NEMETSCHEK Scia

Eurocode Solutions

Design of concrete structures according to the Eurocodes

Scia Engineer

Eurocodes Solutions

Scia Engineer is an ideal tool for calculations of various complexity, from simple beams (1D) and single plates (2D) to whole buildings (3D), to a detailed analysis of the distribution of internal forces over time in prestressed structures (4D).

Scia Engineer version 2010 includes, among others, **innovations** in the area of the **modelling of structures,** the **sharing** of the model **with other applications and programs** (BIM) and, last but not least, also **improvements in calculations and checks of concrete structures according to the European Standards (Eurocodes).** Version 2010 represents an effective tool for the everyday design of structures.

The design and checks of concrete structures are more comprehensive, faster and better managed in the version Scia Engineer 2010 than in previous versions.

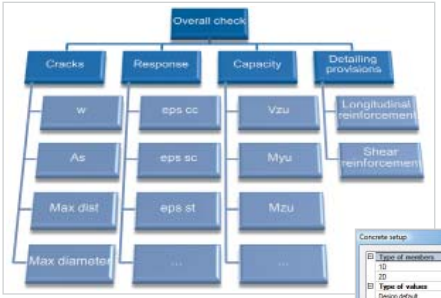
Reinforcing

Scia Engineer enables the user to input practical reinforcement for beams and columns of any cross section. It is possible to define different types of reinforcement (stirrups and longitudinal reinforcement), including anchorage details (bends and hooks). The program also supports automatic design of reinforcement (numbers of reinforcement bars, their lengths and position in the beam) in the ultimate limit state for reinforced concrete frames.

Scia Engineer also allows the user to define a practical reinforcement in slabs or walls. The reinforcement can be inputted into the structure according to the assumed arrangement of the reinforcement bars or on the base of the calculated required reinforcement areas. The reinforcement can be defined by means of reinforcement meshes or free reinforcement bars.

Reinforcement in beams

In Scia Engineer it is possible to define an unlimited number of stirrup shapes along the length of beam. Longitudinal reinforcement is not limited by field length and can pass several fields.



Reinforcement in beams with openings and haunches

Net cross-sections at opening locations can be checked in a standard way by a member check or by a detailed check. The new version also enables the user to reinforce members with haunches or openings.

Anchorage details for bars

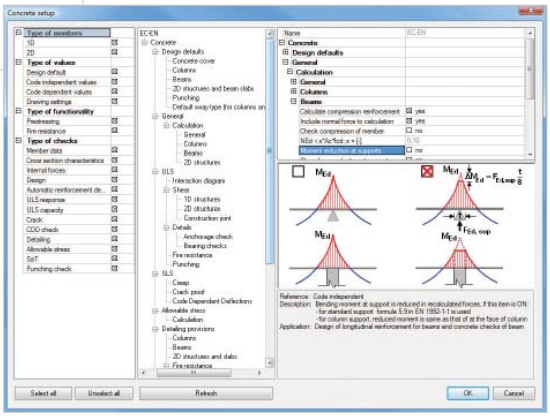
The effect of anchorage details for bars is now taken into account in the checks performed by Scia Engineer. At the anchorage location, the stress-strain diagram of the reinforcement is reduced according to the position along the anchorage length.

Reinforcement in slabs

Scia Engineer supports reinforcing of slabs by means of reinforcement polygons – meshes.

Import of reinforcement

Users can import an existing structure including reinforcement from CAD applications. Reinforcement in beams and slabs is imported as free reinforcement. Free reinforcement is subsequently used for checks in a similar way as normally defined reinforcement.



Design and checks

The program provides the design and check of concrete beams and slabs according to many standards, however the greatest emphasis is placed on the European standards. In addition to the separate checks, also an overall check of non-prestressed concrete is available – in one service there are carried out checks for SLS (cracks), ULS (resistance) and detailing provisions with possible design of reinforcement. Hereby a list of the salient EN articles implemented in Scia Engineer for non-prestressed reinforced concrete:

Material

- Partial factors for materials – art. 2.4.2.4.
- Material properties of concrete – art. 3.1.
- Material properties of steel – art. 3.2 Annex C.

Analysis

- Concrete cover – art. 4.4.1.
- Geometric imperfections – art. 5.2(1)-5.2(6).
- Reduction of support moments – art. 5.5.
- Check of height of the compression zone – art. 5.6.2.
- Check of redistribution of bending moments (art. 5.5.(4) and art. 5.6.2(2)).
- Check of rotation capacity – art. 5.6.3.
- Limit slenderness – art. 5.8.3.1.
- Calculation with influence of second order effect – art. 5.8.8.
- Calculation of effective flange width – art. 5.3.2.

Design of concrete structures

Ultimate limit state

- Design and check of longitudinal reinforcement in beam – art. 6.1.
- Design and check of longitudinal reinforcement in column (uniaxial and also biaxial) – art. 6.1; 5.8.9.
- Design and check of shear reinforcement – art. 6.2.
- Design of shear reinforcement between the web and flange of T sections – art. 6.2.4.
- Design and check of torsional reinforcement – art. 6.3 (also in interaction with shear and bending).
- Check and design of reinforcement at the interface between concretes cast at different times – art. 6.2.5.
- Punching – art. 6.4.

Serviceability limit state

- Limit stress – art. 7.2.
- Calculation of minimum reinforcement area – art. 7.3.2.
- Control of maximum bar diameter – art. 7.3.3.
- Control of maximum bar spacing – art. 7.3.3.
- Calculation and check of crack width – art. 7.3.4.
- Calculation and check of deflection – art. 7.4.3.
- Calculation of creep coefficient – Annex B EN1992-1-1.
- Calculation of creep coefficient – Annex B EN1992-2.

Detailing provisions

- Bar spacing – art. 8.2.
- Minimum mandrel diameter of reinforcement – art. 8.3; tab. 8.1N(a).
- Detailing provisions for beams – art. 9.2.
- Detailing provisions for plates – art. 9.3.
- Detailing provisions for punching – art. 9.4.3.2.
- Detailing provisions for columns – art. 9.5.
- Detailing provisions for walls – art. 9.6.

Bearing areas

Check of end bearings and design of additional reinforcement – art. 10.9.5.

Check of fire resistance

Scia Engineer responds to the increasing demand for checks of structural resistance under fire conditions by means of new calculation methods which are given in EN 1992-1-2.
The program adopts a general calculation procedure and therefore it is applicable to any shape of cross section, including structures with prestressing.

It is also possible to assess post fire structures. The program supports all three calculation methods which are specified in the latest update of EN 1992-1-2.

According to the EN standard, three levels of fire resistance calculations are recognized.

Hereby more explanation on how they are implemented in Scia Engineer:

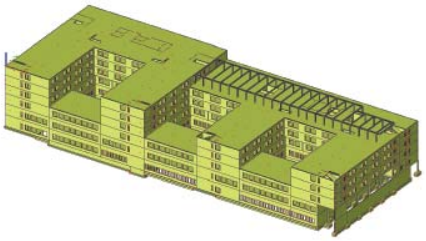
- **Detailing provisions** for beams, columns and hollow core slabs.
- **Simplified method**, which is based on reduced allowable stresses at the reduced cross-section.
- **Advanced method**, which is based on non-linear heat transfer along the cross-section.

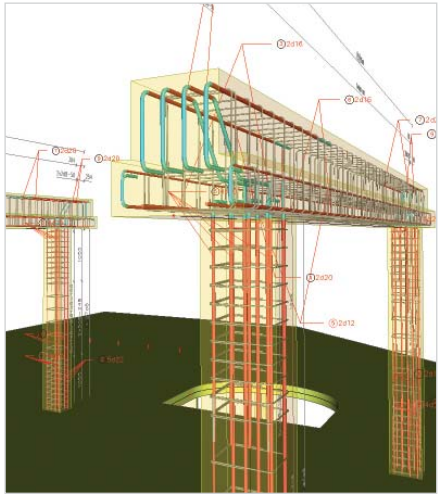
Special features for 2D members

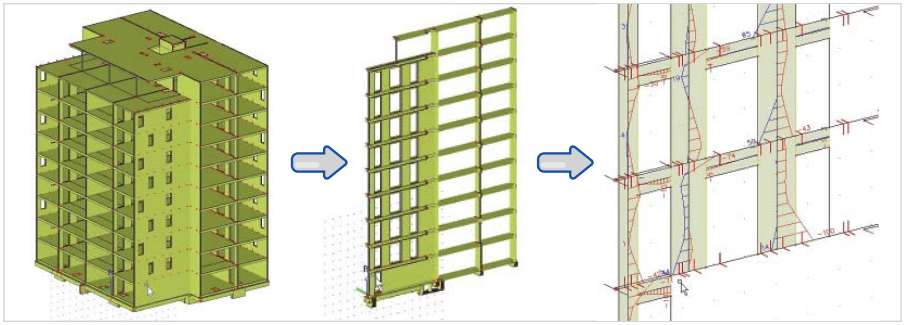
- Clear display of internal forces in the design of 2D members.
- Averaging strips can be used, they can reduce e.g. the peak moments above supports. This will be translated in a more realistic and economic reinforcement layout.
- Many quantities for assessment.
- Degree of reinforcement – for both surfaces (upper and lower) and directions (x and y) separately, total for longitudinal and also shear reinforcement.
- Weight of the reinforcement – for both surfaces - shear and total weight; total weights in kg, kg/m^2, kg/m^3.
- Integration strips which convert 2D results into 1D results. This makes it easier to make the calculation according to the design codes.
- Detailed output in design for quantities at the same surface in one table.
- Easy input of additional data for slabs.

Punching shear checks

- Definition of the control perimeter, in which shear reinforcement is no more required – $u_{out,ef}$.
- Length of the last critical perimeter corresponds to $u_{out,ef}$.
- The position of shear reinforcement for punching is calculated according to the position of the last critical perimeter.
- Reinforcement positioned in rows around the critical perimeter.







Eurocodes Solutions

Prestressed structures

Scia Engineer newly includes part of the EN 1992-1-1 standard related to checks of prestressed structures, in particular checks of resistance, capacity and cracks, allowable stresses and principal stresses. The program performs checks of shear, torsion and principal stresses at characteristic sections of the general cross-section.

Analysis

- Calculation of the development of prestressing force over time including all losses – art. 5.10.9.
- Automatic calculation of transmission and anchorage lengths for pre tensioned steel – art. 8.10.2.
- Defining of heat curing and its effect on the acceleration of concrete maturing and acceleration of prestressing steel relaxation– art.10.3; B.10.
- Time dependant analysis with effect of construction stages. This takes into account among others creep and shrinkage.
- Bill of material for prestressing steel.

Checks

- Check of capacity by interaction diagram.
- Check of capacity by ultimate strain method.
- Check of shear and torsion in interaction with bending.
- Allowable stresses in the concrete and prestressing steel.
- Allowable principal stresses in every section of the structure.
- Check of detailing provisions for non prestressed concrete.

Hollow core slabs according to EN1168

- Input of strand patterns.
- Predefined library of frequently, in practice used, cross-sections and reinforcement types.
- Special simplified interface for fast calculation and estimating.
- Multi-stage general cross-section.
- Fabrication plan for cross-sections.
- Analysis using a simplified cross-section.
- Fire resistance check.
- Check of prestressed concrete.
- Special checks of hollow core slabs according to EN1168.

Setup for parameters for design and checks

- Easy-to-use setup for NA parameters and for concrete.
- Setup is split to groups.
- Unified management for all materials (concrete, steel, composites…).
- Setup library for parameters with an option for user defined setup.
- Brief description with pictures for most of the parameters and code references.
- Default design parameters.
- Library of NA parameters.
- Filtering of input parameters in service Concrete (type of member, functionality and check).

Optimised response of the program

Substantial parts of the calculation core for checks of concrete structures have been optimised for speed. Also more general parts of Scia Engineer are optimised in response:

- Optimisation of drawings: the progress-bar allows the user to monitor the progress of the drawing operation and stop it if needed.
- Transparency: the display algorithm provides for fast and high quality transparent rendering, even for larger structures.
- Document: objects in the Document are persistent, thus the regeneration of the whole document is not necessary whenever the document is reopened.
- Load cases: operations performed with load cases, such as copying and deleting, are optimised as well.

Foundation structures

Pad foundations

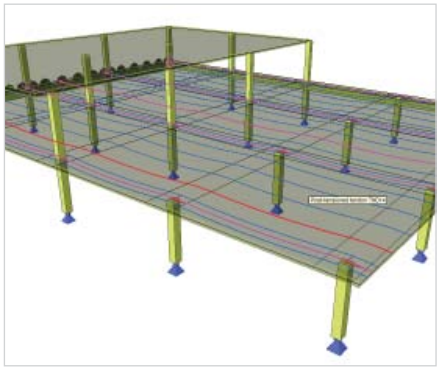
- Pad foundations of various shapes.
- Design of pad dimensions.
- Check of stability according to EN 1997-1.

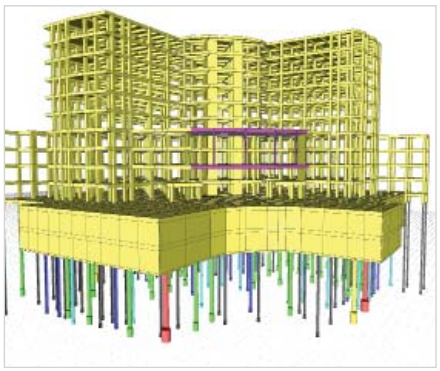
Piles

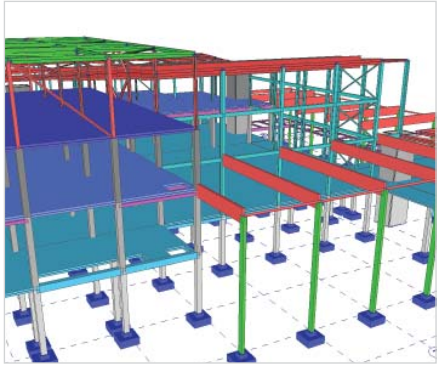
- Application of the CPT method (Cone penetration test).
- Design of pile length and its stress strain diagram.

Highlights

- Clear and self-explanatory input of code-related parameters
- Graphical and tabular representation of check result
- Wide coverage of element types: voided slabs, hollow core slabs, pre- and post- tensioned beams, ...
- Fire resistance including assessment of post fire situation
- Partial or overall check







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