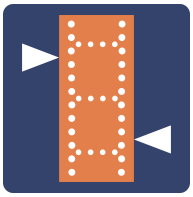

How to use Scage?

1. Introduction

Scage is a calculation tool for designing and checking the internal balance of a retaining wall in accordance with Eurocode 2 and the french national application standard of Eurocode 7 (NF P 94-282).

The internal efforts in the wall are considered as an input data coming from a calculation of soil-structure interaction (ISS calculation, for example obtained from K-Réa) taking into account the staged construction of the structure.

The calculation is carried out phase by phase in simple or compound bending, both at the ULS and SLS. The phases are grouped by Envelope to facilitate the handling of the calculations to be performed.

2. Steps to define a project

2.1. Project

- **General information**

It is possible to define the name of the project and the calculation section.

This information will be included when printing the calculation report.

- **Defining a calculation case (scenario)**

Within a Scage project, it is possible to store several independent calculations in the form of Cases or Scenarios. The idea being to be able to define and compare several calculations performed, which allows to switch between them quickly. The interface also provides a system of preferred cases.

- **Definition of geometry**

The section is considered rectangular, defined from a calculation width and wall thickness.

2.2. Materials

- **Definition of materials**

Concrete is characterized in terms of allowable stresses for each combination (the limitations required by NF P94-282 are also proposed). The inclination of the concrete rods must also be defined. The details of the calculations performed are provided under the Details button, with indications as to the chapter and source paragraph of the NF P94-282 standard. Their values are automatically calculated and can also be customized if the user wishes.

Steel is characterized by its characteristic strength, the branch of its constitutive law (horizontal or inclined), its modulus of elasticity or Young's modulus and its limit strains accessible from Details.

- **Constitutive laws**

The constitutive laws are represented to scale for the ultimate limit states. Graphics accept zoom and can be exported to the clipboard.

- **Partial safety factors**

The partial safety factors on the strength of concrete and steel have to be defined for each calculation combination. The coefficient of equivalence (ratio between the modulus of elasticity of steel and concrete) can also be set for SLS combinations.

2.3. Definition of phases and calculation envelopes

- **Internal efforts**

The internal forces of the wall must come from a soil-structure interaction calculation (ISS), for example from a K-Rea project or from an Excel file (find the model in the installation folder).

In the case of a K-Rea double wall project, it is possible to chose which wall (1 or 2) it should be imported.

In the case of an import from Excel, the solicitations must be provided to the SLS and ULS. Indeed, they are necessary for the proper functioning of the calculation.

When importing, all phases are displayed in the Unassigned Phases list. The user can then switch each phase into an envelope. It is also possible not to assign a phase to an envelope, which allows the freedom not to consider a phase in the calculation.

- **Envelopes**

It is possible to create as many envelopes as desired.

An envelope can contain one or more calculation phases.

In accordance with Eurocode 2, it is necessary to apply an offset to the bending moment diagrams to ensure that the longitudinal bars are loaded over their anchorage length. The offset value can be entered by the user or calculated automatically by the interface.

If the source file is modified during the Scage calculation, it is also possible to either import all phases again or only the values of the requests while keeping the same phase distribution within the envelopes.

- **Internal efforts**

The internal forces are presented in the form of two tabs: ULS (ultimate limit state) or SLS (serviceability limit state). The results can be displayed in graphical or tabular form.

The graphs are all titled and specify the unit of values displayed, as well as the minimum and maximum values. They allow zooming, both on the internal region and on the axes, as well as exporting to the clipboard.

2.4. Necessary steel sections

This section provides the necessary longitudinal and transverse steel sections for each envelope defined above.

- **Envelopes**

The calculation of reinforced concrete requires the definition of the position of the centre of gravity of the longitudinal bars in relation to the corresponding concrete fibre. At this point, this value is considered constant over the entire height of the wall.

The value of the offset value of the bending moment curves is recalled and can be modified again. It is also possible to reload internal requests if the source file has changed in the meantime.

It is necessary to define the situation to be considered at the ULS and SLS for each envelope, as well as the allowable steel stress at the SLS for each side of the wall and according to the depth. This stress can be defined according to the required limit crack opening (the coefficient is adjustable in the Settings tab).

The user is free to request either a simple or compound bending calculation for each calculation phase, which will have an impact on the required steel sections and the stresses generated at the SLS.

- **Required steel sections**

The necessary steel cross-sectional diagrams are shown according to the previous choices. They are presented in graphical or tabular form, both of which can be exported to the clipboard.

In accordance with Eurocode 2, transverse steel are only to be designed at the ULS.

2.5. Detailed calculations

This section provides access to calculation details at any level of calculation.

- **Steel design**

The user can choose the target diagram as well as the envelope and combination. A simple click on a curve allows you to locate and display a new line in the Results table.

- **Results**

The Results table is filled with all available data.

If the SLS combination is Quasi-Permanent, the equivalent diameter must be entered so that the crack opening calculation can be performed (exact method).

Details of the intermediate calculation parameters are displayed under the strain/stress graphs and the geometric section.

3. Cage

This section allows to define the practical steel bars chosen by the user and then to check if they are acceptable with regard to the results obtained. The **steel ratio** is calculated and displayed continuously as steel bars are defined.

The **reinforcement cage** is composed of several elements. The user can define as much as desired.

Each **element** contains a set of longitudinal bars (base and reinforcement bars) as well as transverse reinforcement zones. There is no limit to the number.

A control system the positions of steel bars is guaranteed throughout the bar entry process. The result of the control is presented in the form of coloured circles:

- Green: the position of the bars is feasible (no impact between bars)
- Red: there is at least one conflict between the defined bars.

Longitudinal bars are defined by a diameter, an upper level and a lower level. The positions are to be defined according to the following formalism:

1. Letter L (left) or R (right) to indicate the side of the cage on the right of which they should be positioned.
2. Concatenation of groups: 1A;2C;3B.... to indicate the group and position in which the bars should be positioned.

> For example: L1A;2A;2A;3A;4A;5A;6A;7A;8A;9A;10A;11A;12A

> 12 bars will be positioned on the left side to the right of position A.

To facilitate and facilitate the filling process, it is possible to indicate intervals. For example, the previous entry can be defined by writing: L1-12A

The meaning of letters is as follows:

- A and B are glued and in contact with the transverse reinforcement
- C and D are respectively on A and B

It is possible to duplicate and remove each group of longitudinal bars.

Transverse zones are defined by the upper level from which the zone starts, the spacing of the reinforcement levels and the elements they contain:

Several types of transverse steels exist:

- **Overlapping hoop**: they confine the set of longitudinal bars (they are welded to them)
- **Hoop**: they allow the flow of transverse forces inside the wall.
- **Stirrup**: 2-piece bars connecting 2 groups of longitudinal bars opposite to each other
- **Cross tie**: 1-strand bars connecting 2 groups of longitudinal bars opposite to each other

The dimensions are calculated continuously and are specified in the form of a schematic drawing.

It is possible to duplicate and remove each transverse zone.

The **controls** to be carried out are as follows:

- The useful longitudinal section diagram of steel must cover all the diagrams of the necessary longitudinal sections (both ULS and SLS)
- The useful cross-sectional diagram of steel should include all necessary cross-sectional diagrams (only for the ULS).

The **elevation view** allows to visualize the height position of all longitudinal bar and transversal zones per cage element.

It is possible to test the same cage (complete set of all these elements) by importing it from a case to the current case (see "Properties" tab of the cage).

4. ULS checks

Once the cage is defined, this section provides the following results specific to the choosen reinforcement sections:

- **Allowable bending moment at the ULS**: it is calculated at each level from the strain diagram of the section at each phase (the axial force is kept equal to that applied)
- **Allowable shear force at the ULS**: it corresponds to the maximum shear force that the section can support.
  The values are proposed in graphical and tabular form.

5. SLS checks

Once the cage is defined, this section provides the following results specific to the choosen reinforcement sections:

- **Allowable bending moment**: it is calculated at each level from the practical steel sections while respecting the admissible limit stresses in concrete and steel (the axial force is kept equal to that applied).
- **Steel stress**: they correspond to the stresses generated by the computational stresses on the useful steel sections.
- **Concrete stress**: they correspond to the stresses generated by the computational stresses on the concrete section.
- **Crack opening** (only available for quasi-permanent situation): values of crack openings obtained by the exact method at each level as a function of the practical longitudinal reinforcement section, the working stress of the steel, the equivalent diameter and the average spacing of the longitudinal bars.

6. Listing

This section summarizes all the steel bars placed in the cage by specifying their type, diameter, dimensions, mandrel required for bending, length and mass.

The average diameter, the total mass of the cage and the steel ratio (weight of steel relative to the volume of concrete) are also calculated.

7. Reinforced concrete

This powerful calculation tool is proposed independently of the project carried out.

The objective is to allow the user to verify reinforced concrete calculations for a set of independent input data.

The details of the calculation are provided in the part of the manual dedicated to the compound bending calculation at the ULS and SLS as well as the calculation of transverse steel.

8. Printing the calculation report

Scage allows the printing of the report of the calculations performed while leaving the possibility to choose the content to be included. A dynamic print preview is provided on the interface.

The report can also be printed in PDF format, if a dedicated printer is available in the operating system.

9. Documentation

All Scage documentation is available in this category as .html files that can be opened in parallel with the interface via the default browser.

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