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Analysis of Axisymmetric Structures and Tanks by *ELPLA*

■ Description:

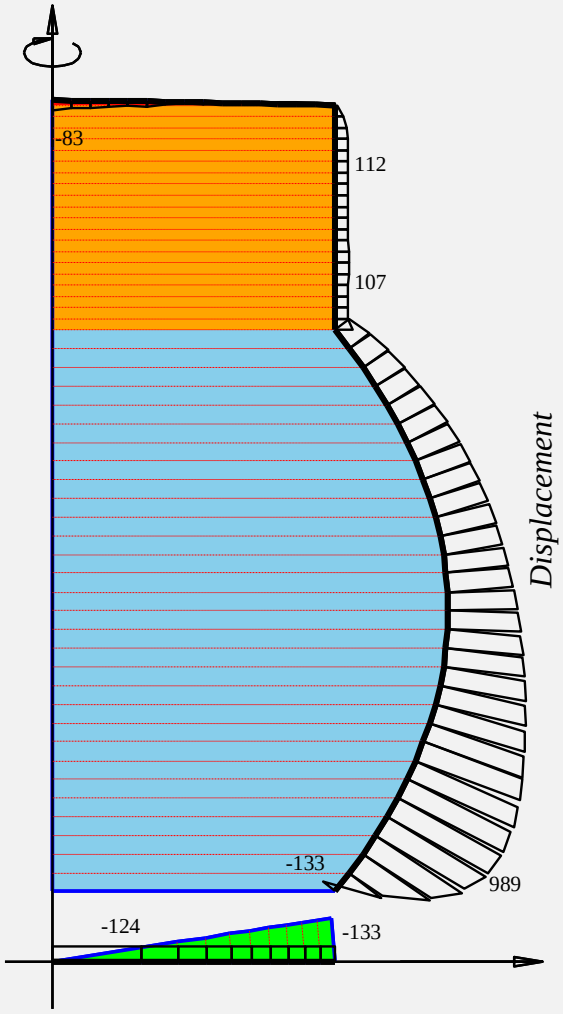
ELPLA (*EL*astic *PLA*te) is a program for analyzing geotechnical and structure problems. One of them is analyzing axisymmetric structures and tanks with the real subsoil model.

The program can analyze different types of subsoil models, especially the three dimensional continuum model that considers any number of irregular layers in the vertical directions.

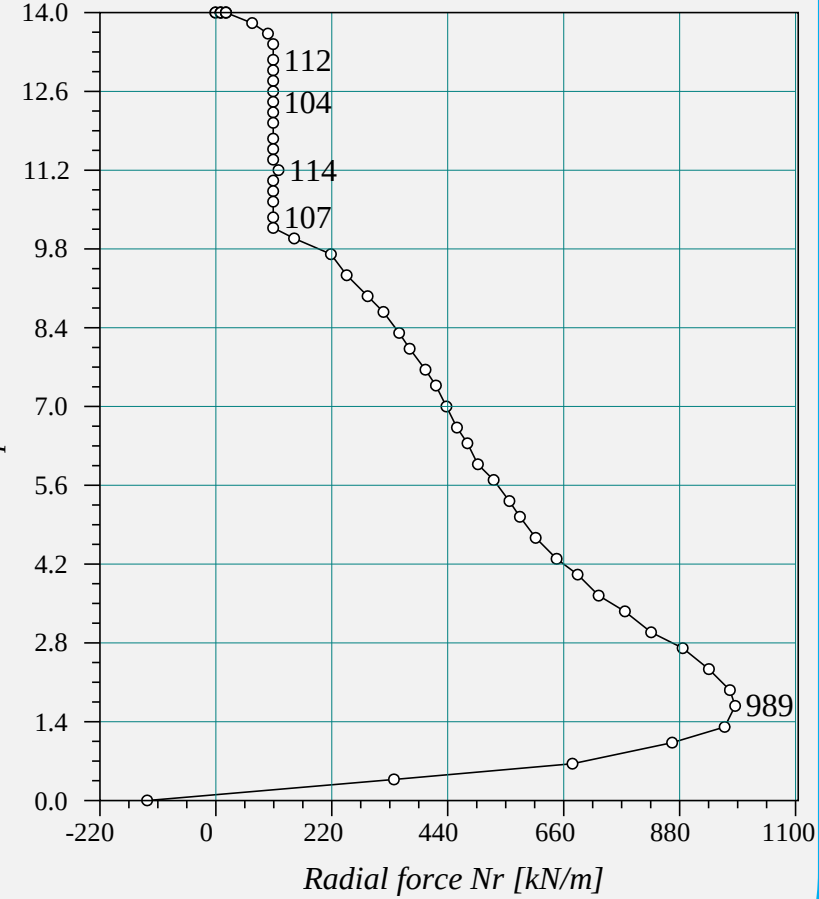
Three known subsoil models for the analysis of axisymmetric structures and tanks (standard models) are considered. The subsoil models are the Simple Assumption Model, the Winkler Model and the Continuum Model.

In the analysis, the wall, the base and the subsoil are treated as one unit. In addition, the base can be considered as an elastic or a rigid slab. The mathematical solution of the wall and the base of axisymmetric structures and tanks is based on the finite element method.

Method (7) (Layered soil model)
Modulus of compressibility



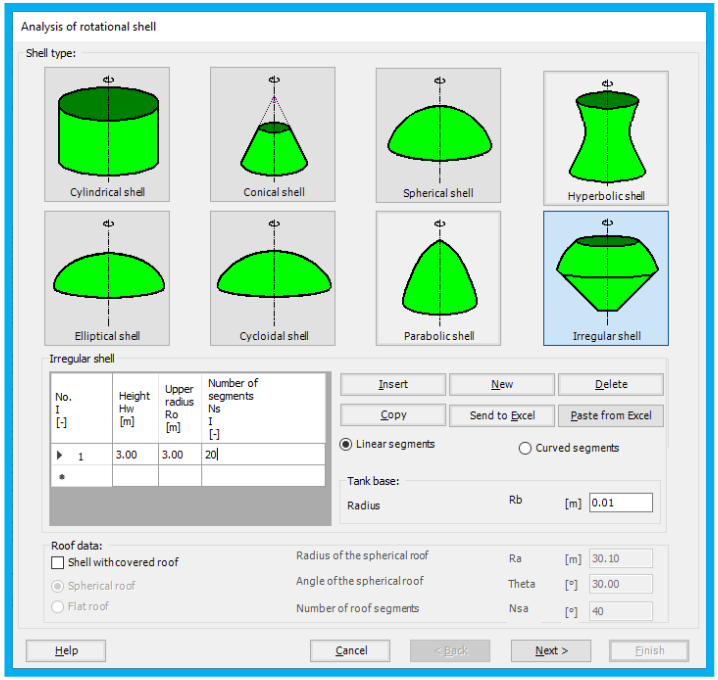
Element groups
No. of element groups = 3

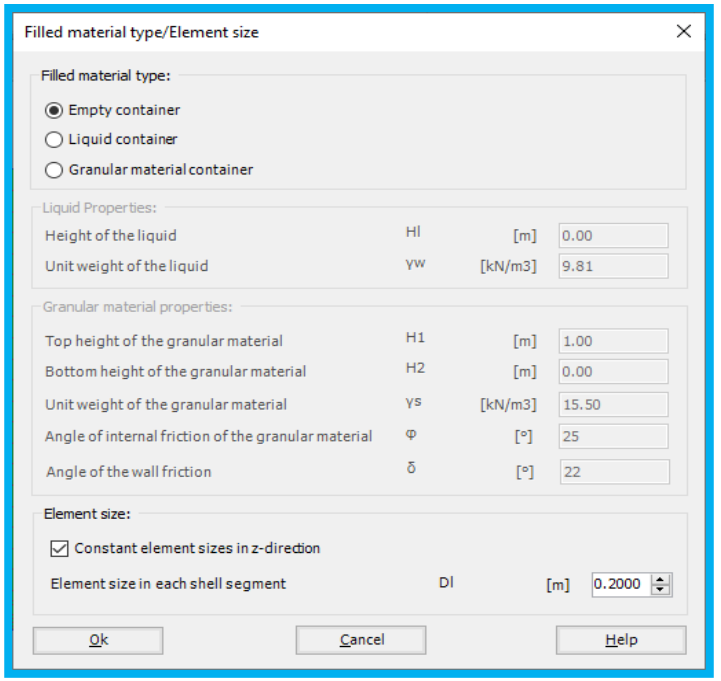


Radial forces
Sections in shell wall

Features:

- User interface and help system are available in 3 languages: English, German and Arabic
- Analyzing a cylindrical tank considering the wall and the base as one unit on layered soil
- Analyzing axisymmetric structures with or without opening base using annular finite elements
- Analysis of an elastic, a rigid or a flexible base on layered soil
- Numerical model of soil-structure interaction is under 9 calculation methods
- Automatic generation for the FE mesh of the wall and the base
- Powerful mesh generator using templates for different axisymmetric structure shapes
- Translational and rotational springs can be added at nodes
- Elastic or fixed rotations and deflections can be taken into account
- Determining contact pressures, settlements, internal forces, subgrade reactions
- Node coordinates and boundary nodes of the FE mesh can be imported from a table via MS Excel
- Spherical or flat roof of the axisymmetric structures and tanks are also possible
- Variable wall and base thickness
- Three cases of filled material types are considered (Empty, Liquid, Granular material)
- Consideration of the reduction coefficients α according to DIN 4019 Part 1
- Point loads, line loads, uniform loads and moments can be applied
- Three types of uniform load can be applied, wind load, snow load and self-weight
- Loading and reloading modulus of compressibility or elasticity are considered
- The soil is defined by a boring log has multi-layers with different soil material
- Drawing soil layers by different symbols and colors according to DIN 4023 for easy identification
- Consideration of groundwater and overburden pressure effects
- Color representation of the dimensions and results on the screen or printer
- Presentation of the results in the plan or diagrams
- Presentation of the data, element groups slab thickness, boundary conditions, loads, … in the plan
- Distribution of results on the wall and the base
- Tabulation of data and final results on the screen or printer
- Results can be saved in an ASCII file
- The drawings can optionally be saved as a WMF file
- There are detailed explanations with numerical examples in three books are available
- Short help information can be requested at any interface location
- Import or export the data to MS Excel
- Export the results and diagrams to MS Excel
- Export the data and results to MS Word
- Copying drawings to the clipboard for use in word processors
- Import or export the FE-Net as DXF format





Calculation methods

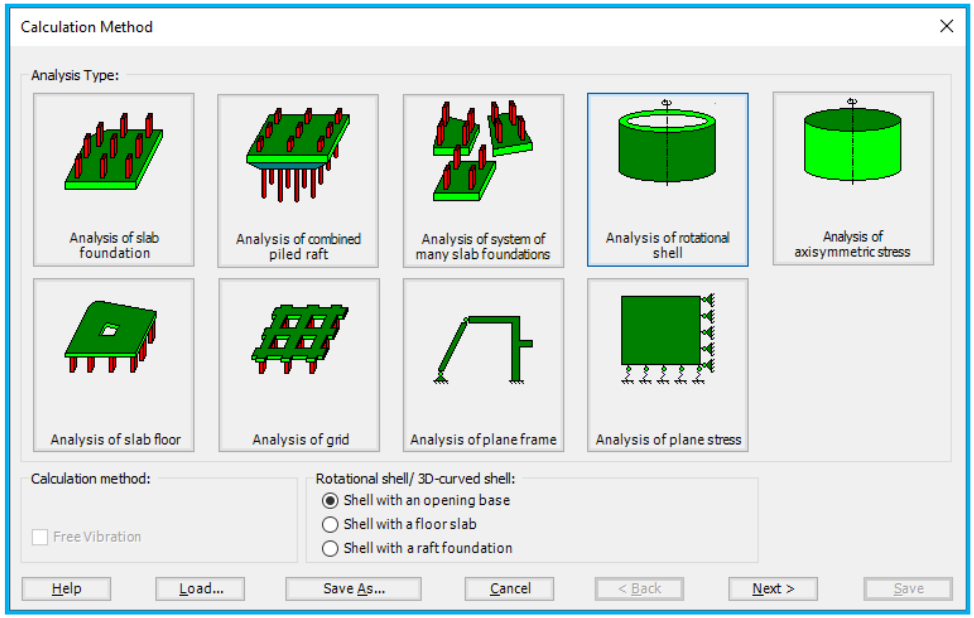
In ***ELPLA***, nine different numerical methods with three soil models are considered for analyzing the base (raft) of axisymmetric structures and tanks as follows:

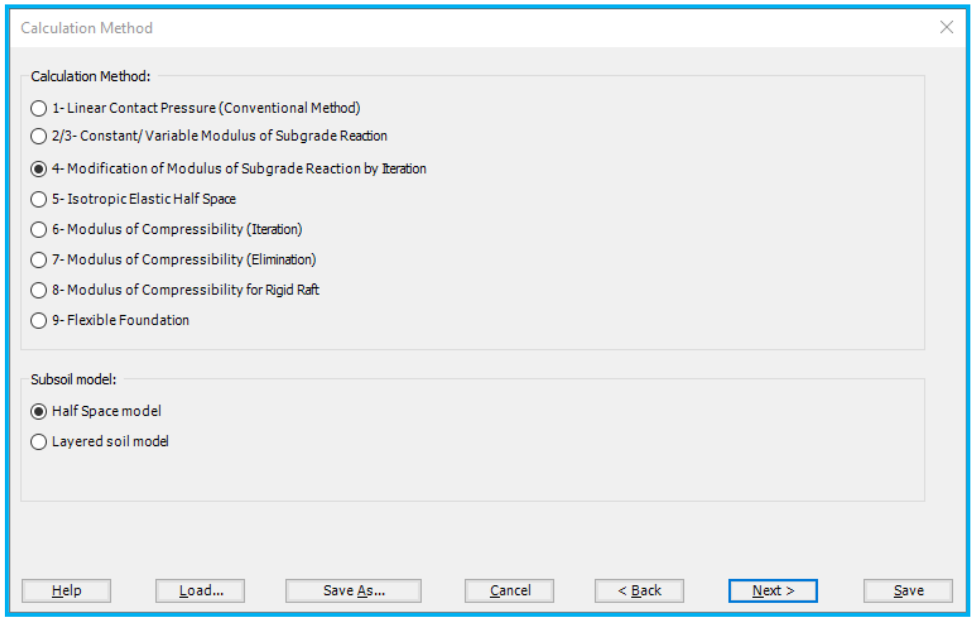
1) Linear contact pressure (Simple assumption model)
2) Constant modulus of subgrade reaction (*Winkler*'s model)
3) Variable modulus of subgrade reaction (*Winkler*'s model)
4) Modification of modulus of subgrade reaction by iteration
   (*Winkler*'s model/ Continuum model)
5) Modulus of compressibility method for elastic raft on half-space soil medium
   (Solving system of linear equations by elimination)
   (Isotropic elastic half-space soil medium - Continuum model)
6) Modulus of compressibility method for elastic raft
   (Solving system of linear equations by iteration)
   (Isotropic elastic half-space soil medium and layered soil medium - Continuum model)
7) Modulus of compressibility method for elastic raft on layered soil medium
   (Solving system of linear equations by elimination)
   (Layered soil medium - Continuum model)
8) Modulus of compressibility method for rigid raft
   (Isotropic elastic half-space soil medium and layered soil medium - Continuum model)
9) Modulus of compressibility method for flexible raft
   (Isotropic elastic half-space soil medium and layered soil medium- Continuum model)

Modelling the axisymmetric structures and tanks

Full computability between the wall, base and the soil. The three parts are treated as one unit. Wall and base are analyzed by the finite element method using annular elements. Three soil models are considered for analyzing base in ***ELPLA*** as follows:

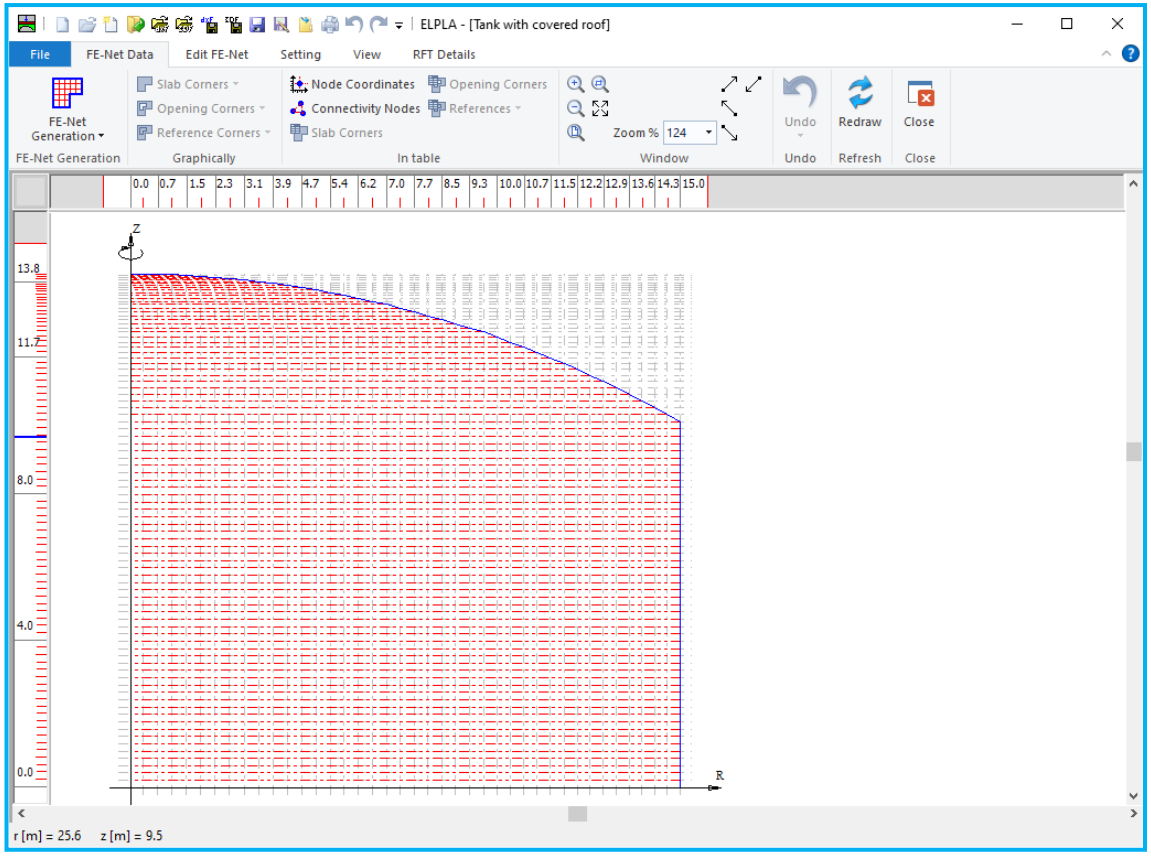
1) Simple assumption model
2) *Winkler*'s model
3) Continuum model

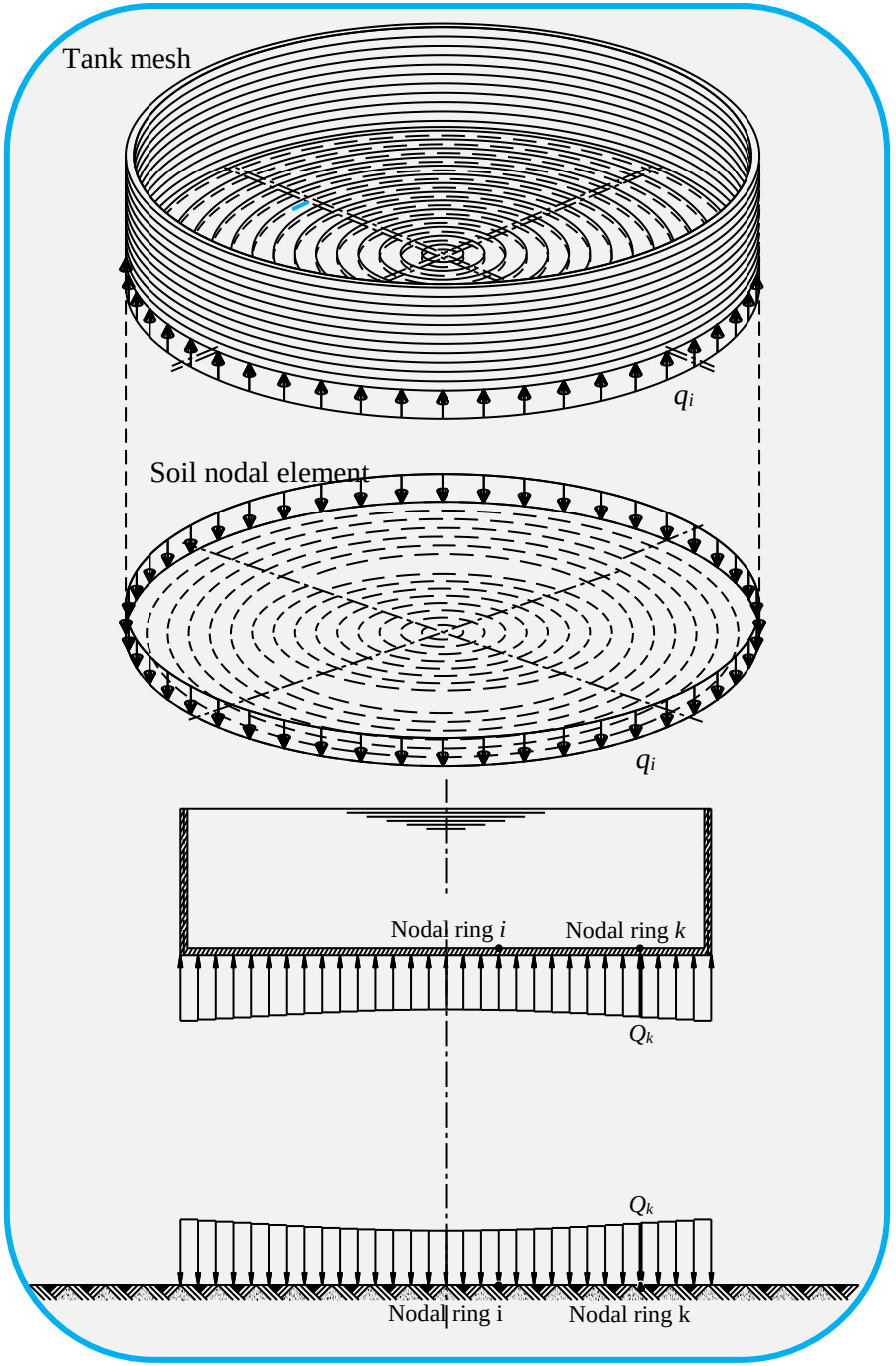


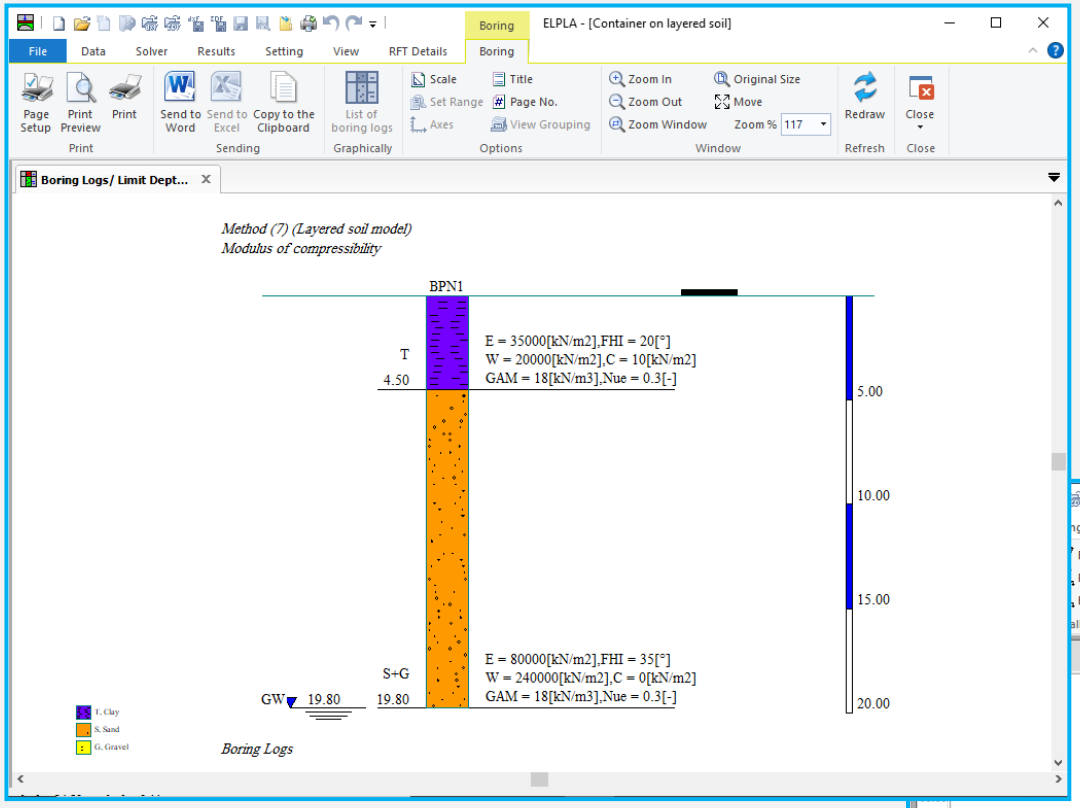


Geometry

- Analyzing axisymmetric structures and tanks of different shapes including base or an opening
- Analyzing a cylindrical tank considering the wall and the base as one unit on layered soil
- Spherical or flat roof of the axisymmetric structures and tanks are also possible
- It is also possible to consider raft with variable thickness
- Analyzing axisymmetric structures with or without opening base using annular finite elements
- Analysis of an elastic, a rigid or a flexible base on layered soil
- Numerical model of soil-structure interaction is under 9 calculation methods
- Automatic generation for the FE mesh of the wall and the base
- Powerful mesh generator using templates for different axisymmetric structure shape

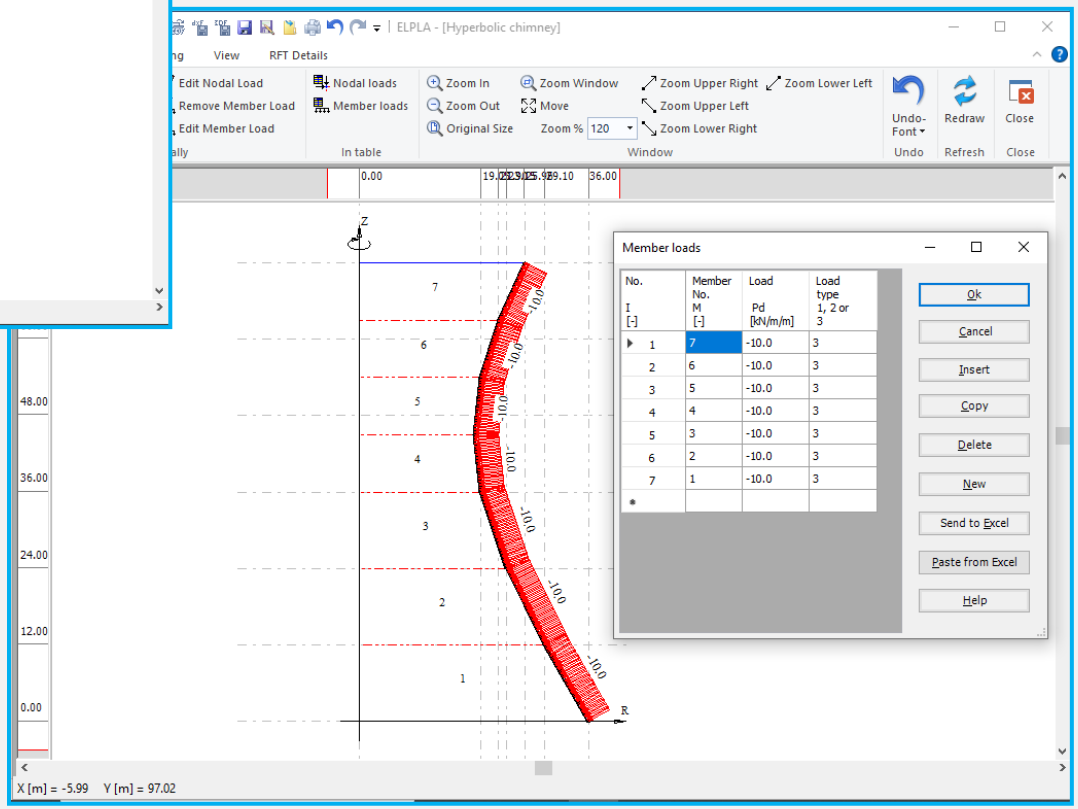






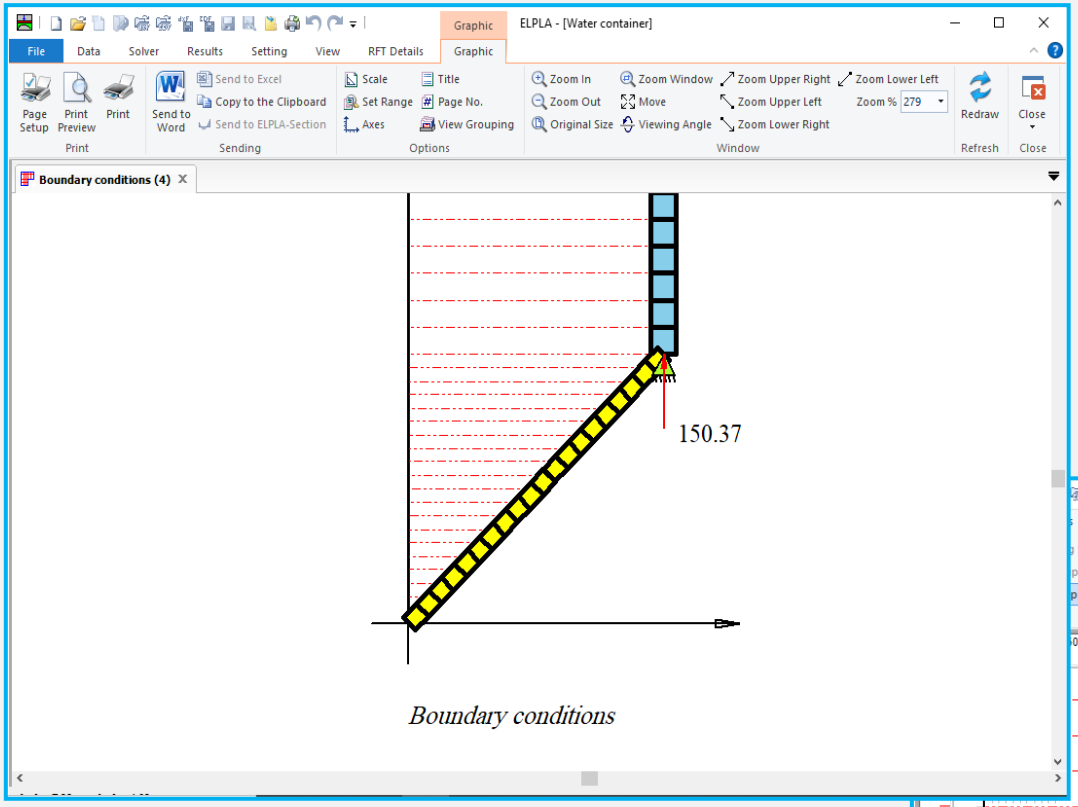
Soil

- Analyzing a cylindrical tank considering the wall and the base as one unit on layered soil
- Analysis of an elastic, a rigid or a flexible base on layered soil
- Numerical model of soil-structure interaction is under 9 calculation methods
- Consideration of the reduction coefficients α according to DIN 4019 Part 1
- Loading and reloading modulus of compressibility or elasticity are considered
- The soil is defined by a boring log has multi-layers with different soil material
- Drawing soil layers by different symbols and colors according to DIN 4023 for easy identification
- Consideration of groundwater and overburden pressure effects



Loads

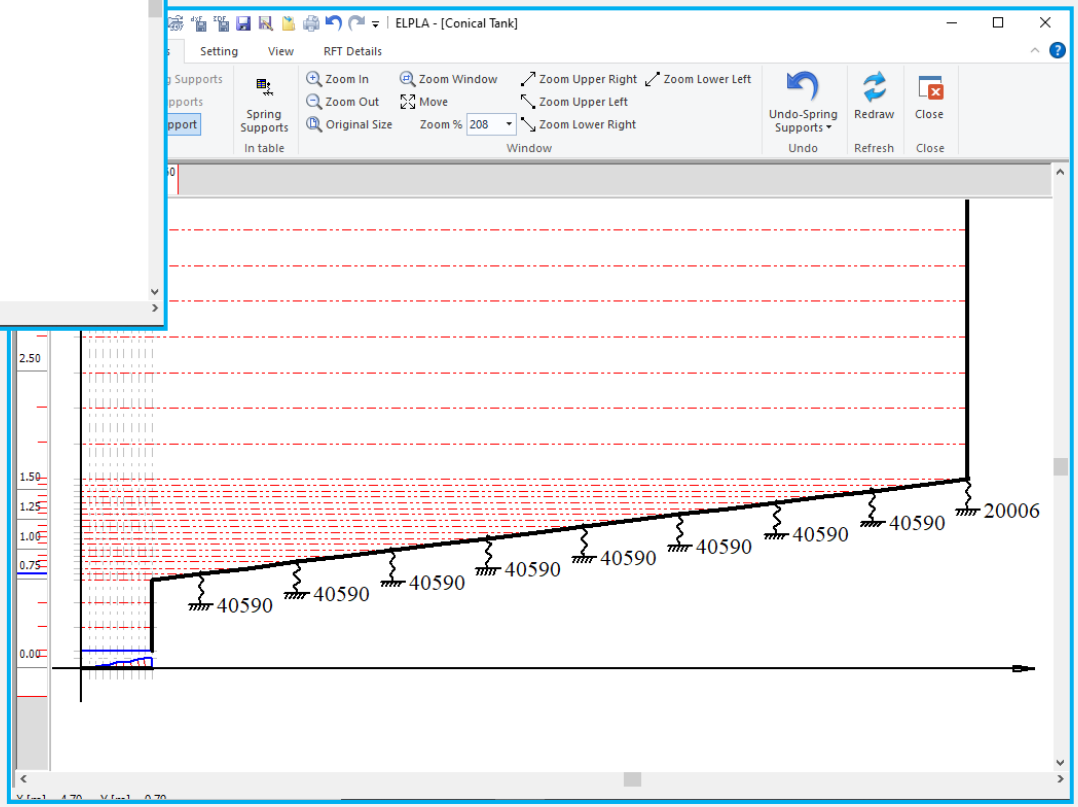
- Point loads, line loads, uniform loads and moments can be applied
- Three types of uniform load can be applied, wind load, snow load and self-weight



Boundary conditions

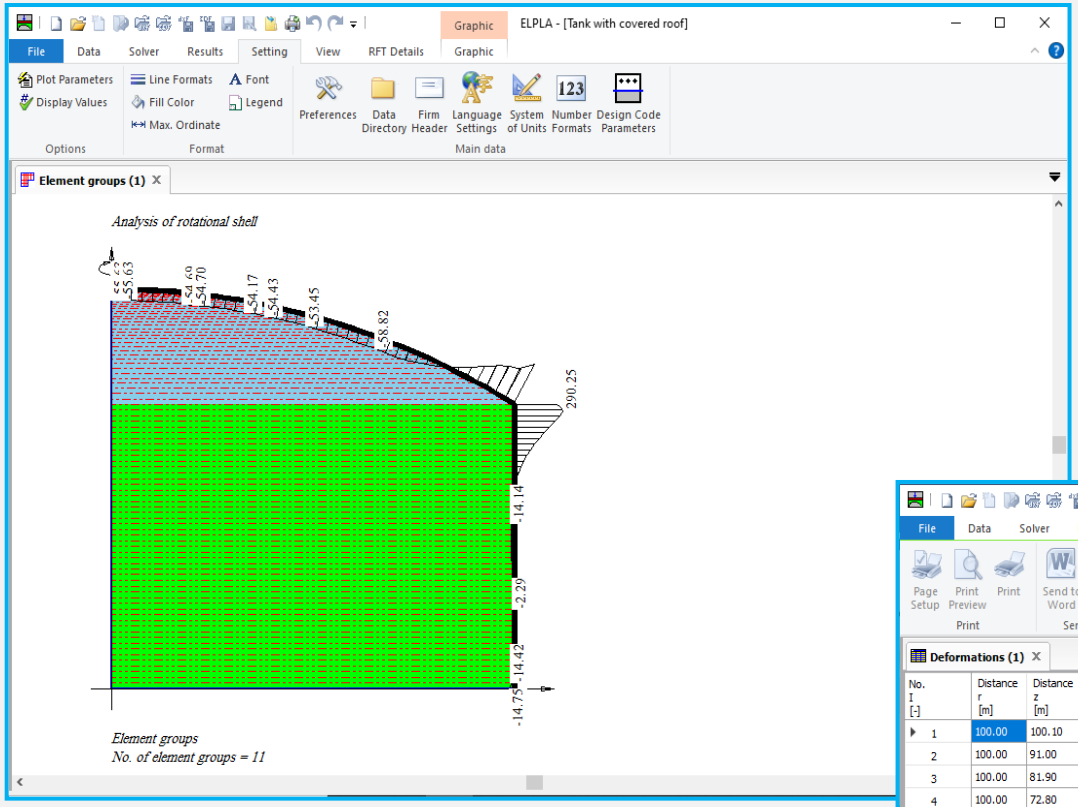
Supports/ Boundary Conditions

It is possible to define elastic or fixed rotations and displacements on the raft



Additional Springs

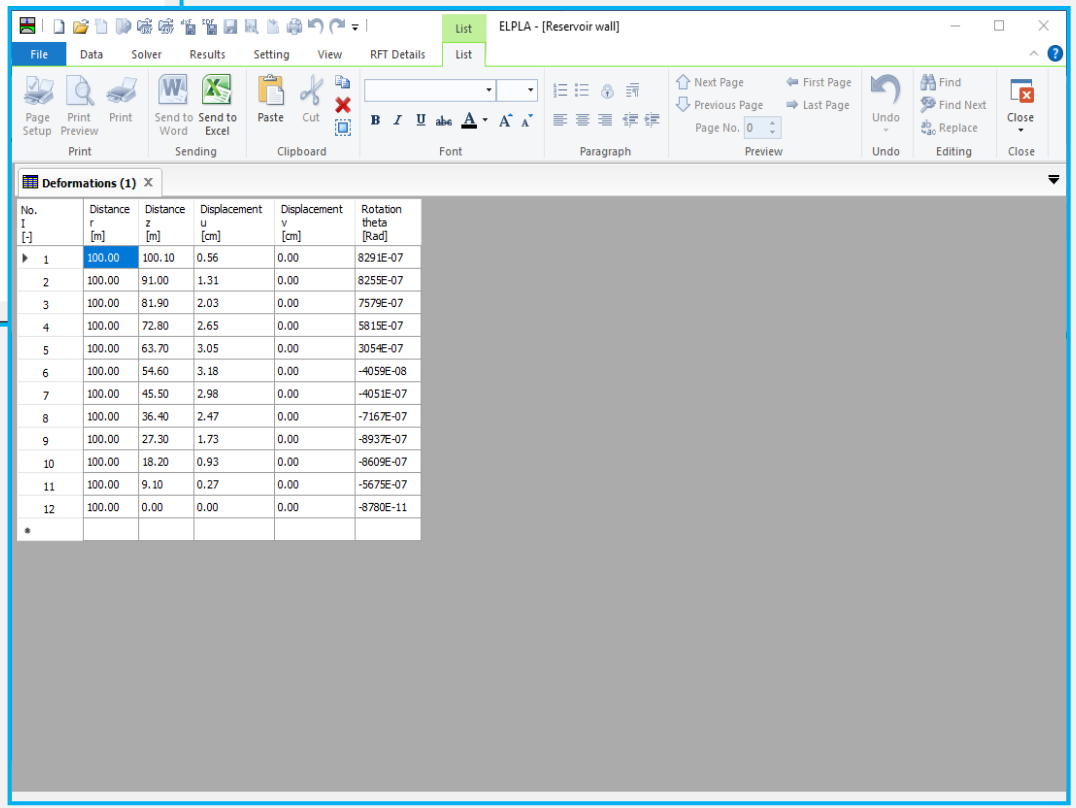
Translational and rotational springs can be added at nodes



Graphical drawing of data and results

The results and data can be presented graphically as follows:

- Data in the plan
- Rotational shell results
- Support reactions
- Sections in shell wall
- Sections in shell base



No. I [-]	Distance r [m]	Distance z [m]	Displacement u [cm]	Displacement v [cm]	Rotation theta [Rad]
1	100.00	100.10	0.56	0.00	8291E-07
2	100.00	91.00	1.31	0.00	8255E-07
3	100.00	81.90	2.03	0.00	7579E-07
4	100.00	72.80	2.65	0.00	5815E-07
5	100.00	63.70	3.05	0.00	3054E-07
6	100.00	54.60	3.18	0.00	-4059E-08
7	100.00	45.50	2.98	0.00	-4051E-07
8	100.00	36.40	2.47	0.00	-7167E-07
9	100.00	27.30	1.73	0.00	-8937E-07
10	100.00	18.20	0.93	0.00	-8609E-07
11	100.00	9.10	0.27	0.00	-5675E-07
12	100.00	0.00	0.00	0.00	-8780E-11

Tabulation of data and results

The results and data can be listed as follows:

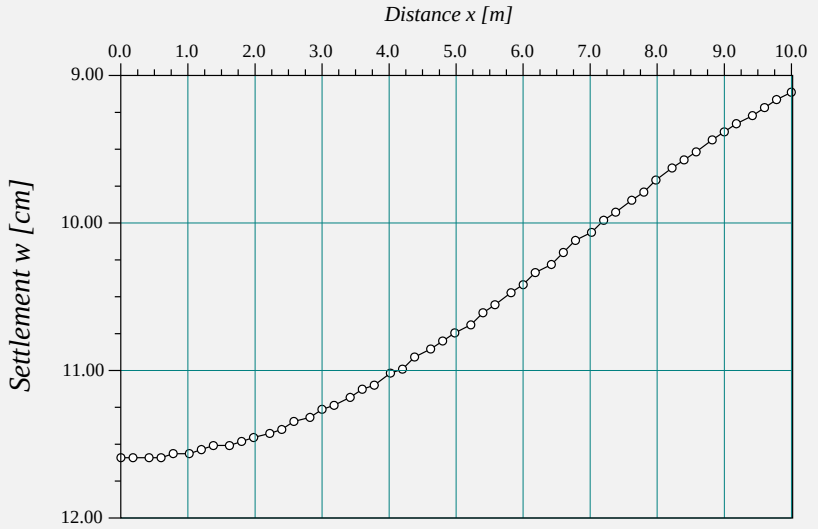
- Display tables of data
- Print tables of data
- List tables of data through Text-Editor
- Display tables of results
- Print tables of results
- List tables of results through Text-Editor

Drawing sections and diagrams

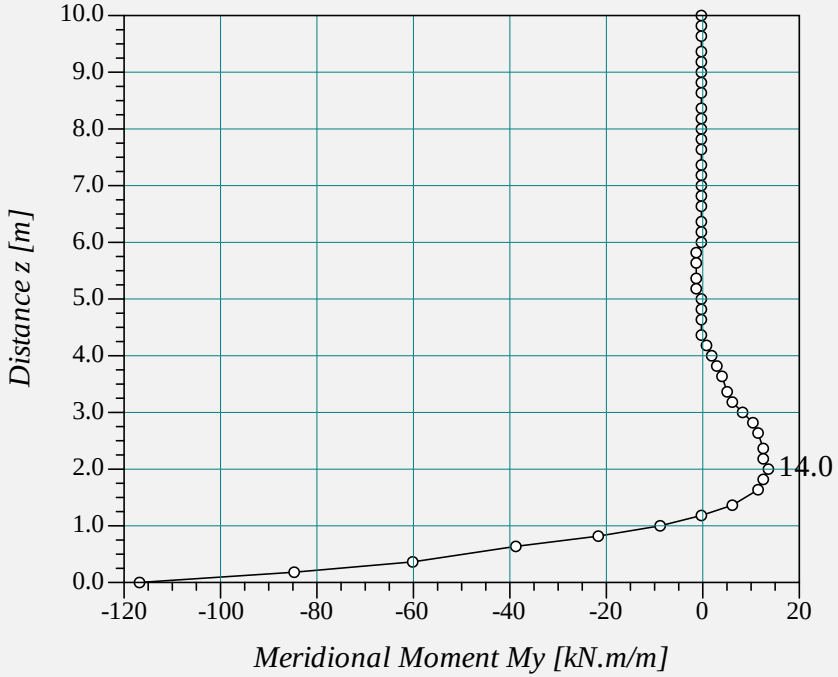
Furthermore, you can display, plot and print results at specified sections in both the base and the wall of the tank graphically using "Section" menu. The results can be presented graphically as follows:

- Radial forces *Nr*
- Meridional moments *My*
- Tangential moments *Mt*
- Horizontal deformations *Vh*
- Vertical deformations *Vv*
- Meridional rotations *Vm*
- Meridional forces *Ny*
- Base settlements *w*
- Base contact pressures *q*
- Soil stiffnesses *Ks*

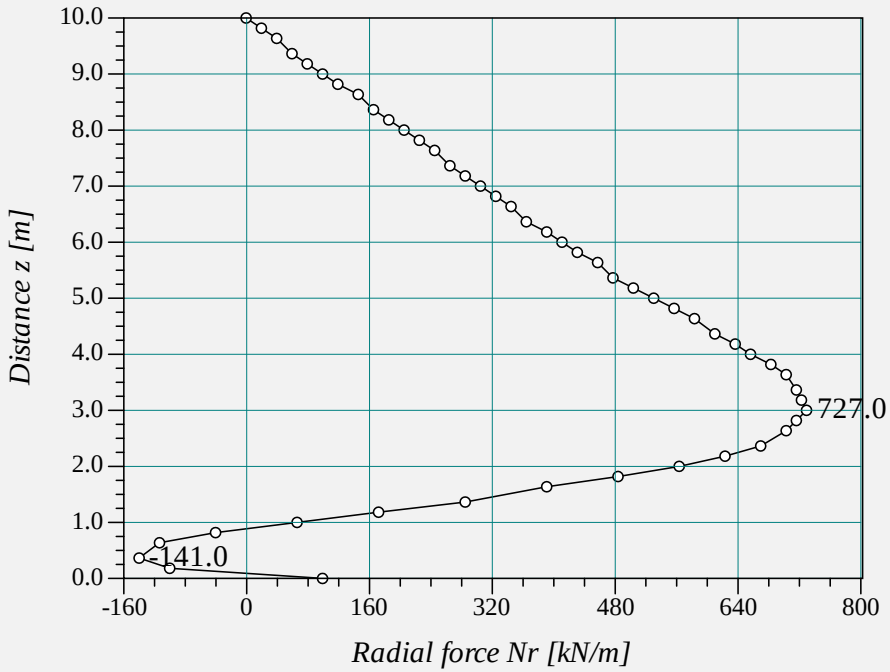
In addition, drawing sections, if desired, can be saved as WMF-Format files, in which they can be exported to other Windows applications to prepare reports, slide presentations or add further information.



Base settlements
Sections in shell base



Meridional moments
Sections in shell wall



Radial forces
Sections in shell wall