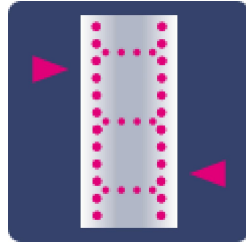


How do we define a steel cage?



1 Reinforcement cage of a pile

1.1 Definition of the reinforcement cage of a pile

The reinforcement cage of a pile is defined by cage elements. This allows for realistic management of the reinforcement, especially with regard to the overlap lengths between cage elements. The overlapping areas are to be managed by the user by positioning the bars to be overlapped in the vicinity. Scage will take into account the exact position in the calculation.

Each element is defined on the height by a top and a bottom level, which allows to deduce the height of the element and the height of the transverse steel zones.

Each cage element is composed of a set of longitudinal bars and transverse zones.

Longitudinal bars are defined by a top and bottom level, a diameter that can vary from bar to bar, a distance from the edge of the pile section to the bare bar and an angle to the vertical axis (α). A wizard is available to quickly and evenly position a set of bars of the same diameter.

The cross-sectional areas are defined from its top level, the spacing of hoops, the number (1 or 2 per level) and the diameter of hoops. The height is determined in relation to the cross-sectional area immediately below.

As the data is entered, all bars are shown in the “Elevation” map.

A data check is implemented in Scage to ensure compatibility among the different bars.

The “Cage Properties” tab allows you to specify :

- The minimum cover to be respected on the whole cage;
- The maximum length of the longitudinal bars to ensure that the bars are not longer than those available on site, i.e. those that the supplier is able to supply;
- The minimum distance between cross zones to determine the position of the first hoop in a cross zone from the last hoop in the previous zone.

1.2 Results

The results provided at the ULS are as follows:

- **Mobilised flexural strength:** this is the ratio of the applied resultant moment to the allowable moment deduced from the interaction diagram calculated for a fixed level of normal force (that concomitant with the applied resultant moment).
- **Normal force:** this is the initially defined diagram concurrent with the applied resultant moment diagram.
- **Combined moment:** this is the resultant moment diagram applied to each level.
- **Mobilised shear strength:** this is the ratio of the resulting applied shear force to the allowable shear force.
- **Combined shear force:** this is the shear force diagram applied to each level.

The results provided at SLS are as follows:

- **Mobilised flexural strength:** this is the ratio of the applied resultant moment to the allowable moment derived from the interaction diagram calculated for a fixed normal force level (that concurrent with the applied resultant moment).
- **Normal force:** this is the initially defined diagram concurrent with the applied resultant moment diagram.
- **Combined moment:** this is the resultant moment diagram applied at each level.

The selected **longitudinal or cross-sectional diagram** is displayed according to the selected result.

The **Interaction diagrams** sub-tab allows access to the interaction diagram at each level by clicking on a given level of the selected result. A first drop-down list allows you to choose a level among those selected, then a second one to choose the desired phase for the active envelope. A reminder of the geometry, in particular the position of the bars, is provided.

2 Reinforcement cage of a diaphragm wall

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 colored 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).

2.1 ULS checks

Once the cage is defined, this section provides the following results specific to the chosen 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.

2.2 SLS checks

Once the cage is defined, this section provides the following results specific to the chosen 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.

3 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.

