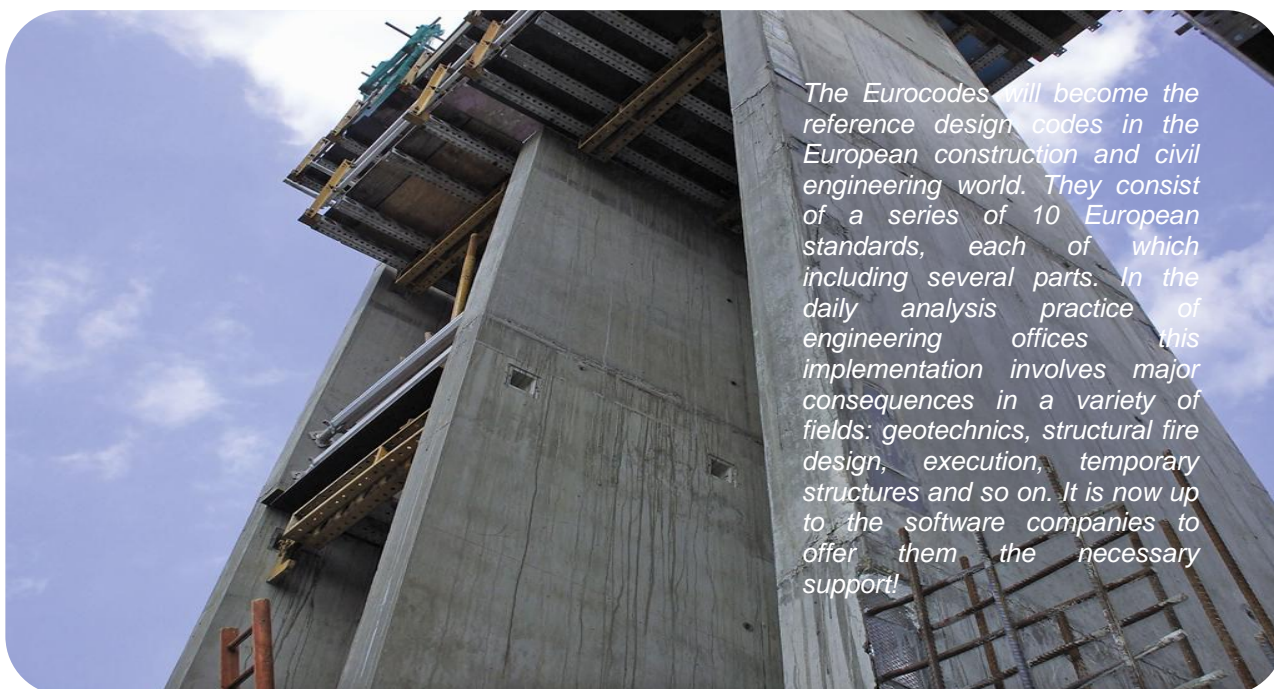


## Eurocodes in software practice



The transition to the Eurocodes takes place in 2010 and gradually the national codes will be withdrawn. As the Eurocodes are already in use in several countries, this phase is called the coexistence period. This period officially ended March 2010, in practice it will probably last until the middle or even the end of 2010 in some countries. It regards here the general part, together with the national annexes. In these annexes are regulated the local differences concerning the geographical, climatical and traditional building practice. This is provided in the form of national determined parameters (NDPs), which can be found in the National Annex (NA) of each country. However, it is recommended to already use the Eurocodes during this transition period. This way one is prepared when the official implementation makes a start.

### Experience of a software company

Nemetschek Scia has already implemented, for the larger part, the Eurocodes in its software. In Scia Engineer 2009, the following codes are already fully supported: EC0, EC1, EC2, EC3, EC4 and EC9. EC5 (wood, ENV) and parts of the EC8 (earthquakes) are also included. In version 2010 this list is supplemented with the EN 1993-1-3 (part of the EC3) for cold formed sections and the EC7 (geotechnical design).

At present, the biggest challenge is the implementation of the NAs. A special interface in Scia Engineer offers the possibility to easily switch over to the concerned national annex. These annexes will be implemented gradually in future versions. In this, the recommended values according to the NA's are considered as standard values. When there is no NA available, the recommended values of the Eurocode are used.

NA's for other countries can be loaded as well. This opens the way to internationalisation. It is possible to work with the same code and therefore with the same methods, only the parameters are different.

Scia Engineer supports reinforced and prestressed concrete, as well for 1D elements, e.g. beams and columns, as well as 2D elements, such as plates, walls and curved elements. For 1D elements the programme supports also the EN 1992-1-2 (fire).

Various elements (1D and 2D) and various Eurocodes can be combined mutually in one project. In this way, constructions which are composed of various elements and several materials can be calculated in one go, e.g. in a 3D model. Shifting back to other codes e.g. ENV, NEN, and DIN is also possible. This allows the user to compare design codes or to convert older projects to the Eurocode.

## 1D elements

### *Reinforced beams and columns*

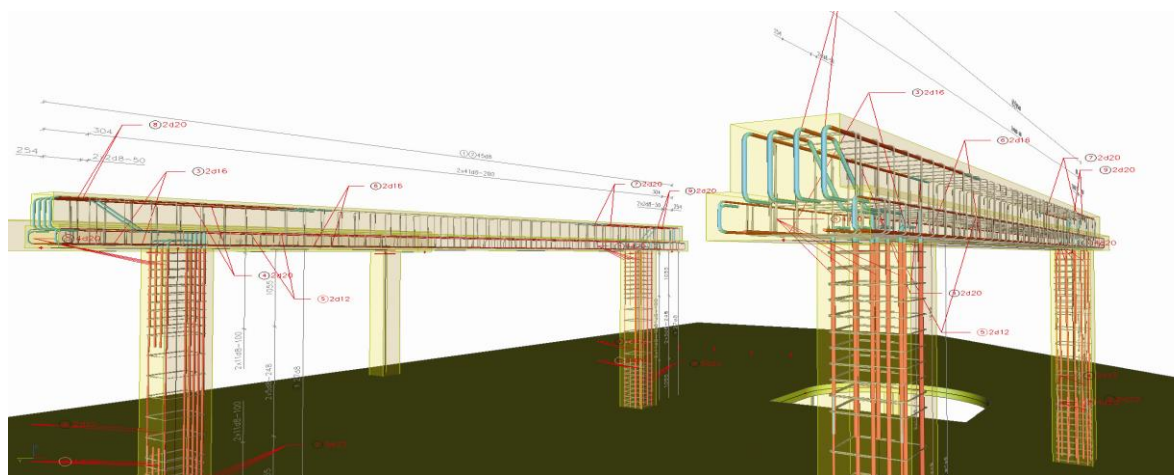
In the Eurocode, the reinforcement has to be calculated according to ULS and SLS. The reinforcement calculation in Scia Engineer includes the theoretical and/or practical needed longitudinal and shear reinforcement. The programme can assume a basic reinforcement on beams; the programme calculates the necessary additional reinforcement. The differences, compared to other codes, in the shear force formulas of the Eurocode 2 are very remarkable.

The calculation of the columns can be executed according to art. 5.8.8 'Nominal curvature' from the EN 1992-1-1, so that a linear first order calculation is sufficient. The Eurocode 2 prescribes rules when a second order calculation is necessary (depending from the slenderness of a column). Should the slenderness be exceeded, than the model-column method can be used in order to consider the second order effects. Consequently the redistributed moment and shear force lines as well as the necessary reinforcement are presented in a graphical and numerical way.

With the detailed check executed on a certain position in the beam, the detailed results can be viewed and checked. Occurring internal forces, strains, stress and details of the strain-stress diagram can be viewed also. A crack proof is also performed in the serviceability limit state.

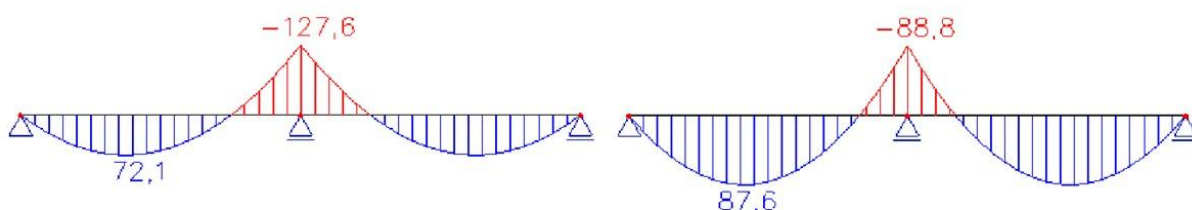
Besides the crack control long term deformations can be calculated according to the Eurocode. The calculation encloses the total, immediate and additional deformations in frames of reinforced concrete, including long-term rigidity. For the Eurocode 2, the deformation is calculated by reducing the stiffnesses using the stiffness/moment diagram. It is used to define the deformation for the individual combinations (shrinkage, immediate, total).

In some cases, the Eurocode prescribes a non-linear calculation (art.5.8.6.). In that case, the engineer has to search for the appropriate tool for determining the non-linear behaviour of the structure. In Scia Engineer the physical and geometrical non-linearity can be applied and calculated. In this way, it is possible to calculate a more realistic redistribution and further savings on reinforcement can be realised.



## Prestressed and post-tensioned beams

Scia Engineer allows calculating and checking prestressed and post-tensioned beams, such as bridges. Furthermore it is possible to check hollow core slabs according to EN 1168. The most important checks from this code are implemented. All elements can be checked after a calculation (possibly phased in time) according to the Eurocode 2.



## Fire (EN 1992-1-2)

Eurocode 2 includes rules for fire resistance. The check of fire resistance can be done with the detailing rules (tabulated values) and/or the simplified calculation method (reduced cross section) according to EN 1992-1-2 (Eurocode 2, Part 1-2: General rules – Design and calculation of structures with fire). The module fire resistance for concrete is available for checking reinforced beams, prestress beams, hollow core slabs and columns. It is also possible to calculate plates through the ‘beam type – plate’.

Besides the detailing rules, the principle of this module is based on a check of the cross section, in which reduced force and stiffness are considered. Concrete sections are also reduced as a consequence of splintering. It is always possible to view these changing properties in the snap check-dialog; here the behaviour of the structure is clarified in detail.

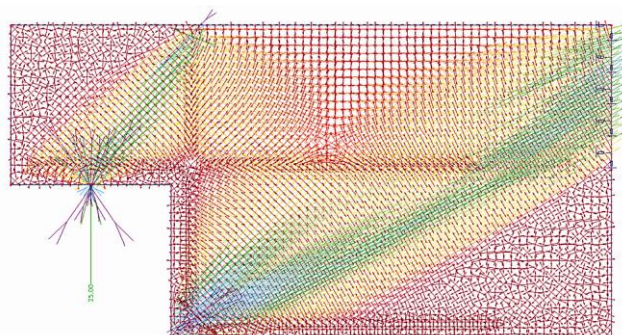
For detailing, an easier approach is possible. In the Eurocode, detailing requirements are defined for cross section dimensions and average beam distances with regard to reinforcement.

Fire safety engineering becomes more and more important. For this purpose has been formed a TETRA project in Belgium. This project has been started to investigate the fire safety and further to translate and spread the gained knowledge to both the industry and educational institutes. Universities, high schools as well as users are involved in this project. Scia puts practical and specialized tools for fire safety calculations at their disposal. In other words: with these design modules, the engineer specifies the general fire safety of a building and consequently insures the public safety in case of fire as prescribed by the Eurocodes.

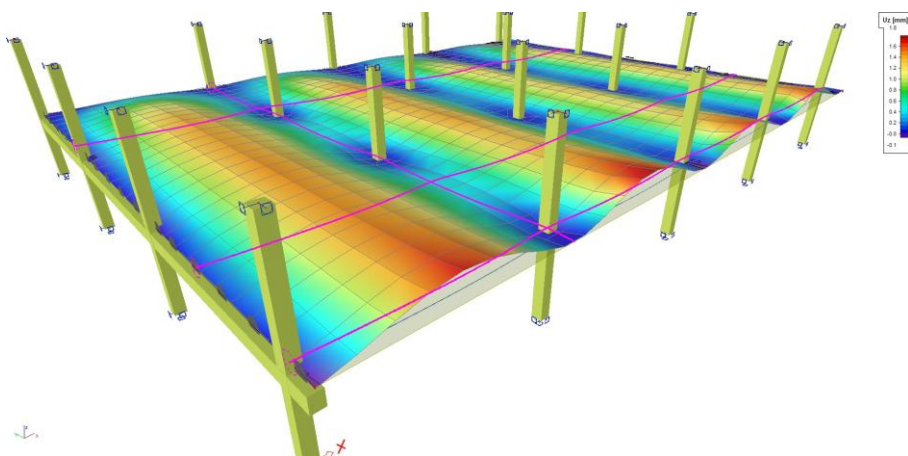
## 2D elements

### Reinforced 2D elements

The Eurocode especially describes the approach of 1D elements. In Scia Engineer the transition to 2D elements is made. Both for ULS (calculation of the required reinforcement) as for SLS (e.g. check of the deflection) multiple possibilities are proposed. Identical as with 1D elements it is possible to work with practical reinforcement. Through an intelligent link, it is possible to send the calculated reinforcement to drawing software (e.g. BIM to Nemetschek Allplan).

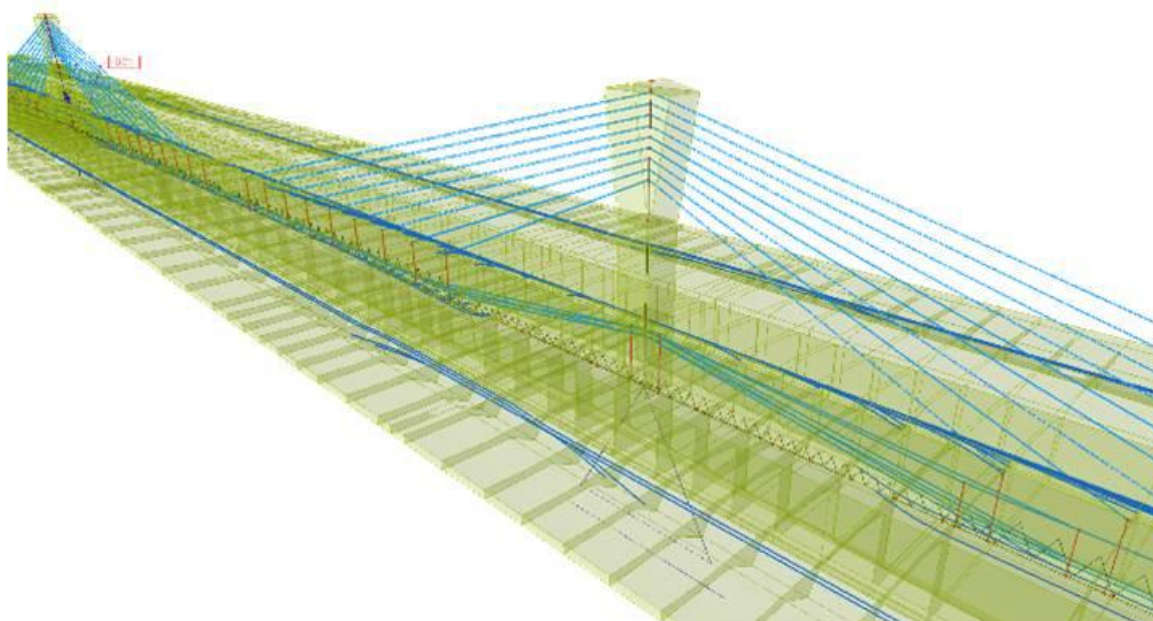


Extra checks for 2D elements are available: such as an extensive punching checks for plates. Another possibility is to perform a plastic analysis for walls. New in Scia Engineer 2010 is the possibility to design a voided slab according to the Eurocodes. To this end, special punch checks are implemented.



### *Post-tensioned 2D elements*

It is possible to apply post-tensioned cables to 2D elements: plates and shells. Internal forces are calculated, considering post-tensioning. Later on, the user can apply the reinforcement calculation according to the Eurocode.



## Eurocodes:

- Eurocode 0 - Basis
- Eurocode 1 – Actions on structures
- Eurocode 2 – Design of concrete structures
- Eurocode 3 – Design of steel structures
- Eurocode 4 – Design of composite steel and concrete structures
- Eurocode 5 – Design of timber structures
- Eurocode 6 – Design and calculation of masonry structures
- Eurocode 7 – Geotechnical design
- Eurocode 8 – Design of structures for earthquake resistance
- Eurocode 9 – Design of aluminium structures

Among other things, the **Eurocode 2** is composed of:

- EN 1992-1-1 Part 1-1: General rules and rules for buildings
- EN 1992-1-2 Part 1-2: General rules – Design and calculation of structures with fire
- EN 1992-2 Part 2: Bridges – Rules for design, calculation and detailing
- EN 1992-3 Part 3: Structures for turning and storing of material

