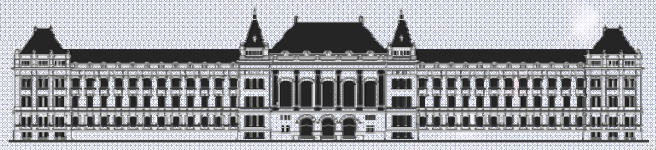

Budapest University of Technology and Economics
Department of Structural Engineering

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

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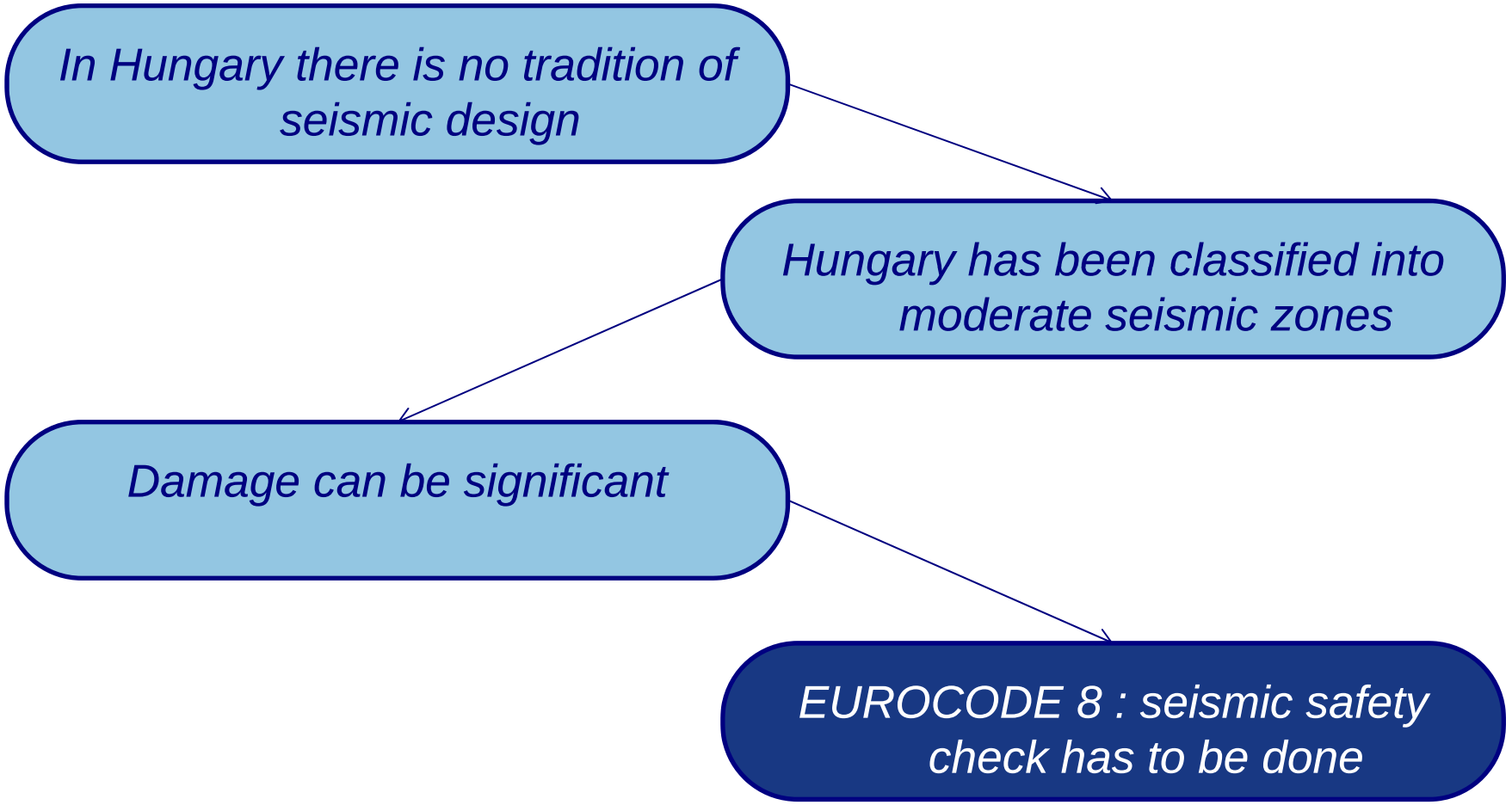
Supervisor
Dr. Vigh László Gergely

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/retrofit methods

2. New design conceptions

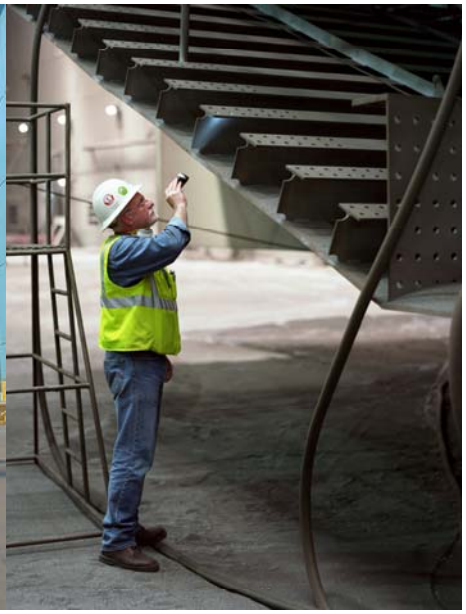
Stiffened plates

Thin-walled structures

Ultimate load/Material consumption
Stability failure is dominant

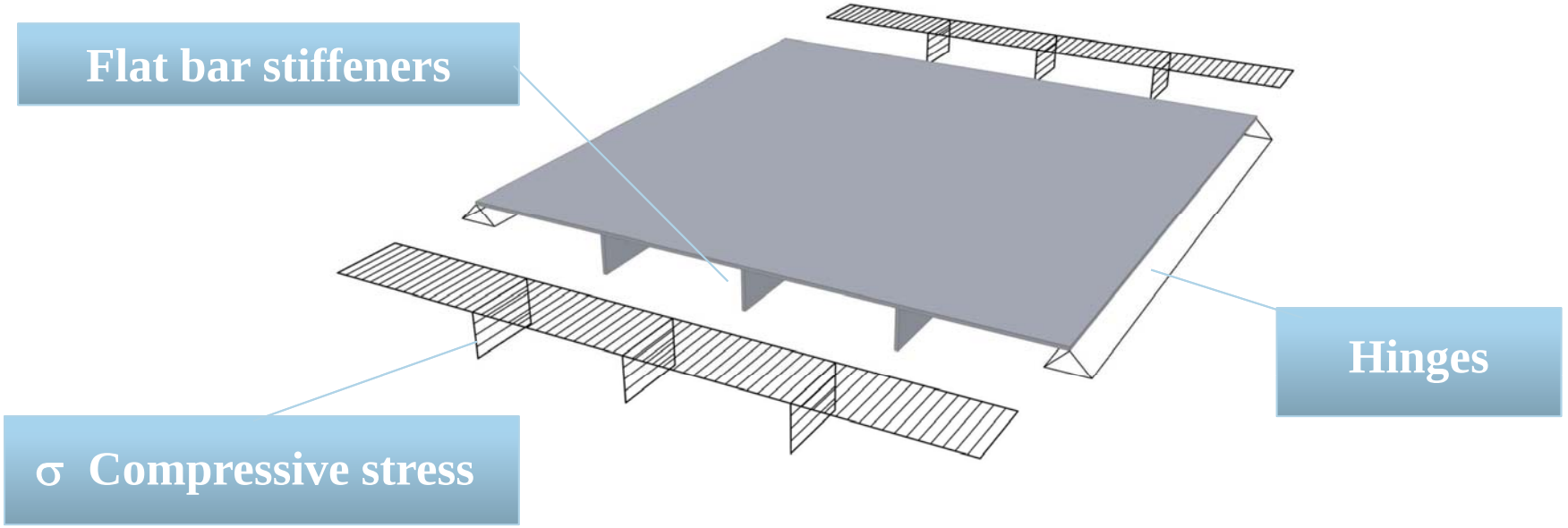
Ultimate load, failure

Stiffness ratios



Aim of the studies

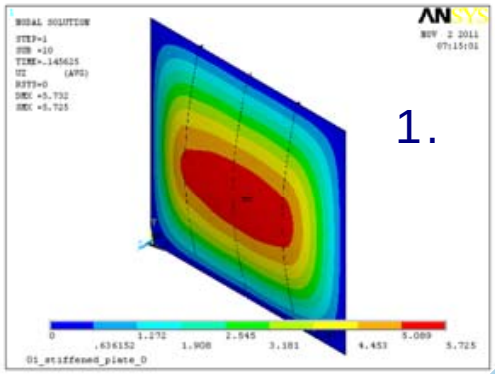
Longitudinally stiffened plate, pure compression.

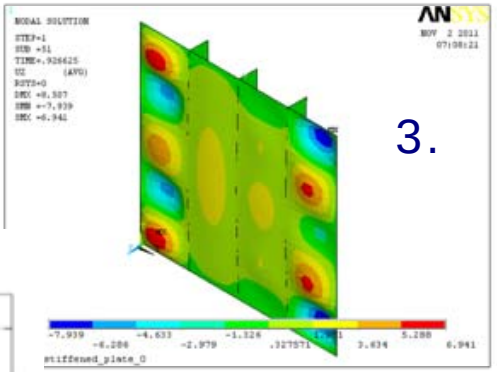


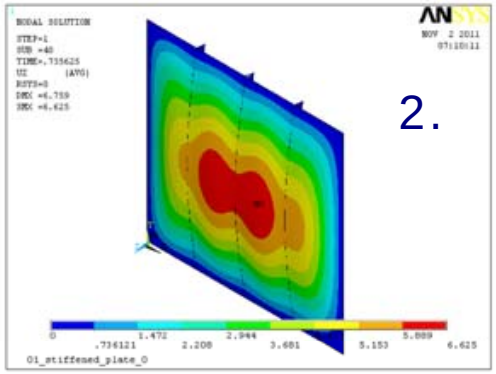
Parameters characterizing the stiffeness relations :

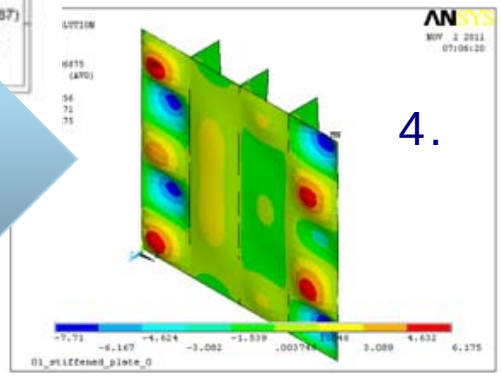
$$\gamma = \frac{EI_y}{D_p b}; \qquad \delta = \frac{A_x}{bt_p}; \qquad D_p = \frac{Et_p^3}{12(1-\nu^2)};$$

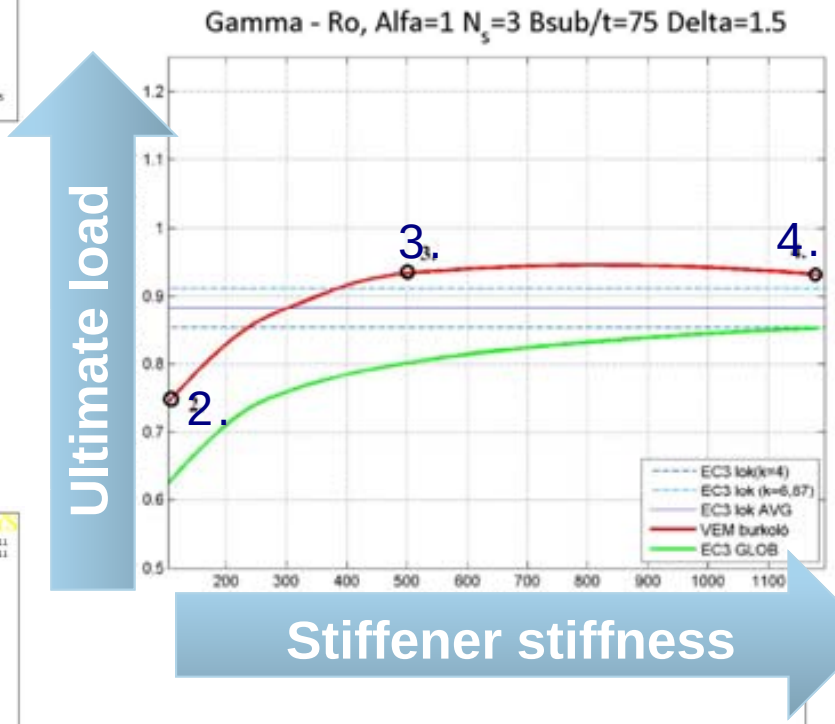
Optimal stiffener geometry











Methods to calculate the optimal relative stiffness

By elastic critical stress

- $$\gamma_c^* = \frac{1}{n_s+1}\left[\frac{\alpha^2}{m_{ov}}\left(4(n_s+1)^2\left(1+\delta(n_s+1)\right)-2-\frac{\alpha^2}{m_{ov}}\right)-1\right]$$
- 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

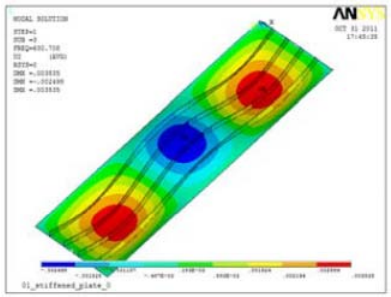
ULS according to EC3-1-5

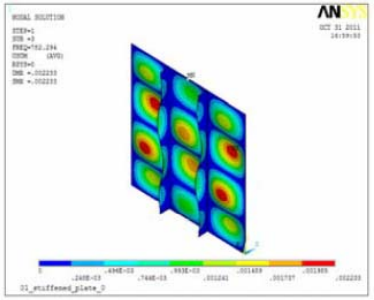
Effecive cross-section method

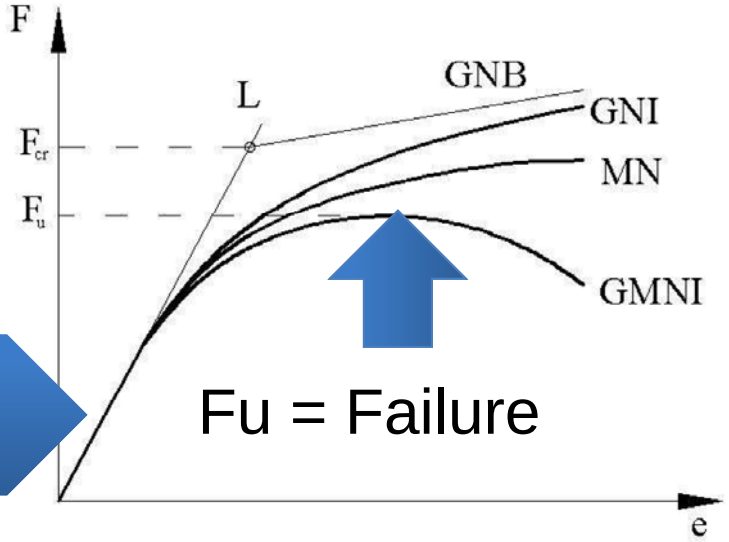
It takes into account the buckling of the elements and their interactions.

Stability failures according to EC3-1-5		
Local	Global	Stiffener
• Buckling of subpanels between the stiffeners	• Plate type behaviour • Coloumn type buckling behaviour • Interaction	• Distortional buckling • Minimum geometric requirements • Should be avoided!

Numerical model



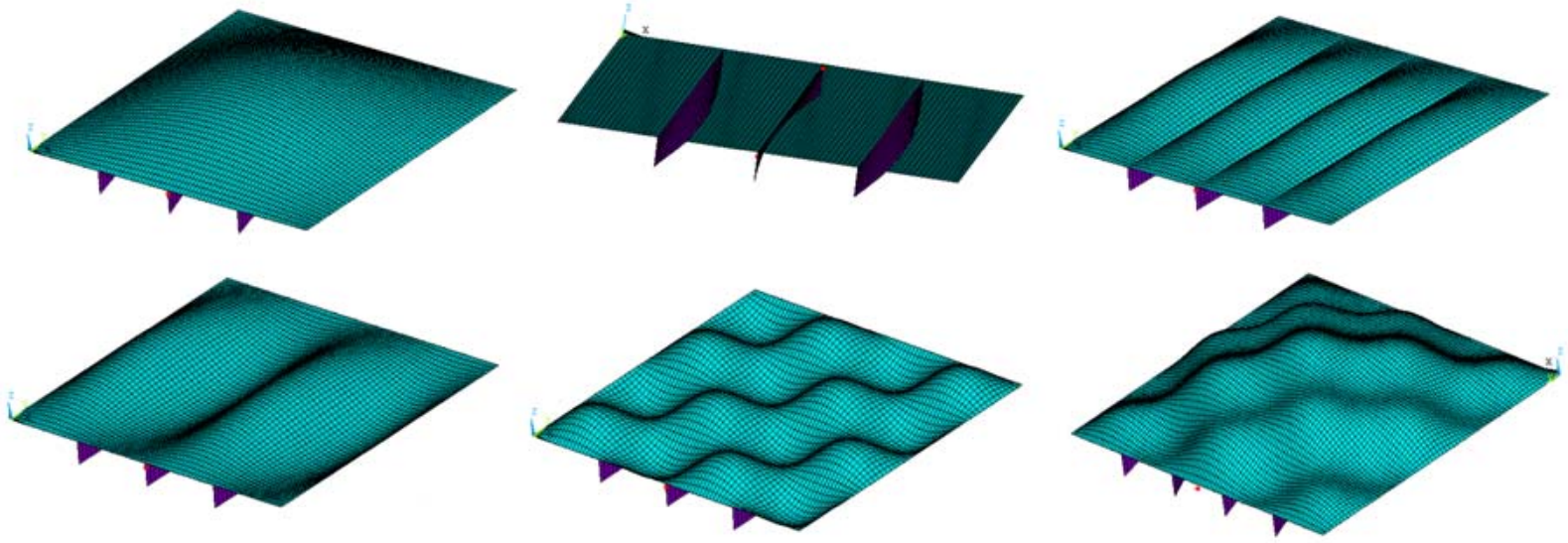




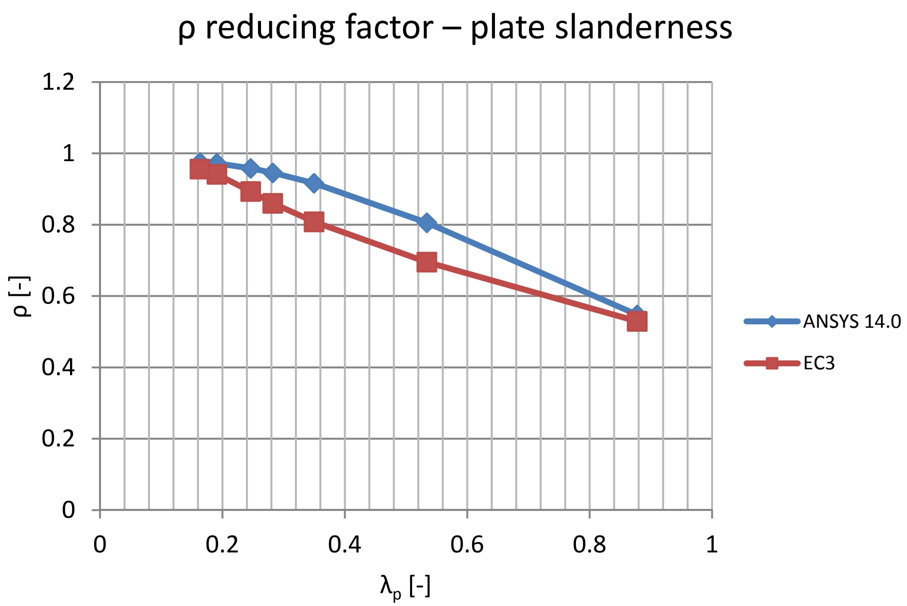
Imperfect geometry
GNI

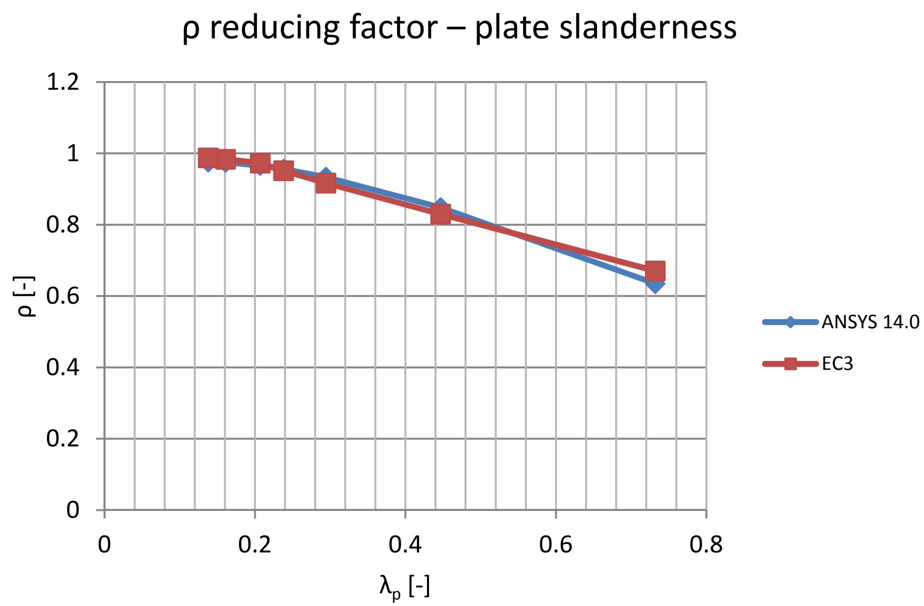
Plastic material behaviour
MN

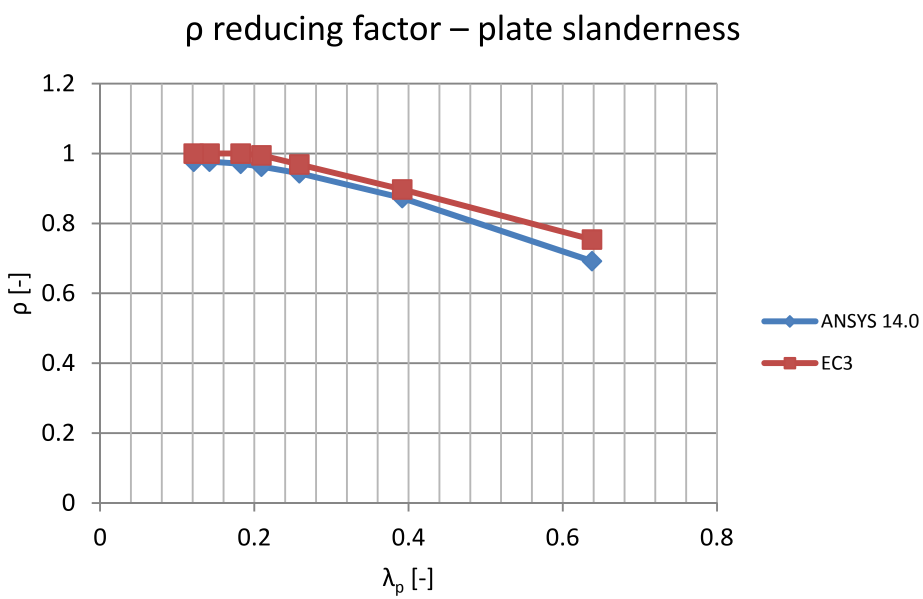
GMNI Analysis

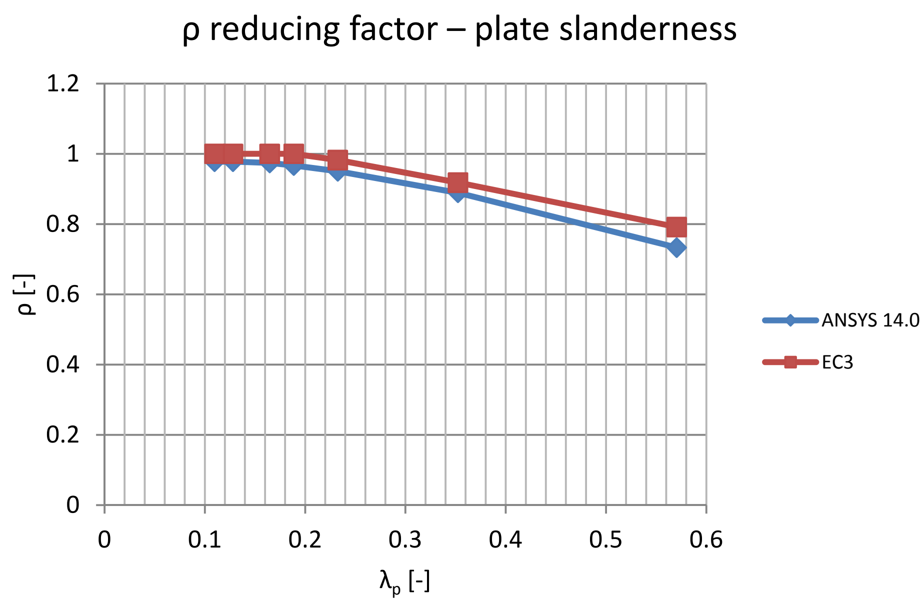


Results 1


ρ reducing factor – plate slanderness
ρ [-]
1.2
1
0.8
0.6
0.4
0.2
0
0 0.2 0.4 0.6 0.8 1
λp [-]
ANSYS 14.0
EC3

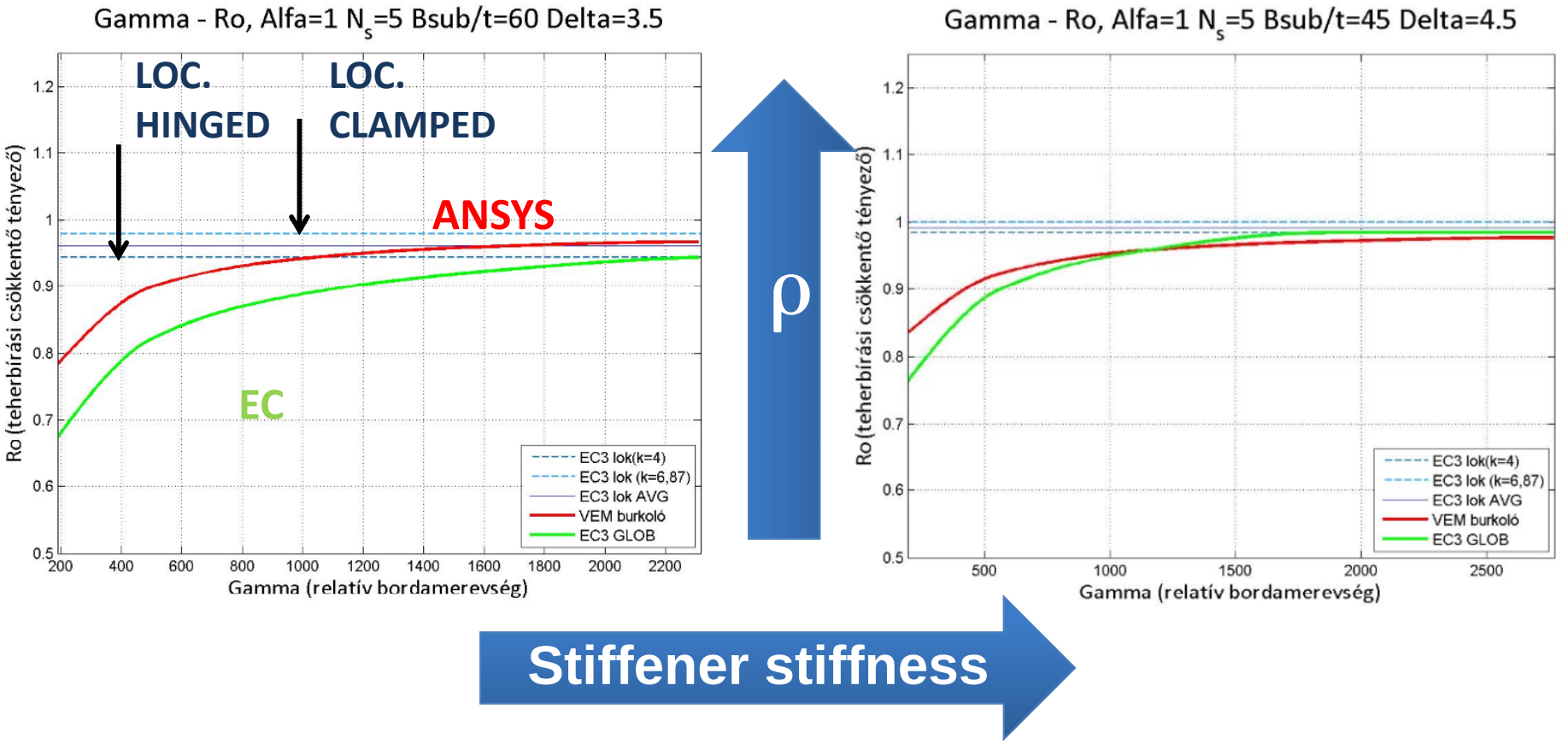

ρ reducing factor – plate slanderness
ρ [-]
1.2
1
0.8
0.6
0.4
0.2
0
0 0.2 0.4 0.6 0.8
λp [-]
ANSYS 14.0
EC3


ρ reducing factor – plate slanderness
ρ [-]
1.2
1
0.8
0.6
0.4
0.2
0
0 0.2 0.4 0.6 0.8
λp [-]
ANSYS 14.0
EC3

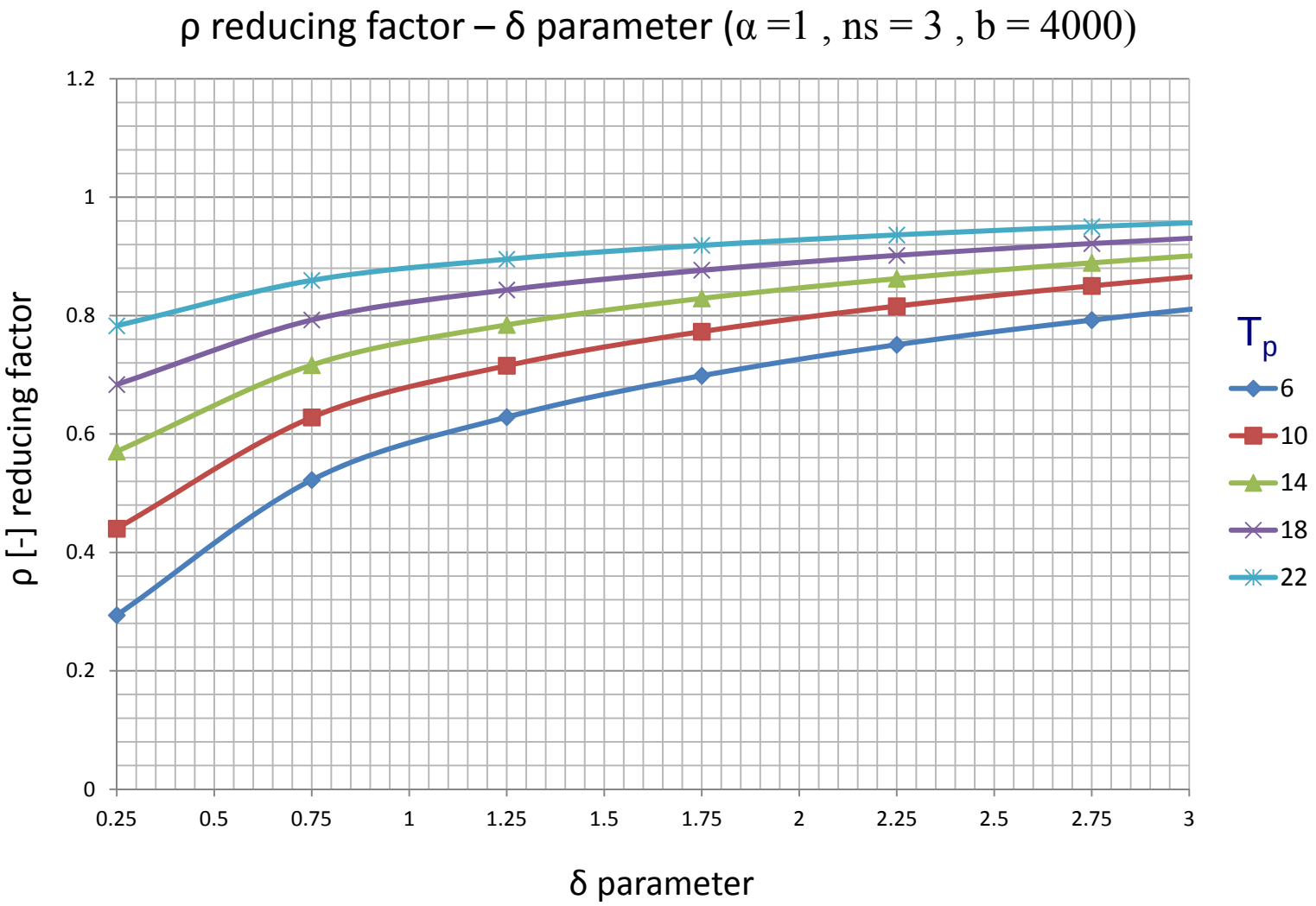

ρ reducing factor – plate slanderness
ρ [-]
1.2
1
0.8
0.6
0.4
0.2
0
0 0.1 0.2 0.3 0.4 0.5 0.6
λp [-]
ANSYS 14.0
EC3

Results 2

Plates with higher and lower slanderness



Results 3


ρ reducing factor – δ parameter (α =1 , ns = 3 , b = 4000)
ρ [-] reducing factor
δ parameter
1.2
1
0.8
0.6
0.4
0.2
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
Tp
6
10
14
18
22

Thank you for your attention!

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