



*Budapest University of Technology and Economics
Department of Structural Engineering*

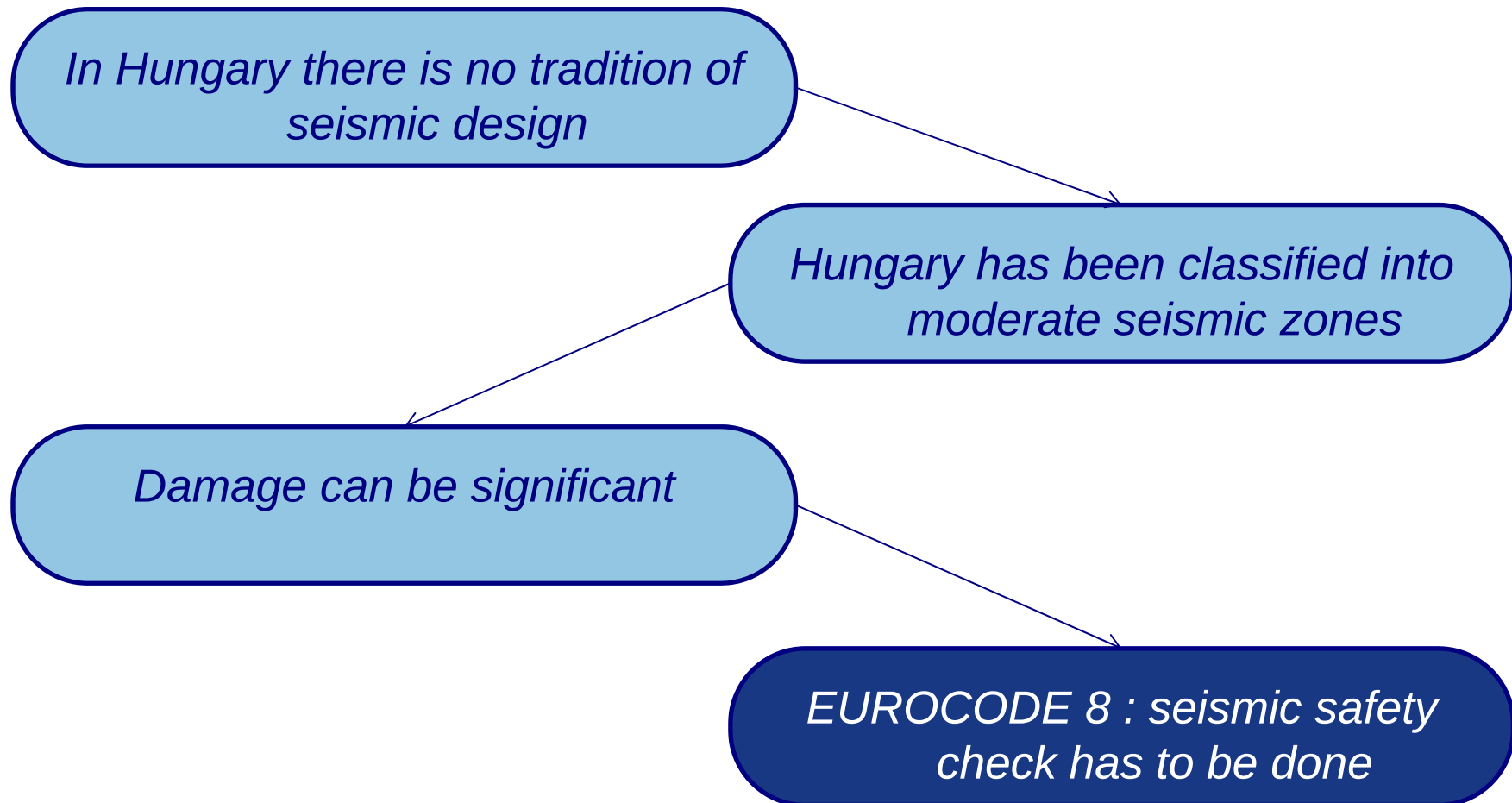
Optimal stiffener geometry based on nonlinear analysis of longitudinally stiffened plates under compression

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PhD workshop in Vilnius, 2012

Earthquake analysis of bridges in moderate seismic zones



Earthquake analysis of bridges in moderate seismic zones

1. Analysis of extant bridges

Database about extant bridges

Representative structures

Numerical analysis (spectral and time-history)

Critical structural types and details

Damage prediction



Alternative reinforcing methods

2. New design conceptions

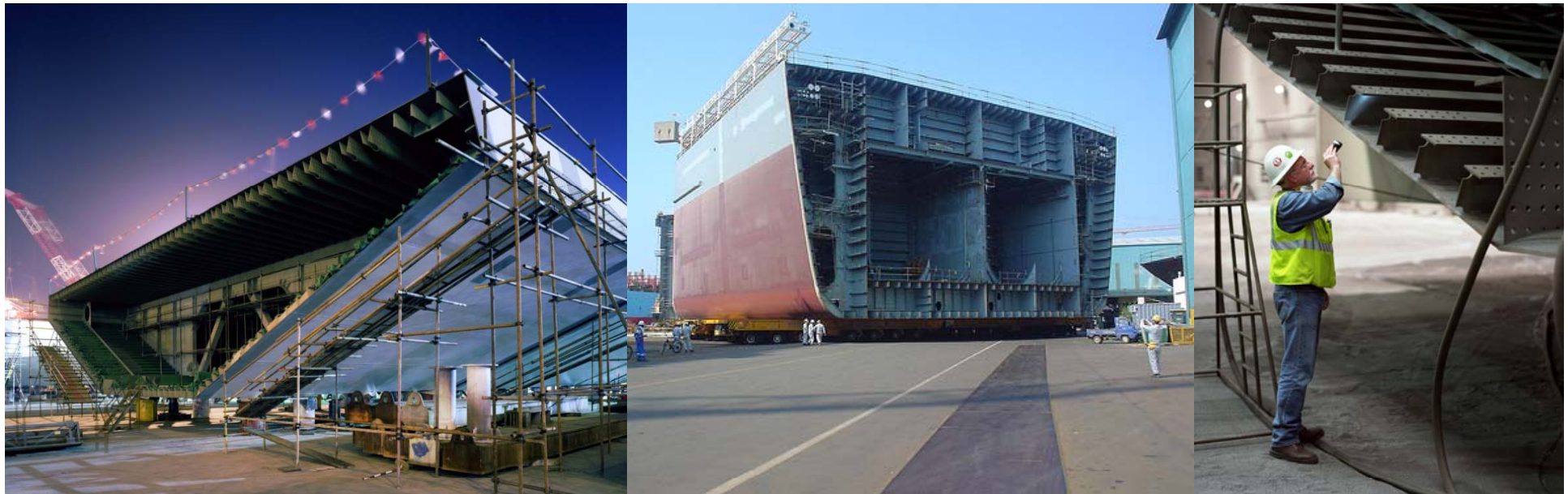
Stiffened plates

Thin-walled structures

Ultimate load/Material consumption
Stability failure is dominant

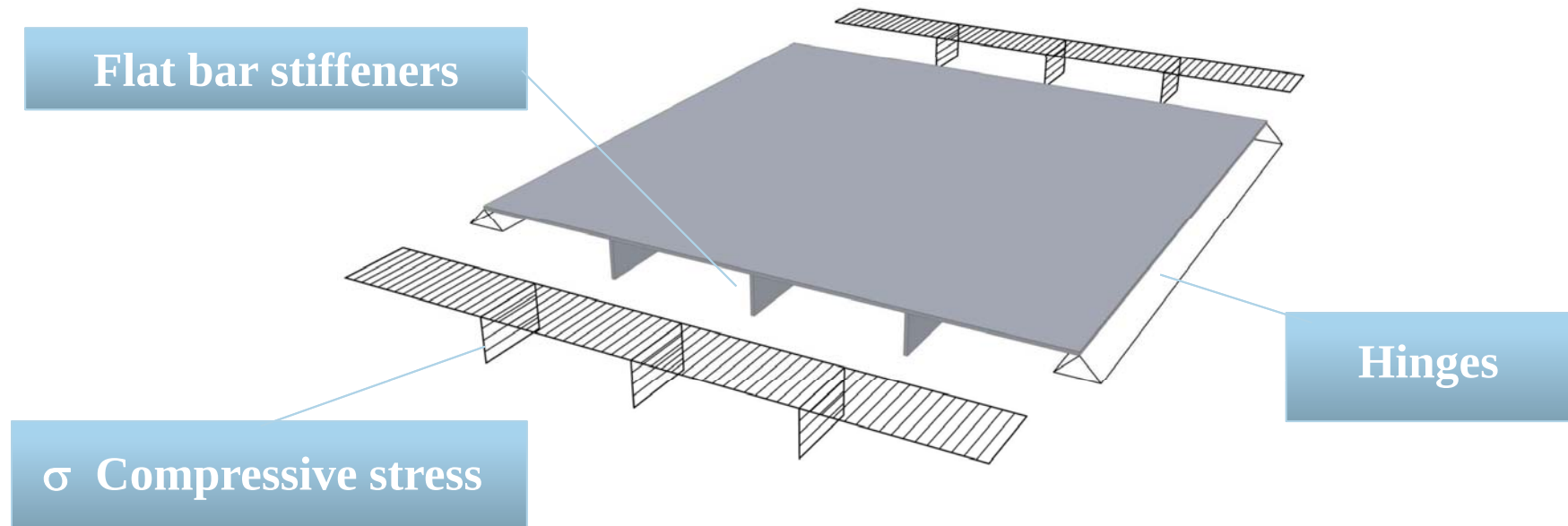
Ultimate load, failure

Stiffness ratios



Aim of the studies

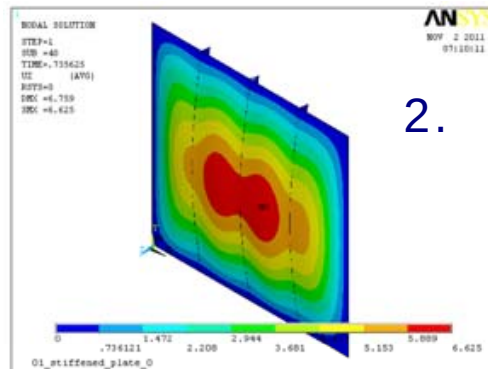
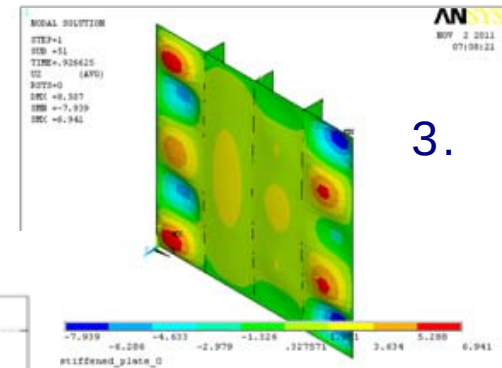
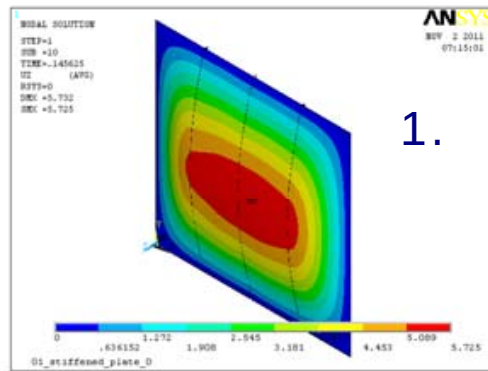
Longitudinally stiffened plate, pure compression.



Parameters characterizing the stiffness relations :

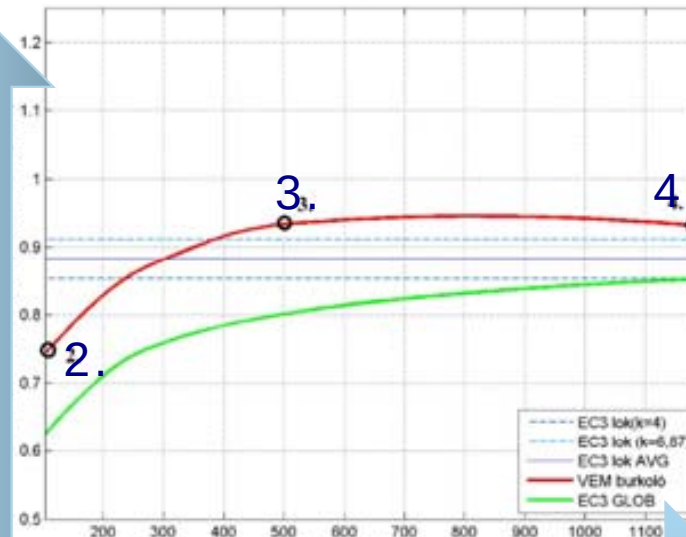
$$\gamma = \frac{EI_y}{D_p b}; \quad \delta = \frac{A_x}{bt_p}; \quad D_p = \frac{Et_p^3}{12(1 - \nu^2)};$$

Optimal stiffener geometry

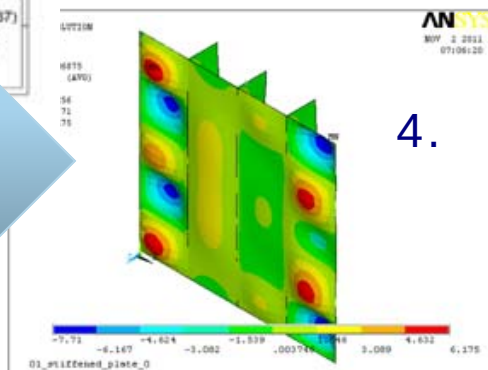


Ultimate load

Gamma - Ro, Alfa=1 $N_s=3$ Bsub/t=75 Delta=1.5



Stiffener stiffness



Methods to calculate the optimal relative stiffness

By elastic critical stress

- $$\gamma_c^* = \frac{1}{n_s + 1} \left[\frac{\alpha^2}{m_{ov}} \left(4(n_s + 1)^2 (1 + \delta(n_s + 1)) - 2 - \frac{\alpha^2}{m_{ov}} \right) - 1 \right]$$
- Perfect geometry, linear elastic material
- Not applicable directly for design

By ultimate loads $\Rightarrow$ GMNI analysis

- Post-critical load bearing capacity
- Imperfections, non-linear, plastic material model
- Can be used for design directly

ULS according to EC3-1-5

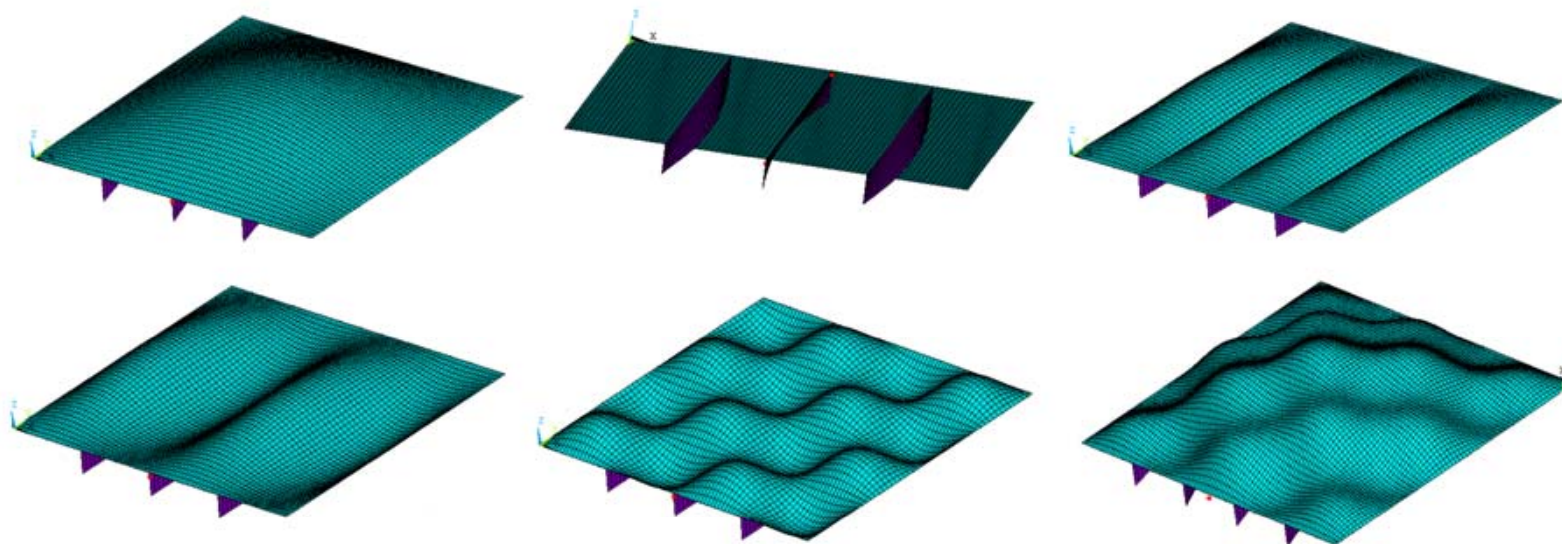
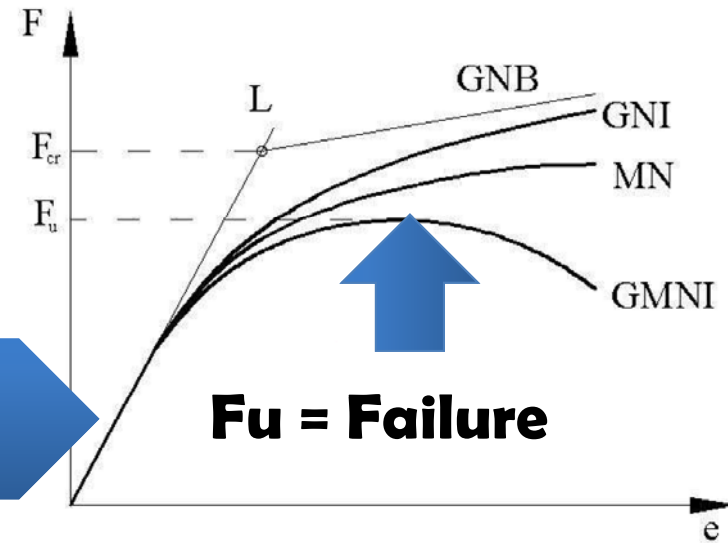
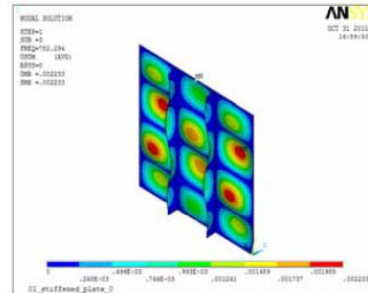
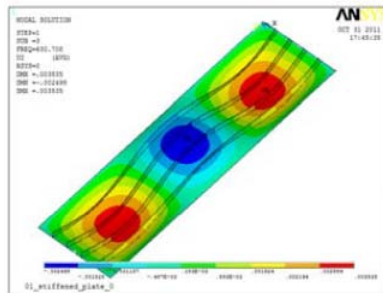
Reduced cross-section method

It takes into account the buckling of the elements and their interactions.

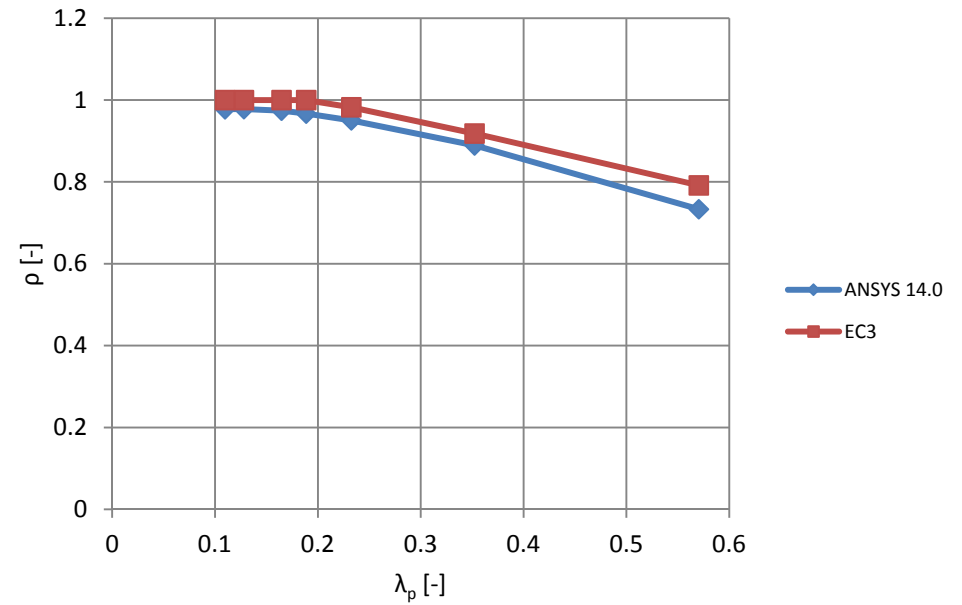
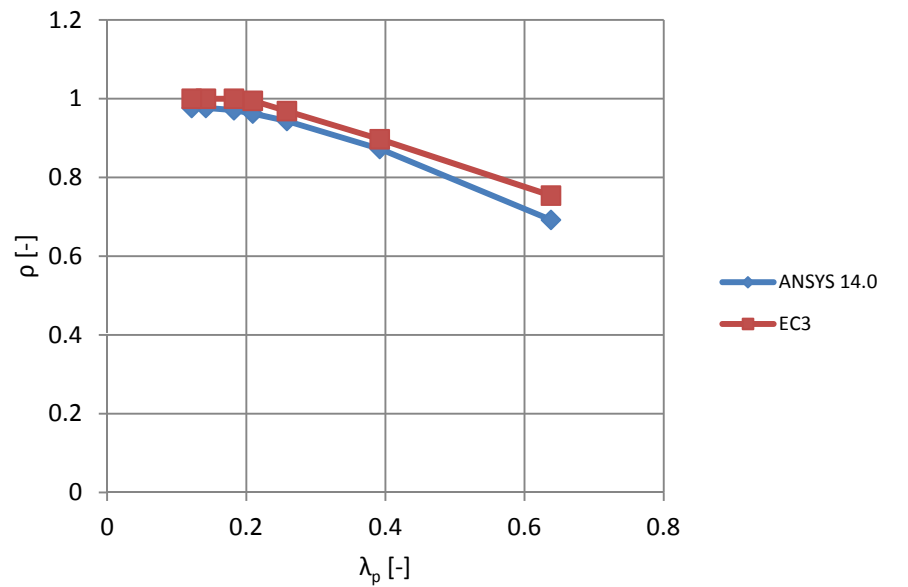
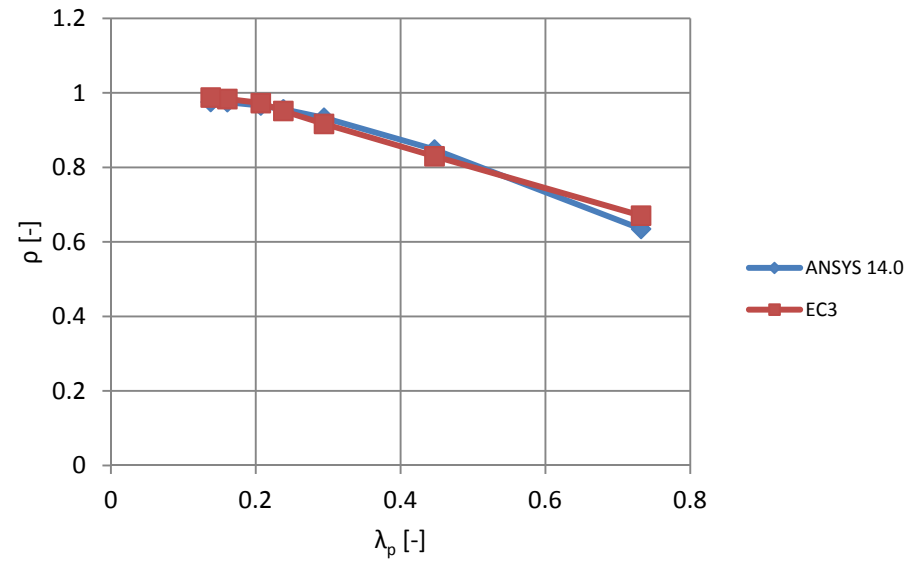
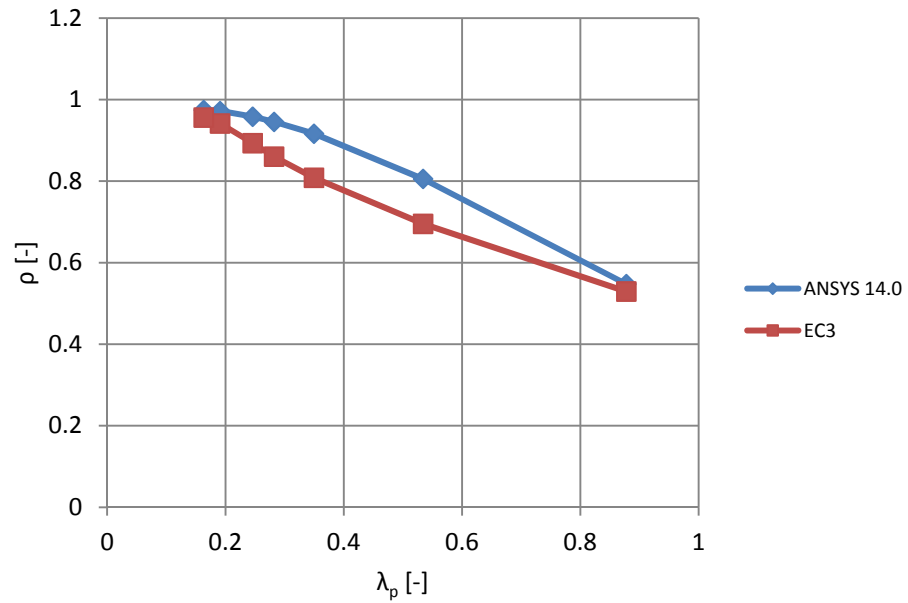
Stability failures according to EC3-1-5

Local	Global	Stiffener
• Buckling of subpanels between the stiffeners	• Plate type behaviour • Column type buckling behaviour • Interaction	• Distortional buckling • Minimum geometric requirements • Should be avoided!

Numerical model

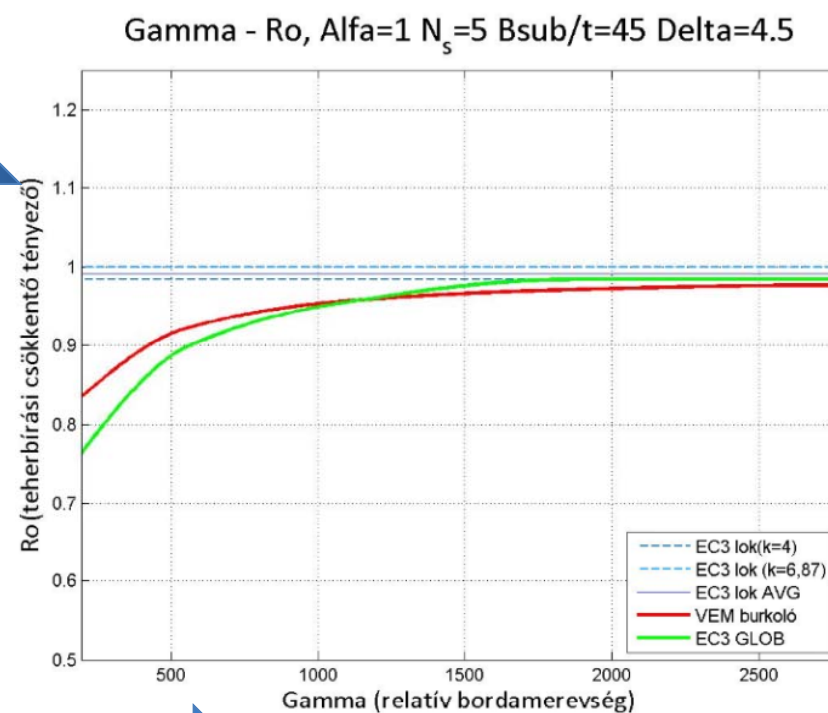
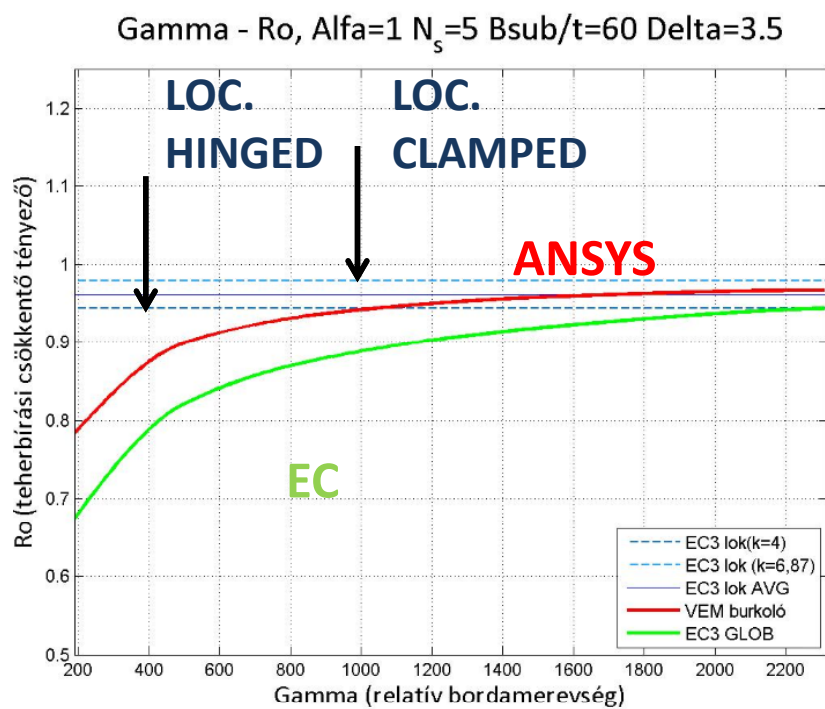


Results 1



Results 2

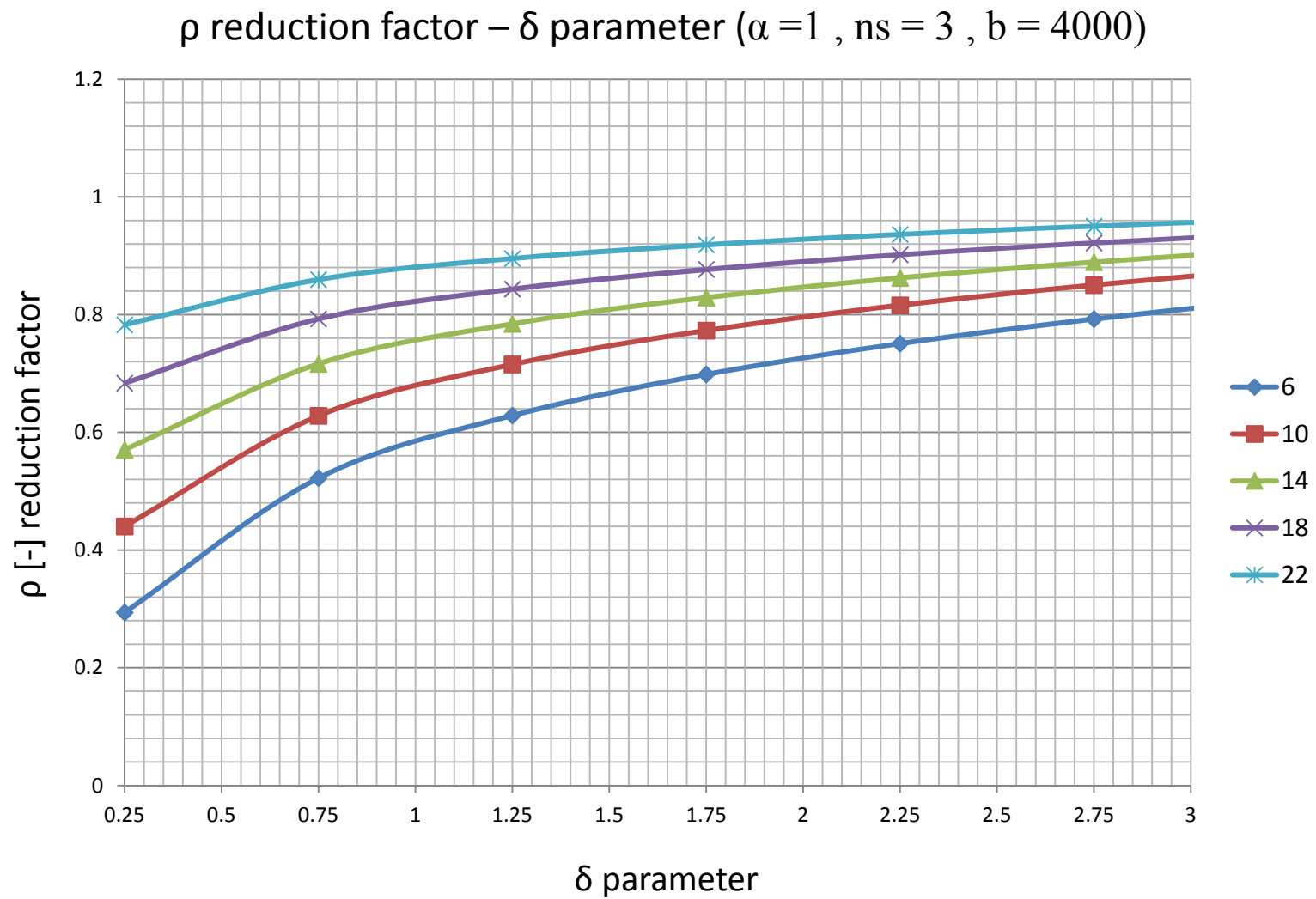
Plates with higher and lower slenderness



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Stiffener stiffness

Results 3



Thank you for your attention!