



GAWAC 3.0

Gabion Wall Design

User Guide Manual

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V.1 | 2021

MACCAFERRI

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Introduction

The purpose of this document is to guide the user in how to use GawacWin GSC for gabion wall design. Therefore, will be demonstrated, step by step, how to define and to verify a gabion wall on the software.

Gabion wall is a kind of application for geotechnical stabilization works. Whenever this solution is indicated for a project, the designer must verify the external analysis in the Ultimate limit state (Sliding, overturning, global stability and bearing capacity). However, the internal stability is an essential analysis to evaluate serviceability state of the gabion. This software contains the new method of serviceability for gabions, the GSC (Gabion serviceability coefficient)



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GAWAC 3.0
Gabion Wall Design
2020

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Expire date:
2021.04.30

GAWAC 3.0 r3.0.47.001 | 2021.03.30

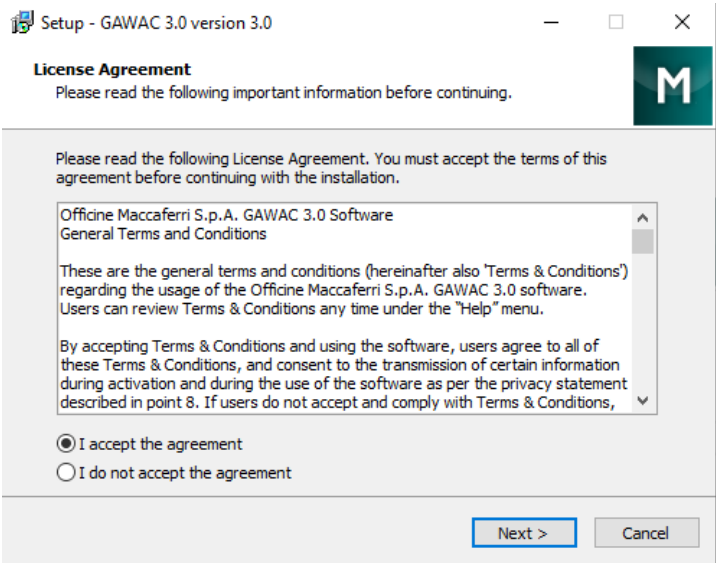
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Software Installation

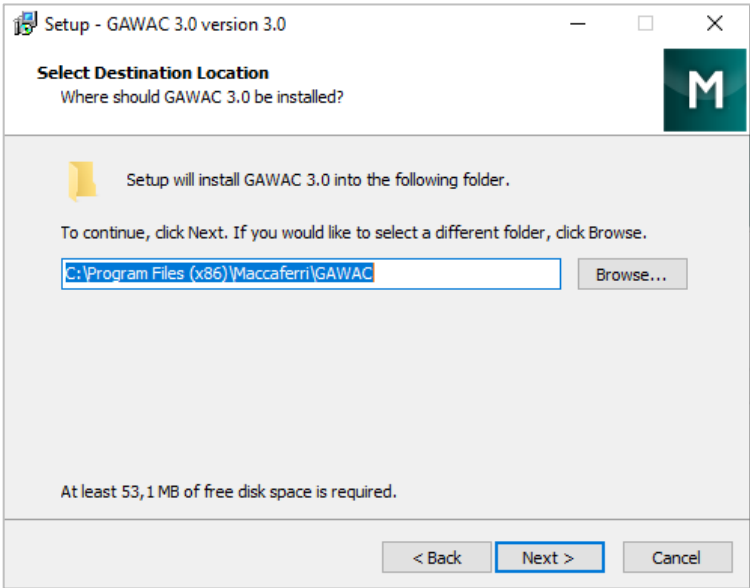
To install the software, execute the file Gawac Set up:

 Setup_GAWAC_3_0.38B.exe	12/11/2019 17:28	Aplicativo	16.009 KB
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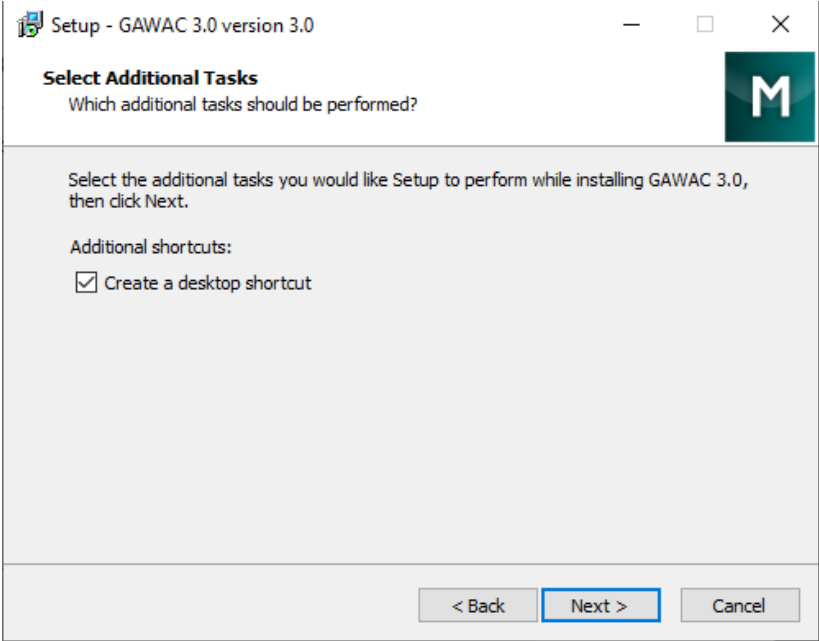
Click on next, then read the agreement. If you accept this, select the option "I accept the agreement" and click on the button next.



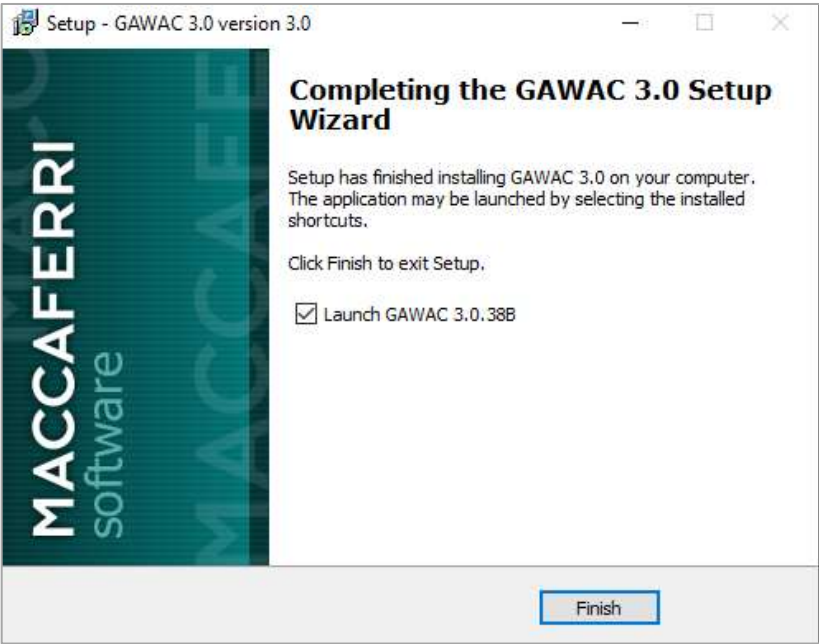
Select a folder to install the software:



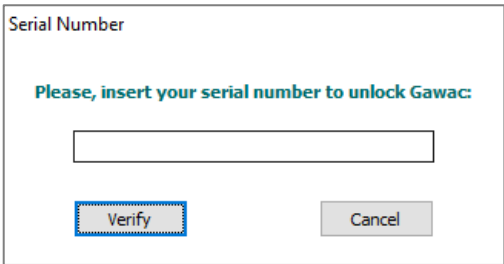
You can create a desktop icon:



At the end, click on the button "Install" and Finish the installation:

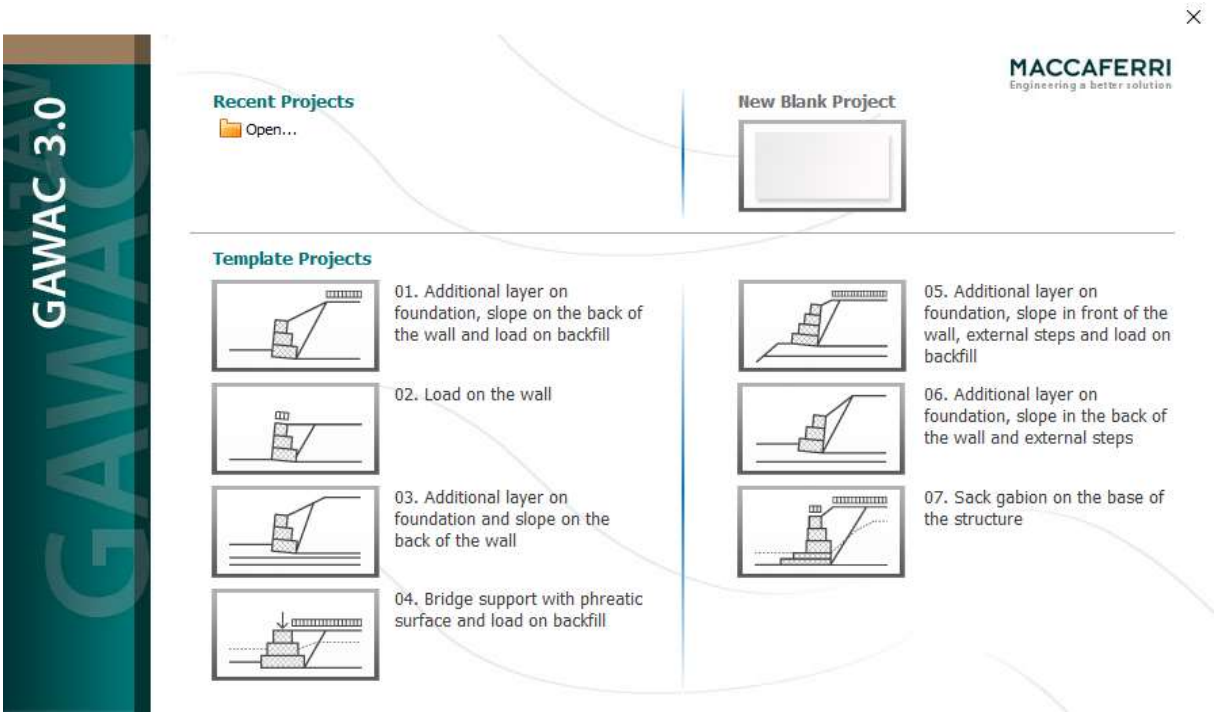


To start the Gawac, you must insert the Serial Code:



Initial Screen

By starting the software, a window with four options will show up: you can open an existent project, open the last saved project, open an example project or select one preset cross section (Template Projects). If you are doing a new project, select the option "New blank project".



The templates are a practical way to start off. After choosing one, you can modify it anyway.

Mesh Setup

After choosing a template or start a new project, the user can select the ambient of the design (**Low aggressive or High Aggressive**), then the user may choose the type of gabion. To finish this step, click in the button "Confirm".

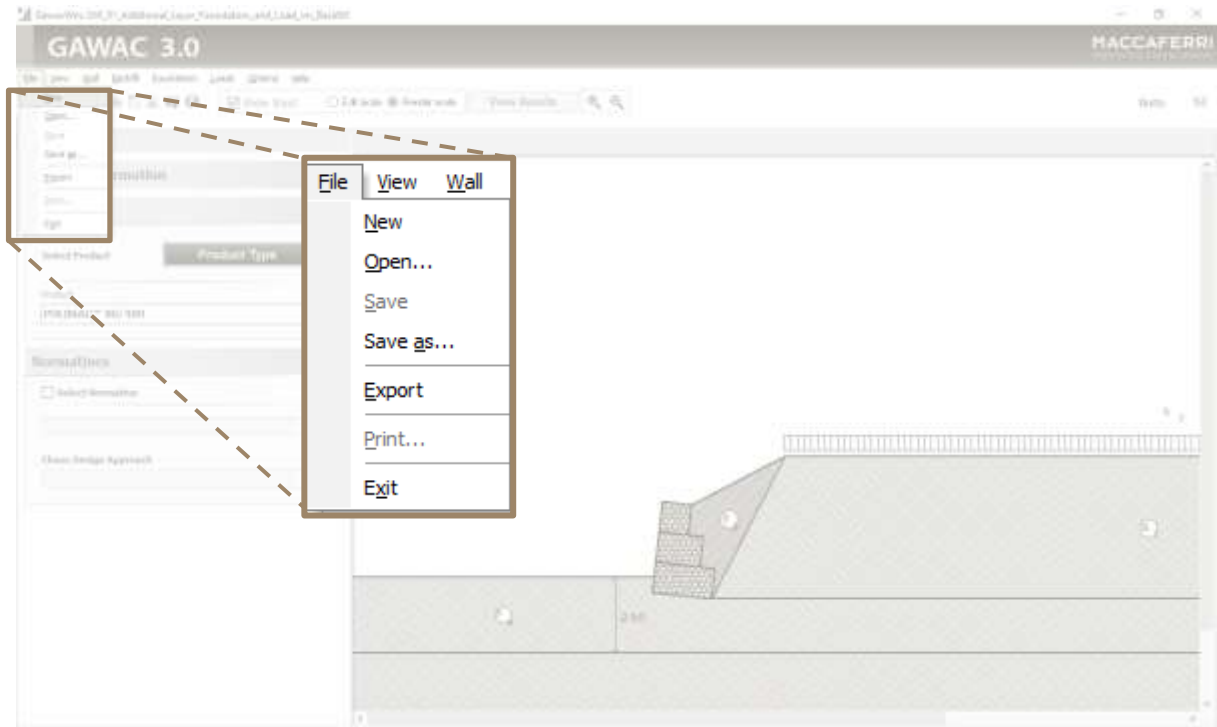
A low aggressive ambient means: Rural areas, urban areas with low level of pollution, temperate, dry or cold zone, atmospheric environment with short time of wetness.

A high aggressive ambient means: Hydraulic works, high pollution, urban and industrial areas, subtropical and tropical zone (very high time of wetness), marine and coastal areas with high salinity, shelter positions at coastline.



Menu functions

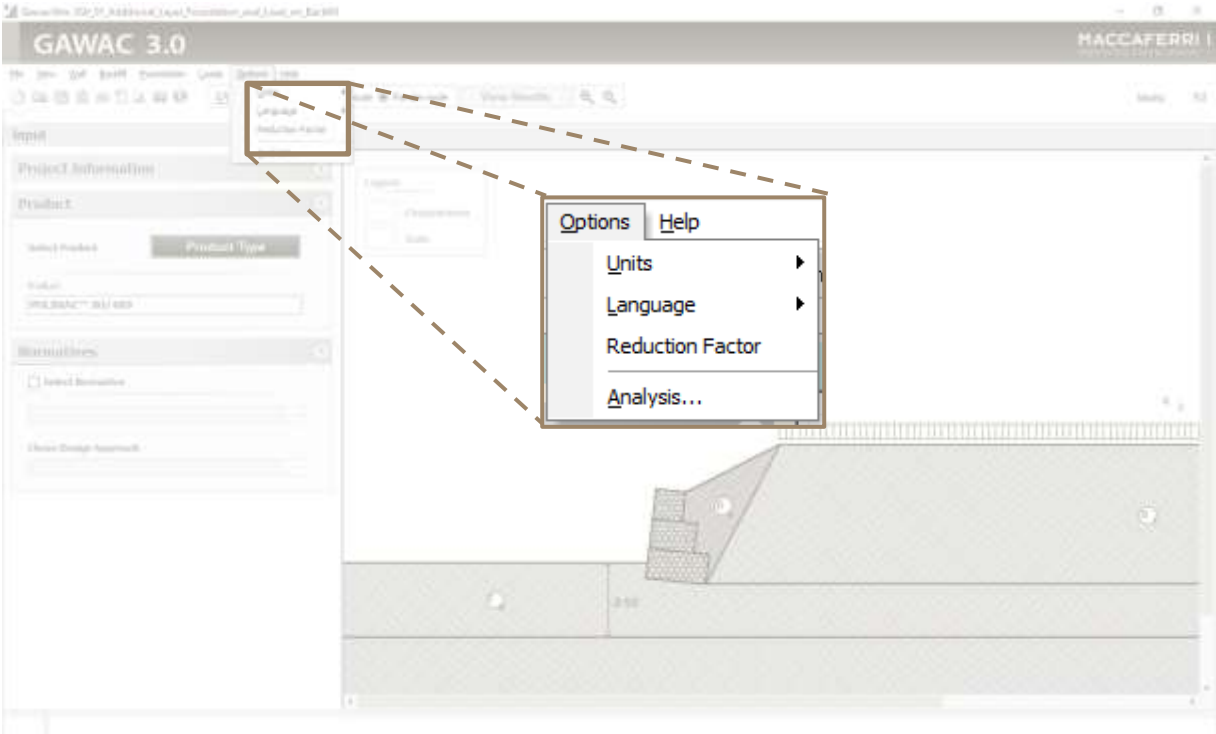
File options



Click on:

- | | |
|--------------------|--|
| New project | To start a new project |
| Open | To open an existent project |
| Save | To save the current project |
| Save as | To save the changes of the current project |
| Export | To export the model into a dxf. File (Compatible with AutoCAD) |
| Print | To print the current project |
| Exit | To close the software |

Options



Click on:

- Language** To select another language
- Reduction Factor** To see the reduction factors

Reduction factors

You can visualize the reduction factors of different types of gabion structures.



Reduction Factors

Partial reduction factors for calculation of GSC (Gabion Serviceability Coefficient) in gabion structures

Revetment	Corrosion and Environmental effects	Installation damage	UV degradation	Indetermination and Man./extrap. of data	RF 120 yr
POLIMAC	0.952	0.920	1.000	0.900	0.788
PVC	0.952	0.869	0.740	0.900	0.551
GALMAC 4R	0.500	1.000	1.000	0.900	0.450
GALMAC 95	0.250	1.000	1.000	0.900	0.225
ZINC	0.083	1.000	1.000	0.900	0.075

Reduction factor (filling material + mesh properties) 1.44

Ok

Reduction Factor

Reduction factor (filling material + mesh properties)

Two reduction factors are introduced to verify the Service Limit States to take into account both the variability of the filling properties of the gabion baskets and the mechanical properties of the mesh.

A first reduction factor ($f_{m,1}$) is introduced to take into account the variability of the filling properties of the gabion baskets. This variability is due to different causes such as different construction techniques, the skills of workers, the grading of the stones, the automatic or the manual filling. All these aspects influence the void ratio and thus the mechanical performance of the basket. $f_{m,1}$ is assumed to be equal to 1.20.

A second reduction factor ($f_{m,2}$) is introduced to take into account the variability of the mechanical properties of the mesh. This variability is due to the intrinsic variation of the mechanical performances of the raw metallic wire constituting the baskets. This is directly reflecting on the mechanical performance of the mesh and thus of the GSC. $f_{m,2}$ is assumed to be equal to 1.20.

The product of both above mentioned reduction factors gives an overall reduction factor (f_m) directly applied to the GSC value. The f_m is equal to 1.44.

$$f_m = f_{m,1} \cdot f_{m,2} = 1.20 \cdot 1.20 = 1.44$$

Ok

Analysis Options

The user can change some considerations in the menu Options > Analysis.



Analysis Options

Analysis Options

- Run Global Stability
- Run Sliding Check
- Run Overturning Check
- Run Stress on Foundation Check
- Run Internal Stability Check

Show rupture surfaces

Allow tension cracks

Passive thrust reduction (%):

Maximum backfill surface length (L/H):

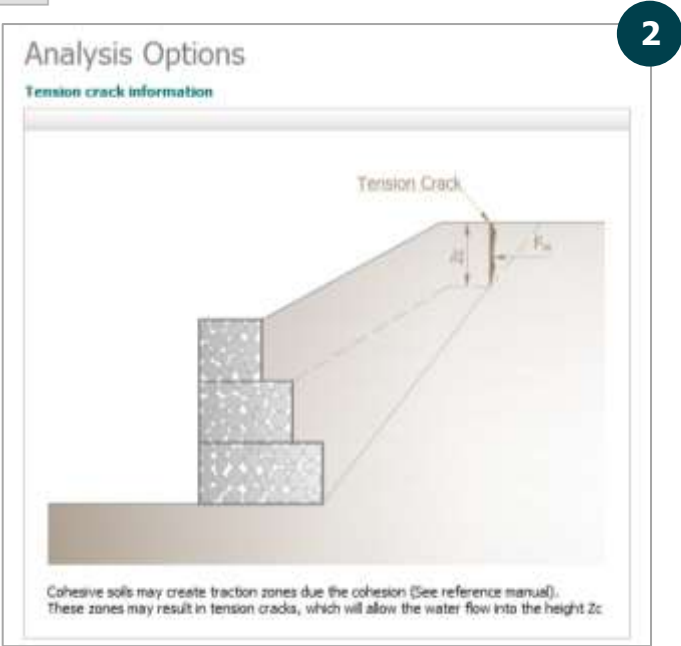
Choose Result Type

Factor of Safety

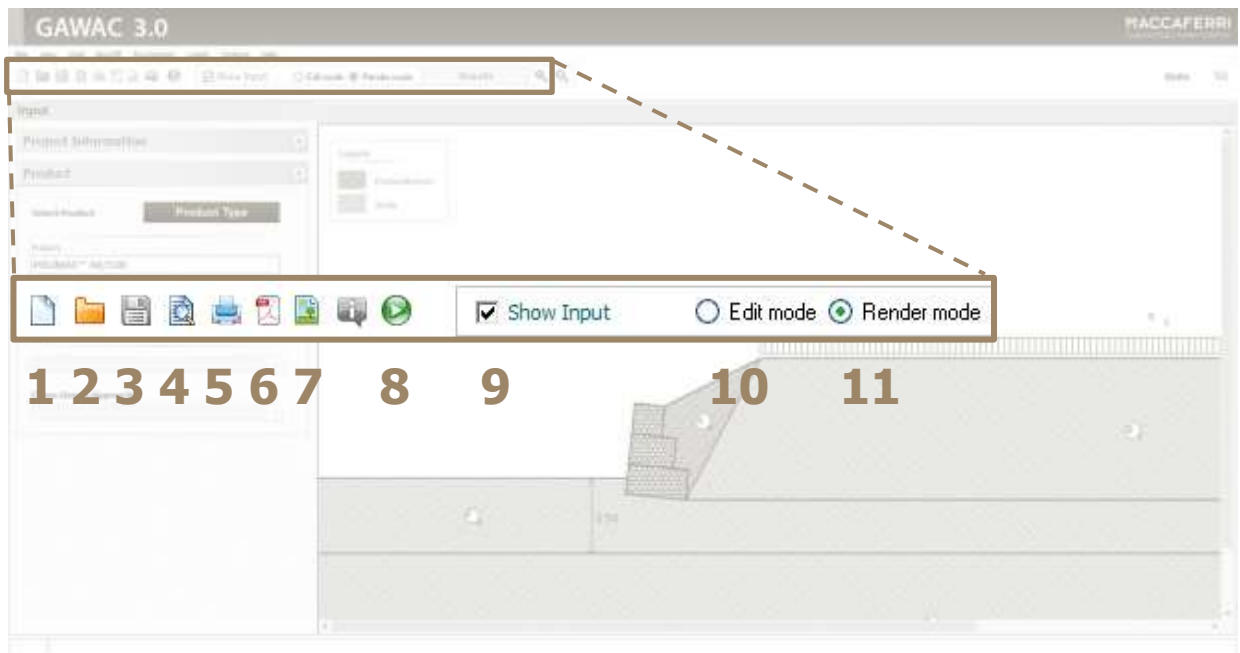
Working Rate

OK

Cancel



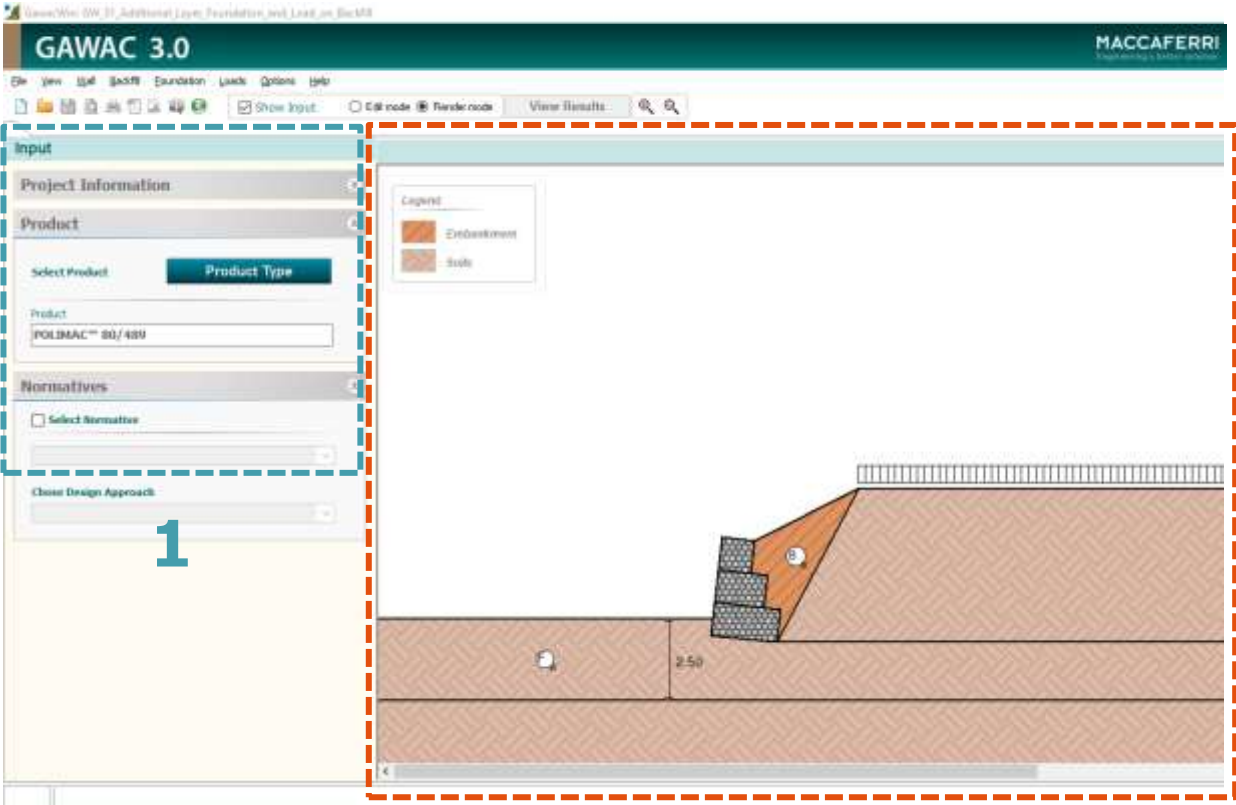
Quick action bar



Click on:

- 1** To start a new project
- 2** To open an existent project
- 3** To save the changes of the current project
- 4** To view the report
- 5** To print the report
- 6** To generate the report as a "pdf" file
- 7** To generate the report as a "jpg" file
- 8** To run the calculation after cross section definition
- 9** To show or hide the Input groups
- 10** To enable the edit mode
- 11** To enable the render mode

Input groups and Results

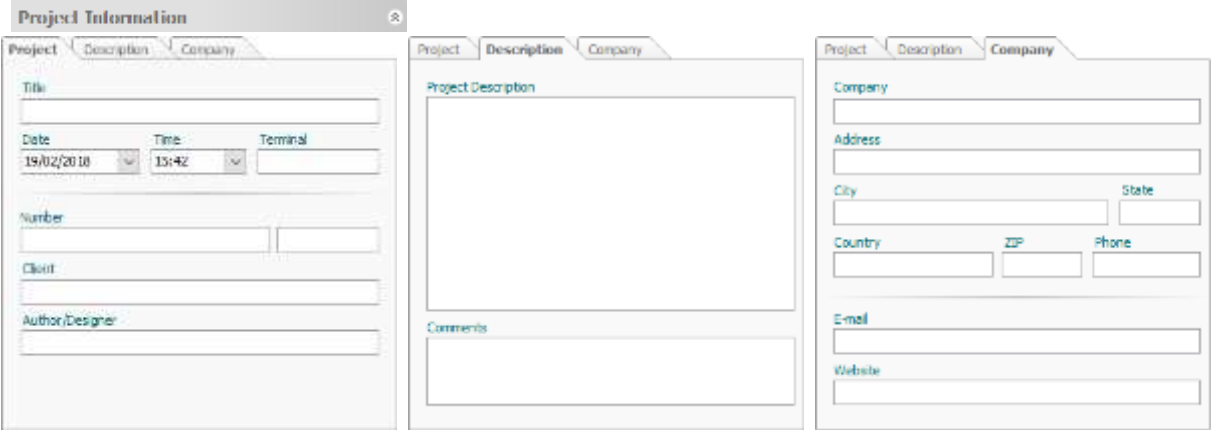


1 - Input Where all input data shall be inserted

2 - Results Where the cross section drawing and results show up

Input groups

Project Information

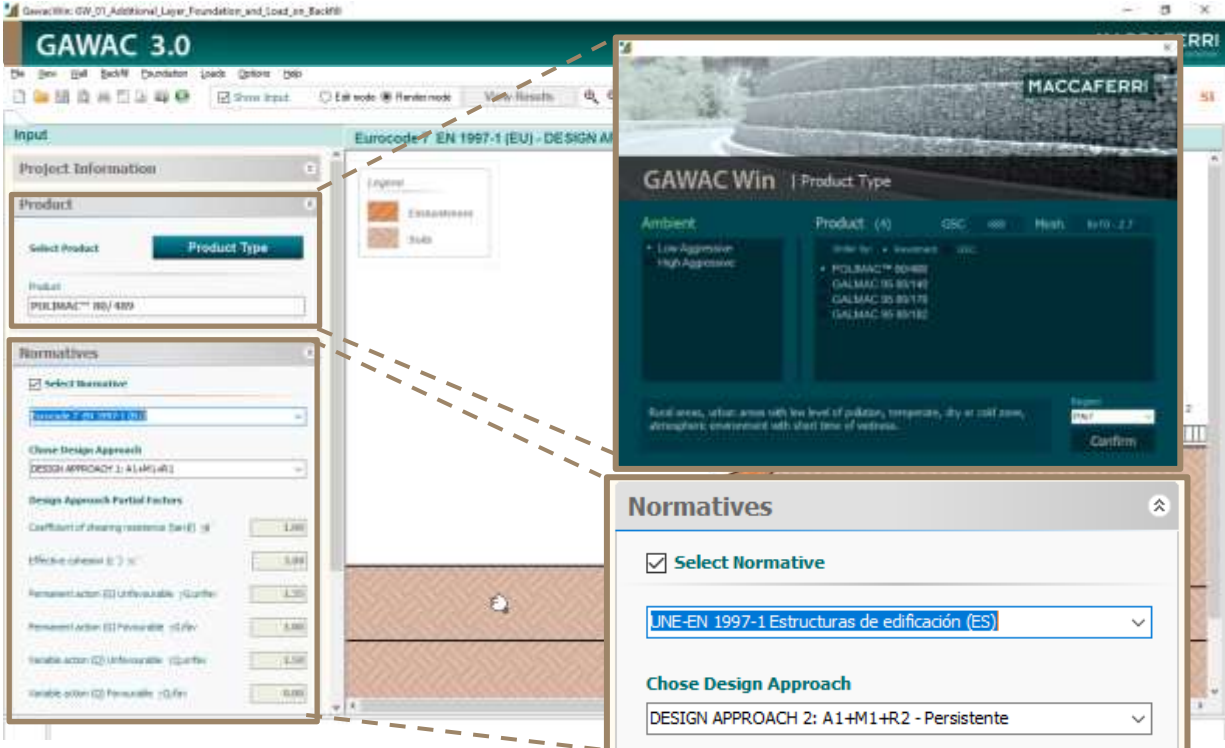


This tab shows the identification of the project, the Client and the Designer

This tab shows the description and the comments about the project

This tab shows the data of the Company that is making the project

Setup GSC and Normative



The user can set the normative and the design approach.

Gabion Wall set up

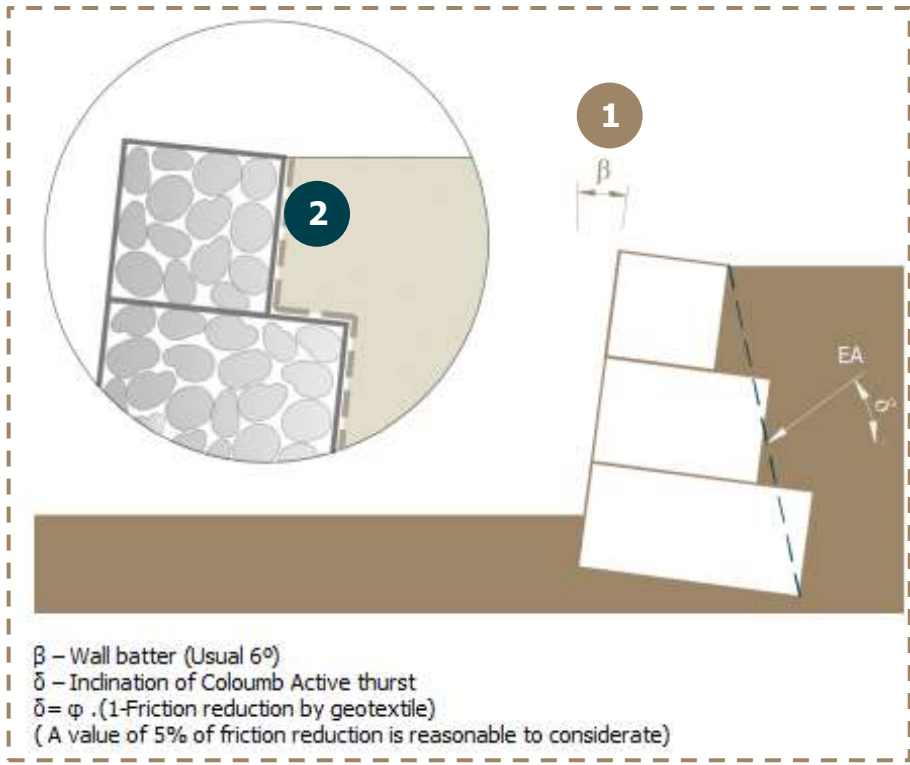
Select Wall > Set up

The screenshot shows the 'Wall set up' dialog box in the software. The 'General' section contains the following fields:

- 1** Wall batter (°): 6.00
- Rockfill unit weight (kN/m³): 25.00
- Gabion Porosity (%): 35.00
- Geotextile in the backfill
 - Friction reduction (%): 5.00
- Geotextile on the base
 - Friction reduction (%):

A circular inset diagram shows a cross-section of a gabion wall. The wall is composed of two layers of gabions. The backfill is shown as a solid mass. The wall batter is indicated by the angle of the wall face. The rockfill unit weight and gabion porosity are indicated by lines pointing to the respective parts of the wall.

The rockfill unit weight is according to the material, usually in a range 25 to 30 kN/m³.
 The porosity may vary according to shape of the rocks and filling process. Usually the values can be assumed 40%.



Wall set up

Wall set up

General

Wall batter (°): 6.00

Rockfill unit weight [kN/m³]: 24.20

Gabion Porosity (%): 30.00

Geotextile in the backfill
Friction reduction (%): 5.00

Geotextile on the base
Friction reduction (%):

Layers

Width (m)	Height (m)	Offset (m)	Strong face
2.00	1.00		<input type="checkbox"/> Base
1.50	1.00	0.00	<input type="checkbox"/>
1.00	1.00	0.00	<input type="checkbox"/> Top

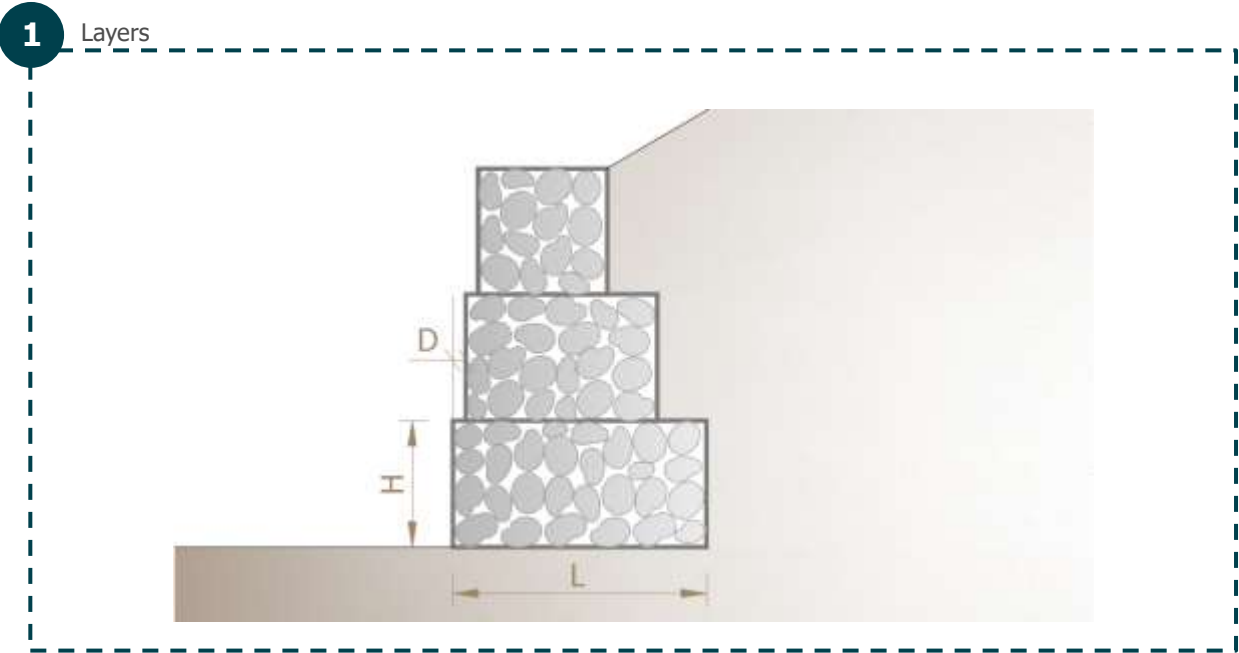
L H D

The user can choose different types of Strong Face Gabions

Strong Face

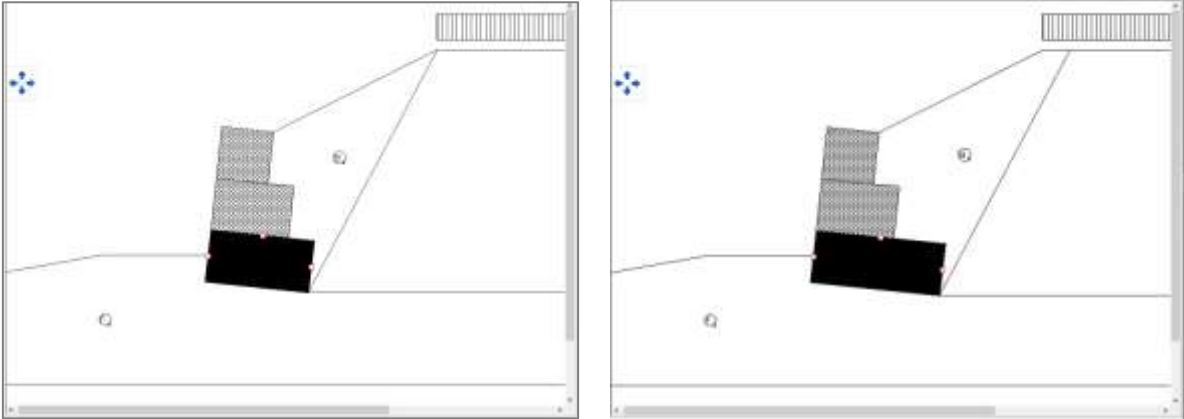
- STRONG FACE GALMAC 4R 80/279/504
- STRONG FACE GALMAC 4R 80/279/504
- STRONG FACE GALMAC 95 80/140/252
- STRONG FACE GALMAC 4R 80/279/387
- STRONG FACE GALMAC 95 80/140/194

Mesh 8x10 - 2.7/3.9

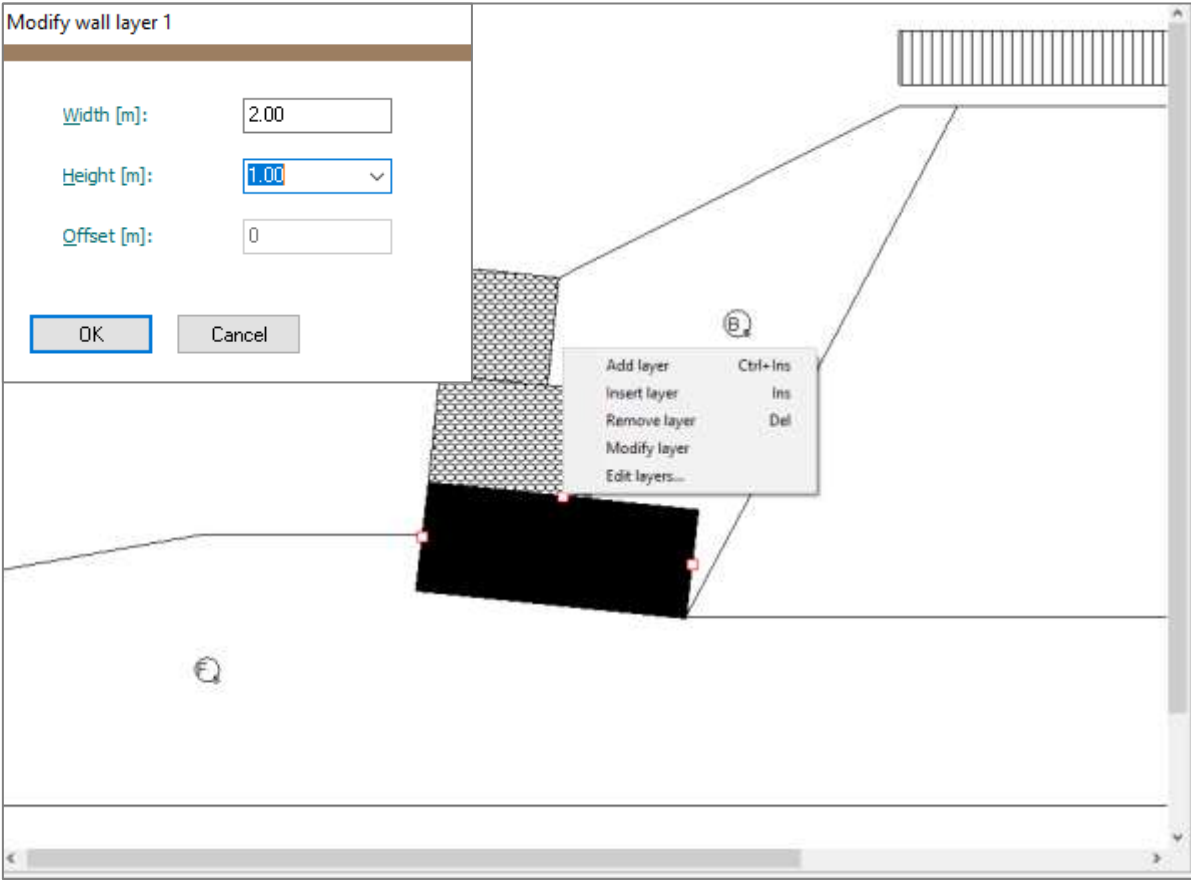


Editing the Gabion Wall

You can edit the gabion layers by activating the **edit mode**.

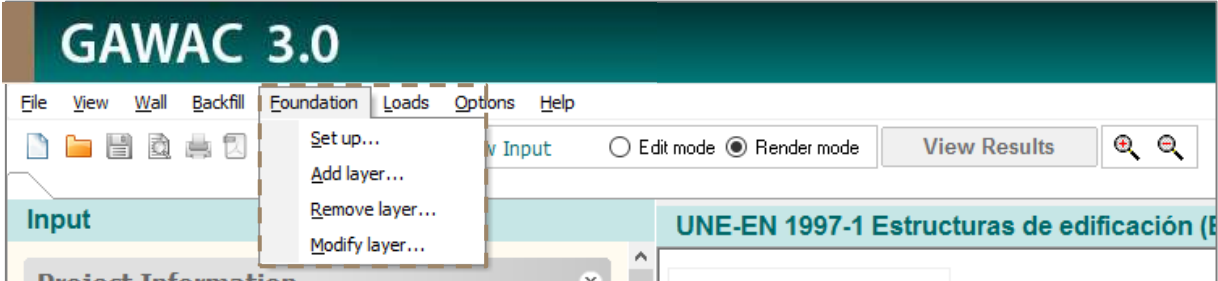


To insert or remove layers, click with the right-button in the gabion box.



Foundation set up

Select Foundation > Set up



Foundation Set Up

Foundation Set Up

Soil profile

1

Initial height (m):	[h]	<input type="text"/>	
Initial length (m):	[D]	<input type="text"/>	
Inclination (°):	[β1]	<input type="text"/>	

Soil properties

Unit weight (kN/m ³):	<input type="text"/>
Friction angle (°):	<input type="text"/>
Cohesion (kN/m ²):	<input type="text"/>

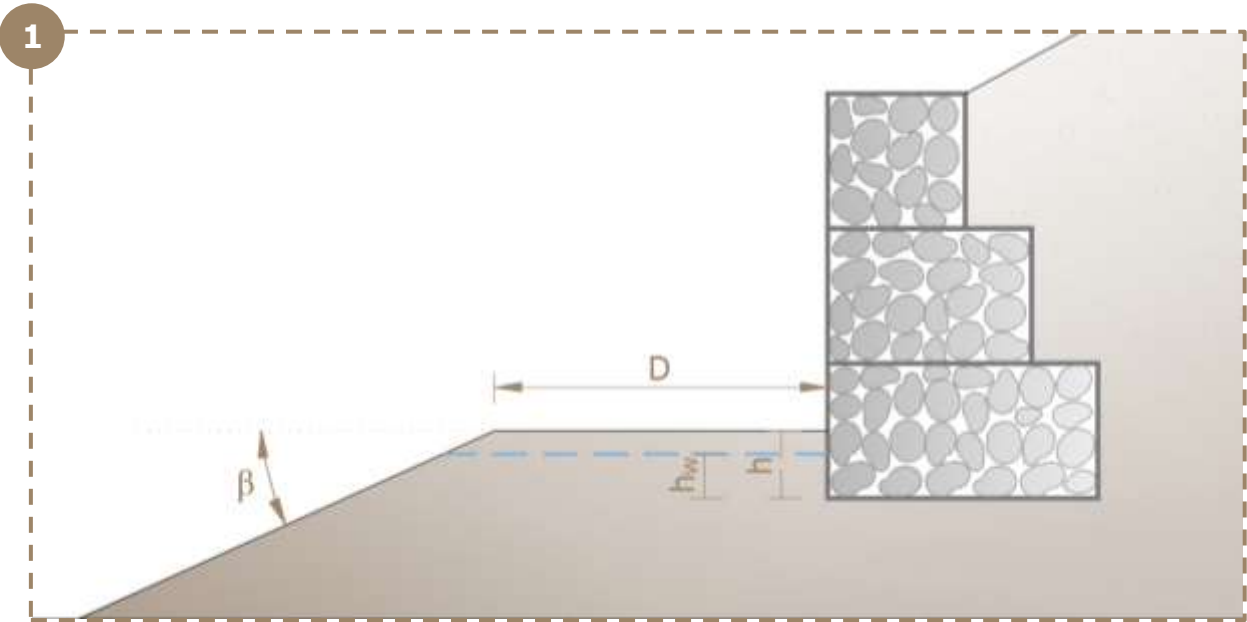
The strength parameters (friction angle and cohesion) must be obtained by specific tests, direct shear or triaxial shear test.

Additional data

1

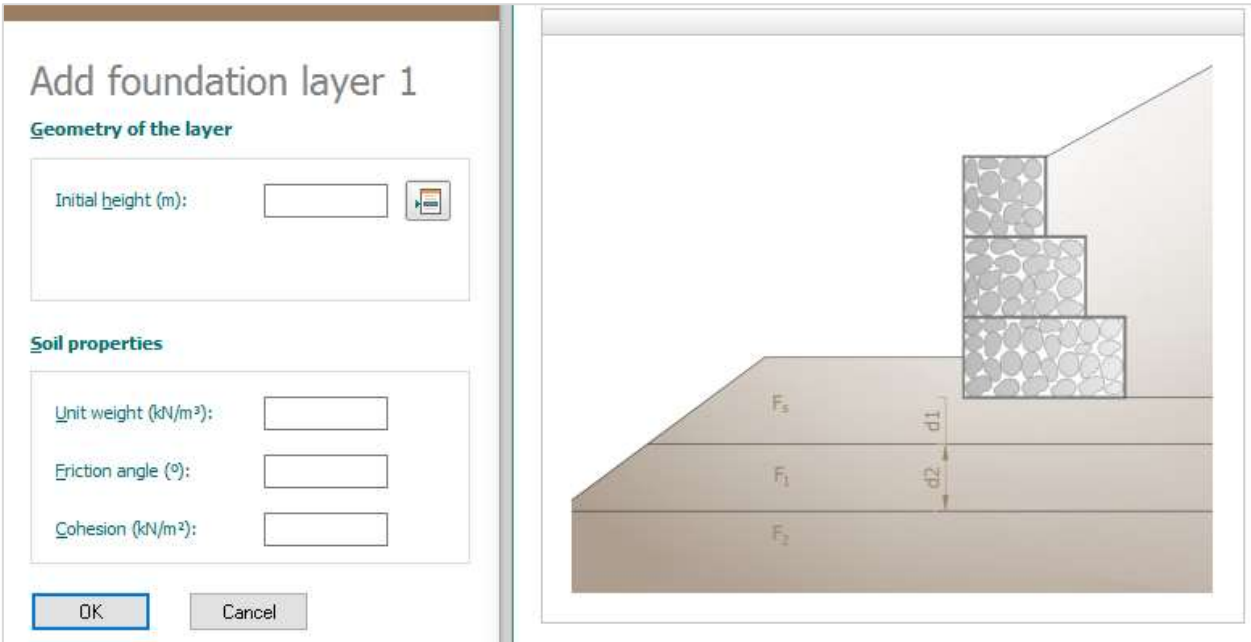
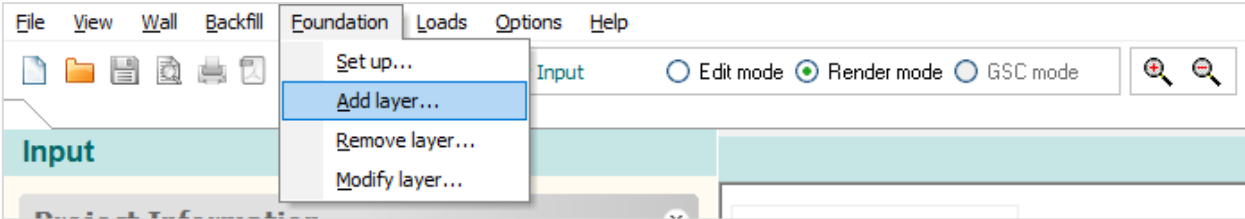
Max. Allow. press. (kN/m ²):	<input type="text"/>	
Water table height (m):	<input type="text"/>	

If you know the maximum allowable pressure of the foundation, you can input the value in this field. Otherwise, leave the input empty and the software will calculate the allowable pressure by the Hansen equation.



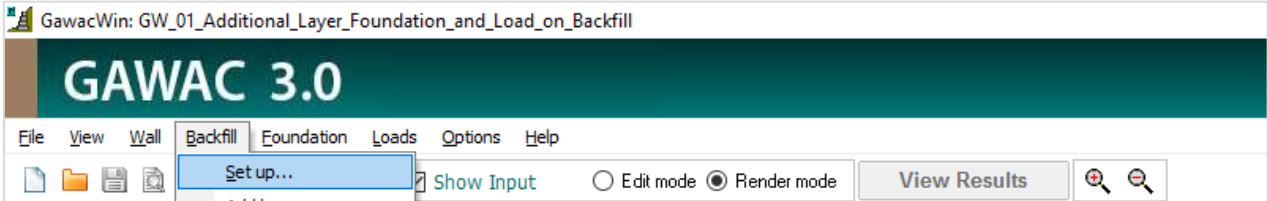
1.1 Add layer in foundation

Select Foundation > Add Layer



Backfill set up

Select Backfill > Set up



Backfill Set Up

Backfill Set Up

Soil profile

1st slope (°): [β1]

1st length (m): [D]

2nd slope (°): [β2]

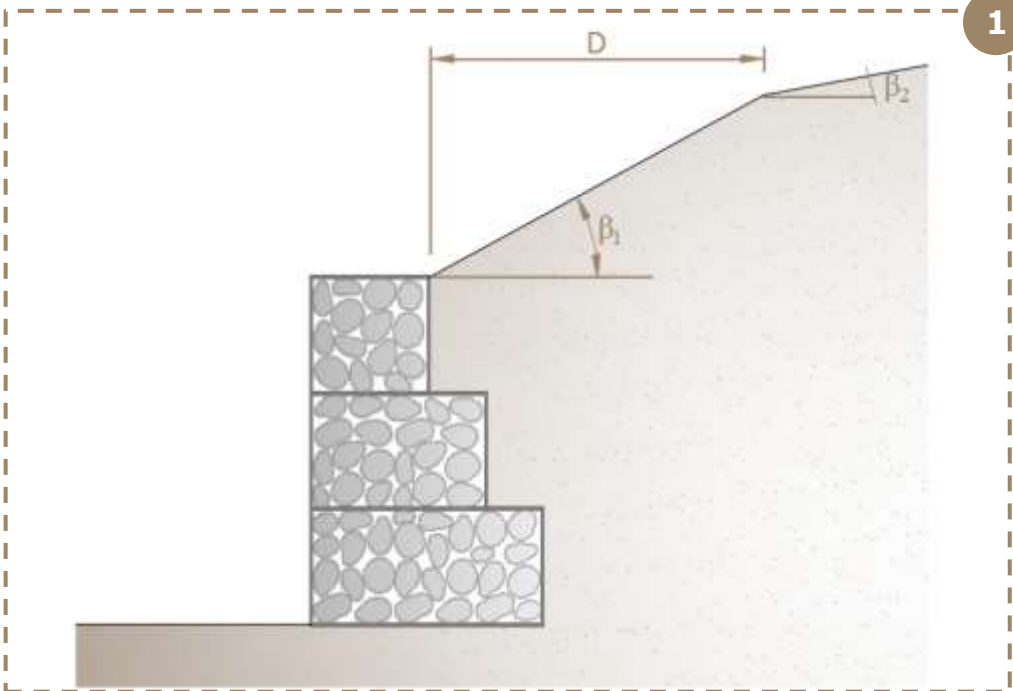
Soil properties

Unit weight (kN/m³):

Friction angle (°):

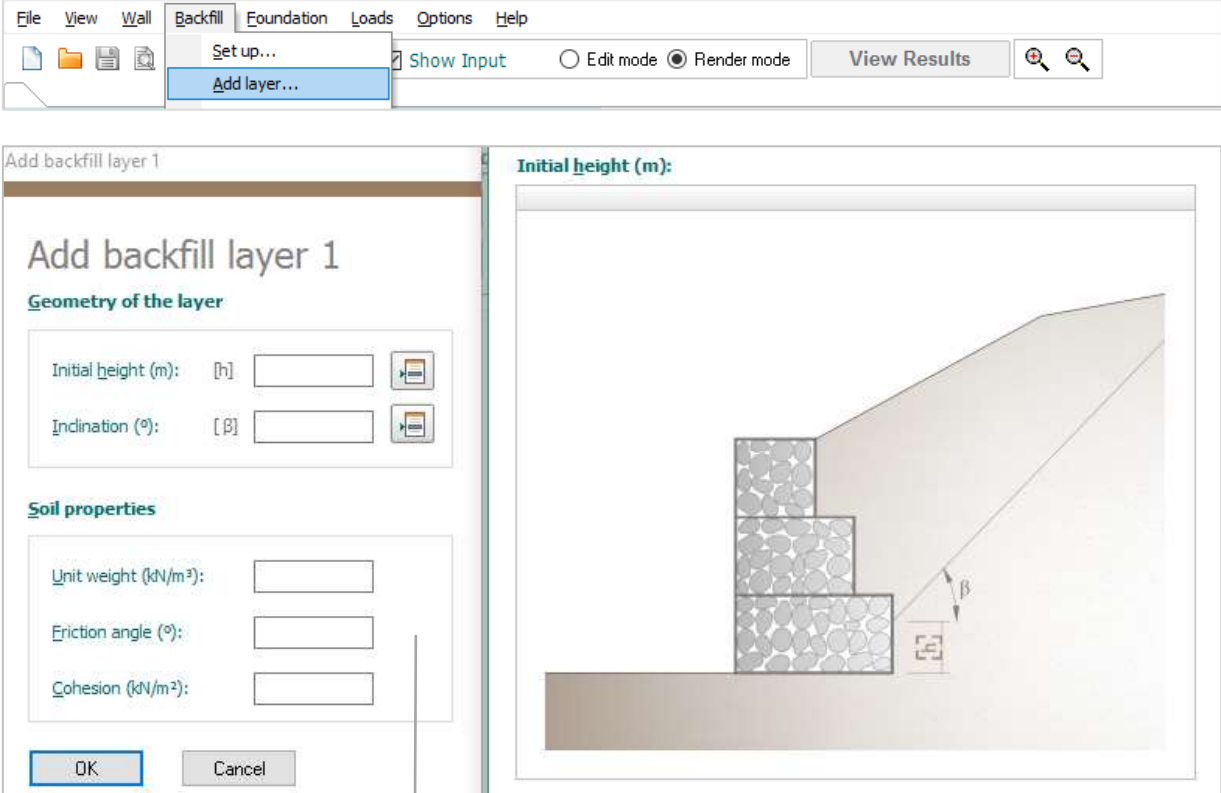
Cohesion (kN/m²):

The strength parameters (friction angle and cohesion) can be obtained by specific tests, direct shear or triaxial shear test.



Add layer in backfill

Select Backfill > Add Layer



The strength parameters (friction angle and cohesion) can be obtained by specific tests, direct shear or triaxial shear test.

You can also remove or modify a layer clicking in the options.

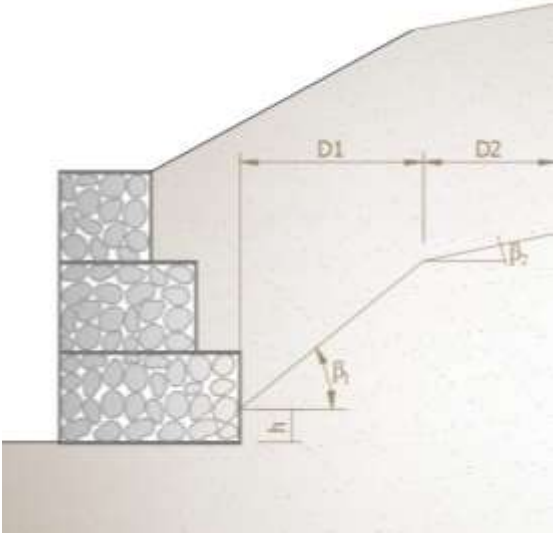
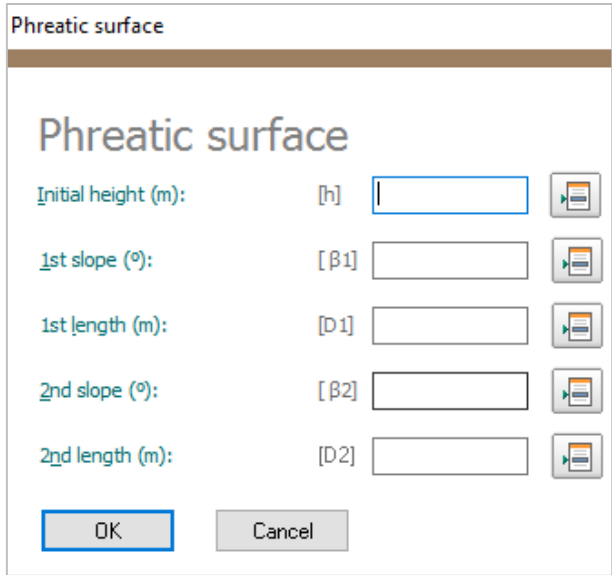
To modify layers you can do a double-click in the line (Edit mode).

Add phreatic surface in Backfill



Whenever the embankment has a phreatic surface, it can be considered through the menu Backfill > Phreatic surface.

The dimensions and angles of stretches can be defined in this menu.



Load Input

The user can insert static loads by clicking in menu Loads.

There are three type of loads:

Load on backfill

Loads on backfill

Loads on backfill

Distributed on backfill

1 1st load (kN/m²): Class Variable Unfavorable

2 2nd load (kN/m²): 20.00 Class Variable Unfavorable

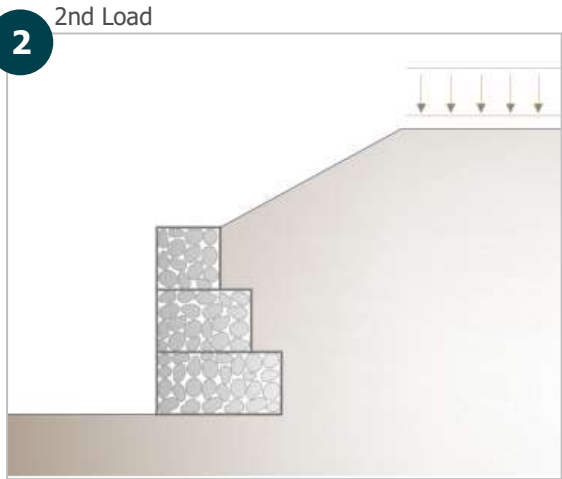
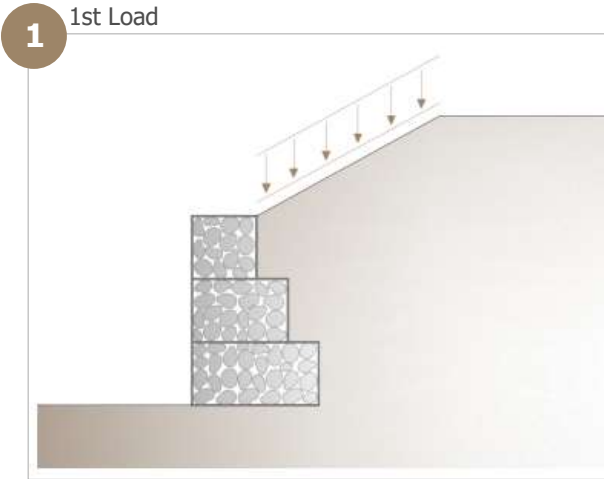
Line loads

Load	Value(kN/m):	Offset(m):	Class
1			Variable Unfavorable
2			Variable Unfavorable
3			Variable Unfavorable

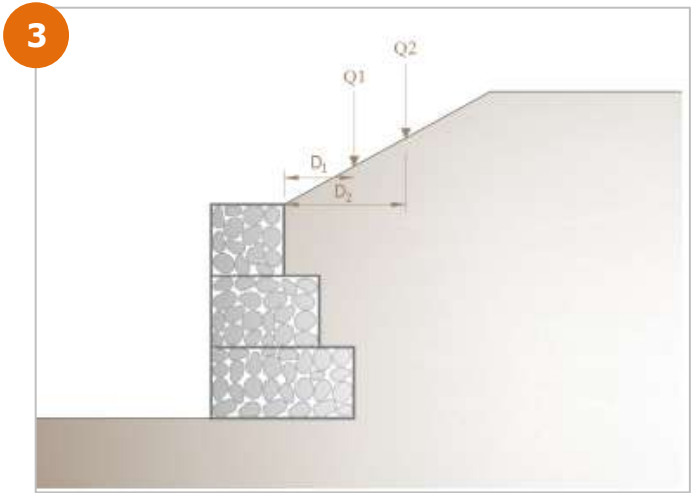
OK Cancel

You also can define the load class. The following options are:

- Variable Favorable
- Variable Unfavorable
- Permanent Favorable
- Permanent Unfavorable



Line Loads



Load on wall

You can insert uniform or line loads on the wall, such as (fences, static loads, walls, etc.)

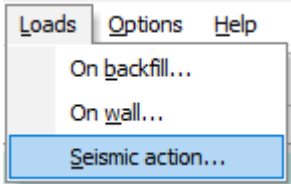
The screenshot shows the software interface for applying loads to a wall. At the top, a menu bar includes 'File', 'View', 'Wall', 'Backfill', 'Foundation', 'Loads', 'Options', and 'Help'. The 'Loads' menu is open, showing options: 'On backfill...', 'On wall...' (highlighted), and 'Seismic action...'. Below the menu bar are buttons for 'Edit mode', 'Render mode', and 'View Results'. A teal 'Input' bar is visible below the menu.

The main area contains three panels:

- Loads on wall dialog box:** A dialog box titled 'Loads on wall' with two sections. The first section, 'Uniform load on the wall (kN/m²)', has a text input field marked with a red circle '1'. The second section, 'Line loads on the wall', has two text input fields: 'load (kN/m):' and 'Offset (m):', both marked with a red circle '2'. At the bottom are 'OK' and 'Cancel' buttons.
- Uniform load on the wall (kN/m²):** A preview window showing a uniform load 'q' applied to the top surface of the gabion wall, marked with a red circle '1'.
- Line loads on the wall:** A preview window showing a line load 'Q' applied to the top surface of the gabion wall at an offset 'd', marked with a red circle '2'.

Seismic action

Whenever the wall is calculated under earthquake effects, the user can insert seismic loads by inserting the acceleration coefficients.




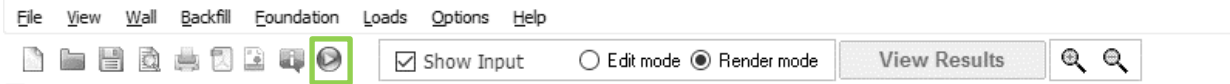
The image shows two windows from a software application. The left window is a dialog box titled 'Seismic action'. It has a section for 'Acceleration coefs.' with two input fields: 'Horizontal:' and 'Vertical:'. Each field has a small icon to its right. At the bottom of the dialog are 'OK' and 'Cancel' buttons.

The right window is a larger window titled 'Seismic action'. It features a diagram of a gabion wall structure. The wall is composed of three rectangular blocks of gabions, each filled with a circular pattern representing stones. The wall is situated on a horizontal base. A dashed line represents the failure surface or backfill slope. A seismic load is represented by a horizontal arrow pointing to the right, labeled $C_h \cdot P$. A vertical load is represented by a downward arrow labeled P . A vertical arrow pointing upwards is labeled $C_v \cdot P$. A small earthquake icon is visible in the top left corner of the diagram area.

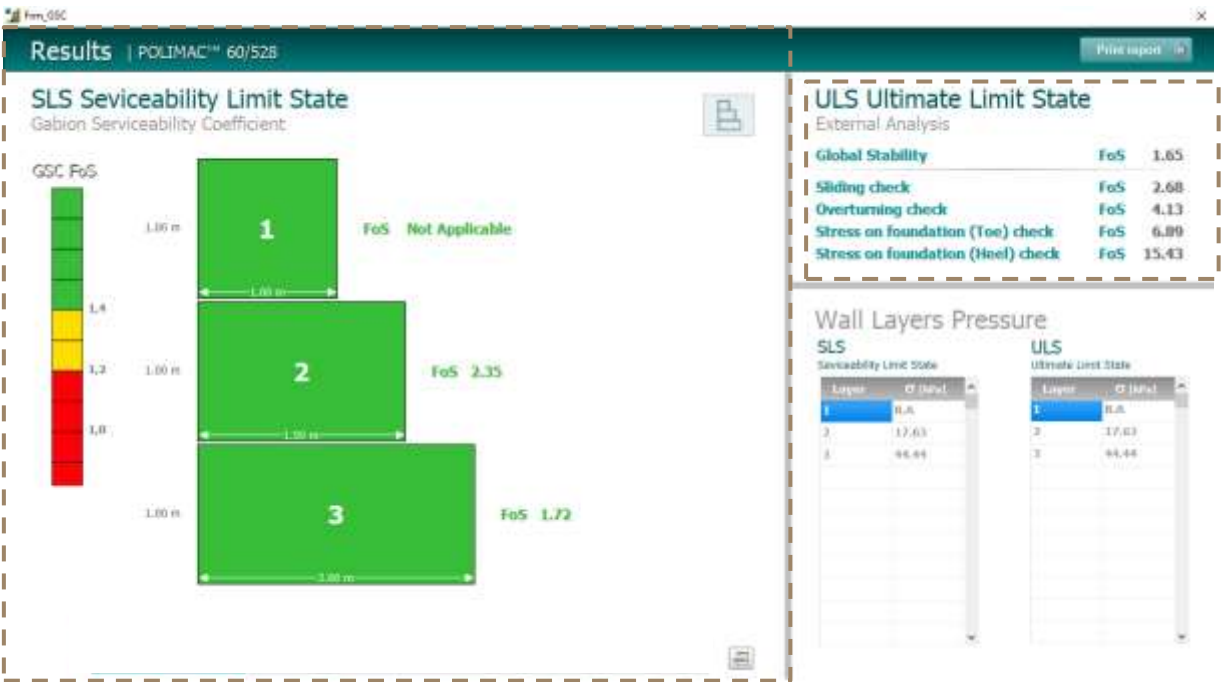
Whenever the site has possibility of seismic actions, the designer is able to consider the coefficients "ch" and "cv".

Analysis

To run the calculations, click in the icon 



Summary of results:



SLS | Serviceability Limit State

The serviceability limit state analysis is based in Gabion Serviceability Analysis Method (See GSC Reference Manual). You can optimize the safety factors by choosing a gabion with high performance, which means a mesh with high wire diameter and high durability.

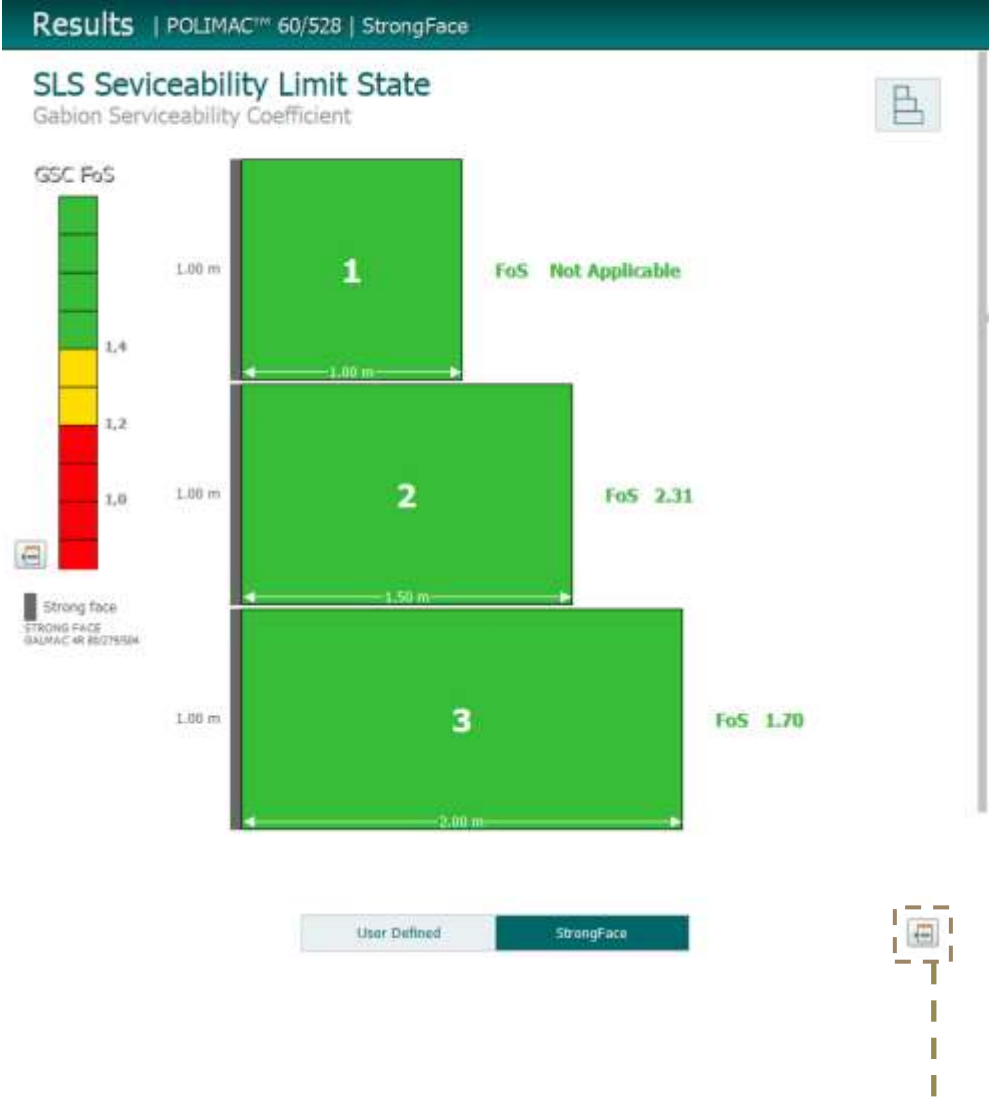
ULS | Ultimate Limit State

The external analysis (Sliding check, overturning check, foundation check) can be calculated in ultimate limit state analysis. Whenever the Eurocode is considered, the partial factors will be applied on soil parameters, loads and active thrust.

Both of analysis (SLS and ULS) can be considered with or without Normative.

Design with StrongFace Gabion

The user can design with StrongFace by clicking in the options below the section:



Alternative Gabion Wall Design


User Defined

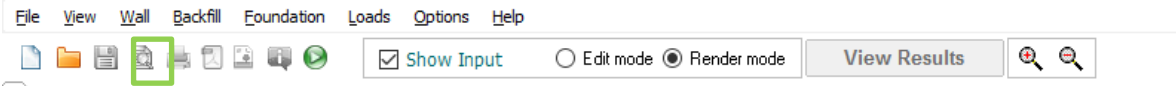
Serviceability Limit State analysis based on the wall designed by the user in Menu > Wall Setup.

StrongFace

Serviceability Limit State analysis with Strong Face gabions in all layers. Strong Face gabion are an excellent solution for use when a gabion wall or revetment needs a stronger face than normal. The units can be used where there are higher loads within the gabion structure or in a situation where a higher abrasion resistance is required on the face of the gabion. This can occur for example in river or lake works where there is the risk of ice movement and increased potential for damage.

Report

To generate the report, click in the icon 



You can navigate in the report by clicking in the pages:

- Main
- Page 1
- Page 2
- Page 3
- Page 4

GAWAC 3.0

Gabion Wall Design Software



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Project Information

Title	Client	Description
Number	Designer	

Input Eurocode 7 EN 1997-1 (EU) - DESIGN APPROACH 1: A1+M1+R1

Wall data

Wall batter [°]	6.00
Rockfill unit weight [kN/m ³]	24.20
Porosity of gabions [%]	30.00
Geotextile in the backfill	Yes
Friction reduction [%]	5.00
Geotextile on the base	No
Friction reduction [%]	0.00

Backfill soil data

Inclination of Stretch 1 [°]	26.56
Length of stretch 1 [m]	3.15
Inclination of Stretch 2 [°]	0.00
Soil unit weight [kN/m ³]	18.00
Soil friction angle [°]	30.00
Soil cohesion [kN/m ²]	0.00

Layer	Drift height [m]	Incl. angle [deg]	Unit weight [kN/m ³]	Cohesion [kN/m ²]	Friction angle [deg]
1	-0.30	62.00	20.00	5.00	28.00

Loads data

Distributed loads on backfill

First stretch [kN/m ²]	Variable Unfavourable	q1
Second stretch [kN/m ²]	Variable Unfavourable	q2 20.00

Distributed loads on wall

Load [kN/m ³]	Variable Favourable
---------------------------	---------------------

Line loads on backfill

Load 1 [kN/m]	Variable Unfavourable
Distance from wall face [m]	
Load 2 [kN/m]	Variable Unfavourable
Distance from wall face [m]	
Load 3 [kN/m]	Variable Unfavourable
Distance from wall face [m]	

Line load on wall

Load [kN/m ³]	Variable Favourable
Distance from wall face [m]	

Water profile data

Initial height [m]	0.00
--------------------	------

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- Page 1
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Gabion Wall Design Software



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Results Eurocode 7 EN 1997-1 (EU) - DESIGN APPROACH 1: A1+M1+R1

ULS Ultimate Limit State
Wall Design



Stability Analysis Results

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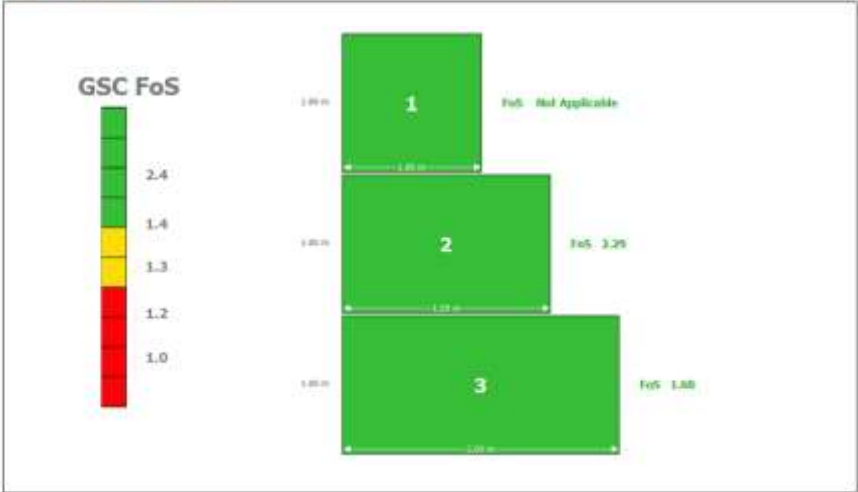
Results

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Eurocode 7 EN 1997-1 (EU) - DESIGN APPROACH 1: A1+M1+R1

SLS Serviceability Limit State

Gabion Serviceability Coefficient



ULS Ultimate Limit State

External stability

Overturning check

Sliding check

Stress on foundation (Toe)

Stress on foundation (Heel)

Global

Global Stability Check

FoS	2.47	FoS	1.84	FoS	3.95	FoS	38.88	FoS	1.57
-----	------	-----	------	-----	------	-----	-------	-----	------

Page 4 will only appear if you select a normative.

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- Page 1
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- Page 4

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normative

Eurocode 7 EN 1997-1 (EU)

DESIGN APPROACH 1: A2+M2+R1

No Seismic Condition

Partial Factors

		Overturning	
Coefficient of shearing resistance	γ_ϕ	1.25	1.25
Effective cohesion	γ_c	1.25	1.25
Undrained shear strength	γ_{cu}	1.40	1.40
Permanent action (G) Unfavourable	$\gamma_{G;unfav}$	1.00	1.10
Permanent action (G) Favourable	$\gamma_{G;fav}$	1.00	0.90
Variable action (Q) Unfavourable	$\gamma_{Q;unfav}$	1.30	1.50
Variable action (Q) Favourable	$\gamma_{Q;fav}$	1.00	1.00
Bearing resistance	γ_{Rv}	1.00	1.00
Sliding resistance	γ_{Rh}	1.00	1.00
Overturning resistance	γ_{Rm}	1.00	1.00
Earth internal resistance shear	$\gamma_{Re}; intShear$	1.00	1.00
Earth internal resistance compression	$\gamma_{Re}; intComp$	1.00	1.00
Earth overall resistance	$\gamma_{Re}; overall$	1.00	1.00
Gabion wall height	$\gamma_{G; Wall}$	1.00	1.00
Water Thrust	γ_{Water}	1.00	1.10