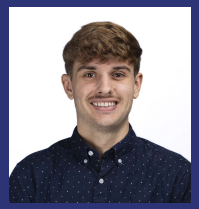
Dlubal

Structural Analysis & Design Software

www.dlubal.com

Amy Heilig, PE
Presenter

CEO – USA Office



Alex Bacon, EIT
Moderator

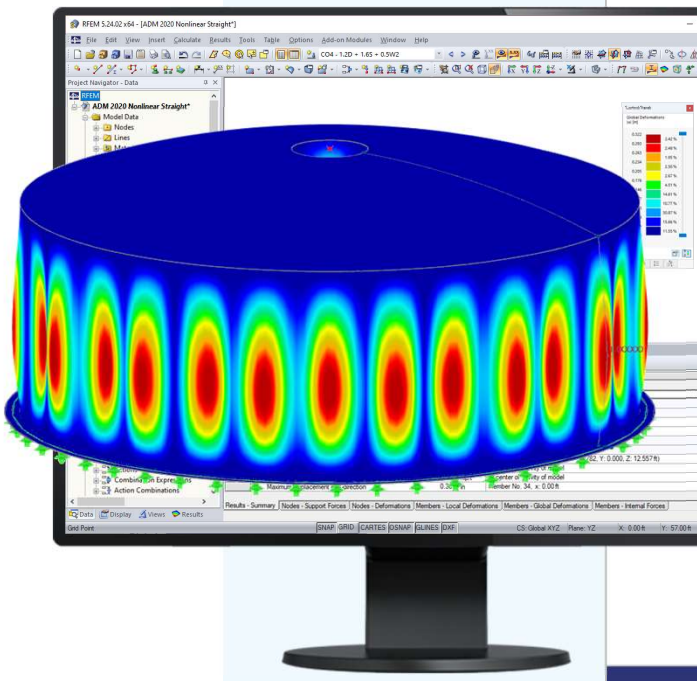
Technical Support Engineer

Cisca Tjoa, PE
Moderator

Technical Support Engineer

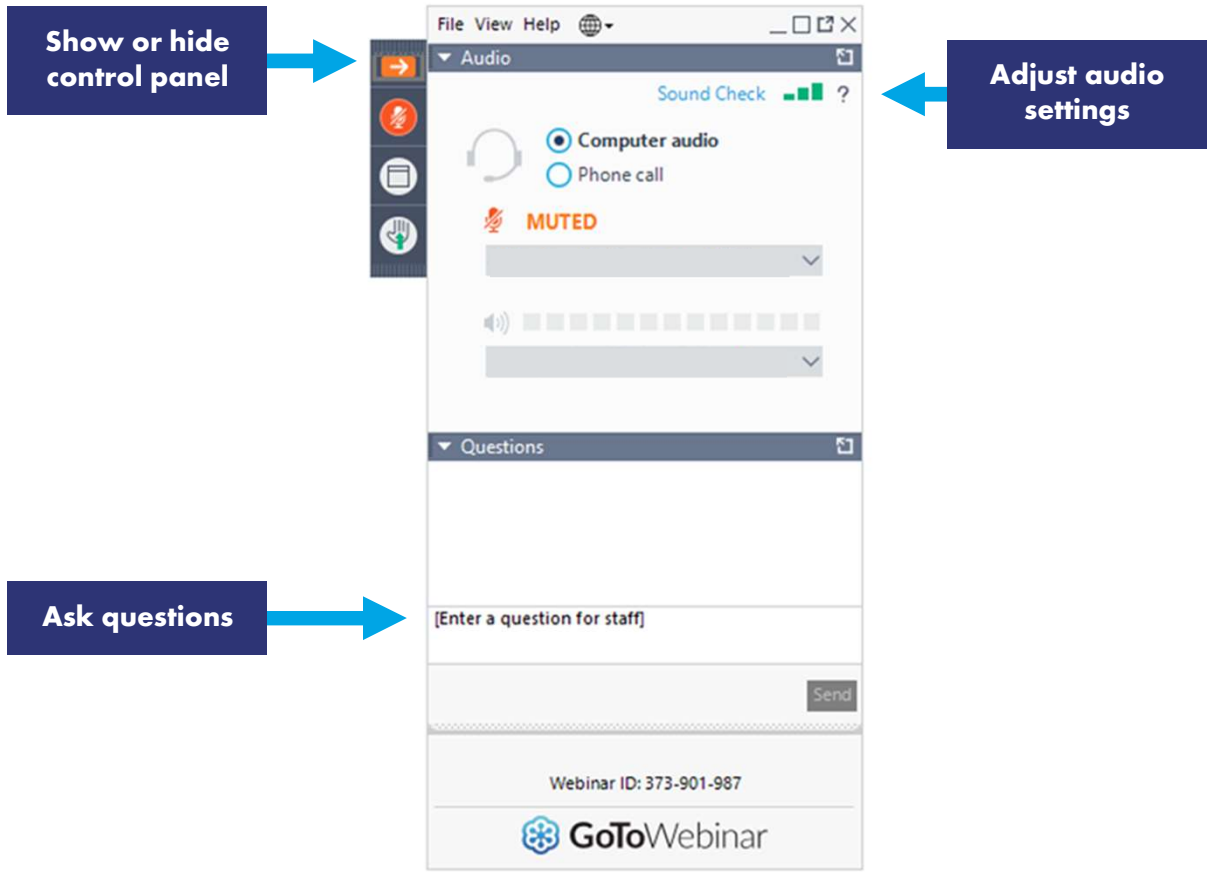
Webinar

Stability Analysis in RFEM 6

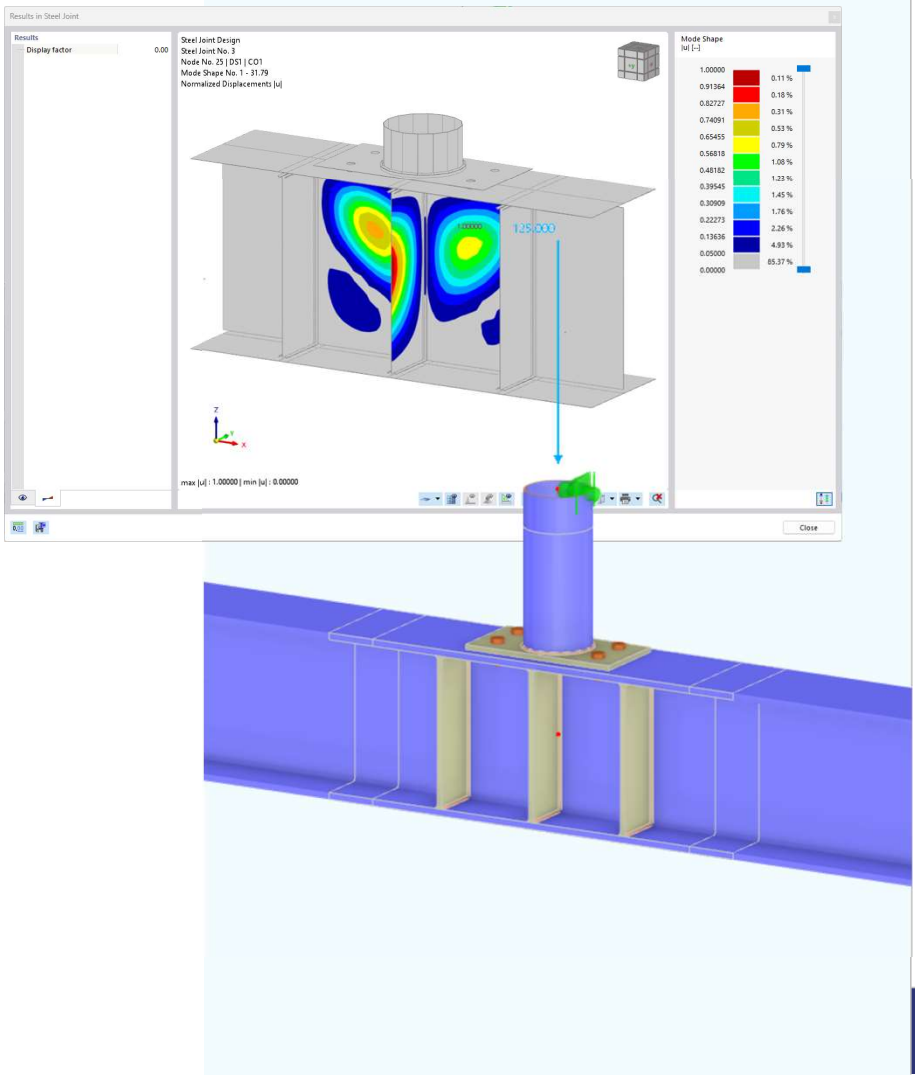


Questions During the Presentation

GoToWebinar Control Panel
Desktop



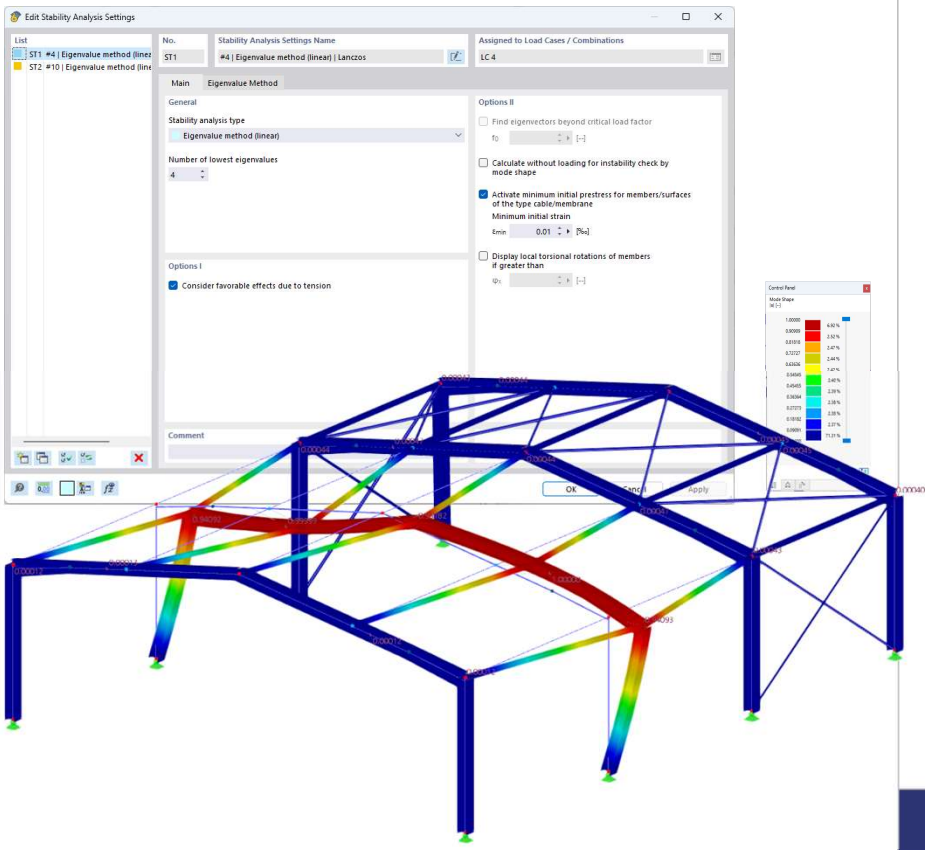
Content



Webinar

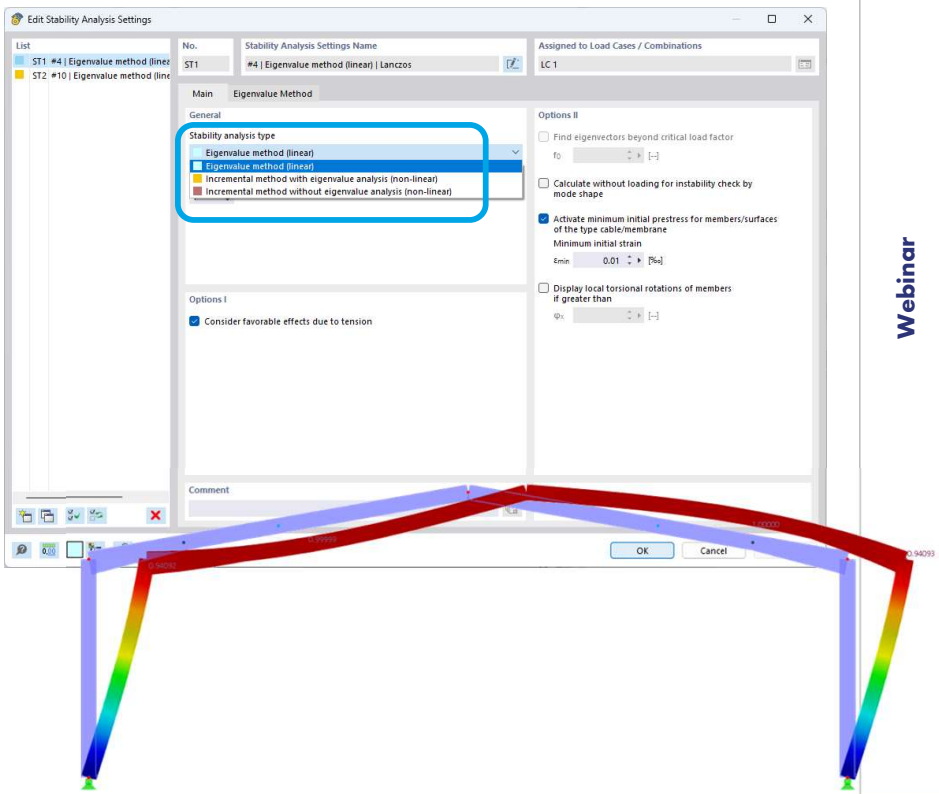
Structure Stability Add-on Benefits

- Eigenvalue analysis to determine critical load factors and eigenvectors (buckling modes)
- Evaluate the stability of the structural system and regions prone to buckling
- Ideal for slender beams and thin-walled shells
- Nonlinear stability analysis available using load increments
- Modeling and instability troubleshooting with load-independent eigenvalue analysis
- Graphical rendering of stability modes
- Basis for applying structure imperfections, importing effective length factors, etc.



Structure Stability Add-on Analysis Options

- **Eigenvalue method (linear)**
  - Buckling modes determined through linear method
  - Nonlinearities are converted to linear elements with constant stiffnesses
- **Incremental method with eigenvalue analysis (non-linear)**
  - Consider all geometric and material nonlinearities
  - Failure criteria and nonlinear effects included during incremental loading increase
  - Linear stability analysis on the last stable state
- **Incremental method without eigenvalue analysis (non-linear)**
  - Nonlinear analysis w/o eigenvalue analysis carried out



Euler Column Example

W 8x35

I_y = 127 in^4

I_z = 42.6 in^4

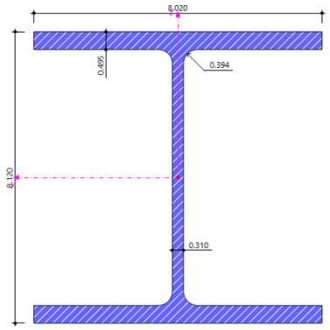
E = 29,000 ksi

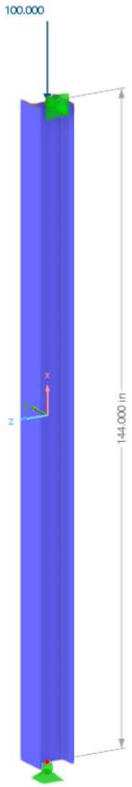
L = 144 in

Support 1 = ☑ uX, uY, uZ, ΦZ

Support 2 = ☑ uX, uY

*Shear stiffness deactivated





Critical Load	Analytical	RFEM 6	Ratio
$N_{cr,y}$ (strong)	1752.98 kip	1752.70 kip	1.000
$N_{cr,z}$ (weak)	588.00 kip	588.00 kip	1.000

$$N_{cr,y} = \frac{\pi^2 EI}{L^2}$$

$$N_{cr,y} = \frac{\pi^2 (29000\ ksi)(127\ in^4)}{(144\ in)^2}$$

$$N_{cr,y} = 1752.98\ kip$$

$$N_{cr,z} = \frac{\pi^2 EI}{L^2}$$

$$N_{cr,z} = \frac{\pi^2 (29000\ ksi)(42.6\ in^4)}{(144\ in)^2}$$

$$N_{cr,z} = 588.00\ kip$$

Euler Shell Example

E = 29,000 ksi

ν = 0.3

b = 10 in

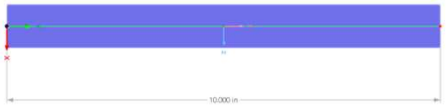
L = 50 in

t = 1 in

$I_x = 0.833\ in^4$

Support 1 = ☑ uX, uY, uZ

Support 2 = ☑ uX, uY



Critical Load	Analytical	RFEM 6	Ratio
N_{cr}/b	9.54 kip/in	9.56 kip/in	0.997

$$N_{cr} = \frac{\pi^2 EI}{L^2}$$

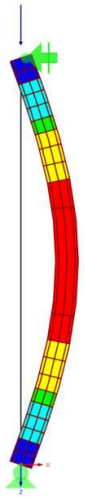
$$N_{cr} = \frac{\pi^2 (29000\ ksi)(0.833\ in^4)}{(50\ in)^2}$$

$$N_{cr} = 95.41\ kip$$

$$\frac{N_{cr}}{b} = \frac{95.41\ kip}{10\ in}$$

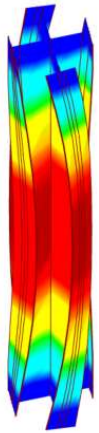
$$\frac{N_{cr}}{b} = 9.54\ kip/in$$

Stability Failure Modes



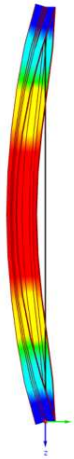
Flexural Buckling

$N_{cr,y/z}$; $N_{cr,u/v}$



Torsional Buckling

$N_{cr,T}$



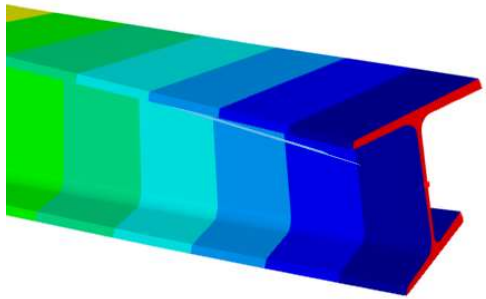
Flexural-Torsional Buckling

Lateral-Torsional Buckling

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

Torsional Warping (7 DOF) Add-on Integration

- **Consideration to cross-sectional warping with an additional DOF for member calculations**
- **Integration with Structural Stability Add-on to determine additional member critical load factors and mode shapes**
  - 6 DOF can only consider flexural buckling failure mode shapes; load application at shear center
  - 7 DOF can additionally capture torsional buckling, flexural-torsional buckling, and lateral torsional buckling; load application at center of gravity
- **Additional options available such as "Member Transverse Stiffeners"**
- **Future development to consider 7 DOF in Steel Design Add-on acc. to AISC and CSA S16 standards**



Dlubal Software Information

Visit website
www.dlubal.com

- **Videos and recorded webinars**
- **Events and conferences**
- **Knowledge Base articles**
- **FAQs**

Register for Online Training

Download Free 90-Day Trial

Dlubal Software, Inc.
30 South15th Street
15th Floor
Philadelphia, PA 19102

Phone: (267) 702-2815
Email: info-us@dlubal.com

Webinars and PDH

Upcoming Webinars

1. Register **www.dlubal.com**
2. Support & Learning → **Webinars**
3. Registration through **email**

PDH Certificates

1. **Automatically emailed** to participants
2. Available for the **full presentation**
3. Additional attendees request PDH to **info-us@dlubal.com**

www.dlubal.com