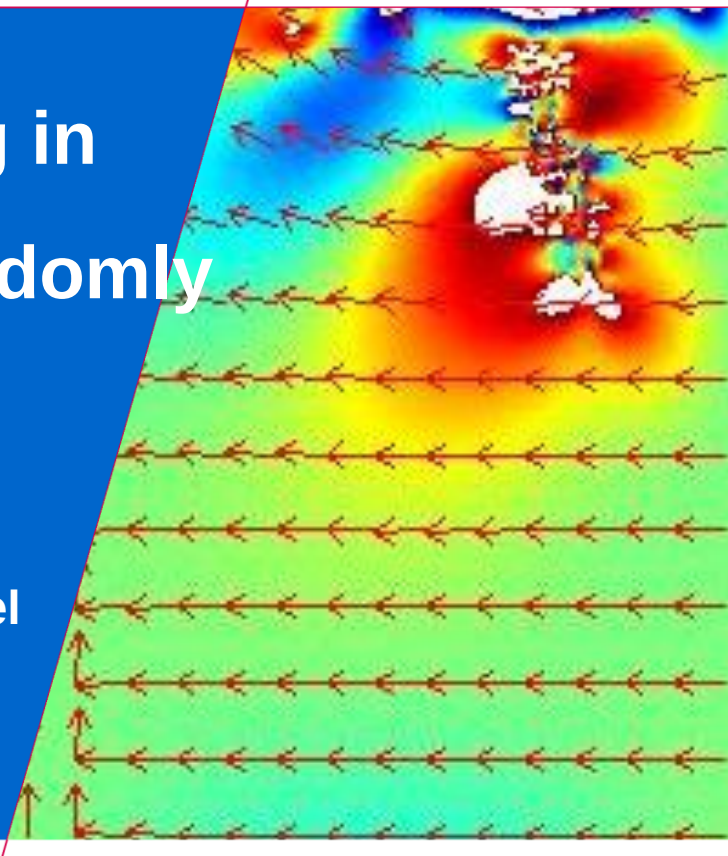
COMSOL CONFERENCE ROTTERDAM2013

Comsol Simulations of Cracking in Point Loaded Masonry with Randomly Distributed Material Properties



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Technische Universiteit Eindhoven University of Technology

Where innovation starts

Calcium silicate, a type of artificial stone, when loaded in compression fails in tension.

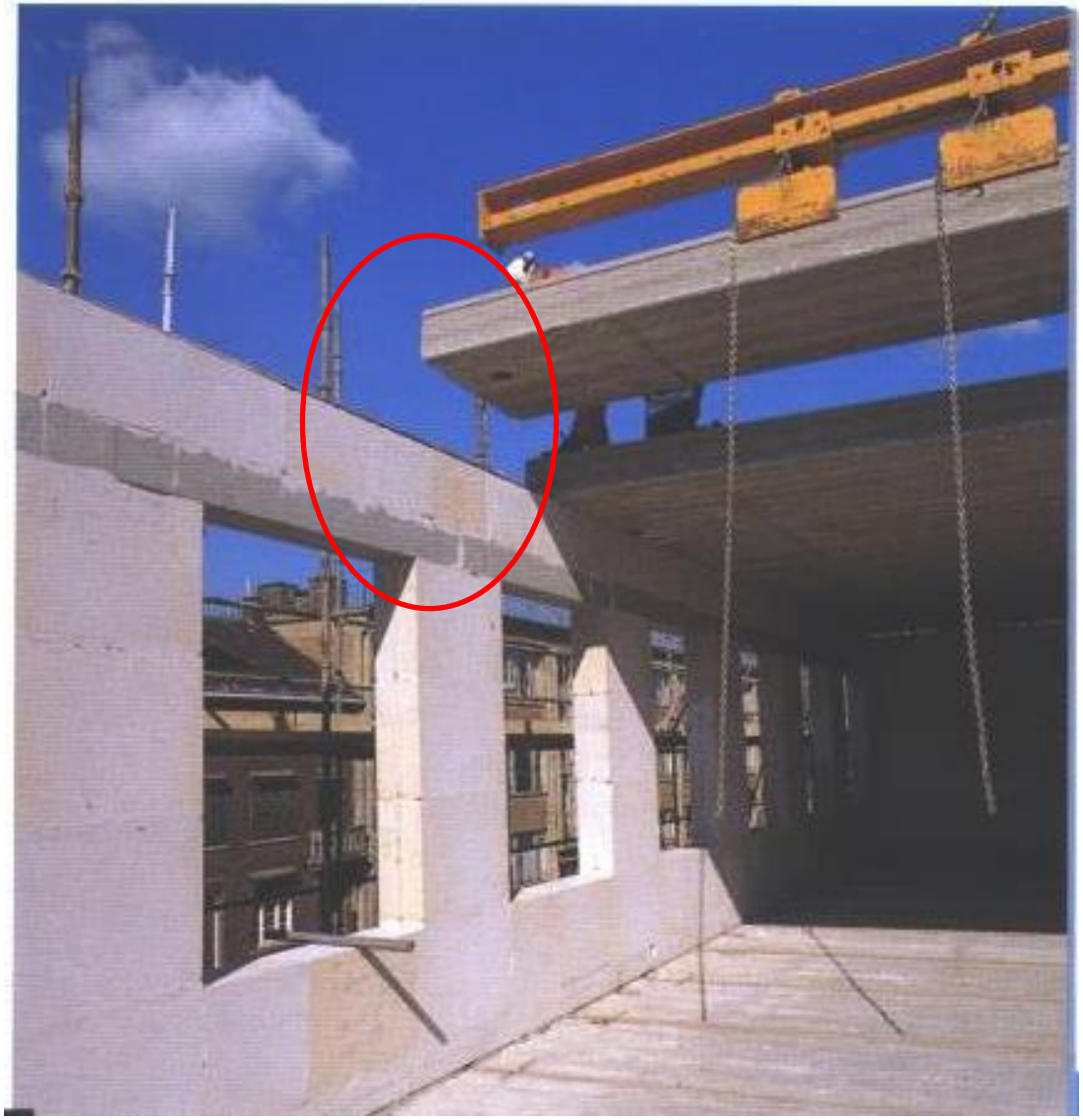
- Building with Calcium silicate Elements
- Tensile properties
- The problem: centre strip to support floors
- Two Strategies used to simulate behaviour:
  SLA & CSS Step function
- Random assigned material properties

Sequential linear elastic modeling & Continuos stress strain model

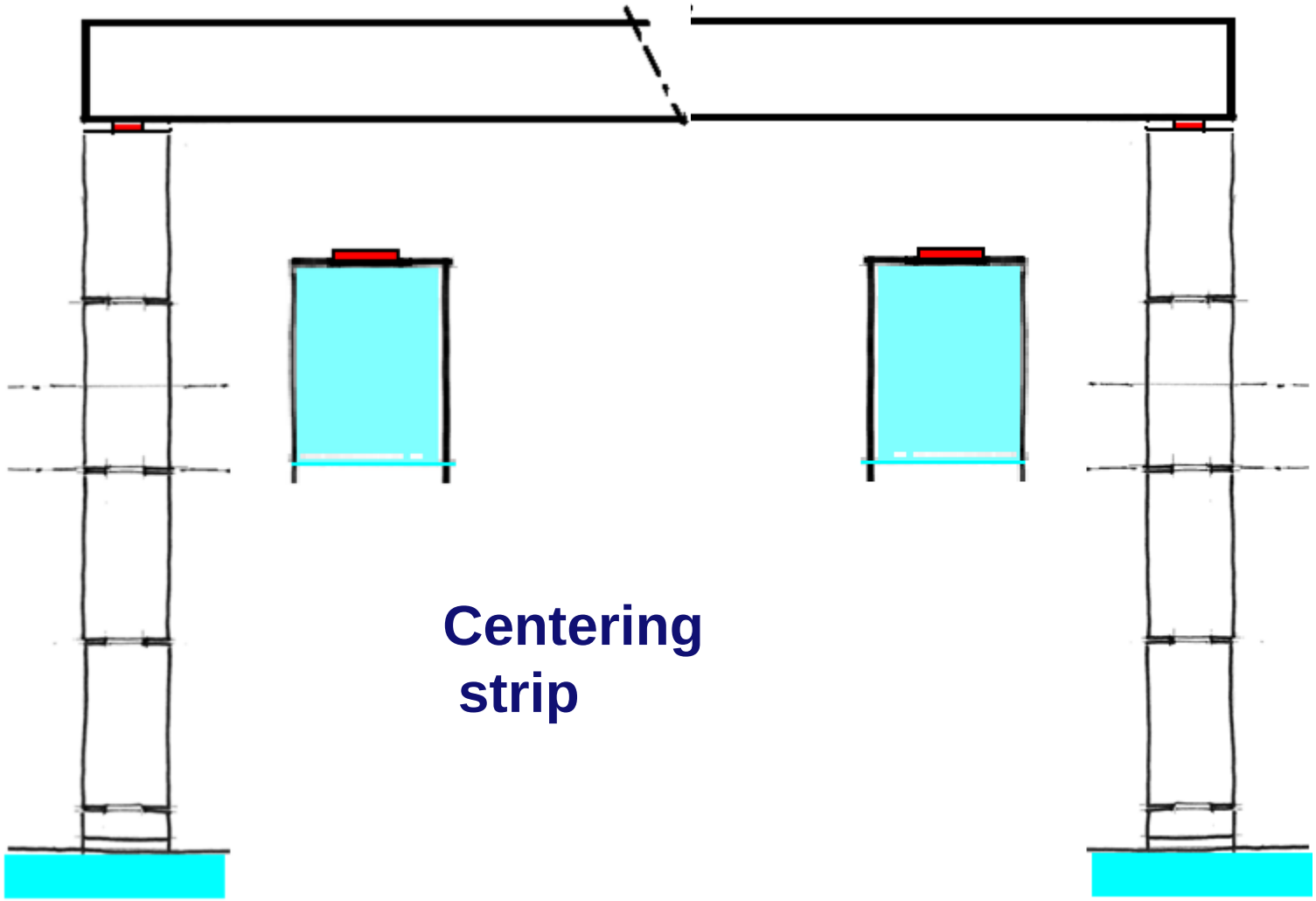
Building with Calcium Silicate Elements

Building with calcium silicate elements 2

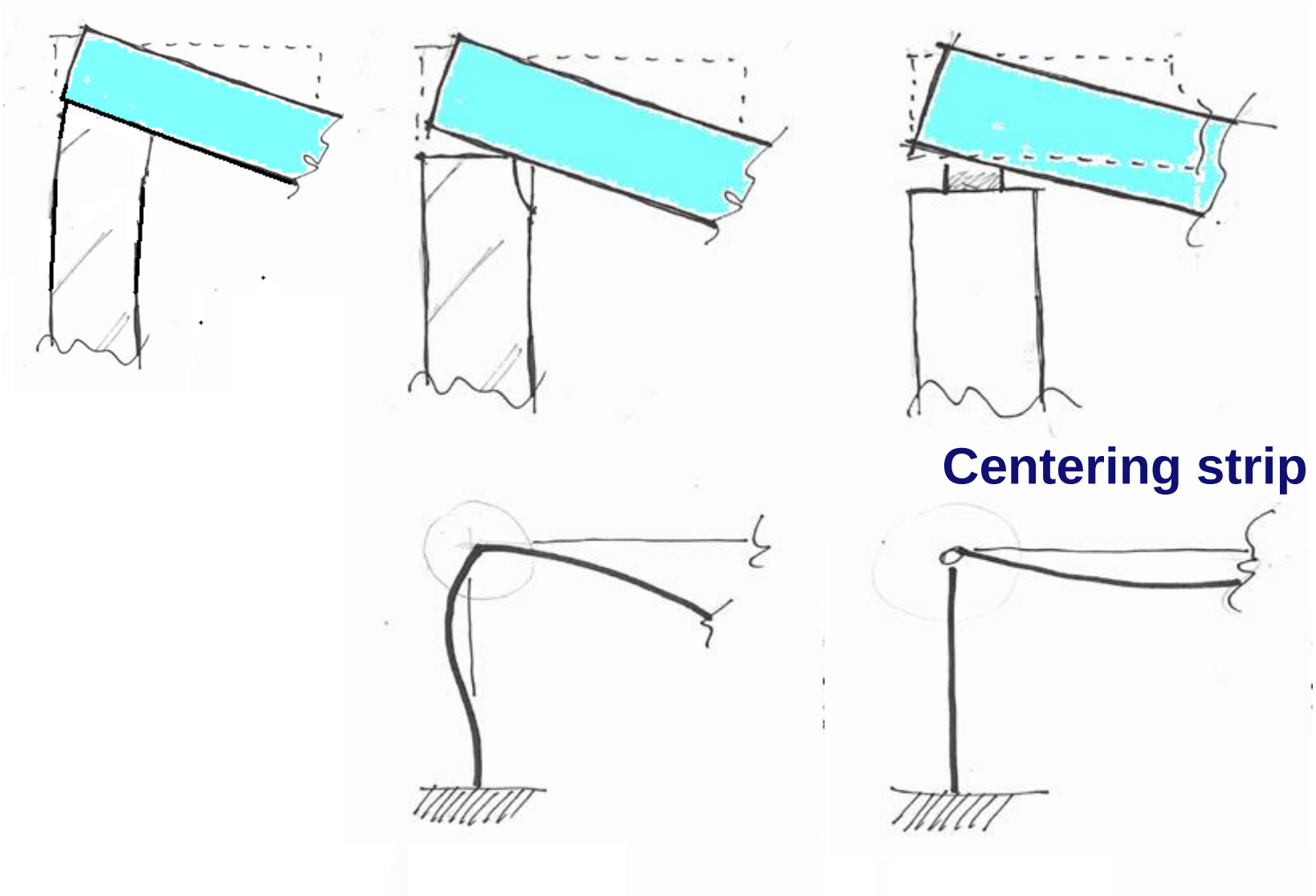
Wall-floor connection / mortar joint



Wall-floor system CSt



Rotation stiffness floor-wall connection



CSt

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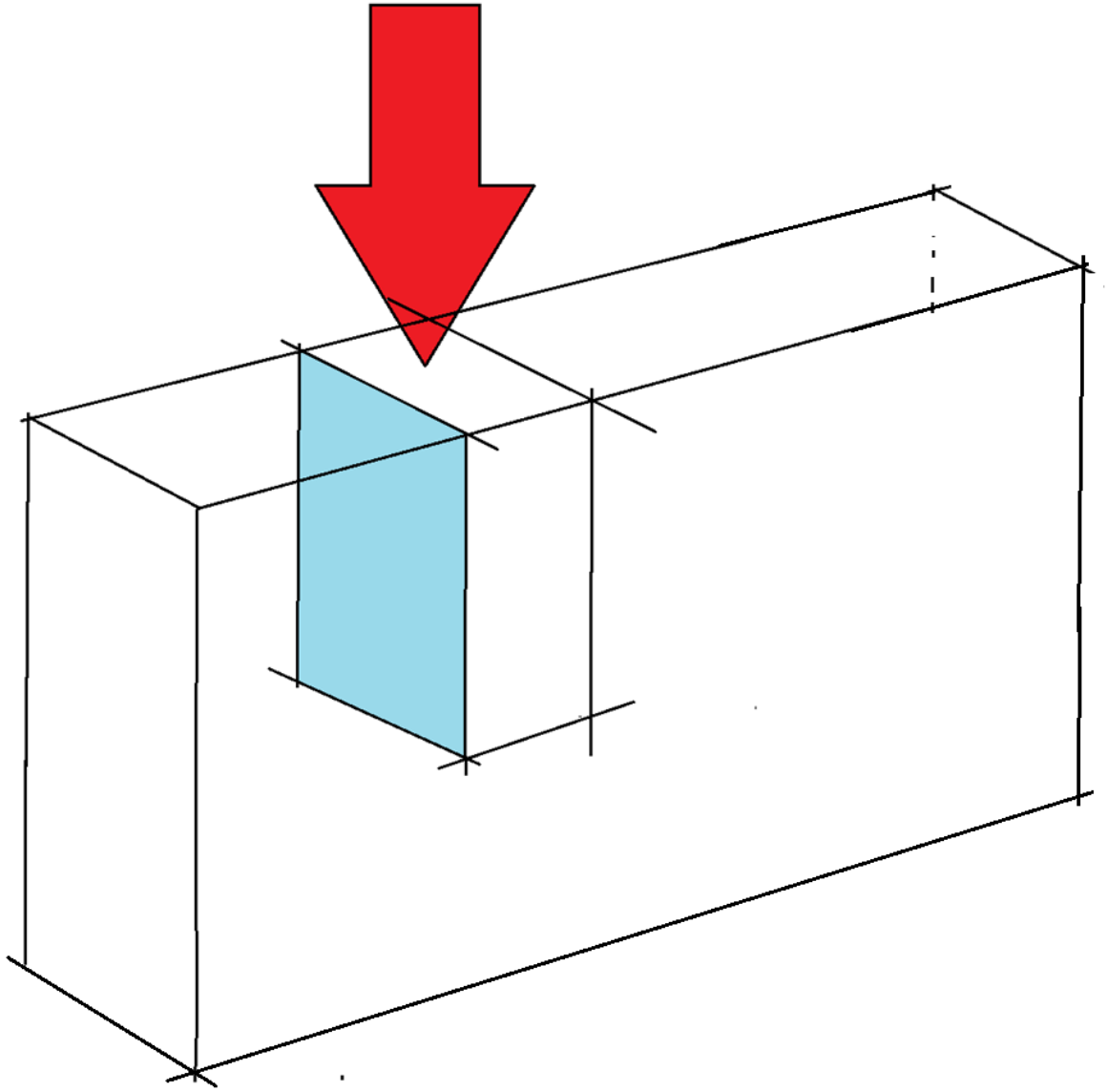
Size of Specimen



CSt

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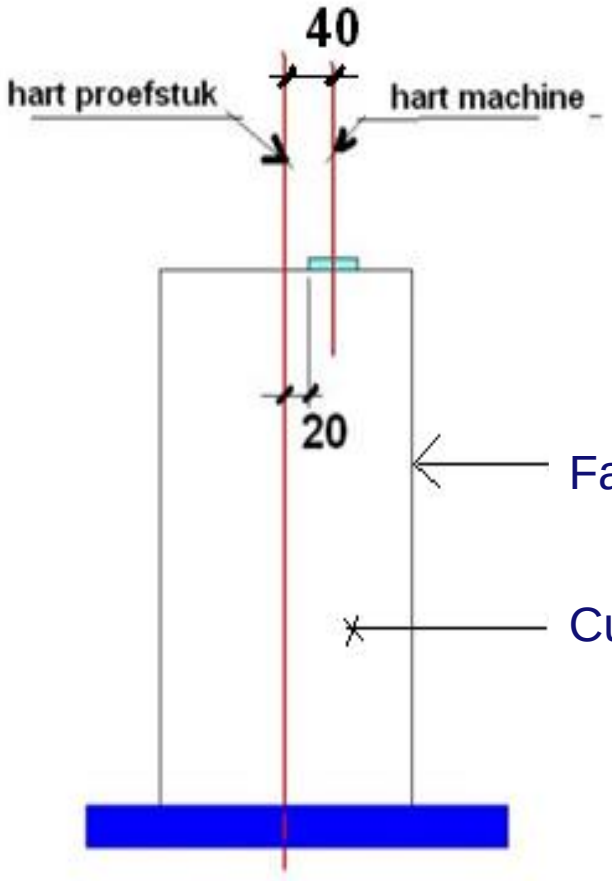
Test & Simulation details



position of the 40 mm wide strip
eccentricity
0, 10, 20, 30, 40, 50, 60, 70 mm

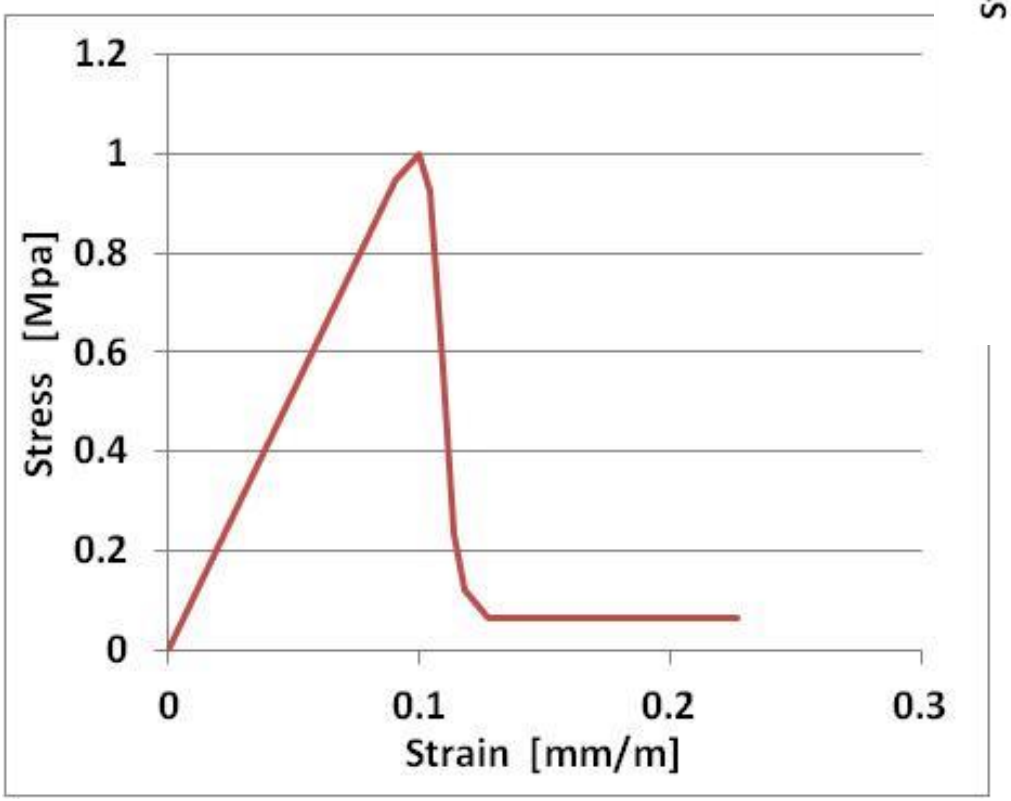
200 x 200 x 400 mm3

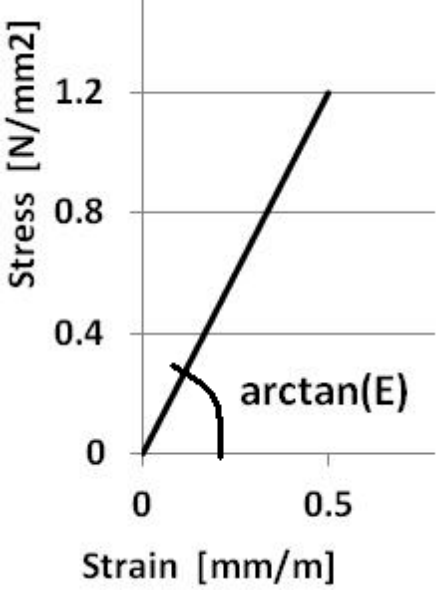
11 tests

Splitting

Splitting block: failure in tension

Stress strain diagram for CaSi

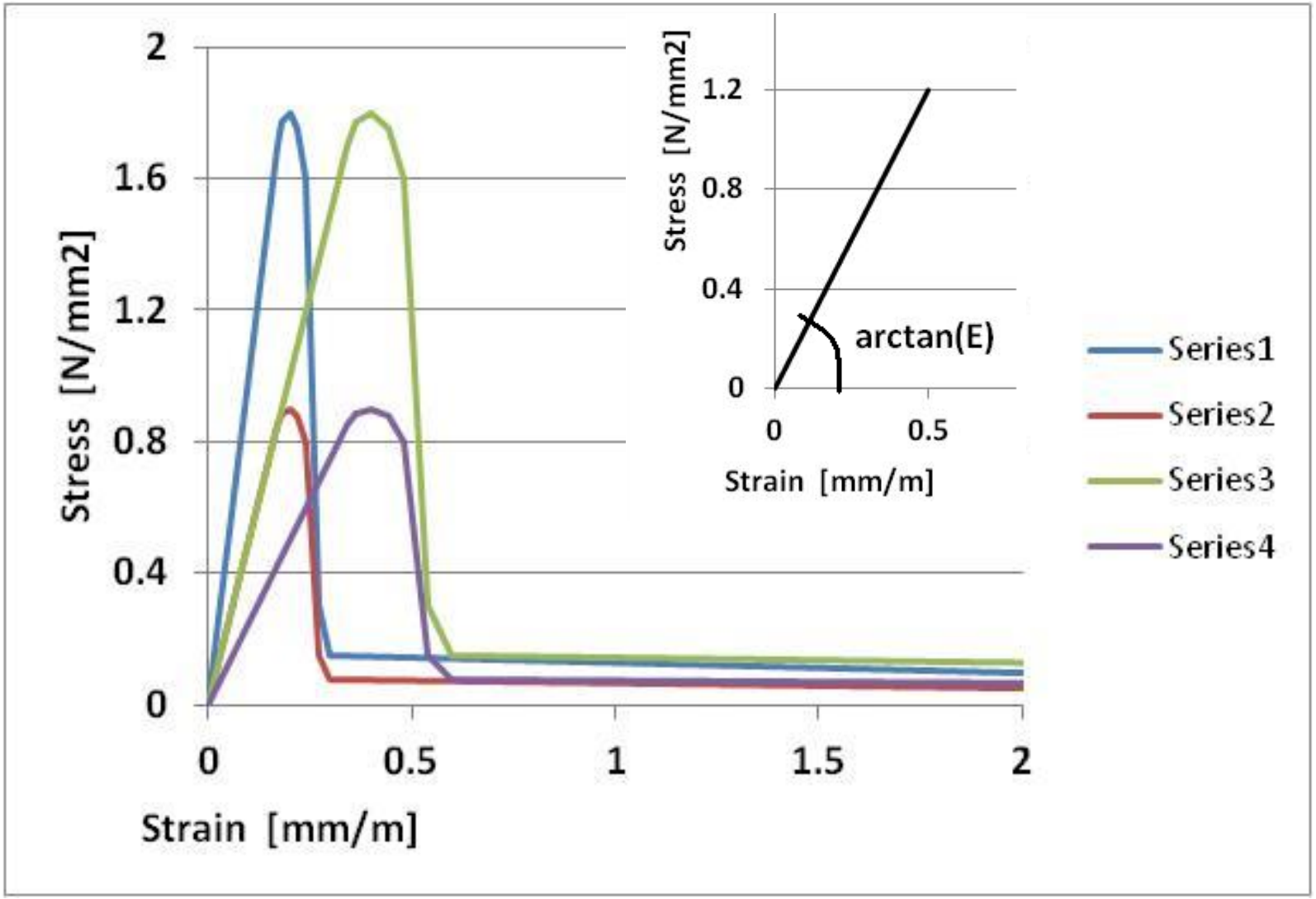




Hordijk
Van der Pluijm

Modulus of Elasticity ~ 10,000 Mpa (1MPa / 0.1mm/m)
Young's modulus

Tension properties: 4 Stress vs strain diagrams



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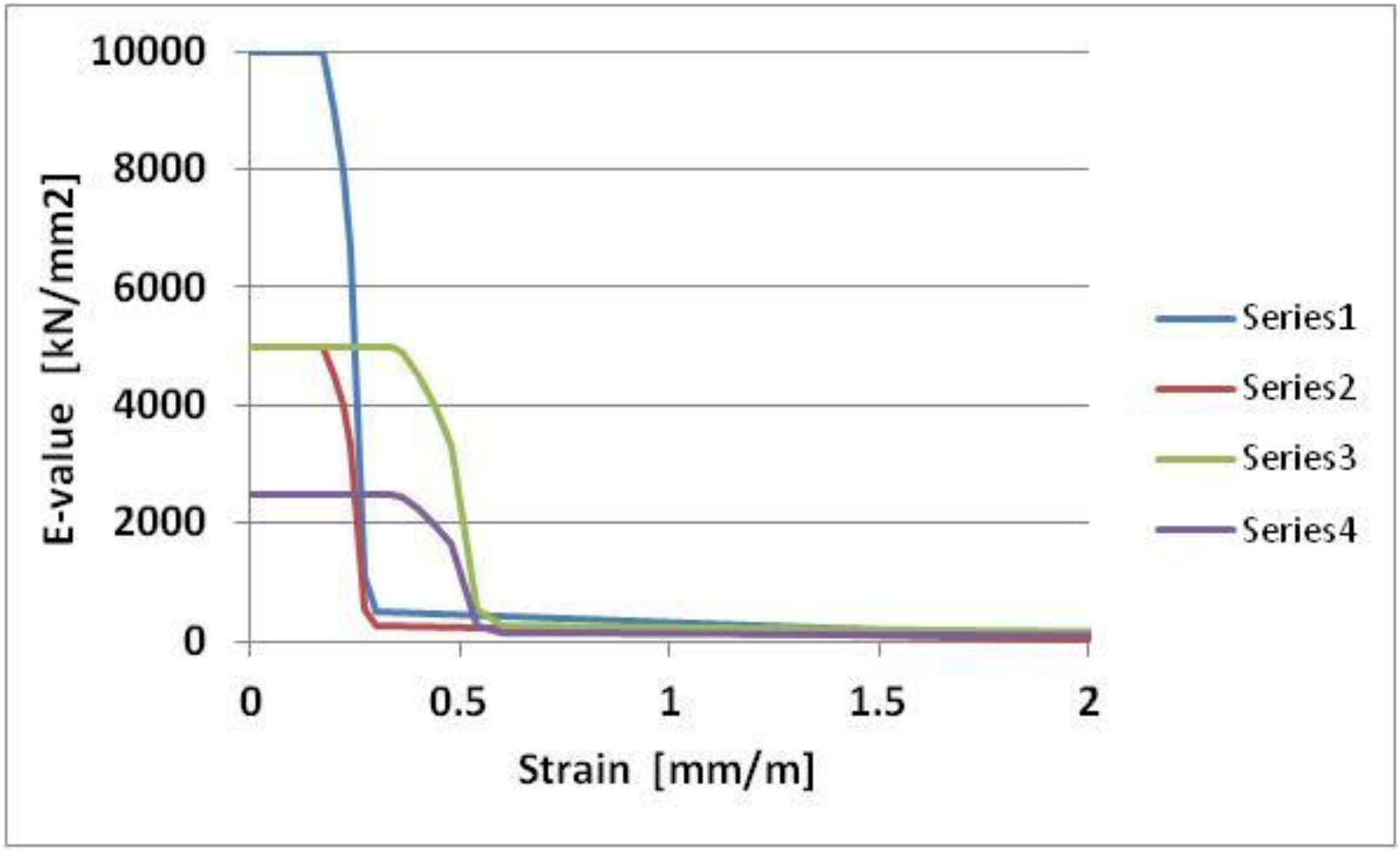
Tension properties E-value vs Strain



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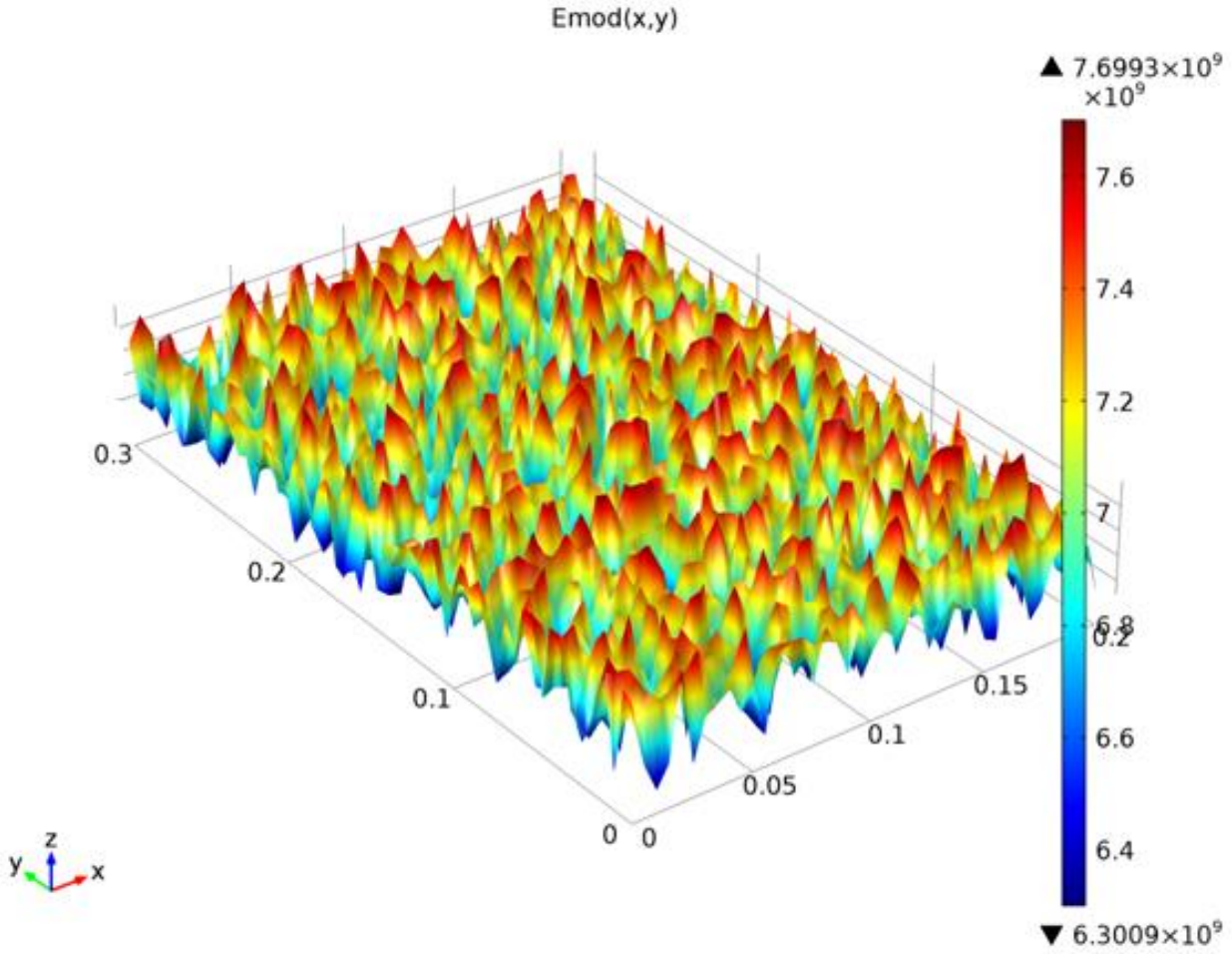
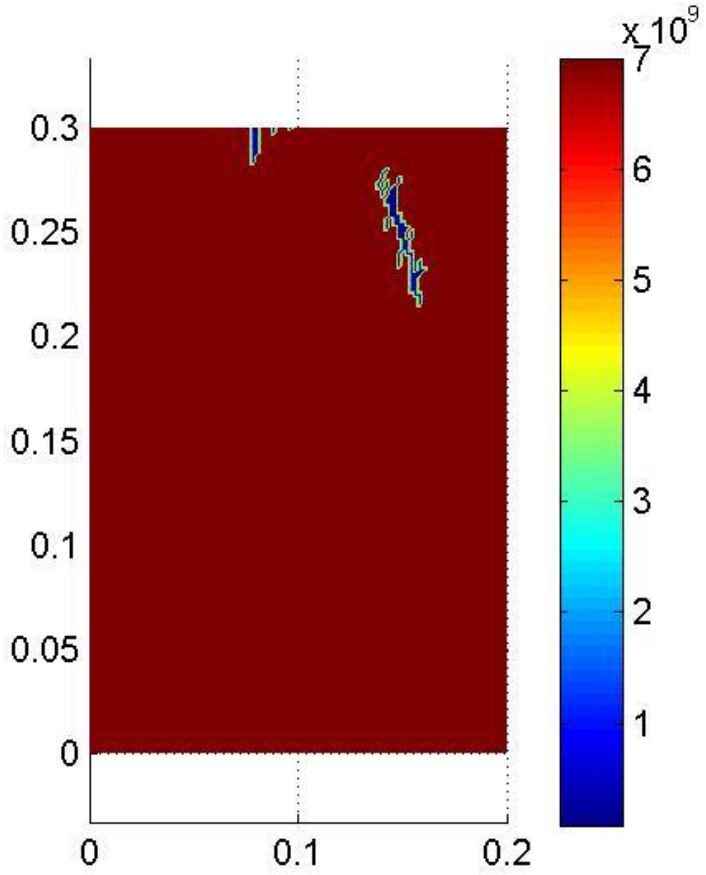
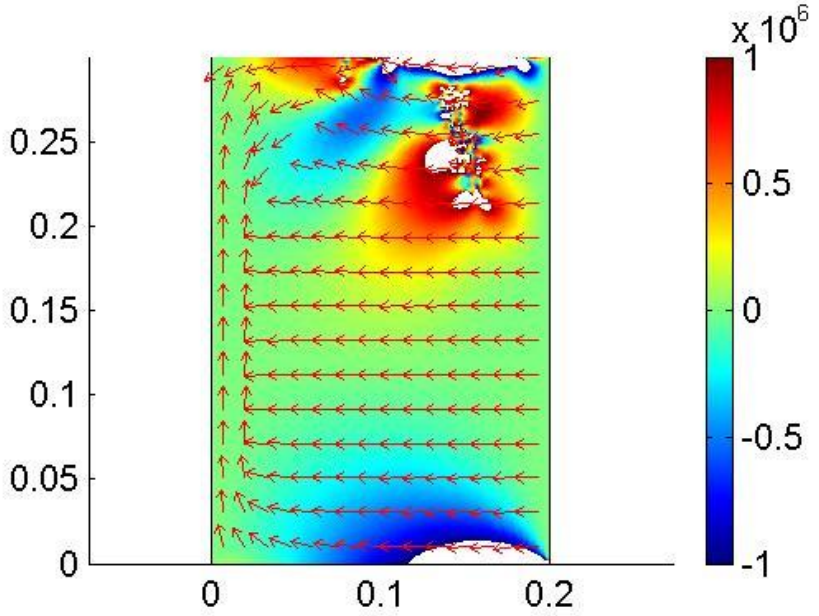
Random properties (initial E-values)

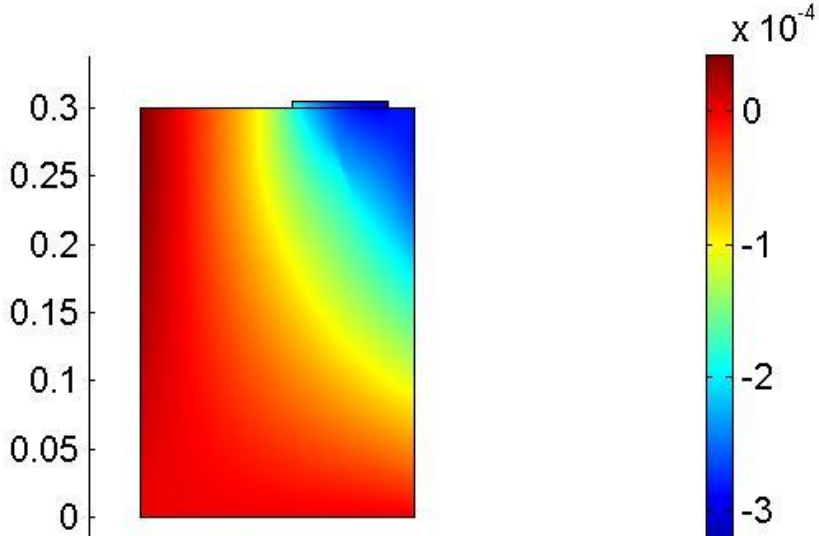


SLA: Sequential linear elastic Analysis

works in steps !!

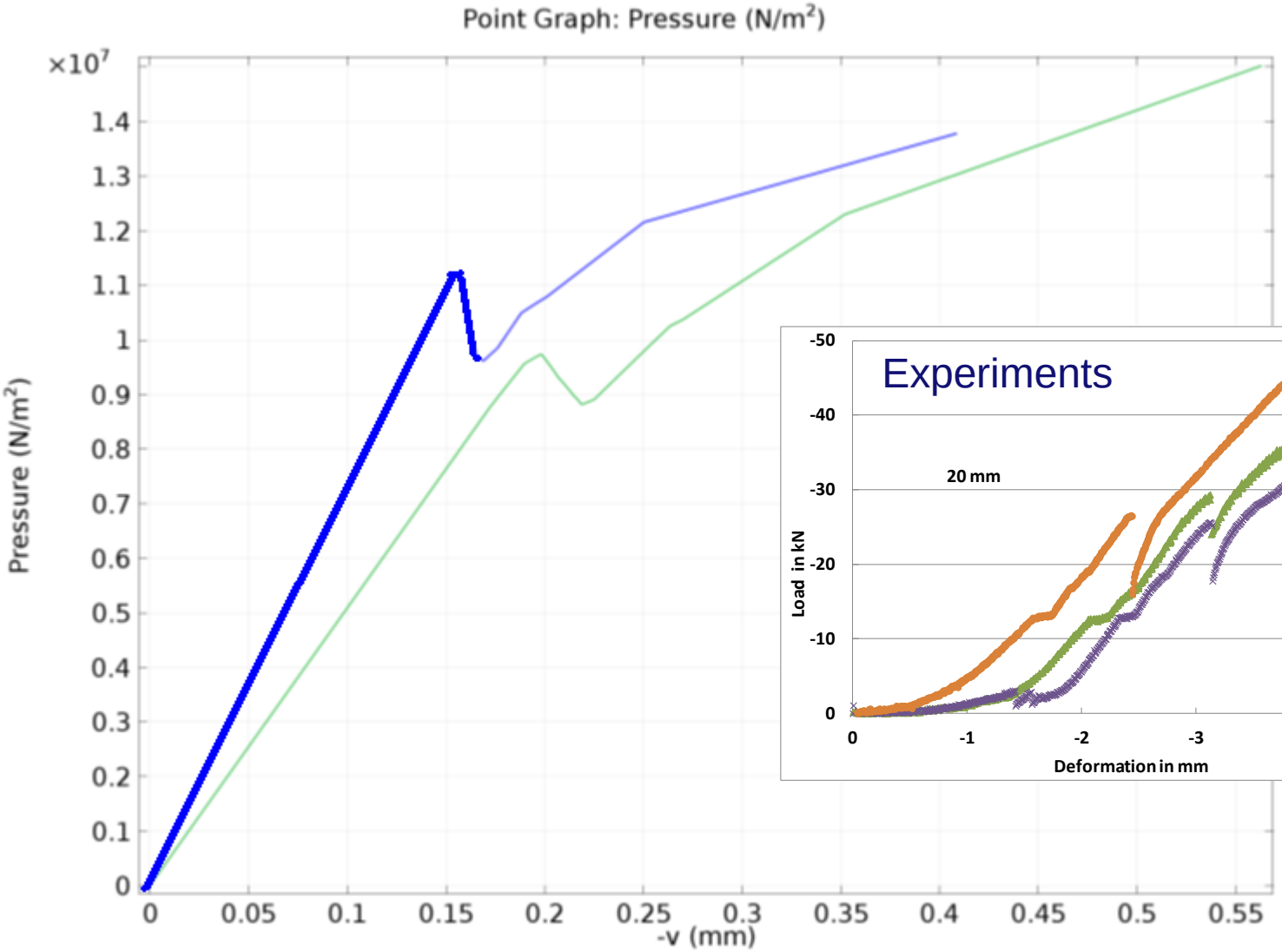






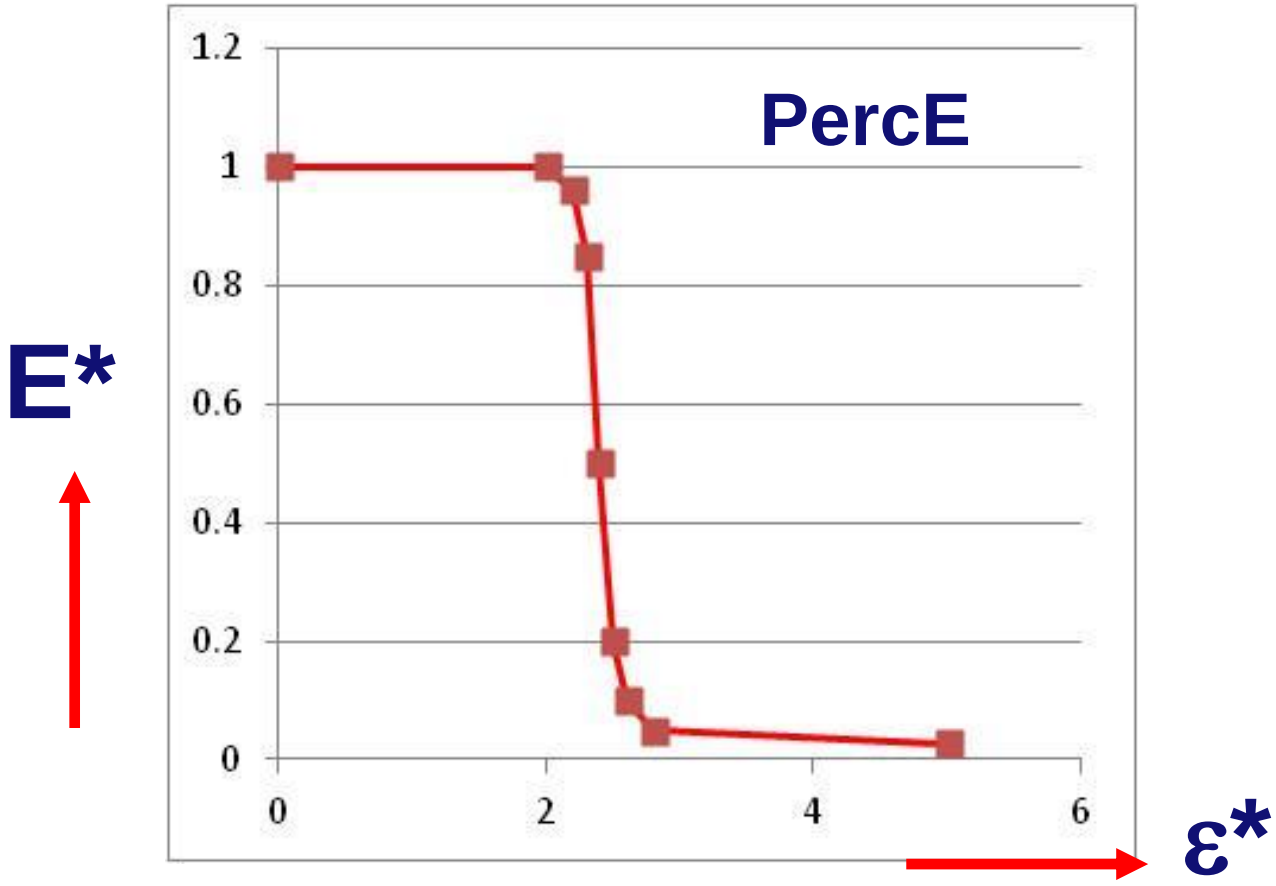
places with
high and low E-values

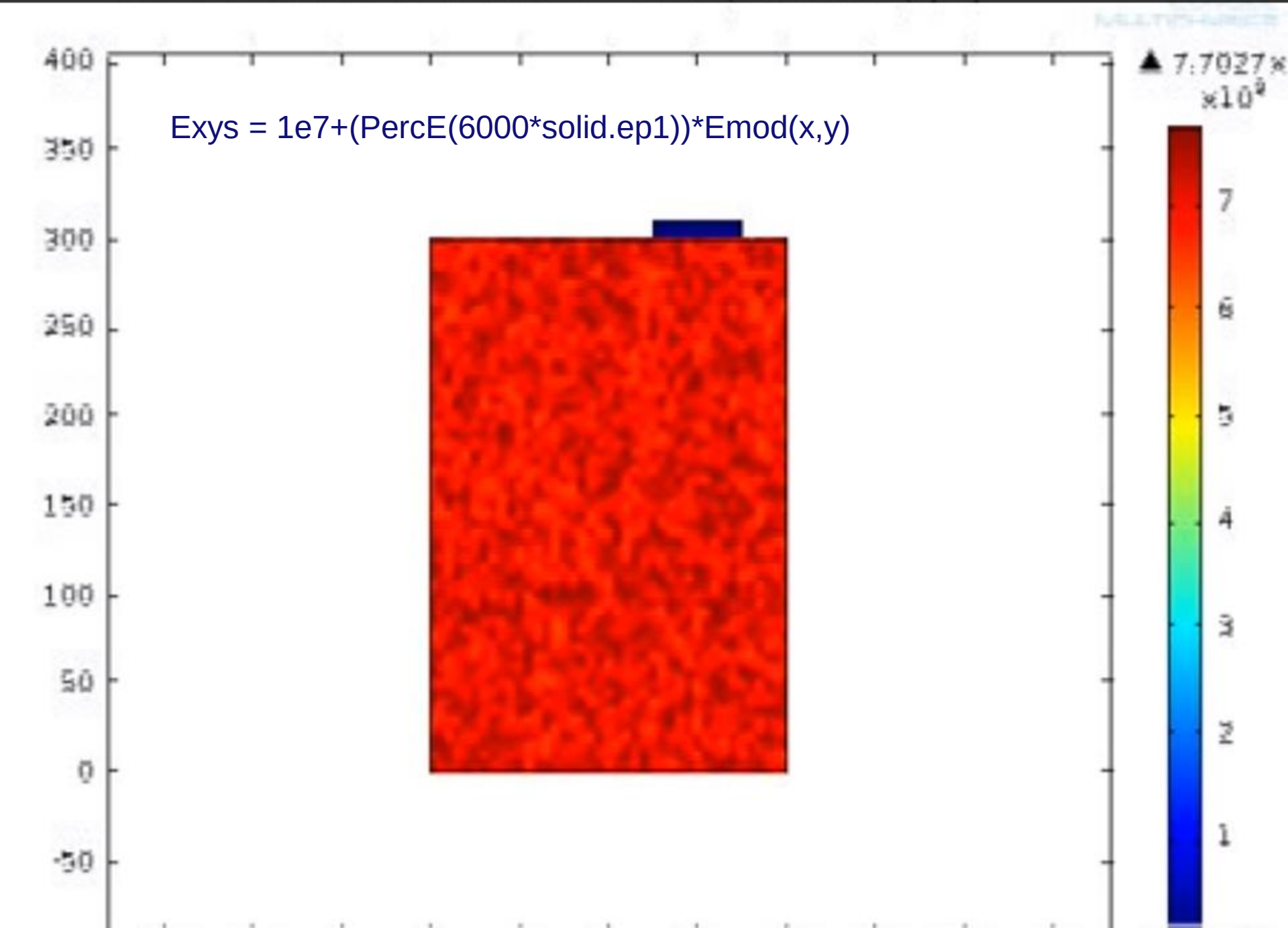
Load - displacement

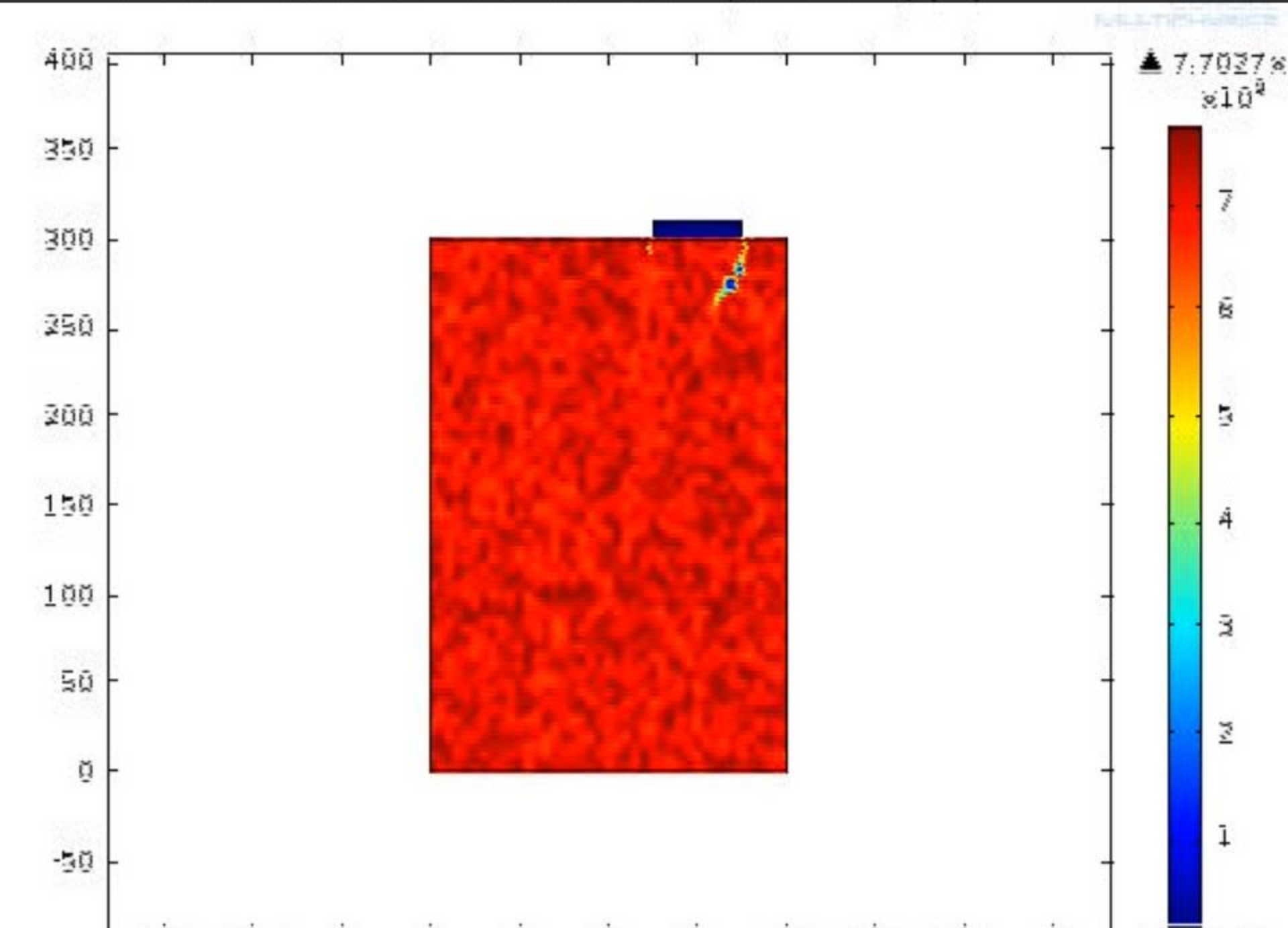


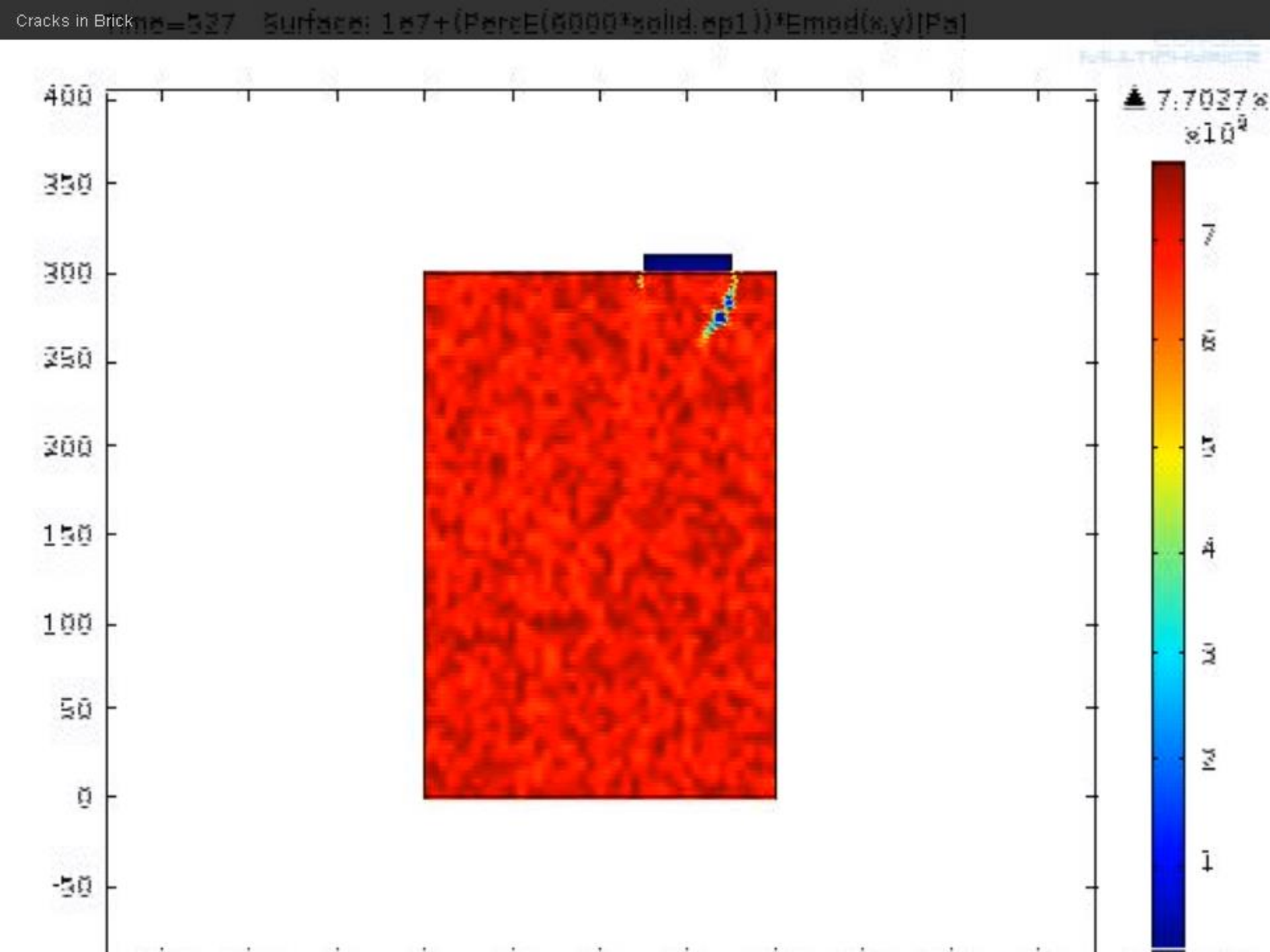
SS: Continuous Stress strain model

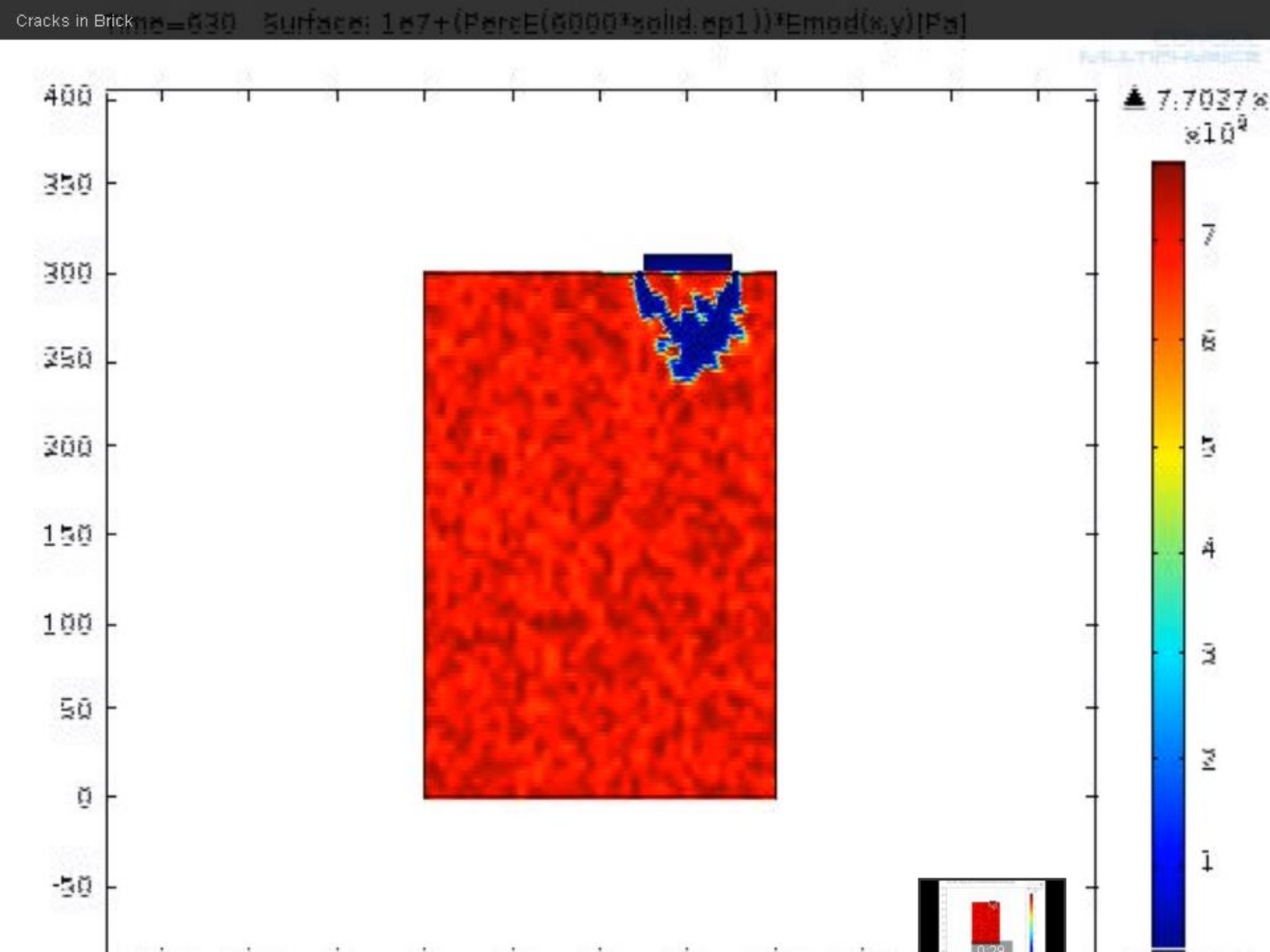
Exys = 1e7+(PercE(6000*solid.ep1))*Emod(x,y)

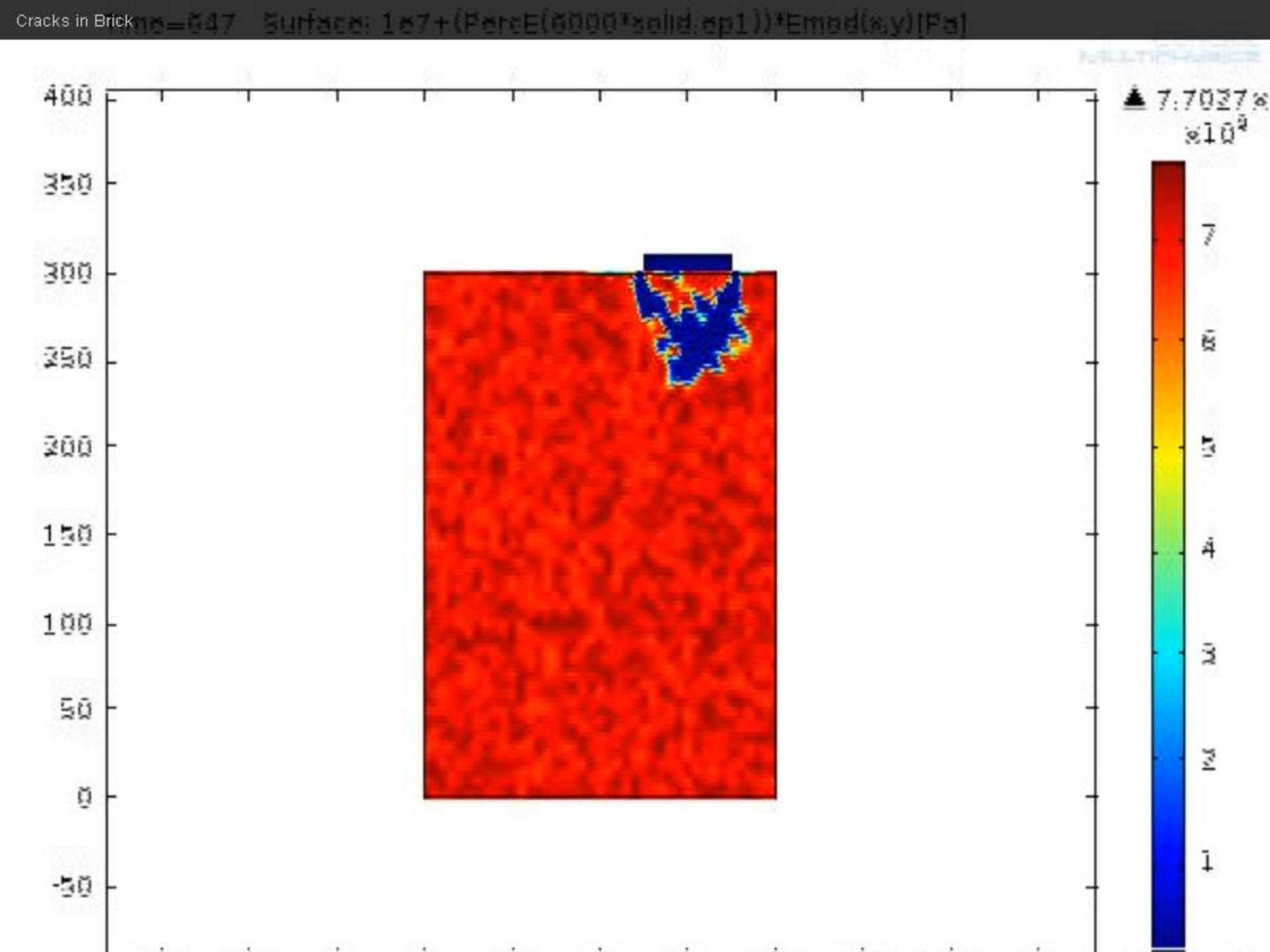


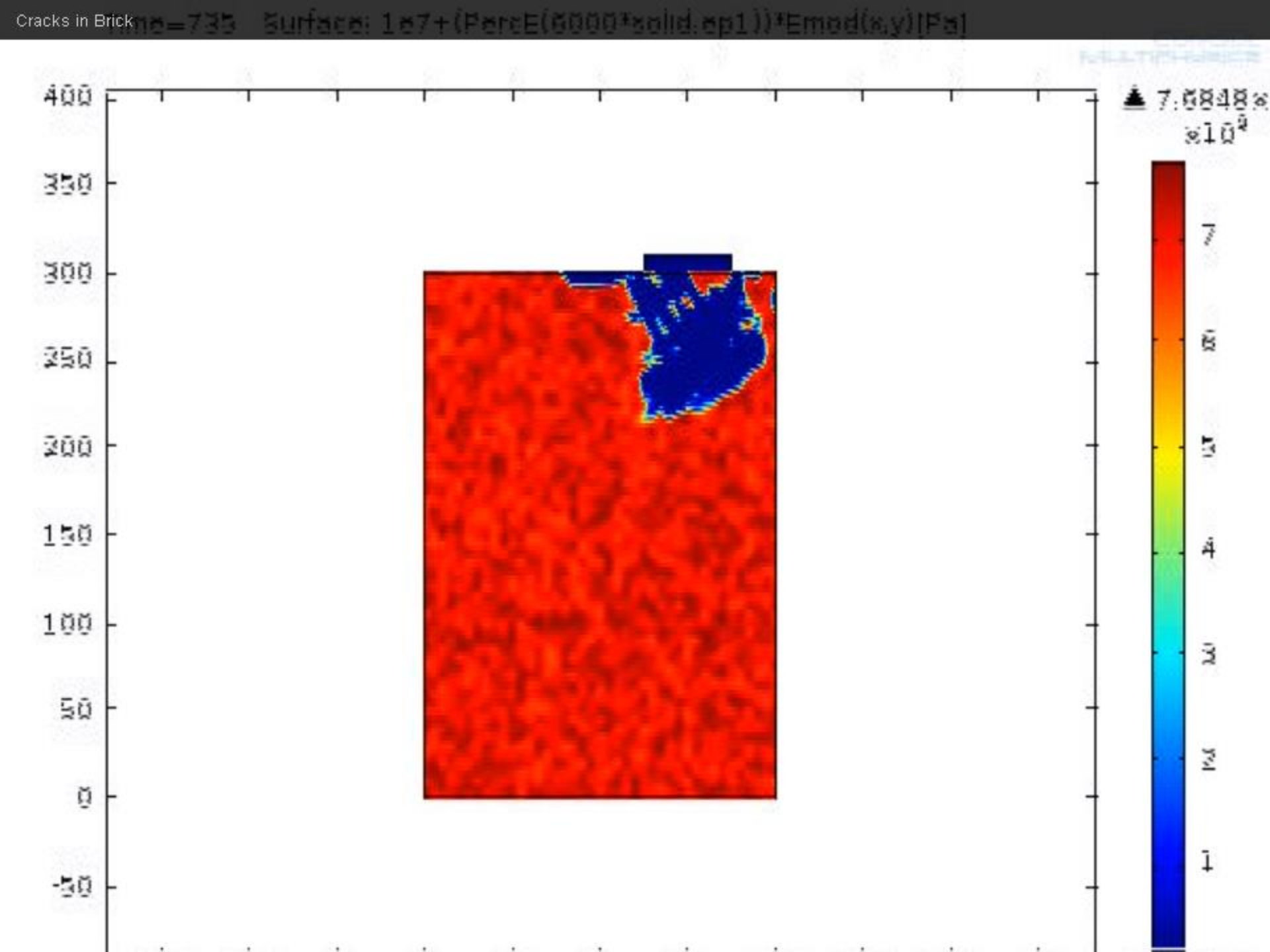

Exys = 1e7+(PercE(6000*solid.ep1))*Emod(x,y)
400
350
300
250
200
150
100
50
0
-50
7.7027
×10⁹
7
6
5
4
3
2
1


Surface: 1e7+(PercE(6000*solid.ep1))*Emod(x,y)[Pa]
7.7027e
400
350
300
250
200
150
100
50
0
-50


Surface: 1e7+(PercE(6000*solid.ep1))*Emod(x,y)[Pa]
7.7027e
%10^2


Surface: 1e7+(PercE(6000*solid.ep1))*Emod(x,y)[Pa]
400
350
300
250
200
150
100
50
0
-50
7.7027e-2
7
6
5
4
3
2
1


ne=647 Surface: 1e7+(PercE(6000*solid.ep1))*Emod(x,y)[Pa]
7.7027e
x10^2
400
350
300
250
200
150
100
50
0
-50

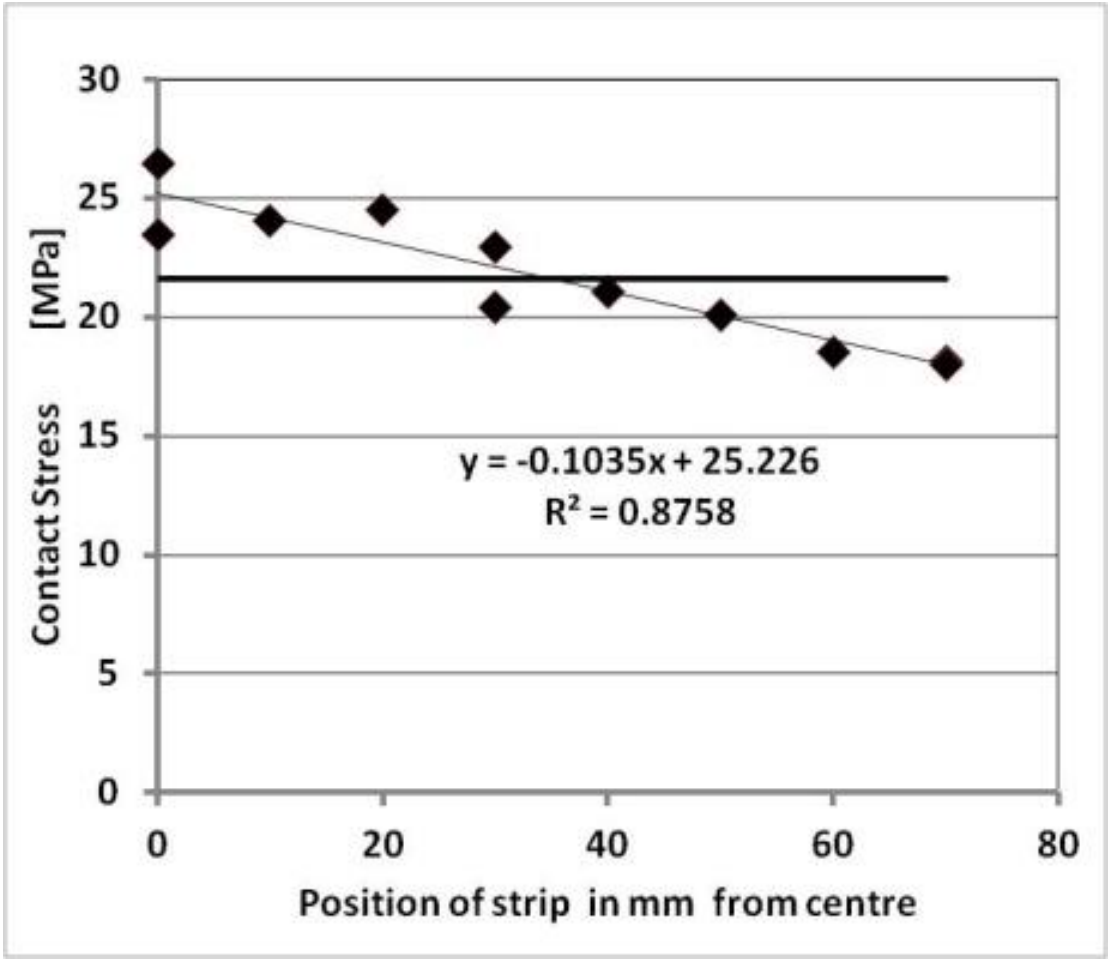

Surface: 1e7+(PercE(6000*solid.ep1))*Emod(x,y)[Pa]
400
350
300
250
200
150
100
50
0
-50
7.5
%10^2

Effect of Strip position on strength

f'w = -0.1035 es + 25.226 **(R2 = 0.88; 11 tests; t = 200 mm)**

es: strip eccentricity

Effect of strip position on ultimate contact stress.



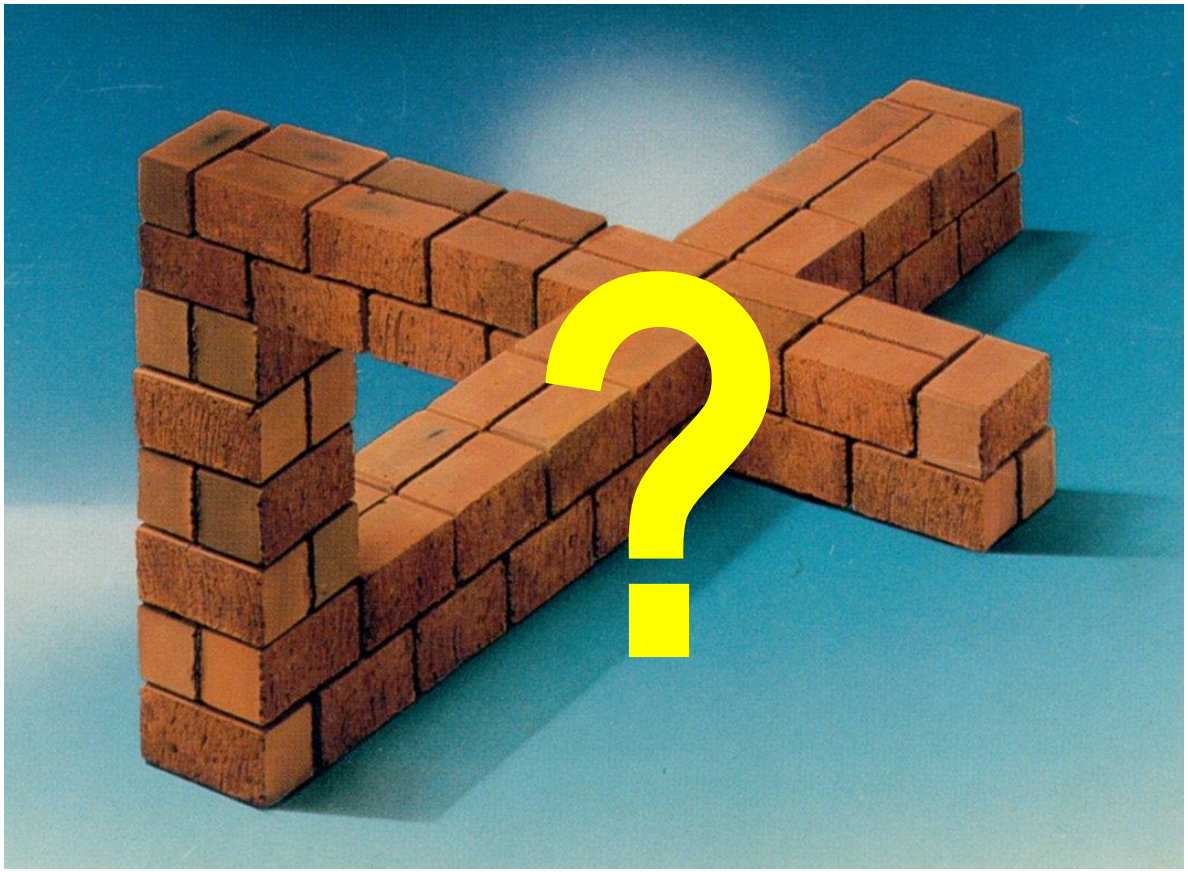
This paper shows the possibility to randomly assign strength and E-values to parts of a specimen and to simulate crack patterns.

The continuous stress strain model worked and showed promising results.

SS method easier than SLA

The direct relation between strain and E-values made work easier compared to work with sequential linear analysis.

Thanks



Video of SS simulation on
http://www.youtube.com/watch?v=A9gJivBOiNQ
Video of SLA simulation on
http://www.youtube.com/watch?v=bdz0GM1IzjE