# Soil modelling in Paratie

The next document contains any information and direction to follow in Paratie Plus in order to configure different soil constitutive models.

Here is a comparison with Paratie 7.0 controls.

Refer to the following table:

## Clays mechanical behaviour (notes)

Pressures on a wall, assuming undrained conditions, result usually lower than the ones calculated supposing drained conditions, so, generally speaking...

| ASSUMING DRAINED CONDITIONS ... | ASSUMING UNDRAINED CONDITIONS |
|---|---|
| •Always with granular soil (sand or gravel)<br>•Always with cohesive soil having a considerable percentage of silt<br>•When long term checking a cohesive soil | •When short term (2-3 months) checking cohesive soil<br>•When the wall is temporary |

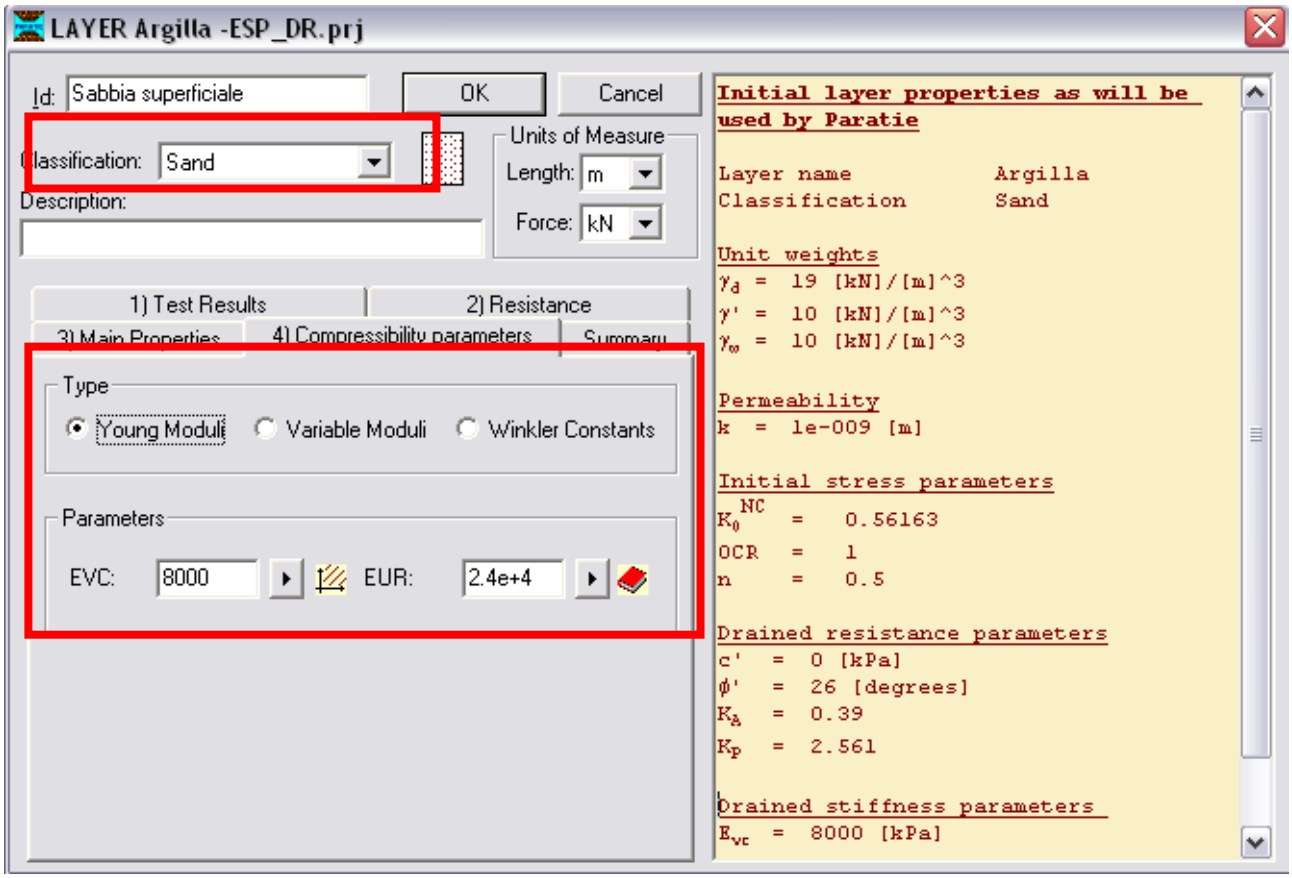
The following soil consitutive models are available in Paratie (both in the previous versions and in Paratie Plus):

- ✓ Granular soil constituve model (always drained conditions)
- ✓ Coesive soil consitutive model (drained or undrained conditions) using effective stresses – ESP.
- ✓ Coesive soil consitutive model (undrained conditions) using total stresses – ESP.

- **Drained conditions for granular soil**

In Paratie 7.0 the user chose the kind of soil in the soil eindow. To use granular soil it was enough to select *sand*.

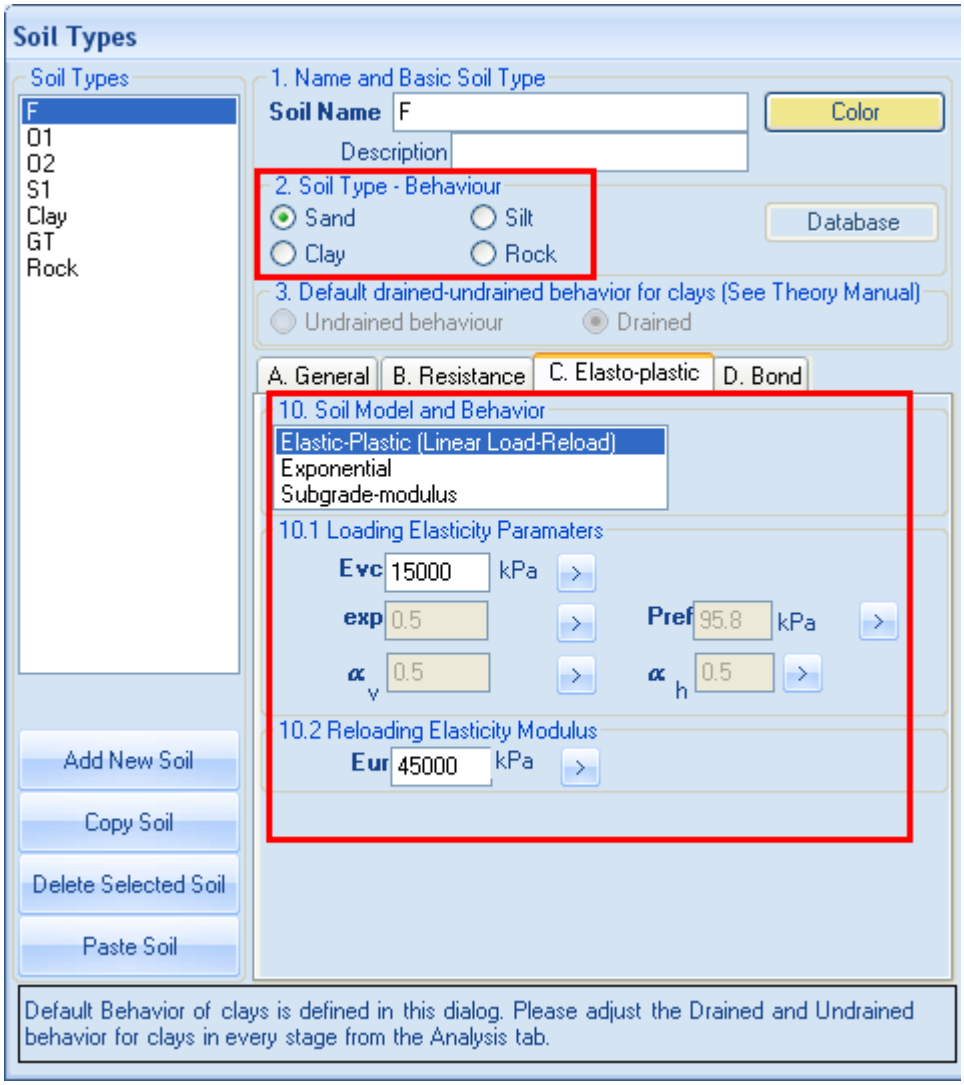
Choosing a *sand* soil the supposed behaviour was always drained.



Selecting a *sand* soil it was possible to chose among three different options:

1. Give two modulus Evc e Eur (elastic vergin compression modulus and elastic unload-reload modulus) constant with depth.
2. Consider elastic modulus variable with depth and depending on external pressure.
3. Give directly Winkler stiffnessr

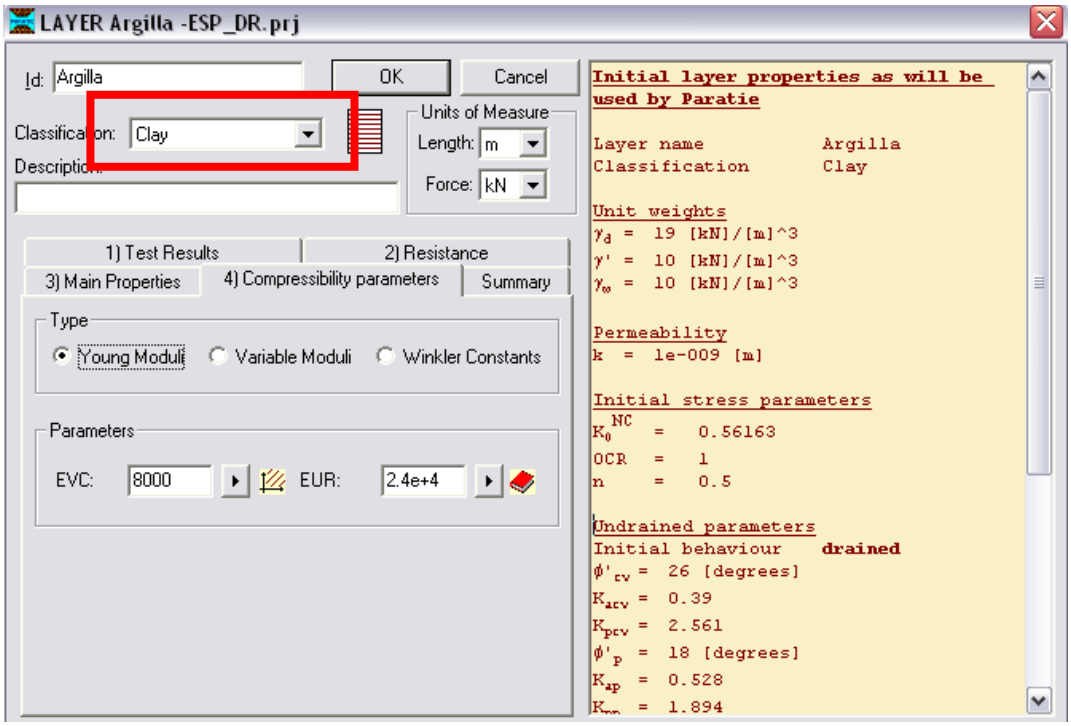
In a similar way the user can set the same options in Paratie Plus:



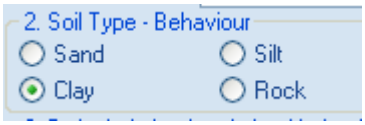
*Silt* and *rock* soils are modelled like a sand soil. Selecting then *silt* or *rock* only conventional analysis results are affected and, using *rock*, the embedment check in non-linear analysis.

- **Coesive soil – Drained and undrained conditions**

Selecting *Clay* in Paratie 7.0, the cohesive soil consitutive model is activated.




The same is in Paratie Plus:



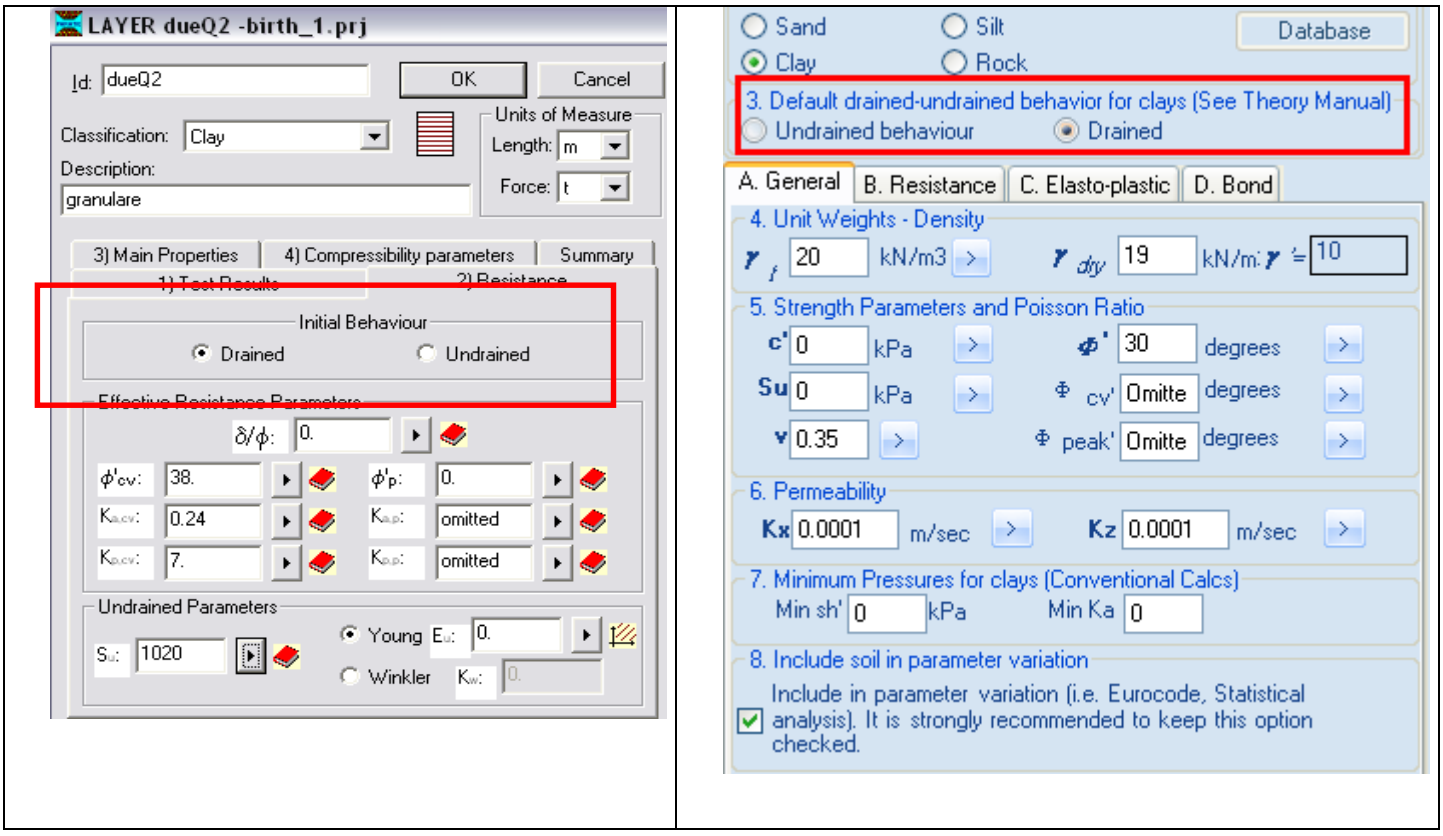

Selecting a Clay constitutitive model the user can choose to consider the soil drained or undained and to use an ESP or TSP model. (cfr Theory manual)

The following table summarizes every possible cofiguration:

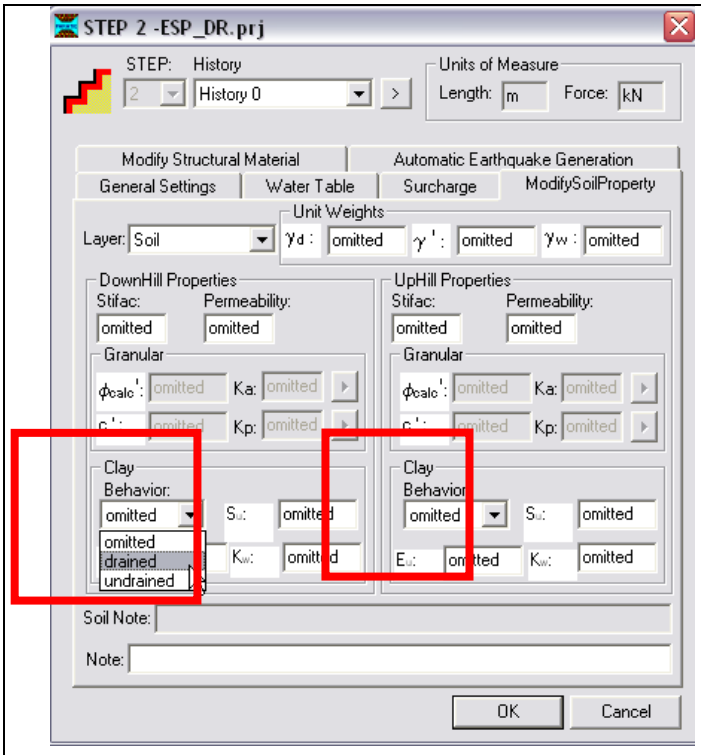
| | | A | B |
|---|---|---|---|
| | *MODEL* | *DRAINED* | *UNDRAINED* |
| **1** | *ESP (Effective stress path)* | YES | YES |
| **2** | *TSP (Total stress path)* | NO | YES |

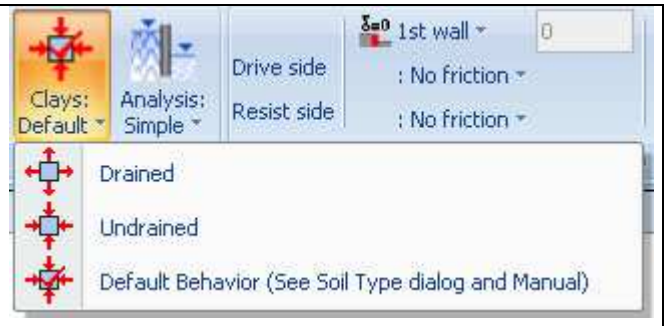
***Configurations A –1 e B-1 (ESP MODEL)**:*

Select the initial behaviour:

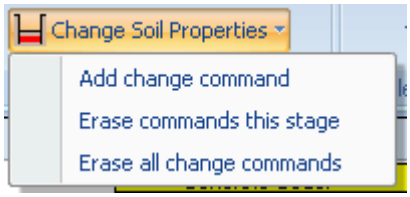


If necessary the user can modify stage by stage clays behaviour through this window:

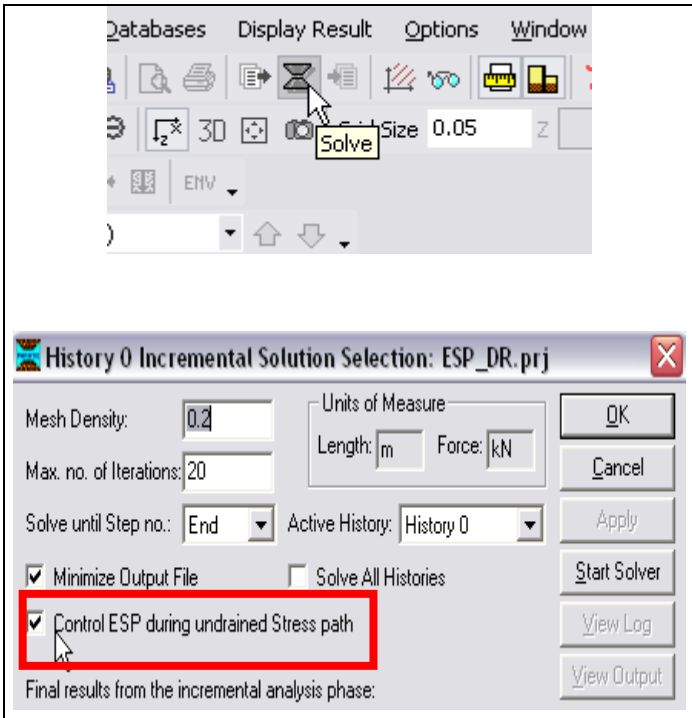
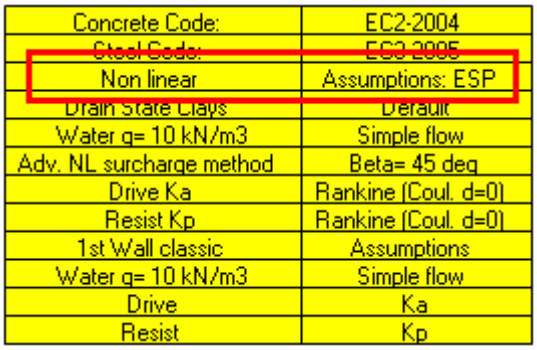



When the user modifies clays behaviour under *Analysis* menu, the changes regard both uphill and downhill ground, for the actual stage. Selecting *Default* the behaviour will be the one defined in the *Edit sol tipe data* window. To distinguish between uphill and downhill ground behaviour use the

| | |
|---|---|
| | option *Model/Advanced/Change soil Properties*:   |

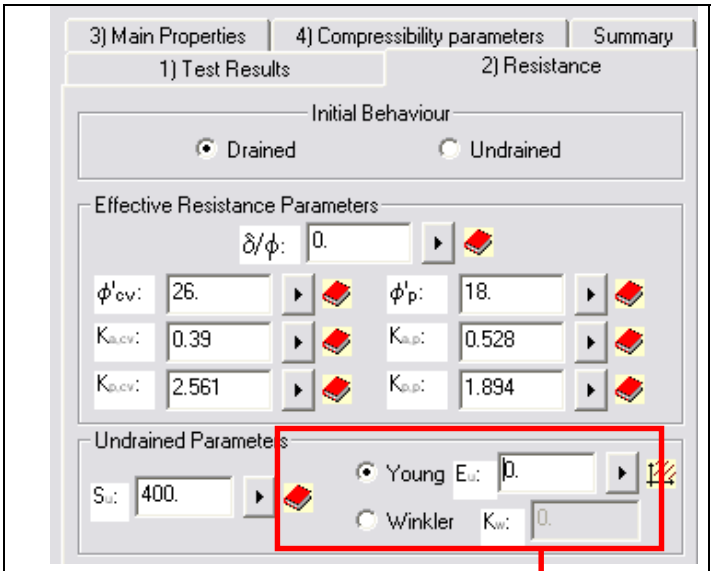
Configure ESP before starting the analysis:

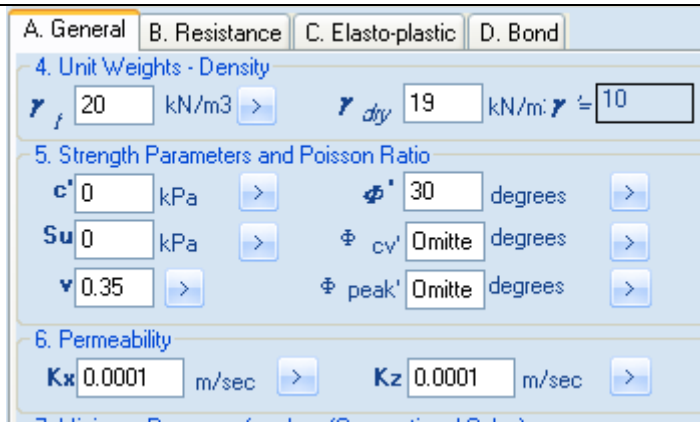
| | |
|---|---|
|   | In Paratie Plus it is a default option.   |

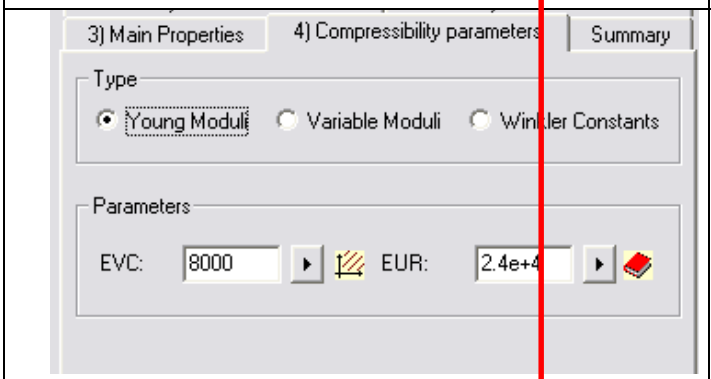
The ESP costitutive model allows to change the soil behaviour from drained to undrained (and vice versa) during any stage.

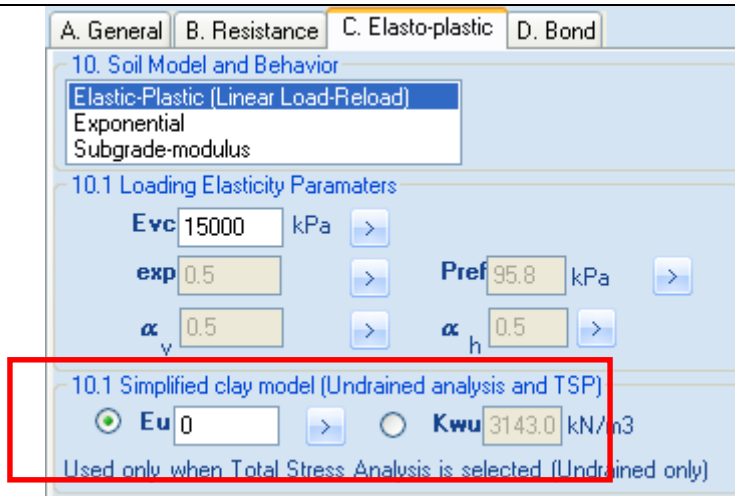
If an ESP model has been chosen the parameters in the red frame ( in the following figure ) are not to be considered.

The Su parameter in ESP model is not essential, it is used as external border of the elasto-plastic field (refer to the documents included into the installation folder or page 14).






This parameters are ignored by the ESP model.

Elastic modulus used are the same of the sand model.

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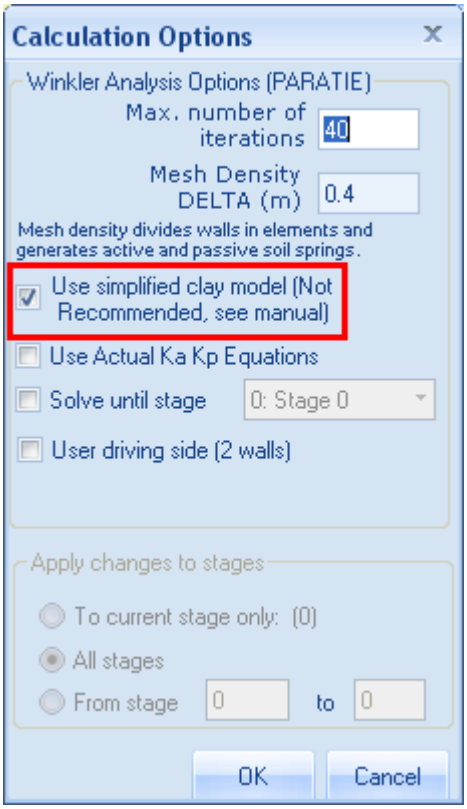
***Configurations B-2 e B-1 (TSP MODEL)**:*

Under Analysis menu it's possible to set TSP model:

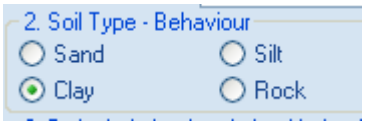



Selecting the option in the red frame, the yellow window will be updated:

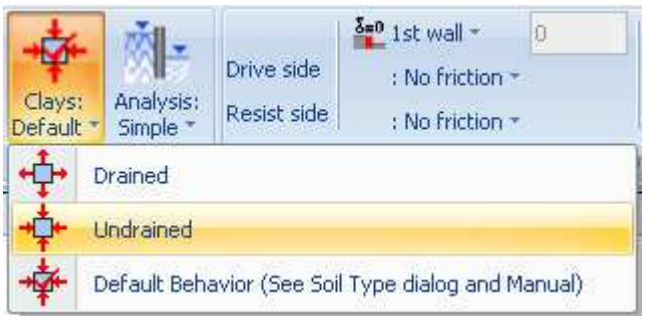
| | |
|---|---|
| Concrete Code: | EC2-2004 |
| Steel Code: | EC3 2005 |
| Non linear | Assumptions: TSP |
| Drain State Clays | Default |
| Water g= 10 kN/m3 | Simple flow |
| Adv. NL surcharge method | Beta= 45 deg |
| Drive Ka | Rankine (Coul. d=0) |
| Resist Kp | Rankine (Coul. d=0) |
| 1st Wall classic | Assumptions |
| Water g= 10 kN/m3 | Simple flow |
| Drive | Ka |
| Resist | Kp |

TSP model has one plain limit: it is impossible to turn from an undrained to a drained condition (effective stresses are lost).

So, in order to analyze a model composed by *n* drained stages and following *m* undrained stages (THIS is possible), the user can select the same functions senn for the ESP model:

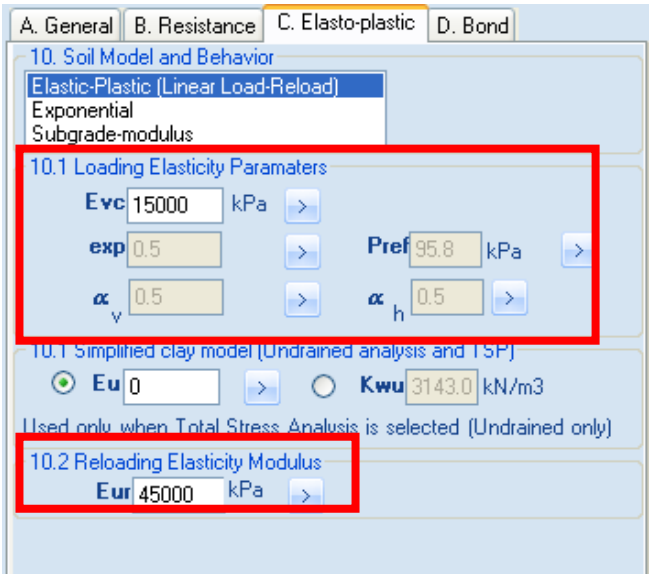



and in all *m* undrained stages:

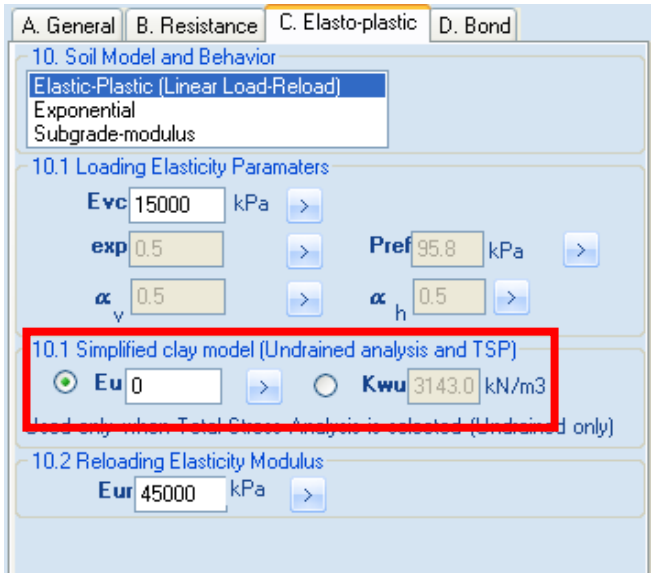



If, after an undrained stage, a drained stage is setted the model will surely collaps!

The solver launches, for the first *n* drained stages, th ESP model and then the used soil elastic modulus will be:

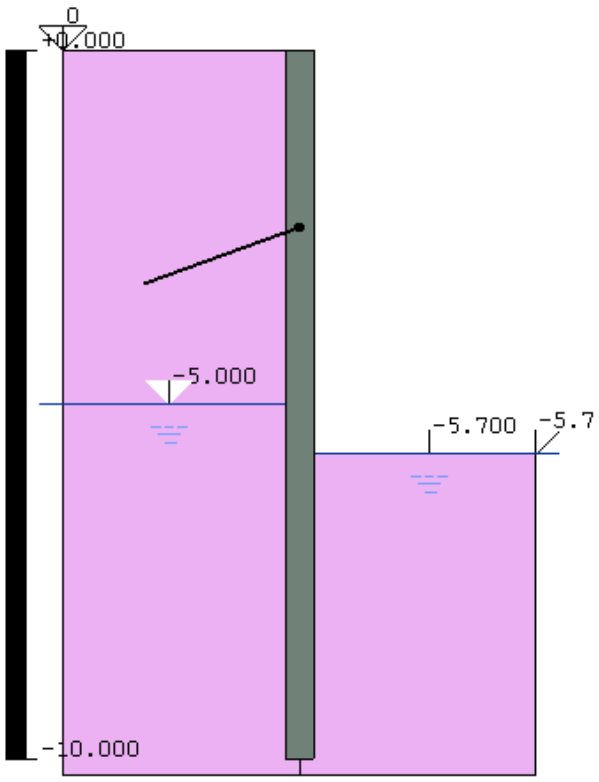


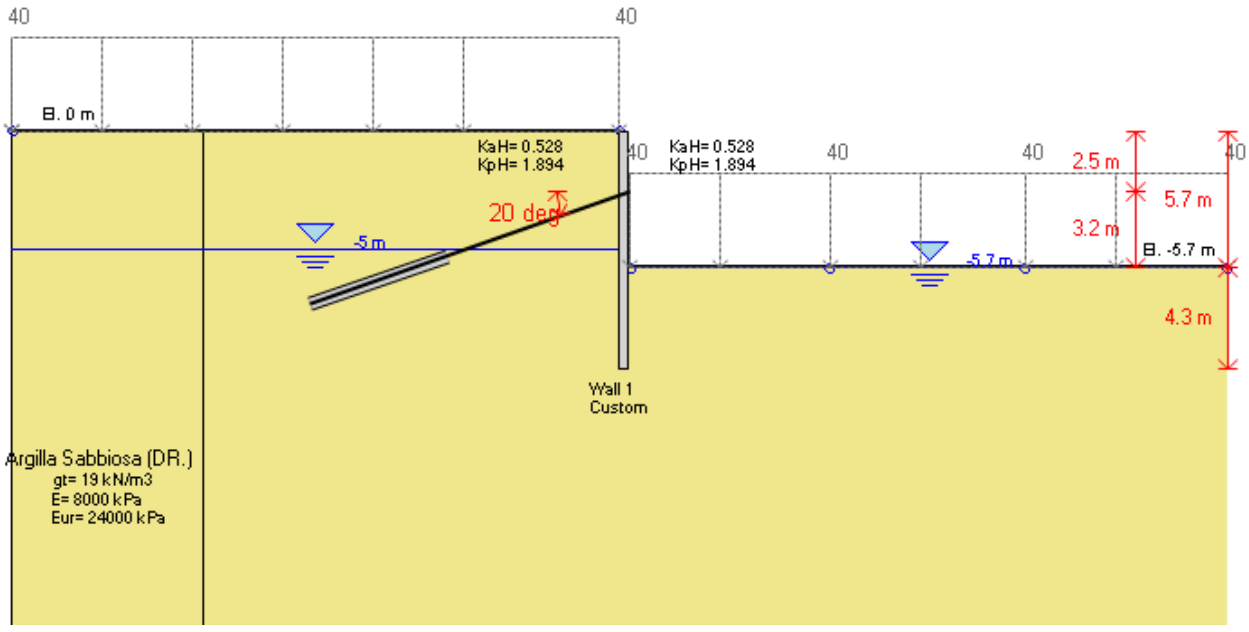

The soil elastic modulus used for the *m* undrained stages will be:




During the undrained steps, $S_u$ has now an essential role if a TSP model has been chosen.

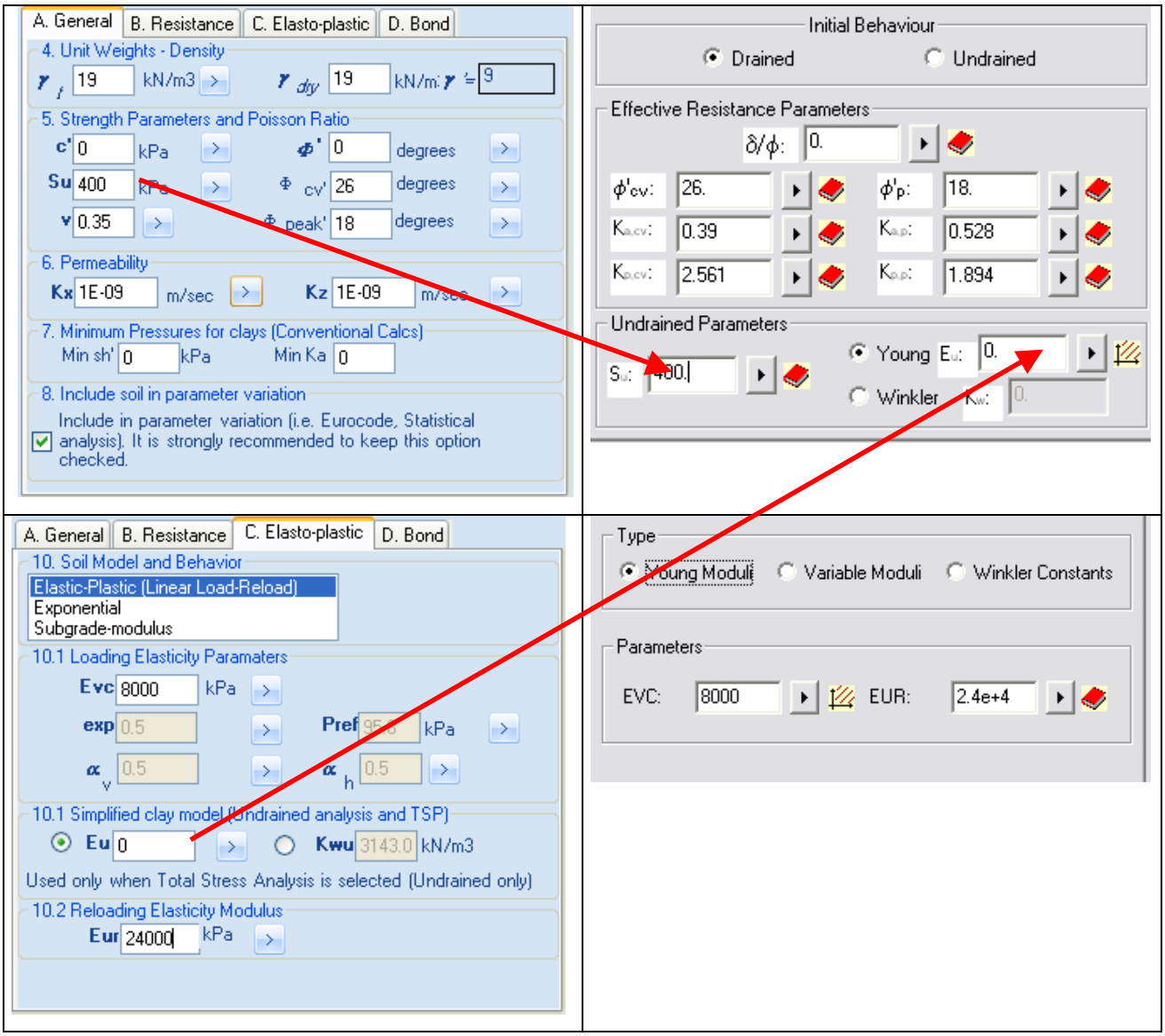
**COMPARISON BETWEEN CLAY ESP MODEL IN PARATIE 7.0 AND PARATIE PLUS**



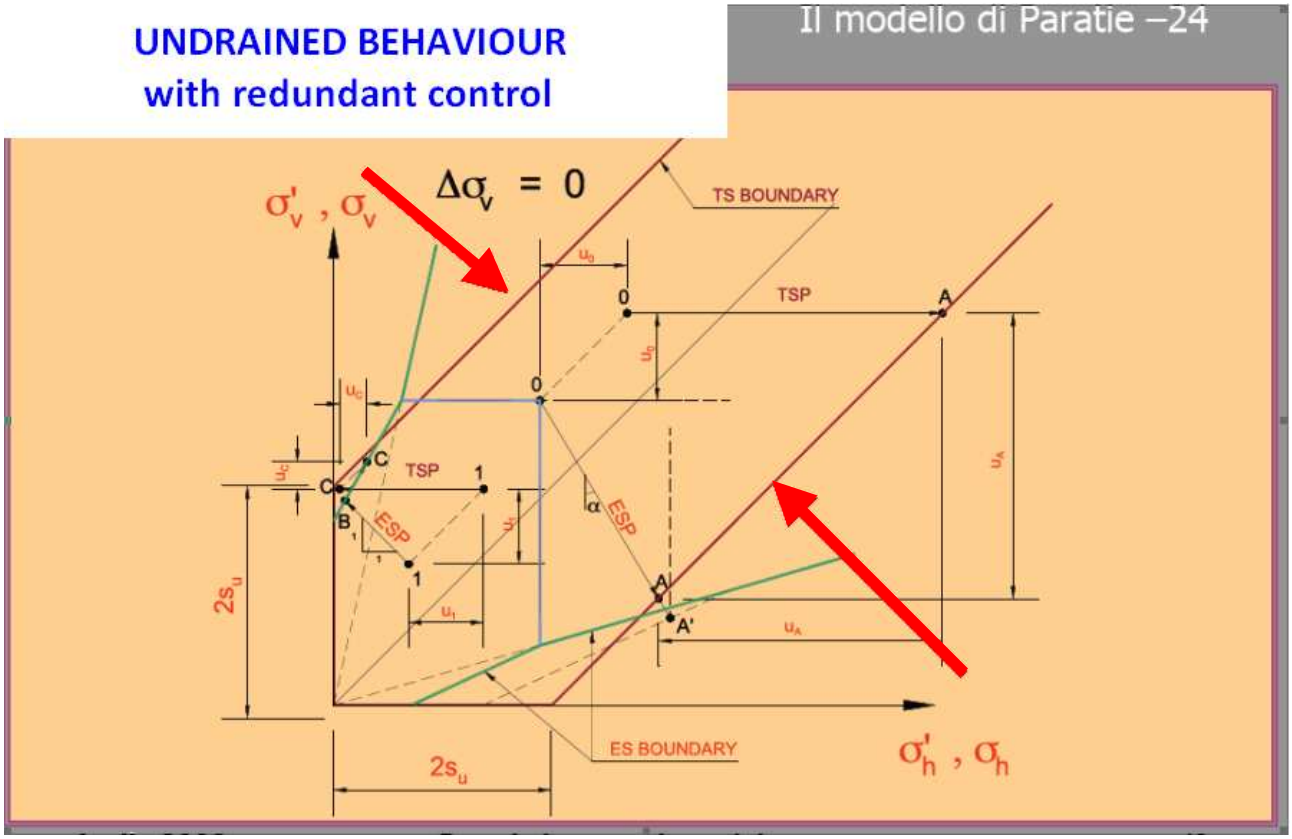



*Stages:*

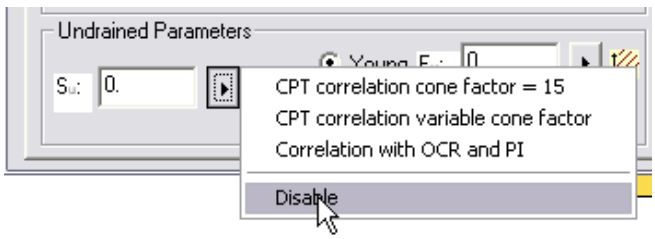
| | |
|---|---|
| Overconsolidation | Drained |
| Geostatic step | Drained |
| 1° excavation | Undrained |
| Tieback | Undrained |
| 2° excavation | Undrained |
| Long term | Drained |



Su has been setted as 400 kPa; this means NOT to consider it; that is to put a very far from the boundary limit to the elasto-plastic field.



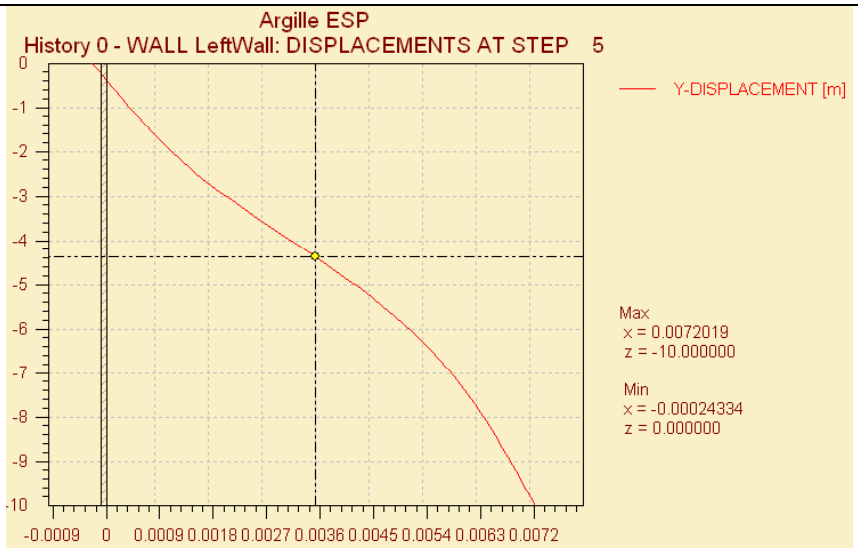
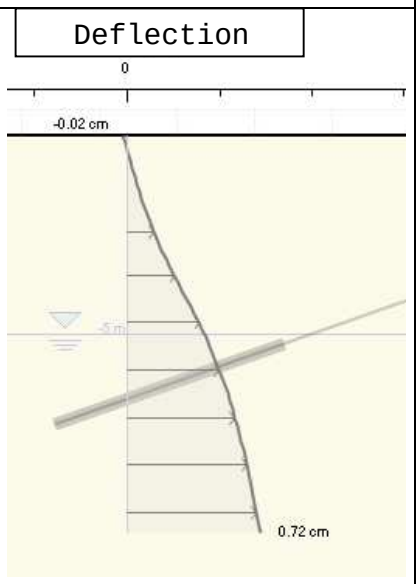
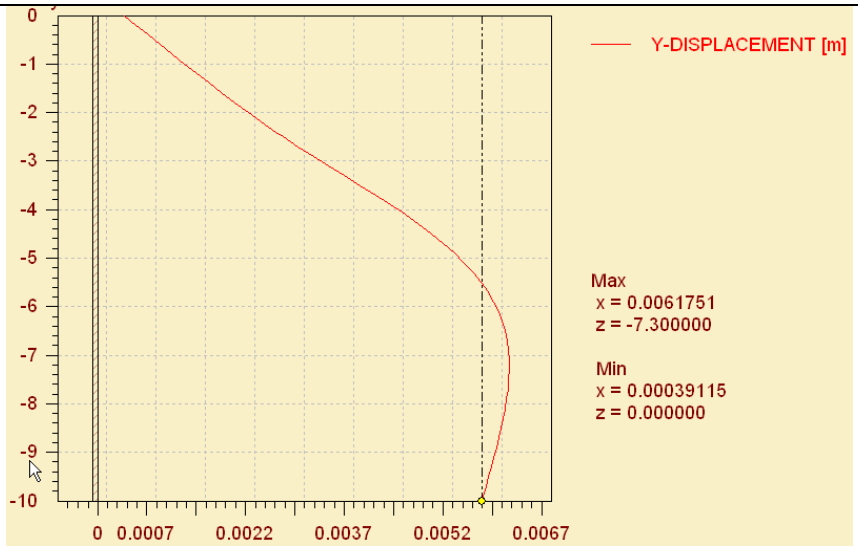
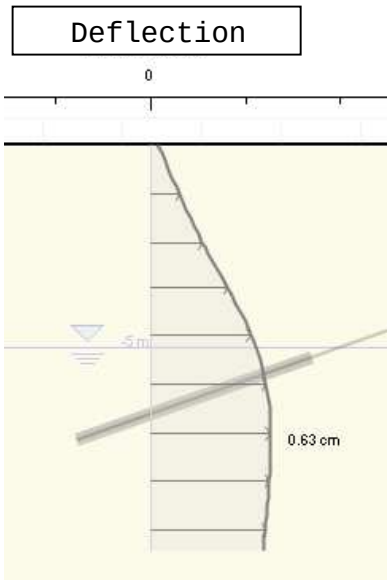

In fact in Paratie 7.0, when the user selected disable:

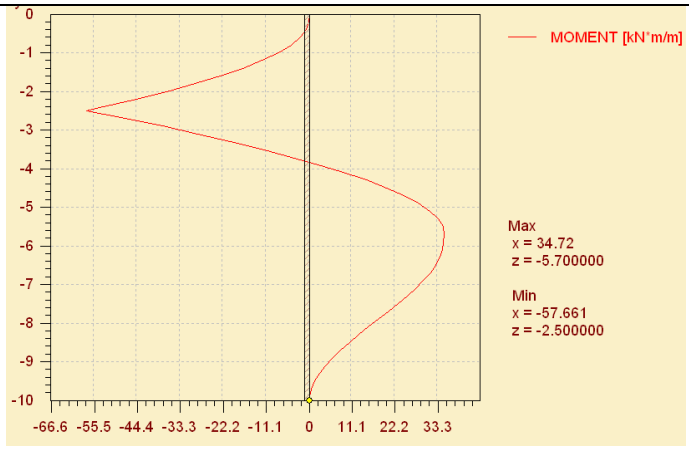
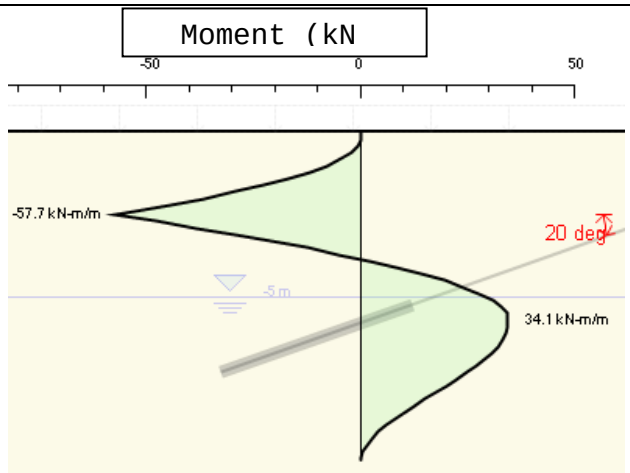
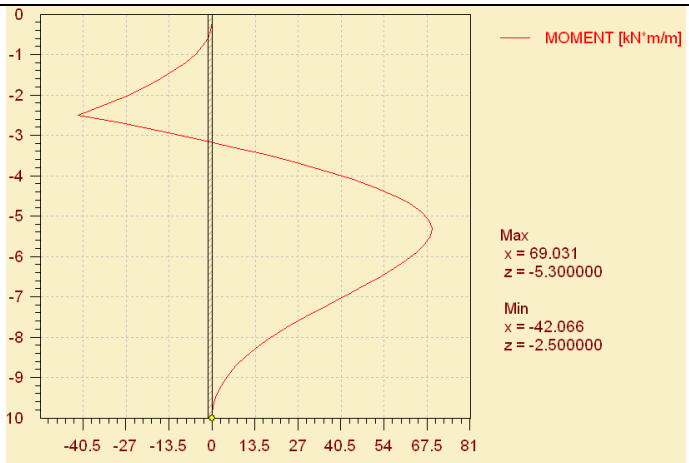
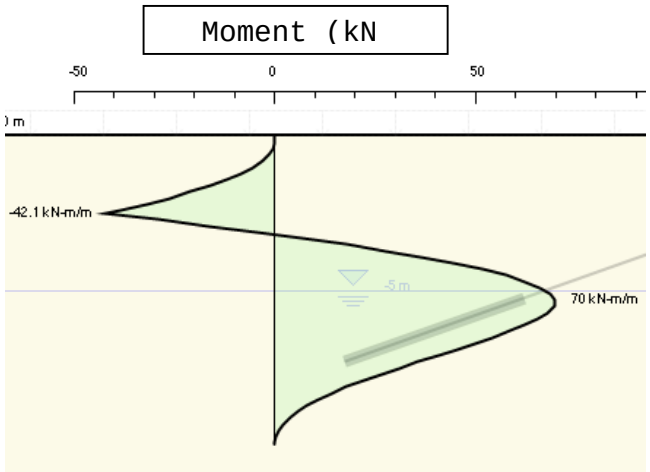



the parameter was brought to a very high value.

This option (disable) is no longer available in Paratie Plus, because Su could be used by the conventional analysis.

The measure than is to force a high value (write 400kPa).

| STAGE | DISPLACEMENTS | |
|---|---|---|
| 2° excavation |  |  |
| L.T. |  |  |

| STAGE | MOMENTS | |
|---|---|---|
| 2° excavation |  |  |
| L.T. |  |  |

**COMPARISON BETWEEN CLAY TSP MODEL IN PARATIE 7.0 AND PARATIE PLUS**

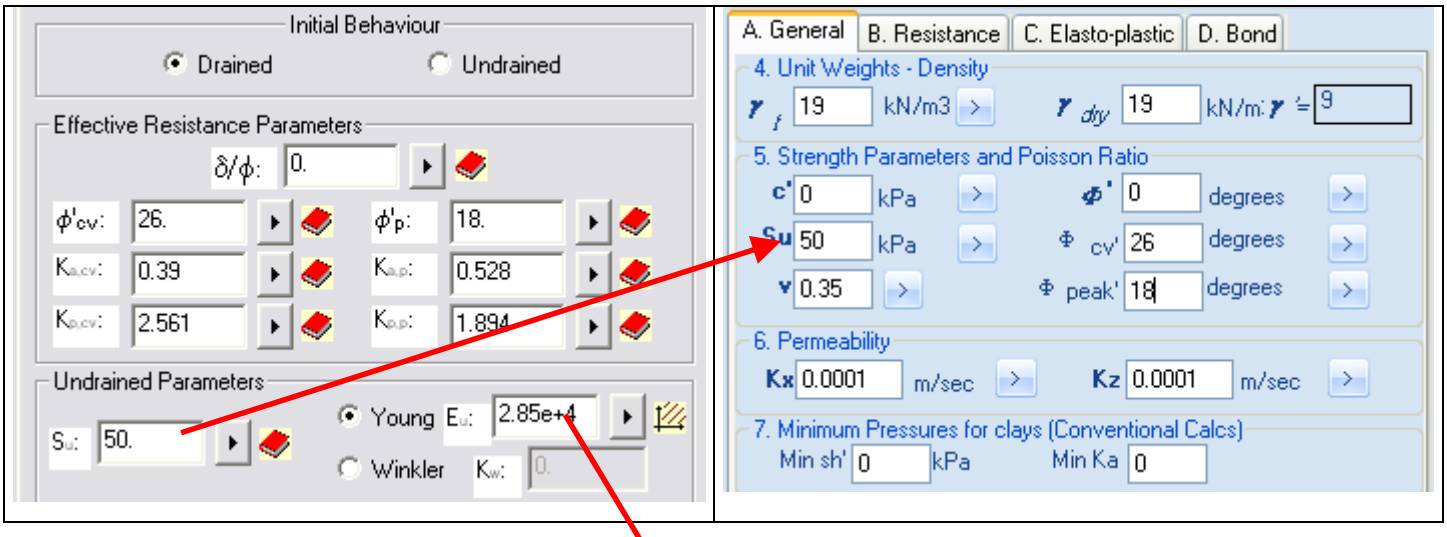
Consider now the same model seen before: this will be analysez using a TSP model.

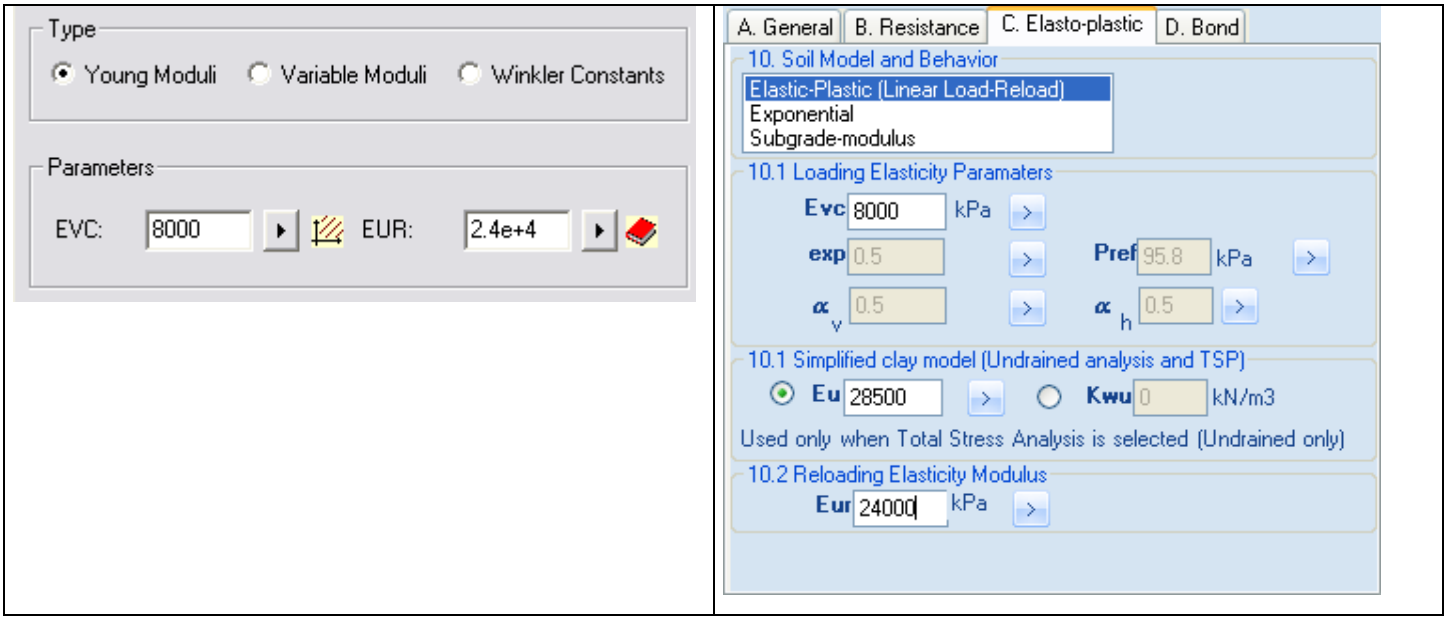
The last drained stage must be removed (using a TSP model it is impossible to turn from undrained to drained behaviour).

The essencial parameters for TSP model are:

- Su
- Eu (or kwu)

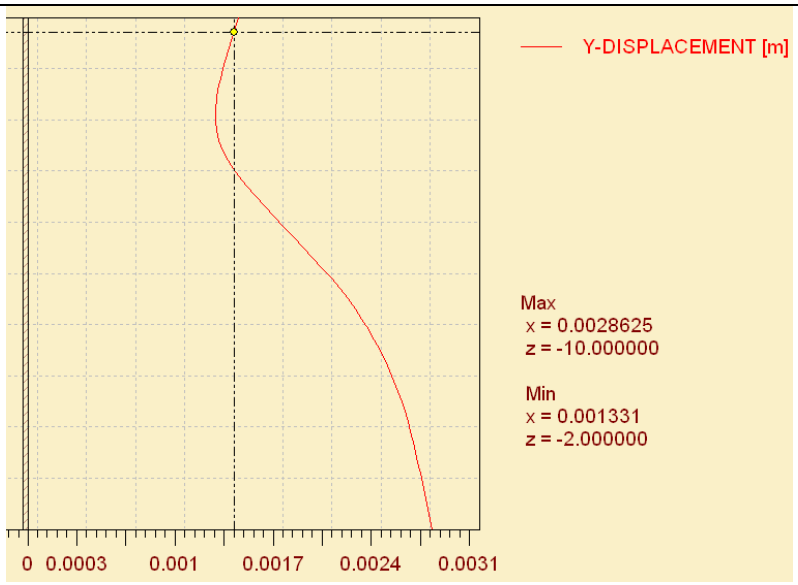
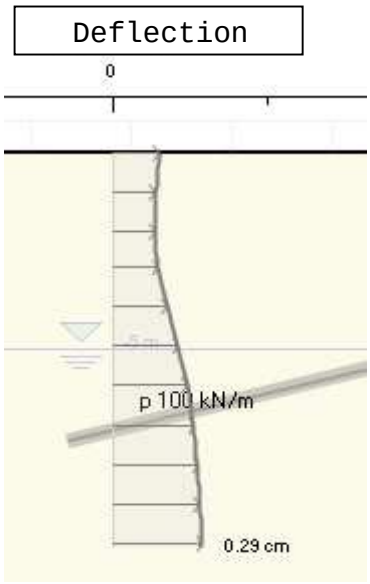
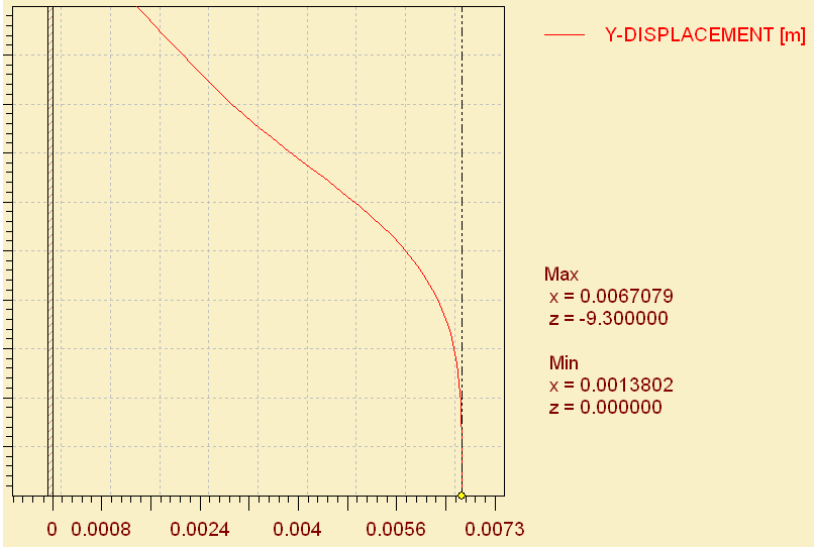
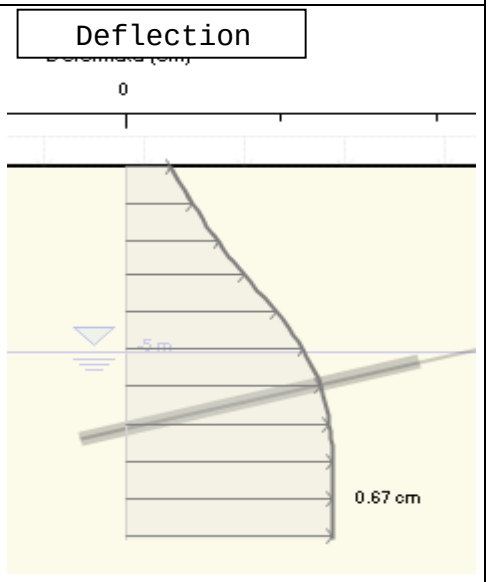
Then:

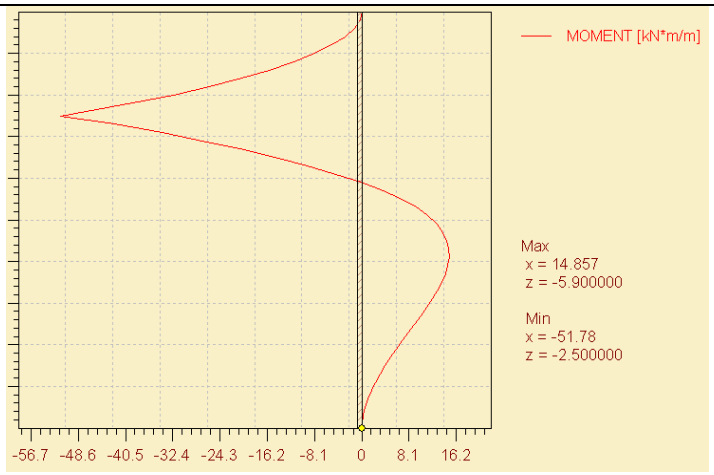
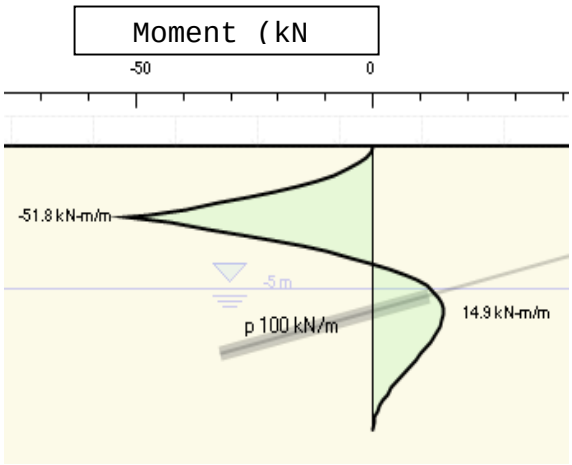
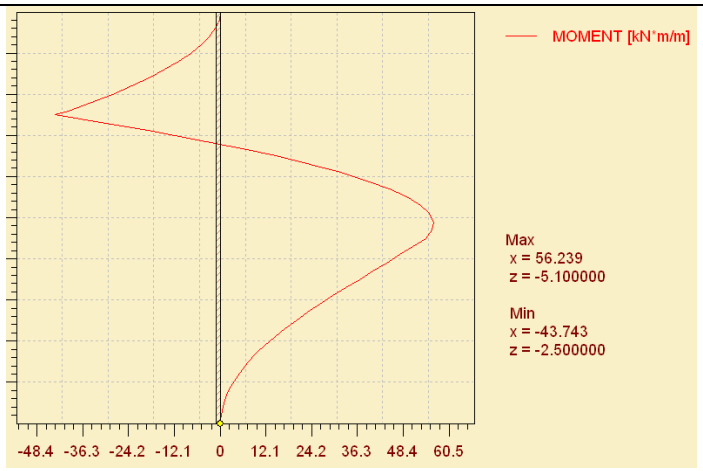
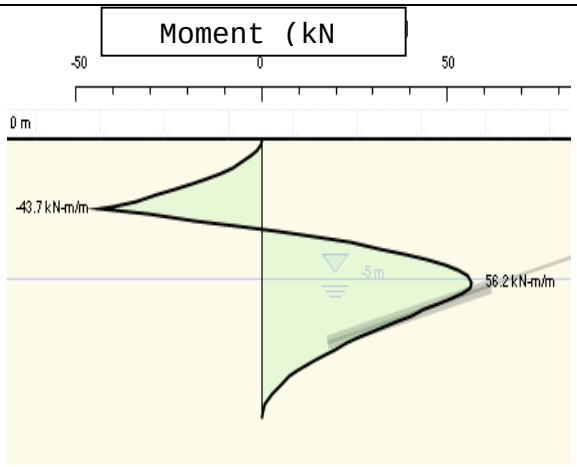





*Stages:*

| | |
|---|---|
| Overconsolidation | Drained |
| Geostatic step | Undrained |
| 1° excavation | Undrained |
| Tieback | Undrained |
| 2° excavation | Undrained |

| STAGE | DISPLACEMENTS | |
|---|---|---|
| Tieback |  |  |
| 2° excavation |  |  |

| STAGE | MOMENTS | |
|---|---|---|
| Tieback |  |  |
| 2° excavation |  |  |