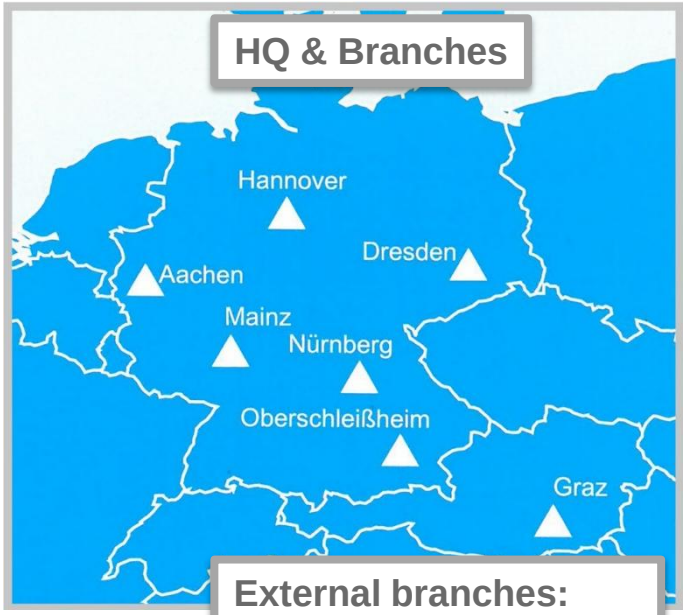
SOFiSTiK

Features and Applications

History & Structure

- **1973** • Beginning of software development
- **1987** • Founding of the company
- **1999** • Registration as SOFiSTiK AG
- **…** • + 80 employees

Numerous certificates & affiliations



External branches:
- Athens (Greece)
- Pretoria (South Africa)

AUTODESK
Authorised Value Added Reseller
Authorised Developer

SOFiSTiK

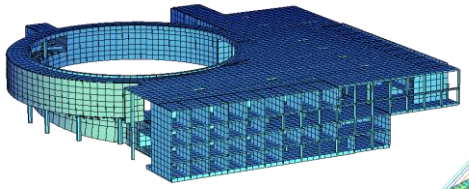
International Presence

30 international distributors

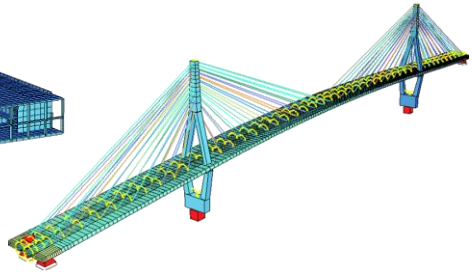
6000+ clients
60+ countries

10 competence centers

Software for the whole construction branch

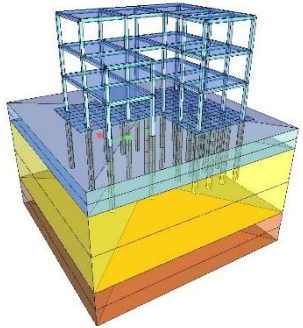


Building

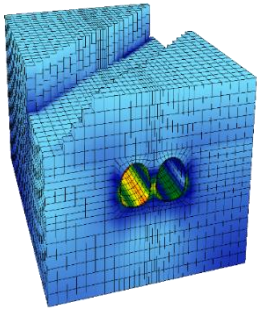


Bridges

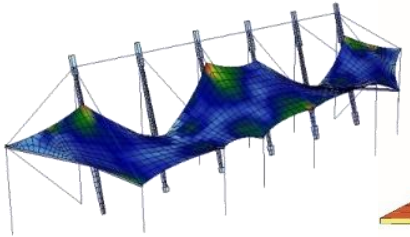
Piles



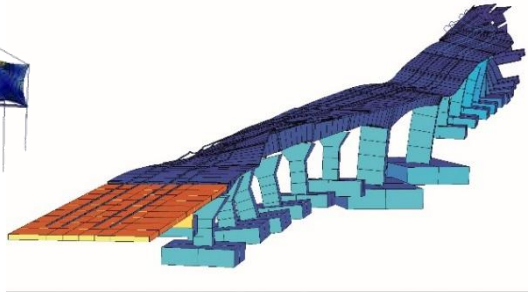
Half-space



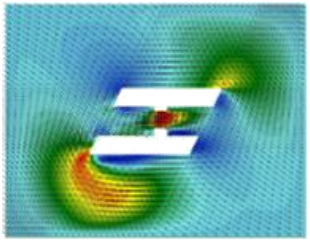
Tunnels



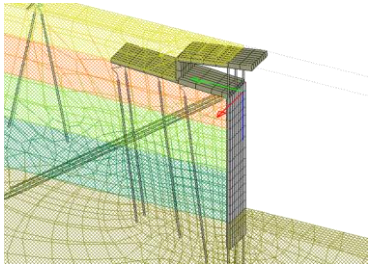
Membranes



Dynamics

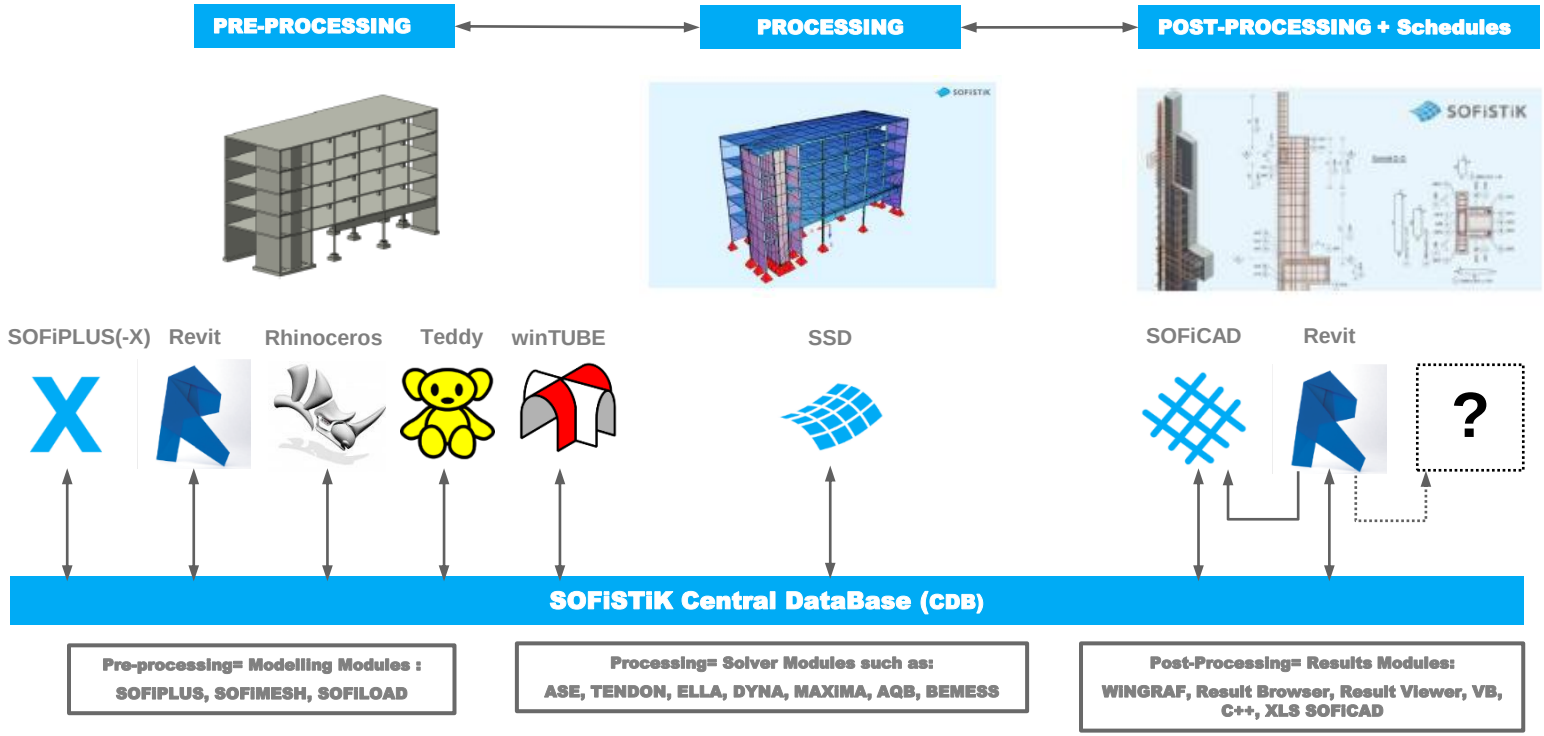


Multi-Physics(CFD)



Geotechnics

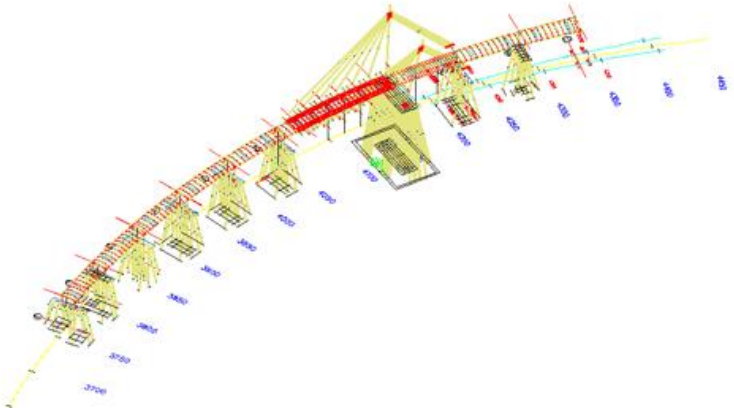
Modular structure & Choice of interface

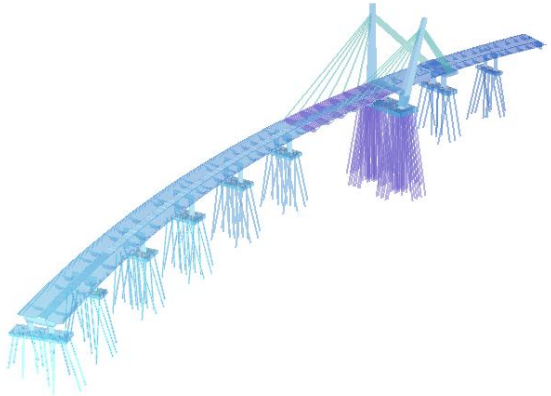


X

SOFiPLUS(-X)

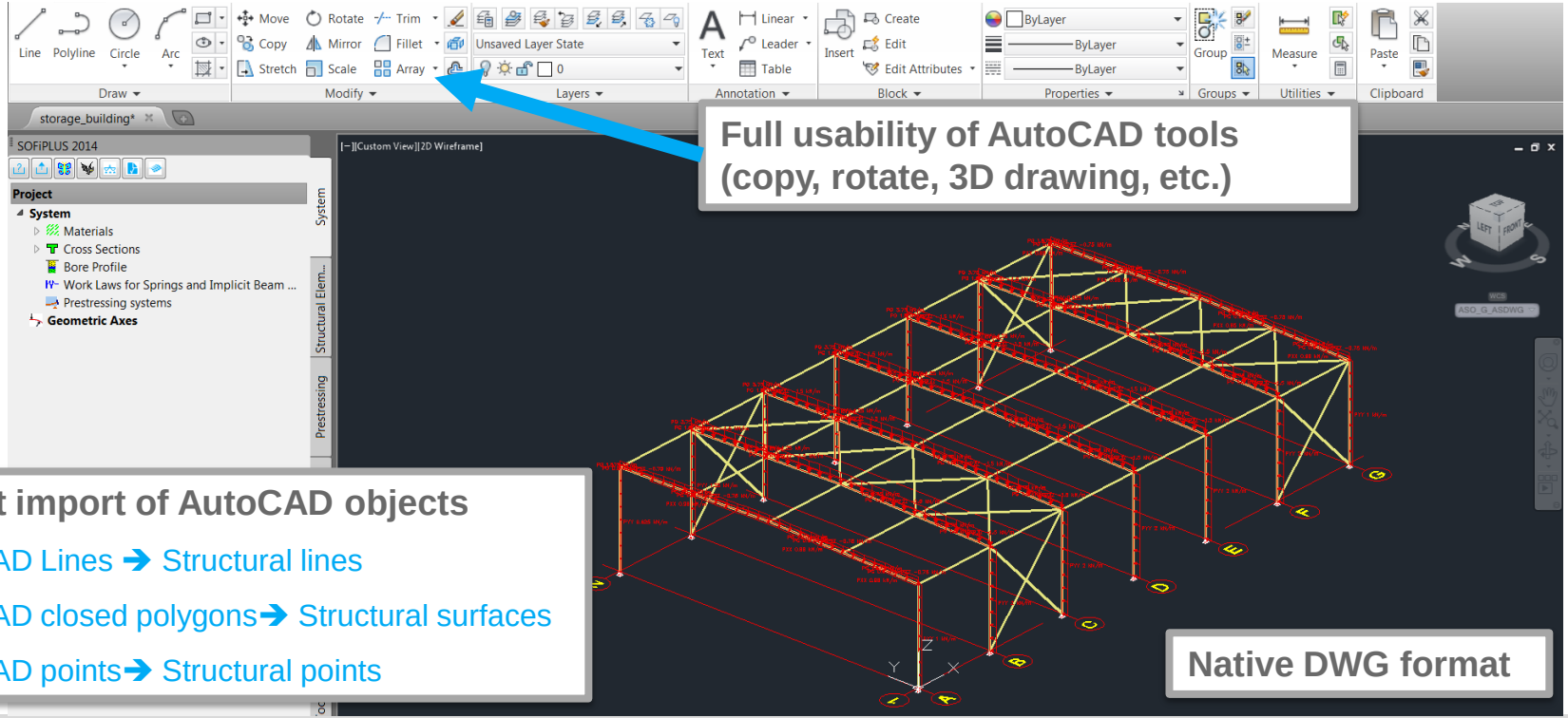
AutoCAD-based Modelling Interface





SOFiSTiK

Full integration of AutoCAD tools



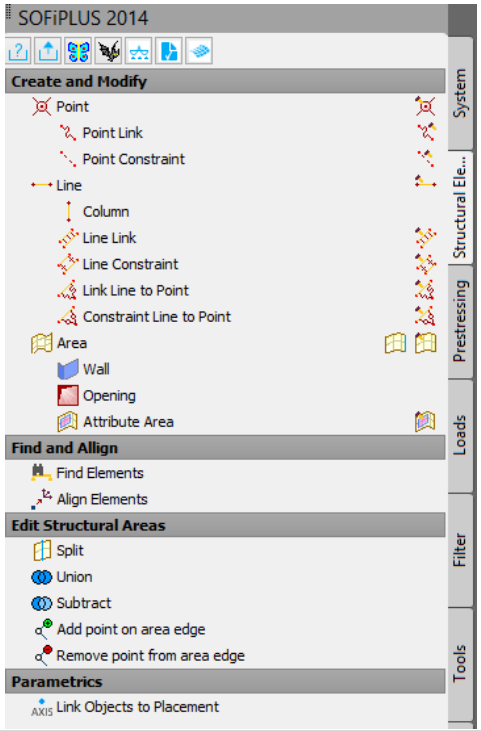
Direct import of AutoCAD objects

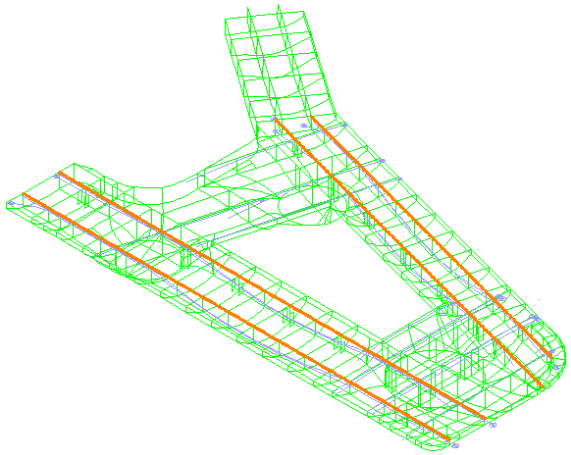
AutoCAD Lines ➔ Structural lines

AutoCAD closed polygons➔ Structural surfaces

AutoCAD points➔ Structural points

Modelling in SOFiPLUS / AutoCAD





Integration in Analysis Workflow

- Automatic meshing from AutoCAD to SOFiSTiK
- Bidirectional dialog with SSD

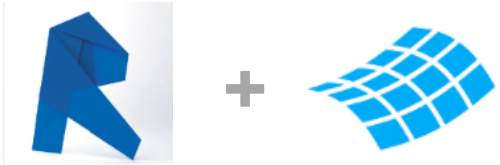
Structure, Loads & Pre-stressing

- All types of elements together
- Modelling of loads and tendons
- Loading independent of meshing

Pre-settings for analysis

- Definition of linear and non-linear supports.
- Free definition of « groups »

SOFiSTiK



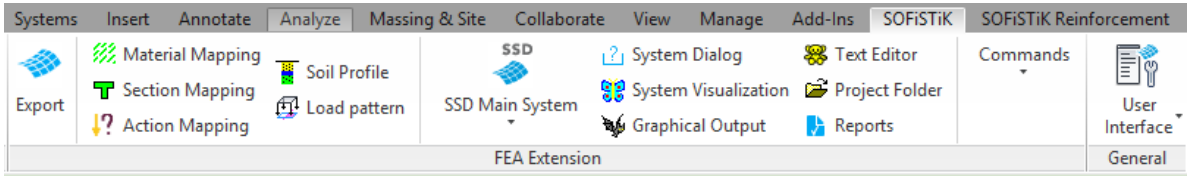
SOFiSTiK – Revit Interface

FE Tools in the BIM Workflow

Modelling in REVIT

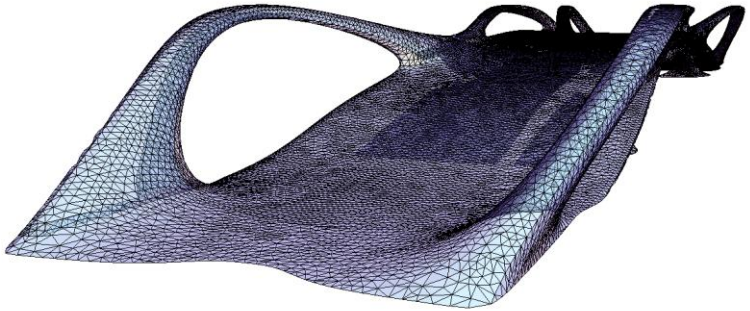
FEA Extension for Revit

- Goal: BIM R/C Building Designers can work with Revit and FEA Extension
- The SOFiSTiK Interface for Autodesk® Revit® Structure provides a seamless integration of FE analysis with all features of the SOFiSTiK software package.
- Automatic FE meshing can be started directly from Revit Structure to allow quick system changes of the calculation model.
- Immediate review of the structural model is possible starting ANIMATOR and WinGRAF directly from Revit.

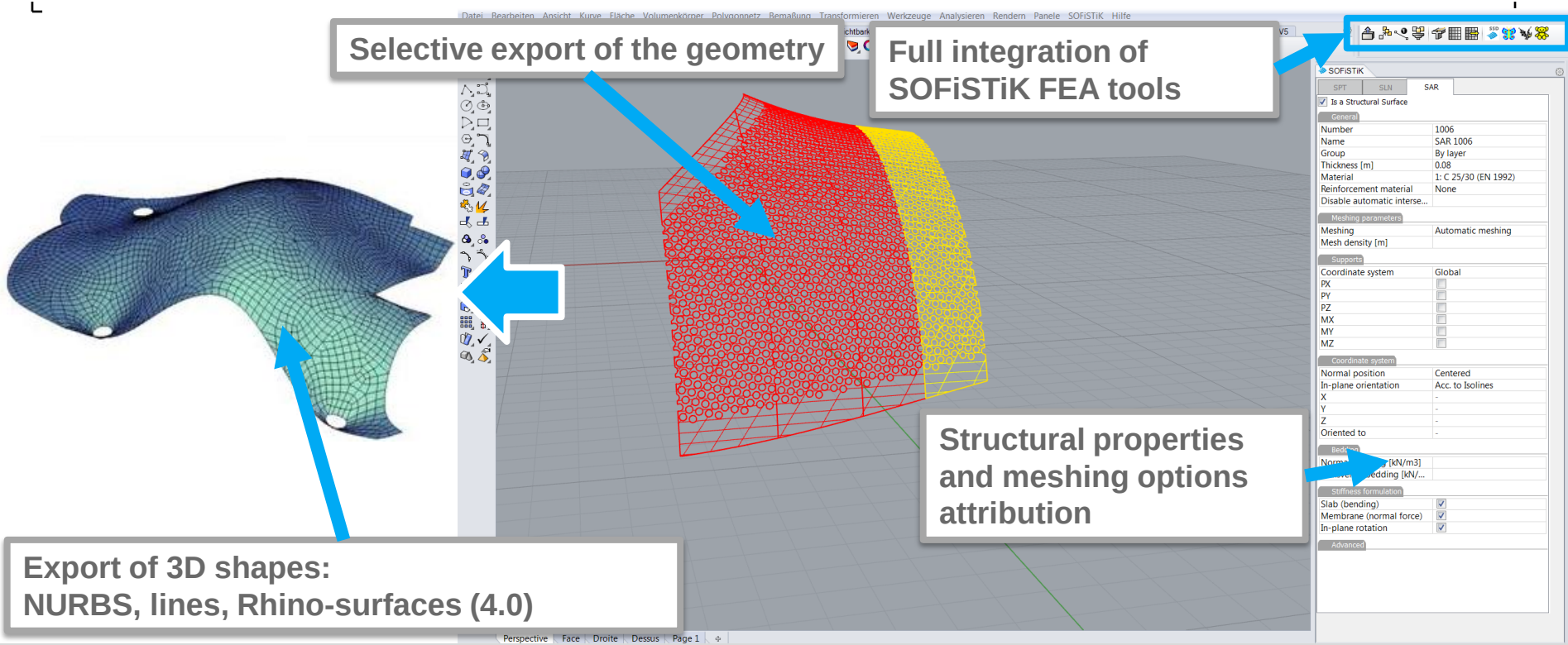


Rhino & SOFiSTiK

Complex (free-form) geometries



SOFiSTiK integrated in Rhino



Finite Element Analysis

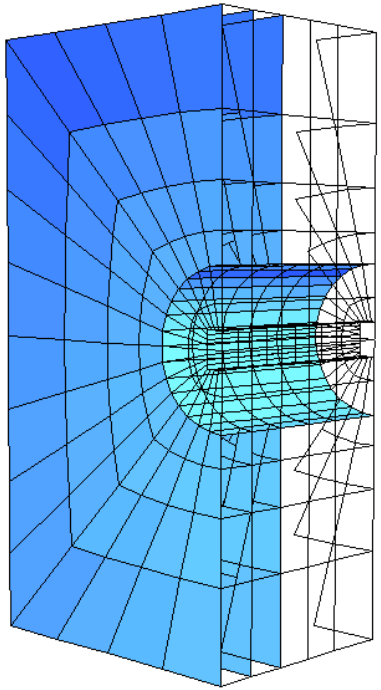
SOFiSTiK Structural Desktop

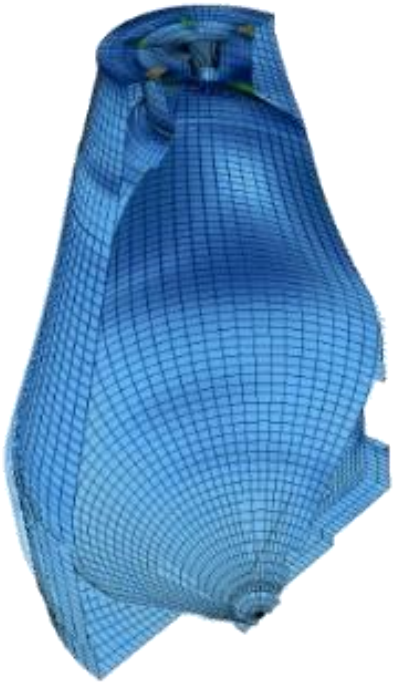
SOFiSTiK Structural Desktop
SSD

Finite Element Analysis

Wide variety of elements available:

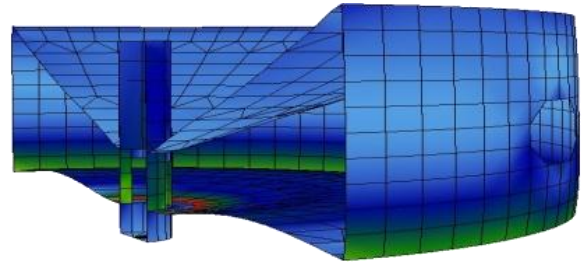
- Isotropic/anisotropic shell- & volume-elements.
- Layered elements (Fiber beam).
- Beam and cable elements.
- Pile elements.
- Membranes.
- Kinematical constraints.
- Nonlinear springs (failure, gaps, user defined stress-strain functions).
- Nonlinear bedding elements.
- Beam- and plate- nonlinear hinges
- Non-linear constraints

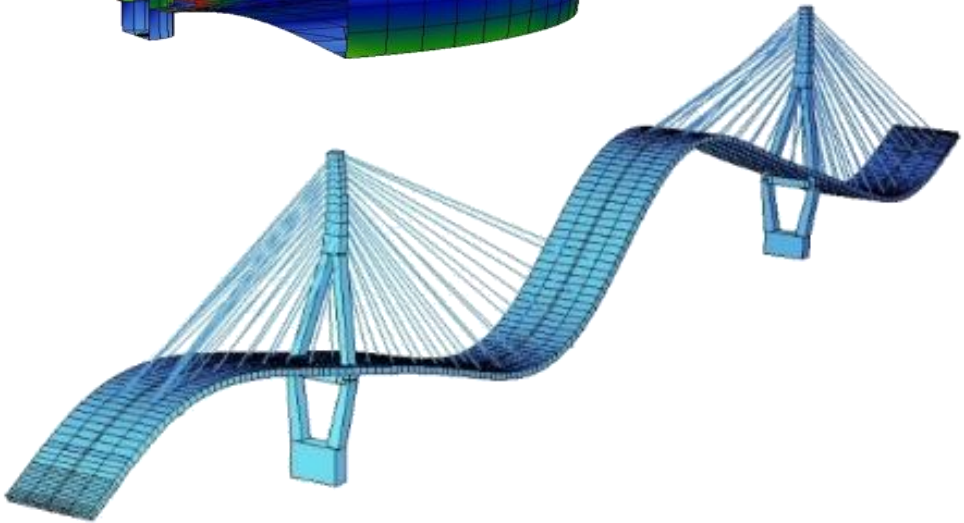




Analysis features

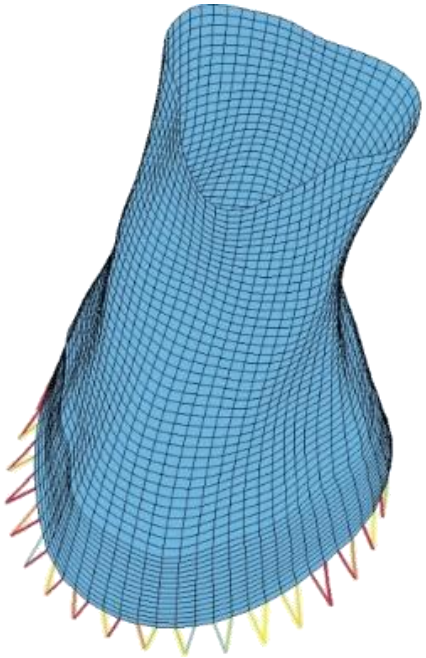
- Linear elastic, static.
- Load iteration, stability failure.
- **Non-linearity:**
  - Geometric
  - Material
  - Combination of geometric and material
- Warping effects on cross-sections.
- Creep and shrinkage, long-term deflections.
- Response spectra
- Push-Over-Analysis.
- Modal stationary and instationary response.





Analysis features

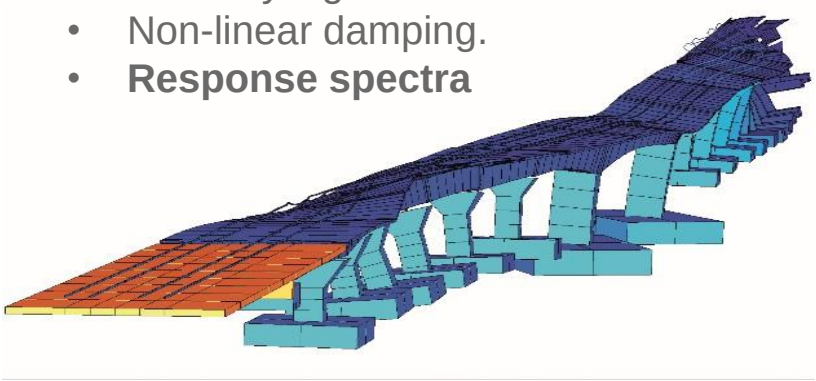
- Tension Stiffening (cracked concrete).
- Automatic update of non-linear stiffness.
- Plastification zones.
- Non-linear Beams.
- Construction stages.
- Primary states of stress and deformation.
- Activation – deactivation of elements or groups.
- Load combinations, Min/Max forces.



- Eigenfrequencies and eigenvalues.
- Forced vibrations.
- Time step method.
- General damper models & non-linear damping.
- Dynamic moving loads.
- Non-linear wind dynamics & CFD Analysis.
- Shape finding of cables or/and membranes.
- Inflated structures.

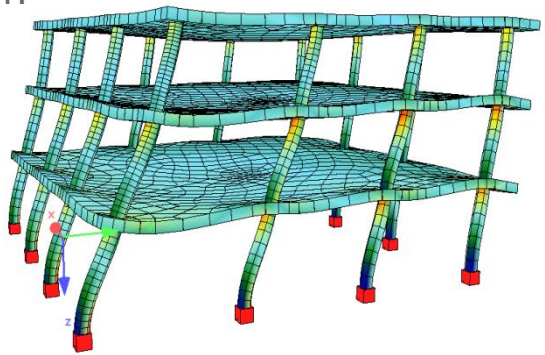
Dynamic & Seismic Analysis

- **Solvers**
  - Sparse Solver
  - Iterative Conjugate Gradient Solver
- **Eigenvalue Solver**
  - Simultaneous vector iteration
  - Lanczos
  - Rayleigh.
- Non-linear damping.
- **Response spectra**

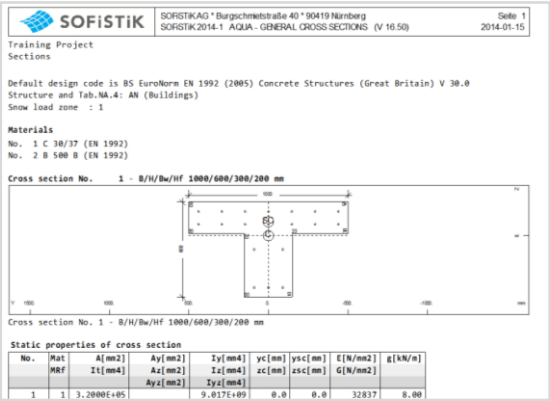


- **Time History**
  - with modal analysis.
  - with direct analysis
- Non-linear wind analysis (SOFiLOAD-DW).
- Vehicle-structure-interaction.
- **Moving loads.**
- **High-speed-trains.**
- Harmonic load generator.
- Push-over analysis

...and a lot more...



Post-processing



SOFiSTiK | SOFISTIKAG * Burgschmietstraße 40 * 90419 Nürnberg | Seite 1
SOFISTIK 2014-1 AQUA - GENERAL CROSS SECTIONS (V 16.50) | 2014-01-15

Training Project
Sections

Default design code is BS EuroNorm EN 1992 (2005) Concrete Structures (Great Britain) V 30.0
Structure and Tab.NA.4: AN (Buildings)
Snow load zone : 1

Materials
No. 1 C 30/37 (EN 1992)
No. 2 B 500 B (EN 1992)

Cross section No. 1 - B/H/Bw/Hf 1000/600/300/200 mm

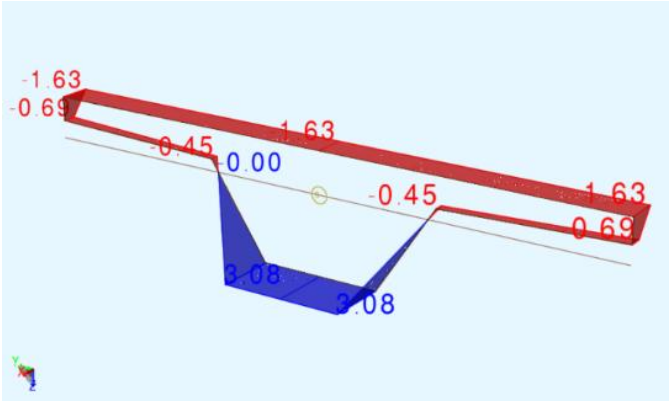
Cross section No. 1 - B/H/Bw/Hf 1000/600/300/200 mm

Static properties of cross section

No.	Mat MRf	A[mm2] It[mm4]	Ay[mm2] Az[mm2] Ayz[mm2]	Iy[mm4] Iz[mm4] Iyz[mm4]	yc[mm] zc[mm]	ysc[mm] zsc[mm]	E[N/mm2] G[N/mm2]	g[kN/m]
1	1	3.2000E+05		9.017E+09	0.0	0.0	32837	8.00

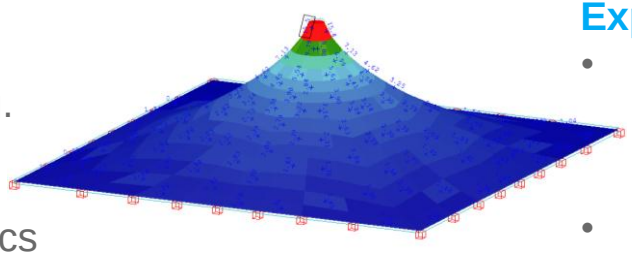
Graphics

- Interactive database evaluation with true scaling.
- Multiple-filter functions.
- Open-GL Animator for plausibility checks and movie files.



Reports

- Full numerical & graphical reporting.
- User-defined macros for standard result output.
- Free input of user-texts and -graphics
- Automatic update after new calculation



Export

- graphics via Copy/Paste and standard formats (PS, GIF, JPEG, etc.) to other applications.
- Excel, Word & PDF.
- VRML for virtual flight through the structure.

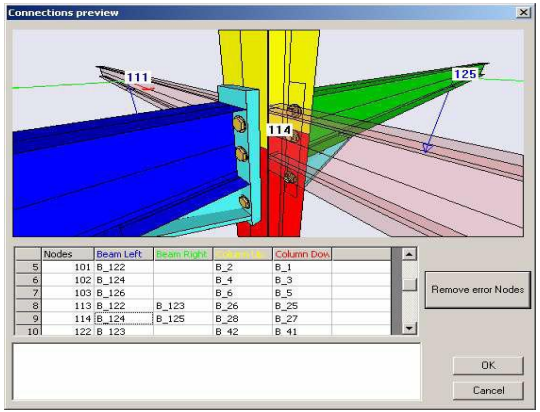
Steel Connections with SteelCon

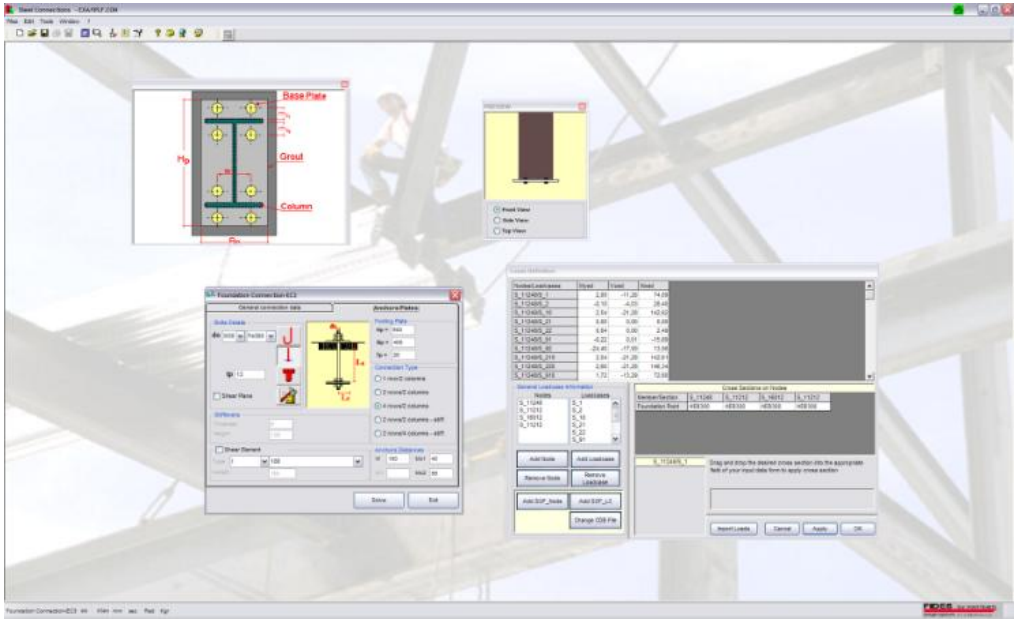
FIDES DV-PARTNER

SteelCon – Steel Connections.

Design of steel connections

- Use of analysis and design results from the database
- Library of standardized connections

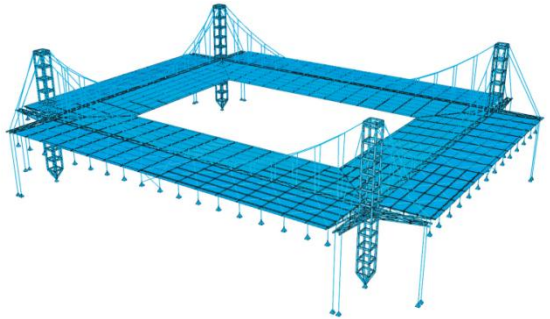


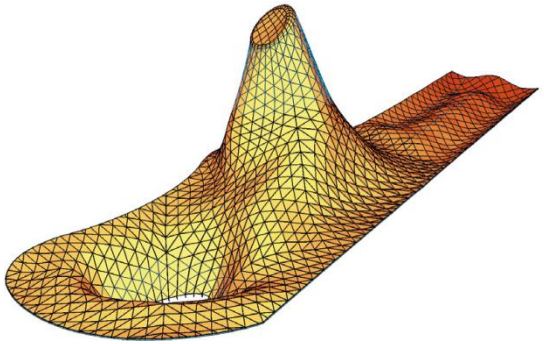


SOFiSTiK

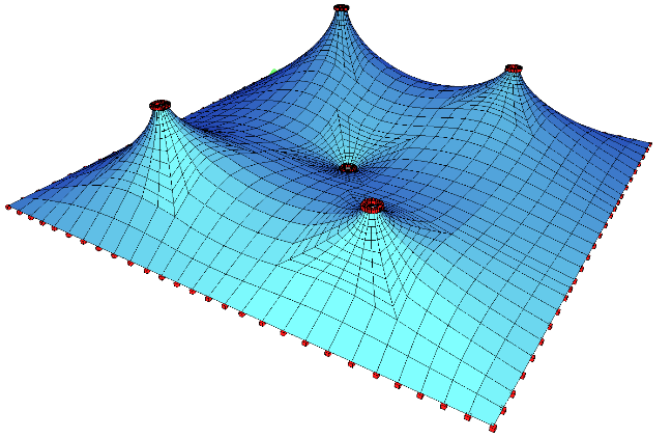
Lightweight Structures

- Analysis of the entire system with the combination of different types of elements such as beams, slabs, walls and shells using different materials like steel, glass, concrete and membranes
- User defined materials
- User defined stress- strain curves for material and spring elements
- Construction stages
- Partial system failure
- 3rd order theory/ full geometric nonlinear analysis
- Warping torsion
- Catenary effects
- Post-tensioned shells
- Non-linear material behavior for concrete or metallic materials
- Local and global stability analysis (plate buckling, lateral buckling)



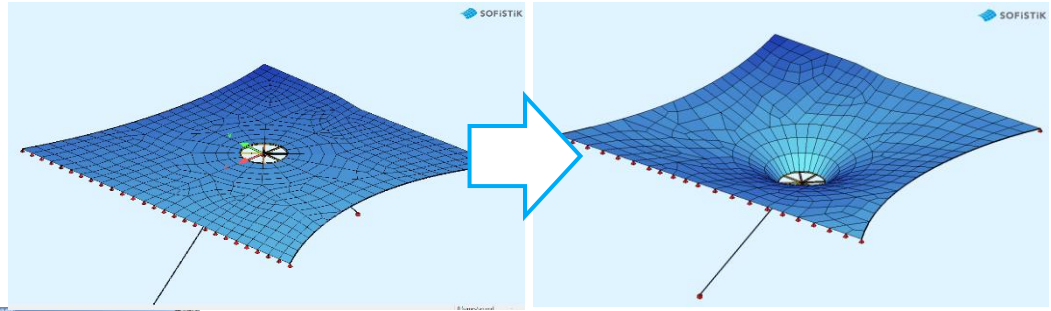


Membrane Structures



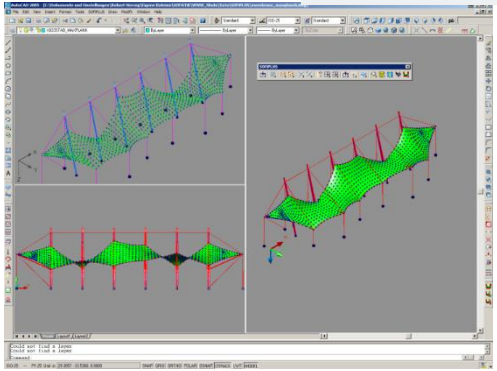
- **Form-finding**
  - with the FE method following the membrane theory
  - with inner pressure
- **Pre-stressing**
  - orthotropic.
  - Isotropic with minimum surface (membrane)
- Iterative analysis with interaction between primary and secondary structure
- Consideration of the shear stiffness of the membrane fabric
- Compression failure for the determination of wrinkling effects
- **Cutting patterns**
  - consideration of material compensation

Membrane Structures

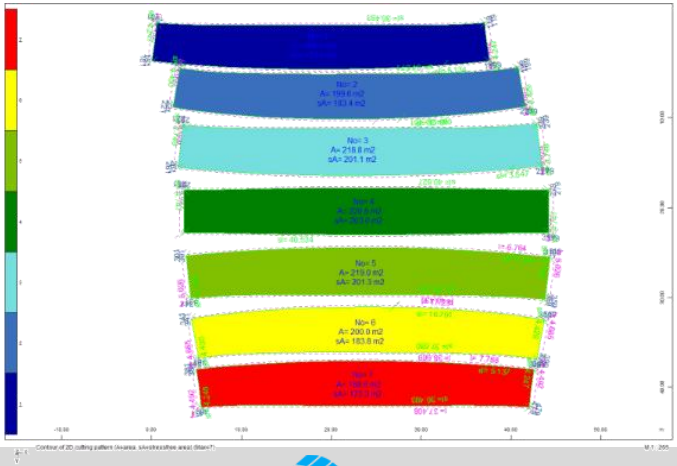


Form-finding

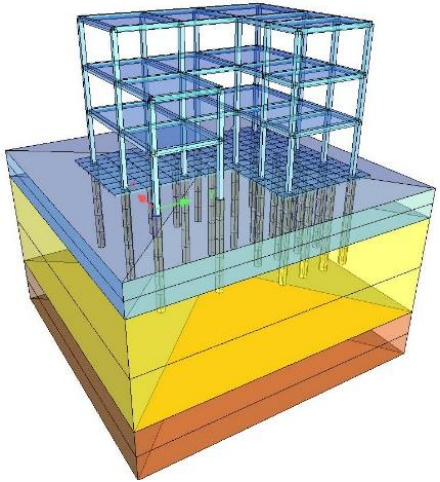
Cutting pattern



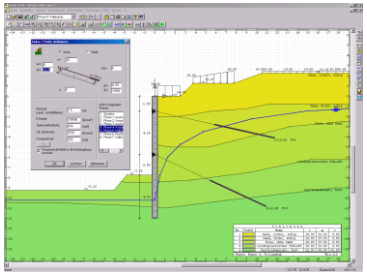
Graphical definition in SOFiPLUS or Rhino



Geotechnics / Geomechanics

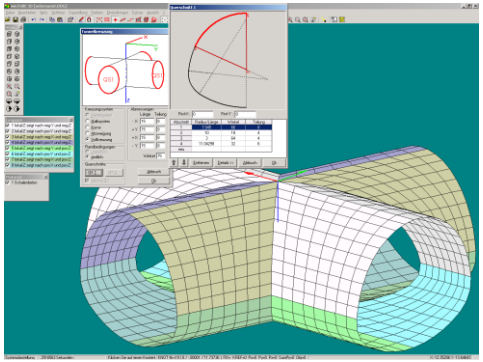


Soil-Structure Analysis



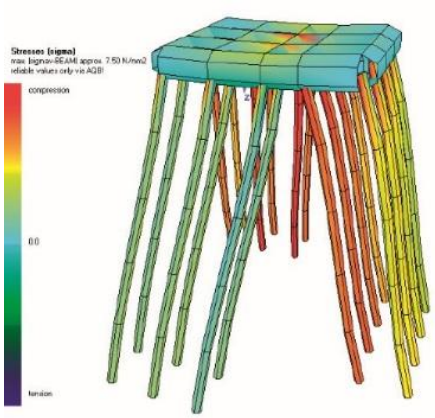
FIDES DV-PARTNER

Analysis of retaining walls



WinTUBE

Graphical pre-processing for tunnel



Graphical pile modeling & analysis

Transient Potential Analysis

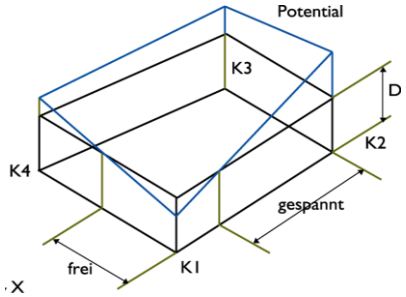
HYDRA – Seepage and Thermal Analysis

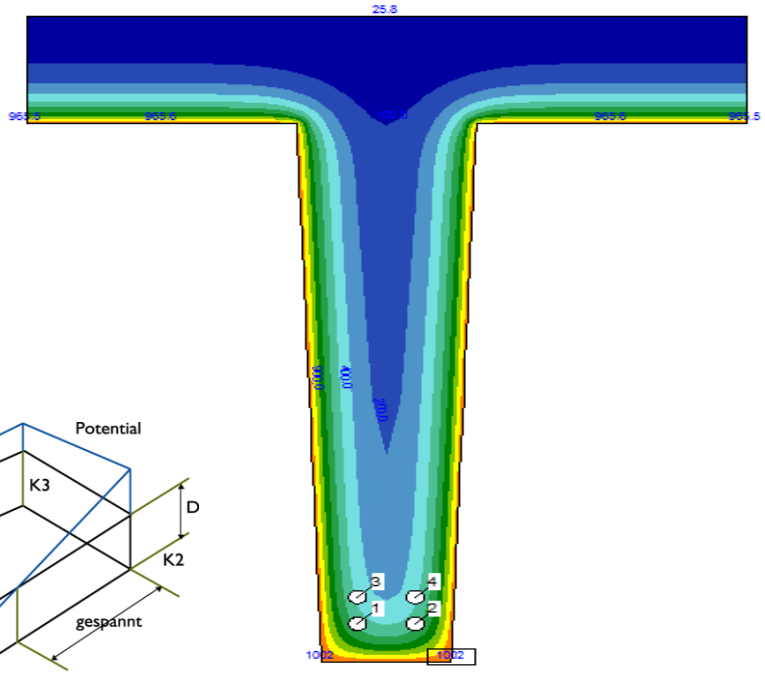
Classical potential problem.

- Ground water flow.
- Heat conduction (convection)
  incl. radiation border conditions.
- Electrical and magnetic fields.
- Torsion/shear problems on a cross-section level.
- Membrane solutions.

Differential equations

- Laplace
- Poisson





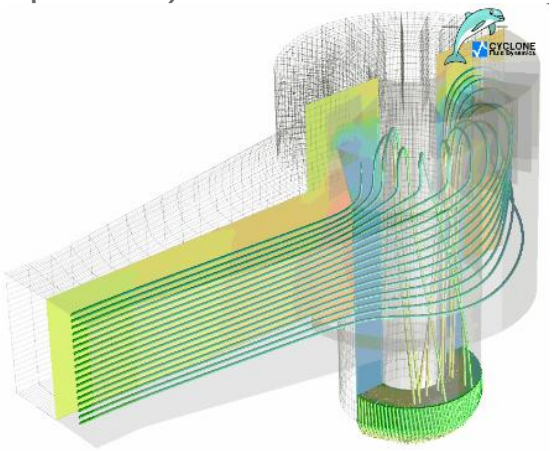
CFD Analysis with DOLFYN

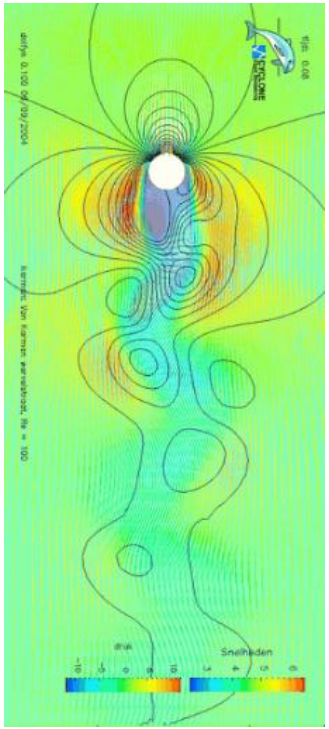
www.dolfyn.net

DOLFYN – Computational Fluid Dynamics / Multi-Physics.

Field of application

- Fluid Mechanics (Navier-Stokes equations).
- RANS family turbulence models.
- Free surfaces for fluids.
- Heat conduction and convection.
- Combustion.
- Melting and solidification.
- Elasticity and plasticity of soils.



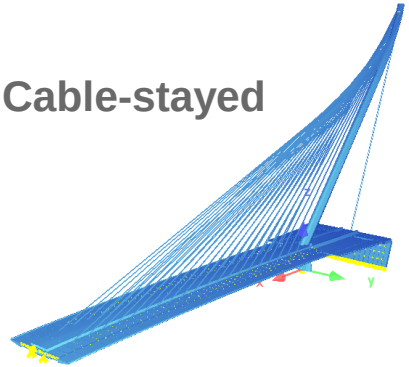


SOFiSTiK

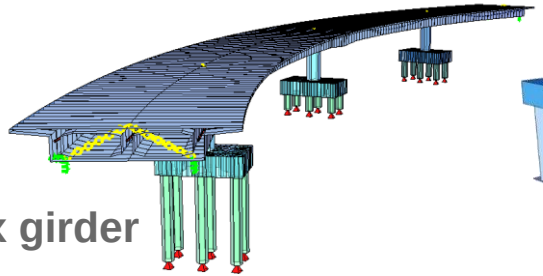
Bridges

Any type of structural bridge system

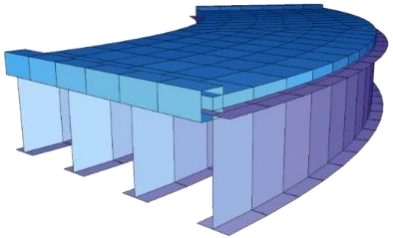
Cable-stayed

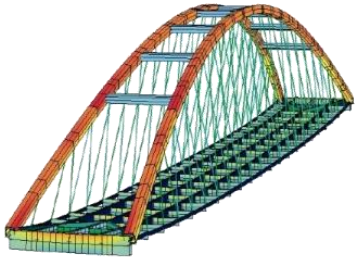


Box girder



Composite





Suspension

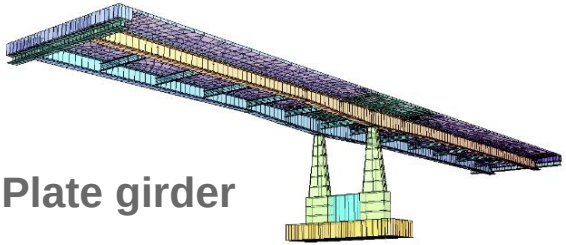
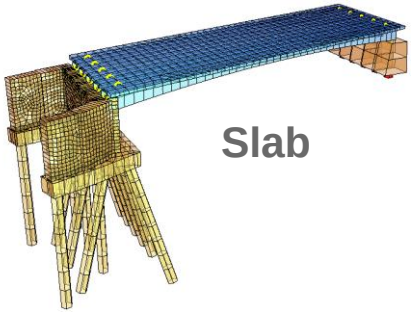
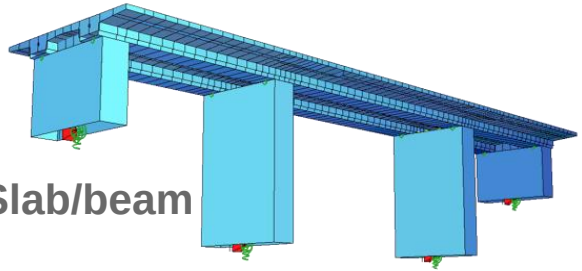


Plate girder



Slab



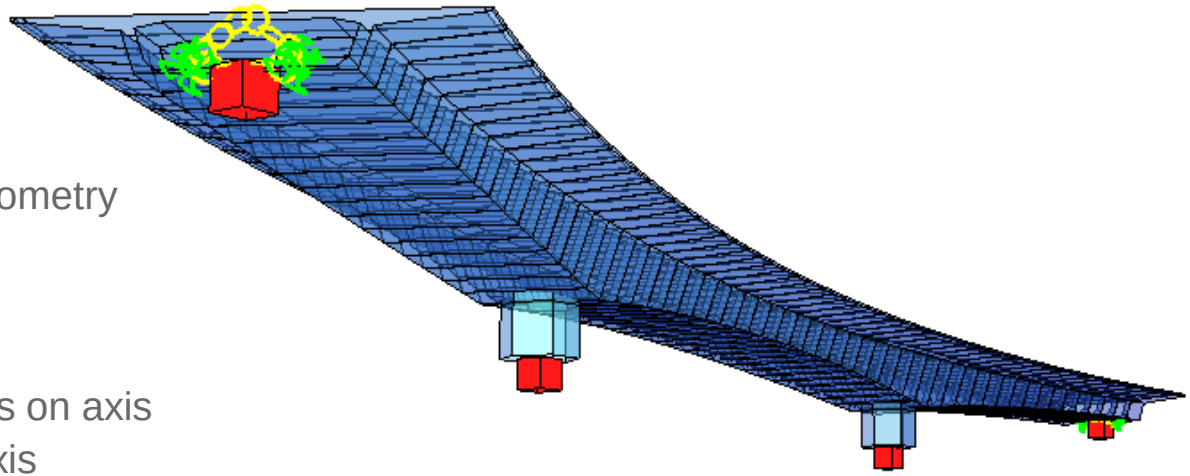
Slab/beam

Parametric Bridge Design

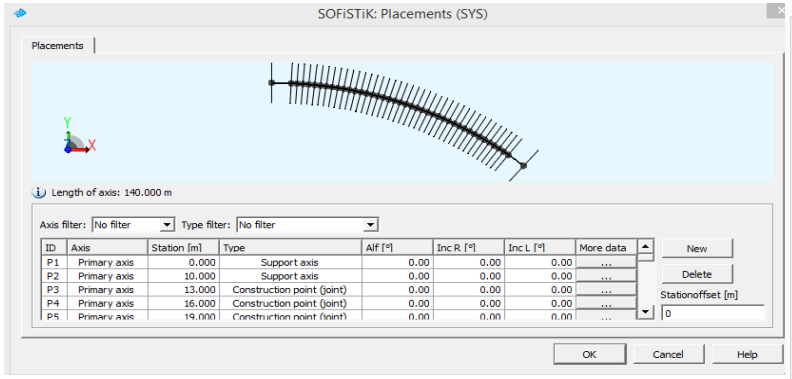
CABD – Computer Aided Bridge Design

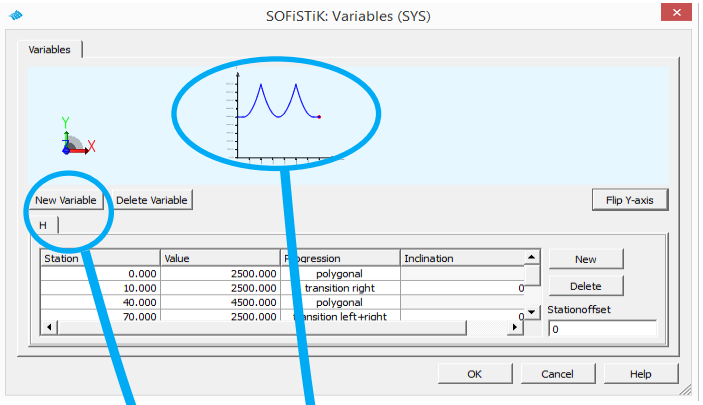
Definition of bridge with parametrical input → Dynamical change in the model

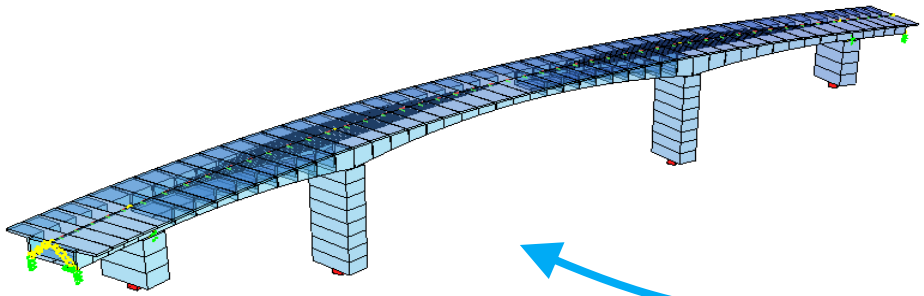
- Fully parametric cross section as basic sections with :
  - Reinforcement layers
  - Location of stress points
  - Location of shear cuts
  - Definition of torsion box
  - Reference points for PT geometry
  - Shear lag
  - Internal dependency
- Axis-related variables
- Support & joints as placements on axis
- Tendon geometry related to axis

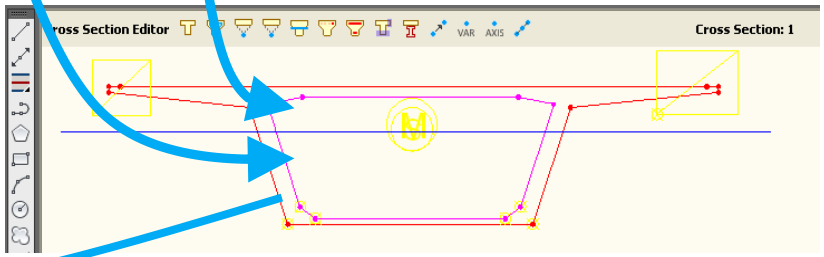


Parametric Bridge Design









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Pre-stressing

Different types of pre-stressing

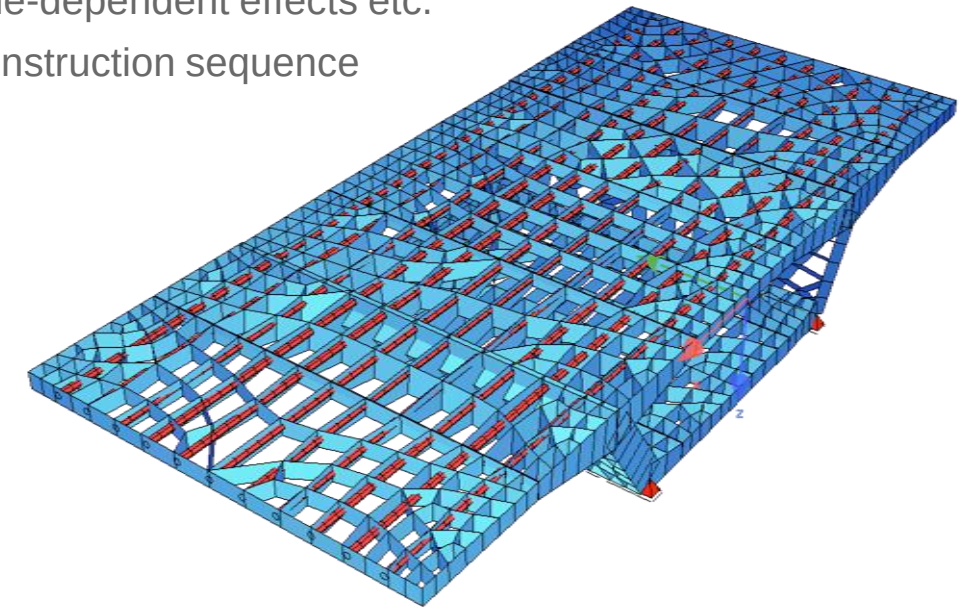
- Internal / external tendons.
- Pre- et post-tension.
- For beam- & shell –elements
- In haunched beam/plate

Definition

- 3D Geometry (spline, polyline, etc.)
- Free-shape modelling in AutoCAD
- Graphical editor
- Eccentric duct position.
- Integrated in CABD (= axis-based)

Modelling/Analysis

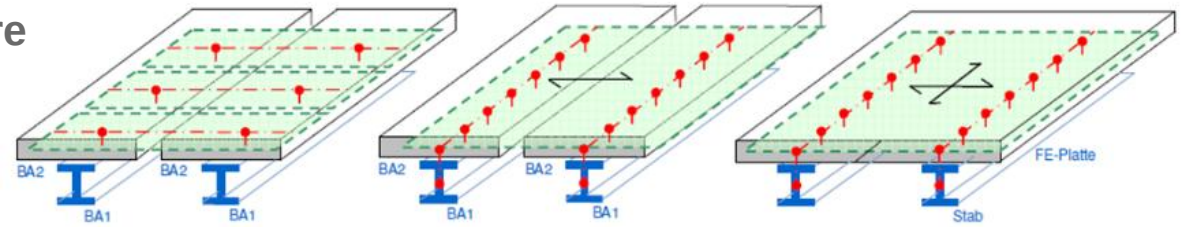
- Detailed loss calculation, including friction, wedge slip, time-dependent effects etc.
- Construction sequence



Composite Bridges

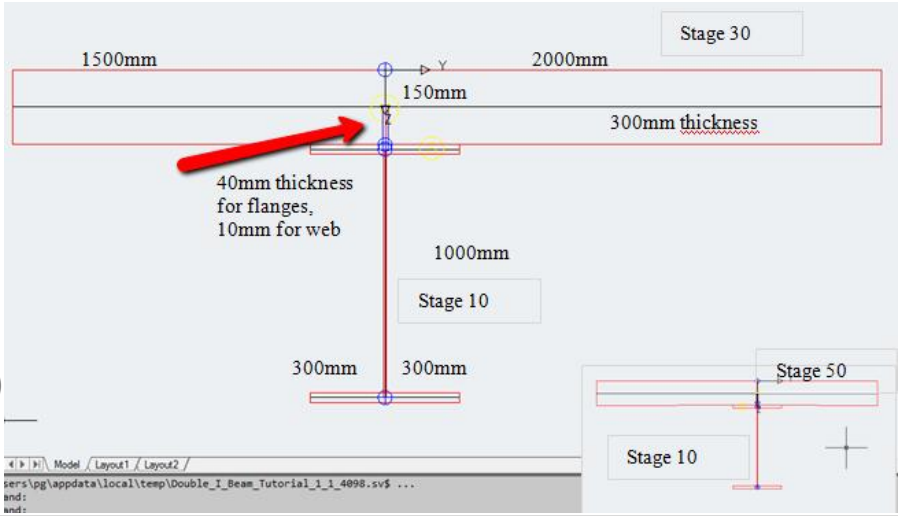
Any type of composite structure

- Steel + Concrete
- Concrete + Concrete



Analysis model

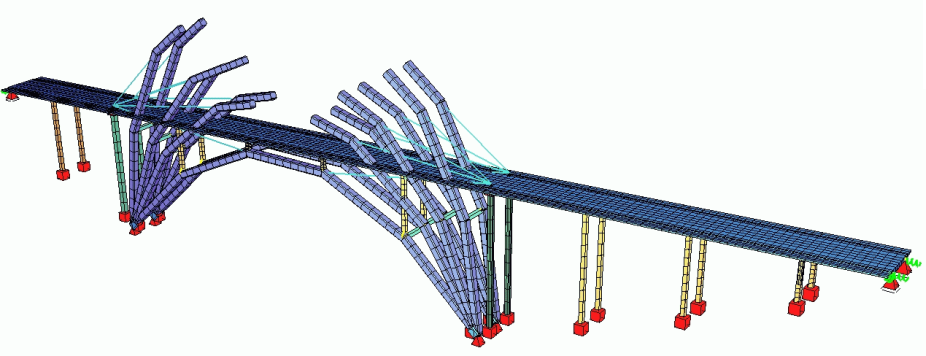
- Thin-walled section (=constant shear flow)
- Thick-walled section
- Free combination of Beam + Shell
- Construction stages

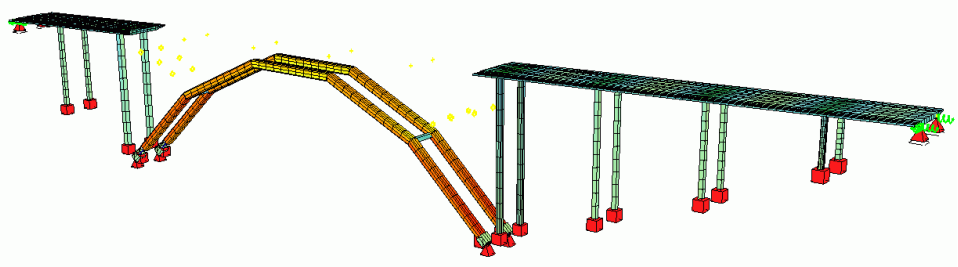


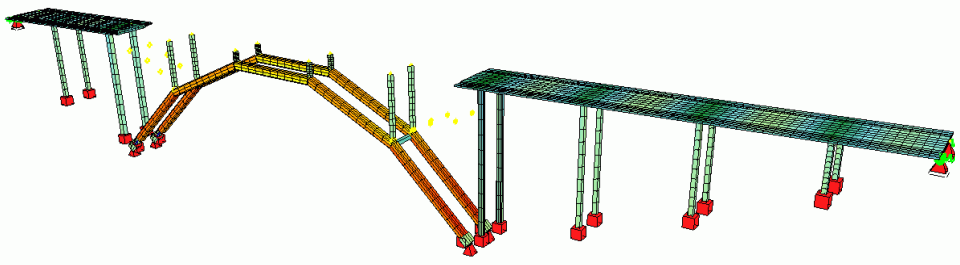
Analysis & Design

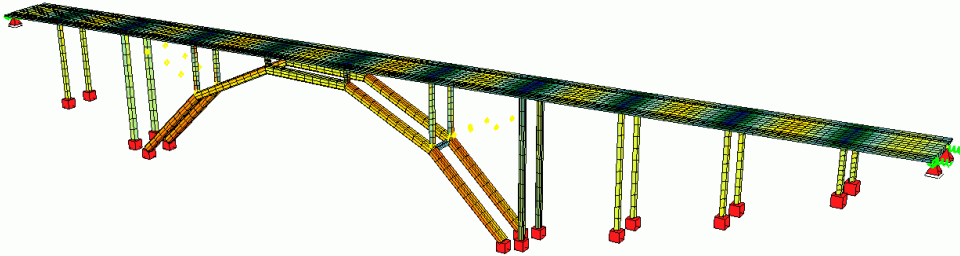
- Time-dependent effects (creep & shrinkage, etc.)
- Design incl. Class 4 sections
- Cracking of concrete over supports

Construction Stages









Bridge & Traffic Loads

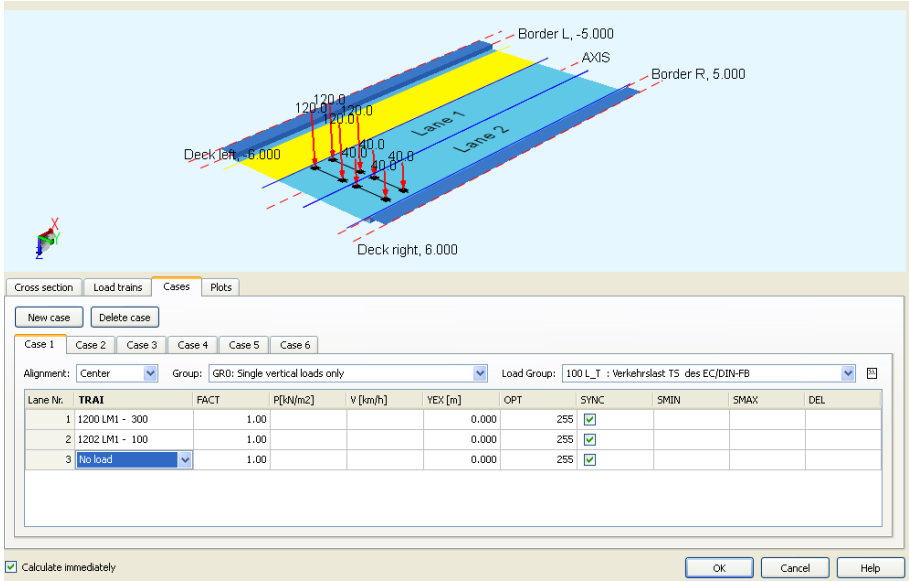
Bridges loads with CSM

- Self weight activated together with Stages
- Creep & Shrinkage based on time-axis
- Additional loads:
  - Additional dead load
  - Temperature gradient and global change.
  - Settlement
  - wind on loaded and unloaded deck

Traffic loads

2 approaches:

1. Load stepping with defined increment + envelop of all steps
2. Influence lines/surfaces analysis



Implemented norms

Eurocode
- EN 1992
- EN 1993
- EN 1994
- EN 1995
- EN 1996
- EN 1997
- EN 1998
- EN 1999

+ National Annexes

DIN (Germany)
- DIN 1045 (1988)
- DIN 1045-1 (1999)
- DIN 4227 + A1 (1995)
- DIN 18800 (Nov.1990 + Nov.2008)
- DIN 1052 (Apr.1988)
- DIN-FB 102 (2003)
- DIN-FB 103 (2003)
- DIN-FB 104 (2003)
- DAfStb hochfest.Beton (1995)

OENORM (Austria)
- OENORM B 4700 (1995)
- OENORM B 4750 (2000)
- OENORM B 4253 (1989)
- OENORM B 4253 (1989)

SIA (Switzerland)
- SIA 162
- SIA 262
- SIA 263
- SIA 265

BS (UK)
- BS 8110 (1997)
- BS 5400 (1990)
- BS 5950 (2001)

ACI + AASHTO (USA)
- ACI 318-M (1999)
- AASHTO (1996/1997 interim + 2002 + 2004 + 2010)

SNIP (Russia)

IS (India)
- IS 456 (01/2002)
- IRC

GB (China)
- GB 500100 (2002)

NBR (Brazil)
- NBR 6118 (2003)

NF (France)
- BAEL-BPEL 91/99

EHE (Spain)

DMI (Italy)
- DM 96

JS (Japan)
- JRA (2002)

...and many more!!

National annexes for EN1992-1-1

Design – Shell & Plate Elements

ULS Design

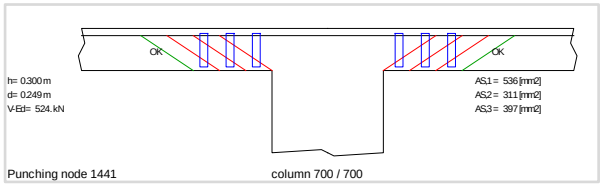
- Each reinforcement layer and direction
- Punching

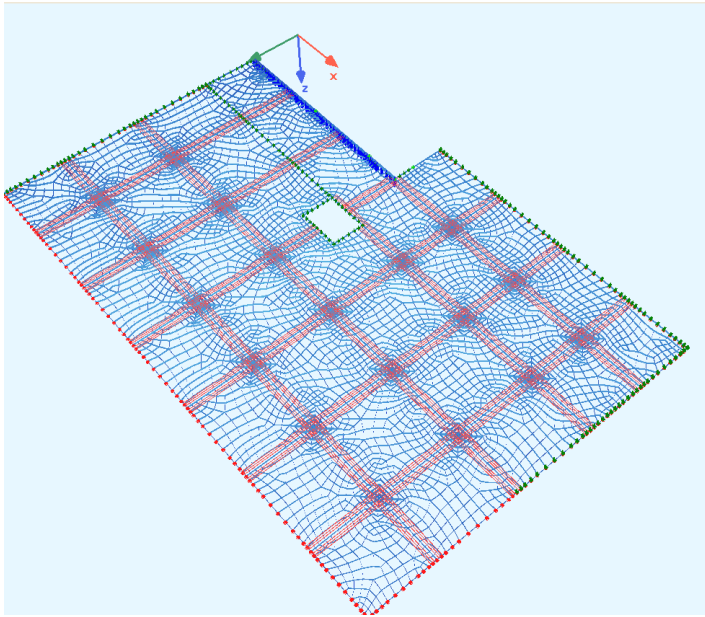
SLS Design

- Crack verification
- Cracked deflection

Special features

- Non-lin. Design
- Pre-stressed slabs





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Design – Beam Elements

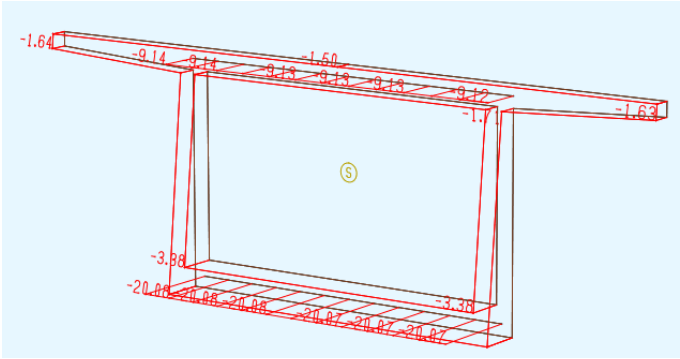
Concrete Sections

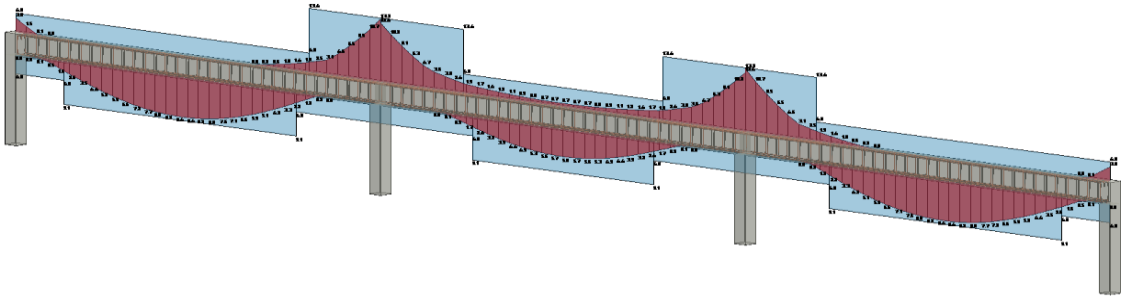
Design

- Auto. selection of envelops/results
- Non-linear design
- Results per reinforcement layer
- Different use per layer
- All geometries:
  - T-Beam
  - Box
  - Etc.

Verifications

- Decompression +/-
- Cracks
- Stress/strain





Design – Beam Elements

Steel / Composite Sections

- c/t Verification
- Section Class
- Class 4 Design
- Composites Sections
- …