Software für Statik und Dynamik

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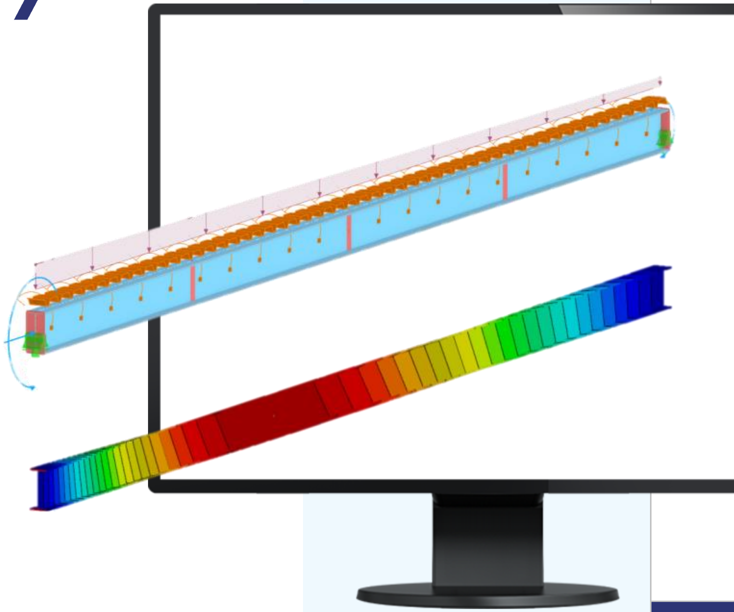
Webinar

Linear Stability Analysis in RFEM 6 and RSTAB 9



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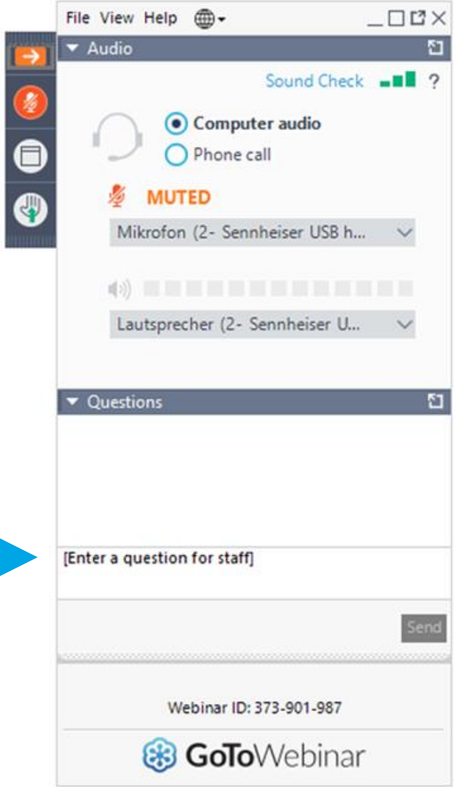

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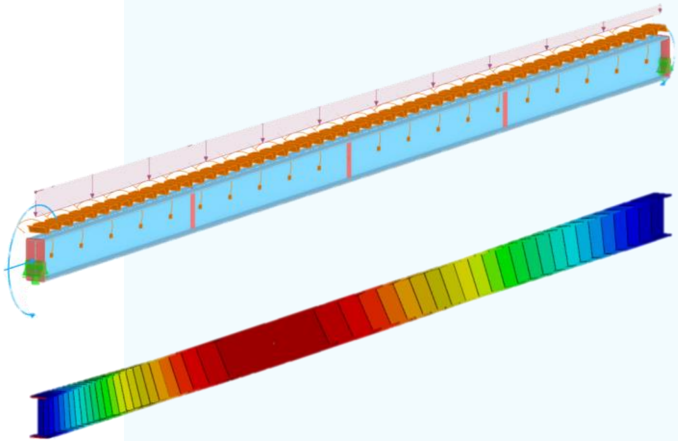
Content

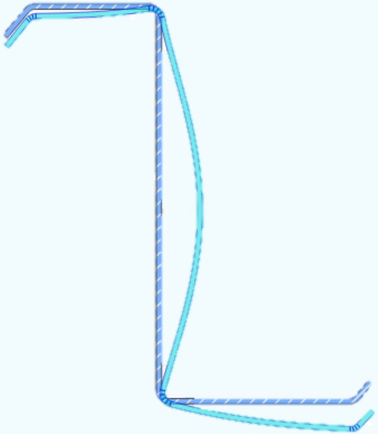
01 **Stability analysis of members and frame structures**

02 **Stability analysis on cross section level using the finite strip method**

03 **Buckling analysis within steel joints**

04 **Detecting modeling errors and instability troubleshooting using stability analysis**





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Stability analysis as an eigenvalue problem

- **Slender** members and structures under compression tend to become **unstable**

Dimensions

Material

Boundary Conditions

„Bifurcation of equilibrium “

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Stability analysis as an eigenvalue problem

- **Slender** members and structures under compression tend to become **unstable**
- Using FEM, the **ideal** bifurcation load can be determined solving a conventional **Eigenvalue problem**

Linear structural behaviour / perfect geometry

General formulation

$$(\bar{A} - \lambda_i \bar{B})\bar{x}_i = 0 \quad \rightarrow \quad det(\bar{A} - \lambda_i \bar{B}) = 0$$

Stability analysis

$$(\overline{K_I} - \propto_i \overline{K_g})\overline{u_i} = 0$$

linear stiffness matrix

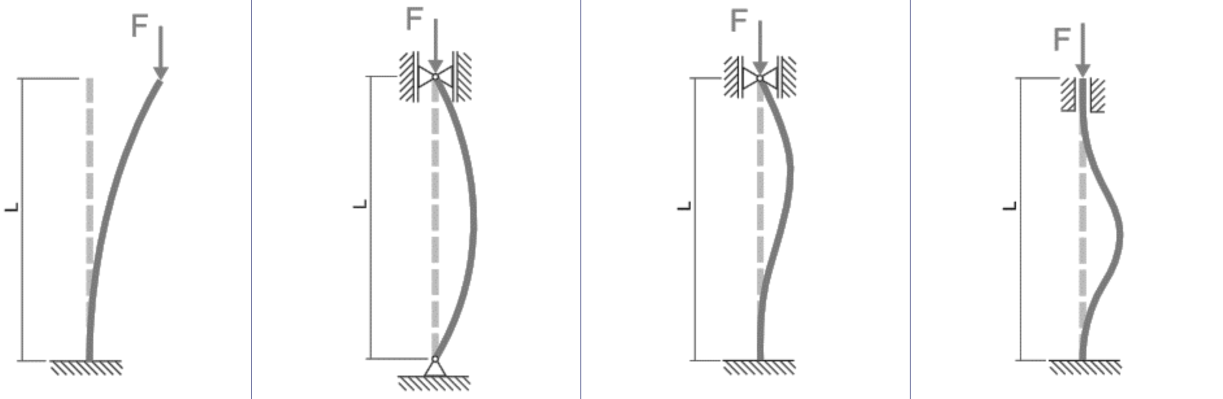
Critical load factor

geometric stiffness matrix

Mode shapes (≠0)

Stability analysis as an eigenvalue problem

- **Slender** members and structures under compression tend to become **unstable**
- Using FEM, the **ideal** bifurcation load can be determined solving a conventional **Eigenvalue problem**
- Fundamental solutions for prismatic members under pure compression were already found by **Euler** in the 18th century.



Case 1	Case 2	Case 3	Case 4
$F_{crit} = \frac{\pi^2 EI}{(2.0L)^2}$	$F_{crit} = \frac{\pi^2 EI}{(1.0L)^2}$	$F_{crit} = \frac{\pi^2 EI}{(0.7L)^2}$	$F_{crit} = \frac{\pi^2 EI}{(0.5L)^2}$

*Buckling length coefficient

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Stability analysis as an eigenvalue problem

- **Slender** members and structures under compression tend to become **unstable**
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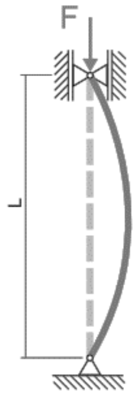

Case 2

$$F_{crit} = \frac{\pi^2 EI}{(1.0L)^2} \rightarrow \beta L = L_{crit} = \sqrt{\frac{\pi^2 EI}{F_{crit}}} \rightarrow L_{crit} = \sqrt{\frac{\pi^2 EI}{\alpha_{crit} \cdot N}}$$

Mode shape dependent!

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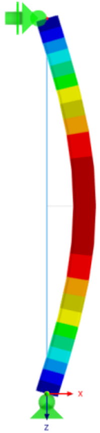
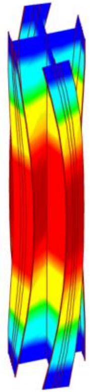
Stability modes of beams



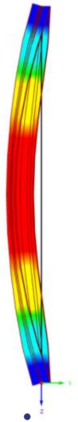
Flexural buckling

$N_{cr,y/z}$



Torsional buckling

$N_{cr,T}$



Flexural-torsional Buckling

Lateral-torsional Buckling

$N_{cr,LTB}$; M_{cr}

Warping torsion required to account for those modes in static / stability analysis!

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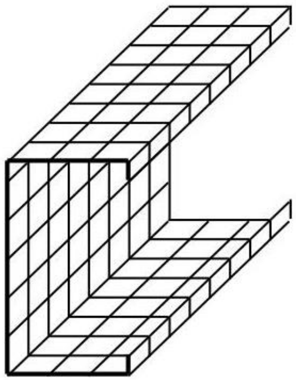
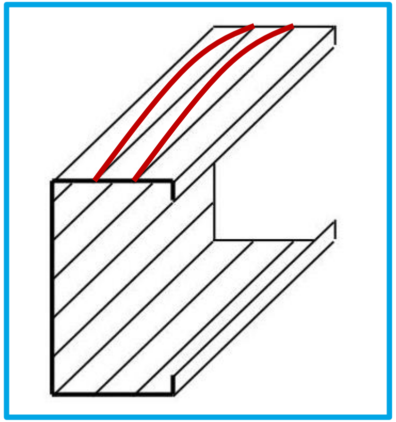
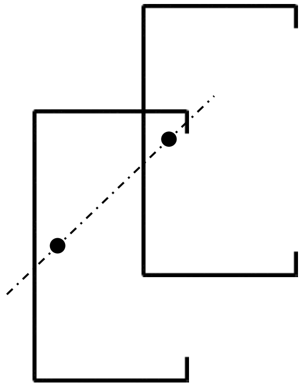
FE vs. FSM vs. Beam

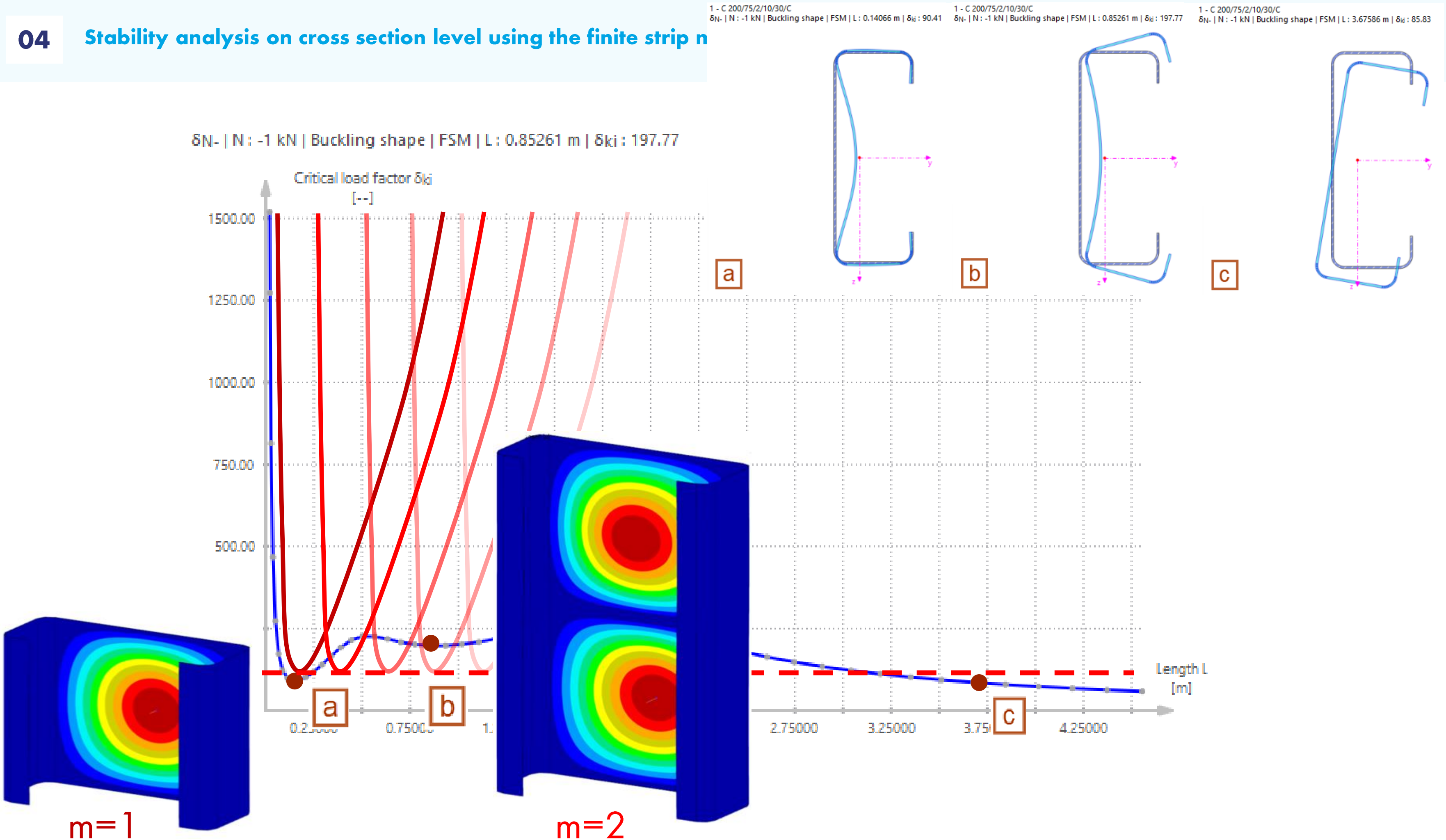






- Structural element is divided into multiple strips (strip length = system length)
- Advantage: Cross section deformation can be investigated (as opposed to beam elements) with very few DOFs (compared to a accurate shell representation)
- Boundary conditions for stability analysis: simply supported (including fork conditions)
- Due to the discretization in longitudinal direction (1 strip/simple shape function) only bow shaped deformations are considered

Stability analysis on cross section level using the finite strip m



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Additional Information

[1] Knowledge Base 1851: Modal Relevance Factor
https://www.dlubal.com/en/support-and-learning/support/knowledge-base/001851

[2] Knowledge Base 1801 : Linear Critical Load Analysis Using Finite Strip Method (FSM)
https://www.dlubal.com/en/support-and-learning/support/knowledge-base/001801

[3] FAQ 005345: My model is unstable. What could be the reason?
https://www.dlubal.com/en/support-and-learning/support/faq/005345

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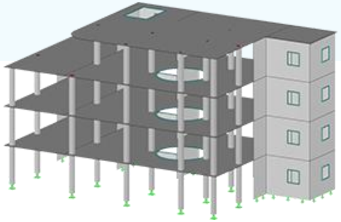
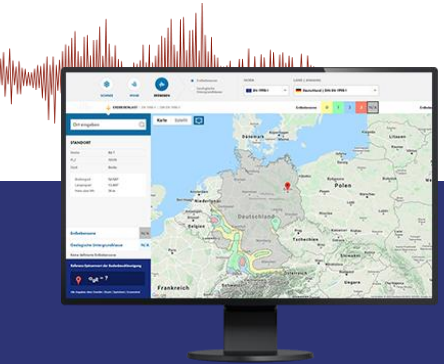


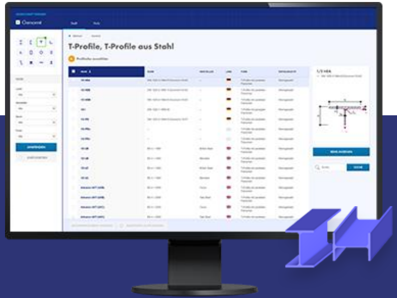
Geo-Zone Tool

Dlubal Software provides an online tool with snow, wind and seismic zone maps.



Cross-Section Properties

With this free online tool, you can select standardized sections from an extensive section library, define parametrized cross-sections and calculate its cross-section properties.



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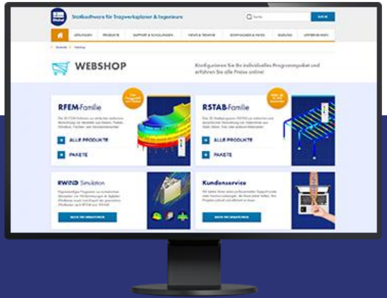

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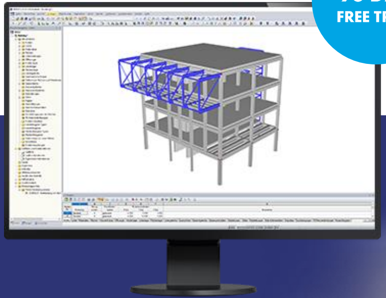

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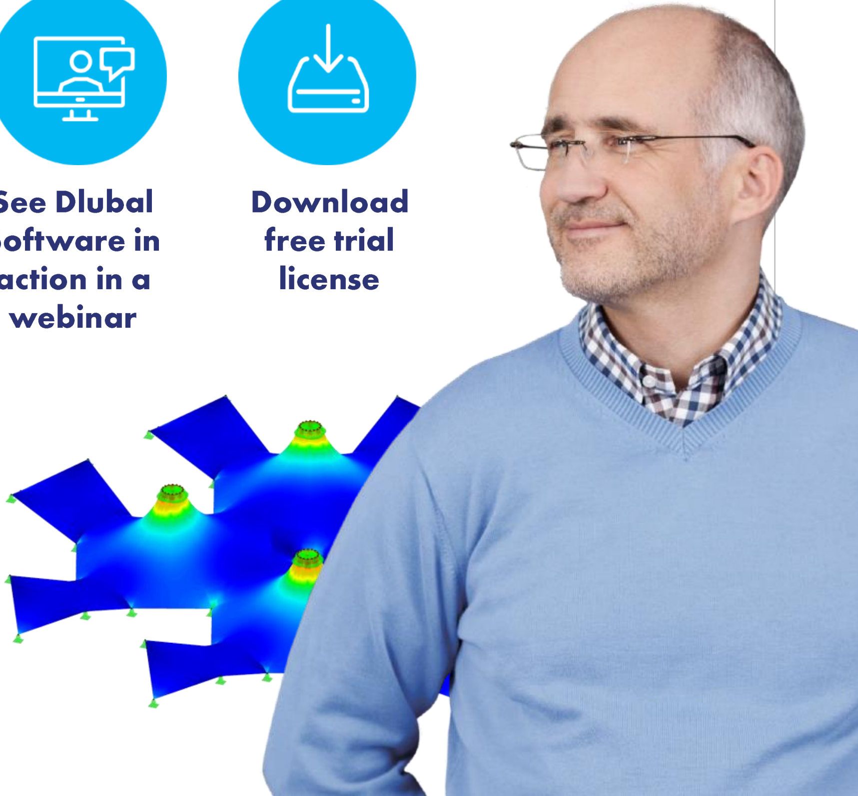

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