• **PREFACE**

This document have the aim to explain all the functions of this tool and it contains an example of calculation report of a Pile.

First of all, I have to specify that the calculation of the bearing capacity is done in accordance with eurocode 7 and the user can choose the design approach 1 and the design approach 2. The user can also choose which contribution take in count for the calculation of the bearing capacity (cohesion, base capacity and side capacity).

For second, I’m sorry for the possible language imprecisions or errors, all the phrases that I was not able to translate with my knowledge were translated using “google translate”. However you can edit or add a language simply traslating from english the words or phrases in “Base” sheet.

The spreadsheet is organized in many sheets, but the user can use only some of them. The main sheet is named "KW" where it can be managed the 80% of the workflow. In addition to the "KW" sheet there is the sheet "Report", where the user can see a preview of the calculation report and can see the results of the length optimization analysis.

For any suggestion or doubt don't esitate to contact me at: stefano@pasquiniprogetti.eu

• **SOIL DEFINITION**

When the user run the spreadsheet, will be automatically selected the main sheet, where the workflow of the commands is organized by steps; the first one is the soil definition.

As shown in the following picture, there are three options:

If the User select the "INPUT SOIL LAYER PROPERTIES" command, it appear the following dialog form, where it can be defined:

1. The layer description;
2. The layer thickness, in meter;
3. The friction angle, in degrees;
4. The layer density, in KN/m3;
5. The cohesion, in KN/m2. This value can be assumed also equal to zero. It happen often that the units of this property is different from the one that the user need, so the user can use the tool "CONVERSION TOOL" present in the bottom left side of the form, as shown in the following picture:
6. The layer subdivision, number. This value is used to define the subdivision of the layer, by default this value is set to 2 times of the layer thickness, so that the user have one point each 0.5 m.

Once the User have completed to digit the soil data, he have some options:

a. **Store Layer**: to save the data in the table, and type the data for the next soil layer. The form will be closed only when the User click on the "CLOSE" button, so it can be loaded all the layers that the user need in only one session.

b. **Calculate Kw**: to calculate the value of the K coefficient to be assigned in the various Z values. The K coefficient is calculated according with the Bowles Formula and it can be generated at the end of the soil definition or at each layer definition.

c. **Generate Pile**: to load the dialog form for the pile generation in Robot or for the calculation of the Bearing Capacity and much more. This command will be explained later.

The user have also the option to "EDIT SOIL LAYER PROPERTIES" and all the options are identical to the definition of the properties already described, with the only difference that it can be selected a stored layer (by description) and all the properties will be load in the form. Simply type the variations and click on "EDIT LAYER" to update the soil properties. Don't forget to update the calculation of the Kw coefficient after edited some values. Layer thickness and layer subdivision can't be edited.

When the user run for the first time the Soil layer definition command, it will be asked to define the PILE DIAMETER. This value is used to calculate the Kw values.

With the command "DELETE SOIL PROPERTIES", will be erased all the data related to the soil, included the ones present in the calculation report and the results and node imported from Robot.
### IMPORT NODES AND REACTIONS

In this section, the user have the option to import from Robot the "Nodes List" of the support that have to be checked and the "Combination List" of the load combination that have to be checked for each node.

For Node List as for Combination List, it can be copied and pasted from Robot Selector or it can be typed manually by the user. It can be digit as a single number (for example node 70 or combination 32) as a complex selection (for example node 1to10 or 10to100by5 or combination 12to67). The macro will translate this selection and create a clean list of all the elements.

When the user click "IMPORT NODE LIST FOR ANALYSIS" the following form will appear:

The User can Paste the Robot selection or digit manually the selection, then select the language used in Robot and press "CREATE NODE LIST". The node list will be created in an apposite sheet and will be presented in the KW sheet as in the Report sheet.

The same behaviour for the "IMPORT REACTIONS FROM ROBOT" command, where the User have to specify the combination list and the number of the components.

When the User click on "CREATE COMBINATION LIST", will be created the List of the combination number and relative component, one for each row in the table, then, one by one, will be created the list of the N value of the reaction and will be calculated the optimal length of the pile, calculated in function of the settings that have to be done in the "CREATE CAPACITY/LENGTH DIAGRAM" command that will be shown during the process, and its properties will be explained later.
In the "CREATE CAPACITY/LENGTH DIAGRAM", the User can set all the parameters that have to be used for the calculation of the bearing capacity of the pile, in function of the length. By default the starting Pile Length is set to 6 m, and the End Pile Length is set to the global soil thickness. However, the User can edit these values in function of its needs, and have also set the following parameters:

a. Consider or not the cohesion contribution in bearing capacity;
b. Consider or not the Side capacity contribution in bearing capacity;
c. Consider or not the Base capacity contribution in bearing capacity;
d. Define the Groundwater level, by default the value is set as soil global thickness, so the groundwater level have no influence in the calculation of the bearing capacity;
e. Choose the design approach.

When the user run the analysis will be created the diagrams (COMB.1 and COMB.2 for design approach 1 and only COMB.1 for design approach 2) that can be activated with the "Comb.1 Diag" or "Comb.2 Diag." button.

The Bearing Capacity is calculated with the "TRADITIONAL TENSIONAL METHOD", and all the values for a manual verification are presented in the calculation report.
PILE DEFINITION

Once the user have generated the list with the optimized pile Length, the piles can be created in the Robot model to run the complete analysis and the rc design of the piles.

Clicking at the "GENERATE PILE IN ROBOT" command, the following form will be shown:

Where all the settings are the same of the previous form, except for:

- Pile Diameter
- Select Pile Type
- Node Number in Robot
- Pile Length
- Calculation Theory
- Consider the Cohesion
- Consider the Side Bearing Capacity
- Consider the Base Bearing Capacity
- Design Approach 1
- Design Approach 2

Calculate the bearing capacity
1. Pile Type, as shown in the following Picture:

It can be choose 12 different type of piles, **ONLY FOR THE CALCULATION OF THE BEARING CAPACITY CONSIDERING THE GROUP EFFECT**, the generation in Robot is always for a single pile under an existing node!!! The User can create, in function of the model geometry, the pile group shape assigning previously nodes and restraints.

2. Node number in Robot: The User have to type here the node number where will be created the pile. It can be typed only nodes one by one, for example node 70. The Form will be closed only when the User click on "CLOSE" button, so it can be generated all the piles that the User want, one by one, clicking on "CREATE PILE IN ROBOT" Button.

3. Pile Lenght: to specify the length of the pile that have to be generated in Robot. Is strongly raccomended to not use half measure (for example not 10.5 or 18.3) but only exact meter length (10 or 18).

In this Form the user have also the option to edit the pile diameter, clicking on "EDIT" Button.

Once all the settings are done, click on "CALCULATE CAPACITY" button to create the calculation report and to check on screen the capacity value of the pile, then click on "CREATE PILE IN ROBOT" Button to create pile in Robot or click on "PLOT REPORT" to plot the calculation report in Microsoft Word.

**REPORT**

In this section the User can plot the calculation report in Microsoft Word clicking on "PLOT REPORT" or click on "GO TO THE REPORT PAGE" button to access to the design report page.
**SETTINGS**

In this section the User can set its working language, this will be used also in the calculation report.

![Select Language](image)

The following form will be shown

![General Settings](image)

Is it possible to edit or add one language simply clicking in the "LANGUAGE BOARD" button and translating from english all the words or phrases present in the sheet

![LANGUAGE BOARD](image)
In the Report sheet the functions are the same of the KW sheet, and are shown in the following Pictures:

- **Robot Data**
  - Import Node List for Analysis
  - Import reactions from Robot

- **Creation of the Node List in Report**
  - Language selector and List
    - Combination(s) in Robot
    - Number of the components: 1

- **Report**
  - PLOT REPORT

- **LINKS**
  - Back to Analysis Sheet
  - LANGUAGE BOARD
  - COMB.1
  - COMB.2

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**Ing. Stefano Romeo Pasquini**
Tel./Fax +39.085.8561045 - cell. 328.9589857 - e-mail. stefano@pasquiniprogetti.eu
CALCULATION REPORT EXAMPLE

The following report is referred to the calculation of the bearing capacity of a r. c. pile.
Here will be shown all the assumptions

CALCULATION ASSUMPTIONS

<table>
<thead>
<tr>
<th>Calculation method:</th>
<th>Tensional method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design approach:</td>
<td>Design Approach 2</td>
</tr>
<tr>
<td>Load combinations:</td>
<td></td>
</tr>
<tr>
<td>Load combination 1</td>
<td>(A1+M1+R3)</td>
</tr>
</tbody>
</table>

PILE PROPERTIES

| Diameter: | 0,80 [m] |
| Length:    | 12,00 [m] |
| Groundwater level: | 6,00 [m] |
| Pile weight: | 120,64 [KN] |
| Pile type: | SINGLE PILE |

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness [m]</th>
<th>Layer Description</th>
<th>$\phi$ [°]</th>
<th>$\gamma$ [KN/m3]</th>
<th>$c$ [KN/m2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23,00</td>
<td>Superficial Layer</td>
<td>173,00</td>
<td>13,14</td>
<td>6,00</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>Compact clay</td>
<td>27,00</td>
<td>18,00</td>
<td>6,00</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>Compact clay OC</td>
<td>35,00</td>
<td>20,00</td>
<td>10,00</td>
</tr>
</tbody>
</table>

CALCULATION OF THE BASE BEARING CAPACITY: $R_b$

Here will be shown the calculation of the base capacity of the pile, if taken into account in the assessment of the global bearing capacity.

\[
R_b = A_b \cdot (N_q \cdot \sigma_0^\phi + N_c \cdot c)
\]

$\sigma_0 = 173,00$ [KN/m2]
$N_q = 13,14$ [-]
$c = 6,00$ [KN/m2]
$N_c = 9,00$ [-]
$FS = 1,70$ [-]
$\gamma_1 = 1,35$ [-]
$\gamma_2 = -$ [-]

Group Factor: $1,00$ [-]
Number of Piles: $1,00$ [n°]

$R_b (COMB.1) = 509,57$ [KN]
CALCULATION OF THE SIDE BEARING CAPACITY: $Rs$

Here will be shown the calculation of the side capacity of the pile, if taken into account in the assessment of the global bearing capacity.

$$
\gamma_{s,1} = 1.15
$$

$$
\gamma_{s,2} = -
$$

$$
Rs_{(COMB.1)} = 1.038.50 [KN]
$$

Then, the bearing capacity of pile system, for load combination 1, is:

$$
1 \times (1038 + 509 - (1.3 \times 120) = 1391 [KN]
$$