Buckling of an Arch
We analyze an arch structure as an example of an Euler buckling analysis. Figure 1 shows the geometry and input data of the model. The used units are newton [N] and meter [m]. The vertical displacement $u_Y$ of node 3 is the only actual degree of freedom, since the displacement of nodes 1 and 2 are restrained. Due to symmetry the horizontal displacement $u_x$ of node 3 is zero. Application of a load $F$ leads to a vertical displacement of node 3.

Figure 1: Geometry and input data
2 Finite Element Model

We start a new project for a two-dimensional structural analysis. The Model Size is set to 1 km. The used units are depicted in Figure 4.

Main menu → File → New  [Fig. 2]
Geometry browser → Reference system → Units  [Fig. 3]
Property Panel  [Fig. 4]
2.1 Geometry

We create two lines representing the arch.

Main menu → Geometry → Create → Add line

Figure 5: Add line 1

Figure 6: Add line 2

Figure 7: Geometry view
2.2 Boundary Conditions

We create supports at the left and right end of the structure. We constrain the translation in $X$ and $Y$ direction.

![Figure 8: Application of the supports](https://dianafea.com)

![Figure 9: View supports](https://dianafea.com)
2.3 Properties

We give the lines material and geometrical properties. The element class is *Enhanced Truss 2D*. The following material parameters are chosen: Young’s modulus $E = 2.1 \times 10^5$ N/m$^2$ and Poisson’s ratio $\nu = 0$. For the geometry a cross-section of 1 m$^2$ is chosen.
2.4 Loads

The loading consists of a point load of 1000 N in the negative Y direction.

![Figure 15: Attach point load](https://dianafea.com)

![Figure 16: View of the applied loads](https://dianafea.com)
2.5 Mesh

We create a mesh by using *Divisions* and set the corresponding value equal to 1.

Figure 17: Mesh properties
3 Structural Stability Analysis

3.1 Commands

We set up the commands for a Structural stability analysis.

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Main menu → Analysis → Add analysis  
Analysis browser → Analysis1  
Analysis browser → Analysis1 → Structural stability  
Main menu → Analysis → Run selected analysis

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Figure 18: Analysis browser  
Figure 19: Analysis browser  
Figure 20: Properties stability analysis

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3.2 Results

The Message window gives us the information that the analysis is finished. The buckling value gives the multiplication factor for the point load of 1000 N at which the buckling of the arch occurs and is displayed in Figure 21.

Figure 21: Obtained buckling value

Figure 22: Buckling mode
Appendix A  Additional Information

Folder: Tutorials/BucklingArch

Number of elements ≈ 2

Keywords:

- **ANALYS**: euler stabil.
- **CONSTR**: suppor.
- **ELEMEN**: enhanc l4tru truss.
- **LOAD**: force node.
- **MATERI**: elasti isotro.
- **OPTION**: direct.
- **POST**: binary ndiana.
- **PRE**: dianai.
- **RESULT**: buckli displa modes values.
Disclaimer: The aim of this technical tutorial is to illustrate various tools, modelling techniques and analysis workflows in DIANA. DIANA FEA BV does not accept any responsibility regarding the presented cases, used parameters, and presented results.