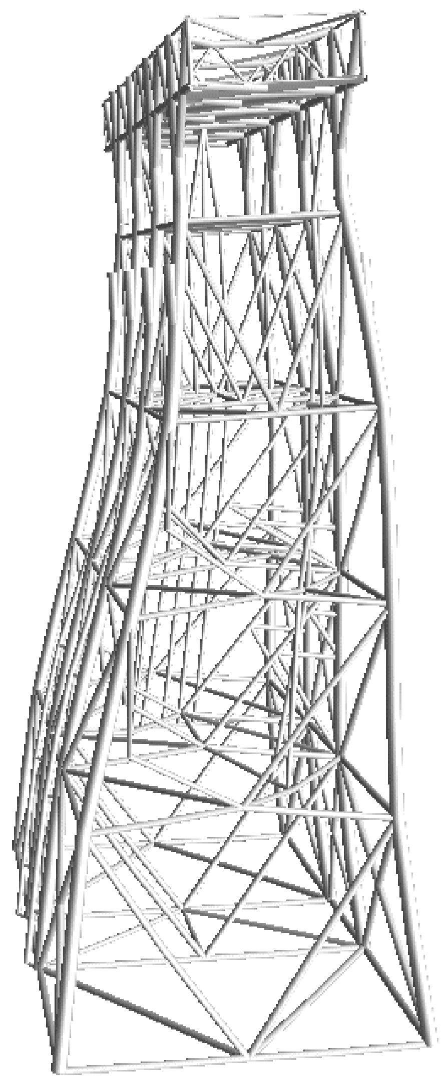

MODELLING OF

GUIDED NODES

In
USFOS

CONTENTS:

1 Introduction

For many jackets, the piles are guided through the legs, and such modelling of guides are modelled using the linear dependency option: BLINDP2.

The BLINDP2 command defines a (slave) node to follow a (master) element, where the actual constraints are defined by the user.

Below, a simple example is described in detail.

2 Typical Jacket Model

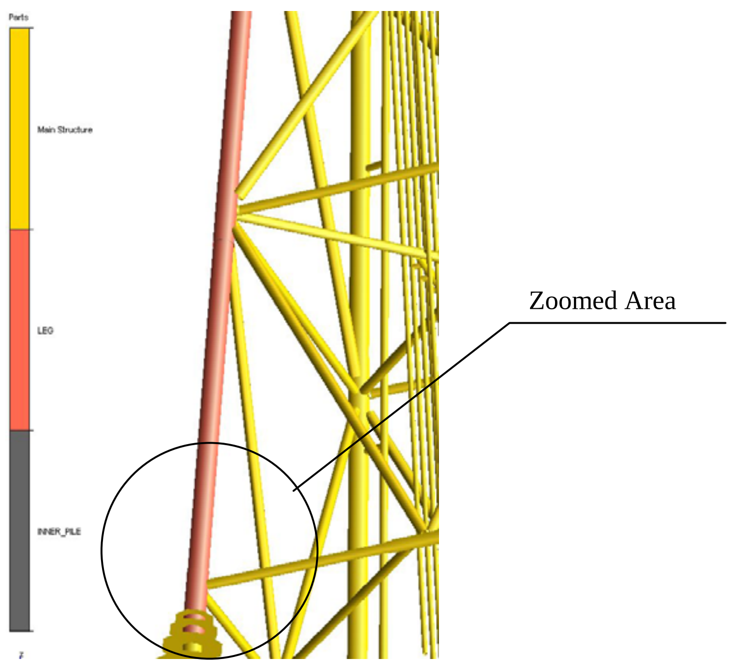

Figure 2-1 Jacket with guided piles. Overview

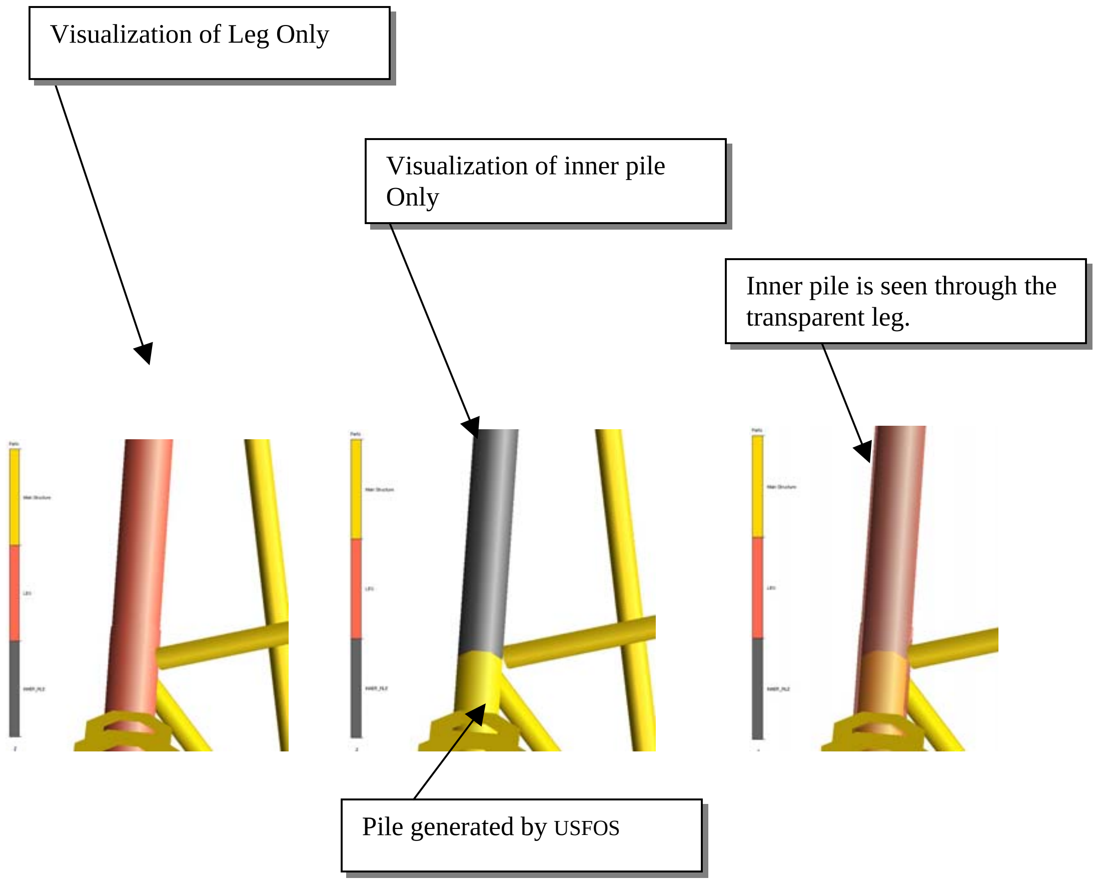

Figure 2-2 Outer leg (red) and Inner Pile (grey). The generated pile/soil is attached to the inner pile.

3 The BLINDP2 command used for guided piles.

3.1 General

The BLINDEP command is described graphically in Figure 3-1:

- The Slave node (red) is forced to follow the element's local axes
- Up to 6 constraint codes (0/1) could be specified, (all 6 numbers have to be specified)
- If the slave node is outside the element's ends, the extrapolated axis is used.
- The slave node's coordinates do not need to coincide with neither the master element's ends nor the master elements axis.

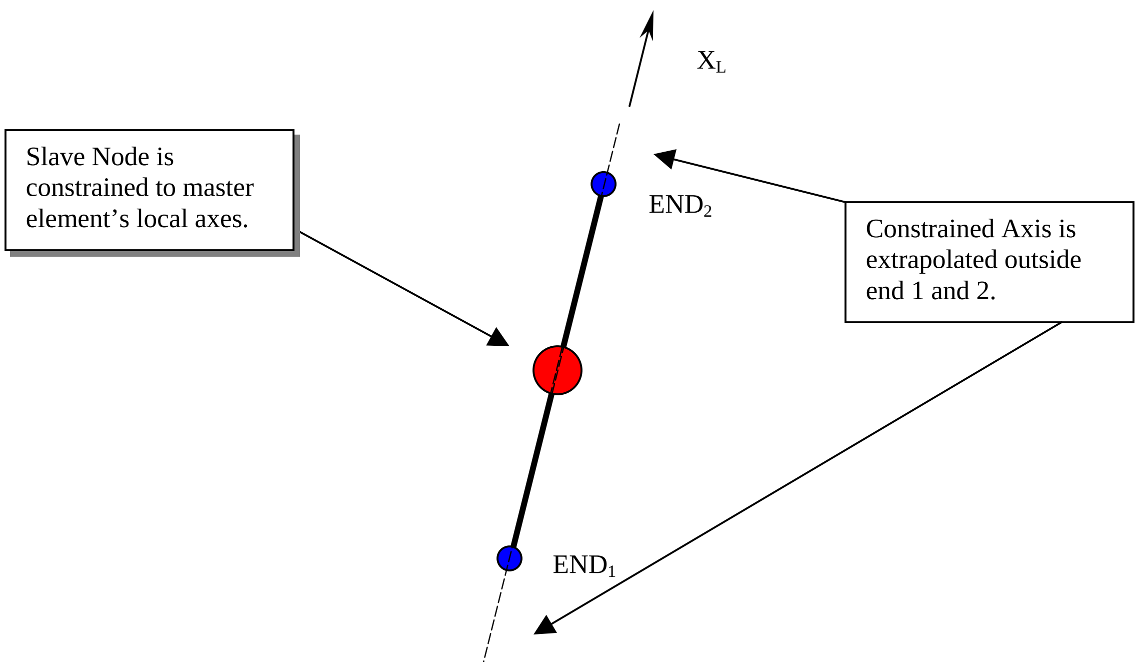

Figure 3-1 The "slave" node (red) is constrained to the "master" element's axes.

3.2 Simple example

3.2.1 Model Description

Figure 3-2 describes the simple demo example, where the vertical force is introduced at the top of the system. The inner pile and the outer leg are connected to the same top node, but except for this point, the leg elements and the pile elements have no common nodes. The leg is sideways supported by the two braces.

The vertical force goes into the inner pile since the leg has no vertical support.

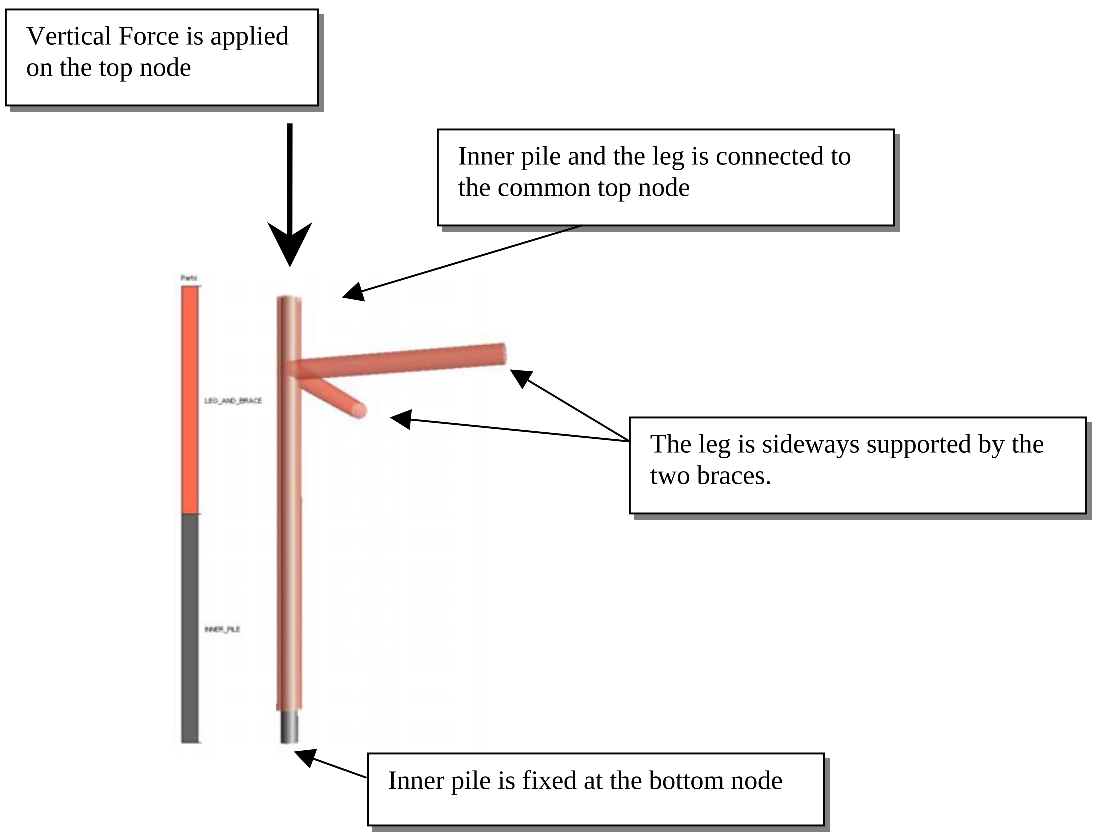

Figure 3-2 The Force applied on top is carried by the inner pile.

Figure 3-3 describes the pile and leg, and the pile node numbers and the leg element numbers are visualized.

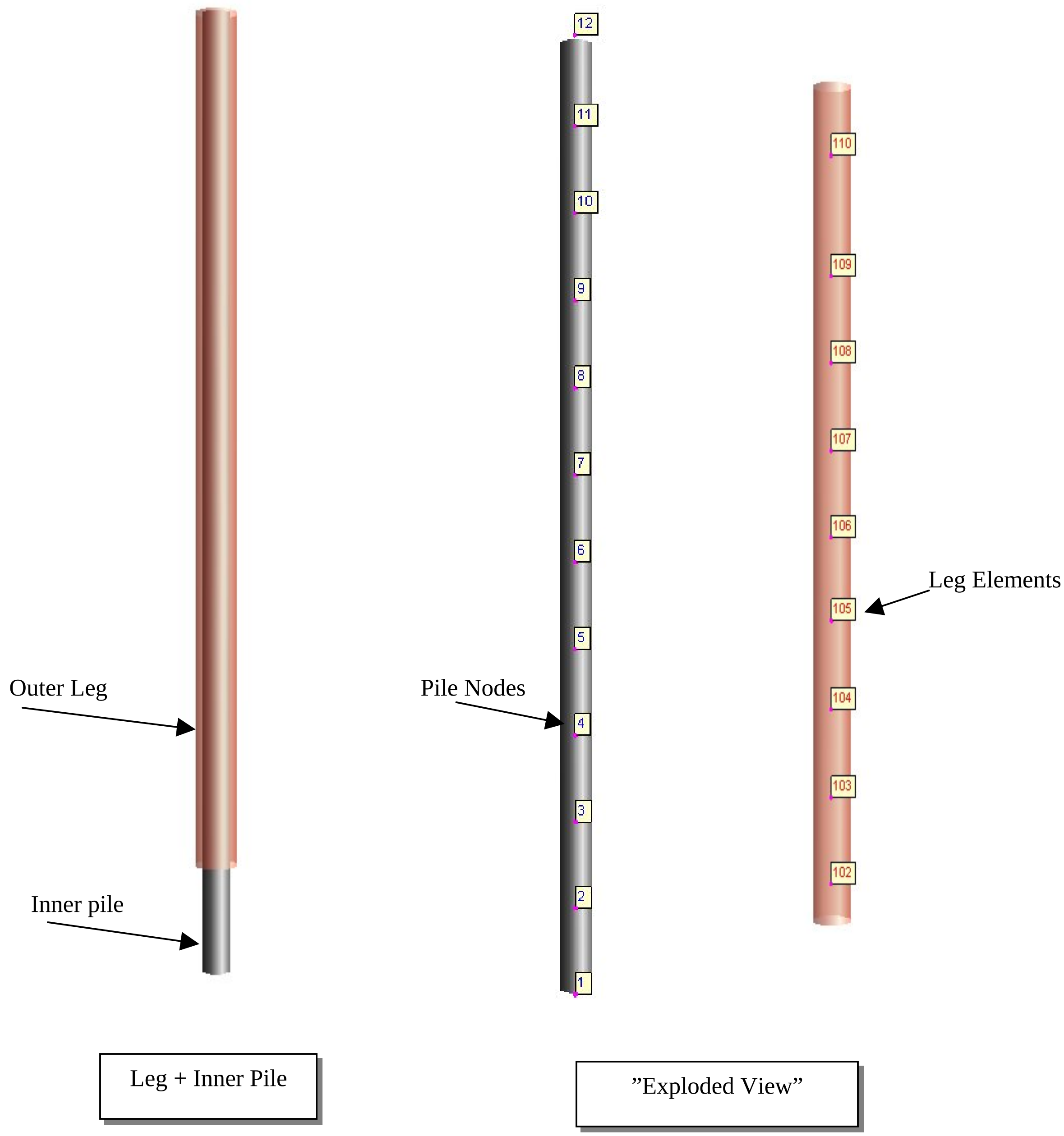

Figure 3-3 "Exploded view" of the finite element model showing the pile node and leg element numbers.

3.2.2 BLINDP2 command description

The input syntax for USFOS is described in the table. In connection with guided piles, the pile nodes are the "*slaves*" while the leg elements are the "*masters*". The 6 constraint codes refer to the *master element's local coordinate system*.

For the guided pile, the following 6 codes are used: 0 1 1 0 0 0, which means that the *slave node no 2* is forced to follow the *master element 102's* lateral movement (and vice versa), Therefore the local Y-and Z degrees of freedom are constrained.

The slave node is free to slide along the master element's local X-axis, and code = 0 is used for DOF 1. No bending constraints are specified.

```
'
'          SlaveNode   MasterElem   <-6 Constraint codes->
'          (PileNode)   (LegElem)     ix iy iz irx iry irz
 BLINDP2      2          102           0  1  1  0   0   0
```

Table 3-1 BLINDP2 command

Restrictions:

The master nodes (the nodes where the master element is attached to) must be free nodes, i.e. the master element's end nodes cannot be *fully* fixed.

3.2.3 Case 1: No guides

As a reference case, the model is run without any guide. The pile buckles for load level 35, and the figure documents the lack of connection between the piles and the leg.

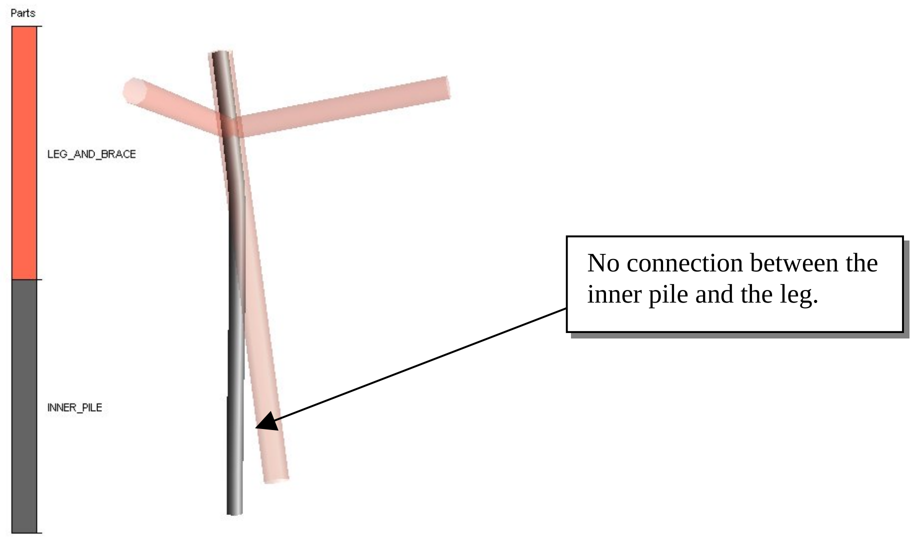

Figure 3-4 The inner pile buckles. The lack of guide is easily seen

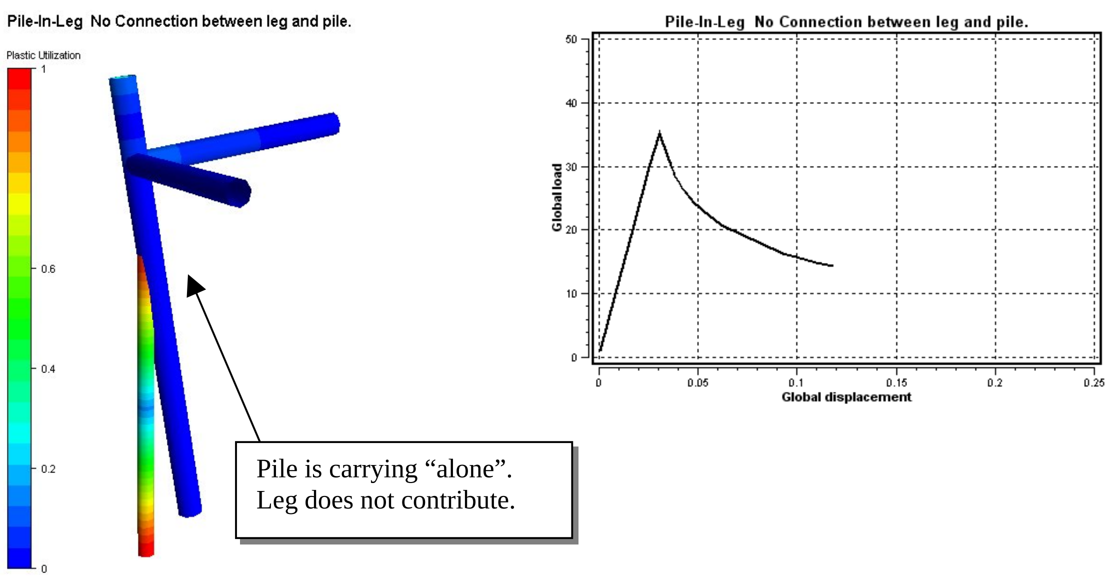

Figure 3-5 Plastic Utilization (left) and Global Load-Deflection (right)

3.2.4 Case 2: One guides point (bottom)

If the lower part of the pile is connected to the leg (guided), results in a different collapse mode. The mid span of the pile gets a plastic hinge. Still an un satisfactory model.

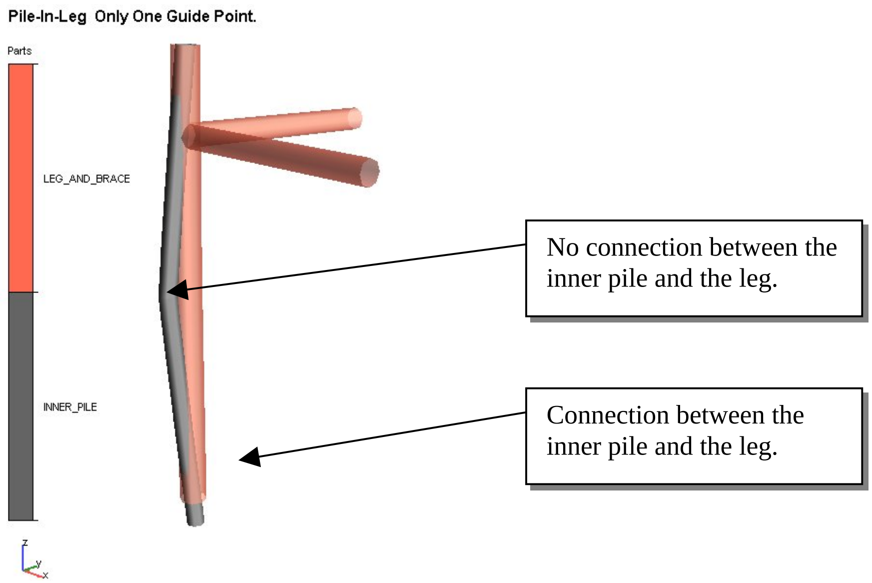

Figure 3-6 The inner pile buckles. The lack of guide is easily seen

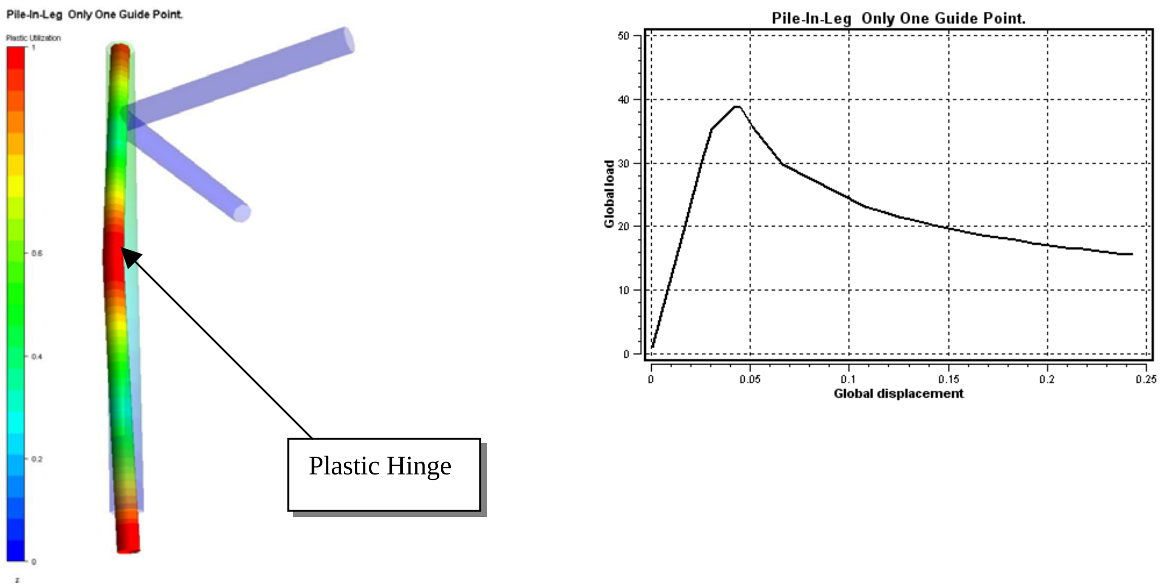

Figure 3-7 Plastic Utilization (left) and Global Load-Deflection (right)

3.2.5 Case 3: Fully guided pile

If all pile nodes are guided, the pile is prevented from buckling and yields in almost pure axial compression.

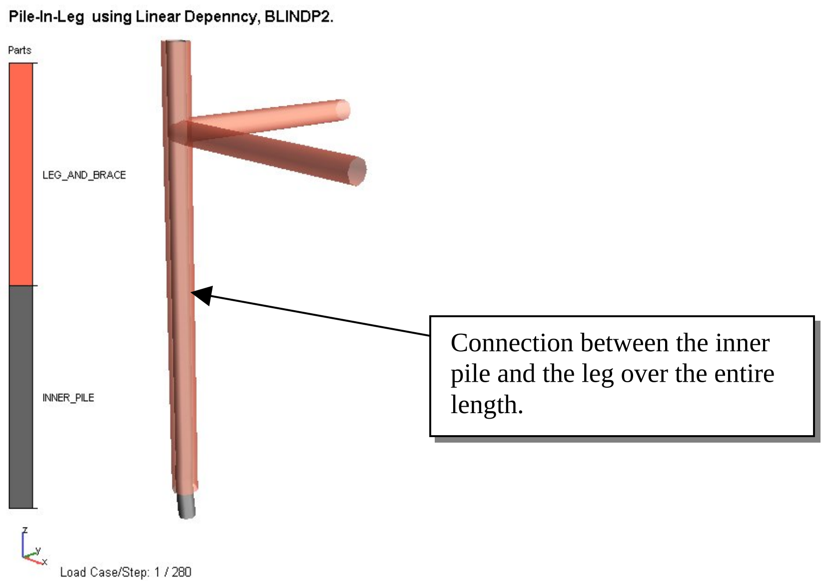

Figure 3-8 "The inner pile is fully connected to the leg.

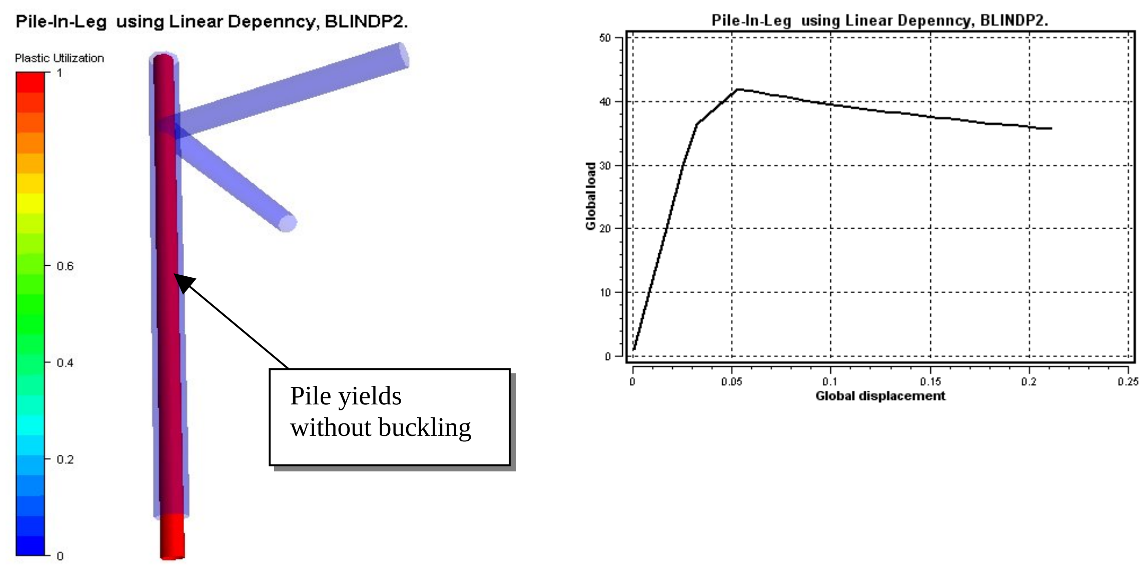

Figure 3-9 The sideways supported (guided) pile does not buckle

The input for the case with fully guided pile is shown in Table 3-2. The structural model is given in Table 3-3.

```
' ---------------------------------------------------
'     Define Connection between inner pile and Leg
'     Pile nodes are linear dependent to Leg Elements
' ---------------------------------------------------
'
'
'         PileNode  LegElem   ix iy iz irx iry irz
 BLINDP2     2        102      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     3        102      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     4        103      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     5        104      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     6        105      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     7        106      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     8        107      0  1  1  0   0   0   ! Node is fixed laterally
 BLINDP2     9        108      0  1  1  0   0   0   ! Node is fixed laterally
```

Table 3-2 BLINDP2 commands. Fully guided pile.

```
' -------------------------------------------------------------------
'     Define Inner Pile Nodes / Element
' -------------------------------------------------------------------
'
'           Node ID          X             Y              Z    Boundary code
 NODE             1         0.000         0.000         -1.000  1 1 1 1 1 1  ! Supported
 NODE             2         0.000         0.000          0.000
 NODE             3         0.000         0.000          2.000
 NODE             4         0.000         0.000          4.000
 NODE             5         0.000         0.000          6.000
 NODE             6         0.000         0.000          8.000
 NODE             7         0.000         0.000         10.000
 NODE             8         0.000         0.000         12.000
 NODE             9         0.000         0.000         14.000
 NODE            10         0.000         0.000         16.000
 NODE            11         0.000         0.000         18.000
 NODE            12         0.000         0.000         20.000
'
'           elem ID     N1   N2   Mat   Geo
 BEAM             1      1    2    1    80050
 BEAM             2      2    3    1    80050
 BEAM             3      3    4    1    80050
 BEAM             4      4    5    1    80050
 BEAM             5      5    6    1    80050
 BEAM             6      6    7    1    80050
 BEAM             7      7    8    1    80050
 BEAM             8      8    9    1    80050
 BEAM             9      9   10    1    80050
 BEAM            10     10   11    1    80050
 BEAM            11     11   12    1    80050
'
' -------------------------------------------------------------------
'     Define Leg&Brace Nodes / Elements
' -------------------------------------------------------------------
'
'           Node ID          X             Y              Z    Boundary code
 NODE           102         0.000         0.000          0.500
 NODE           103         0.000         0.000          2.500
 NODE           104         0.000         0.000          4.500
 NODE           105         0.000         0.000          6.500
 NODE           106         0.000         0.000          8.500
 NODE           107         0.000         0.000         10.500
 NODE           108         0.000         0.000         12.500
 NODE           109         0.000         0.000         14.500
 NODE           110         0.000         0.000         16.500
 NODE           111         0.000         0.000         18.500
'
 NODE           210        10.000         0.000         16.500  1 0 0
 NODE           310         0.000        10.000         16.500  0 1 0
'
'           elem ID     N1   N2    Mat    Geo
 BEAM           102    102  103    101   120030
 BEAM           103    103  104    101   120030
 BEAM           104    104  105    101   120030
 BEAM           105    105  106    101   120030
 BEAM           106    106  107    101   120030
 BEAM           107    107  108    101   120030
 BEAM           108    108  109    101   120030
 BEAM           109    109  110    101   120030
 BEAM           110    110   12    101   120030
'
 BEAM           210    110  210    101   100030
 BEAM           310    110  310    101   100030
'
' -------------------------------------------------------------------
'     Define Cross Sections, Materiasl and Loads
' -------------------------------------------------------------------
'
 PIPE   80050   0.8   0.050    ! Pile  Cross Section
 PIPE  120030   1.2   0.030    ! Leg   Cross Section
 PIPE  100030   1.0   0.030    ! Brace Cross Section
'
''           Mat  ID     E-mod   Poiss   Yield   Density   ThermX
 MISOIEP          1   210000E6    0.3    355E6    7850    1.400E-05
 MISOIEP        101   210000E6    0.3    355E6    7850    1.400E-05
'
'           Load Case   Node    Fx  Fy  Fz
 NODELOAD         1       12      0   0 -1E6
```

Table 3-3 Structural Model description