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PROGRESSIVE COLLAPSE OF PRECAST REINFORCED CONCRETE STRUCTURES

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ICITECH CIENCIA Y TECNOLOGÍA DEL HORMIGÓN

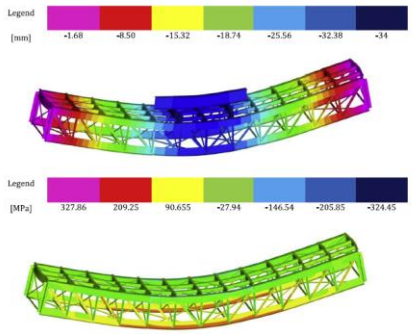
BUILDING RESILIENT

SEI ASCE STRUCTURAL ENGINEERING INSTITUTE

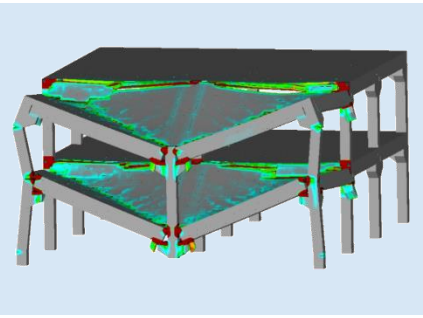
RESEARCH AT BUILDING RESILIENT

BUILDING RESILIENT

Structural assessment



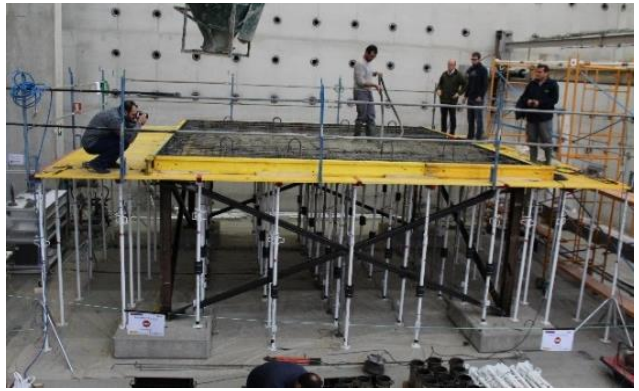
Structural robustness



ICITECH LAB

ICITECH
CIENCIA Y TECNOLOGÍA DEL HORMIGÓN

- 35 × 15 m^2 strong floor
- L-shaped reaction wall with a height of 14 m



FUNDING

European Research Council

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GENERALITAT VALENCIANA

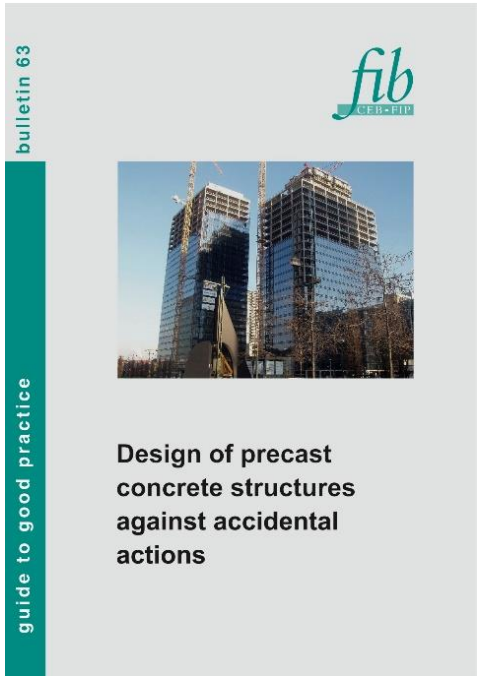
Fundación BBVA

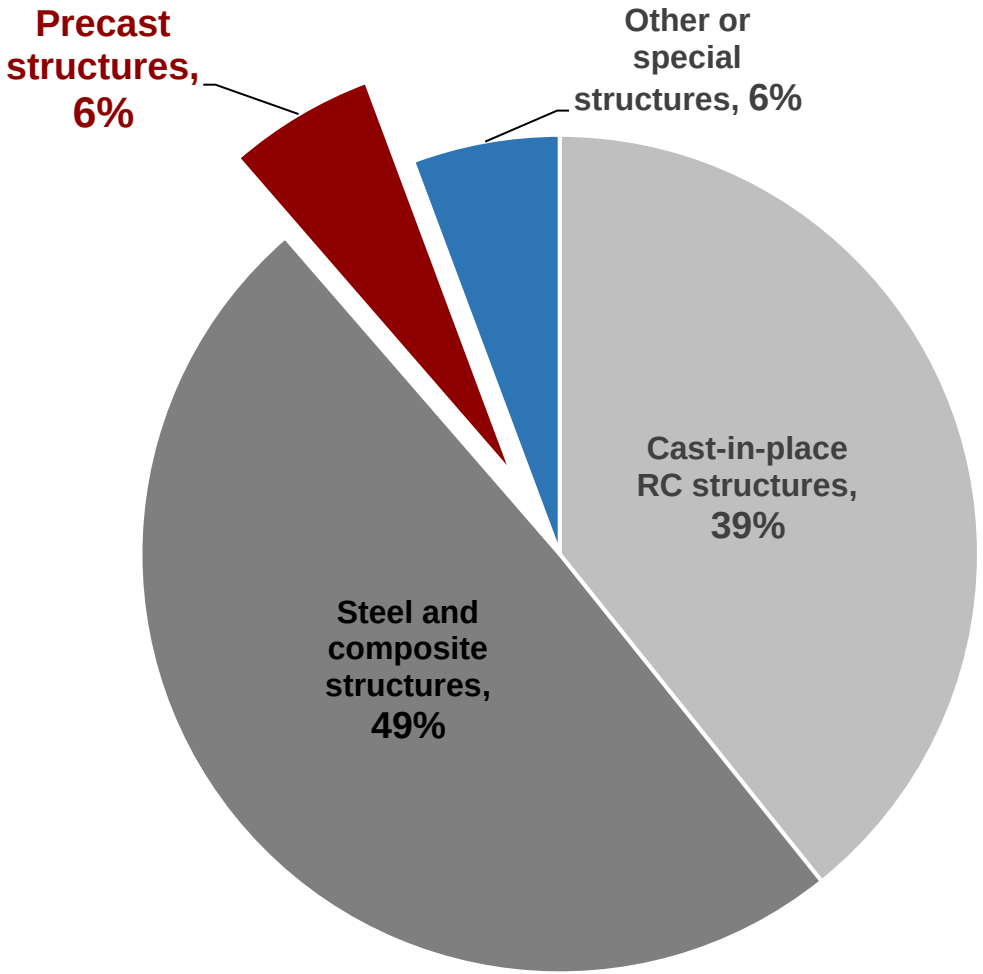
GOBIERNO DE ESPAÑA

MINISTERIO DE CIENCIA E INNOVACIÓN

BACKGROUND & MOTIVATION

MOTIVATION

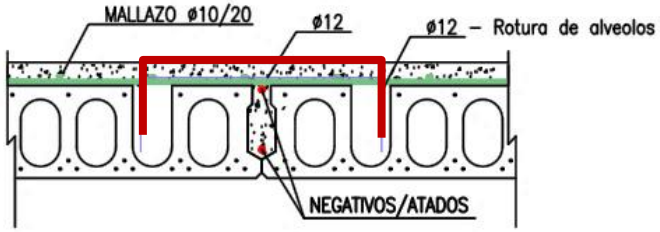




Journal articles on progressive collapse of buildings (SCOPUS, n=564)

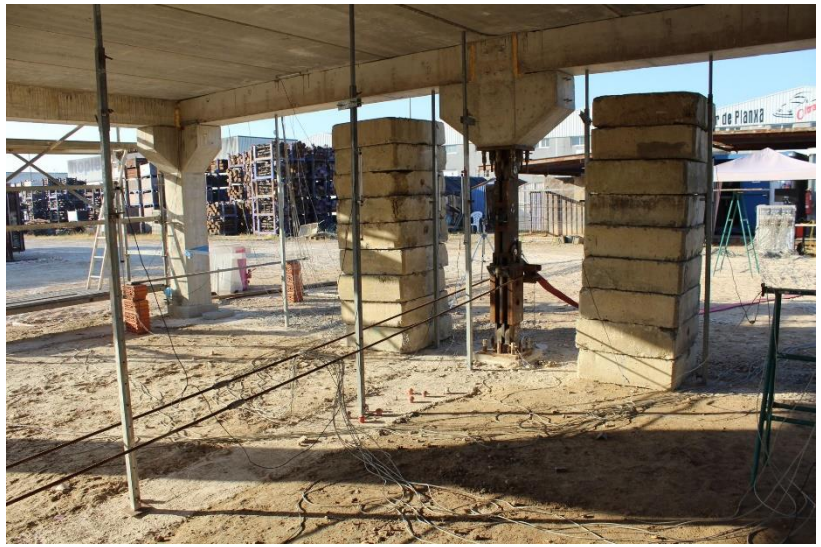
EXPERIMENTAL CAMPAIGN

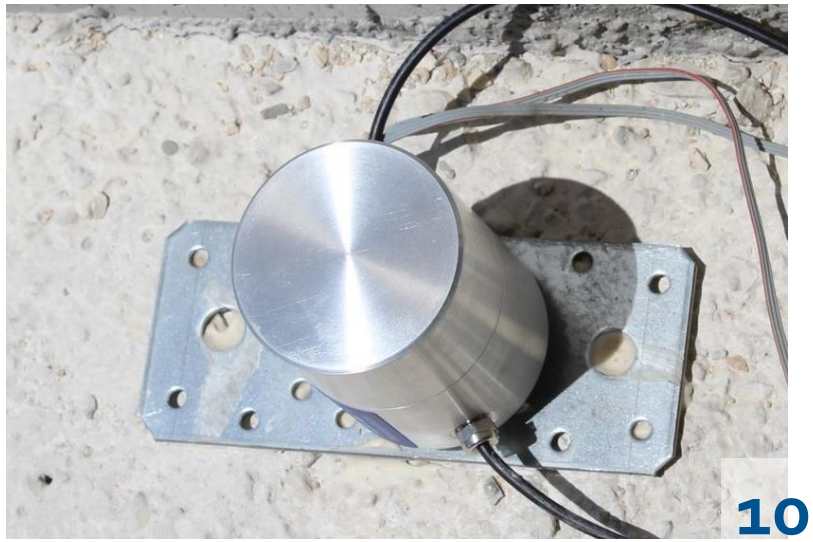
DESIGN & CONSTRUCTION



Conexión entre placas – Simbología representada en anterior plano

MONITORING

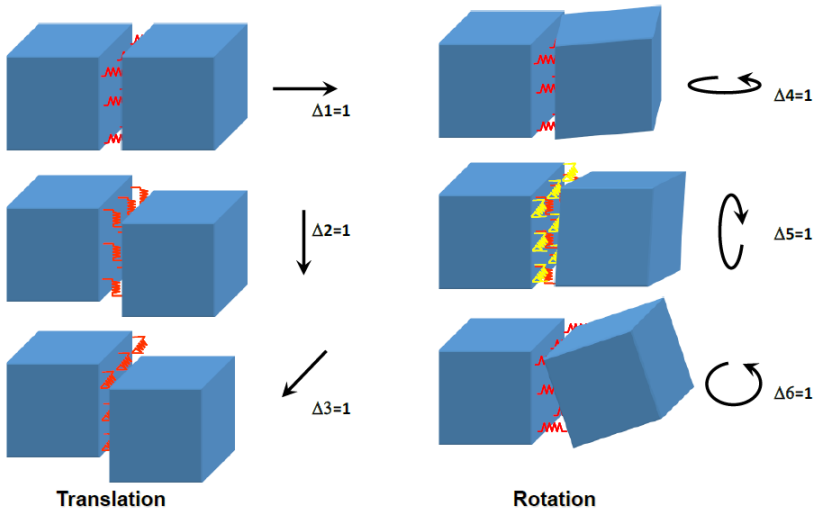


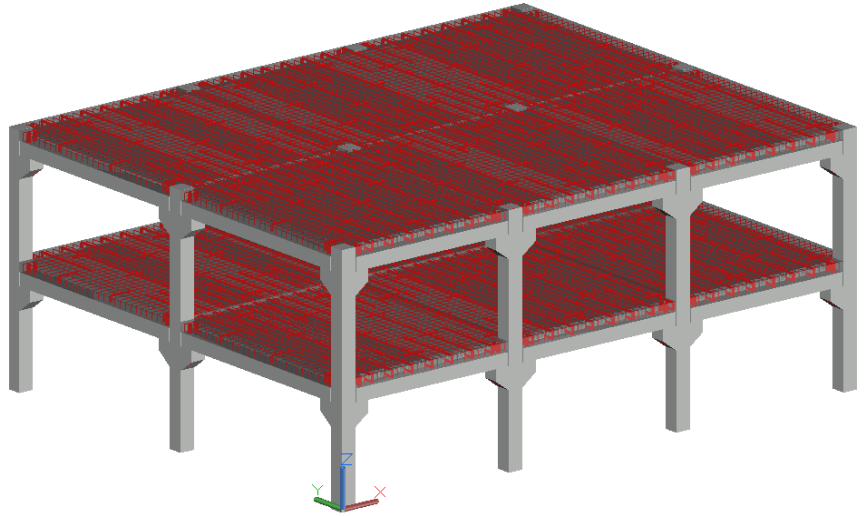


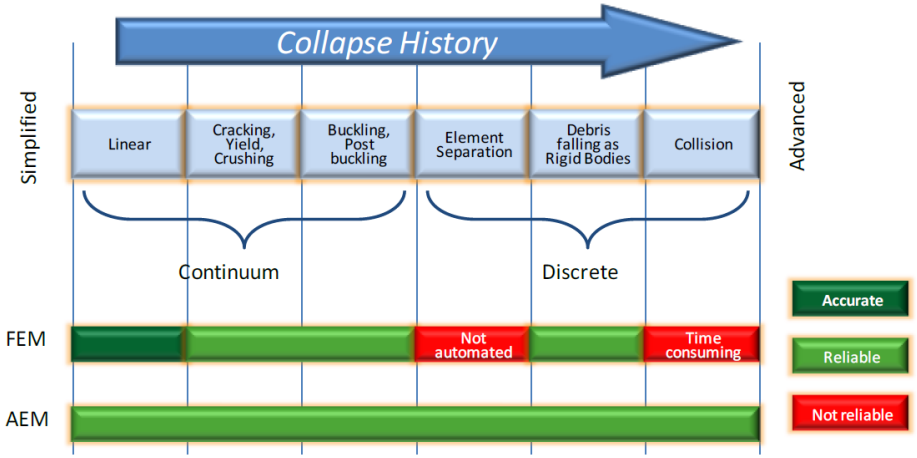
LOADING

COMPUTATIONAL MODELLING

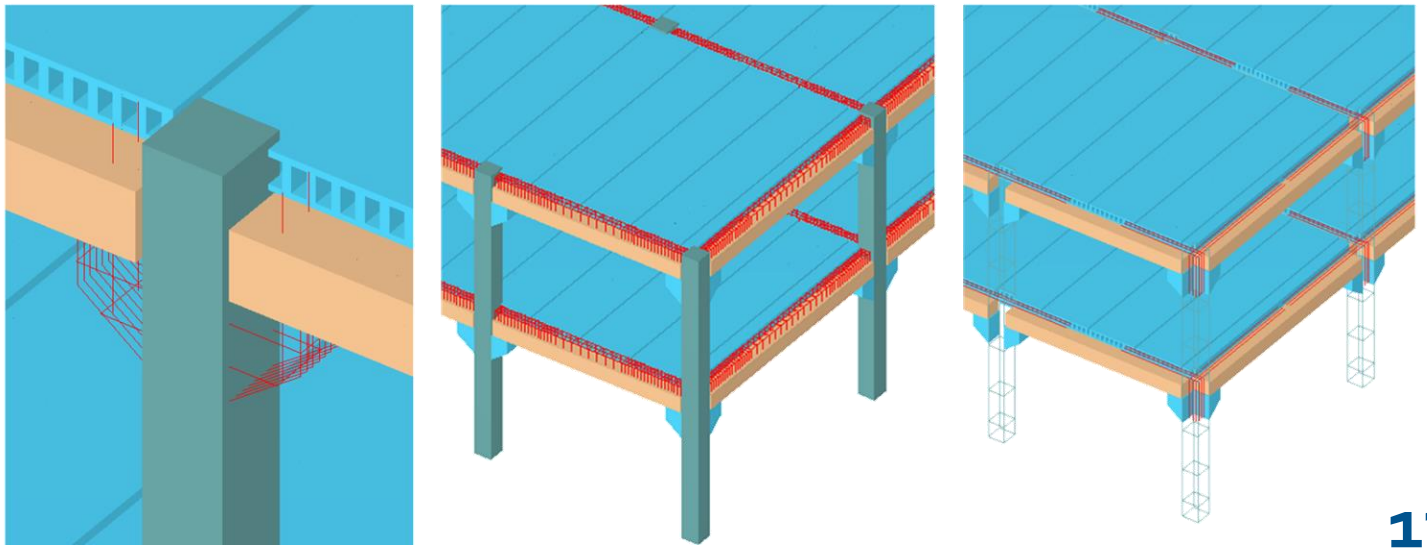
MODELLING STRATEGY



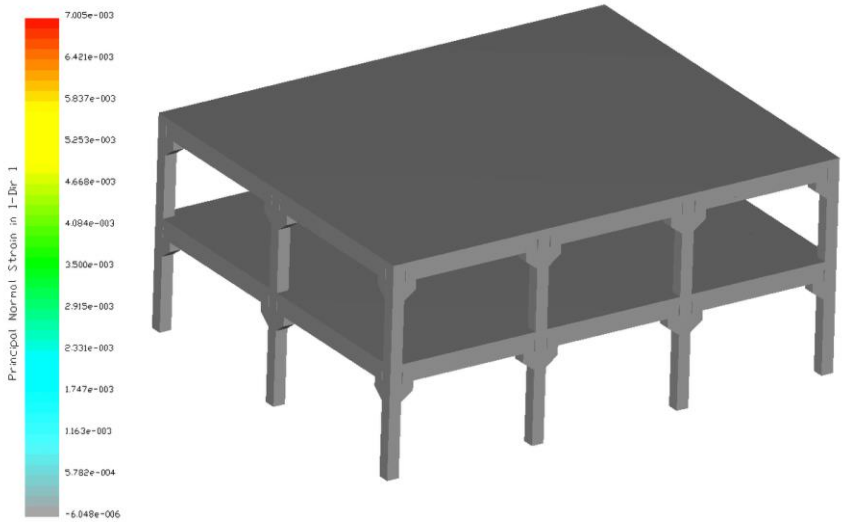


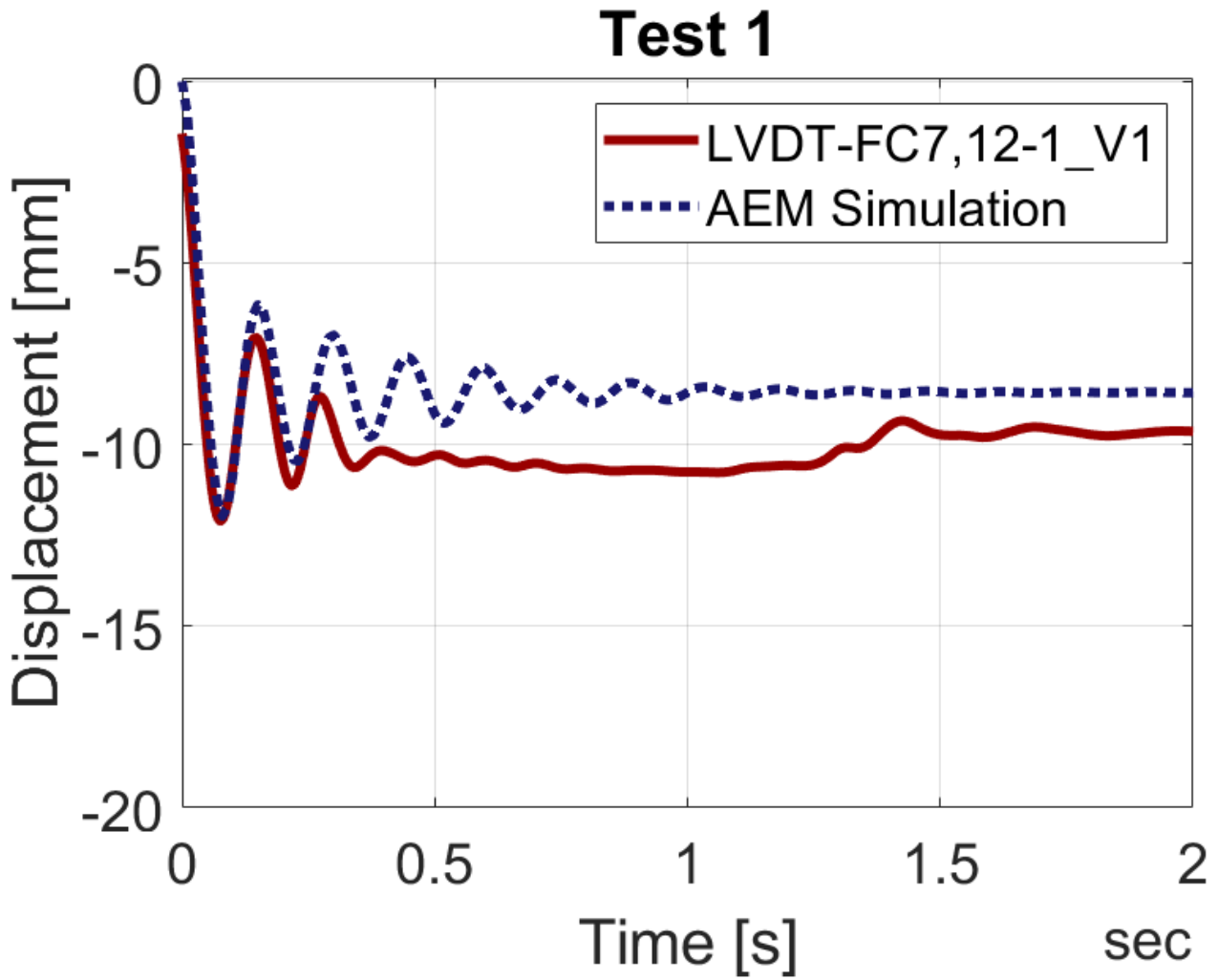


(Source: Applied Science International)

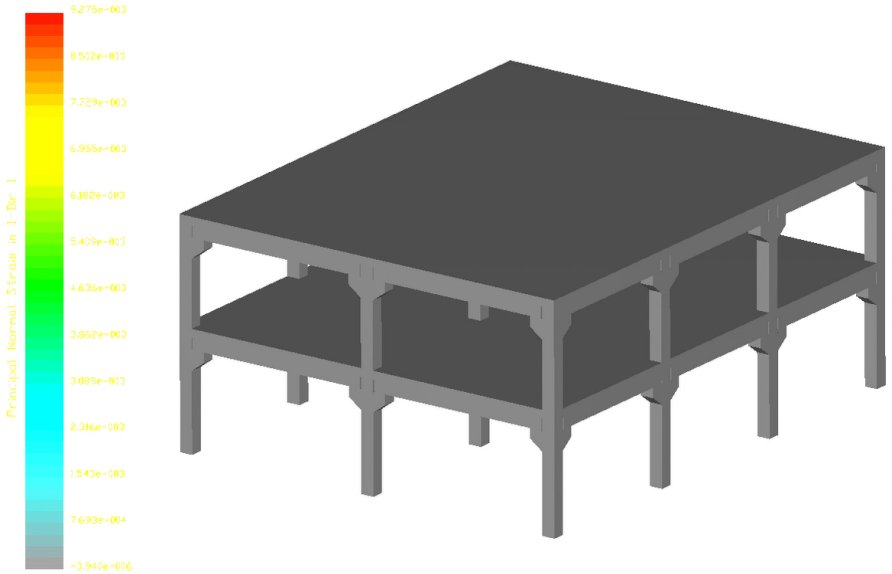


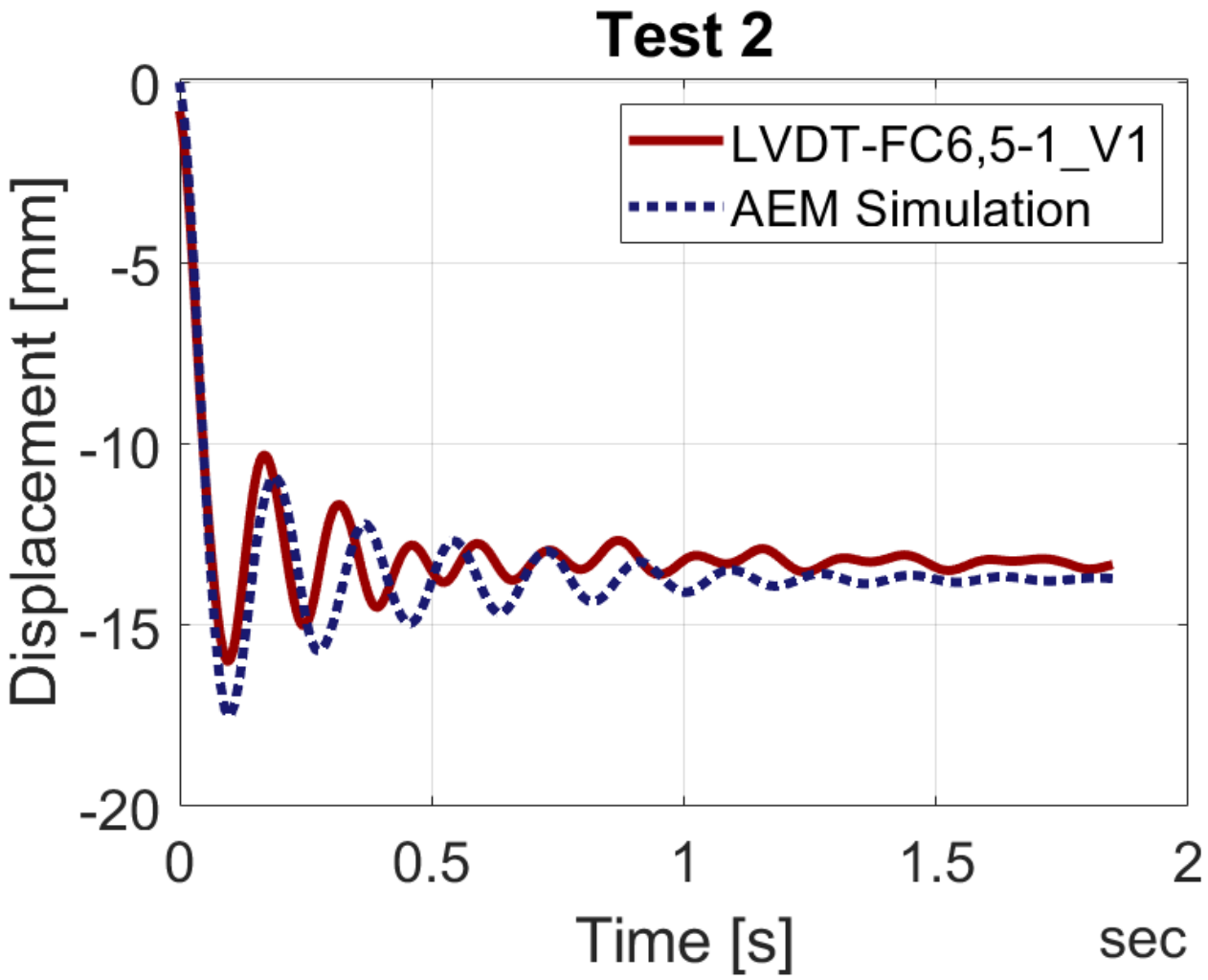
TEST 1


7.005e-003
6.421e-003
5.837e-003
5.253e-003
4.668e-003
4.084e-003
3.500e-003
2.915e-003
2.331e-003
1.747e-003
1.163e-003
5.782e-004
-6.048e-006
Princpol Normal Strain in 1-Dir 1

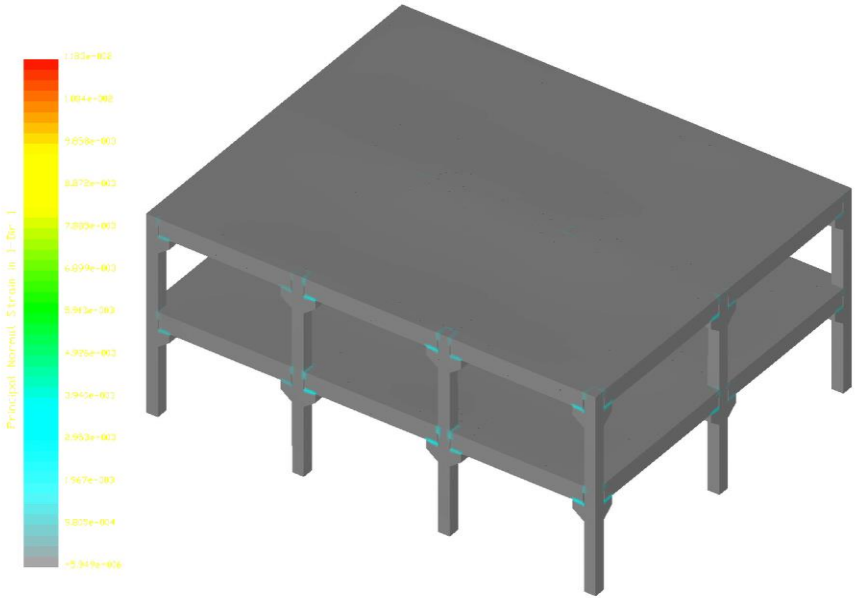

Test 1
LVDT-FC7,12-1_V1
AEM Simulation
Displacement [mm]
0
-5
-10
-15
-20
0
0.5
1
1.5
2
Time [s]
sec

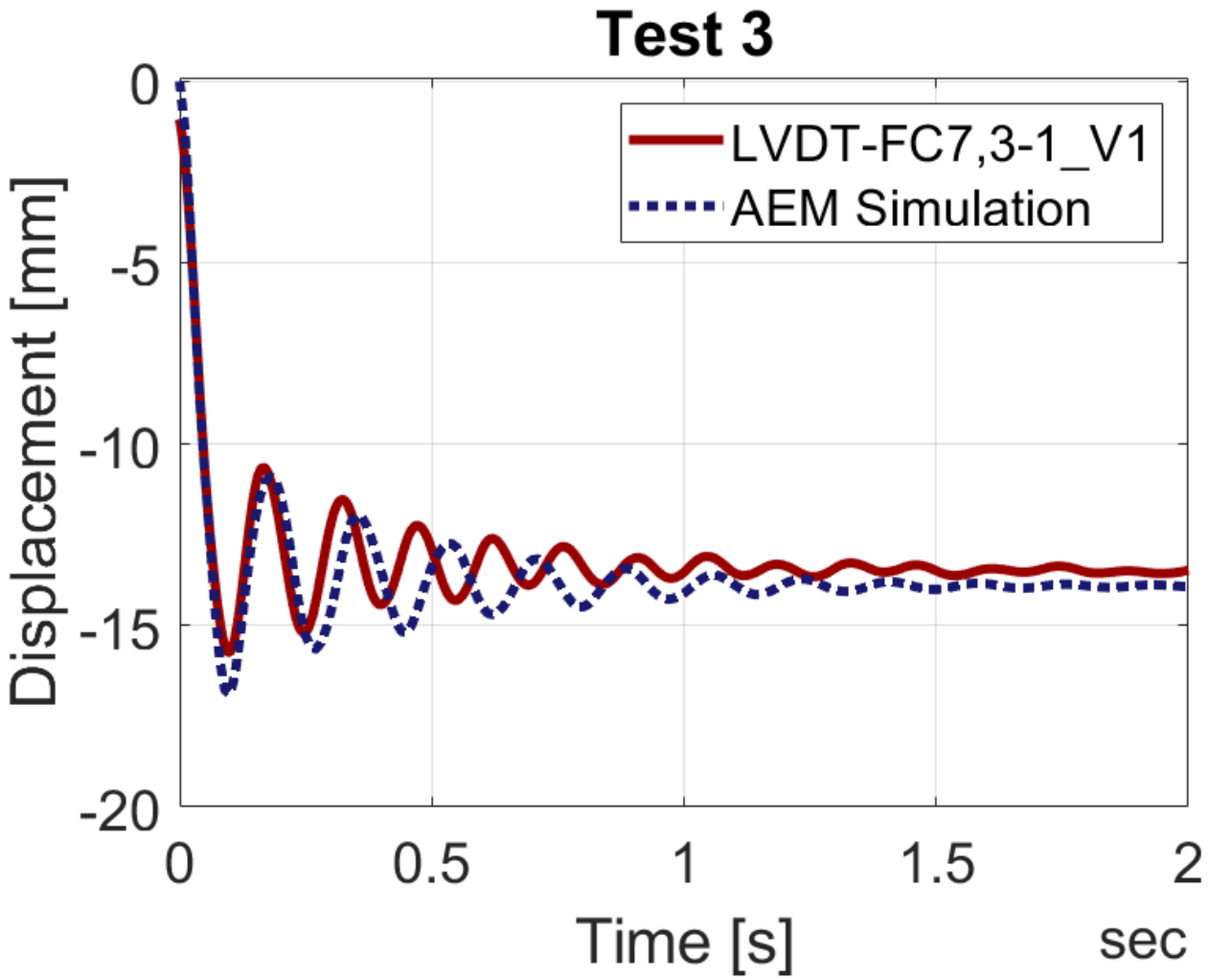
TEST 2




Test 2
LVDT-FC6,5-1_V1
AEM Simulation
Displacement [mm]
0
-5
-10
-15
-20
0
0.5
1
1.5
2
Time [s]
sec

TEST 3



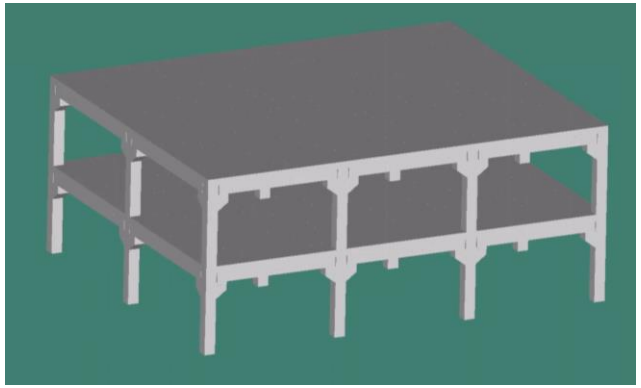

Test 3
LVDT-FC7,3-1_V1
AEM Simulation
Displacement [mm]
0
-5
-10
-15
-20
0
0.5
1
1.5
2
Time [s]
sec

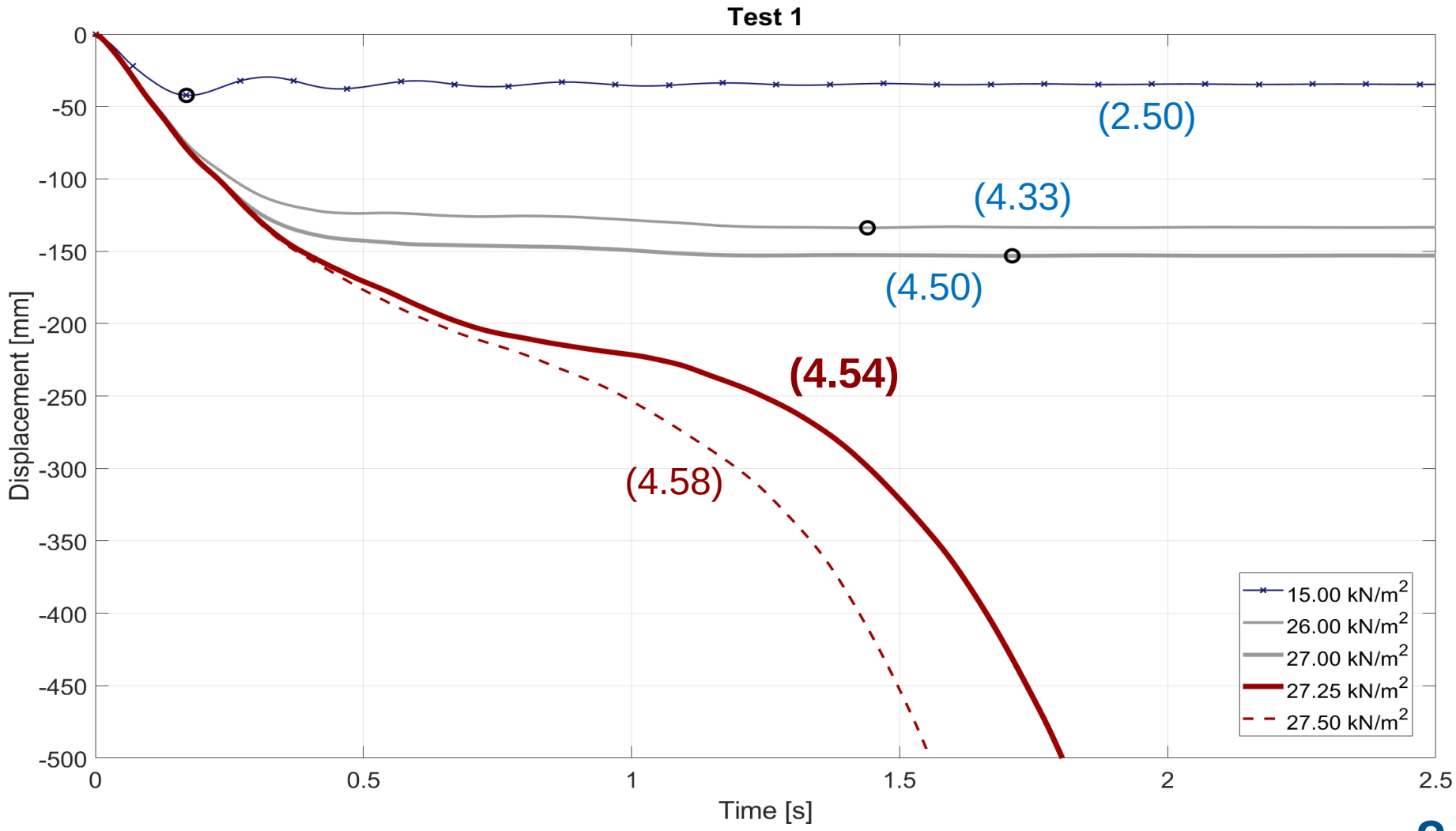
NUMERICAL STUDY OF COLLAPSE

TEST 1

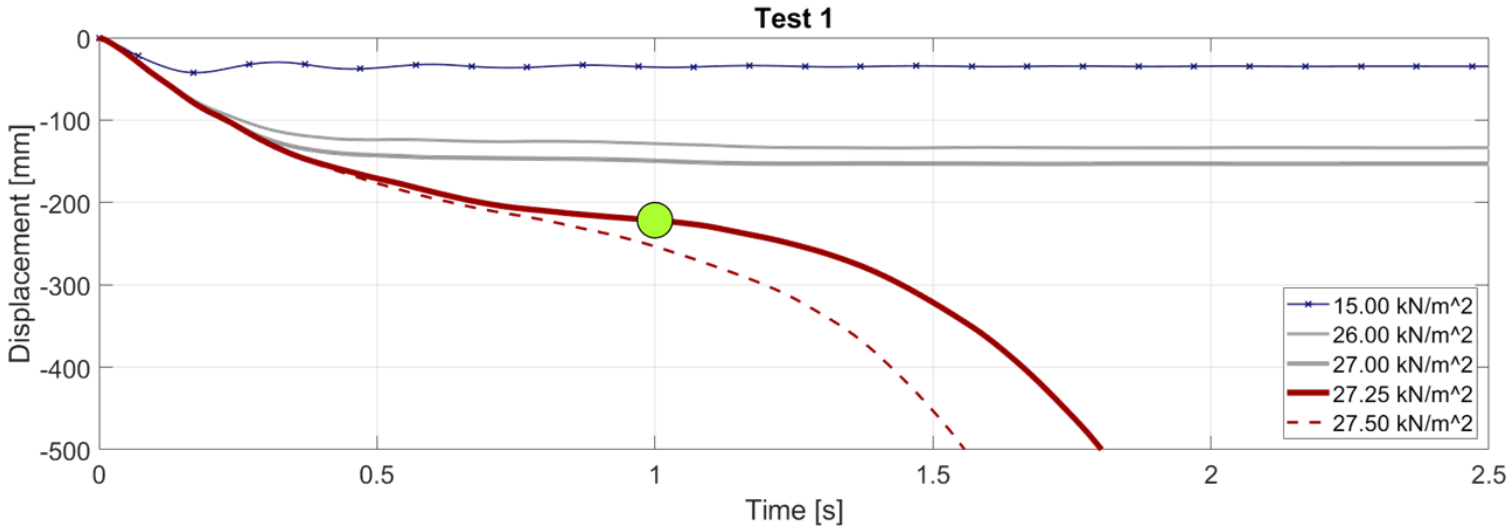
Load combination for accidental design situations:
6 kN/m²

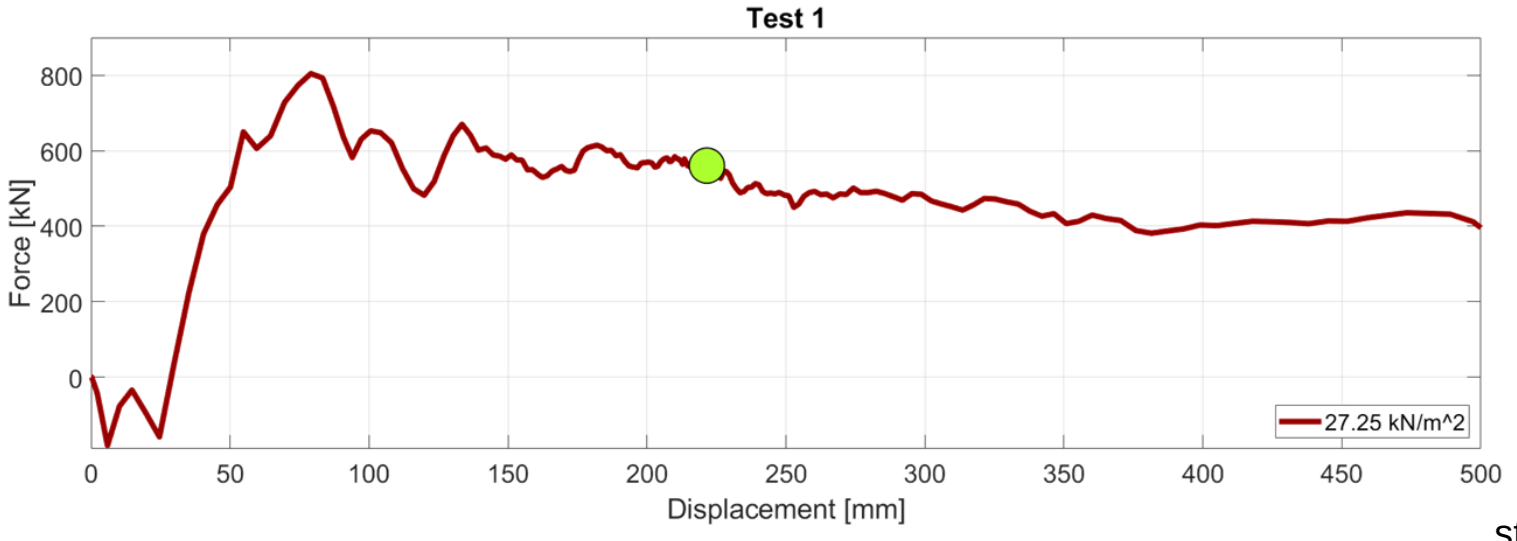
Collapse load:
27.25 kN/m²





TEST 1

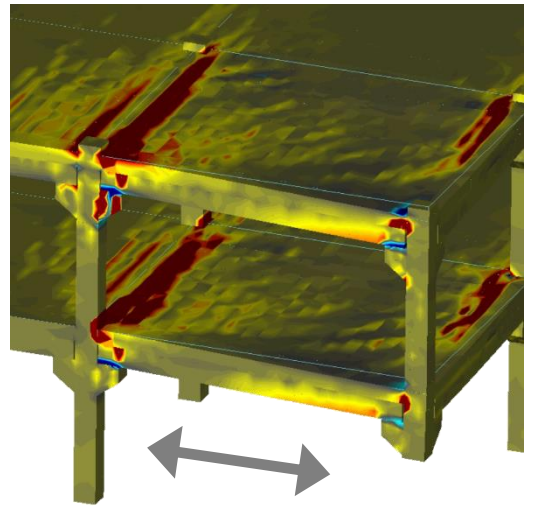


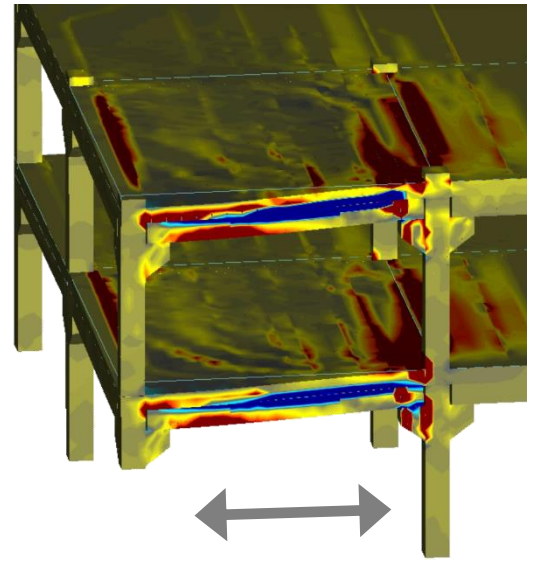


Yield strain of steel

Normal Strain

Peak compressive strain of concrete

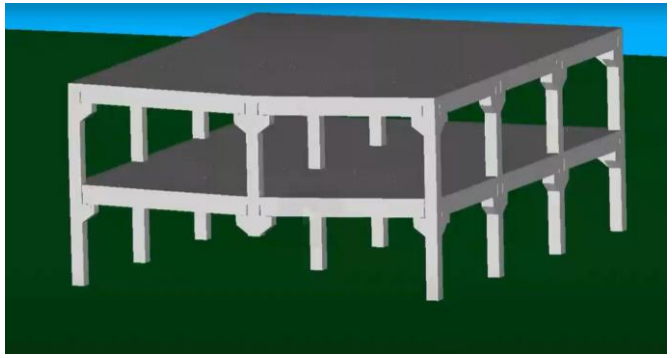


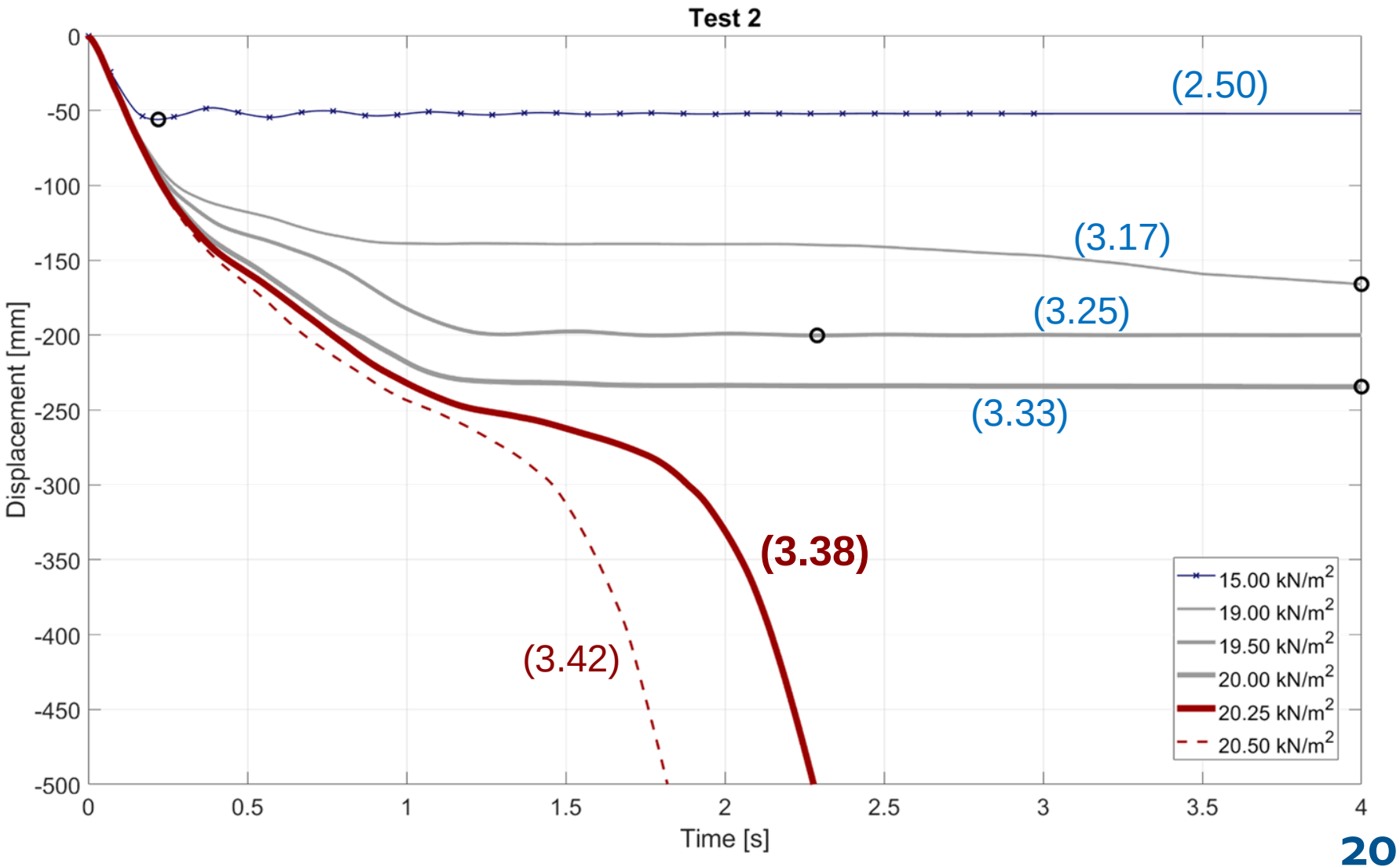


TEST 2

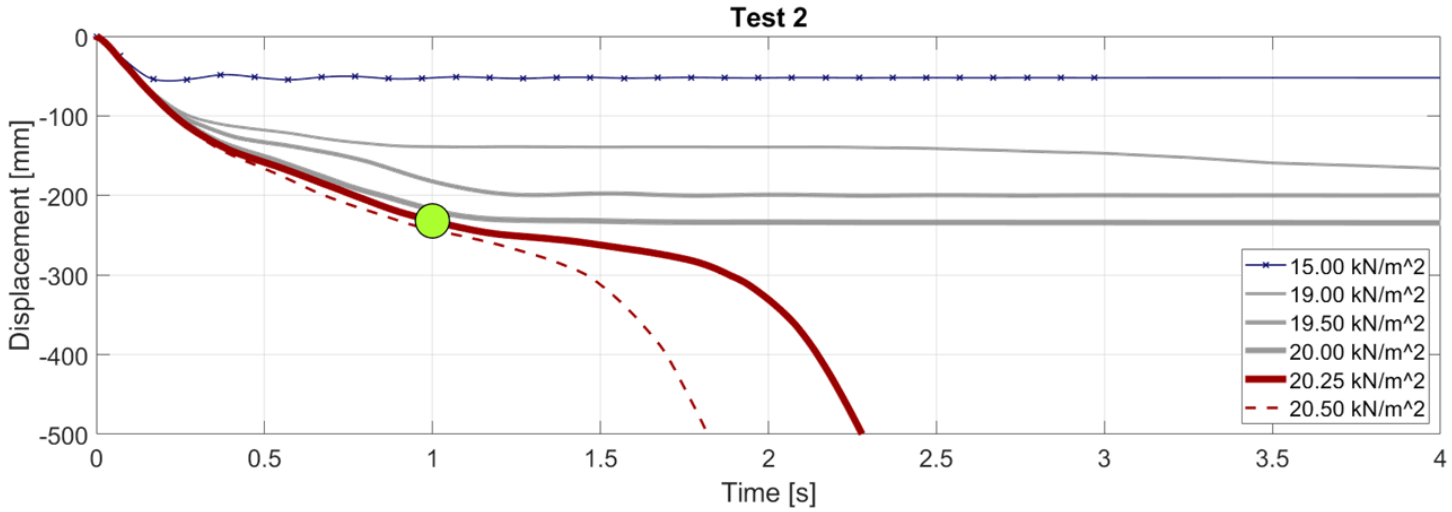
Load combination for accidental design situations:
6 kN/m²

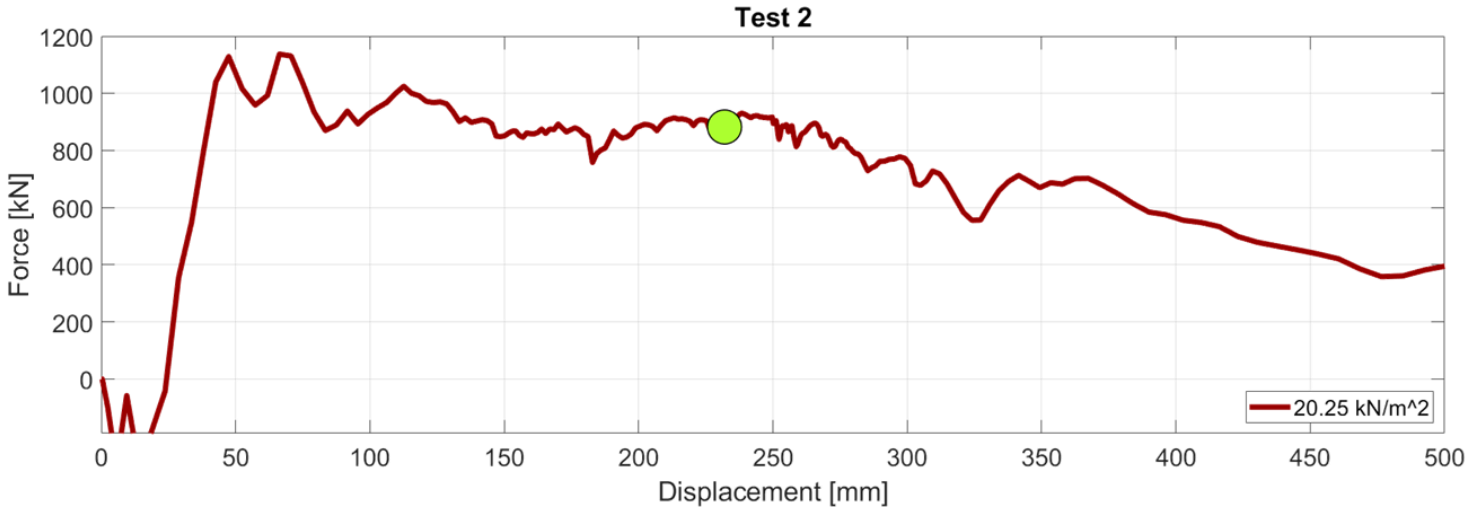
Collapse load:
20.25 kN/m²

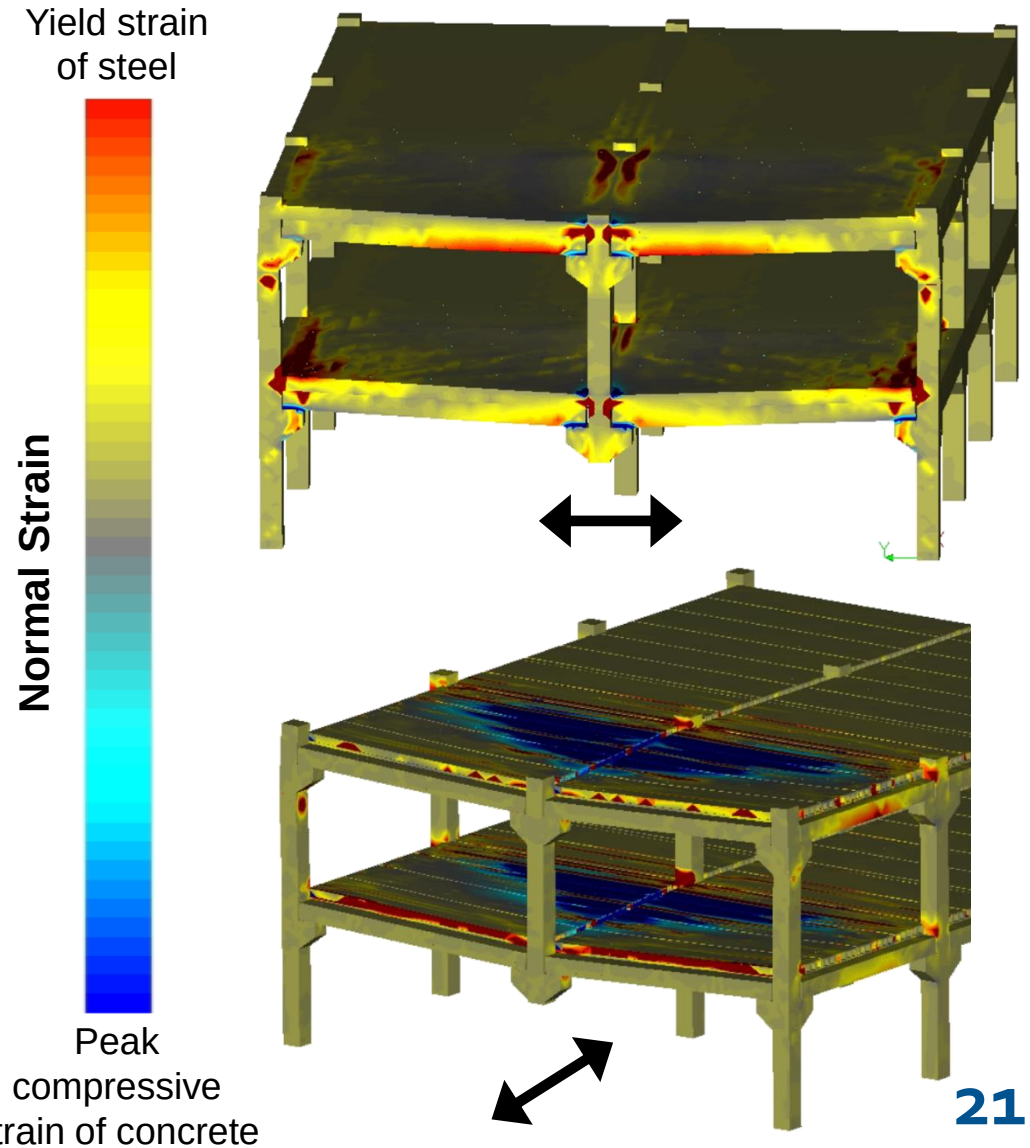




TEST 2


Test 2
Displacement [mm]
Time [s]
0
-100
-200
-300
-400
-500
0
0.5
1
1.5
2
2.5
3
3.5
4
15.00 kN/m^2
19.00 kN/m^2
19.50 kN/m^2
20.00 kN/m^2
20.25 kN/m^2
20.50 kN/m^2

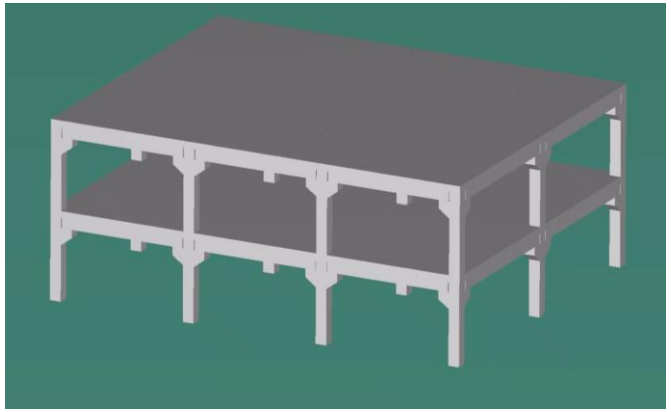

Test 2
Force [kN]
Displacement [mm]
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
350
400
450
500
20.25 kN/m^2

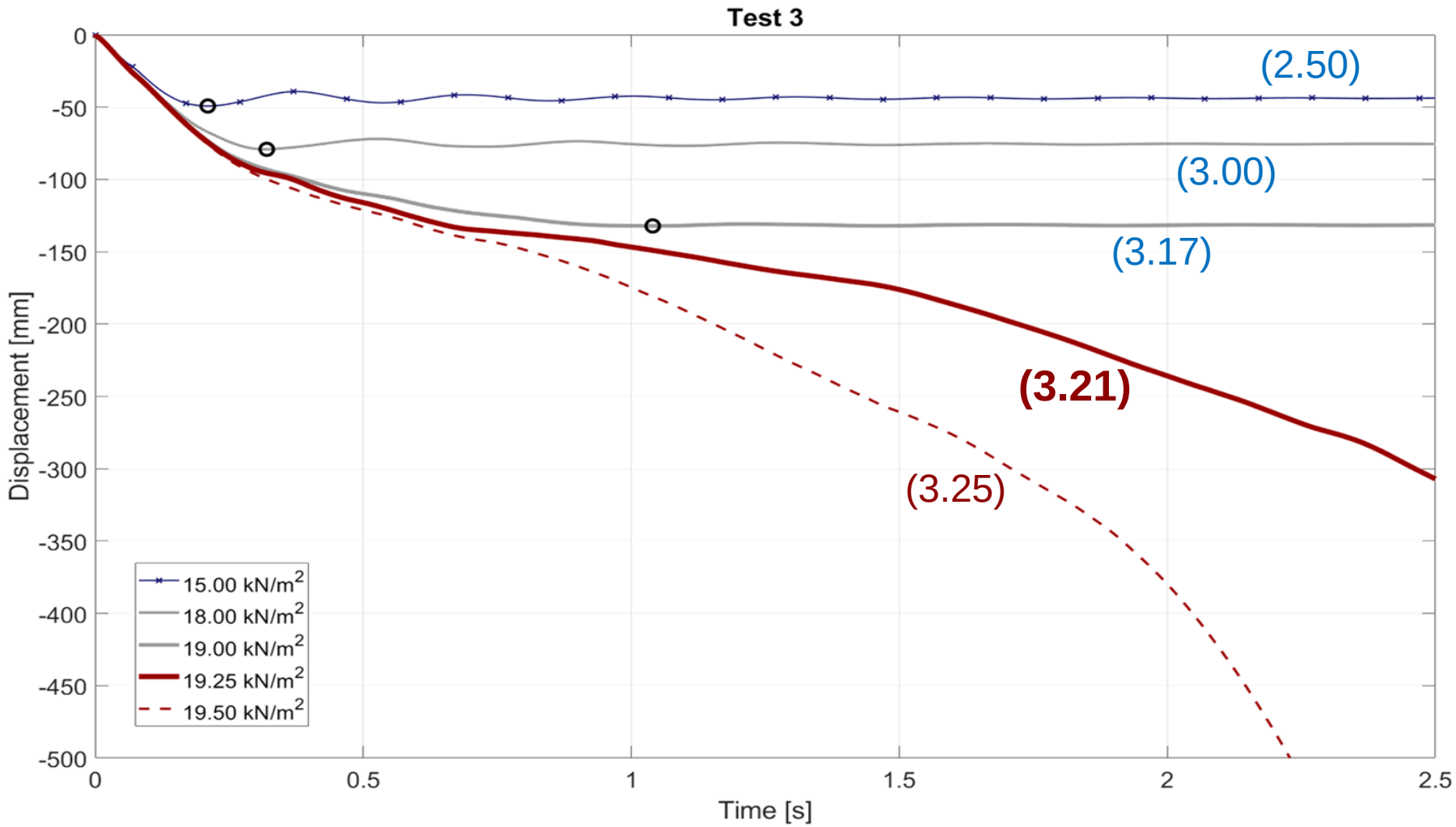

Yield strain of steel
Normal Strain
Peak compressive strain of concrete

TEST 3

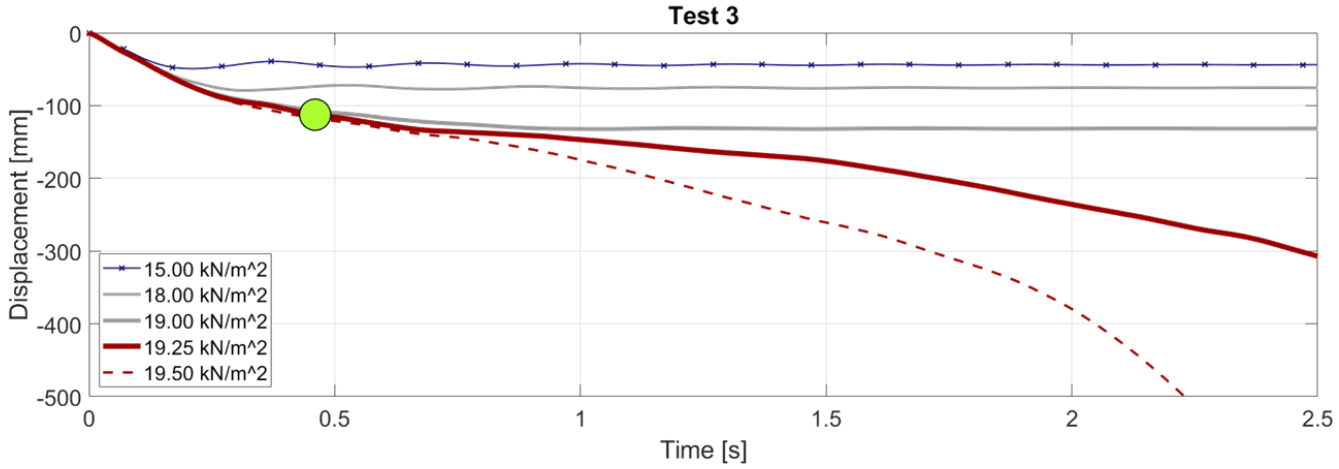
Load combination for accidental design situations:
6 kN/m²

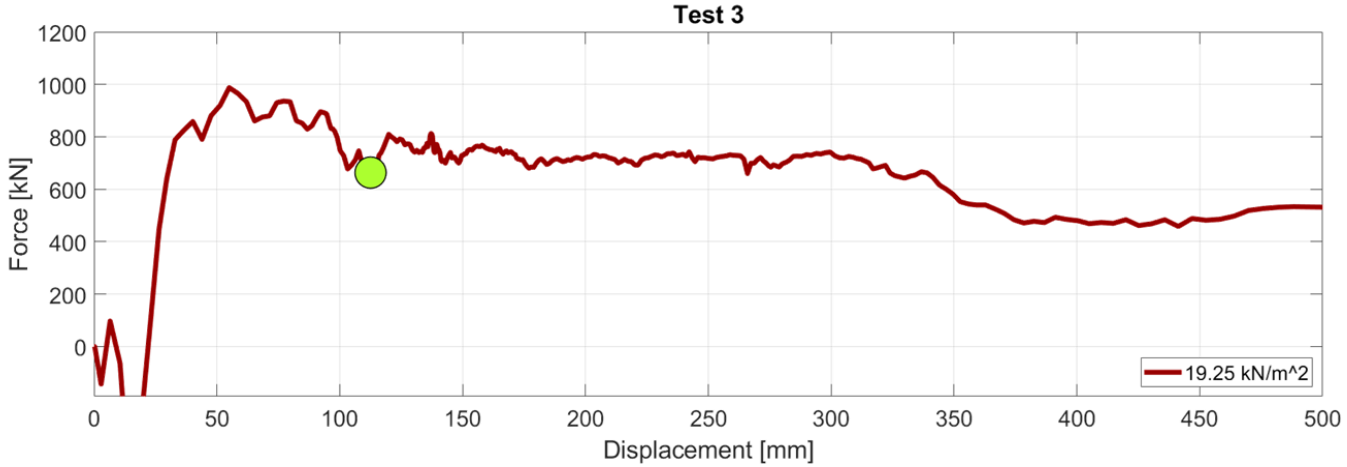
Collapse load:
19.25 kN/m²

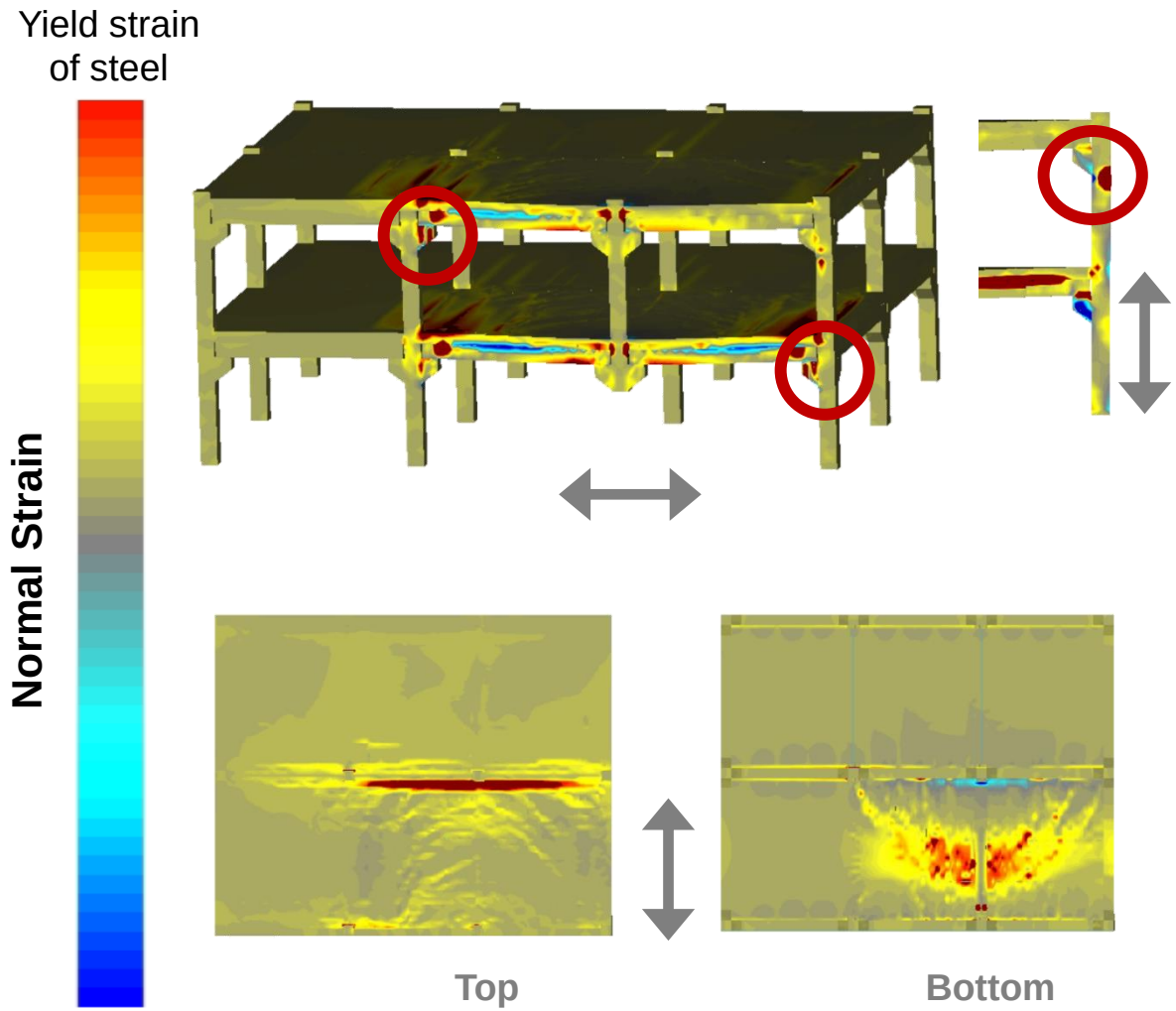




TEST 3


Test 3
Displacement [mm]
Time [s]
15.00 kN/m^2
18.00 kN/m^2
19.00 kN/m^2
19.25 kN/m^2
19.50 kN/m^2

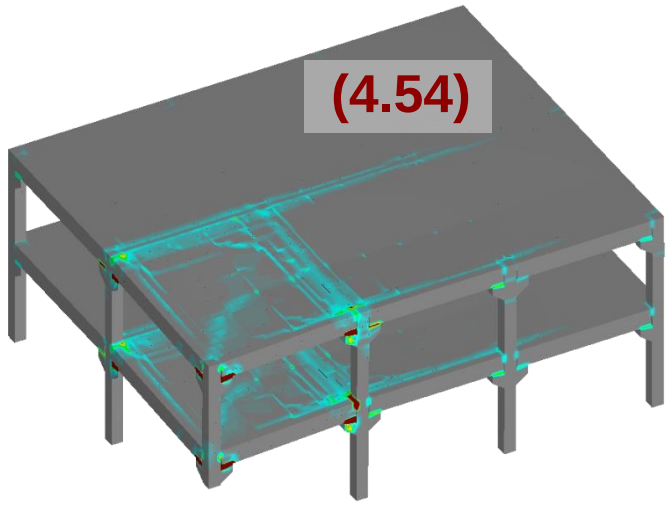

Test 3
Force [kN]
Displacement [mm]
19.25 kN/m^2

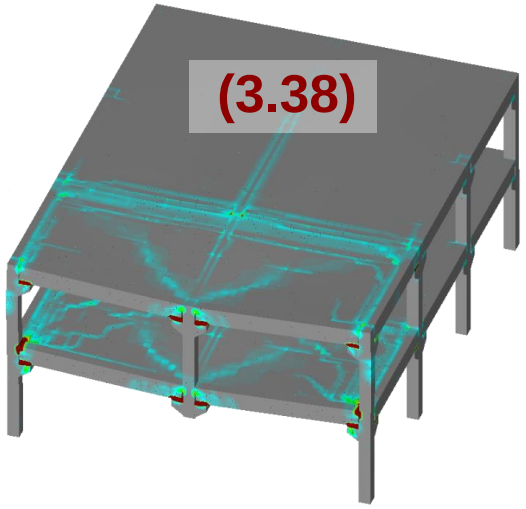

Yield strain of steel
Normal Strain
Peak compressive strain of concrete
Top
Bottom

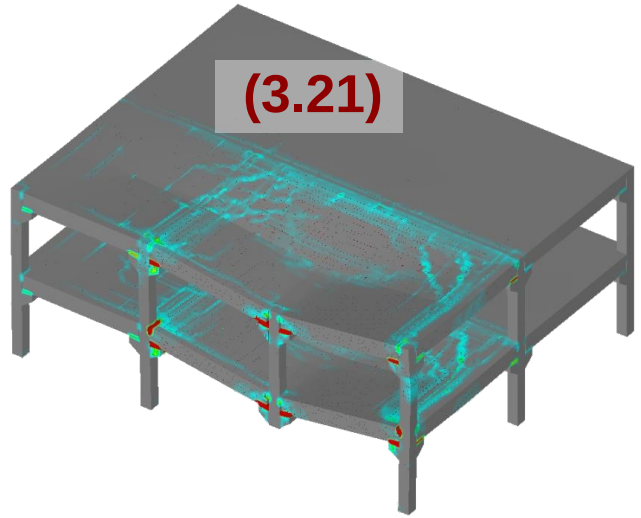
CONCLUSIONS

CONCLUSIONS

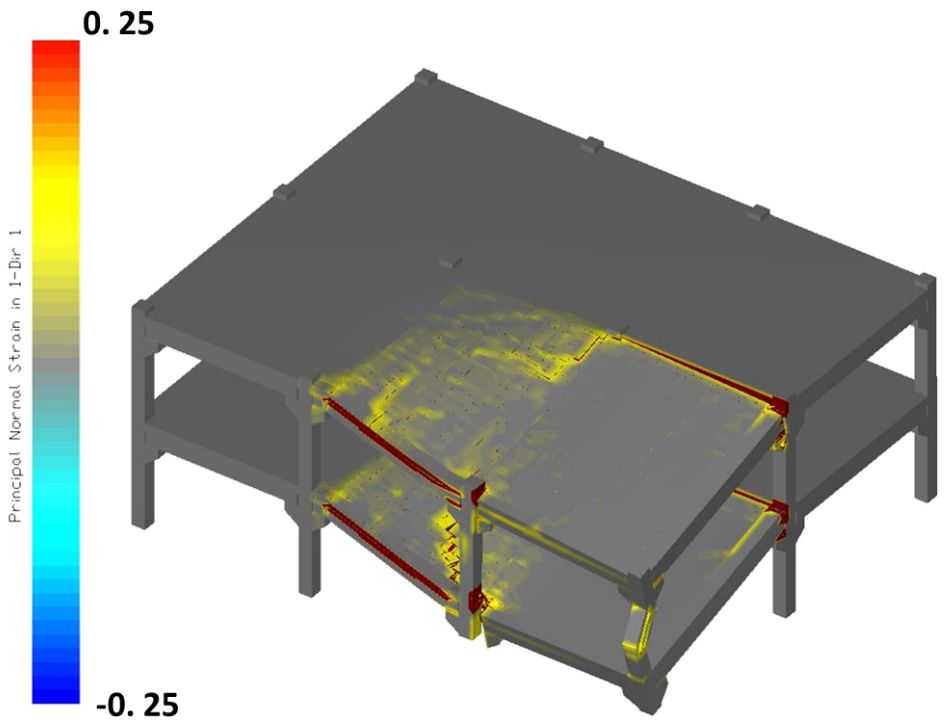
- **Simple solutions** can enhance structural robustness of precast concrete structures.
- Simulations using the applied element method can be an effective tool for evaluating progressive collapse resistance.
- For the column loss scenarios investigated, catenary action does not contribute to greater collapse resistance.
- It is important to consider **system behaviour** when performing progressive collapse design.

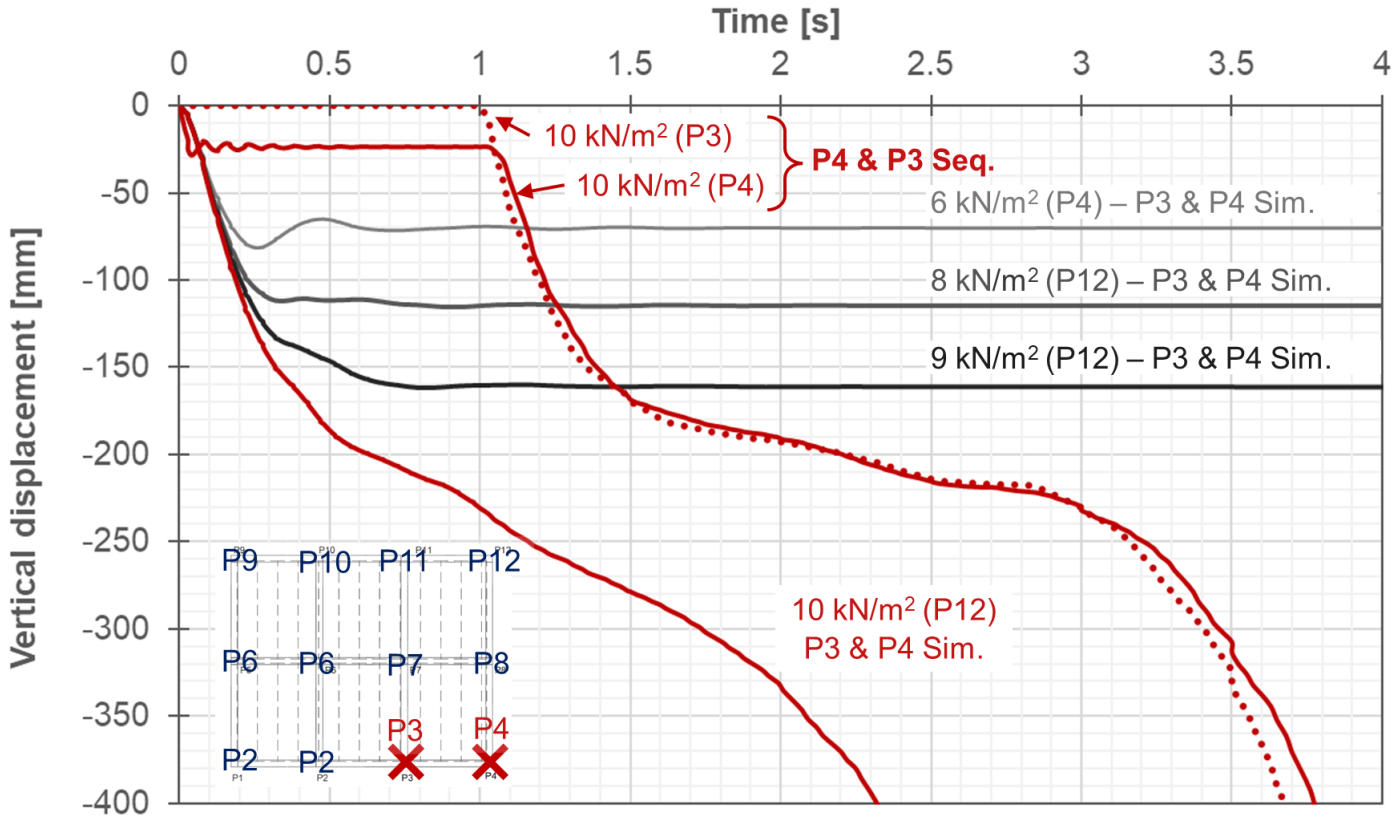






FUTURE WORK


0. 25
Principal Normal Strain in 1-Dir 1
-0. 25


Time [s]
0
0.5
1
1.5
2
2.5
3
3.5
4
Vertical displacement [mm]
0
-50
-100
-150
-200
-250
-300
-350
-400
10 kN/m² (P3)
10 kN/m² (P4)
P4 & P3 Seq.
6 kN/m² (P4) – P3 & P4 Sim.
8 kN/m² (P12) – P3 & P4 Sim.
9 kN/m² (P12) – P3 & P4 Sim.
10 kN/m² (P12)
P3 & P4 Sim.
P9
P10
P11
P12
P6
P6
P7
P8
P2
P2
P3
P4

ACKNOWLEDGEMENTS

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Thank you

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https://b-resilient.webs.upv.es/