COST Action TU0601 Robustness of Structures
FINAL CONFERENCE

**NUMERICAL ANALYSIS OF FRAME SYSTEMS
IN CASE OF PROGRESSIVE COLLAPSE**

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Short Term Scientific Mission

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COST Action TU0601

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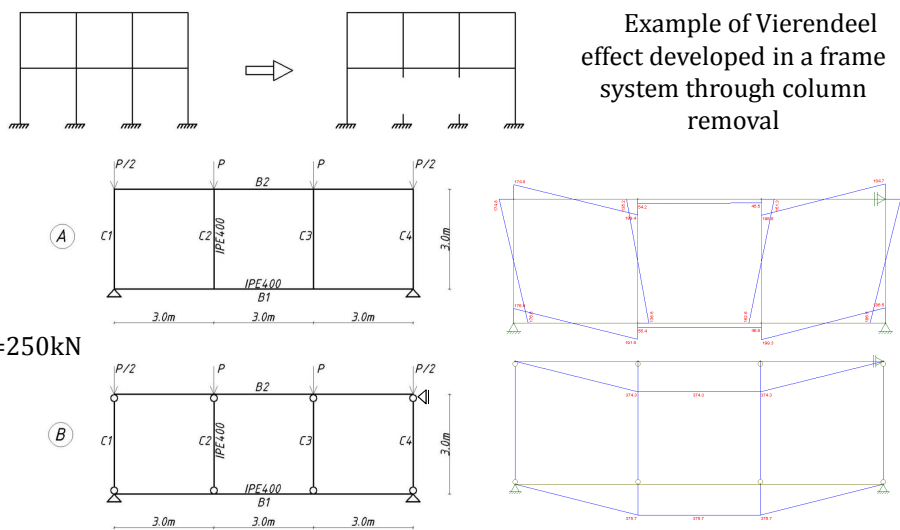
Period of STSM: 12/02/2011 – 27/02/2011

Plan of work

- Selection of representative structural system
- Numerical modelling
- Validation of numerical model
- Comparison of linear and nonlinear approach
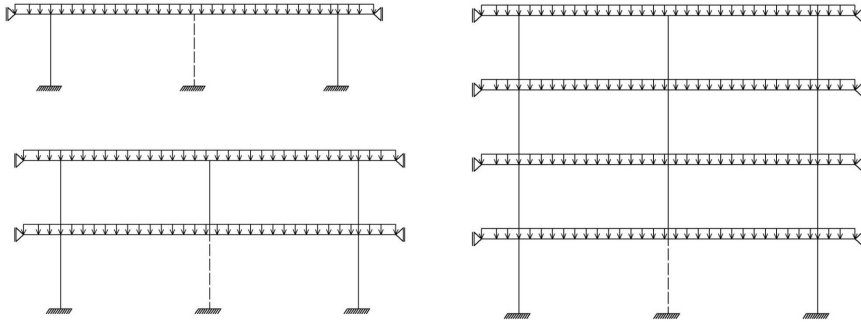- Investigation of Vierendeel effect

Vierendeel effect

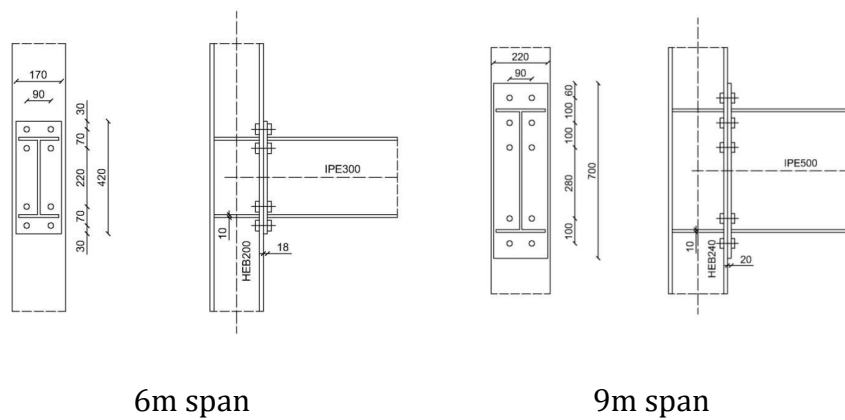Example of Vierendeel effect developed in a frame system through column removal

P=250kN

Parametric study

Scheme of analyzed models with: 1, 2, and 4 stories, span equal to 6 or 9 m, and q=26.5 kN/m

Structural model - connections

6m span

9m span

Linear analysis - F-tool

| Number of storeys	M_{max} [kN]	T_{max} [kN]	N_{max} [kN]	δ [mm]
1	271.2 (0.0%)	159.3 (0.0%)	185.8 (0.0%)	133.4 (0.0%)
2	323.2 (+19.17%)	167.4 (+5.08%)	371.7 (+100%)	113.4 (-14.99%)
4	323.9 (+19.43%)	166.2 (+4.33%)	743.4 (+300%)	109.9 (-17.61%)

Numerical results for model with span 6.0m without middle column

Number of storeys	M_{max} [kN]	T_{max} [kN]	N_{max} [kN]	u [mm]
1	543.8 (0.0%)	258.8 (0.0%)	265.5 (0.0%)	149.8 (-0.0%)
2	698.0 (+28.35)	311.2 (+20.25%)	531.0 (+100%)	120.1 (-19.82)
4	731.9 (+34.59)	340.9 (+31.72)	1062.0 (+300%)	86.3 (-42.38)

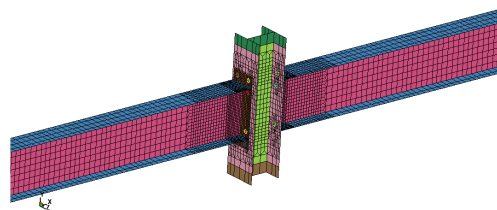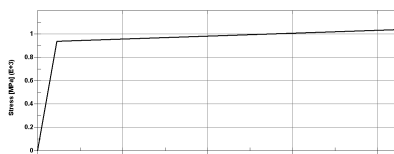Numerical results for model with span 9.0m without middle column

Nonlinear analysis
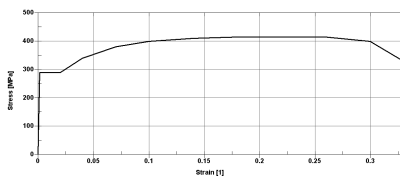
Beams, columns, end plates
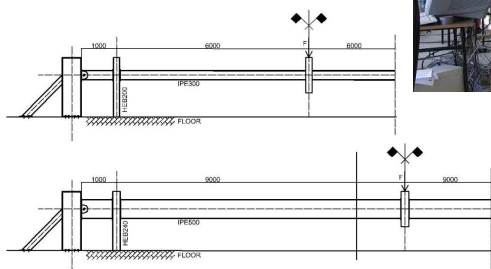

Close up view on the middle joint of steel frame models
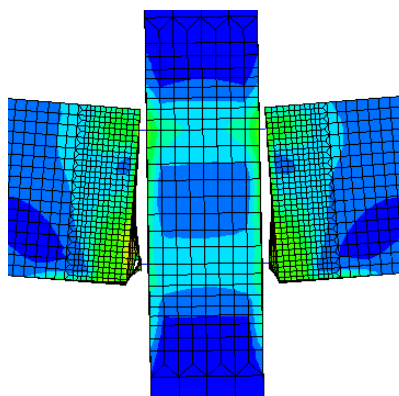

Bolts

Validation of numerical model

Test setup used for
verification of FE models
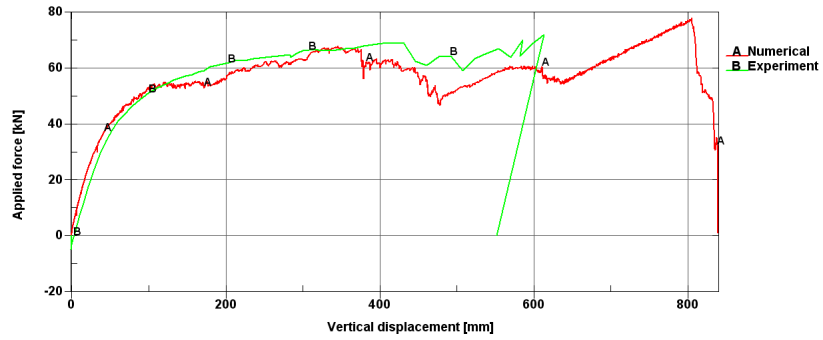Tests conducted at Rzeszow
Technical University,
(Kozłowski et al, 2011)

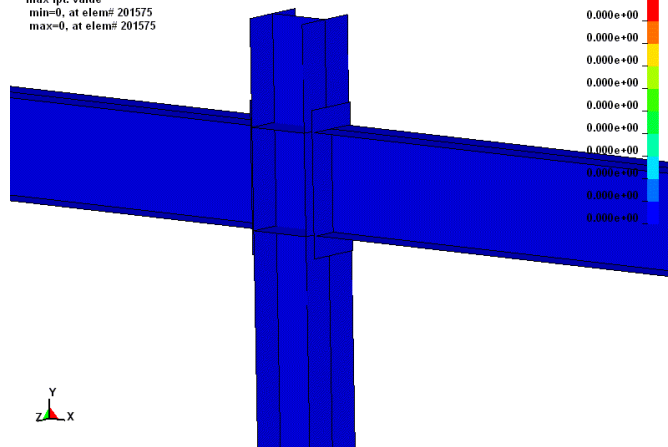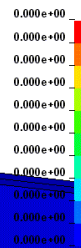# Validation of numerical model

Validation of numerical model

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Nonlinear analysis - results

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Nonlinear analysis - results

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LS-DYNA user input
Time = 7.35
Contours of Effective Stress (v-m)
max ipt. value
 min=0, at elem# 188067
 max=410.868, at elem# 297923

Fringe Levels

3.500e+02
3.150e+02
2.800e+02
2.450e+02
2.100e+02
1.750e+02
1.400e+02
1.050e+02
7.000e+01
3.500e+01
0.000e+00

Stress distribution in the middle joint

Nonlinear analysis - results

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No. of storeys:
A 1 storey
B 2 storeys
C 4 storeys

Reaction forces history in the middle column for variable number of storey (6m span)

No. of storeys:
A 1 storey
B 2 storeys
C 4 storeys

Nondimensional reaction forces history in the middle column for variable number of storey (6m span)

Nonlinear analysis - results

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LS-DYNA user input
Time =   0
Contours of Effective Stress (v-m)
max ipt. value
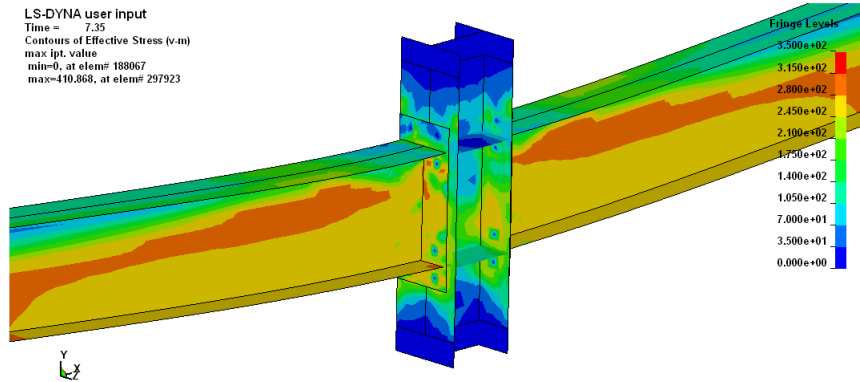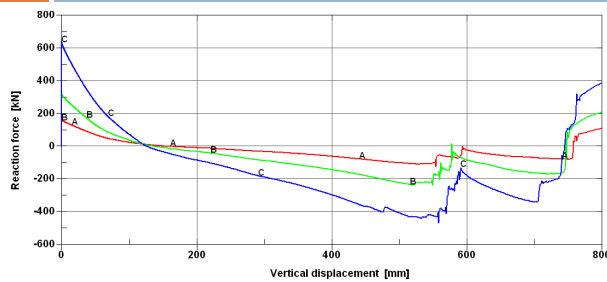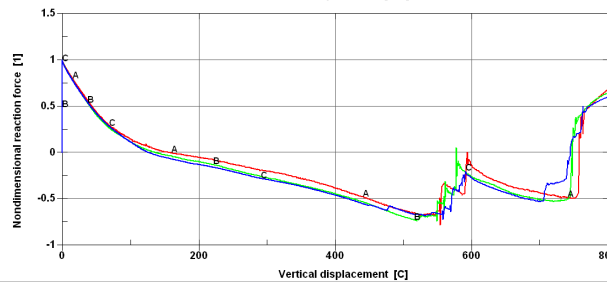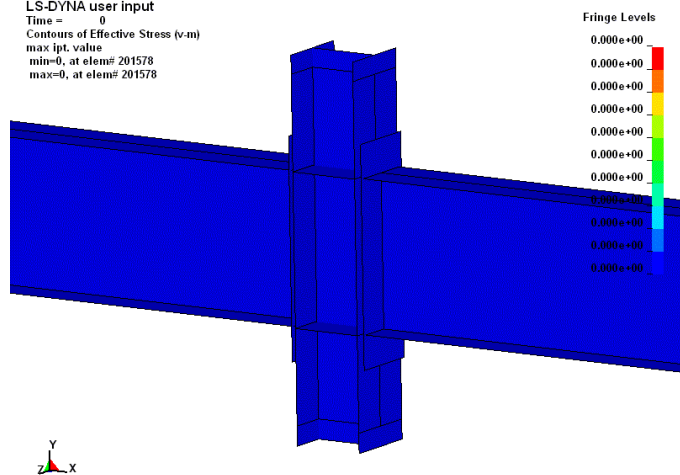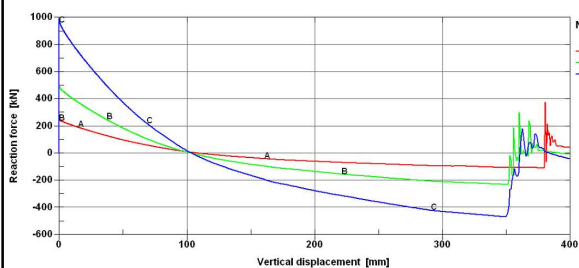 min=0, at elem# 201578
 max=0, at elem# 201578

Fringe Levels
0.000e+00
0.000e+00
0.000e+00
0.000e+00
0.000e+00
0.000e+00
0.000e+00
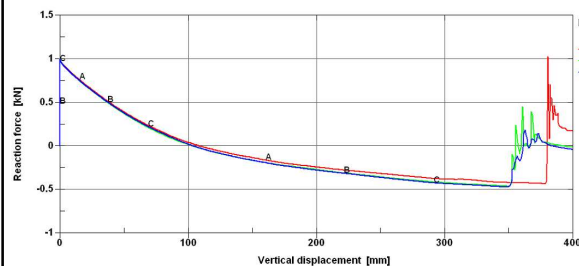0.000e+00
0.000e+00
0.000e+00

Nonlinear analysis - results

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Reaction forces history in the middle column for variable number of storey (9m span)

Nondimensional reaction forces history in the middle column for variable number of storey (9m span).

Conclusions

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- Static linear analysis suggests that the Vierendeel effect has significant influence on the behavior of the structural system
- Static linear analysis gives overestimated catenary actions
- Detailed nonlinear analysis shows smaller influence of Vierendeel effect
- Comparison between 6 m span and 9 m span models suggests that the Vierendeel effect depends on the span of the structural system

Acknowledgement

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Thank you for your attention!