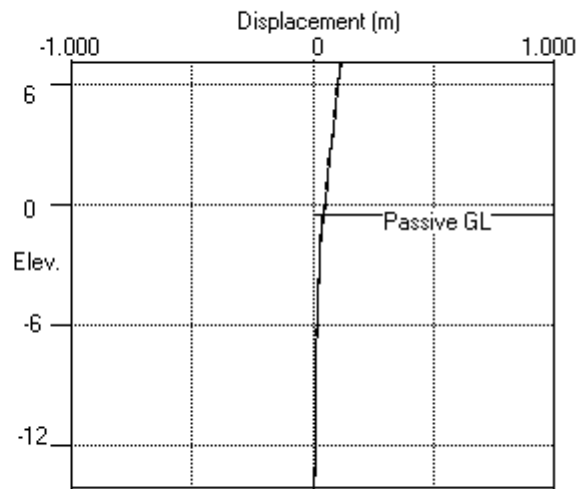
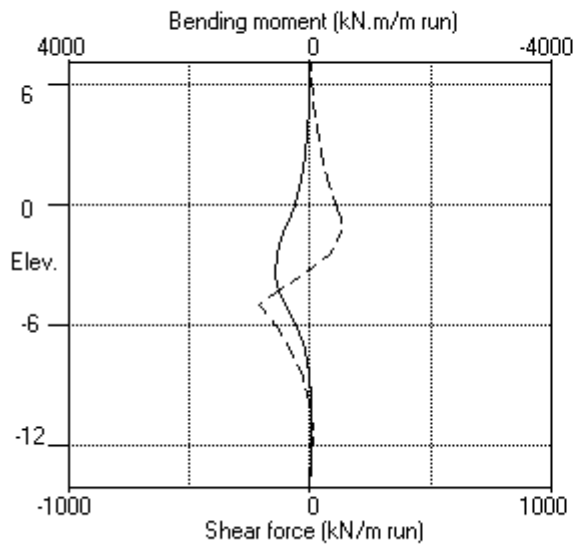
## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
 Tubular King Pile Foundation  
 D1000-14 @ 2500

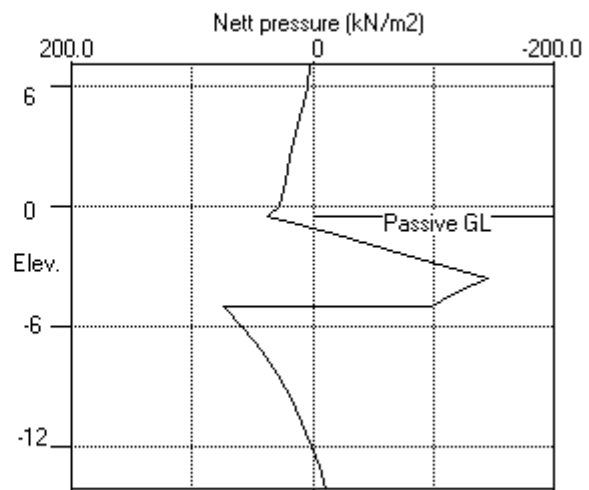
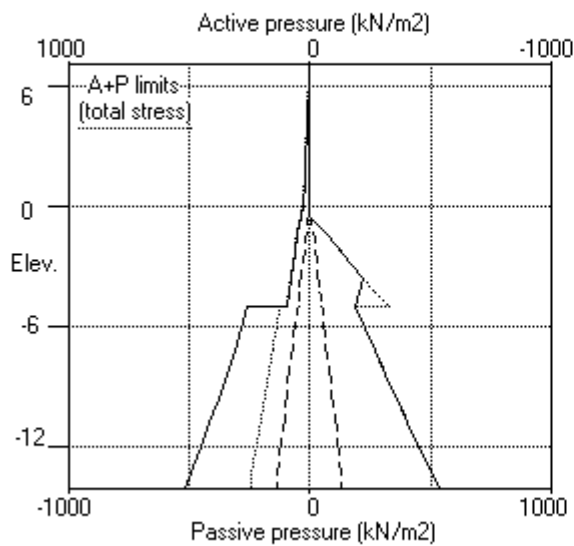
| Sheet No.  
 | Job No. 1504  
 | Made by : HGC  
 | Date: 16-09-2015  
 | Checked :

Units: kN,m

Stage No.10 Change EI of wall to 2.3133E+06kN.m2/m run



Stage No.10 Change EI of wall to 2.3133E+06kN.m2/m run



# APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

## Summary of results

### BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

#### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

#### Limit State: ULS DA1 Combination 1

Calculated Bending Moments and Strut Forces have been multiplied by a factor of 1.35 to obtain values for structural design.

### Bending moment, shear force and displacement envelopes

| Node no. | Y coord | Displacement |       | Bending moment |      |          |      | Shear force |      |          |      |
|----------|---------|--------------|-------|----------------|------|----------|------|-------------|------|----------|------|
|          |         |              |       | Calculated     |      | Factored |      | Calculated  |      | Factored |      |
|          |         | max.         | min.  | max.           | min. | max.     | min. | max.        | min. | max.     | min. |
|          |         | m            | m     | kN.m/m         |      | kN.m/m   |      | kN/m        | kN/m | kN/m     | kN/m |
| 1        | 7.00    | 0.632        | 0.000 | 0              | -0   | 0        | -0   | 183         | 0    | 248      | 0    |
| 2        | 5.90    | 0.574        | 0.000 | 204            | -1   | 275      | -1   | 187         | -2   | 253      | -3   |
| 3        | 4.80    | 0.516        | 0.000 | 414            | -6   | 559      | -9   | 196         | -9   | 264      | -12  |
| 4        | 3.60    | 0.453        | 0.000 | 657            | -23  | 887      | -31  | 210         | -21  | 284      | -28  |
| 5        | 2.40    | 0.390        | 0.000 | 920            | -58  | 1242     | -78  | 230         | -38  | 311      | -51  |
| 6        | 1.20    | 0.328        | 0.000 | 1211           | -116 | 1635     | -156 | 256         | -60  | 345      | -81  |
| 7        | 0.00    | 0.266        | 0.000 | 1536           | -203 | 2074     | -274 | 287         | -87  | 387      | -118 |
| 8        | -0.50   | 0.242        | 0.000 | 1688           | -248 | 2279     | -335 | 304         | -87  | 411      | -117 |
| 9        | -1.45   | 0.197        | 0.000 | 1981           | -325 | 2674     | -439 | 314         | -46  | 424      | -62  |
| 10       | -2.40   | 0.156        | 0.000 | 2274           | -343 | 3070     | -463 | 270         | -33  | 365      | -45  |
| 11       | -3.60   | 0.112        | 0.000 | 2534           | -315 | 3420     | -426 | 137         | -78  | 186      | -105 |
| 12       | -4.30   | 0.090        | 0.000 | 2590           | -278 | 3497     | -375 | 57          | -136 | 77       | -184 |
| 13       | -5.00   | 0.071        | 0.000 | 2553           | -235 | 3446     | -317 | 62          | -212 | 83       | -286 |
| 14       | -6.10   | 0.047        | 0.000 | 2359           | -153 | 3185     | -206 | 71          | -220 | 95       | -297 |
| 15       | -7.20   | 0.030        | 0.000 | 2052           | -79  | 2770     | -107 | 56          | -339 | 76       | -457 |
| 16       | -8.40   | 0.017        | 0.000 | 1591           | -31  | 2147     | -41  | 33          | -432 | 44       | -583 |
| 17       | -9.60   | 0.011        | 0.000 | 1044           | -23  | 1410     | -31  | 14          | -434 | 19       | -585 |
| 18       | -10.80  | 0.009        | 0.000 | 546            | -25  | 737      | -33  | 5           | -350 | 7        | -473 |
| 19       | -12.00  | 0.008        | 0.000 | 201            | -14  | 271      | -19  | 11          | -214 | 14       | -289 |
| 20       | -13.00  | 0.007        | 0.000 | 46             | -5   | 63       | -7   | 8           | -99  | 11       | -134 |
| 21       | -14.00  | 0.006        | 0.000 | 0              | -0   | 0        | -0   | 0           | -0   | 0        | -0   |

### Maximum and minimum bending moment and shear force at each stage

| Stage no. | Bending moment               |            |            |            | Shear force |            |            |            |
|-----------|------------------------------|------------|------------|------------|-------------|------------|------------|------------|
|           | Calculated                   |            | Factored   |            | Calculated  |            | Factored   |            |
|           | max. elev.                   | min. elev. | max. elev. | min. elev. | max. elev.  | min. elev. | max. elev. | min. elev. |
|           | kN.m/m                       | kN.m/m     | kN.m/m     | kN.m/m     | kN/m        | kN/m       | kN/m       | kN/m       |
| 1         | 8 -10.80                     | -343 -2.40 | 10 -463    | 71 -6.10   | -87 0.00    | 95 -118    |            |            |
| 2         | 4 -12.00                     | -127 -5.00 | 5 -171     | 32 -7.20   | -36 -1.45   | 43 -49     |            |            |
| 3         | No calculation at this stage |            |            |            |             |            |            |            |
| 4         | 323 -2.40                    | -8 -9.60   | 437 -11    | 87 0.00    | -74 -4.30   | 118 -100   |            |            |
| 5         | No calculation at this stage |            |            |            |             |            |            |            |
| 6         | 416 -2.40                    | -9 -10.80  | 561 -12    | 105 -0.50  | -89 -4.30   | 142 -121   |            |            |
| 7         | 422 -2.40                    | -9 -10.80  | 570 -12    | 106 -0.50  | -88 -4.30   | 143 -119   |            |            |
| 8         | 591 -3.60                    | -13 -12.00 | 798 -17    | 131 -1.45  | -127 -6.10  | 176 -171   |            |            |
| 9         | 591 -3.60                    | -25 -10.80 | 798 -33    | 131 -1.45  | -212 -5.00  | 176 -286   |            |            |
| 10        | 591 -3.60                    | -25 -10.80 | 798 -33    | 131 -1.45  | -212 -5.00  | 176 -286   |            |            |
| 11        | 2590 -4.30                   | -0 7.00    | 3497 -0    | 314 -1.45  | -434 -9.60  | 424 -585   |            |            |

## APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

### Summary of results (continued)

#### Maximum and minimum displacement at each stage

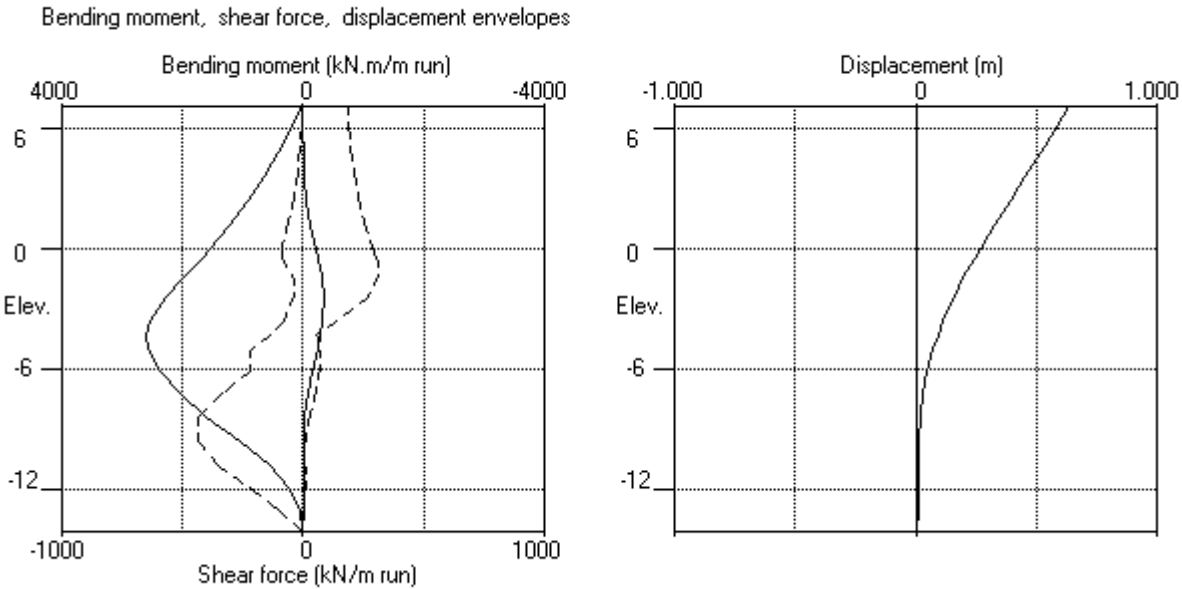
| Stage no. | Displacement maximum elev. m                                                | Displacement minimum elev. m | Stage description                          |
|-----------|-----------------------------------------------------------------------------|------------------------------|--------------------------------------------|
| 1         | 0.000                                                                       | -0.051                       | Excav. to elev. 0.00 on ACTIVE side        |
| 2         | 0.000                                                                       | -0.018                       | Excav. to elev. 0.00 on PASSIVE side       |
| 3         | Wall displacements reset to zero Change EI of wall to 4.6265E+06kN.m2/m run |                              |                                            |
| 4         | 0.052                                                                       | 0.000                        | Fill to elev. 7.00 on ACTIVE side          |
| 5         | No calculation at this stage Apply surcharge no.1 at elev. 7.00             |                              |                                            |
| 6         | 0.065                                                                       | 0.000                        | Apply surcharge no.2 at elev. 7.00         |
| 7         | 0.066                                                                       | 0.000                        | Apply water pressure profile no.1          |
| 8         | 0.104                                                                       | 0.000                        | Excav. to elev. -0.50 on PASSIVE side      |
| 9         | 0.114                                                                       | 0.000                        | Change soil type 3 to soil type 4          |
| 10        | 0.115                                                                       | 0.000                        | Change EI of wall to 2.3133E+06kN.m2/m run |
| 11        | 0.632                                                                       | 0.000                        | Apply load no.1 at elev. 7.00              |

APPENDIX A-2. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1

Program: WALLAP Version 6.05 Revision A45.B58.R49  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS1  
Tubular King Pile Foundation  
D1000-14 @ 2500

| Sheet No.  
| Job No. 1504  
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| Made by : HGC  
| Date: 16-09-2015  
| Checked :

Units: kN,m



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
 Licensed from GEOSOLVE | Made by : HGC  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
 Tubular King File Foundation | Date: 16-09-2015  
 D1000-14 @ 2500 | Checked :

Units: kN,m

## INPUT DATA

### SOIL PROFILE

| Stratum no. | Elevation of top of stratum | Active side         | Soil types          | Passive side |
|-------------|-----------------------------|---------------------|---------------------|--------------|
| 1           | 7.00                        | 1 Fill              | 1 Fill              |              |
| 2           | 0.00                        | 2 Medium Dense Sand | 2 Medium Dense Sand |              |
| 3           | -5.00                       | 3 Stiff Clay (Und)  | 3 Stiff Clay (Und)  |              |

### SOIL PROPERTIES (Unfactored SLS soil strengths)

| Soil type       | density  | Young's Modulus | At rest coeff. | Consol. state. | Active limit | Passive limit | Cohesion |
|-----------------|----------|-----------------|----------------|----------------|--------------|---------------|----------|
| No. Description | kN/m3    | Eh, kN/m2       | Ko             | NC/OC          | Ka           | Kp            | kN/m2    |
| (Datum elev.)   |          | (dEh/dy)        | (dKo/dy)       | (Nu)           | (Kac)        | (Kpc)         | (dc/dy)  |
| 1 Fill          | 18.00a   | 10000           | 0.500          | OC             | 0.198        | 8.432         |          |
| ( 5.00 )        | 19.00b   | ( 5000 )        |                | (0.300)        | (0.000)      | ( 0.000 )     |          |
| 2 Medium De..   | 18.00a   | 25000           | 0.430          | OC             | 0.227        | 6.670         |          |
| ( 0.00 )        | 19.00b   | ( 5000 )        |                | (0.300)        | (0.000)      | ( 0.000 )     |          |
| 3 Stiff Cla..   | 20.00    | 100000          | 1.500          | OC             | 1.000        | 1.000         | 100.0u   |
| ( -5.00 )       | ( 7000 ) |                 | (0.490)        | (2.000)        | ( 2.000 )    | ( 7.000 )     |          |
| 4 Stiff Cla..   | 20.00    | 80000           | 1.500          | OC             | 0.444        | 2.488         | 10.00d   |
| ( -5.00 )       | ( 5600 ) |                 | (0.200)        | (1.529)        | ( 4.088 )    |               |          |

Note: (a) and (b) are Bulk Densities above and below the water table

### Additional soil parameters associated with Ka and Kp

| Soil type           | parameters for Ka   |             |            | parameters for Kp   |             |            |
|---------------------|---------------------|-------------|------------|---------------------|-------------|------------|
|                     | Soil friction angle | Wall coeff. | Back- fill | Soil friction angle | Wall coeff. | Back- fill |
| 1 Fill              | 38.00               | 0.667       | 0.00       | 38.00               | 0.667       | 0.00       |
| 2 Medium Dense Sand | 35.00               | 0.667       | 0.00       | 35.00               | 0.667       | 0.00       |
| 3 Stiff Clay (Und)  | 0.00                | 0.000       | 0.00       | 0.00                | 0.000       | 0.00       |
| 4 Stiff Clay (Dra)  | 20.00               | 0.500       | 0.00       | 20.00               | 0.500       | 0.00       |

### GROUND WATER CONDITIONS

Density of water = 9.807 kN/m3

|                               | Active side | Passive side |
|-------------------------------|-------------|--------------|
| Initial water table elevation | -0.50       | -0.50        |

Automatic water pressure balancing at toe of wall : No

| Active side   |           |         |                          | Passive side  |           |         |                          |        |
|---------------|-----------|---------|--------------------------|---------------|-----------|---------|--------------------------|--------|
| Water profile | Point no. | Elev. m | Piezo Water press. kN/m2 | Water profile | Point no. | Elev. m | Piezo Water press. kN/m2 |        |
| 1             | 1         | 0.00    | 0.00                     | 0.0           | 1         | -0.50   | -0.50                    | 0.0 MC |
| 2             | 1         | 0.50    | 0.50                     | 0.0           | 1         | -0.50   | -0.50                    | 0.0 WC |

### WALL PROPERTIES

Type of structure = Fully Embedded Wall  
 Elevation of toe of wall = -14.00  
 Maximum finite element length = 1.20 m  
 Youngs modulus of wall E = 2.1000E+08 kN/m2  
 Moment of inertia of wall I = 2.1085E-03 m4/m run  
 E.I = 442785 kN.m2/m run  
 Yield Moment of wall = Not defined

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

## HORIZONTAL and MOMENT LOADS/RESTRAINTS

| Load no. | Elevation | Horizontal load<br>kN/m run | Moment load<br>kN.m/m run | Moment restraint<br>kN.m/m/rad | Partial factor/<br>Category |
|----------|-----------|-----------------------------|---------------------------|--------------------------------|-----------------------------|
| 1        | 7.00      | 166.7                       | 0                         | 0                              | 1.30 Var                    |

## SURCHARGE LOADS

| Surch-<br>arge<br>no. | Distance<br>Elev. | Length<br>from wall | Width<br>parallel to wall | perpend.<br>to wall | Surcharge<br>kN/m2 | Equiv. soil<br>type | Partial<br>factor/<br>Category |
|-----------------------|-------------------|---------------------|---------------------------|---------------------|--------------------|---------------------|--------------------------------|
| 1                     | 7.00              | 0.00 (A)            | 1000.00                   | 2.00                | 5.00 =             | N/A                 | 1.30 Var                       |
| 2                     | 7.00              | 2.00 (A)            | 1000.00                   | 20.00               | 20.00 =            | N/A                 | 1.30 Var                       |

Note: A = Active side, P = Passive side

Limit State Categories P/U = Permanent Unfavourable

P/F = Permanent Favourable

Var = Variable (unfavourable)

## CONSTRUCTION STAGES

| Construction stage no. | Stage description                                                                                                                                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                      | Excavate to elevation 0.00 on ACTIVE side<br>Toe of berm at elevation 7.00<br>Width of top of berm = 2.00<br>Width of toe of berm = 12.50                |
| 2                      | Excavate to elevation 0.00 on PASSIVE side                                                                                                               |
| 3                      | Change EI of wall to 4.6265E+06 kN.m2/m run<br>From elevation 7.00 to 0.00<br>Yield moment not defined<br>Reset wall displacements to zero at this stage |
| 4                      | Fill to elevation 7.00 on ACTIVE side with soil type 1                                                                                                   |
| 5                      | Apply surcharge no.1 at elevation 7.00<br>No analysis at this stage                                                                                      |
| 6                      | Apply surcharge no.2 at elevation 7.00                                                                                                                   |
| 7                      | Apply water pressure profile no.2 ( Worst Cred. )                                                                                                        |
| 8                      | Excavate to elevation -0.50 on PASSIVE side                                                                                                              |
| 9                      | Change properties of soil type 3 to soil type 4<br>Ko pressures will be reset                                                                            |
| 10                     | Change EI of wall to 2.3133E+06 kN.m2/m run<br>From elevation 7.00 to 0.00<br>Yield moment not defined<br>Allow wall to relax with new modulus value     |
| 11                     | Apply load no.1 at elevation 7.00                                                                                                                        |

## FACTORS OF SAFETY and ANALYSIS OPTIONS

Limit State options: ULS DA1 Combination 2

Water pressures : Worst Credible

Partial factor on C' = 1.250

Partial factor on Phi' = 1.250

Partial factor on Cu = 1.400

Partial factor on Soil Modulus = 1.000

Partial factor on Permanent Unfavourable loads = 1.000

Partial factor on Permanent Favourable loads = 1.000

Partial factor on Permanent Variable loads = 1.300

Stability analysis:

Method of analysis - Strength Factor method

Overall factor on soil strength for calculating wall depth = 1.00

Parameters for undrained strata:

Minimum equivalent fluid density = 5.00 kN/m3

Maximum depth of water filled tension crack = 0.00 m

Bending moment and displacement calculation:

Method - Subgrade reaction model using Influence Coefficients

Open Tension Crack analysis? - No

Non-linear Modulus Parameter (L) = 0 m

## APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

### Boundary conditions:

Length of wall (normal to plane of analysis) = 1000.00 m

Width of excavation on active side of wall = 20.00 m

Width of excavation on passive side of wall = 20.00 m

Distance to rigid boundary on active side = 20.00 m

Distance to rigid boundary on passive side = 20.00 m

### OUTPUT OPTIONS

| Stage no. | Stage description                      | Displacement | Active, Graph. | Passive output pressures |
|-----------|----------------------------------------|--------------|----------------|--------------------------|
| 1         | Excav. to elev. 0.00 on ACTIVE side    | No           | No             | No                       |
| 2         | Excav. to elev. 0.00 on PASSIVE side   | No           | No             | No                       |
| 3         | Change EI of wall to 4.6265E+06kN.m2/m | No           | No             | No                       |
| 4         | Fill to elev. 7.00 on ACTIVE side      | Yes          | Yes            | Yes                      |
| 5         | Apply surcharge no.1 at elev. 7.00     | No           | No             | No                       |
| 6         | Apply surcharge no.2 at elev. 7.00     | No           | No             | No                       |
| 7         | Apply water pressure profile no.2      | Yes          | Yes            | Yes                      |
| 8         | Excav. to elev. -0.50 on PASSIVE side  | No           | No             | No                       |
| 9         | Change soil type 3 to soil type 4      | No           | No             | No                       |
| 10        | Change EI of wall to 2.3133E+06kN.m2/m | No           | No             | No                       |
| 11        | Apply load no.1 at elev. 7.00          | No           | No             | No                       |
| *         | Summary output                         | Yes          | -              | Yes                      |

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APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49

Sheet No. 1504

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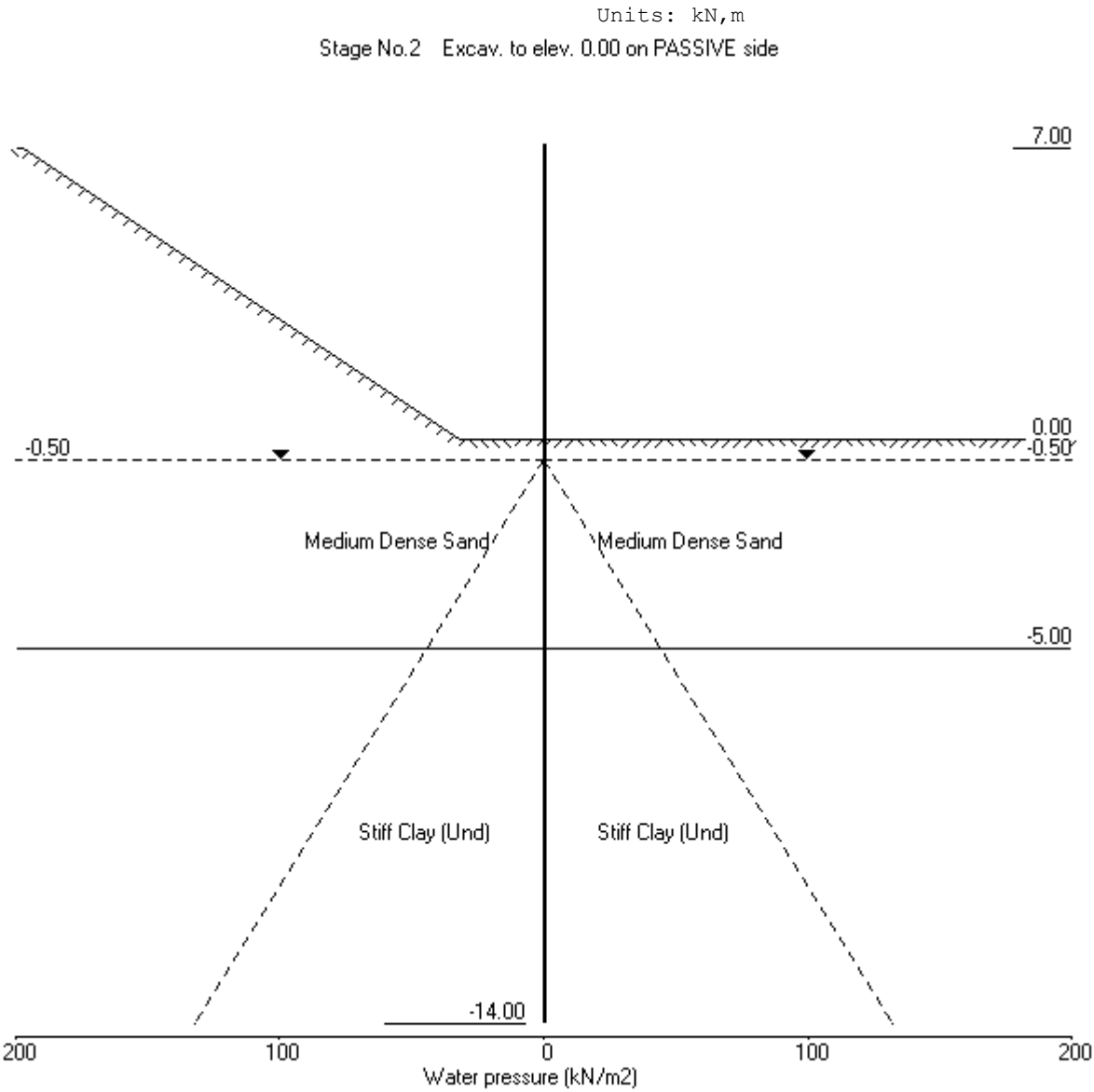
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Date: 16-09-2015

Tubular King Pile Foundation

Checked :

D1000-14 @ 2500





# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 2 Excavate to elevation 0.00 on PASSIVE side

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|       |              |                 |                                       |               |              |
|-------|--------------|-----------------|---------------------------------------|---------------|--------------|
|       |              | Overall         |                                       |               |              |
|       |              | FoS for toe     |                                       | Toe elev. for |              |
|       |              | elev. = -14.00  |                                       | FoS = 1.000   |              |
|       |              | -----           |                                       | -----         |              |
| Stage | --- G.L. --- | Strut           | Factor                                | Moment        | Toe Wall     |
| No.   | Act. Pass.   | Elev.           | of                                    | equilib.      | elev. Penetr |
|       |              | Safety at elev. |                                       | -ation        |              |
| 2     | 0.00 0.00    | Cant.           | Conditions not suitable for FoS calc. |               |              |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 2

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 0.00                | -0.038       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 2        | 5.90    | 0.00                | -0.035       | -3.01E-03          | 0.0              | -0.0                  |                   | 442785             |
| 3        | 4.80    | 0.00                | -0.031       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 4        | 3.60    | 0.00                | -0.028       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 5        | 2.40    | 0.00                | -0.024       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 6        | 1.45    | 0.00                | -0.021       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 7        | 0.50    | 0.00                | -0.018       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 8        | 0.00    | 0.00                | -0.017       | -3.01E-03          | 0.0              | 0.0                   |                   | 442785             |
| 9        | -0.50   | -37.62              | -0.015       | -3.00E-03          | -9.4             | -1.6                  |                   | 442785             |
| 10       | -1.45   | -66.40              | -0.013       | -2.99E-03          | -58.8            | -9.9                  |                   | 442785             |
| 11       | -2.40   | 9.37                | -0.010       | -2.89E-03          | -85.9            | -89.8                 |                   | 442785             |
| 12       | -3.60   | 41.07               | -0.006       | -2.48E-03          | -55.6            | -210.7                |                   | 442785             |
| 13       | -4.30   | 40.69               | -0.005       | -2.12E-03          | -27.0            | -239.3                |                   | 442785             |
| 14       | -5.00   | 37.73               | -0.003       | -1.74E-03          | 0.4              | -248.1                |                   | 442785             |
|          |         | 31.45               | -0.003       | -1.74E-03          | 0.4              | -248.1                |                   |                    |
| 15       | -6.10   | 25.84               | -0.002       | -1.15E-03          | 31.9             | -227.5                |                   | 442785             |
| 16       | -7.20   | 13.71               | -0.001       | -6.50E-04          | 53.7             | -175.6                |                   | 442785             |
| 17       | -8.40   | -6.82               | -0.000       | -2.55E-04          | 57.8             | -115.9                |                   | 442785             |
| 18       | -9.60   | -18.06              | -0.000       | -2.92E-05          | 42.9             | -51.4                 |                   | 442785             |
| 19       | -10.80  | -16.78              | -0.000       | 5.80E-05           | 22.0             | -13.0                 |                   | 442785             |
| 20       | -12.00  | -10.03              | -0.000       | 7.38E-05           | 5.9              | 1.3                   |                   | 442785             |
| 21       | -13.00  | -3.06               | -0.000       | 6.98E-05           | -0.7             | 2.2                   |                   | 442785             |
| 22       | -14.00  | 4.38                | -0.000       | 6.74E-05           | -0.0             | -0.0                  |                   | ---                |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.2 Excavate to elevation 0.00 on PASSIVE side

| Node no. | Y coord | ----- ACTIVE side ----- |                  |                    |                     |                      | Total earth pressure | Soil stiffness coeff. |
|----------|---------|-------------------------|------------------|--------------------|---------------------|----------------------|----------------------|-----------------------|
|          |         | Water press. kN/m2      | Vertic -al kN/m2 | Active limit kN/m2 | Passive limit kN/m2 | Earth pressure kN/m2 |                      |                       |
| 1        | 7.00    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 2        | 5.90    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 3        | 4.80    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 4        | 3.60    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 5        | 2.40    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 6        | 1.45    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 7        | 0.50    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 8        | 0.00    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
|          |         | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 6987                  |
| 9        | -0.50   | 0.00                    | 9.00             | 2.64               | 40.26               | 2.64a                | 2.64a                | 7685                  |
| 10       | -1.45   | 9.32                    | 17.75            | 5.20               | 79.41               | 6.51                 | 15.82                | 9013                  |
| 11       | -2.40   | 18.63                   | 26.56            | 7.78               | 118.79              | 64.08                | 82.71                | 10340                 |
| 12       | -3.60   | 30.40                   | 37.80            | 11.07              | 169.07              | 76.58                | 106.98               | 12017                 |
| 13       | -4.30   | 37.26                   | 44.44            | 13.01              | 198.77              | 68.22                | 105.49               | 12995                 |
| 14       | -5.00   | 44.13                   | 51.15            | 14.98              | 228.77              | 59.91                | 104.04               | 13973                 |
|          |         | Total>                  | 95.28            | 25.00m             | 238.16              | 180.49               | 180.49               | 36332                 |
| 15       | -6.10   | Total>                  | 117.86           | 30.50m             | 271.75              | 225.32               | 225.32               | 39129                 |
| 16       | -7.20   | Total>                  | 140.65           | 36.00m             | 305.54              | 259.99               | 259.99               | 41927                 |
| 17       | -8.40   | Total>                  | 165.76           | 42.00m             | 342.65              | 283.53               | 283.53               | 44979                 |
| 18       | -9.60   | Total>                  | 191.10           | 48.00m             | 380.00              | 309.02               | 309.02               | 48031                 |
| 19       | -10.80  | Total>                  | 216.68           | 54.00m             | 417.58              | 342.06               | 342.06               | 51082                 |
| 20       | -12.00  | Total>                  | 242.46           | 60.00m             | 455.37              | 378.27               | 378.27               | 54134                 |
| 21       | -13.00  | Total>                  | 264.08           | 65.00m             | 486.99              | 409.17               | 409.17               | 56678                 |
| 22       | -14.00  | Total>                  | 285.80           | 70.00m             | 518.72              | 440.37               | 440.37               | 59221                 |

| Node no. | Y coord | ----- PASSIVE side ----- |                  |                    |                     |                      | Total earth pressure | Soil stiffness coeff. |
|----------|---------|--------------------------|------------------|--------------------|---------------------|----------------------|----------------------|-----------------------|
|          |         | Water press. kN/m2       | Vertic -al kN/m2 | Active limit kN/m2 | Passive limit kN/m2 | Earth pressure kN/m2 |                      |                       |
| 1        | 7.00    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 2        | 5.90    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 3        | 4.80    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 4        | 3.60    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 5        | 2.40    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 6        | 1.45    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 7        | 0.50    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
| 8        | 0.00    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 0.0                   |
|          |         | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                 | 6987                  |
| 9        | -0.50   | 0.00                     | 9.00             | 2.64               | 40.26               | 40.26p               | 40.26p               | 7685                  |
| 10       | -1.45   | 9.32                     | 17.75            | 5.20               | 79.41               | 72.90                | 82.22                | 9013                  |
| 11       | -2.40   | 18.63                    | 26.56            | 7.78               | 118.79              | 54.71                | 73.34                | 10340                 |
| 12       | -3.60   | 30.40                    | 37.80            | 11.07              | 169.07              | 35.51                | 65.91                | 12017                 |
| 13       | -4.30   | 37.26                    | 44.44            | 13.01              | 198.77              | 27.54                | 64.80                | 12995                 |
| 14       | -5.00   | 44.13                    | 51.15            | 14.98              | 228.77              | 22.18                | 66.31                | 13973                 |
|          |         | Total>                   | 95.28            | 25.00m             | 238.16              | 149.04               | 149.04               | 36332                 |
| 15       | -6.10   | Total>                   | 117.86           | 30.50m             | 271.75              | 199.48               | 199.48               | 39129                 |
| 16       | -7.20   | Total>                   | 140.65           | 36.00m             | 305.54              | 246.28               | 246.28               | 41927                 |
| 17       | -8.40   | Total>                   | 165.76           | 42.00m             | 342.65              | 290.36               | 290.36               | 44979                 |
| 18       | -9.60   | Total>                   | 191.10           | 48.00m             | 380.00              | 327.08               | 327.08               | 48031                 |
| 19       | -10.80  | Total>                   | 216.68           | 54.00m             | 417.58              | 358.85               | 358.85               | 51082                 |
| 20       | -12.00  | Total>                   | 242.46           | 60.00m             | 455.37              | 388.30               | 388.30               | 54134                 |
| 21       | -13.00  | Total>                   | 264.08           | 65.00m             | 486.99              | 412.24               | 412.24               | 56678                 |
| 22       | -14.00  | Total>                   | 285.80           | 70.00m             | 518.72              | 435.99               | 435.99               | 59221                 |

APPENDIX A-3. WALLAP run ID: TKPF \_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| Run ID. TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS2 | Sheet No.       |
| Tubular King Pile Foundation                          | Date:16-09-2015 |
| D1000-14 @ 2500                                       | Checked :       |

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(continued)

Stage No.2   Excavate to elevation 0.00 on PASSIVE side

Note:        2.64a   Soil pressure at active limit

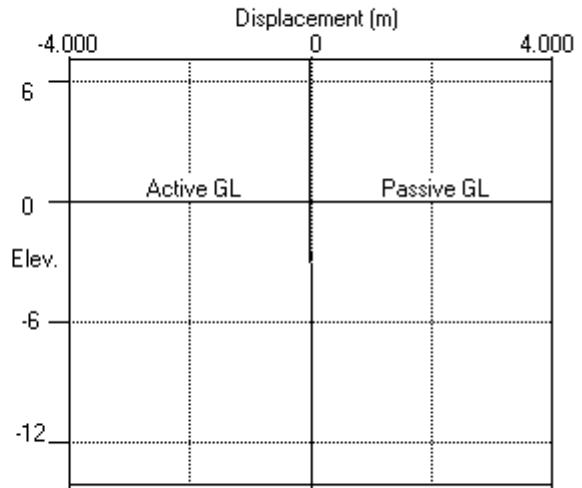
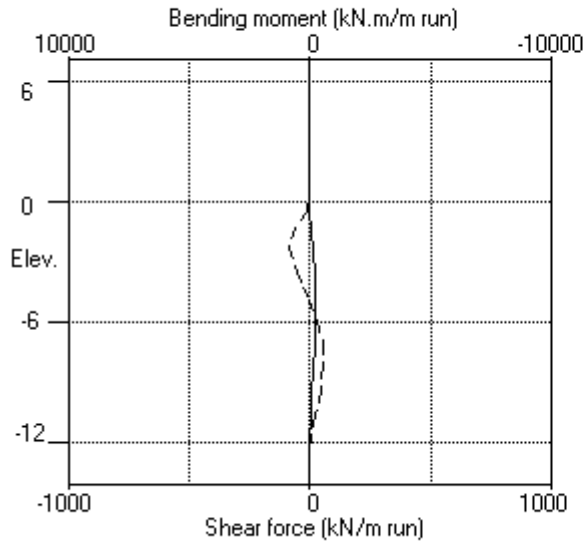
             40.26p   Soil pressure at passive limit

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

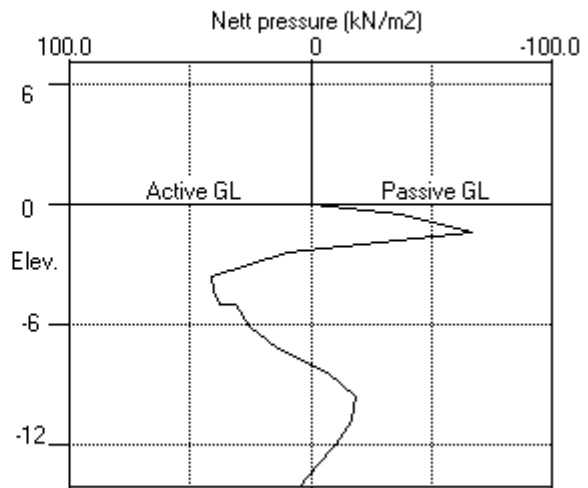
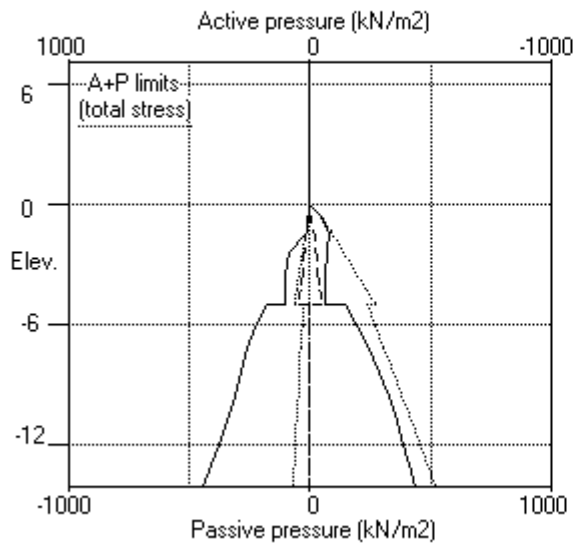
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.2 Excav. to elev. 0.00 on PASSIVE side



Stage No.2 Excav. to elev. 0.00 on PASSIVE side



APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49

| Sheet No. 1504

Licensed from GEOSOLVE

| Made by : HGC

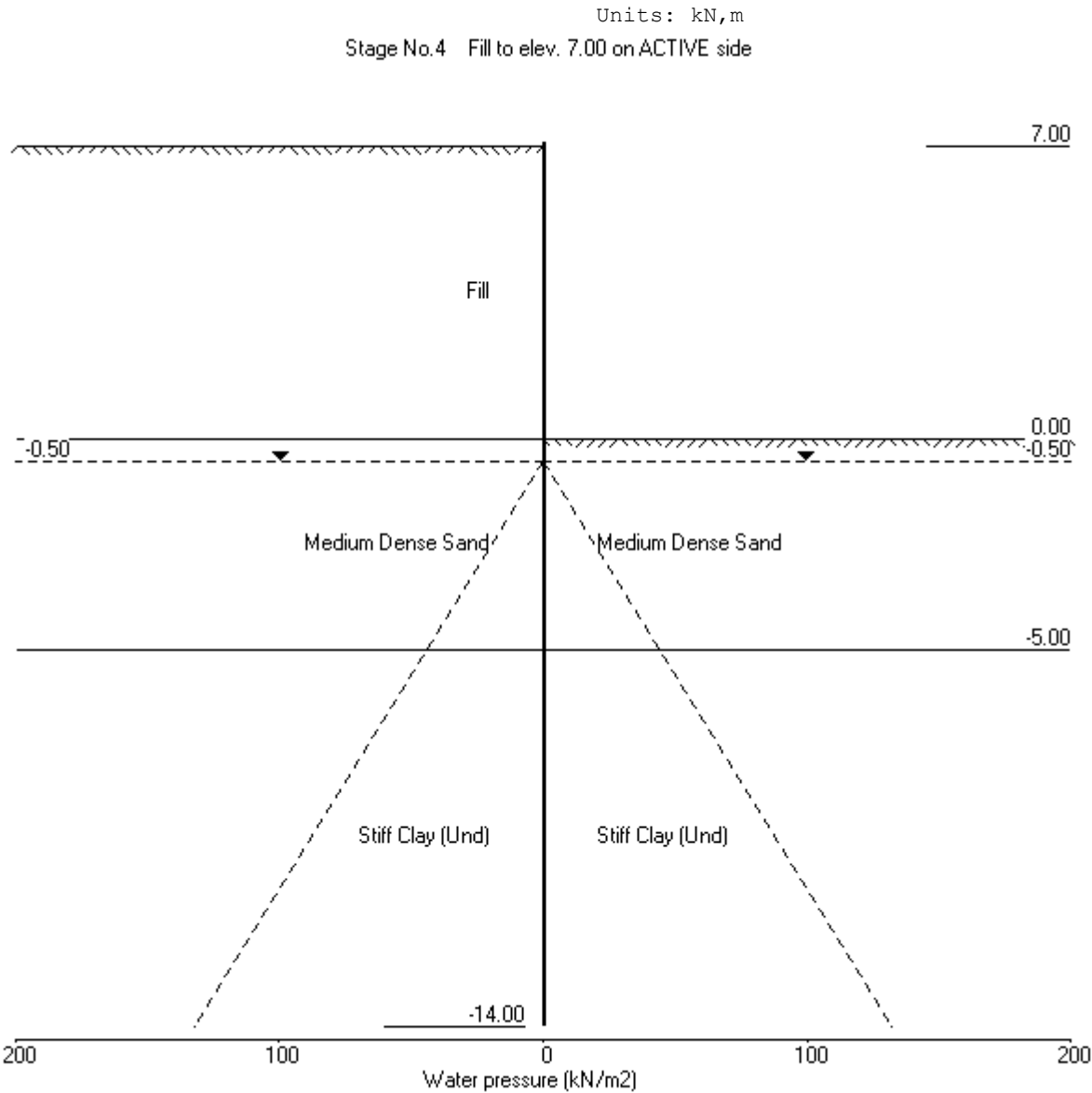
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Tubular King Pile Foundation

| Date:16-09-2015

D1000-14 @ 2500

| Checked :



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No. 4 Fill to elevation 7.00 on ACTIVE side with soil type 1

**STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method**  
Factor of safety on soil strength

|       |              |                 |        |               |              |
|-------|--------------|-----------------|--------|---------------|--------------|
|       |              | Overall         |        |               |              |
|       |              | FoS for toe     |        | Toe elev. for |              |
|       |              | elev. = -14.00  |        | FoS = 1.000   |              |
|       |              | -----           |        | -----         |              |
| Stage | --- G.L. --- | Strut           | Factor | Moment        | Toe Wall     |
| No.   | Act. Pass.   | Elev.           | of     | equilib.      | elev. Penetr |
|       |              | Safety at elev. |        | -ation        |              |
| 4     | 7.00 0.00    | Cant.           | 1.540  | -12.36        | -6.88 6.88   |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

**Limit State: ULS DA1 Combination 2**

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 0.00                | 0.109        | 9.81E-03           | 0.0              | 0.0                   |                   | 4626512            |
| 2        | 5.90    | 5.14                | 0.098        | 9.81E-03           | 2.8              | 1.0                   |                   | 4626512            |
| 3        | 4.80    | 10.28               | 0.087        | 9.81E-03           | 11.3             | 8.3                   |                   | 4626512            |
| 4        | 3.60    | 15.88               | 0.075        | 9.80E-03           | 27.0             | 30.6                  |                   | 4626512            |
| 5        | 2.40    | 21.49               | 0.064        | 9.79E-03           | 49.4             | 75.8                  |                   | 4626512            |
| 6        | 1.45    | 25.93               | 0.054        | 9.77E-03           | 72.0             | 133.1                 |                   | 4626512            |
| 7        | 0.50    | 30.37               | 0.045        | 9.73E-03           | 98.7             | 213.8                 |                   | 4626512            |
| 8        | 0.00    | 32.70               | 0.040        | 9.71E-03           | 114.5            | 267.1                 |                   | 442785             |
|          |         | 36.90               | 0.040        | 9.71E-03           | 114.5            | 267.1                 |                   |                    |
| 9        | -0.50   | -0.73               | 0.035        | 9.37E-03           | 123.5            | 327.4                 |                   | 442785             |
| 10       | -1.45   | -37.32              | 0.027        | 8.51E-03           | 105.4            | 460.8                 |                   | 442785             |
| 11       | -2.40   | -74.14              | 0.019        | 7.34E-03           | 52.5             | 533.1                 |                   | 442785             |
| 12       | -3.60   | -93.16              | 0.012        | 5.46E-03           | -47.9            | 551.1                 |                   | 442785             |
| 13       | -4.30   | -49.41              | 0.008        | 4.28E-03           | -97.8            | 495.0                 |                   | 442785             |
| 14       | -5.00   | -14.39              | 0.006        | 3.18E-03           | -120.1           | 414.6                 |                   | 442785             |
|          |         | -42.10              | 0.006        | 3.18E-03           | -120.1           | 414.6                 |                   |                    |
| 15       | -6.10   | 13.99               | 0.003        | 1.74E-03           | -135.6           | 261.4                 |                   | 442785             |
| 16       | -7.20   | 39.32               | 0.002        | 7.55E-04           | -106.3           | 136.2                 |                   | 442785             |
| 17       | -8.40   | 41.33               | 0.001        | 1.45E-04           | -57.9            | 22.2                  |                   | 442785             |
| 18       | -9.60   | 24.51               | 0.001        | -8.70E-05          | -18.4            | -17.8                 |                   | 442785             |
| 19       | -10.80  | 10.07               | 0.001        | -1.19E-04          | 2.4              | -22.6                 |                   | 442785             |
| 20       | -12.00  | 0.55                | 0.001        | -8.73E-05          | 8.8              | -12.9                 |                   | 442785             |
| 21       | -13.00  | -4.64               | 0.001        | -6.42E-05          | 6.7              | -4.1                  |                   | 442785             |
| 22       | -14.00  | -8.77               | 0.002        | -5.71E-05          | 0.0              | -0.0                  |                   | ---                |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.4 Fill to elevation 7.00 on ACTIVE side with soil type 1

| Node no. | Y coord | ----- ACTIVE side ----- |                  |                    |                     |                      |                            | Soil stiffness coeff. |
|----------|---------|-------------------------|------------------|--------------------|---------------------|----------------------|----------------------------|-----------------------|
|          |         | Water press. kN/m2      | Vertic -al kN/m2 | Active limit kN/m2 | Passive limit kN/m2 | Earth pressure kN/m2 | Total earth pressure kN/m2 |                       |
| 1        | 7.00    | 0.00                    | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 2        | 5.90    | 0.00                    | 19.80            | 5.14               | 106.47              | 5.14                 | 5.14a                      | 754                   |
| 3        | 4.80    | 0.00                    | 39.60            | 10.28              | 212.95              | 10.28                | 10.28a                     | 1508                  |
| 4        | 3.60    | 0.00                    | 61.20            | 15.88              | 329.10              | 15.88                | 15.88a                     | 2331                  |
| 5        | 2.40    | 0.00                    | 82.80            | 21.49              | 445.25              | 21.49                | 21.49a                     | 3154                  |
| 6        | 1.45    | 0.00                    | 99.90            | 25.93              | 537.20              | 25.93                | 25.93a                     | 3805                  |
| 7        | 0.50    | 0.00                    | 117.00           | 30.37              | 629.16              | 30.37                | 30.37a                     | 4457                  |
| 8        | 0.00    | 0.00                    | 126.00           | 32.70              | 677.55              | 32.70                | 32.70a                     | 4800                  |
|          |         | 0.00                    | 126.00           | 36.90              | 563.58              | 36.90                | 36.90a                     | 3428                  |
| 9        | -0.50   | 0.00                    | 135.00           | 39.53              | 603.83              | 39.53                | 39.53a                     | 3771                  |
| 10       | -1.45   | 9.32                    | 143.73           | 42.09              | 642.90              | 42.09                | 51.41a                     | 4423                  |
| 11       | -2.40   | 18.63                   | 152.47           | 44.65              | 681.96              | 44.65                | 63.28a                     | 5074                  |
| 12       | -3.60   | 30.40                   | 163.50           | 47.88              | 731.31              | 61.74                | 92.14                      | 5897                  |
| 13       | -4.30   | 37.26                   | 169.94           | 49.76              | 760.09              | 69.45                | 106.72                     | 6377                  |
| 14       | -5.00   | 44.13                   | 176.37           | 51.65              | 788.88              | 74.93                | 119.06                     | 6857                  |
|          |         | Total>                  | 220.50           | 77.62              | 363.41              | 196.06               | 196.06                     | 18586                 |
| 15       | -6.10   | Total>                  | 242.50           | 88.62              | 396.41              | 285.74               | 285.74                     | 20017                 |
| 16       | -7.20   | Total>                  | 264.50           | 99.62              | 429.41              | 344.10               | 344.10                     | 21448                 |
| 17       | -8.40   | Total>                  | 288.50           | 111.62             | 465.42              | 375.40               | 375.40                     | 23009                 |
| 18       | -9.60   | Total>                  | 312.50           | 123.62             | 501.42              | 397.99               | 397.99                     | 24571                 |
| 19       | -10.80  | Total>                  | 336.50           | 135.62             | 537.42              | 424.22               | 424.22                     | 26132                 |
| 20       | -12.00  | Total>                  | 360.50           | 147.61             | 573.43              | 453.27               | 453.27                     | 27693                 |
| 21       | -13.00  | Total>                  | 380.50           | 157.61             | 603.43              | 478.65               | 478.65                     | 28994                 |
| 22       | -14.00  | Total>                  | 400.50           | 167.61             | 633.43              | 504.49               | 504.49                     | 30295                 |

| Node no. | Y coord | ----- PASSIVE side ----- |                  |                    |                     |                      |                            | Soil stiffness coeff. |
|----------|---------|--------------------------|------------------|--------------------|---------------------|----------------------|----------------------------|-----------------------|
|          |         | Water press. kN/m2       | Vertic -al kN/m2 | Active limit kN/m2 | Passive limit kN/m2 | Earth pressure kN/m2 | Total earth pressure kN/m2 |                       |
| 1        | 7.00    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 2        | 5.90    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 3        | 4.80    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 4        | 3.60    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 5        | 2.40    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 6        | 1.45    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 7        | 0.50    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
| 8        | 0.00    | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 0.0                   |
|          |         | 0.00                     | 0.00             | 0.00               | 0.00                | 0.00                 | 0.00                       | 5957                  |
| 9        | -0.50   | 0.00                     | 9.00             | 2.64               | 40.26               | 40.26                | 40.26p                     | 6552                  |
| 10       | -1.45   | 9.32                     | 17.75            | 5.20               | 79.41               | 79.41                | 88.73p                     | 7684                  |
| 11       | -2.40   | 18.63                    | 26.56            | 7.78               | 118.79              | 118.79               | 137.42p                    | 8816                  |
| 12       | -3.60   | 30.40                    | 37.80            | 11.07              | 169.07              | 154.90               | 185.30                     | 10246                 |
| 13       | -4.30   | 37.26                    | 44.44            | 13.01              | 198.77              | 118.86               | 156.12                     | 11080                 |
| 14       | -5.00   | 44.13                    | 51.15            | 14.98              | 228.77              | 89.32                | 133.45                     | 11914                 |
|          |         | Total>                   | 95.28            | 25.00m             | 238.16              | 238.16               | 238.16p                    | 31170                 |
| 15       | -6.10   | Total>                   | 117.86           | 30.50m             | 271.75              | 271.75               | 271.75p                    | 33570                 |
| 16       | -7.20   | Total>                   | 140.65           | 36.00m             | 305.54              | 304.77               | 304.77                     | 35970                 |
| 17       | -8.40   | Total>                   | 165.76           | 42.00m             | 342.65              | 334.07               | 334.07                     | 38589                 |
| 18       | -9.60   | Total>                   | 191.10           | 48.00m             | 380.00              | 373.48               | 373.48                     | 41207                 |
| 19       | -10.80  | Total>                   | 216.68           | 54.00m             | 417.58              | 414.14               | 414.14                     | 43825                 |
| 20       | -12.00  | Total>                   | 242.46           | 60.00m             | 455.37              | 452.72               | 452.72                     | 46443                 |
| 21       | -13.00  | Total>                   | 264.08           | 65.00m             | 486.99              | 483.30               | 483.30                     | 48625                 |
| 22       | -14.00  | Total>                   | 285.80           | 70.00m             | 518.72              | 513.26               | 513.26                     | 50807                 |

APPENDIX A-3. WALLAP run ID: TKPF \_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| Run ID. TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS2 | Sheet No.       |
| Tubular King Pile Foundation                          | Date:16-09-2015 |
| D1000-14 @ 2500                                       | Checked :       |

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(continued)

Stage No.4    Fill to elevation 7.00 on ACTIVE side with soil type 1

Note:        63.28a    Soil pressure at active limit

             271.75p    Soil pressure at passive limit

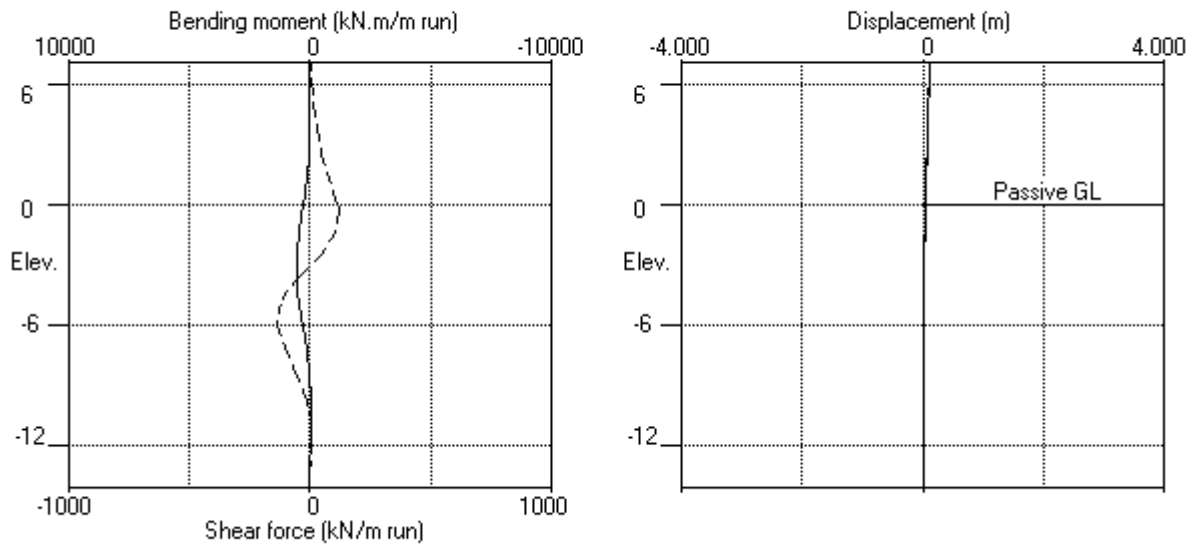


# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

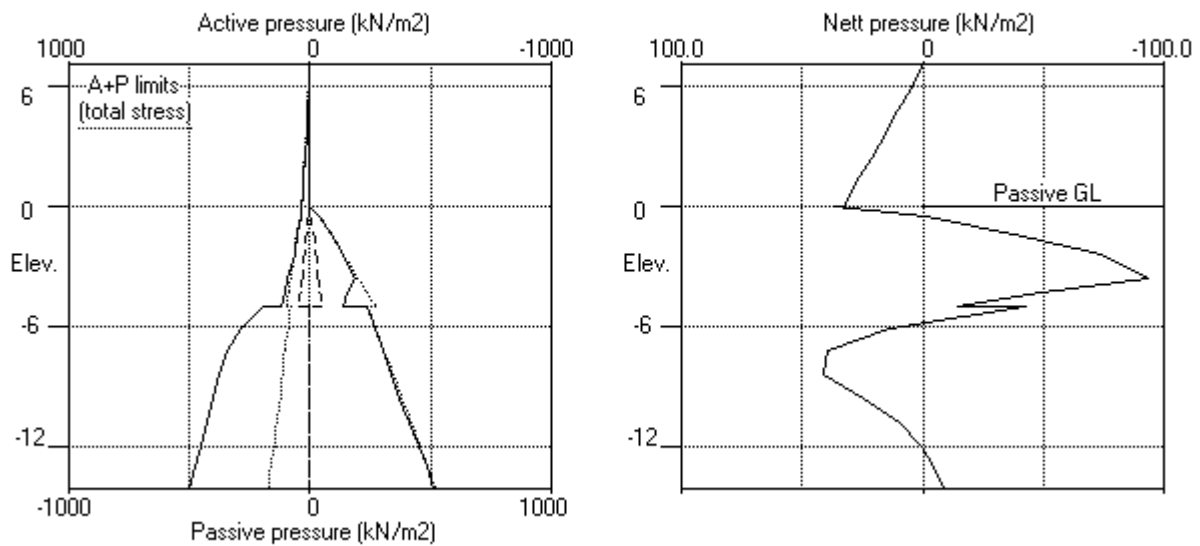
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.4 Fill to elev. 7.00 on ACTIVE side

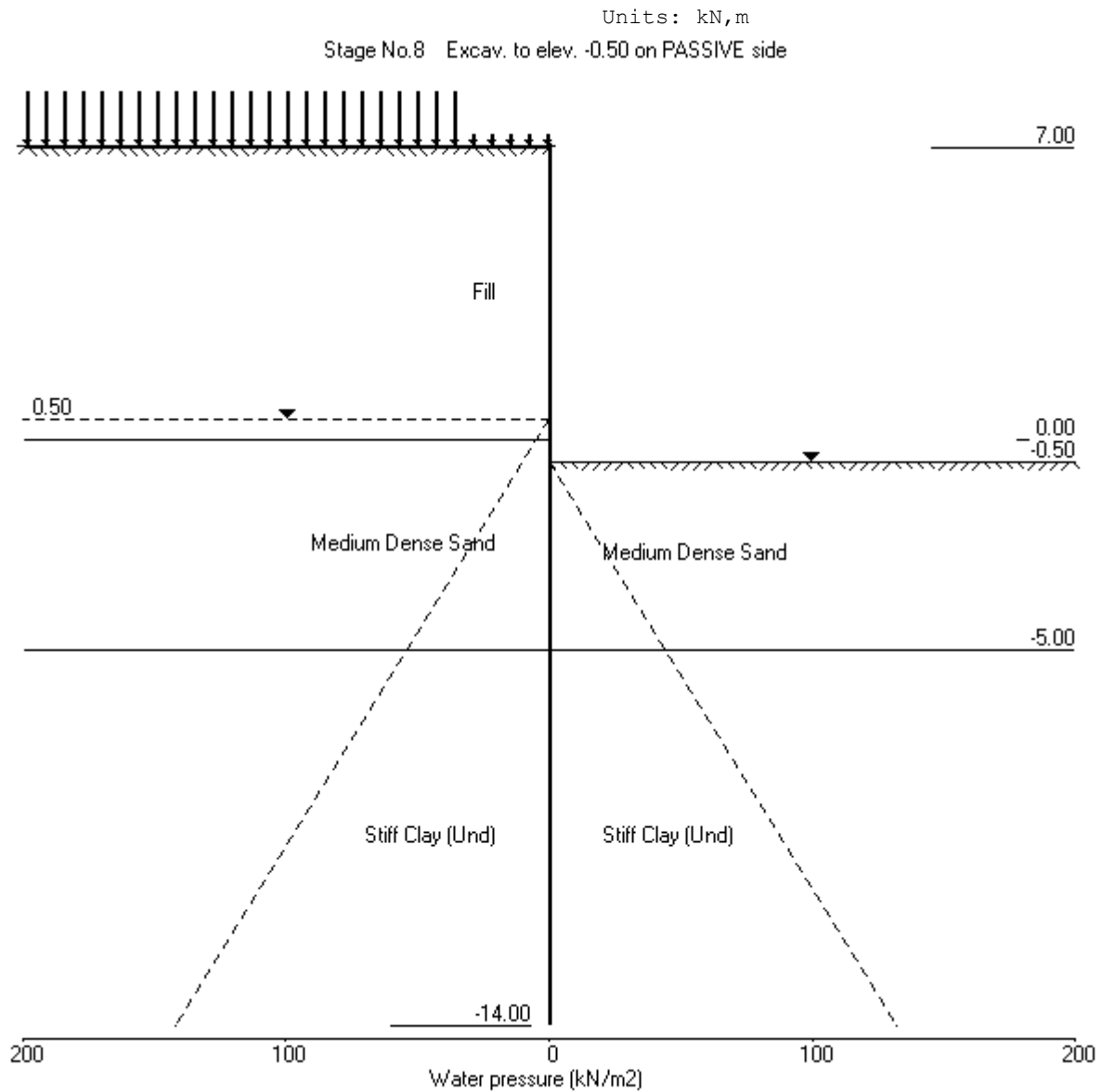


Stage No.4 Fill to elev. 7.00 on ACTIVE side



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

|                                                                     |                 |
|---------------------------------------------------------------------|-----------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                   | Sheet No.       |
| Licensed from GEOSOLVE                                              | Job No. 1504    |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS2 | Made by : HGC   |
| Tubular King Pile Foundation                                        | Date:16-09-2015 |
| D1000-14 @ 2500                                                     | Checked :       |



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 8 Excavate to elevation -0.50 on PASSIVE side

**STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method**  
Factor of safety on soil strength

|       |              |                 |        |               |              |
|-------|--------------|-----------------|--------|---------------|--------------|
|       |              | Overall         |        |               |              |
|       |              | FoS for toe     |        | Toe elev. for |              |
|       |              | elev. = -14.00  |        | FoS = 1.000   |              |
|       |              | -----           |        | -----         |              |
| Stage | --- G.L. --- | Strut           | Factor | Moment        | Toe Wall     |
| No.   | Act. Pass.   | Elev.           | of     | equilib.      | elev. Penetr |
|       |              | Safety at elev. |        | -ation        |              |
| 8     | 7.00 -0.50   | Cant.           | 1.239  | -12.40        | -10.08 9.58  |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

**Limit State: ULS DA1 Combination 2**

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m2 | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m2/m |
|----------|---------|---------------------|--------------|--------------------|------------------|-----------------------|-------------------|--------------------|
| 1        | 7.00    | 2.79                | 0.253        | 2.09E-02           | 0.0              | 0.0                   |                   | 4626512            |
| 2        | 5.90    | 7.09                | 0.230        | 2.09E-02           | 5.4              | 2.6                   |                   | 4626512            |
| 3        | 4.80    | 13.04               | 0.207        | 2.09E-02           | 16.5             | 14.0                  |                   | 4626512            |
| 4        | 3.60    | 19.50               | 0.182        | 2.09E-02           | 36.0             | 44.8                  |                   | 4626512            |
| 5        | 2.40    | 25.71               | 0.156        | 2.08E-02           | 63.2             | 103.5                 |                   | 4626512            |
| 6        | 1.45    | 30.49               | 0.137        | 2.08E-02           | 89.9             | 175.8                 |                   | 4626512            |
| 7        | 0.50    | 35.18               | 0.117        | 2.08E-02           | 121.0            | 275.7                 |                   | 4626512            |
| 8        | 0.00    | 41.38               | 0.106        | 2.07E-02           | 140.2            | 340.8                 |                   | 442785             |
|          |         | 46.06               | 0.106        | 2.07E-02           | 140.2            | 340.8                 |                   |                    |
| 9        | -0.50   | 52.41               | 0.096        | 2.03E-02           | 164.8            | 417.0                 |                   | 442785             |
| 10       | -1.45   | 16.02               | 0.077        | 1.92E-02           | 197.3            | 613.6                 |                   | 442785             |
| 11       | -2.40   | -20.57              | 0.060        | 1.76E-02           | 195.2            | 797.3                 |                   | 442785             |
| 12       | -3.60   | -67.30              | 0.040        | 1.47E-02           | 142.4            | 1018.5                |                   | 442785             |
| 13       | -4.30   | -94.93              | 0.031        | 1.27E-02           | 85.6             | 1102.0                |                   | 442785             |
| 14       | -5.00   | -122.88             | 0.023        | 1.05E-02           | 9.4              | 1133.1                |                   | 442785             |
|          |         | -129.75             | 0.023        | 1.05E-02           | 9.4              | 1133.1                |                   |                    |
| 15       | -6.10   | -135.28             | 0.013        | 7.21E-03           | -136.4           | 1079.6                |                   | 442785             |
| 16       | -7.20   | -26.27              | 0.006        | 4.30E-03           | -225.2           | 863.2                 |                   | 442785             |
| 17       | -8.40   | 28.00               | 0.003        | 1.98E-03           | -224.2           | 557.3                 |                   | 442785             |
| 18       | -9.60   | 44.01               | 0.001        | 5.86E-04           | -181.0           | 308.5                 |                   | 442785             |
| 19       | -10.80  | 62.49               | 0.001        | -8.62E-05          | -117.1           | 123.3                 |                   | 442785             |
| 20       | -12.00  | 48.41               | 0.001        | -3.06E-04          | -50.5            | 27.6                  |                   | 442785             |
| 21       | -13.00  | 26.13               | 0.002        | -3.34E-04          | -13.3            | 0.8                   |                   | 442785             |
| 22       | -14.00  | 0.38                | 0.002        | -3.32E-04          | 0.0              | -0.0                  |                   | ---                |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.8 Excavate to elevation -0.50 on PASSIVE side

| Node no. | Y coord | ----- ACTIVE side ----- |            |              |               |                |                      | Soil stiffness |
|----------|---------|-------------------------|------------|--------------|---------------|----------------|----------------------|----------------|
|          |         | Water press.            | Vertic -al | Active limit | Passive limit | Earth pressure | Total earth pressure |                |
|          |         | kN/m2                   | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2                | kN/m3          |
| 1        | 7.00    | 0.00                    | 6.50       | 1.69         | 34.95         | 2.79           | 2.79                 | 0.0            |
| 2        | 5.90    | 0.00                    | 27.30      | 7.09         | 146.80        | 7.09           | 7.09a                | 676            |
| 3        | 4.80    | 0.00                    | 50.25      | 13.04        | 270.22        | 13.04          | 13.04a               | 1351           |
| 4        | 3.60    | 0.00                    | 75.13      | 19.50        | 404.03        | 19.50          | 19.50a               | 2089           |
| 5        | 2.40    | 0.00                    | 99.07      | 25.71        | 532.76        | 25.71          | 25.71a               | 2826           |
| 6        | 1.45    | 0.00                    | 117.48     | 30.49        | 631.75        | 30.49          | 30.49a               | 3409           |
| 7        | 0.50    | 0.00                    | 135.55     | 35.18        | 728.90        | 35.18          | 35.18a               | 3993           |
| 8        | 0.00    | 4.90                    | 140.55     | 36.48        | 755.77        | 36.48          | 41.38a               | 4300           |
|          |         | 4.90                    | 140.55     | 41.16        | 628.64        | 41.16          | 46.06a               | 3072           |
| 9        | -0.50   | 9.81                    | 145.48     | 42.60        | 650.73        | 42.60          | 52.41a               | 3379           |
| 10       | -1.45   | 19.12                   | 154.73     | 45.31        | 692.08        | 45.31          | 64.43a               | 3962           |
| 11       | -2.40   | 28.44                   | 163.83     | 47.97        | 732.78        | 47.97          | 76.41a               | 4546           |
| 12       | -3.60   | 40.21                   | 175.16     | 51.29        | 783.45        | 51.29          | 91.50a               | 5283           |
| 13       | -4.30   | 47.07                   | 181.70     | 53.21        | 812.70        | 53.21          | 100.28a              | 5713           |
| 14       | -5.00   | 53.94                   | 188.19     | 55.11        | 841.76        | 55.11          | 109.04a              | 6143           |
|          |         | Total>                  | 242.13     | 99.25        | 385.04        | 99.25          | 99.25a               | 16855          |
| 15       | -6.10   | Total>                  | 264.15     | 110.27       | 418.07        | 127.25         | 127.25               | 18153          |
| 16       | -7.20   | Total>                  | 286.10     | 121.22       | 451.02        | 270.01         | 270.01               | 19451          |
| 17       | -8.40   | Total>                  | 309.98     | 133.09       | 486.90        | 361.35         | 361.35               | 20867          |
| 18       | -9.60   | Total>                  | 333.80     | 144.91       | 522.72        | 414.47         | 414.47               | 22283          |
| 19       | -10.80  | Total>                  | 357.57     | 156.68       | 558.49        | 454.72         | 454.72               | 38273          |
| 20       | -12.00  | Total>                  | 381.30     | 168.41       | 594.23        | 479.59         | 479.59               | 40559          |
| 21       | -13.00  | Total>                  | 401.06     | 178.17       | 623.99        | 495.49         | 495.49               | 42465          |
| 22       | -14.00  | Total>                  | 420.80     | 187.91       | 653.74        | 508.74         | 508.74               | 44370          |

| Node no. | Y coord | ----- PASSIVE side ----- |            |              |               |                |                      | Soil stiffness |
|----------|---------|--------------------------|------------|--------------|---------------|----------------|----------------------|----------------|
|          |         | Water press.             | Vertic -al | Active limit | Passive limit | Earth pressure | Total earth pressure |                |
|          |         | kN/m2                    | kN/m2      | kN/m2        | kN/m2         | kN/m2          | kN/m2                | kN/m3          |
| 1        | 7.00    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 2        | 5.90    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 3        | 4.80    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 4        | 3.60    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 5        | 2.40    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 6        | 1.45    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 7        | 0.50    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 8        | 0.00    | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
| 9        | -0.50   | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 0.0            |
|          |         | 0.00                     | 0.00       | 0.00         | 0.00          | 0.00           | 0.00                 | 5377           |
| 10       | -1.45   | 9.32                     | 8.74       | 2.56         | 39.09         | 39.09          | 48.41p               | 6306           |
| 11       | -2.40   | 18.63                    | 17.52      | 5.13         | 78.35         | 78.35          | 96.98p               | 7235           |
| 12       | -3.60   | 30.40                    | 28.71      | 8.41         | 128.40        | 128.40         | 158.80p              | 8408           |
| 13       | -4.30   | 37.26                    | 35.31      | 10.34        | 157.94        | 157.94         | 195.21p              | 9093           |
| 14       | -5.00   | 44.13                    | 41.99      | 12.29        | 187.80        | 187.80         | 231.92p              | 9777           |
|          |         | Total>                   | 86.12      | 22.50m       | 228.99        | 228.99         | 228.99p              | 25826          |
| 15       | -6.10   | Total>                   | 108.65     | 28.00m       | 262.53        | 262.53         | 262.53p              | 27814          |
| 16       | -7.20   | Total>                   | 131.40     | 33.50m       | 296.28        | 296.28         | 296.28p              | 29803          |
| 17       | -8.40   | Total>                   | 156.47     | 39.50m       | 333.36        | 333.36         | 333.36p              | 31972          |
| 18       | -9.60   | Total>                   | 181.80     | 45.50m       | 370.70        | 370.46         | 370.46               | 34142          |
| 19       | -10.80  | Total>                   | 207.39     | 51.50m       | 408.29        | 392.23         | 392.23               | 38273          |
| 20       | -12.00  | Total>                   | 233.21     | 57.50m       | 446.11        | 431.19         | 431.19               | 40559          |
| 21       | -13.00  | Total>                   | 254.88     | 62.50m       | 477.79        | 469.36         | 469.36               | 42465          |
| 22       | -14.00  | Total>                   | 276.68     | 67.50m       | 509.58        | 508.36         | 508.36               | 44370          |

APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| Run ID. TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS2 | Sheet No.       |
| Tubular King Pile Foundation                          | Date:16-09-2015 |
| D1000-14 @ 2500                                       | Checked :       |

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(continued)

Stage No.8 Excavate to elevation -0.50 on PASSIVE side

Note: 99.25a Soil pressure at active limit

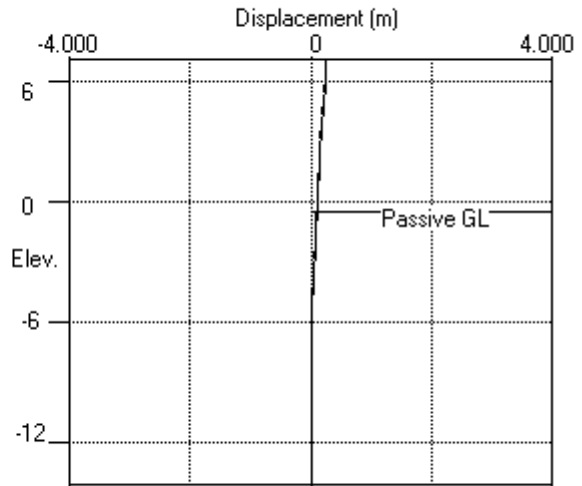
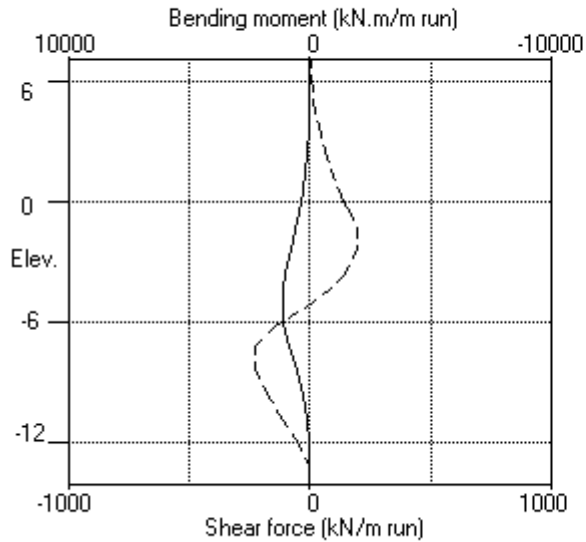
333.36p Soil pressure at passive limit

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

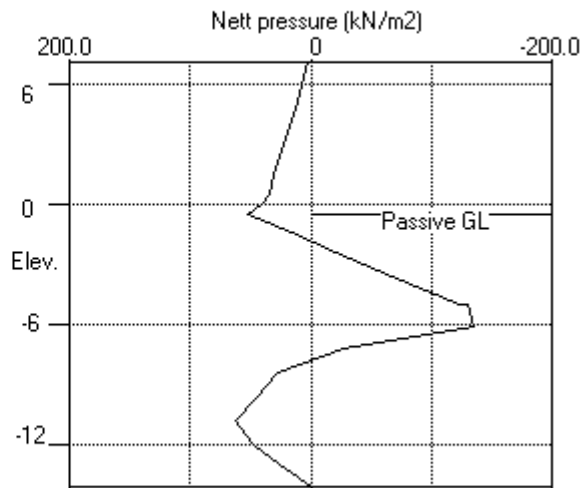
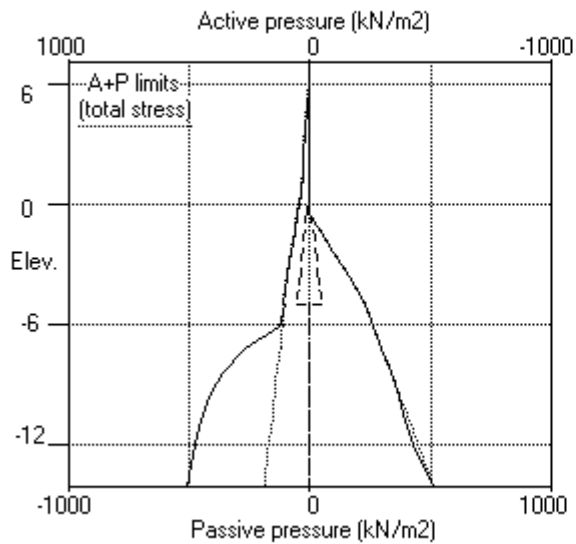
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.8 Excav. to elev. -0.50 on PASSIVE side

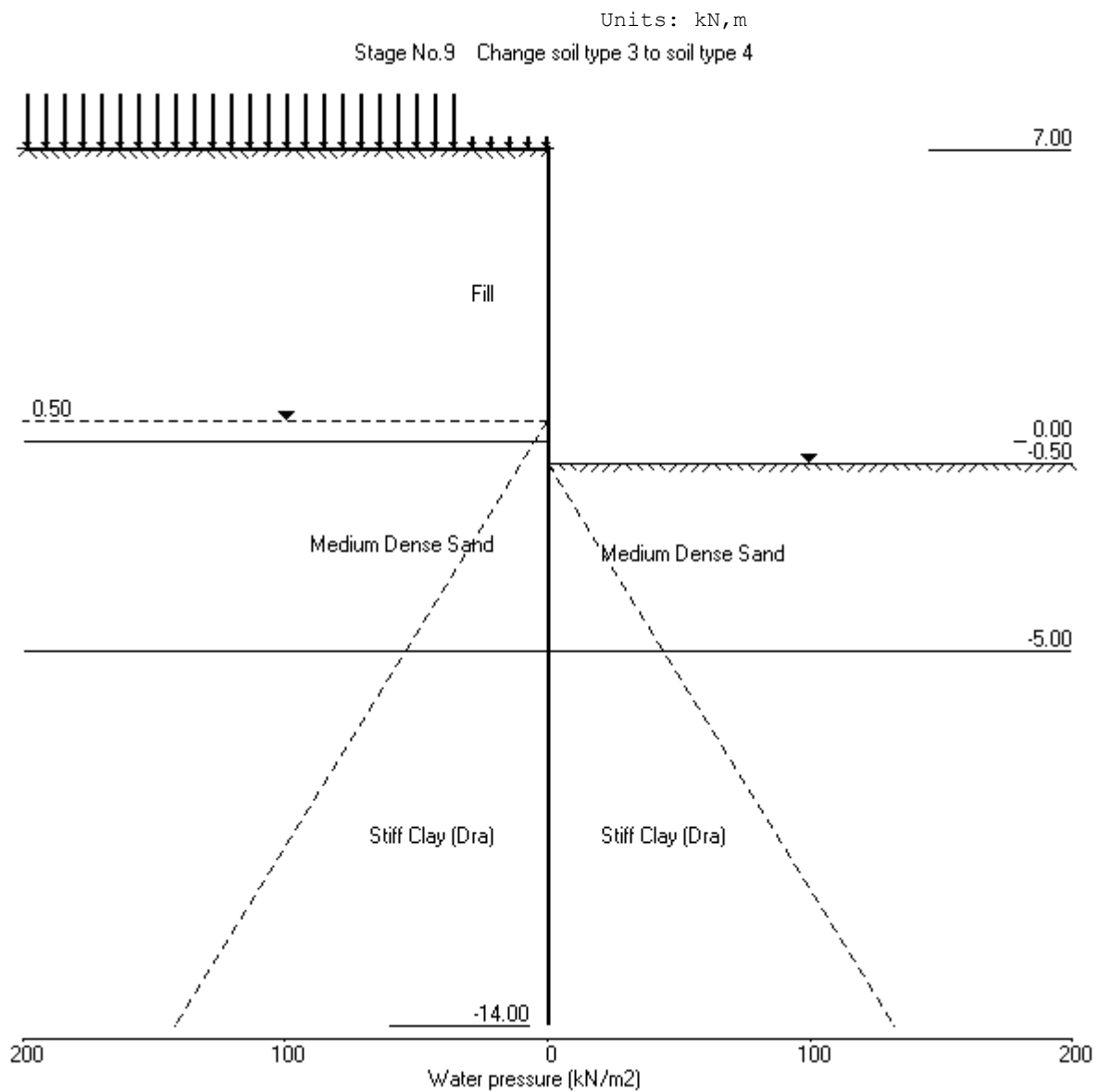


Stage No.8 Excav. to elev. -0.50 on PASSIVE side



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
 Licensed from GEOSOLVE | Job No. 1504  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Made by : HGC  
 Tubular King Pile Foundation | Date:16-09-2015  
 D1000-14 @ 2500 | Checked :



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 9 Change properties of soil type 3 to soil type 4  
Ko pressures will be reset

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|                    |                                            |
|--------------------|--------------------------------------------|
| Overall            |                                            |
| FoS for toe        | Toe elev. for                              |
| elev. = -14.00     | FoS = 1.000                                |
| -----              |                                            |
| Stage --- G.L. --- | Strut Factor Moment                        |
| No. Act. Pass.     | Elev. of equilb.                           |
| Safety at elev.    |                                            |
| 9                  | 7.00 -0.50 Cant. 1.055 -12.93 -12.16 11.66 |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 2

\*\*\* Wall displacements reset to zero at stage 3

| Node no. | Y coord | Nett pressure kN/m <sup>2</sup> | Wall disp. m | Wall rotation rad. | Shear force kN/m | Bending moment kN.m/m | Strut forces kN/m | EI of wall kN.m <sup>2</sup> /m |
|----------|---------|---------------------------------|--------------|--------------------|------------------|-----------------------|-------------------|---------------------------------|
| 1        | 7.00    | 2.79                            | 0.390        | 2.84E-02           | 0.0              | -0.0                  |                   | 4626512                         |
| 2        | 5.90    | 7.09                            | 0.359        | 2.84E-02           | 5.4              | 2.6                   |                   | 4626512                         |
| 3        | 4.80    | 13.04                           | 0.327        | 2.84E-02           | 16.5             | 14.0                  |                   | 4626512                         |
| 4        | 3.60    | 19.50                           | 0.293        | 2.84E-02           | 36.0             | 44.8                  |                   | 4626512                         |
| 5        | 2.40    | 25.71                           | 0.259        | 2.83E-02           | 63.2             | 103.5                 |                   | 4626512                         |
| 6        | 1.45    | 30.49                           | 0.232        | 2.83E-02           | 89.9             | 175.8                 |                   | 4626512                         |
| 7        | 0.50    | 35.18                           | 0.205        | 2.83E-02           | 121.0            | 275.7                 |                   | 4626512                         |
| 8        | 0.00    | 41.38                           | 0.191        | 2.82E-02           | 140.2            | 340.8                 |                   | 442785                          |
|          |         | 46.06                           | 0.191        | 2.82E-02           | 140.2            | 340.8                 |                   |                                 |
| 9        | -0.50   | 52.41                           | 0.177        | 2.78E-02           | 164.8            | 417.0                 |                   | 442785                          |
| 10       | -1.45   | 16.02                           | 0.151        | 2.67E-02           | 197.3            | 613.6                 |                   | 442785                          |
| 11       | -2.40   | -20.57                          | 0.127        | 2.51E-02           | 195.2            | 797.3                 |                   | 442785                          |
| 12       | -3.60   | -67.30                          | 0.098        | 2.22E-02           | 142.4            | 1018.5                |                   | 442785                          |
| 13       | -4.30   | -94.93                          | 0.083        | 2.02E-02           | 85.6             | 1102.0                |                   | 442785                          |
| 14       | -5.00   | -122.88                         | 0.070        | 1.80E-02           | 9.4              | 1133.1                |                   | 442785                          |
|          |         | -21.95                          | 0.070        | 1.80E-02           | 9.4              | 1133.1                |                   |                                 |
| 15       | -6.10   | -40.36                          | 0.052        | 1.46E-02           | -24.9            | 1142.2                |                   | 442785                          |
| 16       | -7.20   | -59.25                          | 0.038        | 1.13E-02           | -79.6            | 1080.0                |                   | 442785                          |
| 17       | -8.40   | -66.09                          | 0.026        | 8.22E-03           | -154.9           | 962.7                 |                   | 442785                          |
| 18       | -9.60   | -21.80                          | 0.018        | 5.70E-03           | -207.6           | 723.2                 |                   | 442785                          |
| 19       | -10.80  | 16.72                           | 0.012        | 4.03E-03           | -210.6           | 451.7                 |                   | 442785                          |
| 20       | -12.00  | 49.99                           | 0.008        | 3.11E-03           | -170.6           | 211.5                 |                   | 442785                          |
| 21       | -13.00  | 76.05                           | 0.005        | 2.80E-03           | -107.6           | 67.5                  |                   | 442785                          |
| 22       | -14.00  | 139.14                          | 0.002        | 2.73E-03           | 0.0              | -0.0                  |                   | ---                             |



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.9 Change properties of soil type 3 to soil type 4  
Ko pressures will be reset

| Node<br>no. | Y<br>coord | ----- ACTIVE side -----        |              |                |                |                   |                                     |                                      |
|-------------|------------|--------------------------------|--------------|----------------|----------------|-------------------|-------------------------------------|--------------------------------------|
|             |            | ----- Effective stresses ----- |              |                |                |                   | Total<br>earth<br>pressure<br>kN/m2 | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|             |            | Water                          | Vertic       | Active         | Passive        | Earth             |                                     |                                      |
|             |            | press.<br>kN/m2                | -al<br>kN/m2 | limit<br>kN/m2 | limit<br>kN/m2 | pressure<br>kN/m2 |                                     |                                      |
| 1           | 7.00       | 0.00                           | 6.50         | 1.69           | 34.95          | 2.79              | 2.79                                | 0.0                                  |
| 2           | 5.90       | 0.00                           | 27.30        | 7.09           | 146.80         | 7.09              | 7.09a                               | 582                                  |
| 3           | 4.80       | 0.00                           | 50.25        | 13.04          | 270.22         | 13.04             | 13.04a                              | 1165                                 |
| 4           | 3.60       | 0.00                           | 75.13        | 19.50          | 404.03         | 19.50             | 19.50a                              | 1800                                 |
| 5           | 2.40       | 0.00                           | 99.07        | 25.71          | 532.76         | 25.71             | 25.71a                              | 2436                                 |
| 6           | 1.45       | 0.00                           | 117.48       | 30.49          | 631.75         | 30.49             | 30.49a                              | 2939                                 |
| 7           | 0.50       | 0.00                           | 135.55       | 35.18          | 728.90         | 35.18             | 35.18a                              | 3442                                 |
| 8           | 0.00       | 4.90                           | 140.55       | 36.48          | 755.77         | 36.48             | 41.38a                              | 3706                                 |
|             |            | 4.90                           | 140.55       | 41.16          | 628.64         | 41.16             | 46.06a                              | 2647                                 |
| 9           | -0.50      | 9.81                           | 145.48       | 42.60          | 650.73         | 42.60             | 52.41a                              | 2912                                 |
| 10          | -1.45      | 19.12                          | 154.73       | 45.31          | 692.08         | 45.31             | 64.43a                              | 3415                                 |
| 11          | -2.40      | 28.44                          | 163.83       | 47.97          | 732.78         | 47.97             | 76.41a                              | 3918                                 |
| 12          | -3.60      | 40.21                          | 175.16       | 51.29          | 783.45         | 51.29             | 91.50a                              | 4553                                 |
| 13          | -4.30      | 47.07                          | 181.70       | 53.21          | 812.70         | 53.21             | 100.28a                             | 4924                                 |
| 14          | -5.00      | 53.94                          | 188.19       | 55.11          | 841.76         | 55.11             | 109.04a                             | 5295                                 |
|             |            | 53.94                          | 188.19       | 83.96          | 417.15         | 83.96             | 137.90a                             | 7654                                 |
| 15          | -6.10      | 64.72                          | 199.43       | 89.77          | 440.31         | 89.77             | 154.49a                             | 8243                                 |
| 16          | -7.20      | 75.51                          | 210.59       | 95.54          | 463.32         | 95.54             | 171.05a                             | 8832                                 |
| 17          | -8.40      | 87.28                          | 222.70       | 101.79         | 488.29         | 116.12            | 203.40                              | 9475                                 |
| 18          | -9.60      | 99.05                          | 234.75       | 108.02         | 513.13         | 188.39            | 287.43                              | 10118                                |
| 19          | -10.80     | 110.81                         | 246.75       | 114.22         | 537.87         | 255.40            | 366.21                              | 10761                                |
| 20          | -12.00     | 122.58                         | 258.72       | 120.41         | 562.54         | 317.63            | 440.22                              | 11404                                |
| 21          | -13.00     | 132.39                         | 268.67       | 125.55         | 583.06         | 368.16            | 500.55                              | 11940                                |
| 22          | -14.00     | 142.19                         | 278.61       | 130.68         | 603.54         | 434.51            | 576.70                              | 97177                                |

| Node<br>no. | Y<br>coord | ----- PASSIVE side -----       |                        |                          |                           |                                     |                            | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|-------------|------------|--------------------------------|------------------------|--------------------------|---------------------------|-------------------------------------|----------------------------|--------------------------------------|
|             |            | ----- Effective stresses ----- |                        |                          |                           | Total<br>earth<br>pressure<br>kN/m2 |                            |                                      |
|             |            | Water<br>press.<br>kN/m2       | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 |                                     | Earth<br>pressure<br>kN/m2 |                                      |
| 1           | 7.00       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 2           | 5.90       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 3           | 4.80       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 4           | 3.60       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 5           | 2.40       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 6           | 1.45       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 7           | 0.50       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 8           | 0.00       | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
| 9           | -0.50      | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 0.0                                  |
|             |            | 0.00                           | 0.00                   | 0.00                     | 0.00                      | 0.00                                | 0.00                       | 3829                                 |
| 10          | -1.45      | 9.32                           | 8.74                   | 2.56                     | 39.09                     | 39.09                               | 48.41p                     | 4490                                 |
| 11          | -2.40      | 18.63                          | 17.52                  | 5.13                     | 78.35                     | 78.35                               | 96.98p                     | 5151                                 |
| 12          | -3.60      | 30.40                          | 28.71                  | 8.41                     | 128.40                    | 128.40                              | 158.80p                    | 5987                                 |
| 13          | -4.30      | 37.26                          | 35.31                  | 10.34                    | 157.94                    | 157.94                              | 195.21p                    | 6474                                 |
| 14          | -5.00      | 44.13                          | 41.99                  | 12.29                    | 187.80                    | 187.80                              | 231.92p                    | 6961                                 |
|             |            | 44.13                          | 41.99                  | 8.42                     | 115.72                    | 115.72                              | 159.85p                    | 10165                                |
| 15          | -6.10      | 54.92                          | 53.73                  | 14.49                    | 139.94                    | 139.94                              | 194.86p                    | 10948                                |
| 16          | -7.20      | 65.70                          | 65.69                  | 20.67                    | 164.60                    | 164.60                              | 230.30p                    | 11731                                |
| 17          | -8.40      | 77.47                          | 78.99                  | 27.54                    | 192.02                    | 192.02                              | 269.49p                    | 12585                                |
| 18          | -9.60      | 89.24                          | 92.56                  | 34.55                    | 219.99                    | 219.99                              | 309.23p                    | 13438                                |
| 19          | -10.80     | 101.01                         | 106.38                 | 41.69                    | 248.48                    | 248.48                              | 349.49p                    | 14292                                |
| 20          | -12.00     | 112.78                         | 120.43                 | 48.95                    | 277.45                    | 277.45                              | 390.23p                    | 15146                                |
| 21          | -13.00     | 122.58                         | 132.30                 | 55.08                    | 301.92                    | 301.92                              | 424.50p                    | 15858                                |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.9 Change properties of soil type 3 to soil type 4  
Ko pressures will be reset

| Node | Y      | ----- PASSIVE side -----       |        |        |         |          |          |           |
|------|--------|--------------------------------|--------|--------|---------|----------|----------|-----------|
| no.  | coord  | ----- Effective stresses ----- |        |        |         | Total    | Soil     |           |
|      |        | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|      |        | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|      |        | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 22   | -14.00 | 132.39                         | 144.29 | 61.28  | 326.63  | 305.18   | 437.57   | 125566    |

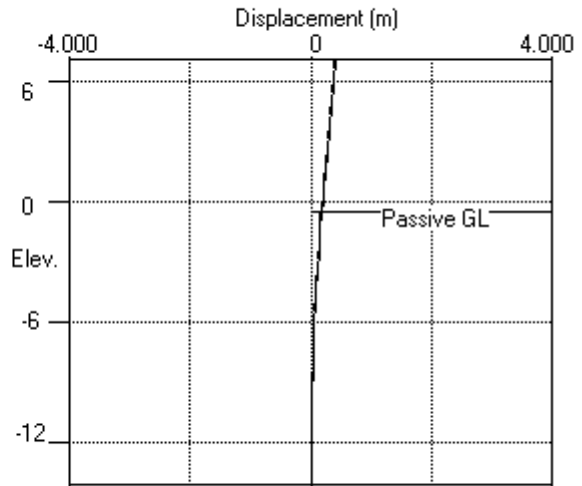
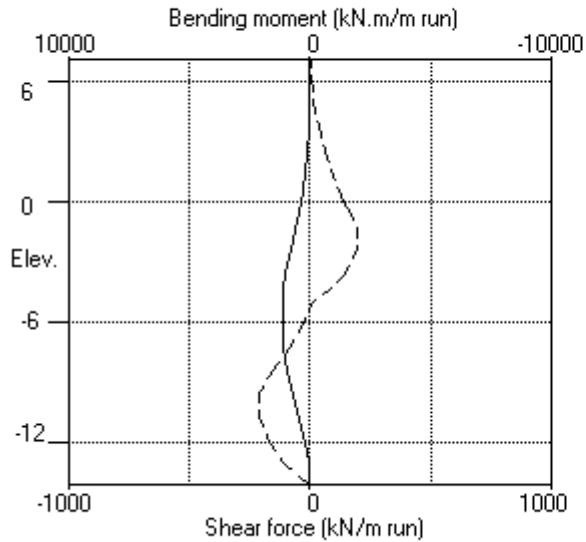
Note: 171.05a Soil pressure at active limit  
424.50p Soil pressure at passive limit

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

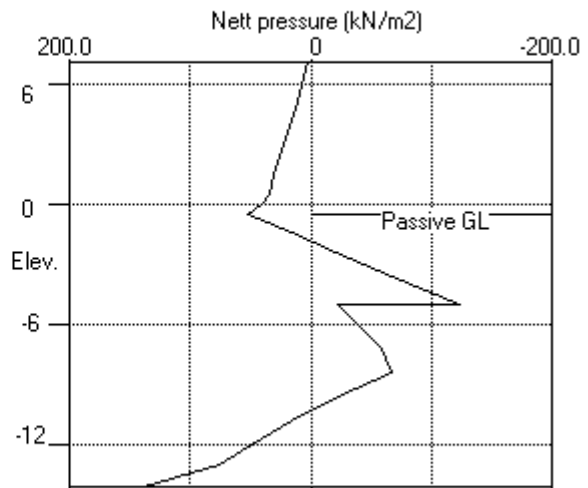
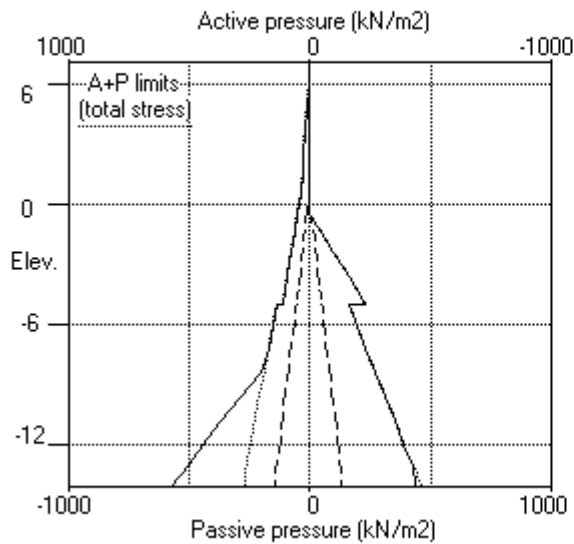
Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

Stage No.9 Change soil type 3 to soil type 4

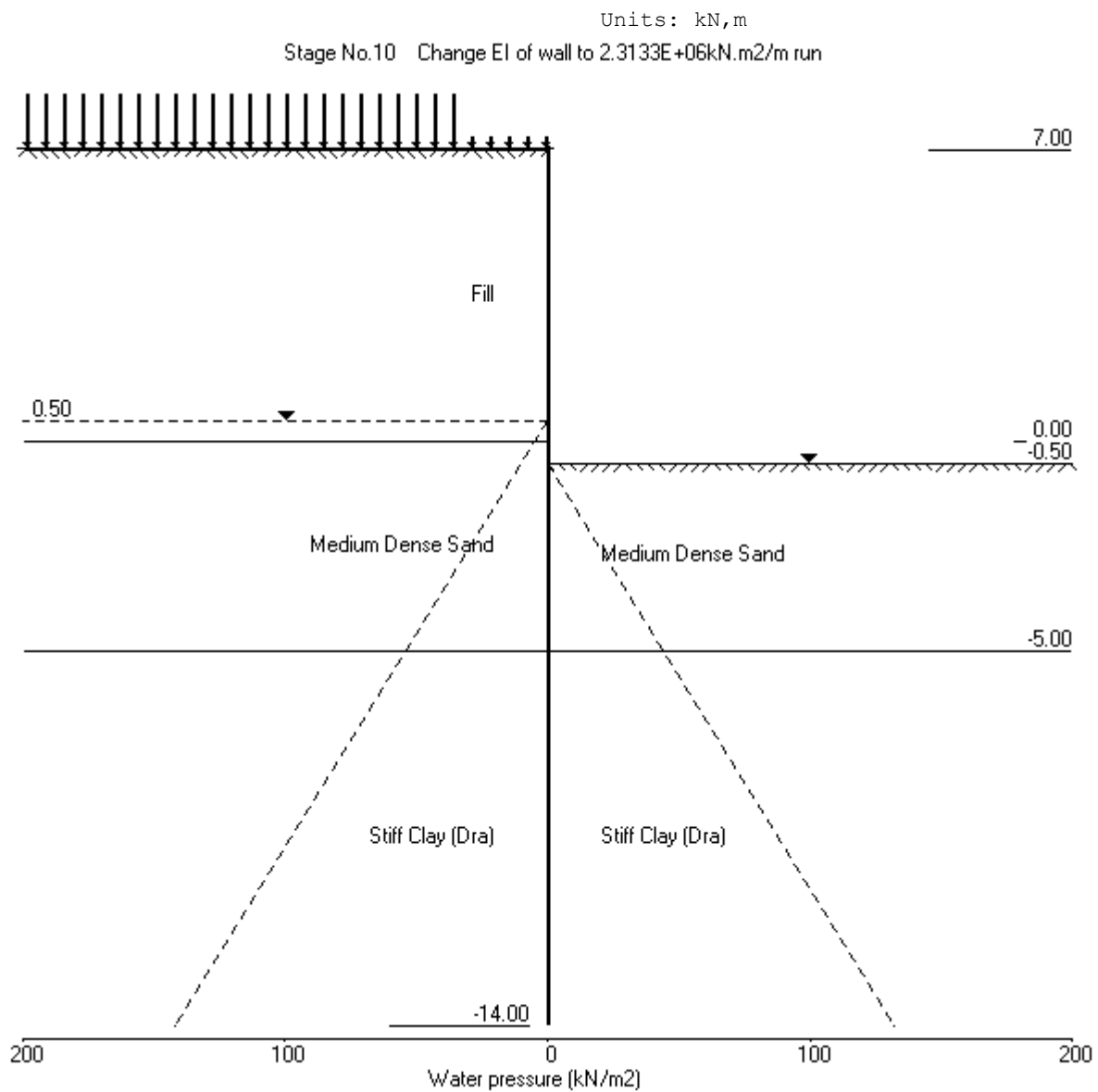


Stage No.9 Change soil type 3 to soil type 4



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

|                                                                     |                 |
|---------------------------------------------------------------------|-----------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                   | Sheet No.       |
| Licensed from GEOSOLVE                                              | Job No. 1504    |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS2 | Made by : HGC   |
| Tubular King Pile Foundation                                        | Date:16-09-2015 |
| D1000-14 @ 2500                                                     | Checked :       |



# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m  
Stage No. 10 Change EI of wall to 2.3133E+06 kN.m2/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

## STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|                |  |               |  |
|----------------|--|---------------|--|
| Overall        |  | Toe elev. for |  |
| FoS for toe    |  | FoS = 1.000   |  |
| elev. = -14.00 |  |               |  |

| Stage | --- G.L. --- | Strut | Factor | Moment      | Toe    | Wall         |
|-------|--------------|-------|--------|-------------|--------|--------------|
| No.   | Act.         | Pass. | Elev.  | of equilib. | elev.  | Penetr       |
|       |              |       | Safety | at elev.    | -ation |              |
| 10    | 7.00         | -0.50 | Cant.  | 1.055       | -12.93 | -12.16 11.66 |

## BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

### Limit State: ULS DA1 Combination 2

\*\*\* Wall displacements reset to zero at stage 3

| Node | Y      | Nett     | Wall  | Wall     | Shear  | Bending | Strut  | EI of   |
|------|--------|----------|-------|----------|--------|---------|--------|---------|
| no.  | coord  | pressure | disp. | rotation | force  | moment  | forces | wall    |
|      |        | kN/m2    | m     | rad.     | kN/m   | kN.m/m  | kN/m   | kN.m2/m |
| 1    | 7.00   | 2.79     | 0.391 | 2.85E-02 | 0.0    | -0.0    |        | 2313256 |
| 2    | 5.90   | 7.09     | 0.359 | 2.85E-02 | 5.4    | 2.6     |        | 2313256 |
| 3    | 4.80   | 13.04    | 0.328 | 2.85E-02 | 16.5   | 14.0    |        | 2313256 |
| 4    | 3.60   | 19.50    | 0.294 | 2.85E-02 | 36.0   | 44.8    |        | 2313256 |
| 5    | 2.40   | 25.71    | 0.259 | 2.84E-02 | 63.2   | 103.5   |        | 2313256 |
| 6    | 1.45   | 30.49    | 0.232 | 2.84E-02 | 89.9   | 175.8   |        | 2313256 |
| 7    | 0.50   | 35.18    | 0.205 | 2.83E-02 | 121.0  | 275.7   |        | 2313256 |
| 8    | 0.00   | 41.38    | 0.191 | 2.82E-02 | 140.2  | 340.8   |        | 442785  |
|      |        | 46.06    | 0.191 | 2.82E-02 | 140.2  | 340.8   |        |         |
| 9    | -0.50  | 52.41    | 0.177 | 2.78E-02 | 164.8  | 417.0   |        | 442785  |
| 10   | -1.45  | 16.02    | 0.151 | 2.67E-02 | 197.3  | 613.6   |        | 442785  |
| 11   | -2.40  | -20.57   | 0.127 | 2.51E-02 | 195.2  | 797.3   |        | 442785  |
| 12   | -3.60  | -67.30   | 0.098 | 2.22E-02 | 142.4  | 1018.5  |        | 442785  |
| 13   | -4.30  | -94.93   | 0.083 | 2.02E-02 | 85.6   | 1102.0  |        | 442785  |
| 14   | -5.00  | -122.88  | 0.070 | 1.80E-02 | 9.4    | 1133.1  |        | 442785  |
|      |        | -21.95   | 0.070 | 1.80E-02 | 9.4    | 1133.1  |        |         |
| 15   | -6.10  | -40.36   | 0.052 | 1.46E-02 | -24.9  | 1142.2  |        | 442785  |
| 16   | -7.20  | -59.25   | 0.038 | 1.13E-02 | -79.6  | 1080.0  |        | 442785  |
| 17   | -8.40  | -66.09   | 0.026 | 8.22E-03 | -154.9 | 962.7   |        | 442785  |
| 18   | -9.60  | -21.80   | 0.018 | 5.70E-03 | -207.6 | 723.2   |        | 442785  |
| 19   | -10.80 | 16.72    | 0.012 | 4.03E-03 | -210.6 | 451.7   |        | 442785  |
| 20   | -12.00 | 49.99    | 0.008 | 3.11E-03 | -170.6 | 211.5   |        | 442785  |
| 21   | -13.00 | 76.05    | 0.005 | 2.80E-03 | -107.6 | 67.5    |        | 442785  |
| 22   | -14.00 | 139.14   | 0.002 | 2.73E-03 | 0.0    | -0.0    |        | ---     |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.10 Change EI of wall to 2.3133E+06 kN.m2/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

| Node<br>no. | Y<br>coord | ----- ACTIVE side -----        |                        |                          |                           |                            |                            |                              |
|-------------|------------|--------------------------------|------------------------|--------------------------|---------------------------|----------------------------|----------------------------|------------------------------|
|             |            | ----- Effective stresses ----- |                        |                          |                           |                            | Total                      | Soil                         |
|             |            | Water<br>press.<br>kN/m2       | Vertic<br>-al<br>kN/m2 | Active<br>limit<br>kN/m2 | Passive<br>limit<br>kN/m2 | Earth<br>pressure<br>kN/m2 | earth<br>pressure<br>kN/m2 | stiffness<br>coeff.<br>kN/m3 |
| 1           | 7.00       | 0.00                           | 6.50                   | 1.69                     | 34.95                     | 2.79                       | 2.79                       | 0.0                          |
| 2           | 5.90       | 0.00                           | 27.30                  | 7.09                     | 146.80                    | 7.09                       | 7.09a                      | 1154                         |
| 3           | 4.80       | 0.00                           | 50.25                  | 13.04                    | 270.22                    | 13.04                      | 13.04a                     | 2309                         |
| 4           | 3.60       | 0.00                           | 75.13                  | 19.50                    | 404.03                    | 19.50                      | 19.50a                     | 3568                         |
| 5           | 2.40       | 0.00                           | 99.07                  | 25.71                    | 532.76                    | 25.71                      | 25.71a                     | 4827                         |
| 6           | 1.45       | 0.00                           | 117.48                 | 30.49                    | 631.75                    | 30.49                      | 30.49a                     | 5824                         |
| 7           | 0.50       | 0.00                           | 135.55                 | 35.18                    | 728.90                    | 35.18                      | 35.18a                     | 6821                         |
| 8           | 0.00       | 4.90                           | 140.55                 | 36.48                    | 755.77                    | 36.48                      | 41.38a                     | 7346                         |
|             |            | 4.90                           | 140.55                 | 41.16                    | 628.64                    | 41.16                      | 46.06a                     | 5247                         |
| 9           | -0.50      | 9.81                           | 145.48                 | 42.60                    | 650.73                    | 42.60                      | 52.41a                     | 5772                         |
| 10          | -1.45      | 19.12                          | 154.73                 | 45.31                    | 692.08                    | 45.31                      | 64.43a                     | 6768                         |
| 11          | -2.40      | 28.44                          | 163.83                 | 47.97                    | 732.78                    | 47.97                      | 76.41a                     | 7765                         |
| 12          | -3.60      | 40.21                          | 175.16                 | 51.29                    | 783.45                    | 51.29                      | 91.50a                     | 9025                         |
| 13          | -4.30      | 47.07                          | 181.70                 | 53.21                    | 812.70                    | 53.21                      | 100.28a                    | 7096                         |
| 14          | -5.00      | 53.94                          | 188.19                 | 55.11                    | 841.76                    | 55.11                      | 109.04a                    | 7630                         |
|             |            | 53.94                          | 188.19                 | 83.96                    | 417.15                    | 83.96                      | 137.90a                    | 11168                        |
| 15          | -6.10      | 64.72                          | 199.43                 | 89.77                    | 440.31                    | 89.77                      | 154.49a                    | 12027                        |
| 16          | -7.20      | 75.51                          | 210.59                 | 95.54                    | 463.32                    | 95.54                      | 171.05a                    | 12887                        |
| 17          | -8.40      | 87.28                          | 222.70                 | 101.79                   | 488.29                    | 116.12                     | 203.40                     | 13825                        |
| 18          | -9.60      | 99.05                          | 234.75                 | 108.02                   | 513.13                    | 188.39                     | 287.43                     | 14764                        |
| 19          | -10.80     | 110.81                         | 246.75                 | 114.22                   | 537.87                    | 255.40                     | 366.21                     | 15702                        |
| 20          | -12.00     | 122.58                         | 258.72                 | 120.41                   | 562.54                    | 317.63                     | 440.22                     | 16640                        |
| 21          | -13.00     | 132.39                         | 268.67                 | 125.55                   | 583.06                    | 368.16                     | 500.55                     | 74953                        |
| 22          | -14.00     | 142.19                         | 278.61                 | 130.68                   | 603.54                    | 434.51                     | 576.70                     | 78317                        |

| Node<br>no. | Y<br>coord | ----- PASSIVE side -----       |              |                |                |                   |                                     |                                      |
|-------------|------------|--------------------------------|--------------|----------------|----------------|-------------------|-------------------------------------|--------------------------------------|
|             |            | ----- Effective stresses ----- |              |                |                |                   | Total<br>earth<br>pressure<br>kN/m2 | Soil<br>stiffness<br>coeff.<br>kN/m3 |
|             |            | Water                          | Vertic       | Active         | Passive        | Earth             |                                     |                                      |
|             |            | press.<br>kN/m2                | -al<br>kN/m2 | limit<br>kN/m2 | limit<br>kN/m2 | pressure<br>kN/m2 |                                     |                                      |
| 1           | 7.00       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 2           | 5.90       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 3           | 4.80       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 4           | 3.60       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 5           | 2.40       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 6           | 1.45       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 7           | 0.50       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 8           | 0.00       | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
| 9           | -0.50      | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 0.0                                  |
|             |            | 0.00                           | 0.00         | 0.00           | 0.00           | 0.00              | 0.00                                | 9972                                 |
| 10          | -1.45      | 9.32                           | 8.74         | 2.56           | 39.09          | 39.09             | 48.41p                              | 11694                                |
| 11          | -2.40      | 18.63                          | 17.52        | 5.13           | 78.35          | 78.35             | 96.98p                              | 13417                                |
| 12          | -3.60      | 30.40                          | 28.71        | 8.41           | 128.40         | 128.40            | 158.80p                             | 15592                                |
| 13          | -4.30      | 37.26                          | 35.31        | 10.34          | 157.94         | 157.94            | 195.21p                             | 7096                                 |
| 14          | -5.00      | 44.13                          | 41.99        | 12.29          | 187.80         | 187.80            | 231.92p                             | 7630                                 |
|             |            | 44.13                          | 41.99        | 8.42           | 115.72         | 115.72            | 159.85p                             | 11168                                |
| 15          | -6.10      | 54.92                          | 53.73        | 14.49          | 139.94         | 139.94            | 194.86p                             | 12027                                |
| 16          | -7.20      | 65.70                          | 65.69        | 20.67          | 164.60         | 164.60            | 230.30p                             | 12887                                |
| 17          | -8.40      | 77.47                          | 78.99        | 27.54          | 192.02         | 192.02            | 269.49p                             | 13825                                |
| 18          | -9.60      | 89.24                          | 92.56        | 34.55          | 219.99         | 219.99            | 309.23p                             | 14764                                |
| 19          | -10.80     | 101.01                         | 106.38       | 41.69          | 248.48         | 248.48            | 349.49p                             | 15702                                |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

(continued)

Stage No.10 Change EI of wall to 2.3133E+06 kN.m2/m run  
From elevation 7.00 to 0.00  
Yield moment not defined  
Allow wall to relax with new modulus value

| Node | Y      | ----- PASSIVE side -----       |        |        |         |          |          |           |
|------|--------|--------------------------------|--------|--------|---------|----------|----------|-----------|
| no.  | coord  | ----- Effective stresses ----- |        |        |         |          | Total    | Soil      |
|      |        | Water                          | Vertic | Active | Passive | Earth    | earth    | stiffness |
|      |        | press.                         | -al    | limit  | limit   | pressure | pressure | coeff.    |
|      |        | kN/m2                          | kN/m2  | kN/m2  | kN/m2   | kN/m2    | kN/m2    | kN/m3     |
| 20   | -12.00 | 112.78                         | 120.43 | 48.95  | 277.45  | 277.45   | 390.23p  | 16640     |
| 21   | -13.00 | 122.58                         | 132.30 | 55.08  | 301.92  | 301.92   | 424.50p  | 74953     |
| 22   | -14.00 | 132.39                         | 144.29 | 61.28  | 326.63  | 305.18   | 437.57   | 78317     |

Note: 171.05a Soil pressure at active limit  
424.50p Soil pressure at passive limit

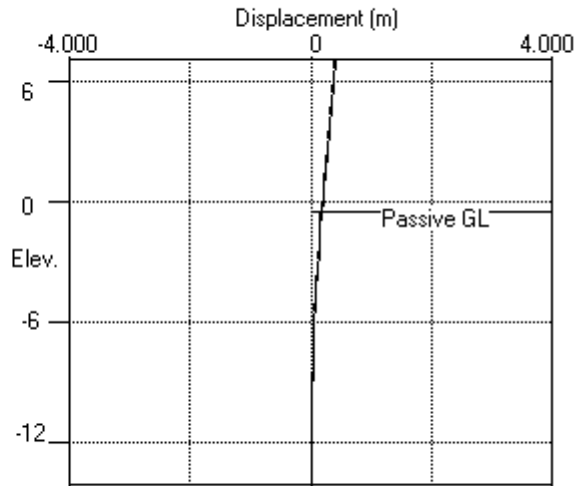
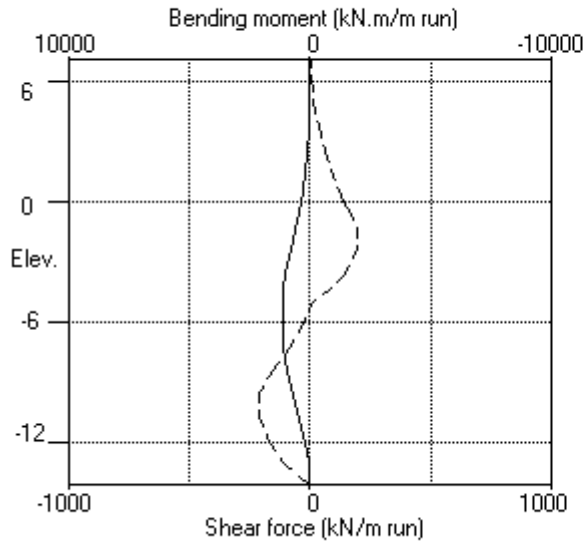
# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49  
 Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
 Tubular King Pile Foundation  
 D1000-14 @ 2500

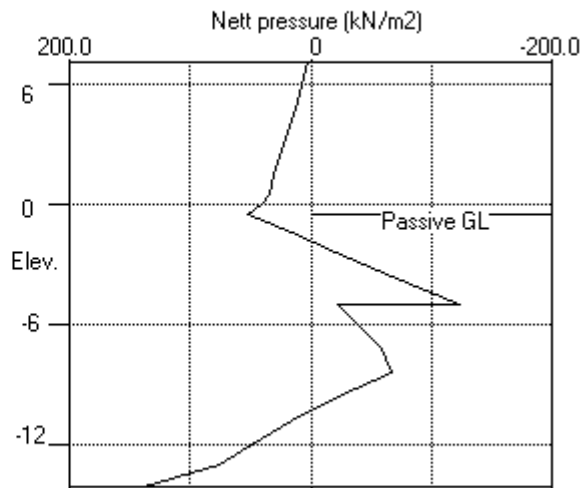
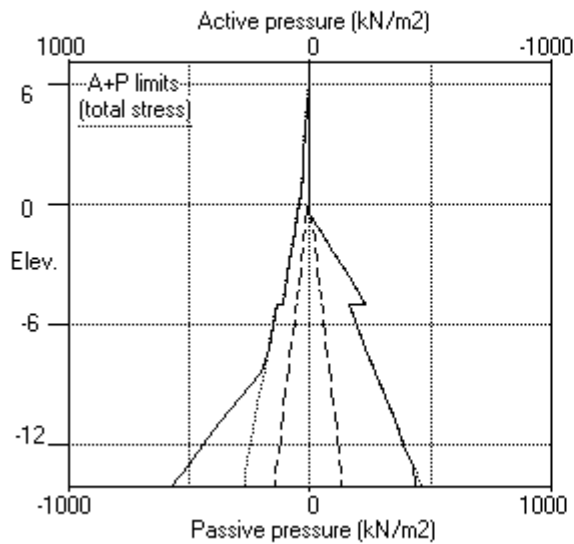
| Sheet No.  
 | Job No. 1504  
 | Made by : HGC  
 | Date: 16-09-2015  
 | Checked :

Units: kN,m

Stage No.10 Change EI of wall to 2.3133E+06kN.m2/m run



Stage No.10 Change EI of wall to 2.3133E+06kN.m2/m run





# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date: 16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

## Summary of results

### LIMIT STATE PARAMETERS

Limit State: ULS DA1 Combination 2  
Water pressures : Worst Credible  
Partial factor on C' = 1.250  
Partial factor on Phi' = 1.250  
Partial factor on Cu = 1.400  
Partial factor on Soil Modulus = 1.000  
Partial factor on Permanent Unfavourable loads = 1.000  
Partial factor on Permanent Favourable loads = 1.000  
Partial factor on Permanent Variable loads = 1.300

### STABILITY ANALYSIS of Fully Embedded Wall according to Strength Factor method

Factor of safety on soil strength

|       |              | Overall        |        |                                         |        |        |       |
|-------|--------------|----------------|--------|-----------------------------------------|--------|--------|-------|
|       |              | FoS for toe    |        | Toe elev. for                           |        |        |       |
|       |              | elev. = -14.00 |        | FoS = 1.000                             |        |        |       |
|       |              | -----          |        | -----                                   |        |        |       |
| Stage | --- G.L. --- | Strut          | Factor | Moment                                  | Toe    | Wall   |       |
| No.   | Act.         | Pass.          | Elev.  | of                                      | elev.  | Penetr |       |
|       |              |                |        | Safety at elev.                         | -ation |        |       |
| 1     | 0.00         | 7.00           |        | Wall tending to move from right to left |        |        |       |
| 2     | 0.00         | 0.00           | Cant.  | Conditions not suitable for FoS calc.   |        |        |       |
| 3     | 0.00         | 0.00           |        | No analysis at this stage               |        |        |       |
| 4     | 7.00         | 0.00           | Cant.  | 1.540                                   | -12.36 | -6.88  | 6.88  |
| 5     | 7.00         | 0.00           |        | No analysis at this stage               |        |        |       |
| 6     | 7.00         | 0.00           | Cant.  | 1.396                                   | -12.44 | -7.68  | 7.68  |
| 7     | 7.00         | 0.00           | Cant.  | 1.366                                   | -12.42 | -8.04  | 8.04  |
| 8     | 7.00         | -0.50          | Cant.  | 1.239                                   | -12.40 | -10.08 | 9.58  |
| 9     | 7.00         | -0.50          | Cant.  | 1.055                                   | -12.93 | -12.16 | 11.66 |
| 10    | 7.00         | -0.50          | Cant.  | 1.055                                   | -12.93 | -12.16 | 11.66 |
| 11    | 7.00         | -0.50          | Cant.  | 0.831                                   | -12.40 | ***    | ***   |

Legend: \*\*\* Result not found

Note: To obtain a Factor of Safety for the case of wall failing from  
right to left you should reverse the data (Ctrl+K) and re-analyse.

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Program: WALLAP Version 6.05 Revision A45.B58.R49 | Sheet No.  
| Job No. 1504  
Licensed from GEOSOLVE | Made by : HGC  
Data filename/Run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2  
Tubular King File Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

Units: kN,m

## Summary of results

### BENDING MOMENT and DISPLACEMENT ANALYSIS of Fully Embedded Wall

#### Analysis options

Length of wall perpendicular to section = 1000.00m  
Subgrade reaction model - Boussinesq Influence coefficients  
Soil deformations are elastic until the active or passive limit is reached  
Open Tension Crack analysis - No

Rigid boundaries: Active side 20.00 from wall  
Passive side 20.00 from wall

#### Limit State: ULS DA1 Combination 2

### Bending moment, shear force and displacement envelopes

| Node<br>no. | Y<br>coord | Displacement |              | Bending moment    |                   | Shear force     |                 |
|-------------|------------|--------------|--------------|-------------------|-------------------|-----------------|-----------------|
|             |            | maximum<br>m | minimum<br>m | maximum<br>kN.m/m | minimum<br>kN.m/m | maximum<br>kN/m | minimum<br>kN/m |
| 1           | 7.00       | 2.349        | 0.000        | 0.0               | -0.0              | 216.7           | 0.0             |
| 2           | 5.90       | 2.181        | 0.000        | 240.9             | -1.0              | 222.1           | -2.8            |
| 3           | 4.80       | 2.013        | 0.000        | 490.7             | -8.3              | 233.2           | -11.3           |
| 4           | 3.60       | 1.830        | 0.000        | 781.4             | -30.6             | 252.7           | -27.0           |
| 5           | 2.40       | 1.648        | 0.000        | 1100.2            | -75.8             | 279.8           | -49.4           |
| 6           | 1.45       | 1.504        | 0.000        | 1378.4            | -133.1            | 306.5           | -72.0           |
| 7           | 0.50       | 1.360        | 0.000        | 1684.0            | -213.8            | 337.7           | -98.7           |
| 8           | 0.00       | 1.285        | 0.000        | 1857.5            | -267.1            | 356.9           | -114.5          |
| 9           | -0.50      | 1.211        | 0.000        | 2042.0            | -327.4            | 381.5           | -123.5          |
| 10          | -1.45      | 1.072        | 0.000        | 2444.5            | -438.8            | 414.0           | -105.4          |
| 11          | -2.40      | 0.939        | 0.000        | 2834.0            | -516.6            | 411.8           | -85.9           |
| 12          | -3.60      | 0.779        | 0.000        | 3315.2            | -551.6            | 359.1           | -55.6           |
| 13          | -4.30      | 0.691        | 0.000        | 3550.4            | -514.4            | 302.3           | -97.8           |
| 14          | -5.00      | 0.607        | 0.000        | 3733.2            | -454.7            | 226.1           | -143.1          |
| 15          | -6.10      | 0.484        | 0.000        | 3980.6            | -332.0            | 191.8           | -179.6          |
| 16          | -7.20      | 0.373        | 0.000        | 4156.8            | -210.6            | 137.0           | -225.2          |
| 17          | -8.40      | 0.265        | 0.000        | 4296.0            | -115.9            | 77.5            | -224.2          |
| 18          | -9.60      | 0.171        | 0.000        | 4280.0            | -51.4             | 45.8            | -207.6          |
| 19          | -10.80     | 0.091        | 0.000        | 4151.5            | -22.6             | 22.0            | -210.6          |
| 20          | -12.00     | 0.024        | 0.000        | 2607.1            | -12.9             | 8.8             | -355.3          |
| 21          | -13.00     | 0.005        | -0.026       | 205.1             | -5.0              | 6.7             | -160.0          |
| 22          | -14.00     | 0.002        | -0.074       | 0.0               | -0.0              | 384.9           | -0.0            |

### Maximum and minimum bending moment and shear force at each stage

| Stage<br>no. | Bending moment               |        |                   |        | Shear force     |       |                 |        |
|--------------|------------------------------|--------|-------------------|--------|-----------------|-------|-----------------|--------|
|              | maximum<br>kN.m/m            | elev.  | minimum<br>kN.m/m | elev.  | maximum<br>kN/m | elev. | minimum<br>kN/m | elev.  |
| 1            | 5.9                          | -12.00 | -551.6            | -3.60  | 109.8           | -6.10 | -123.5          | -0.50  |
| 2            | 2.2                          | -13.00 | -248.1            | -5.00  | 57.8            | -8.40 | -85.9           | -2.40  |
| 3            | No calculation at this stage |        |                   |        |                 |       |                 |        |
| 4            | 551.1                        | -3.60  | -22.6             | -10.80 | 123.5           | -0.50 | -135.6          | -6.10  |
| 5            | No calculation at this stage |        |                   |        |                 |       |                 |        |
| 6            | 744.4                        | -3.60  | -11.3             | -12.00 | 151.1           | -0.50 | -174.3          | -6.10  |
| 7            | 791.7                        | -3.60  | -9.5              | -12.00 | 154.7           | -0.50 | -179.6          | -6.10  |
| 8            | 1133.1                       | -5.00  | -0.0              | -14.00 | 197.3           | -1.45 | -225.2          | -7.20  |
| 9            | 1142.2                       | -6.10  | -0.0              | 7.00   | 197.3           | -1.45 | -210.6          | -10.80 |
| 10           | 1142.2                       | -6.10  | -0.0              | 7.00   | 197.3           | -1.45 | -210.6          | -10.80 |
| 11           | 4296.0                       | -8.40  | 0.0               | 7.00   | 414.0           | -1.45 | -355.3          | -12.00 |

## APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

Run ID. TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2 | Sheet No.  
Tubular King Pile Foundation | Date:16-09-2015  
D1000-14 @ 2500 | Checked :

### Summary of results (continued)

#### Maximum and minimum displacement at each stage

| Stage no. | Displacement maximum elev. m                                                | Displacement minimum elev. m | Stage description                          |
|-----------|-----------------------------------------------------------------------------|------------------------------|--------------------------------------------|
| 1         | 0.000                                                                       | 7.00                         | Excav. to elev. 0.00 on ACTIVE side        |
| 2         | 0.000                                                                       | 7.00                         | Excav. to elev. 0.00 on PASSIVE side       |
| 3         | Wall displacements reset to zero Change EI of wall to 4.6265E+06kN.m2/m run |                              |                                            |
| 4         | 0.109                                                                       | 7.00                         | Fill to elev. 7.00 on ACTIVE side          |
| 5         | No calculation at this stage Apply surcharge no.1 at elev. 7.00             |                              |                                            |
| 6         | 0.143                                                                       | 7.00                         | Apply surcharge no.2 at elev. 7.00         |
| 7         | 0.156                                                                       | 7.00                         | Apply water pressure profile no.2          |
| 8         | 0.253                                                                       | 7.00                         | Excav. to elev. -0.50 on PASSIVE side      |
| 9         | 0.390                                                                       | 7.00                         | Change soil type 3 to soil type 4          |
| 10        | 0.391                                                                       | 7.00                         | Change EI of wall to 2.3133E+06kN.m2/m run |
| 11        | 2.349                                                                       | 7.00                         | Apply load no.1 at elev. 7.00              |

\*\*\* Convergence errors have occurred in at least one Construction Stage.  
The errors are cumulative, and the results of all stages must be inspected for significant out of balance moment or shear at the toe of the wall.

Failure of the iterative procedure to converge to an equilibrium solution may be due to a very high ratio of soil stiffness to wall stiffness. The data should be reviewed to see if realistic values have been specified

Out of balance shear forces.

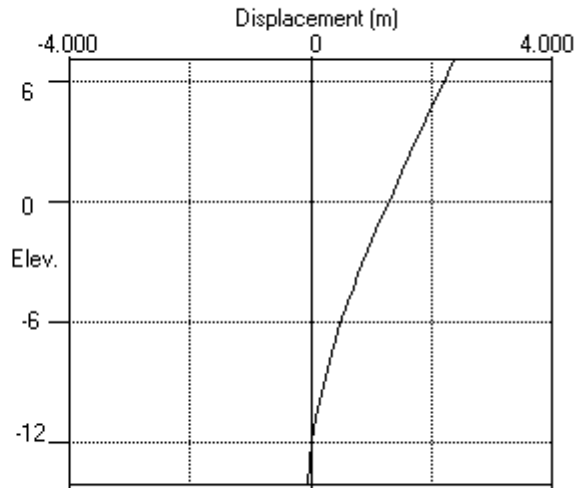
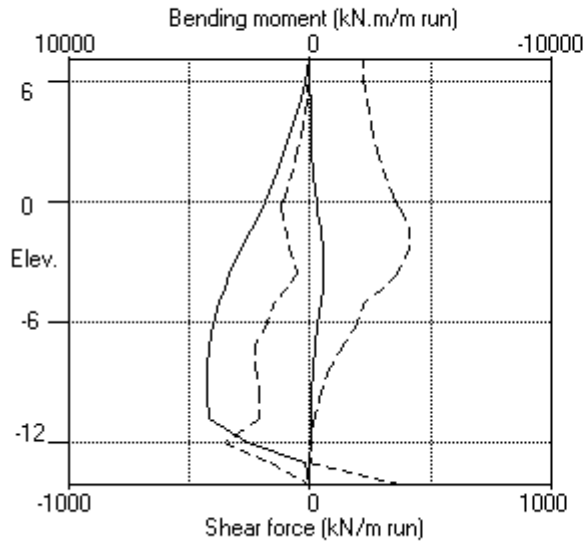
| Percentage Error | Interpretation       |
|------------------|----------------------|
| < 2%             | Generally acceptable |
| 2% to 4%         | Use with caution     |
| > 4%             | Should not be used   |

# APPENDIX A-3. WALLAP run ID: TKPF\_D1000-14at2500\_Toe-14m\_Fill+7m\_STLT\_ULS2

|                                                                     |                  |
|---------------------------------------------------------------------|------------------|
| Program: WALLAP Version 6.05 Revision A45.B58.R49                   | Sheet No.        |
| Licensed from GEOSOLVE                                              | Job No. 1504     |
| Data filename/Run ID: TKPF_D1000-14at2500_Toe-14m_Fill+7m_STLT_ULS2 | Made by : HGC    |
| Tubular King Pile Foundation                                        | Date: 16-09-2015 |
| D1000-14 @ 2500                                                     | Checked :        |

Units: kN,m

Bending moment, shear force, displacement envelopes



# **APPENDIX B**

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

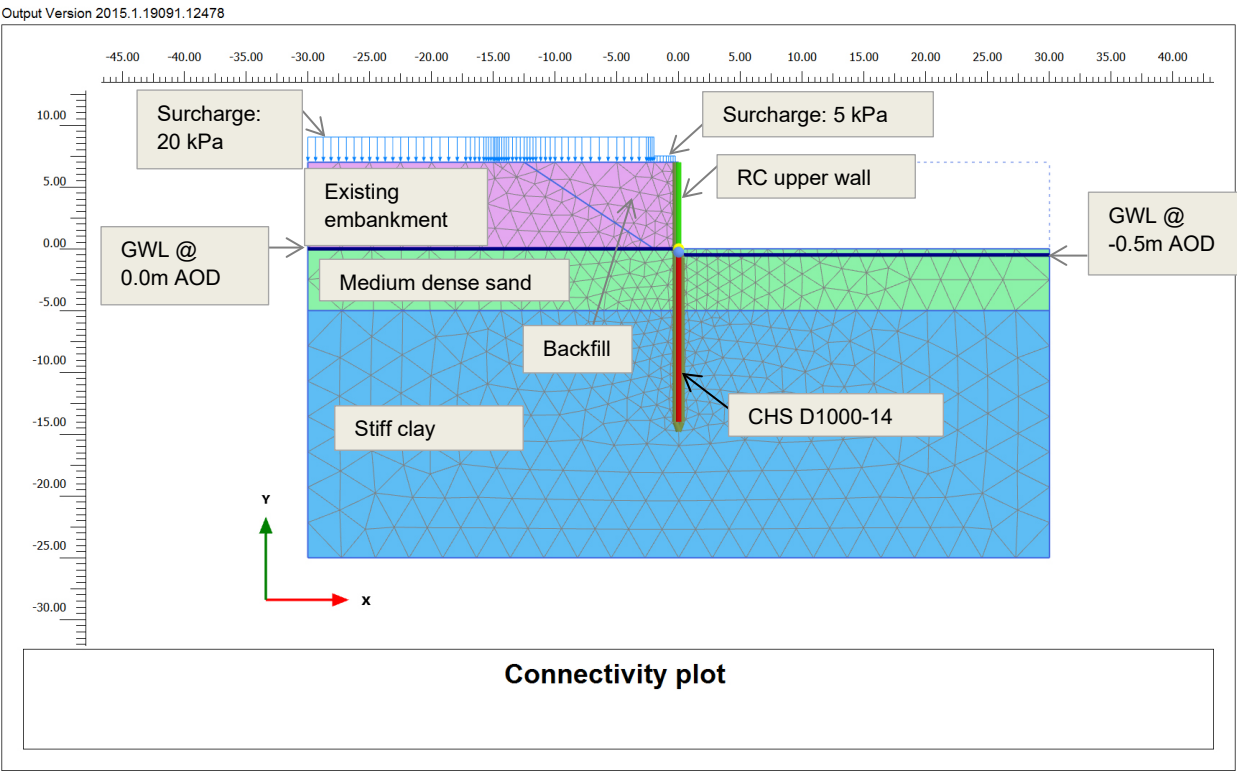


Figure B.1 Connectivity plot

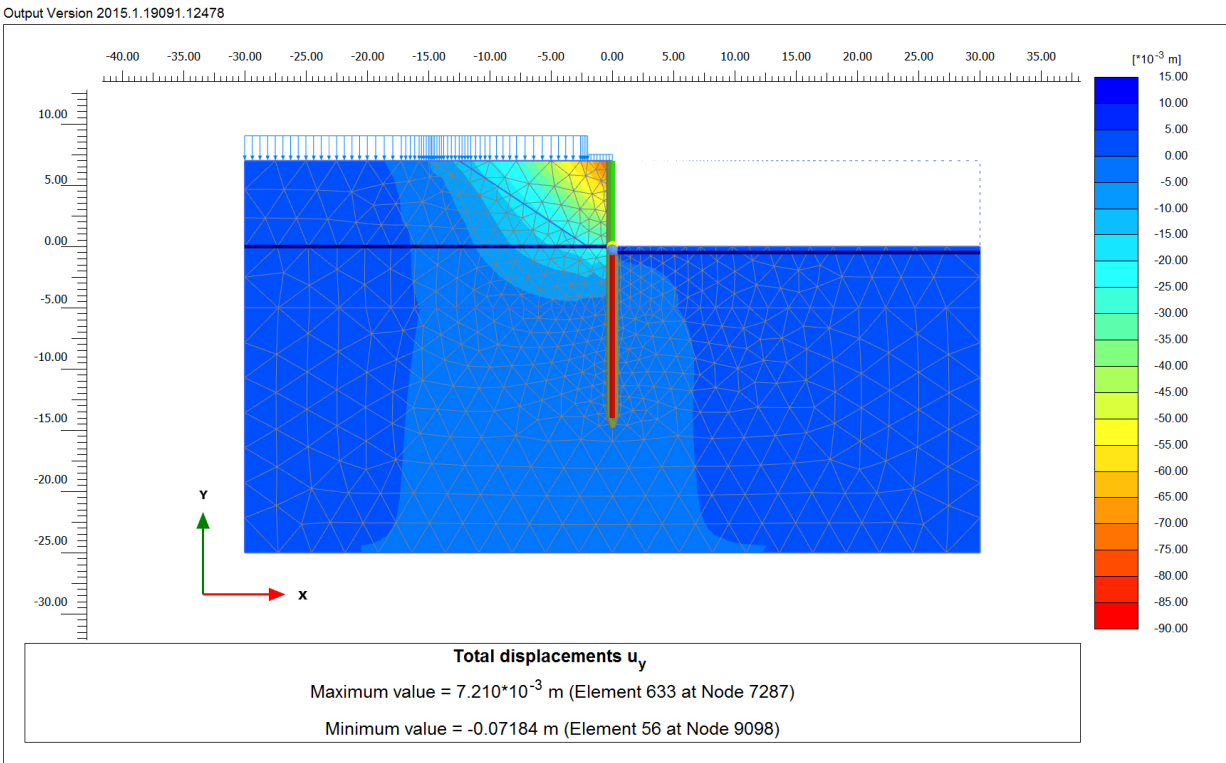


Figure B.2 Total vertical displacements (Short-term)

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

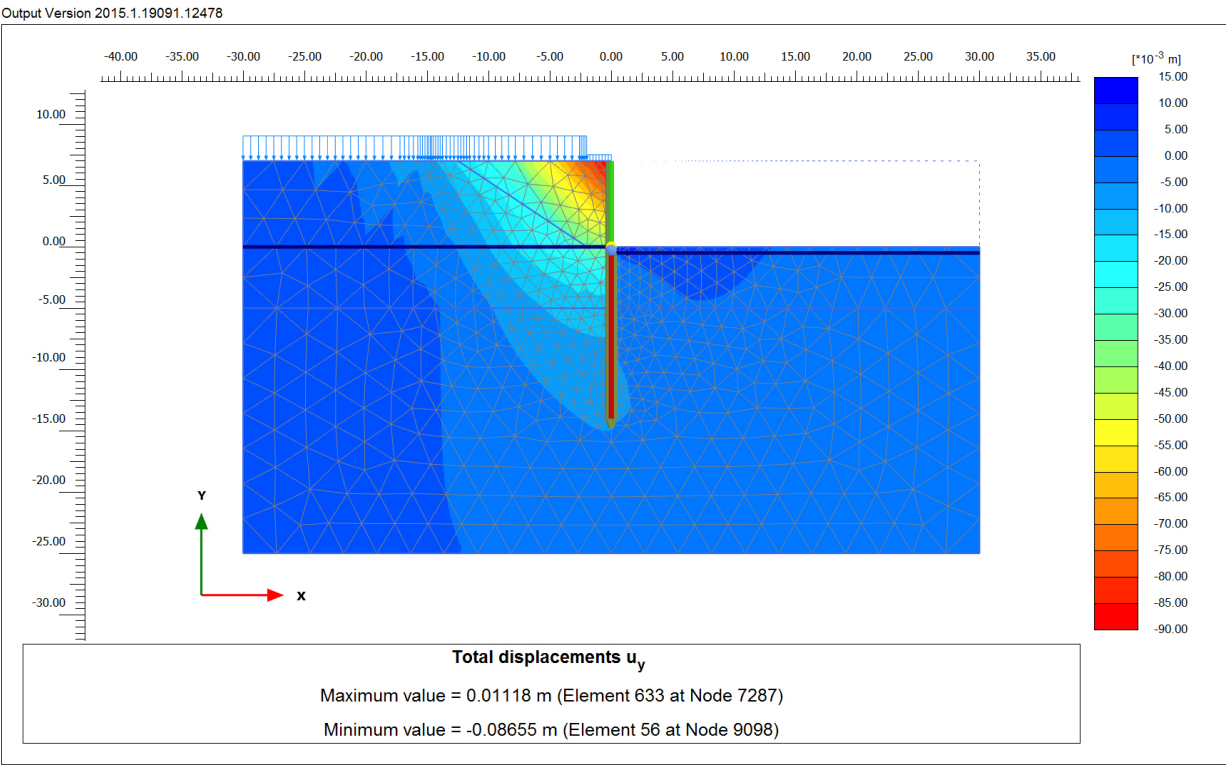


Figure B.3 Total vertical displacements (Long-term)

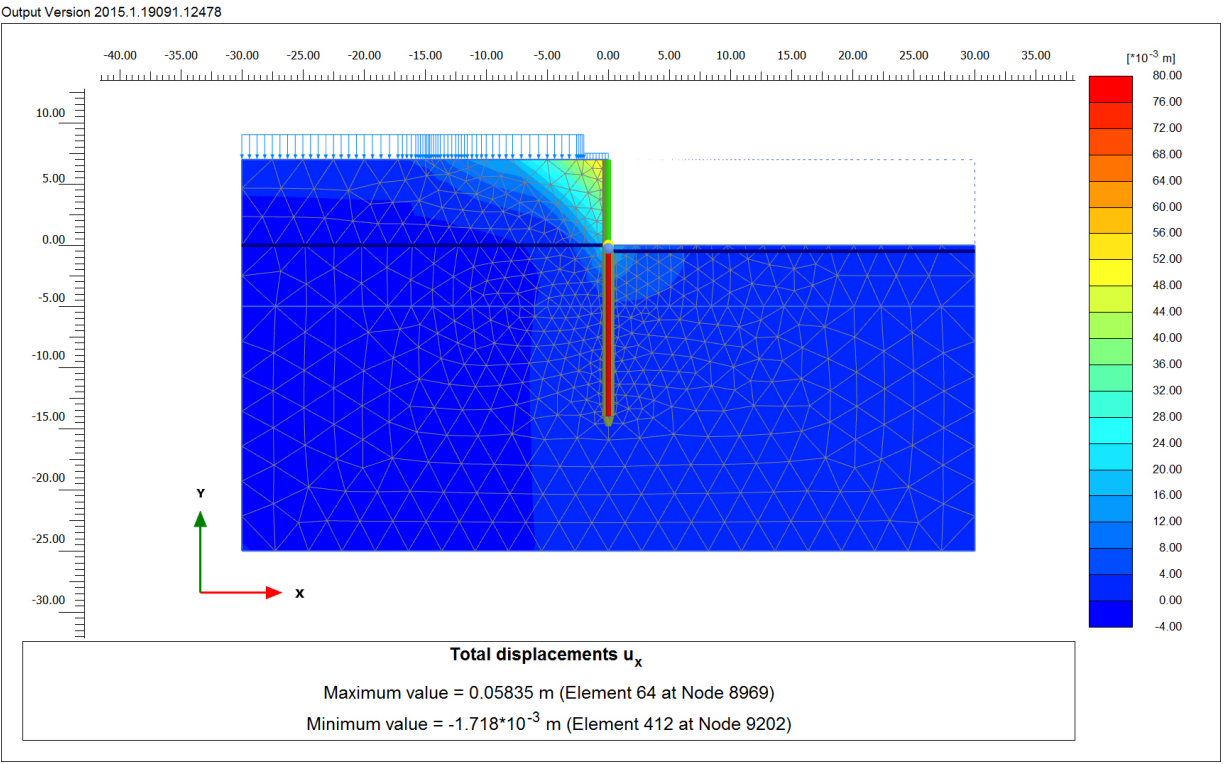


Figure B.4 Total horizontal displacements (Short-term)

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

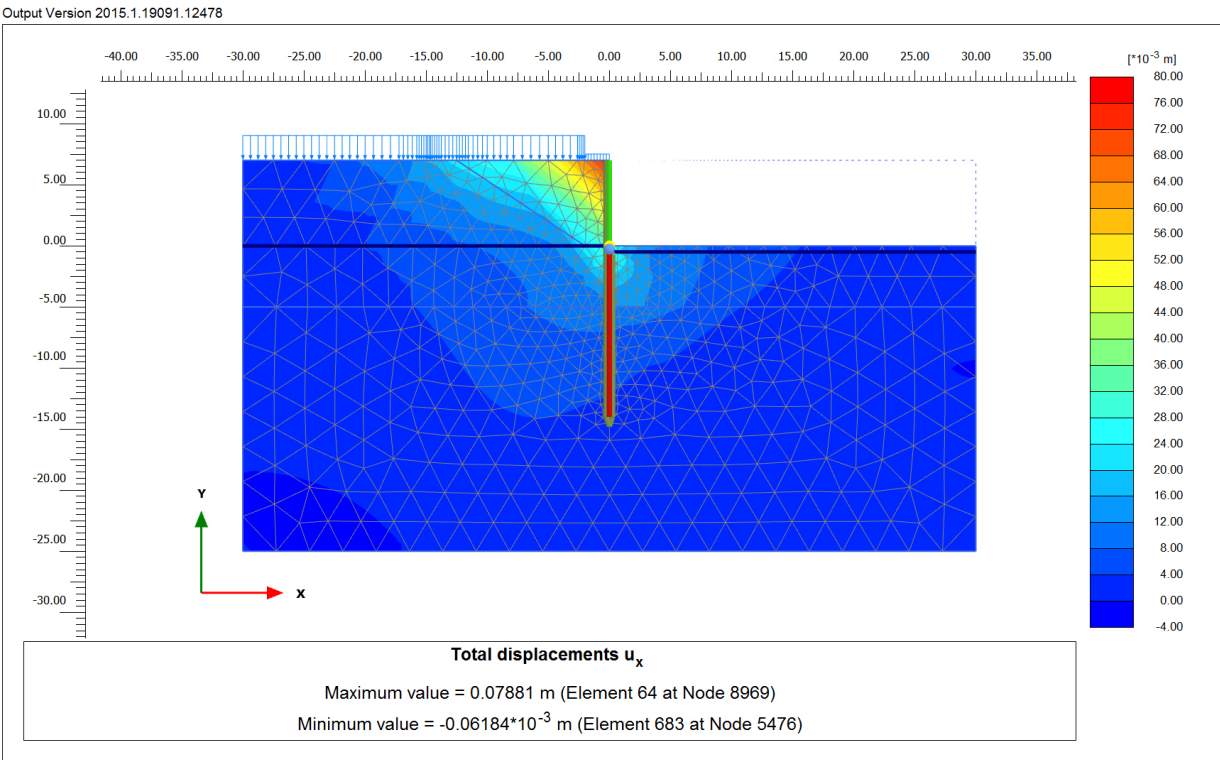


Figure B.5 Total horizontal displacements (Long-term)

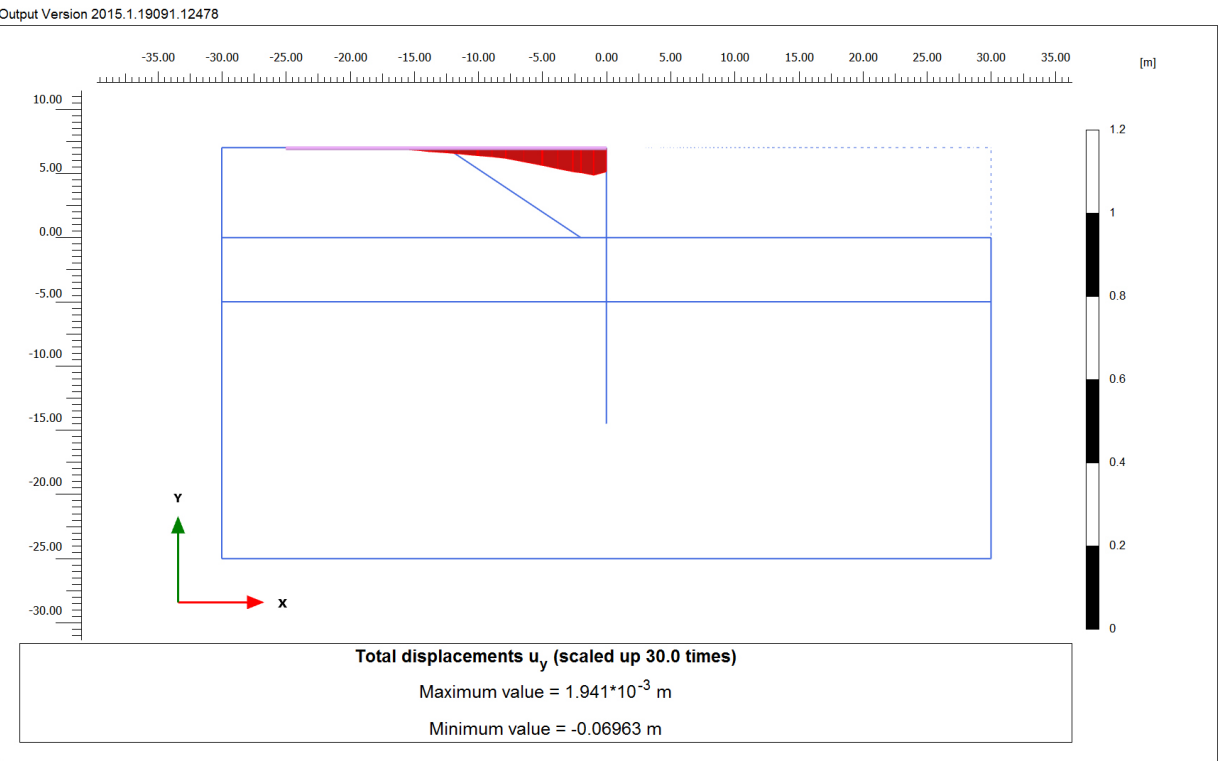


Figure B.6 Profile of ground surface settlement behind the wall (Short-term)



APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

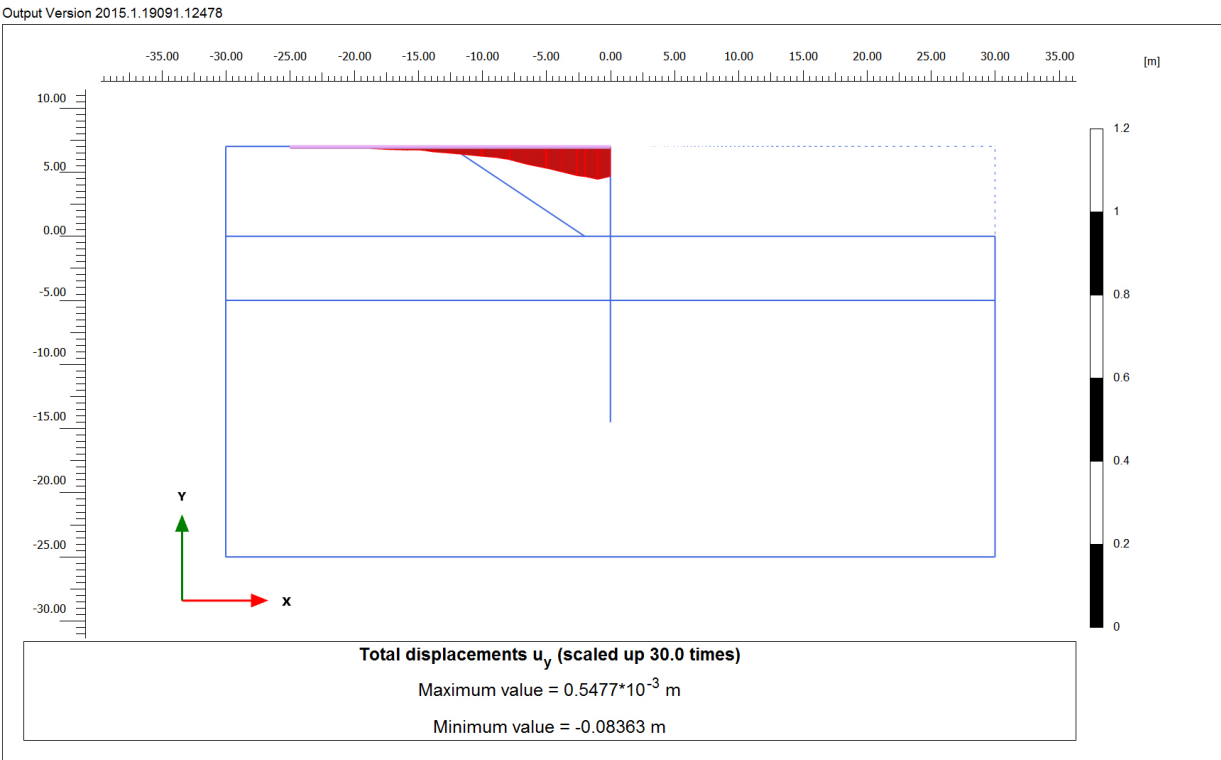


Figure B.7 Profile of ground surface settlement behind the wall (Long-term)

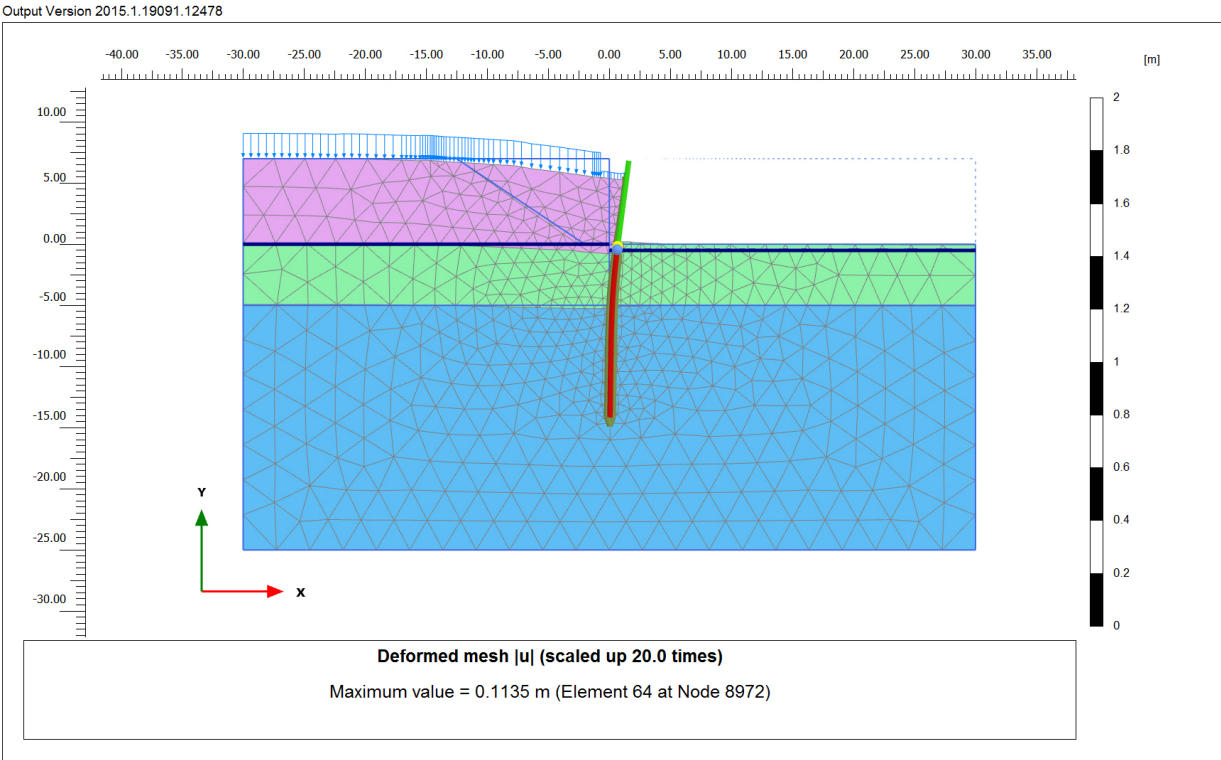


Figure B.8 Deformed mesh  $|u|$  (Long-term)

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

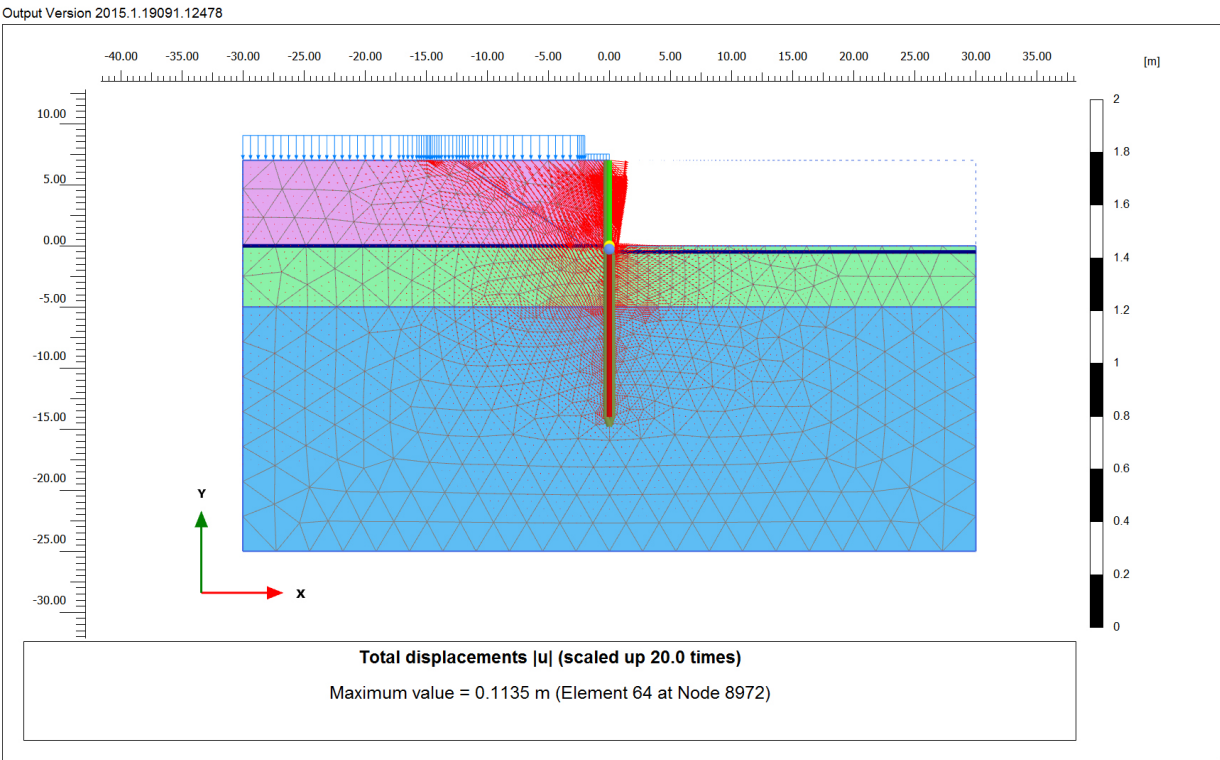


Figure B.9 Vector of total displacements (Long-term)

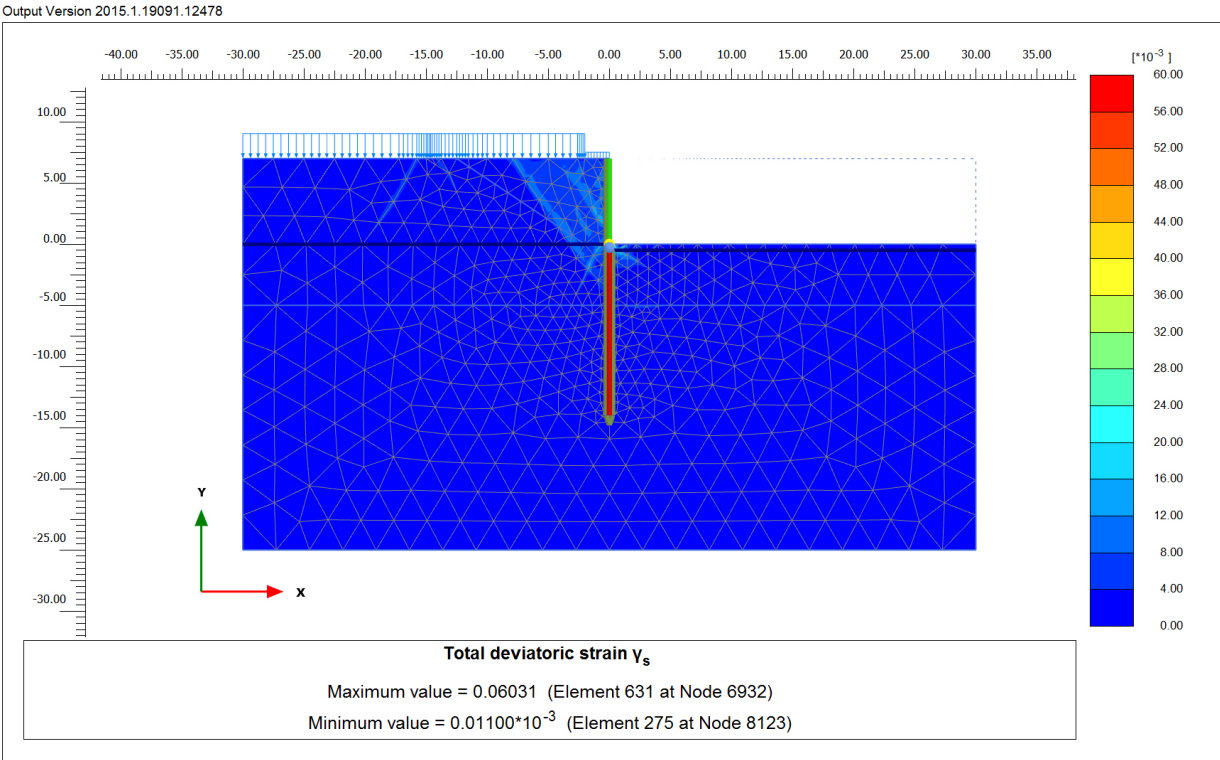


Figure B.10 Total shear strain,  $\gamma_s$  (Long-term)

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

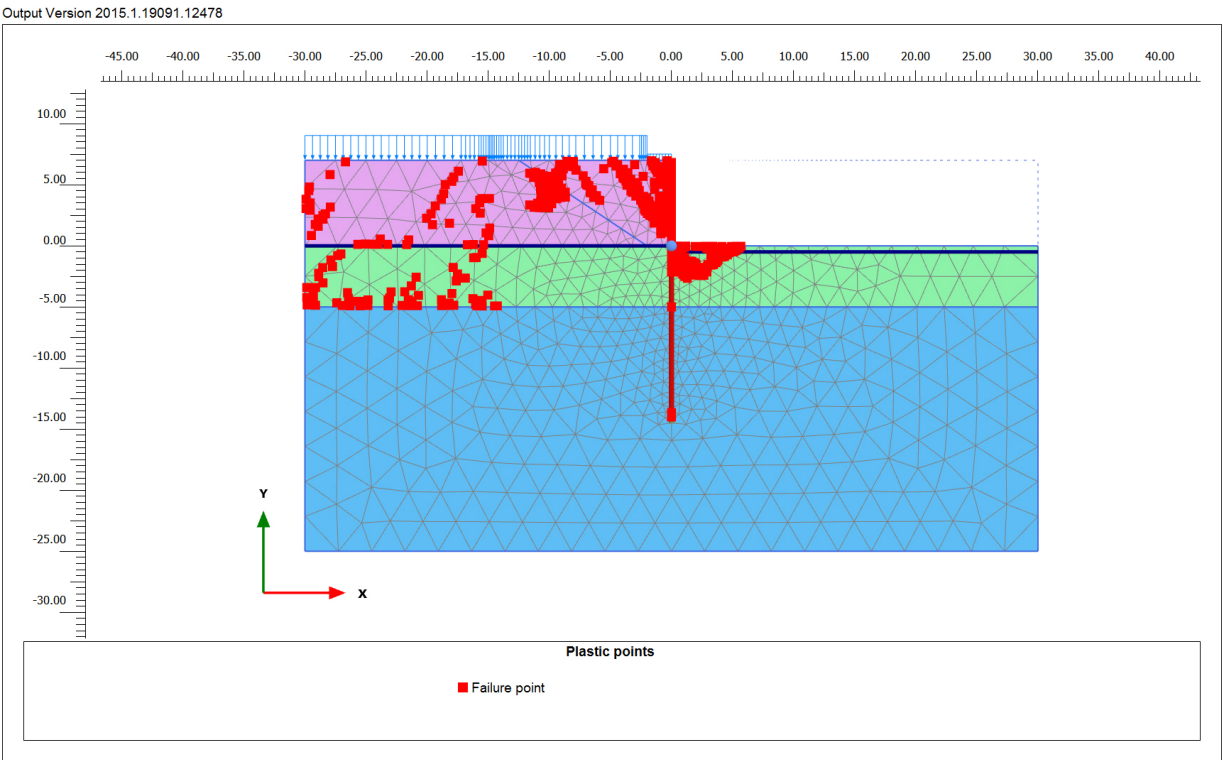


Figure B.11 Distribution of plastic points (Long-term)

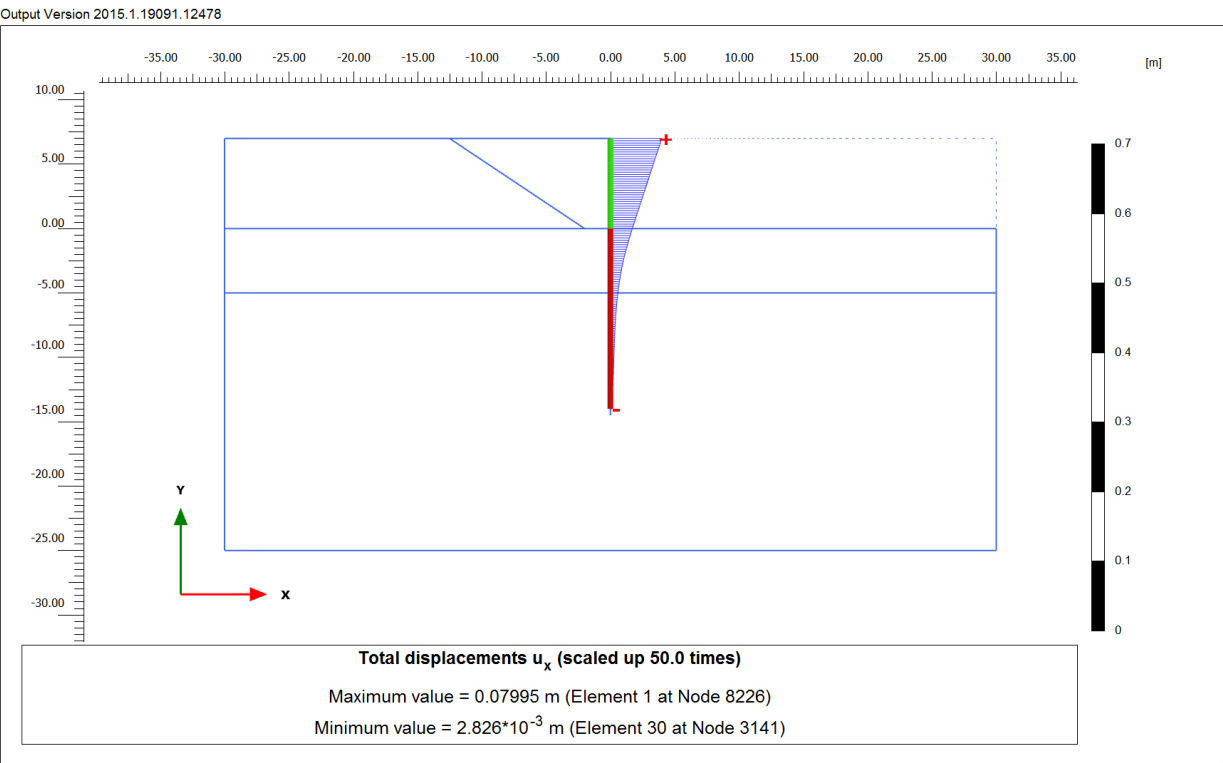


Figure B.12 Profile of horizontal wall displacements (Long-term)

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

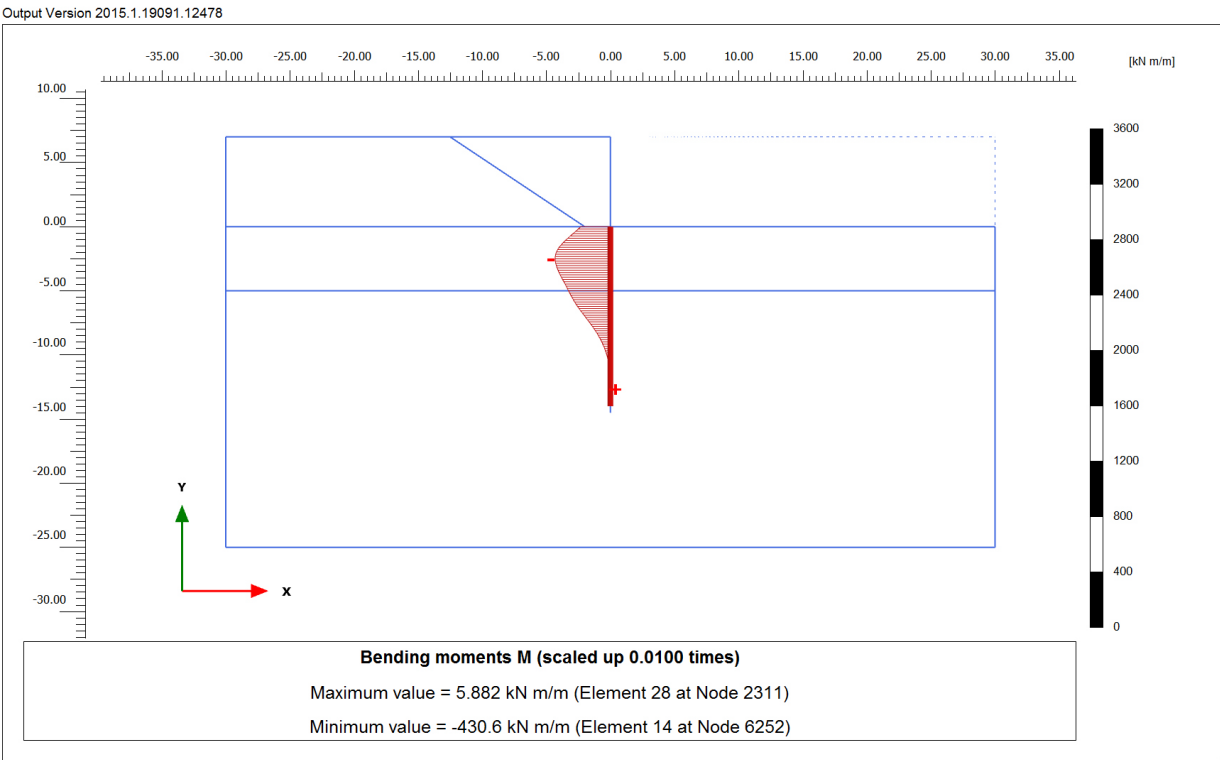


Figure B.13 Profile of wall bending moment for CHS D1000-14 (Long-term)

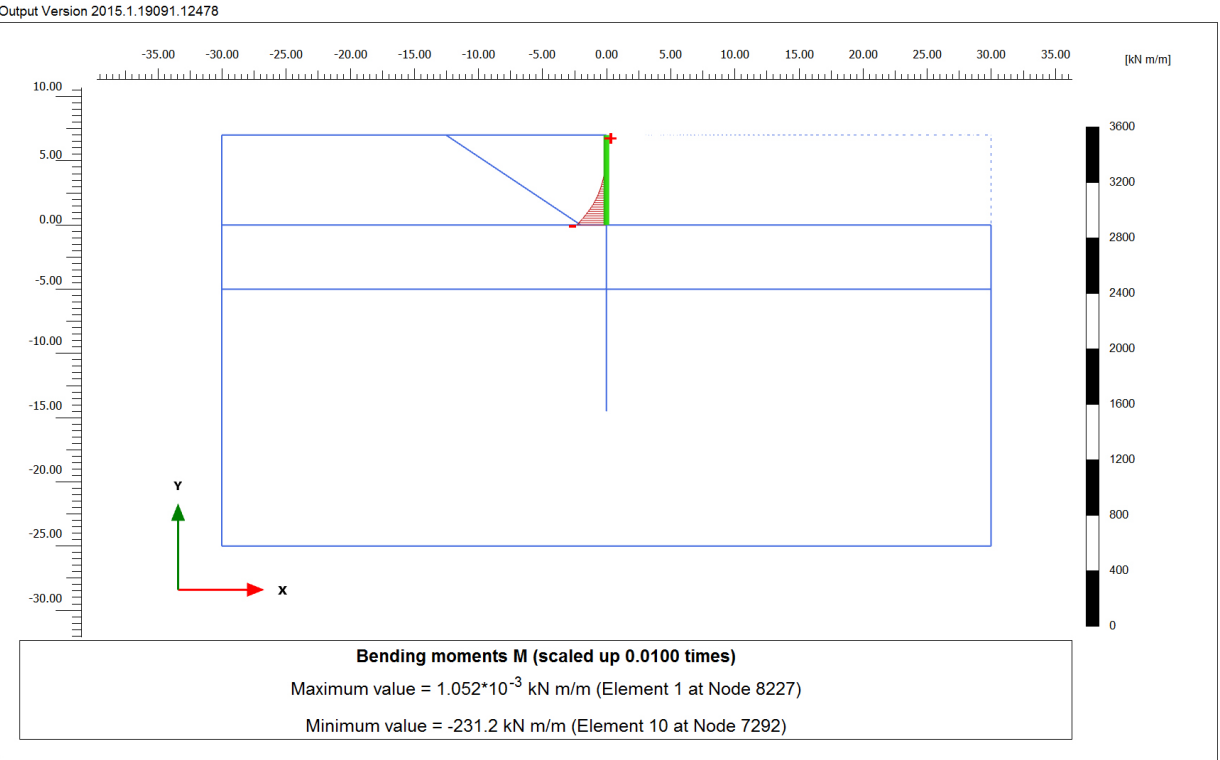


Figure B.14 Profile of wall bending moment for RC upper wall (Long-term)

APPENDIX B Plaxis 2D FE Analysis of Tubular King Pile Foundation

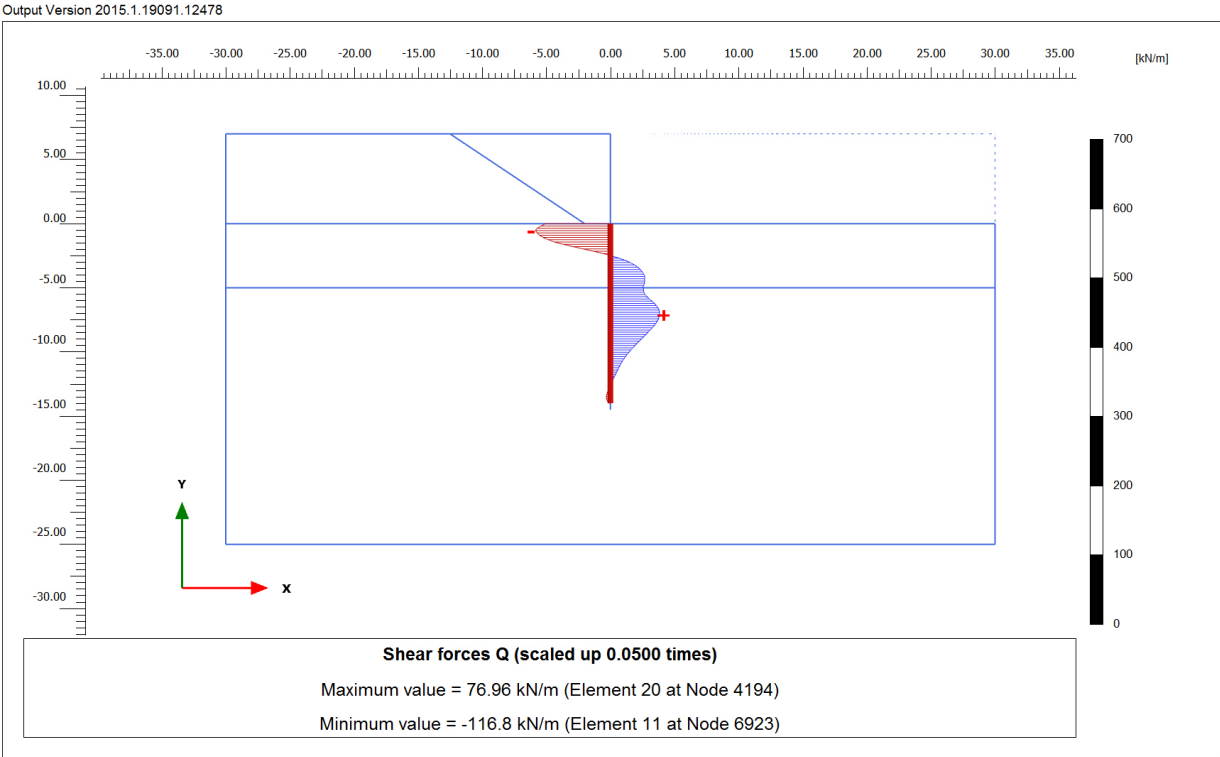


Figure B.15 Profile of wall shear force for CHS D1000-14 (Long-term)

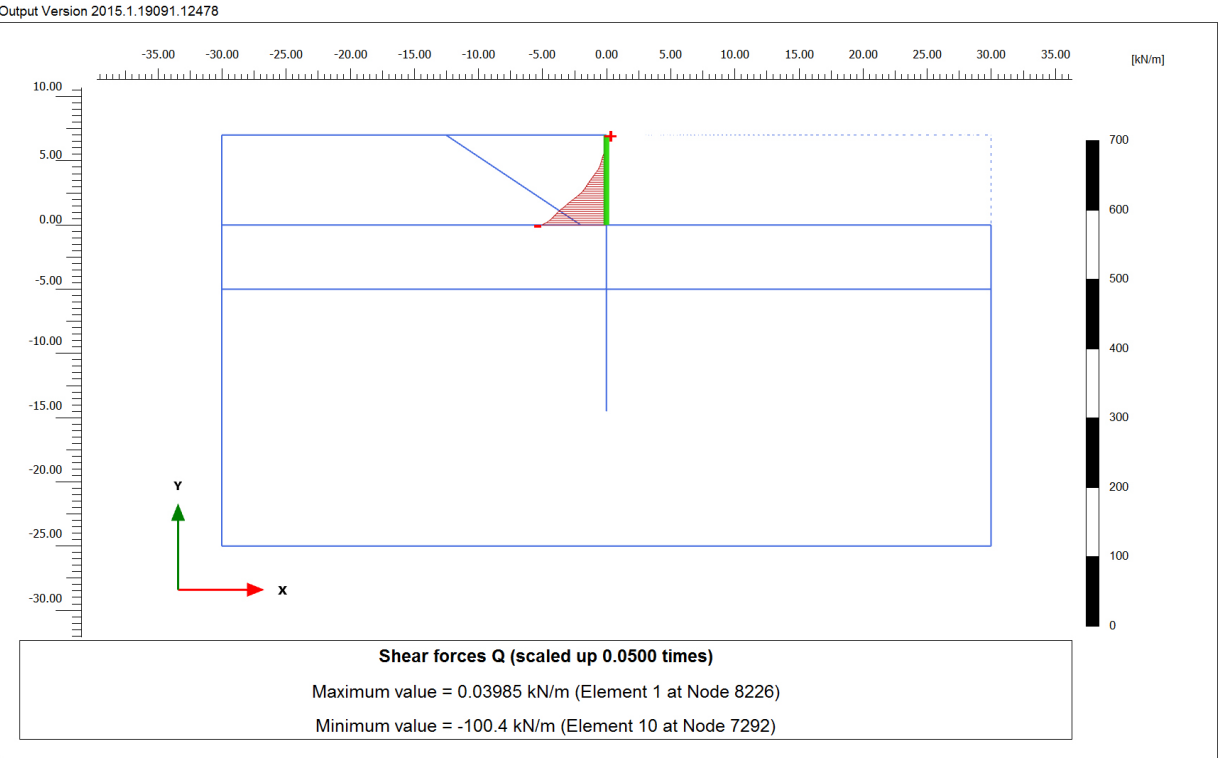


Figure B.16 Profile of wall shear force for RC upper wall (Long-term)



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