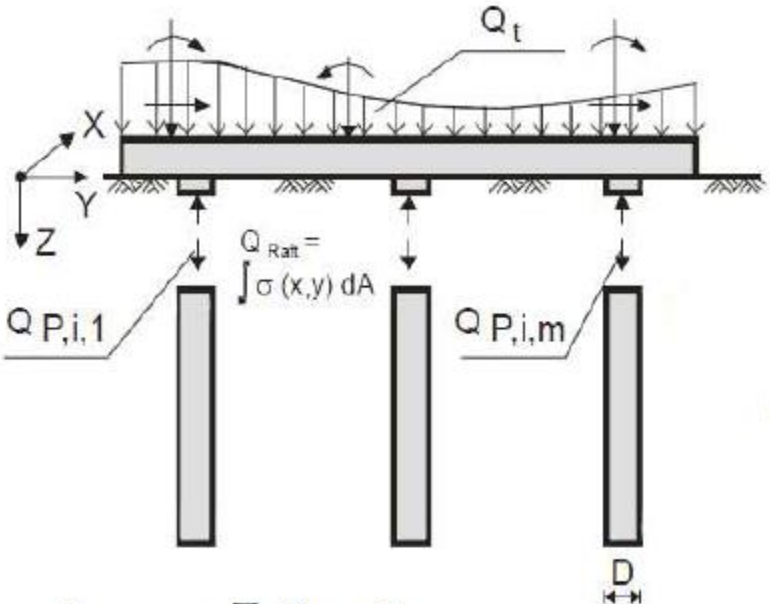
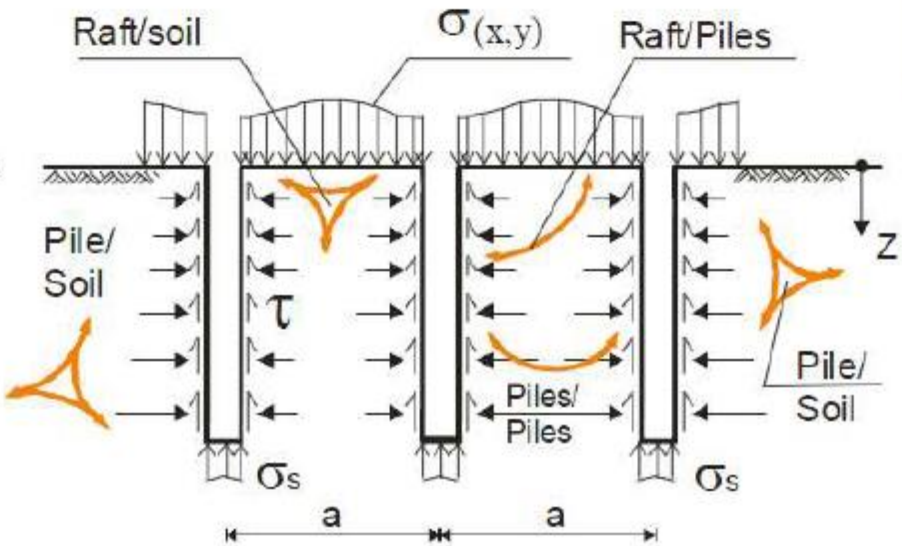
Bearing Behavior of a Piled Raft





$$Q_{tot} = \sum Q_P + Q_R$$

$$Q_P = Q_b + Q_s$$

$$Q_R = \int \sigma(x,y)\, dA$$

$$Q_{tot} \geq \eta \cdot \sum S_{tot}$$

Interaction influences:

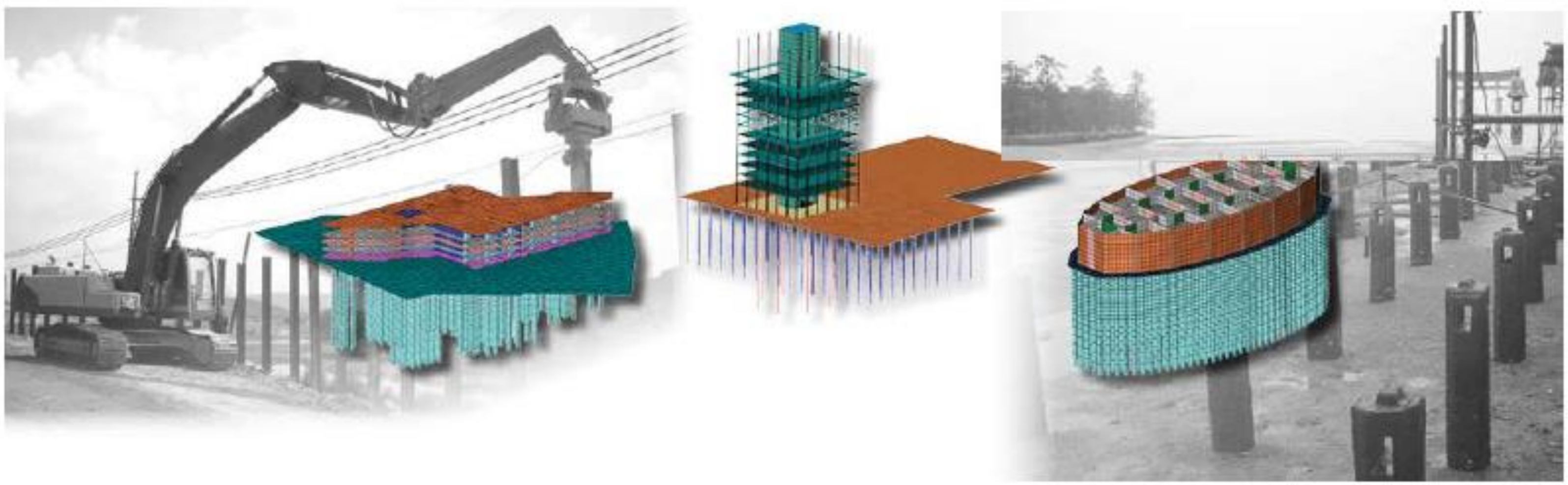
- Pile-Soil interaction
- Pile-Pile interaction
- Raft-Soil interaction
- Pile-Raft interaction

Pile Modeling in GTS NX

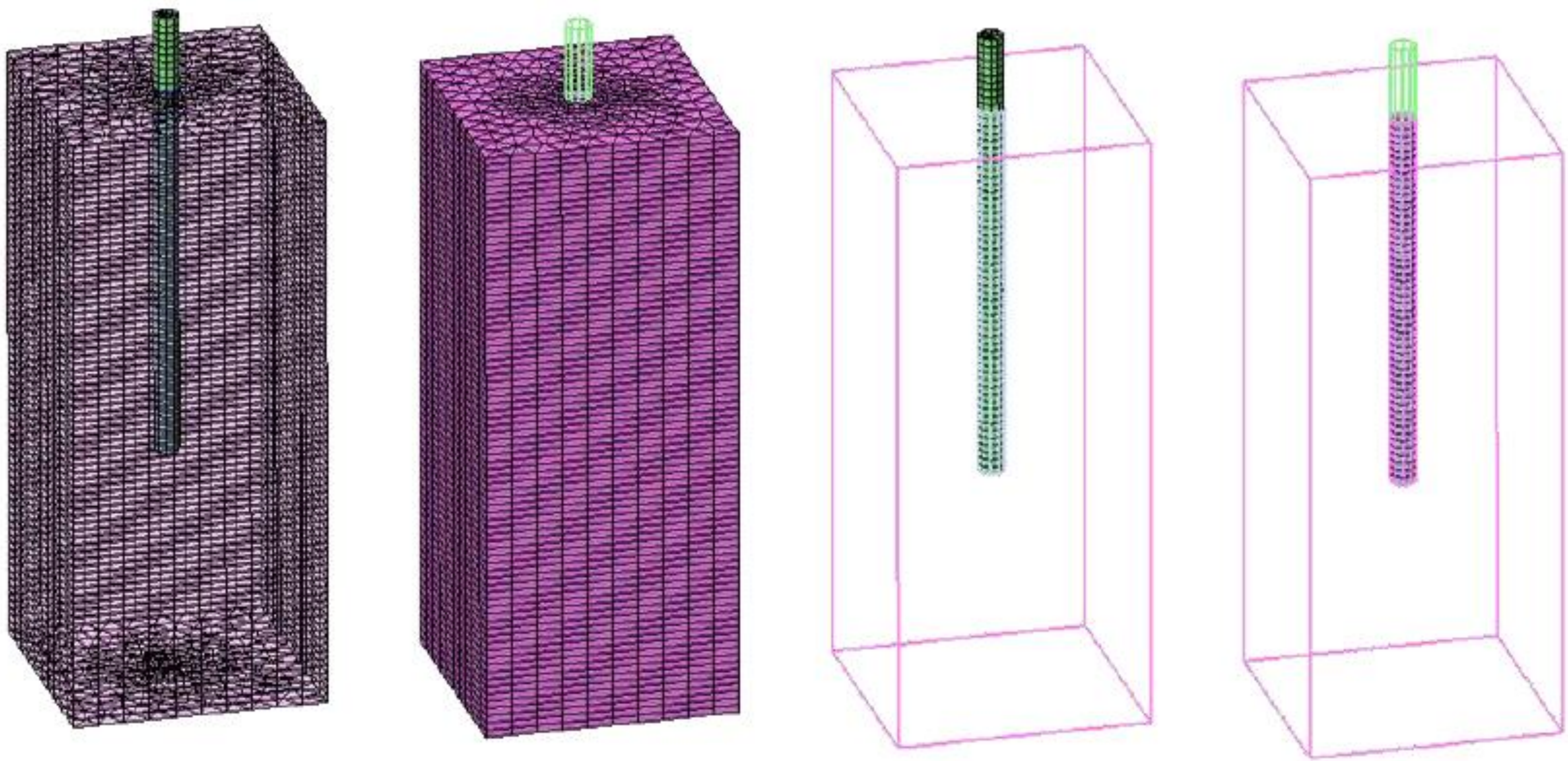
GTS NX

Three pile modeling approaches are available:

- Solid Element Model
- Beam-Solid Connectivity Model
- Line-to-Solid Interface Model (embedded pile)



Solid Element Model

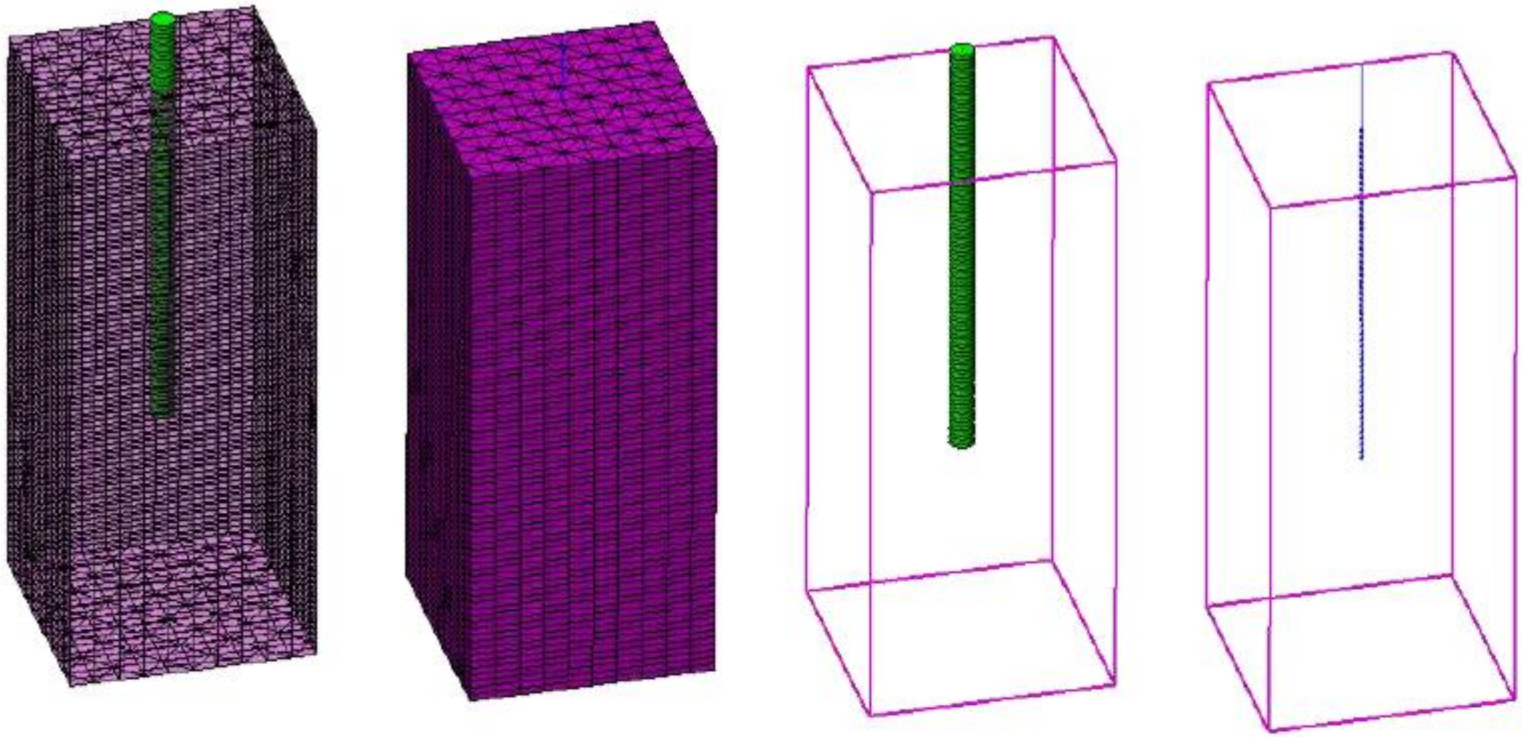


Model = Soil (solid) + Pile (solid) + Interface (surface)

Nodal connectivity is required on pile outer surface

Beam-Solid Connectivity Model

GTS NX

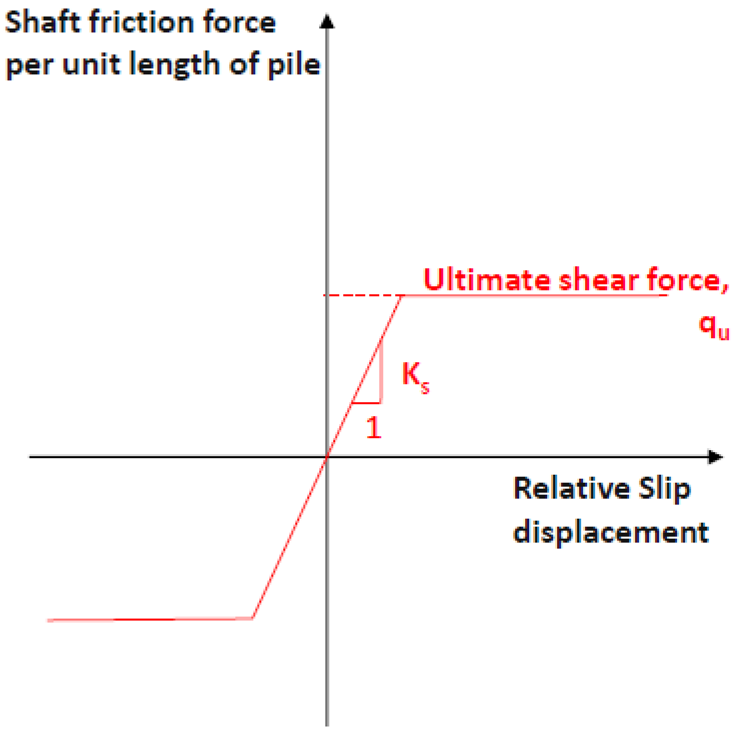


Model = Soil (solid) + Pile (beam) + Interface (line)

Nodal connectivity is required along pile length

Pile Element Parameters

GTS NX



Input parameters:

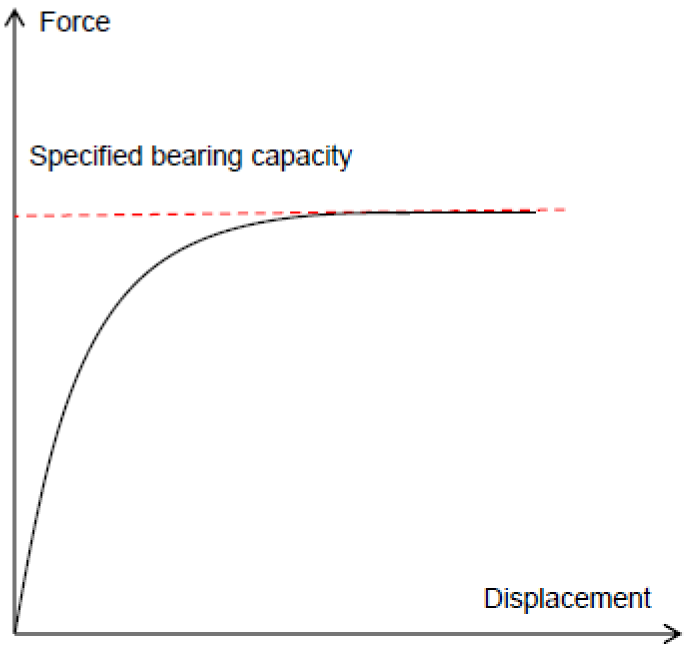
- **Ultimate shear force, q_u** [kN/m]
per unit length of the pile, at reference depth.
- **Shear Stiffness Modulus, K_s** [kPa]
Linear elastic penalty stiffness of the interface in the longitudinal direction of the pile.
- **Normal Stiffness Modulus, K_n,K_t** [kPa]
Linear elastic penalty stiffness of the interface in the transversal direction.

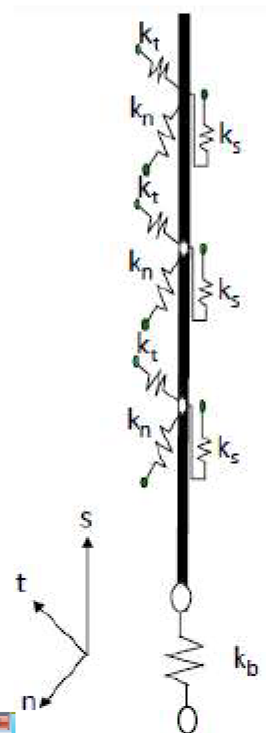
These input parameters are best extracted from SLT results after separating shaft friction and base bearing behavior from the total response

Pile bearing capacity is input in pile elements and not a result of the calculation!

=> Deformation behavior

Pile Element Parameters



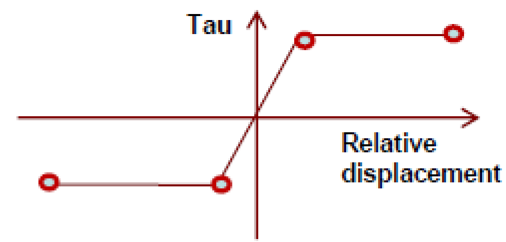


Skin tractions

$t_s = q_s/\text{length} = k_s * (\Delta u) \leq q_{ult}$

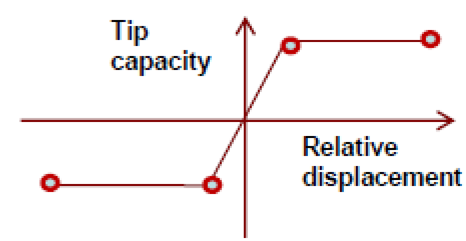
$t_n = q_n/\text{length} = k_n * (\Delta u)$

$t_t = q_t/\text{length} = k_t * (\Delta u)$



Base (tip) bearing capacity

$q_b = k_b * (\Delta u) \leq q_{bult}$

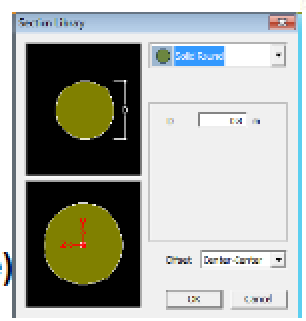


Pile beam properties

Cross section properties

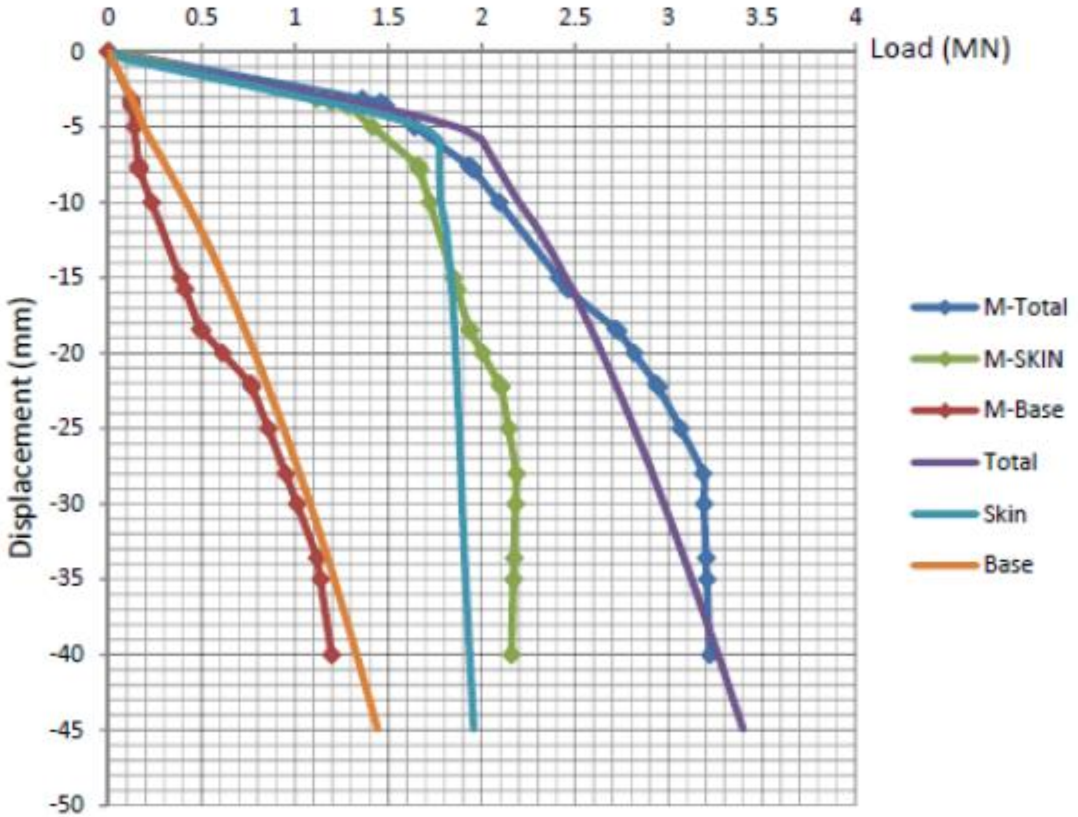
Length

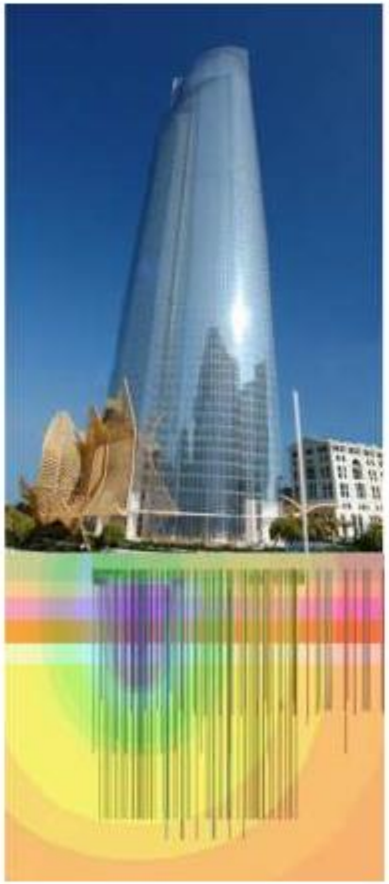
Material properties (e.g. Concrete)



Verification

Single pile analysis of the Alzey Bridge pile loading test

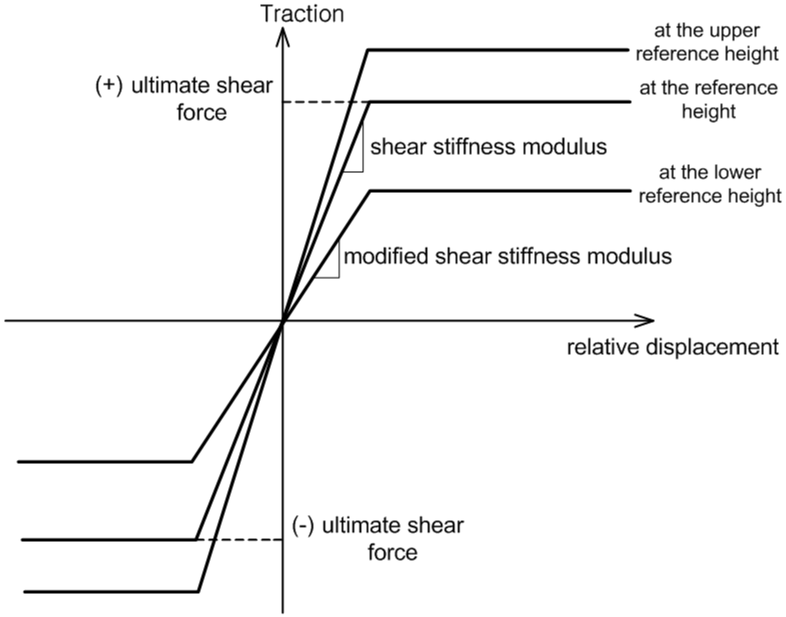




Elkadi, O. (2010)

The behavior of pile elements can be divided into a normal behavior and a tangential behavior. First, the normal behavior between the pile and the surrounding ground is considered as fixed and rigid, whereas the tangential behavior is a nonlinear elastic behavior. The nonlinear elastic behavior is divided into the yield force and the yield function assigned.

The graph bellow represents the relative displacement between the 2 bodies and the friction when yield force is defined. If the relation is defined by a function, the relation between relative displacement and friction can be defined more precisely.



The Pile tip element works as solid-point interface that presents the relative behavior between the ground elements and pile node. In the element coordinate system of the pile tip element regard the normal direction behavior toward the element as rigid behavior just like a pile behavior. And, regard the tangent direction behavior as nonlinear elastic behavior.

To define the behavior, the material and property of a pile element can be entered based on test data, such as Load Test.

For more information about entering parameters of pile element, look up [User Manual] Ch4 (General Material) or Select F1 for [Online Manual].

Pile connection

In the case of the pile connection point coinciding with pile cap elements, the connection behaviour is as follows:

1. Free (Mesh > Element > Pile)

The connection point is free to move and rotate relative to the surrounding soil and the pile cap element. The pile interacts with the surrounding soil and the pile cap elements only through the pile interface elements. Note that the pile cap elements are not free to move and rotate relative to the surrounding soil.

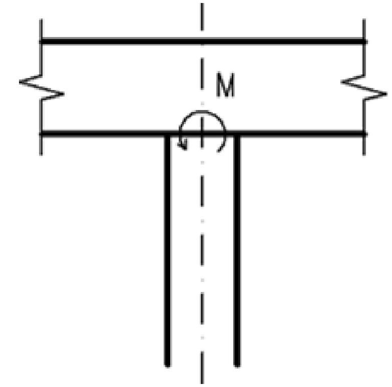
2. Rigid (Mesh > Node > Merge)

The displacement and rotation at the pile connection point are both coupled with the displacement and rotation of the pile cap and/or soil element in which the pile top is located.

3. Hinged (Mesh > Element > Parameters > Beam End Release)

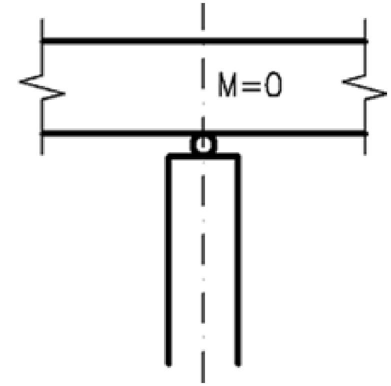
The displacement at the connection point of the pile is directly coupled with the displacement of the pile cap element and/or the surrounding soil in which the pile connection point is located, which means that they undergo exactly the same displacement.

FIXED



FIXED END
(supports moment)

HINGE



HINGE
(zero moment at the hinge)