Part 42 – Nonlinear Buckling Analysis of a Cola Can

A aluminum Cola Can with dimensions of 115 mm x 66 mm x 0.3 mm is simulated with FEM-System MEANS V14 (www.fem-infos.com) nonlinearly in two calculation steps using shell elements.

1. Linear Buckling Analysis

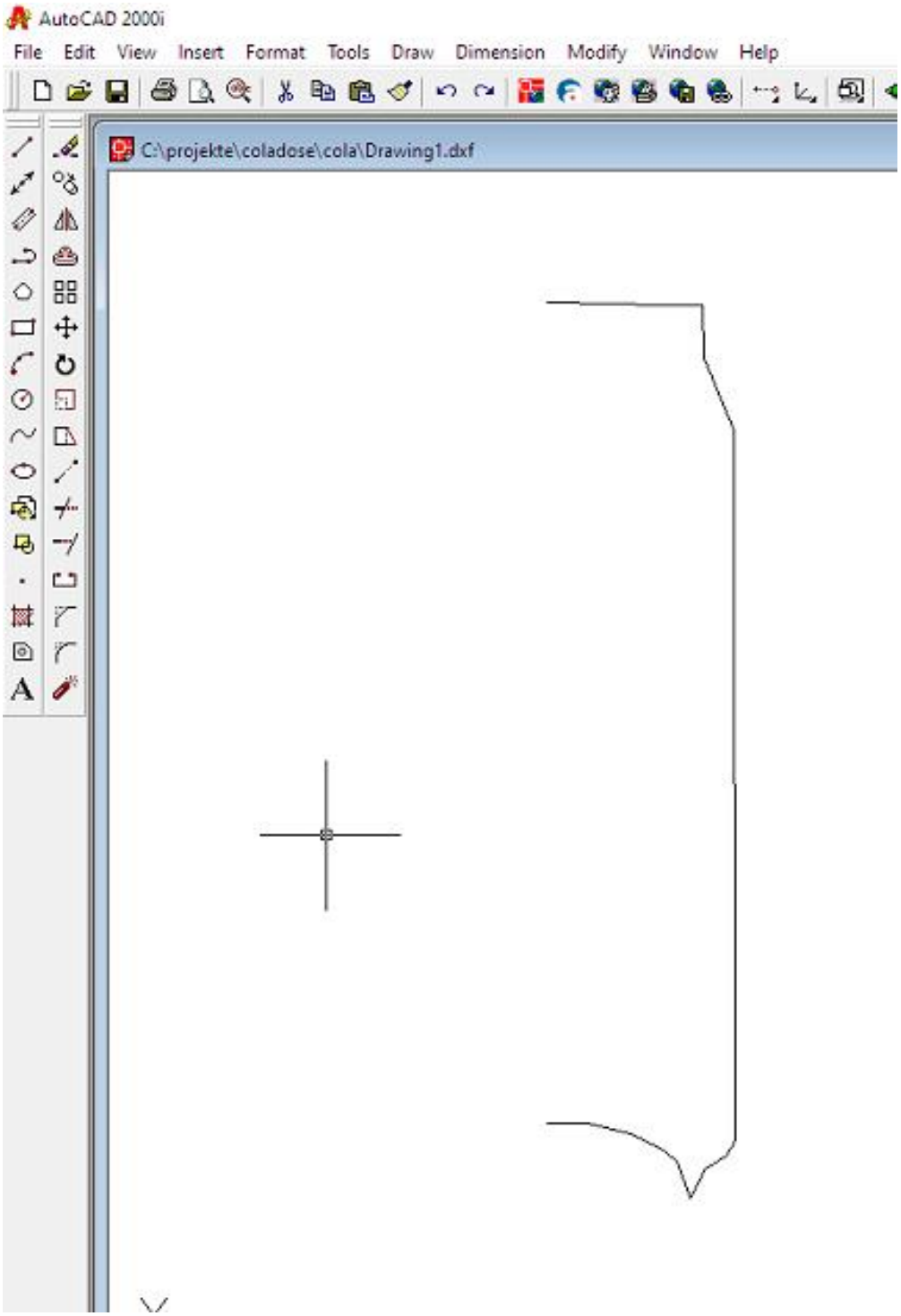
In the first step, a linear buckling analysis with imperfection (small axial load of 1 N) is calculated. The resulting buckling deformations scaled by a deformation factor of 200 are added to the nodal coordinates.

2. Nonlinear Static Analysis with large deformations

In the second step, a nonlinear static analysis with large deformations is calculated using the stress-strain curve for aluminum.

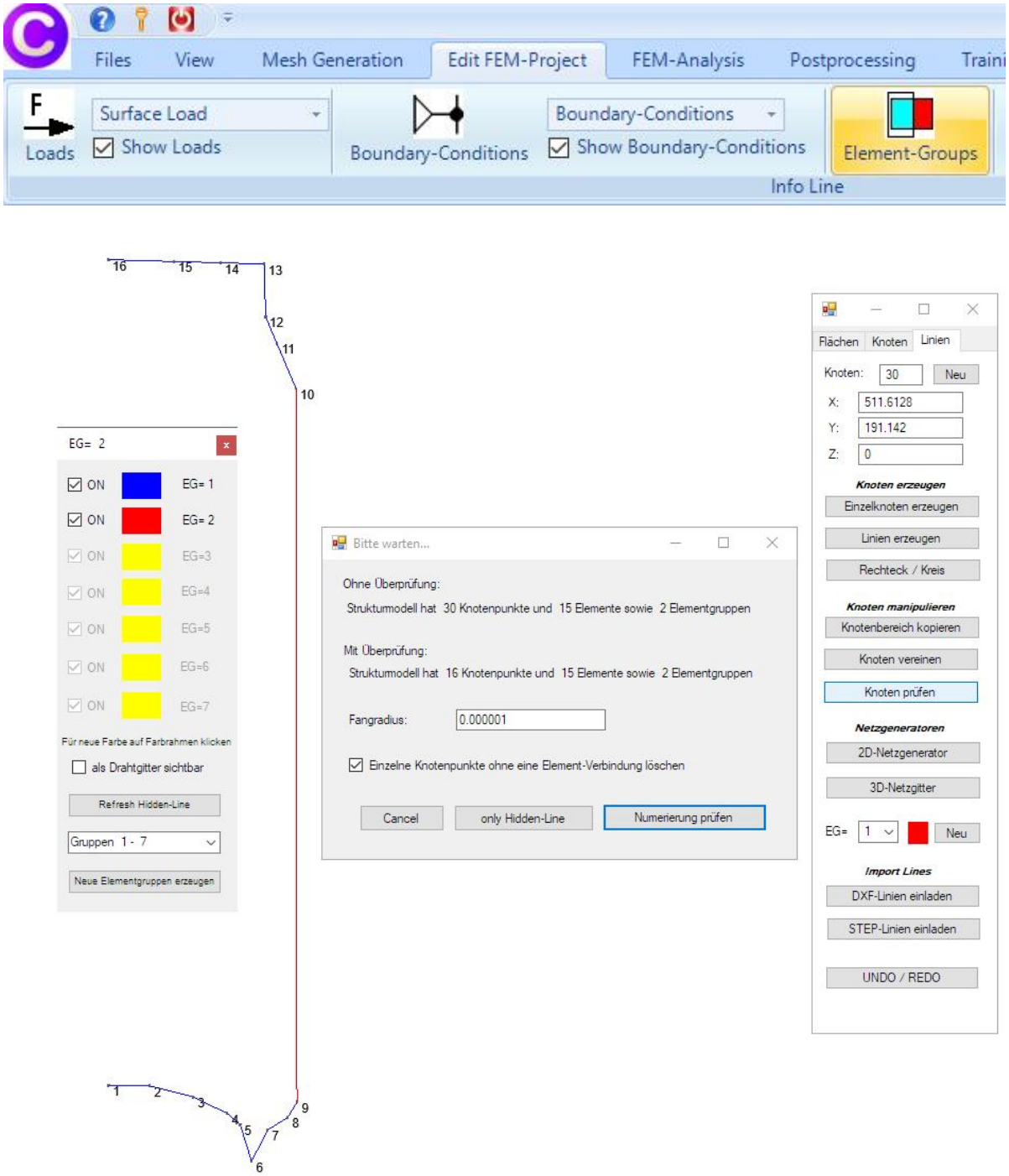
Drawing the cross-section using AutoCAD lines

First, the cross-section of the can is created by inserting the image file mentioned above into AutoCAD as a template and tracing the rim of the can using 15 lines. Finally, the lines are exported in DXF format.



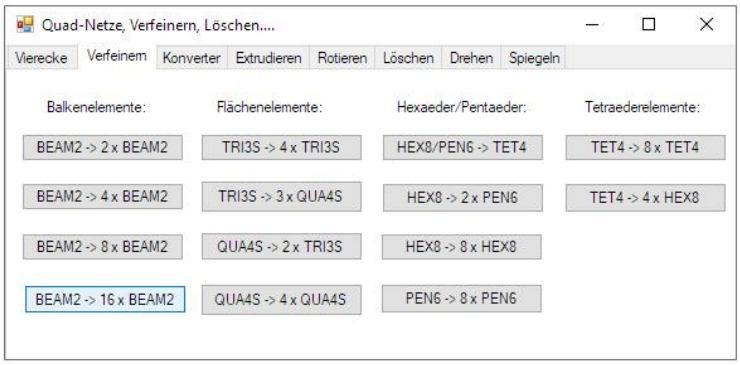
Import and refine the 2D cross-section

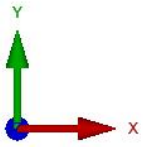
The DXF file is imported into MEANS V14 as a beam model; a model check in line mode reduces the structure from 30 overlapping nodes to 16 nodes. Using the "Edit FEM Project" tab and the "Element Groups" menu, convert the longest beam with Selection "Rectangle" into Element Group 2, and then hide the remaining beams in EG 1.



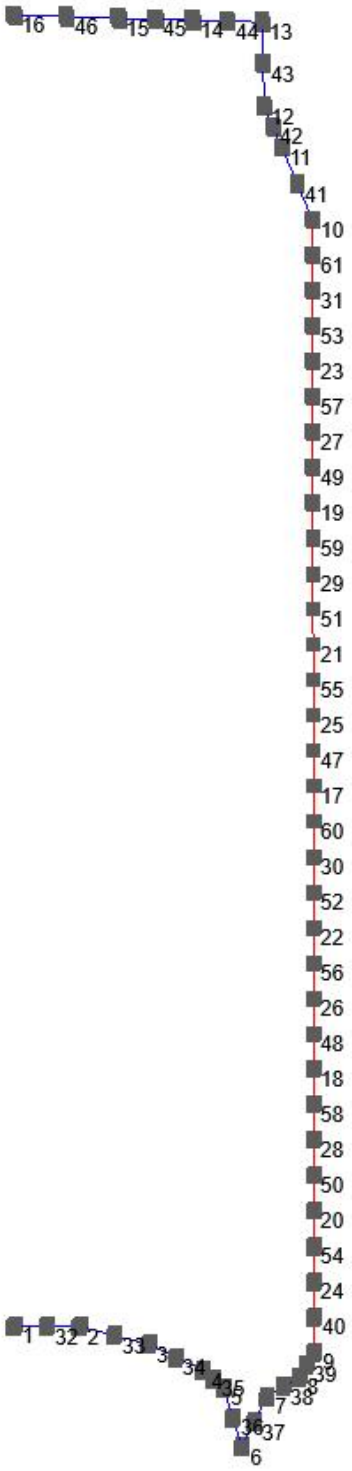
Then, using the "Mesh Generation" tab and the "Quad Meshes, Refine, Delete" menu...

as well as the "BEAM2 -> 16x BEAM2" menu to refine only the cross-beam 16-fold using EG2.





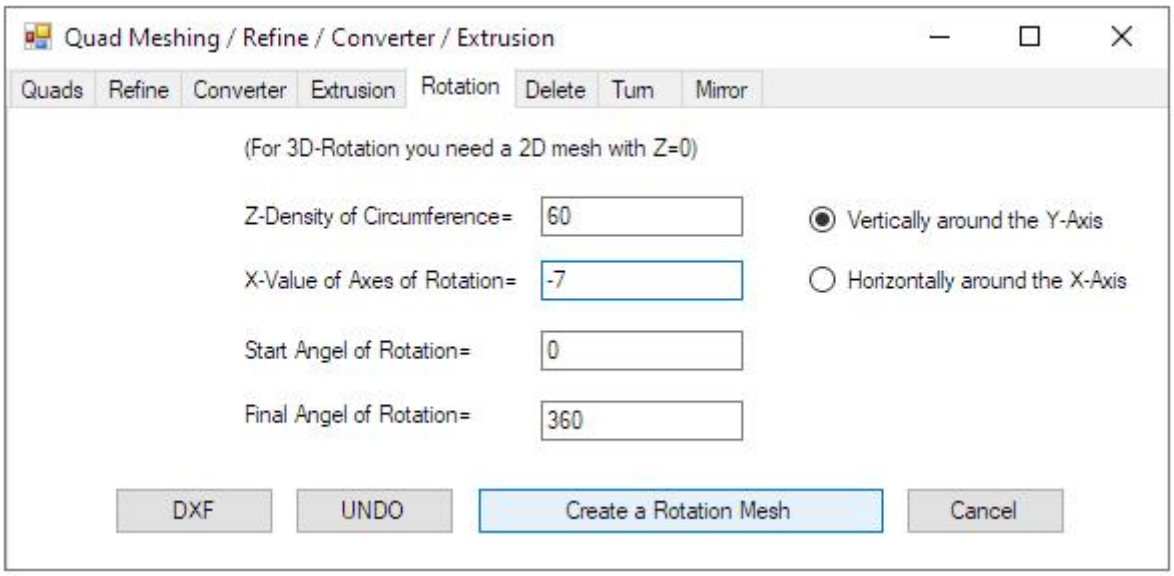
Redisplay EG 1 and refine it further by a factor of 2 using "BEAM2 -> 2x BEAM2". menu. The new beam model now consists of 61 nodes and must finally be saved under "Rand.fem".

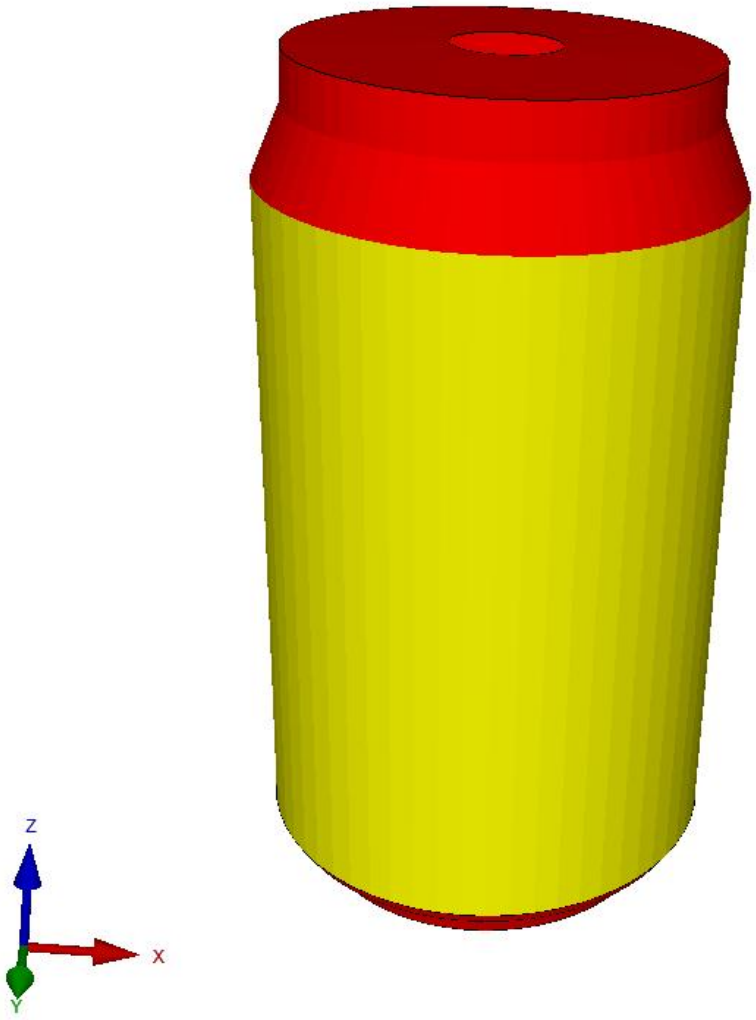


For the 3D rotation, first multiply the node coordinates of the BEAM model by a Coordinate Factor of 1.55 and position the origin at node 16.

Generating a 3D shell model using rotation

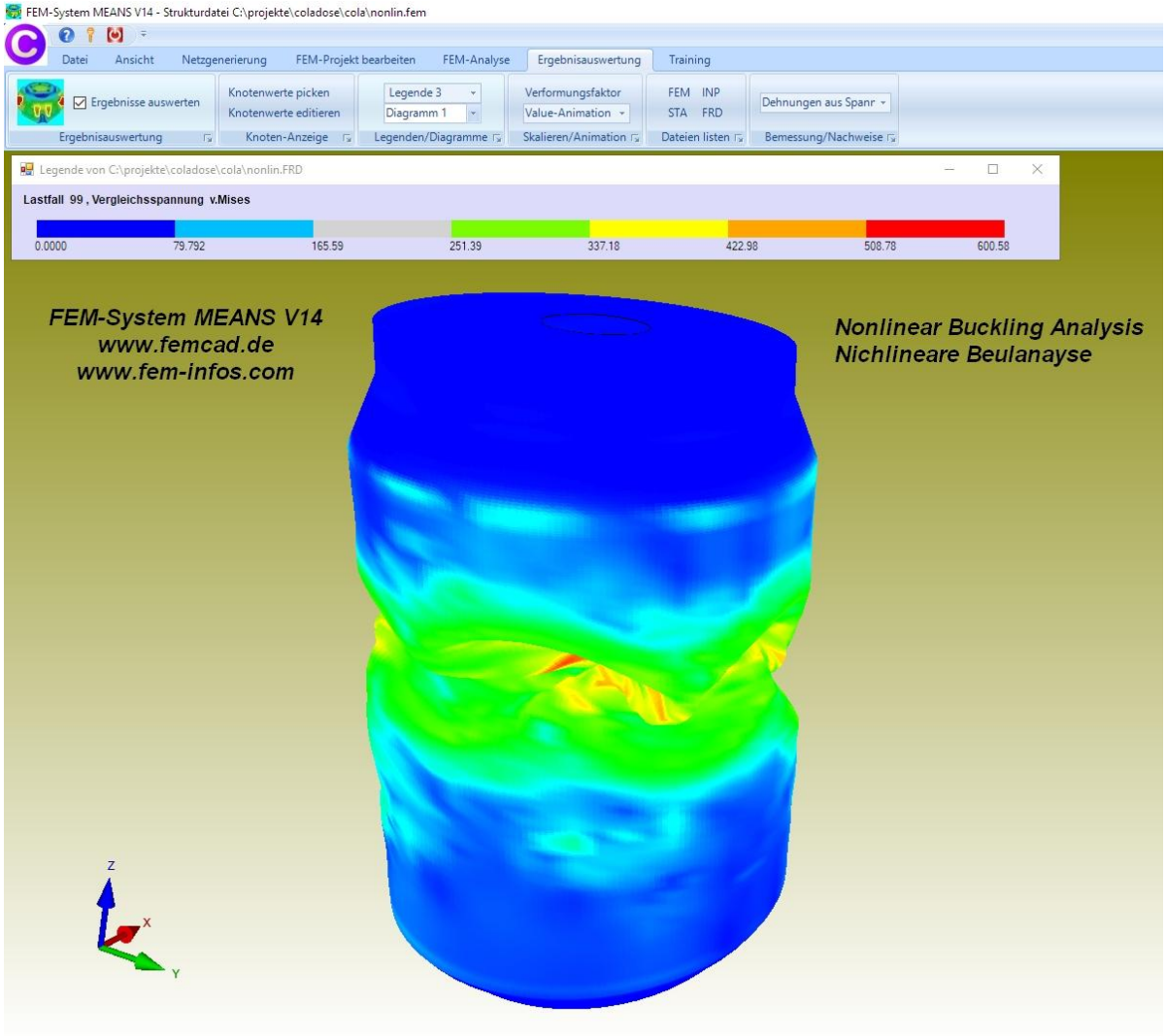
Select the "Mesh Generation" tab and the "Quad Meshes, Refine, Delete" menu, followed by "Rotate," to generate a linear shell mesh consisting of 7 260 nodes and 7 200 SHEL4 shell elements using a vertical rotation with 60 nodes and an X-Value of -7 mm for the axis of rotation.





Postprocessing

Following the nonlinear Statics Analysis with 50 Load Increments, the resulting von Mises stress distribution is obtained.



All examples can be downloaded and recalculated using the demo version.