Dlubal

Structural Analysis & Design Software

www.dlubal.com

Amy Heilig, PE
Presenter

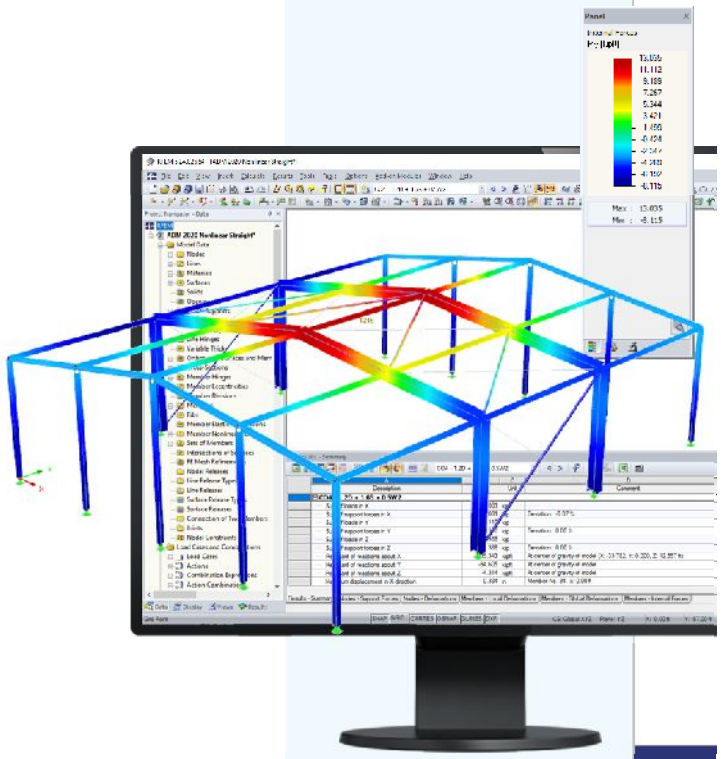
CEO – USA Office
Technical Support & Sales Engineer
Dlubal Software, Inc.

Alex Bacon, EIT
Moderator

Technical Support Engineer
Dlubal Software, Inc.

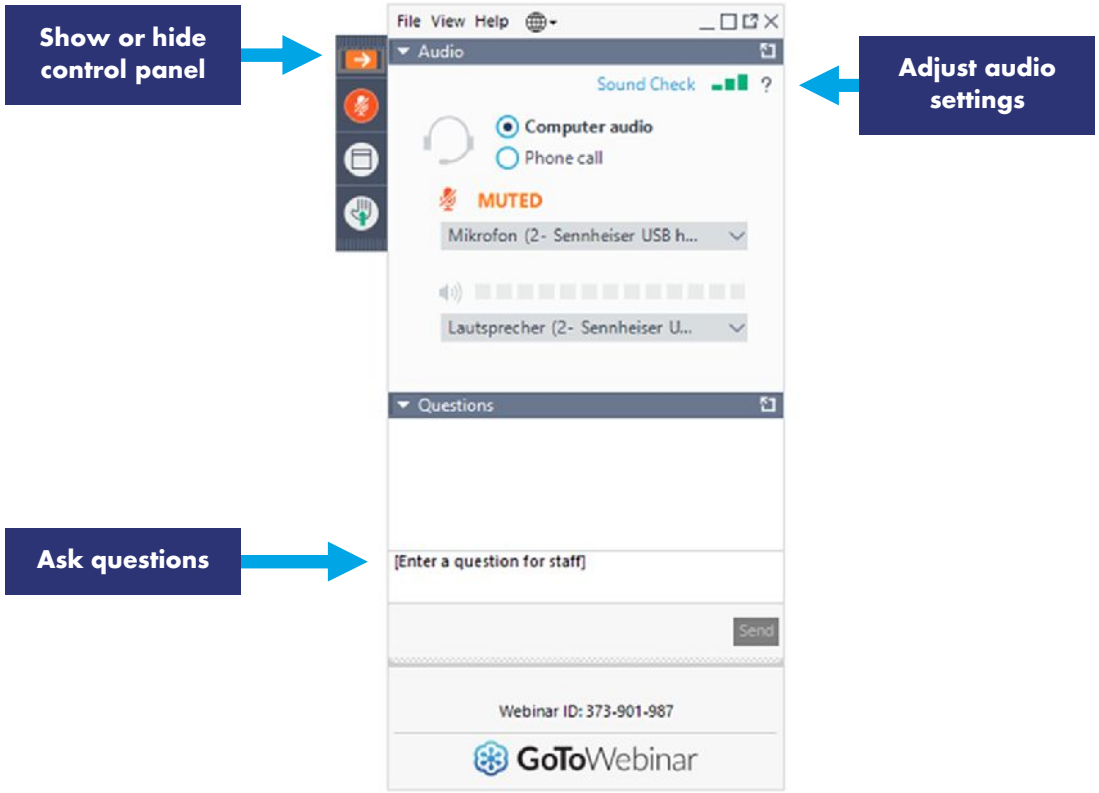
Webinar

CSA S16:19 Steel Design in RFEM

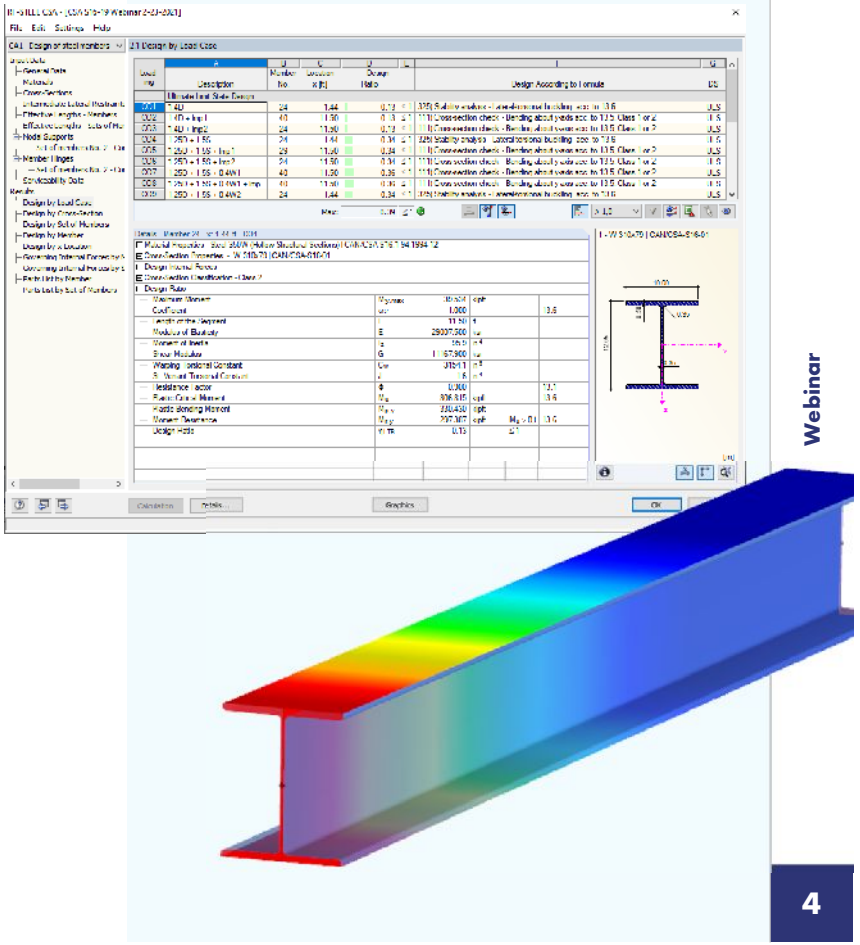


Questions During the Presentation

GoToWebinar Control Panel
Desktop



Content

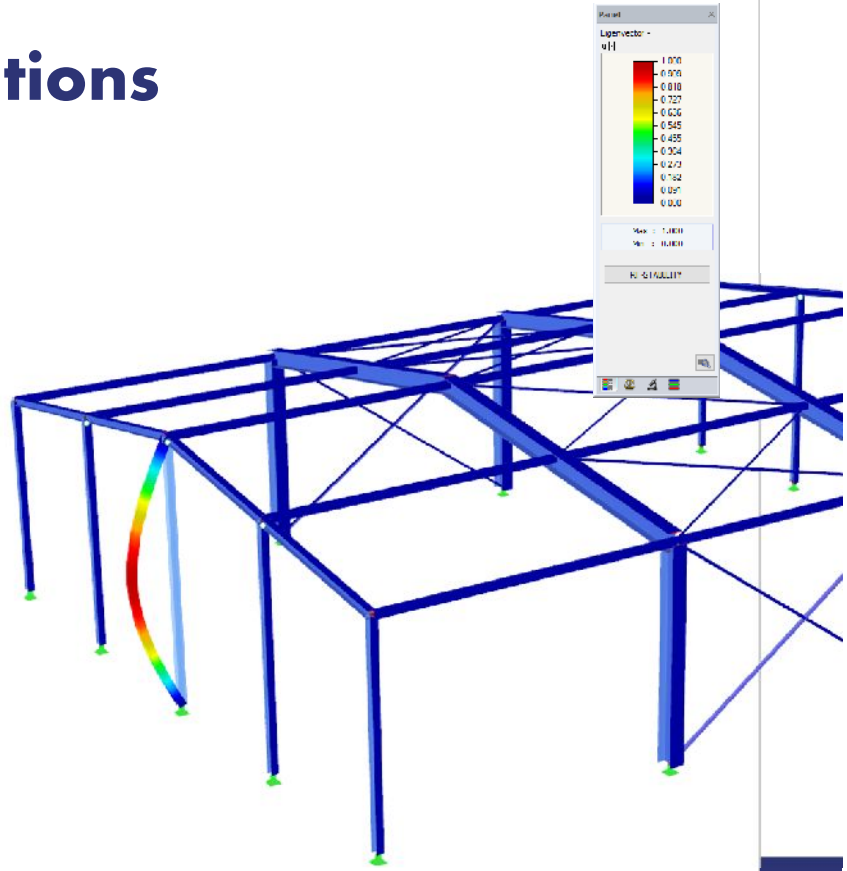


Webinar

CSA S16:19 Stability Considerations

Design for Structure Stability [Clause 8.4]

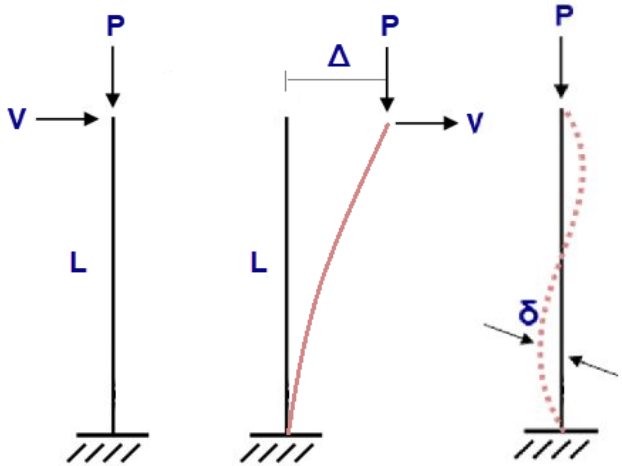
- **Stability requirements [Clause 8.4.1]**
  - Consideration to deformation, P-Delta, P-delta, geometric imperfections, stiffness reduction, uncertainty in strength/stiffness
- **Methods of analysis and design for stability [Clause 8.4.2]**
  - Simplified stability analysis method [Clause 8.4.3]
  - Stability effects in elastic analysis [Clause O.2]



8.4.3 Simplified Stability Requirements

Simplified stability analysis method [Clause 8.4.3]

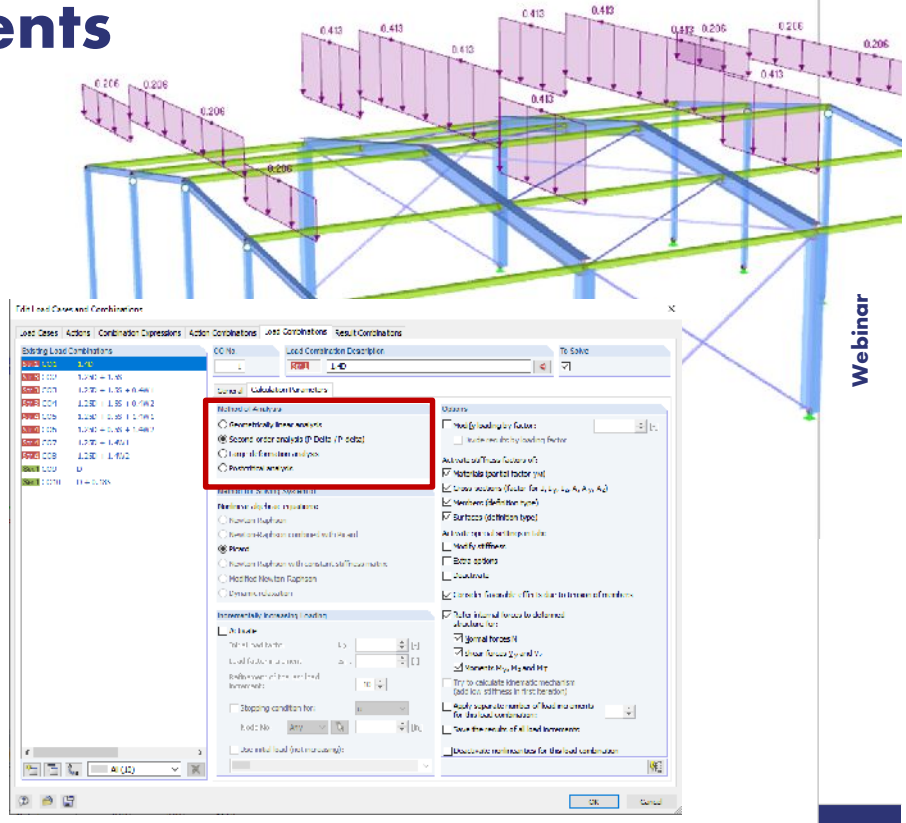
- **P-Δ effects [Clause 8.4.3.2]**
  - 2nd order analysis (RFEM approach) [Clause 8.4.3.2a]
  - U_2 amplification factor, axial loads and bending moments [Clause 8.4.3.2b]
- **Notional Lateral Loads [Clause 8.4.3.3]**
  - 0.005 x factored gravity load
  - Applied independently in 3D structure's orthogonal directions



O.2 Second-Order Requirements

Stability effects in elastic analysis [Clause O.2]

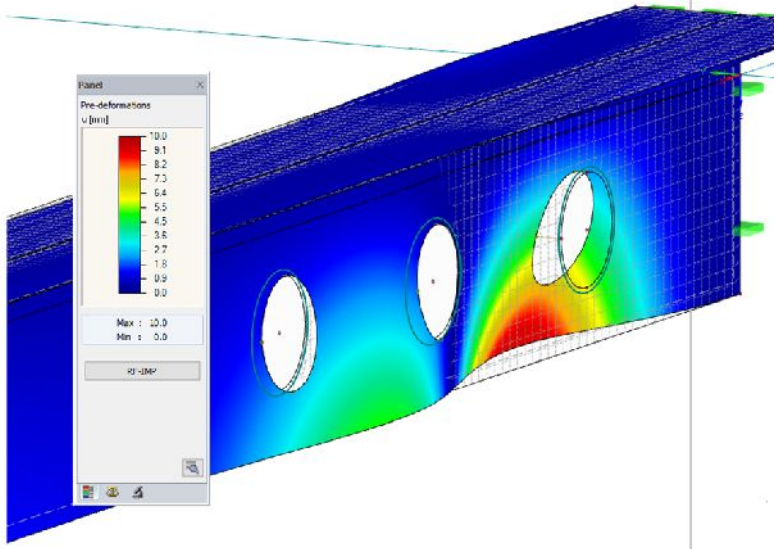
- **Geometric nonlinearity (second-order) effects [Clause O.2.2]**
  - P-Δ and P-δ effects
  - Conditions to neglect P-δ effects [Clause O.2.2a-d]
  - P-δ included, U_1 = 1.0 (factor to account 2nd order effects due to the deformation between member ends) [Clause 13.8.5]



O.2 Imperfection Requirements

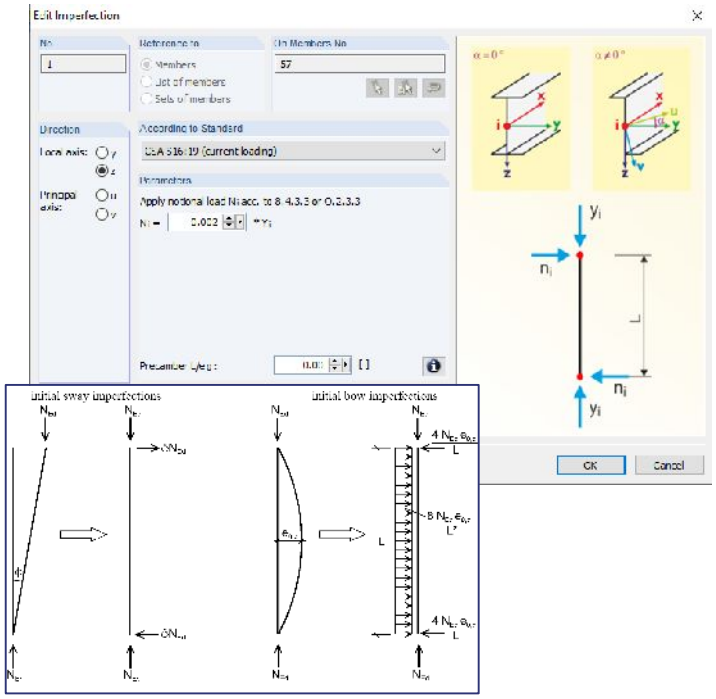
Geometric Imperfections [Clause O.2.3]

- **Member and local geometric imperfections neglected for elastic analysis**
- **Global geometric imperfections must be accounted for with listed methods**
- **Global imperfections can be neglected for lateral load COs [Clause O.2.3.1]**
  - Gravity loads primarily supported by vertical elements
  - 1st to 2nd order story drift ratio with reduced member stiffnesses < 1.7



O.2 Imperfection Requirements (cont'd)

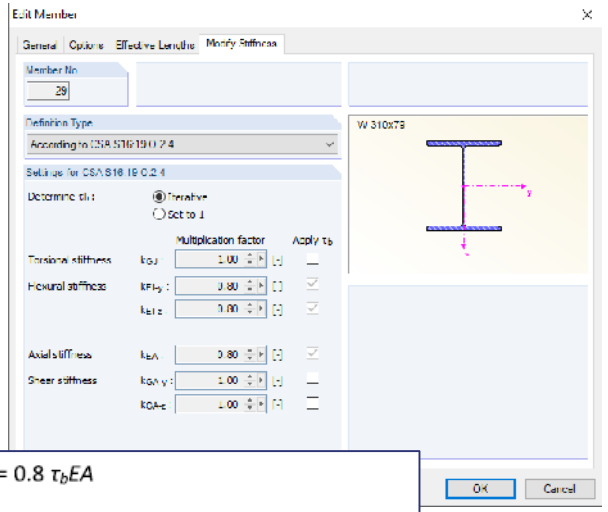
- **Method 1: Direct modeling (Clause O.2.3.2)**
  - Displaced member intersection points (Clause 29.3 and column out-of-plumbness 1/500)
  - Difficult and requires multiple different models
- **Method 2: Notional lateral loads (Clause O.2.3.3)**
  - 0.002 x factored gravity load
  - Simplified stability analysis method - 0.005 [Clause 8.4.3.3] vs. 0.002 magnitude
  - Applied in the direction for greatest destabilizing effect



O.2 Reduced Stiffness Requirements

Reduced member stiffnesses [Clause O.2.4]

- Account for initial geometric imperfections, inelasticity, uncertainty in strength and stiffness
- Reduced member axial stiffness (EA) and flexural stiffness (EI)
  - 0.8 reduction factor
  - τ_b dependent on factored axial force (C_f) and axial strength (C_y)
- Recommended application to <u>all</u> members
- Apply to shear stiffness (GA) and torsional stiffness (GJ) when stiffnesses contribute significantly to lateral stability
- Not applicable to drifts, deflections, vibrations, periods, etc.



$EA_r = 0.8\ \tau_b EA$

$EI_r = 0.8\ \tau_b EI$

where τ_b is given by

a) when $C_f/C_y < 0.5$: $\tau_b = 1.0$;

b) when $C_f/C_y > 0.5$: $\tau_b = 4\ C_f/C_y\ (1 - C_f/C_y)$.

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.
The Graham Building, 30 South 15th Street,
15th Floor, Philadephia, PA 19102

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

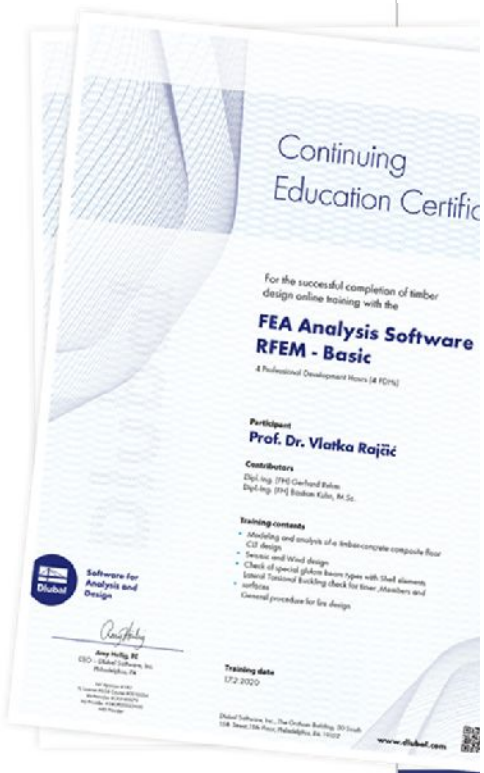
Webinars and PDH

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 **info-us@dlubal.com**



www.dlubal.com