MEPLA PRO

2025

Comparison of calculation results

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Inhaltsverzeichnis

1 Circular plate – under bending and membrane effects

In Theory of Plates and Shells, Stephen P. Timoshenko, S.Woinowsky-Krieger an analytic solution under large displacements for the deflection w_0 has been given for a clamped circular plate of thickness h = 5, radius a = 500 and under uniform pressure q.

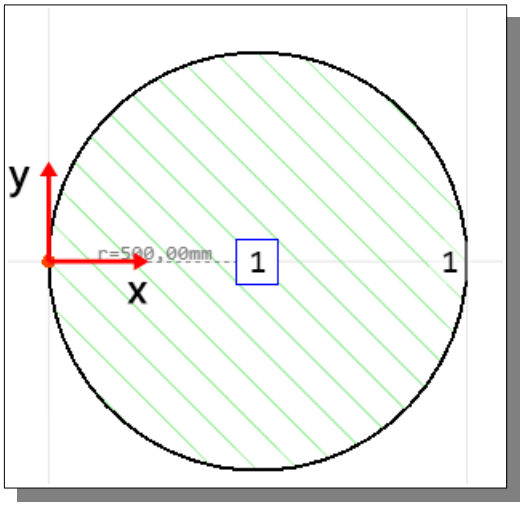
$$w_0 = \frac{qa^4}{64D} \frac{1}{1 + 0.488 \frac{w_0^2}{h^2}} \qquad (232)$$

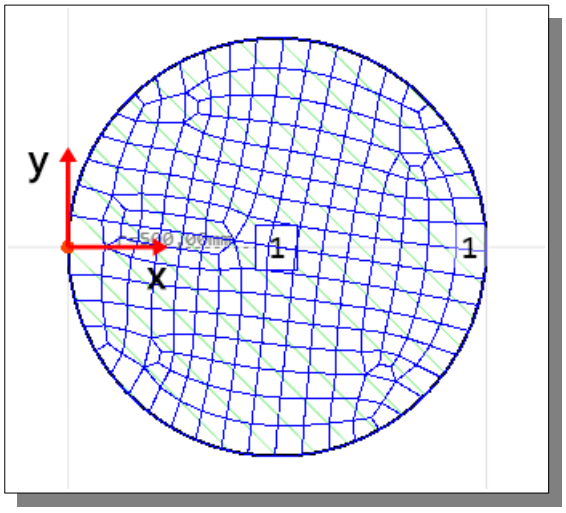
where D is the plate stiffness
$D = E / (1-\nu^2) * h^3/12$
and E is here taken as 70000 and q = 0.001.

For this solution a poisons ratio of $\nu = 0.3$ is used.

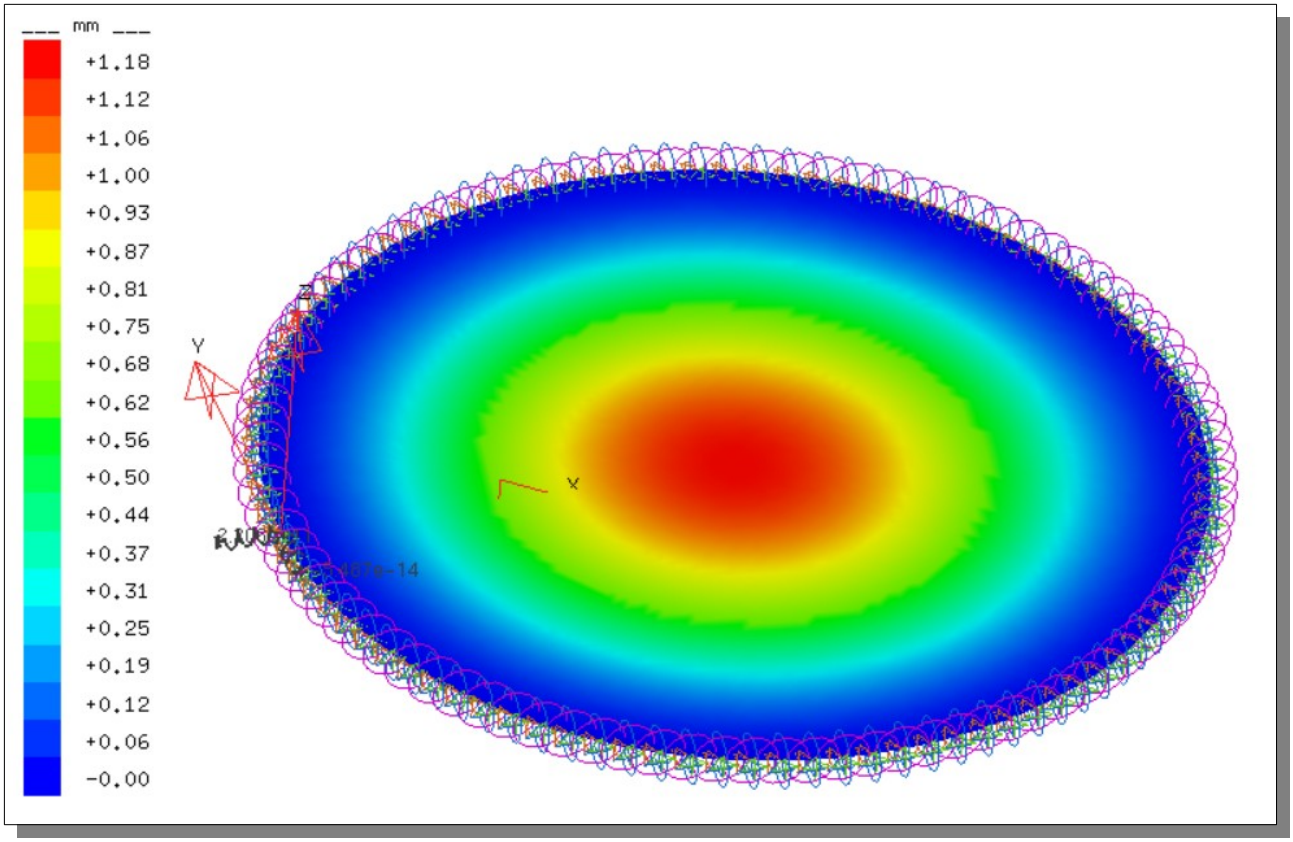
Solving this quadratic equation will lead to a deflection under large deformation effects of **w_0 = 1.18 mm.**

Mepla Pro is using boundary condition typ 1 for a clamped solution.





Deformation obtained here is: **1.18 mm**



2 Circular plate – pure membrane effects

In the same publication there is found a solution for pure membrane effects, so under neglecting any bending effect for very thin plates:

$$0.583\left(\frac{w_0}{h}\right)^3 \approx 0.176\,\frac{q}{E}\left(\frac{a}{h}\right)^4 \qquad \text{and} \qquad w_0 = 0.665a\sqrt[3]{\frac{qa}{Eh}}$$

For a plate thickness h = 1.0 mm the deformation w_0 is found to **6.40** mm.

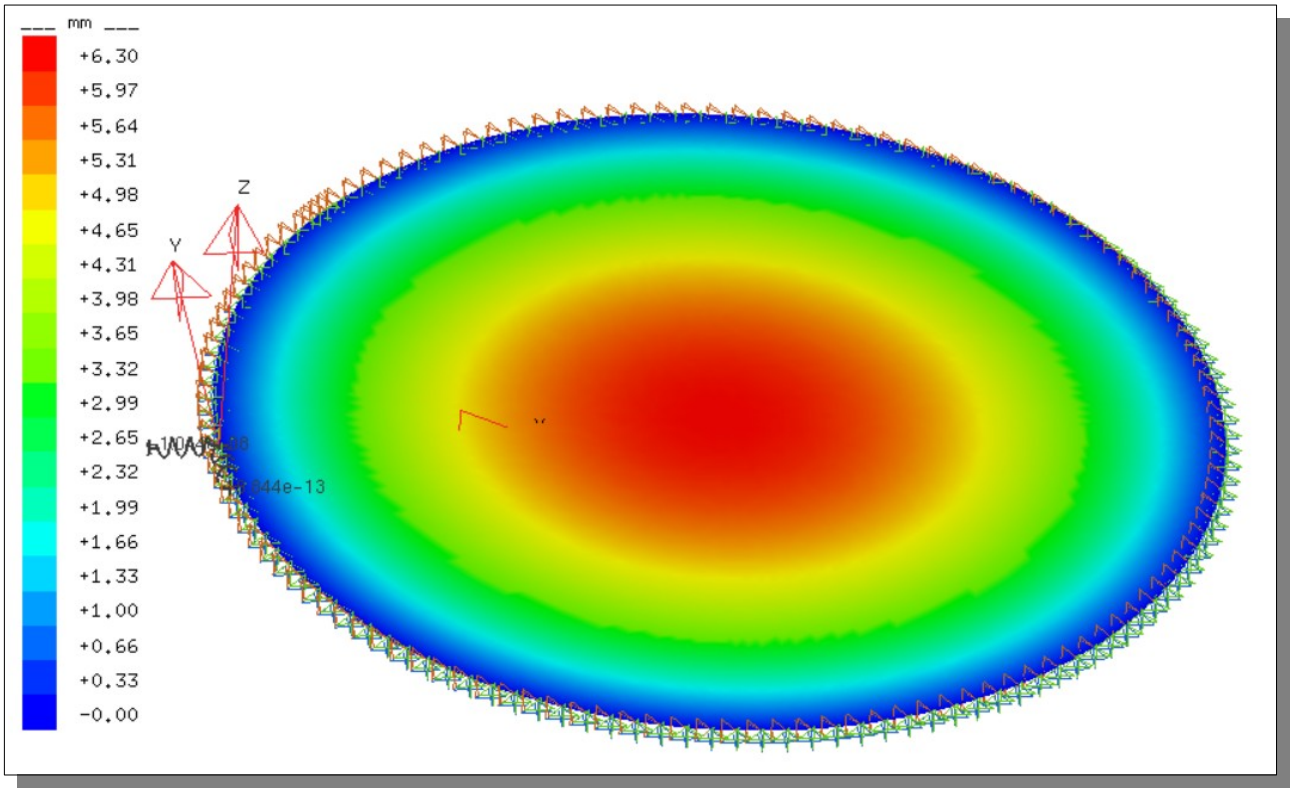
And a more complete solution of the same problem using ν = 0.25

$$w_0 = 0.662a\sqrt[3]{\frac{qa}{Eh}} \qquad (236)$$

leads to **6.37 mm.**

Mepla Pro is using typ 7 support to allow free membrane behaviour without clamping effects as requested. The face load used here is the same as above q = 0.001.

The deformation found here under high geometrically non-linear effects is **6.30** mm.

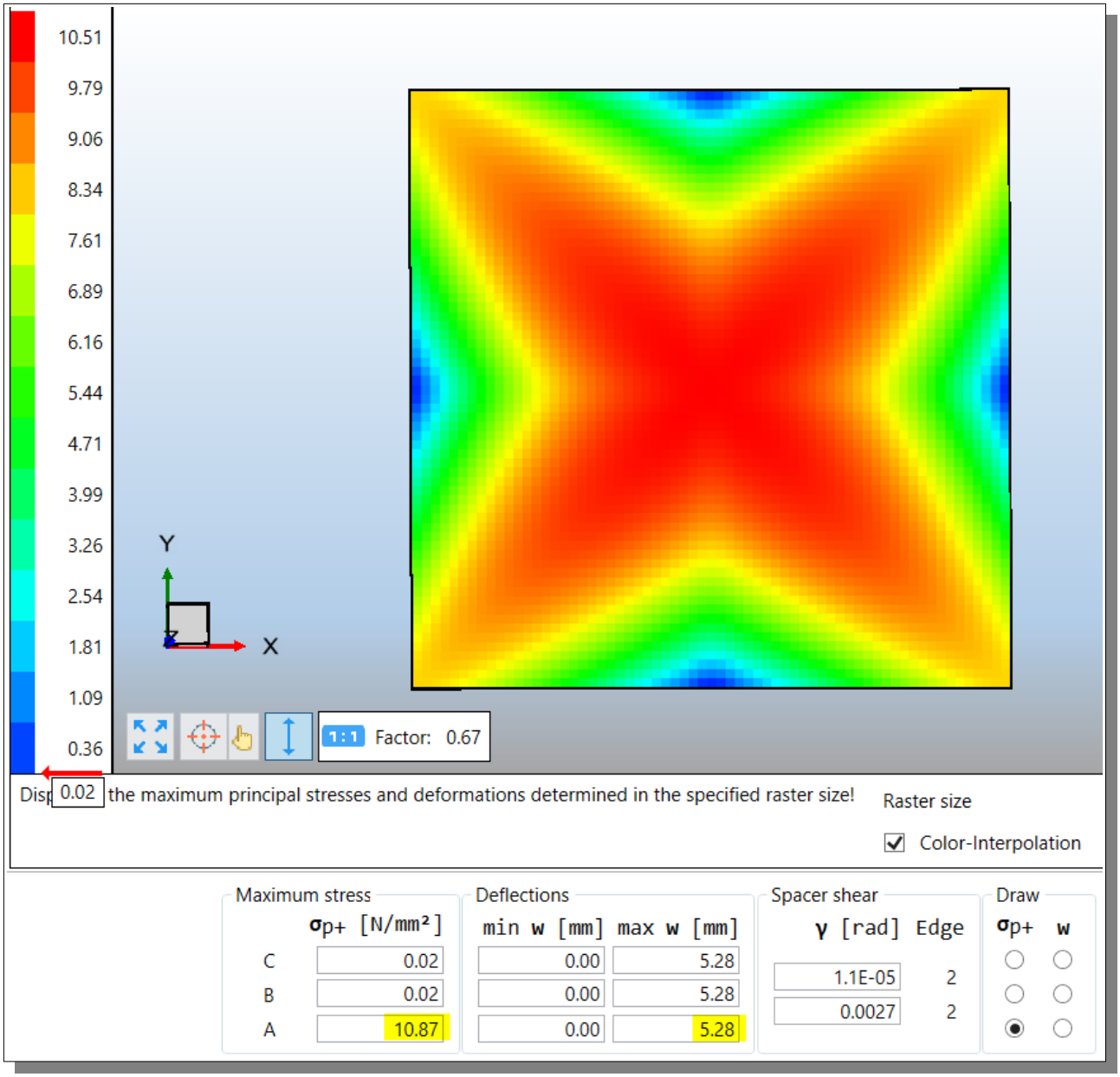


3 Quadratic plate – linear geometrically

For a quadratic system of 1000x1000 mm the plate differential equation is solved by Fourier Series using Mepla Iso. The thickness of the plate is again 5mm and the uniform load is 1 KN/m². The plate is simply supported all around.

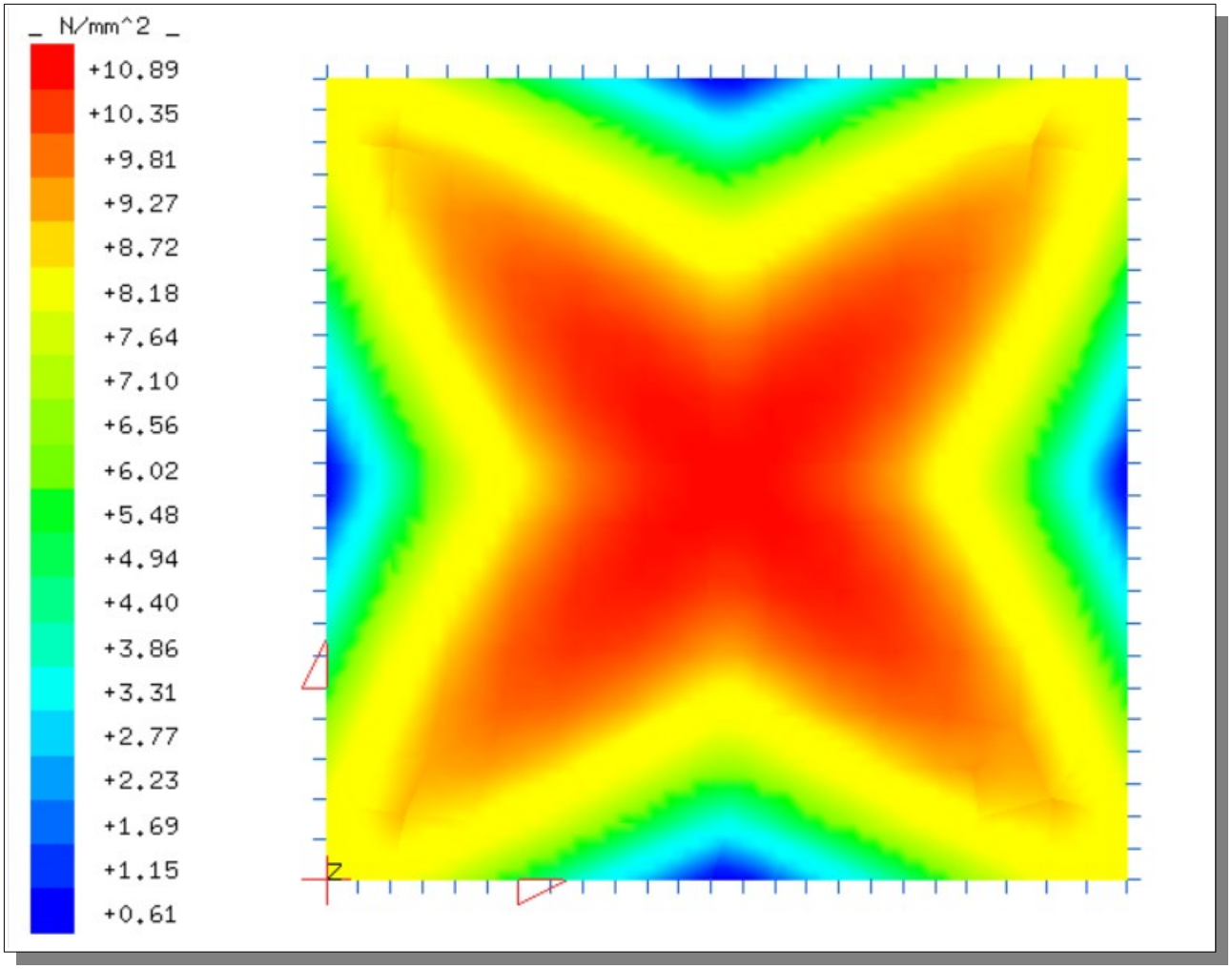
Deflections under linear theory are **5.28 mm**

Stresses in the center are **10.51 N/mm²**.



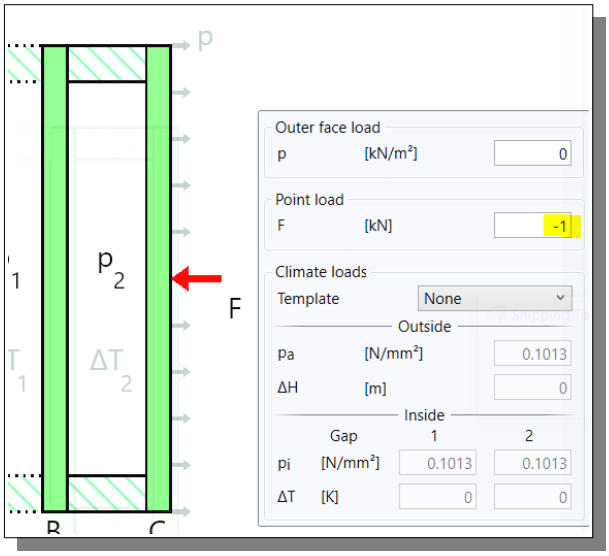
Solving the same in **MEPLA PRO** leads to

a deformation in the center of **5.26 mm** and stresses of **10.89 N/mm².**

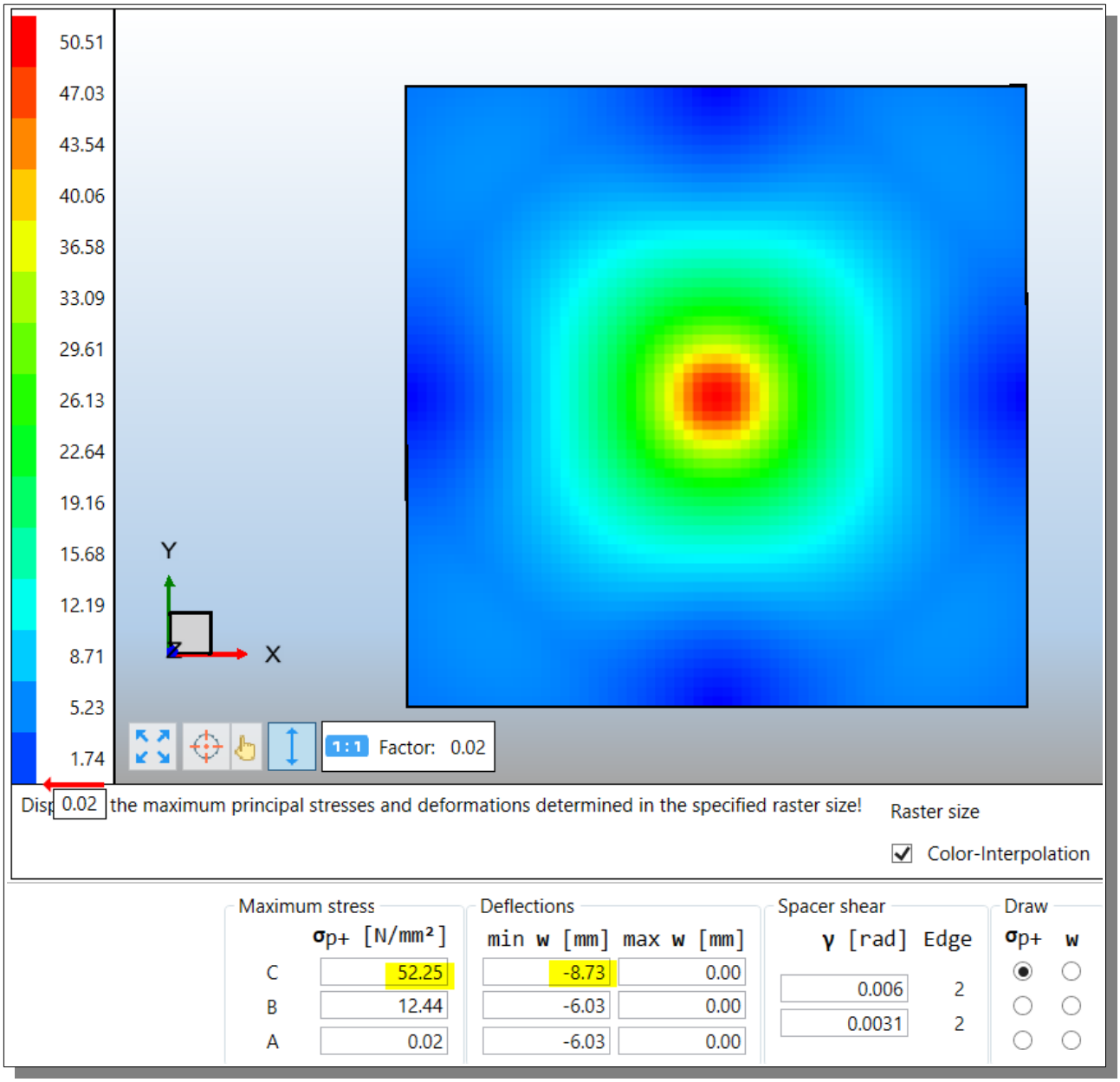


4 Quadratic insulated glass – linear geometrically

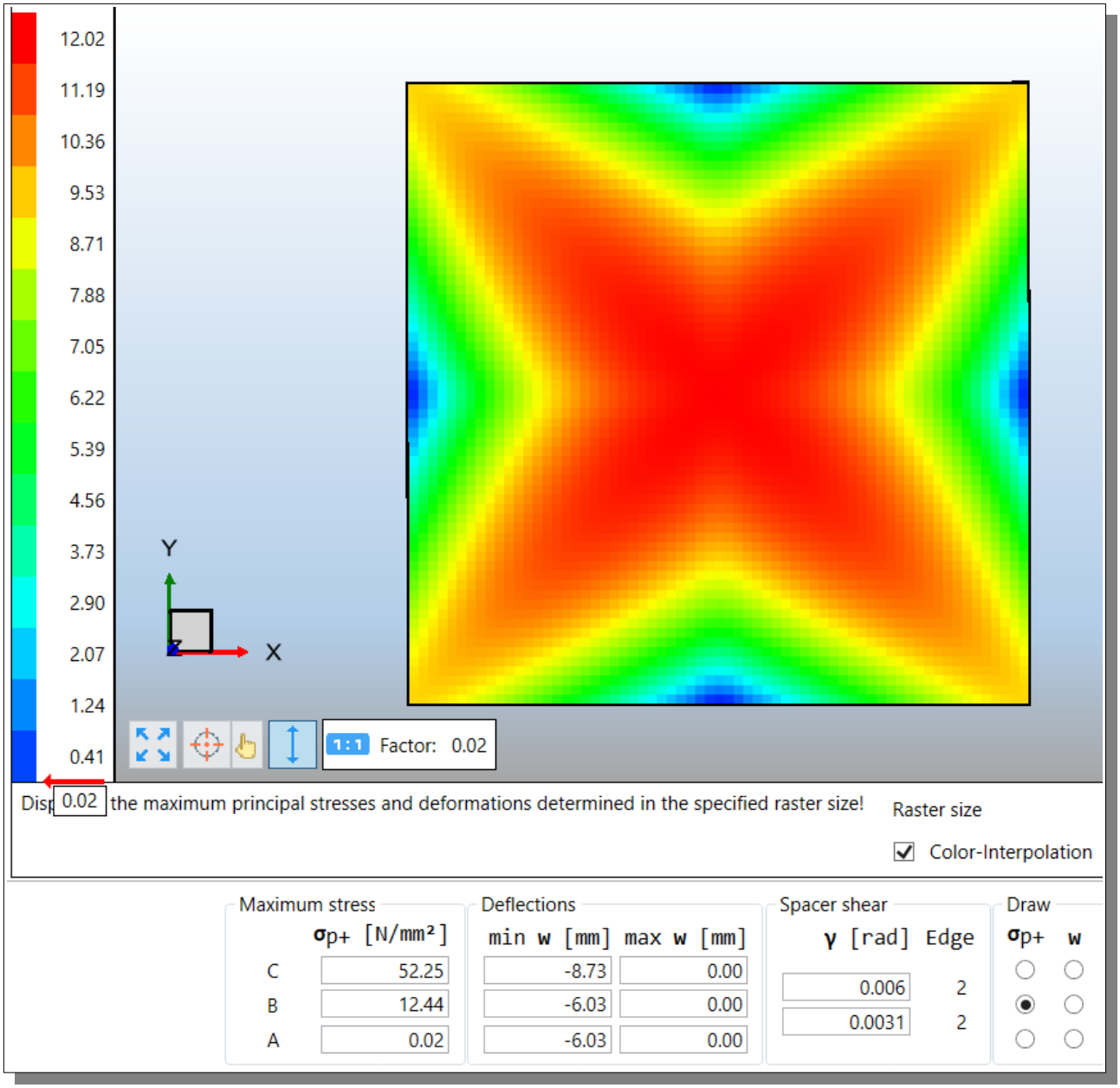
An insulated glass of 2 x 5 mm with a 16 mm gap is regarded. The outside plate is loaded by 1.0 kN on an area of 100 x 100 mm. Size as above.



The resulting deformations in the outside glass are **8.73 mm** and by stresses of **50.51 N/mm²**.



The inside glass is hereby only loaded by the compressed air in the gap – so a uniform face load. A climate load has not been set.

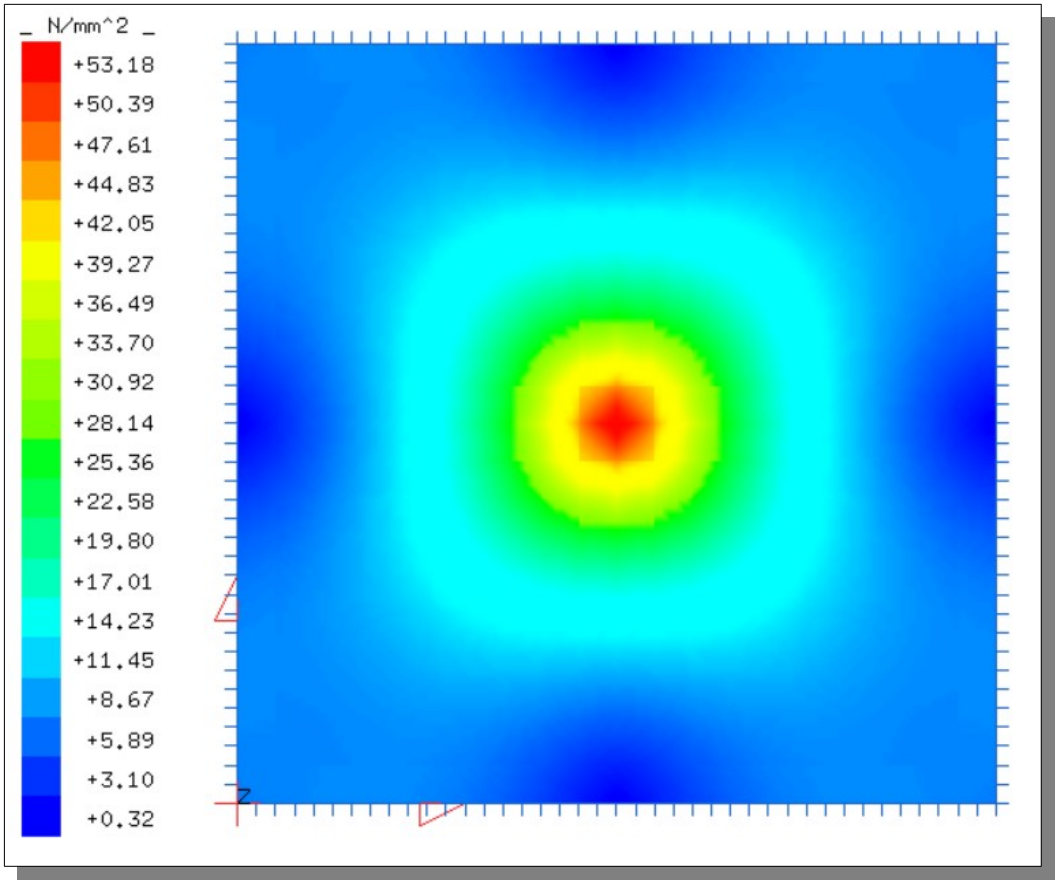


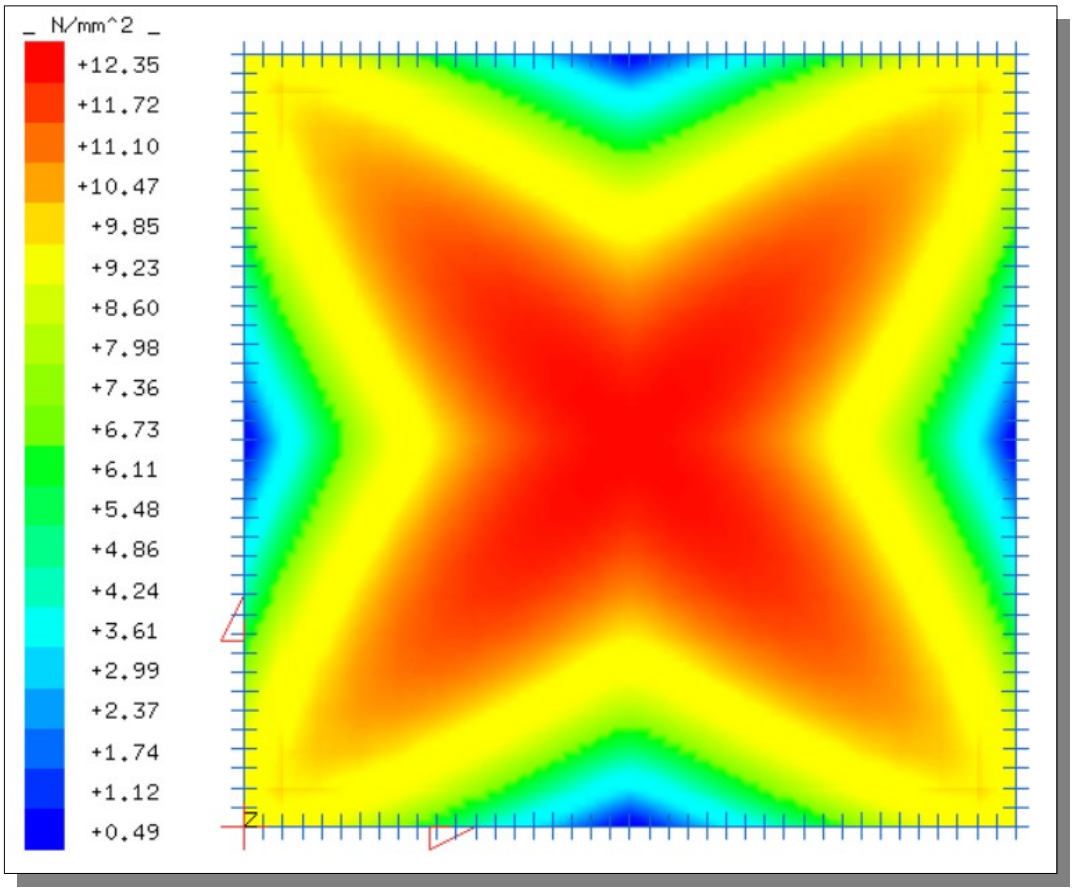
Deformations are **6.03 mm** mm and stresses inside **12.44 N/mm²**.

Comparing this with **MEPLA PRO**, also on a linear basis results in

- deformations outside **8.80 mm** and stresses of **53.18 N/mm²**
- deformations inside **5.99 mm** and stresses **12.35 N/mm²**

Also here the inside glass is only loaded uniformly by the compressed air in the gap.


N/mm^2
+53.18
+50.39
+47.61
+44.83
+42.05
+39.27
+36.49
+33.70
+30.92
+28.14
+25.36
+22.58
+19.80
+17.01
+14.23
+11.45
+8.67
+5.89
+3.10
+0.32
Z


N/mm^2
+12.35
+11.72
+11.10
+10.47
+9.85
+9.23
+8.60
+7.98
+7.36
+6.73
+6.11
+5.48
+4.86
+4.24
+3.61
+2.99
+2.37
+1.74
+1.12
+0.49
Z