Finite Elemente für Plattentragwerke

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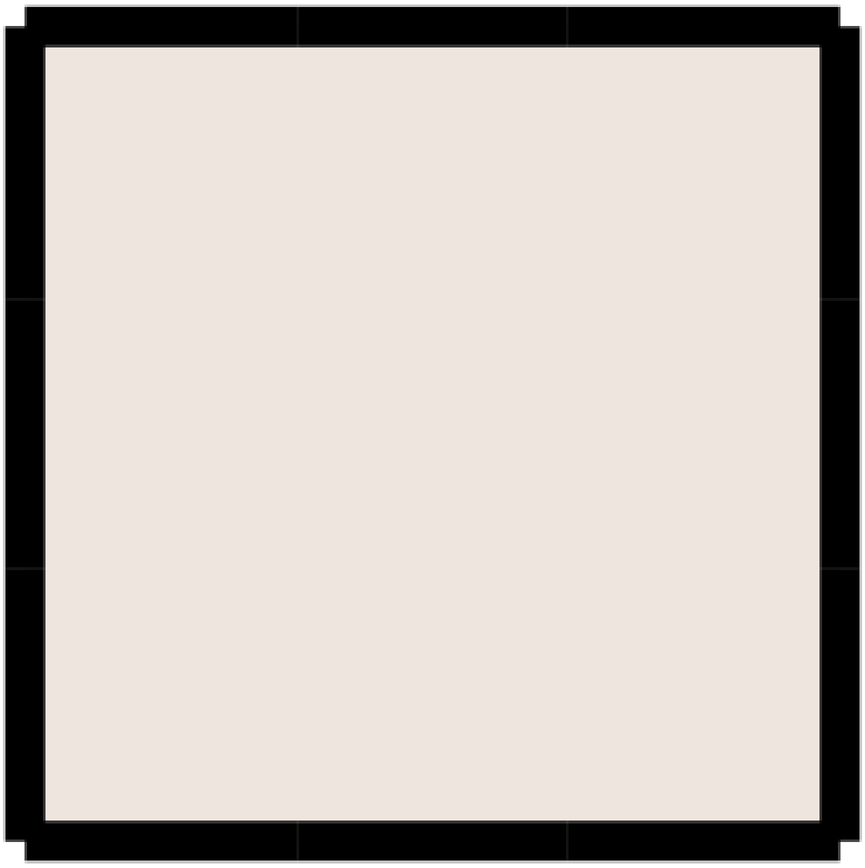
1 Näherungslösung mit Finiten Elementen

```
include("setup.jl")

m, w = plate(p, 3);
NN = 4 * nnodes(m)
nb = collect(m.groups[:boundarynodes])
ni = [i for i in 1:nnodes(m) if i ∉ nb]
adofs = idxDOFs(ni, 4)
NNa = length(adofs);
```

1.1 Anwendungsbeispiel

```
f = mkfig(a3d=false, w=230, h=200)
mplot!(m, edgesvisible=false, nodesvisible=false)
f
```



- Deckenplatte $8\text{m} \times 8\text{m}$
- Allseitig eingespannt gelagert
- $E = 31000 \frac{\text{N}}{\text{mm}^2}$ und $\nu = 0$
- Dicke $d = 20\text{cm}$,
- Belastung $q = 5 \frac{\text{kN}}{\text{m}^2}$
- Kirchhoff-Plattentheorie

$\nu = 0$ für Vergleich mit Czerny-Tafeln

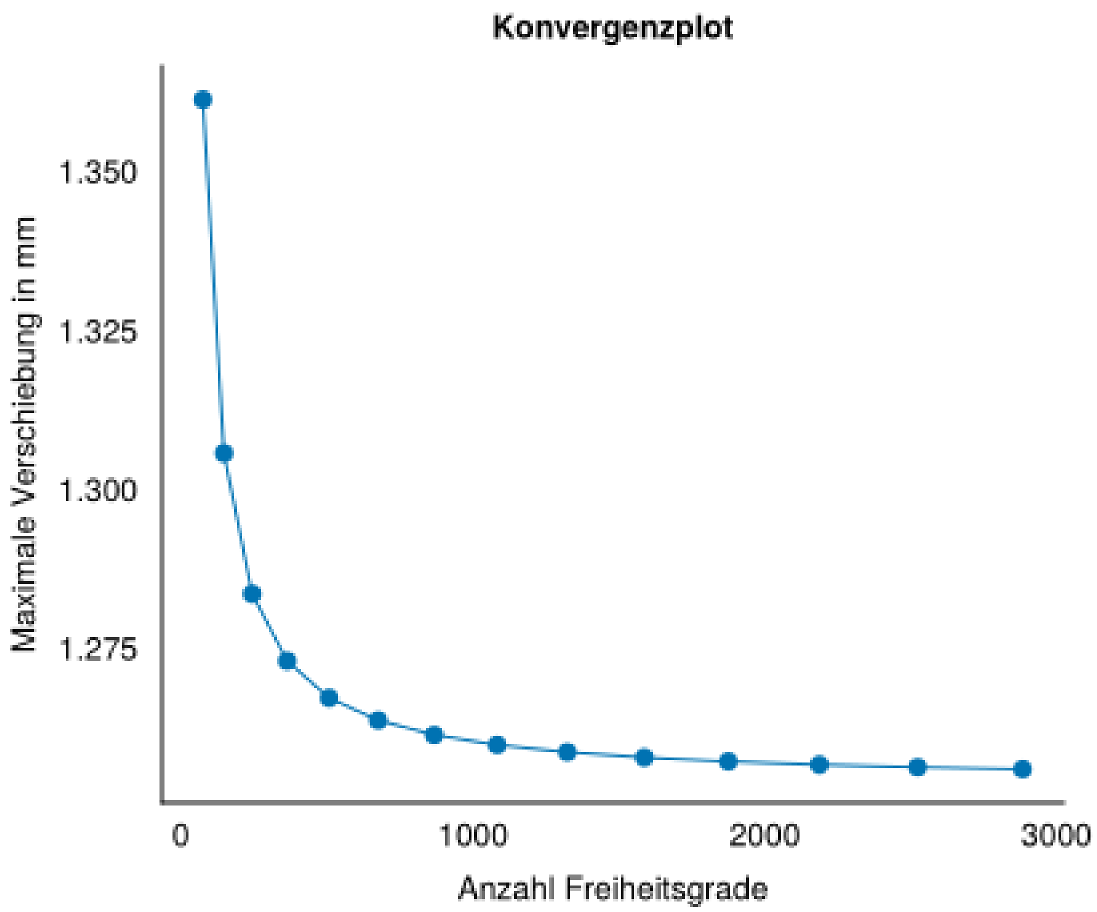
1.2 Konvergenzplot

Zusammenhang zwischen der Anzahl an Freiheitsgraden und der maximalen Verschiebung. Es ist erkennbar, dass mit steigender Anzahl an Freiheitsgraden, also einem feineren Netz, die maximale Verschiebung immer weiter angenähert wird.

```
CairoMakie.activate!()
l = 8
nn = zeros(0);
ww = zeros(0);
for n = 4:2:30
    mn, wn = plate(p, n)
    push!(nn, 3 * nnodes(mn))
```

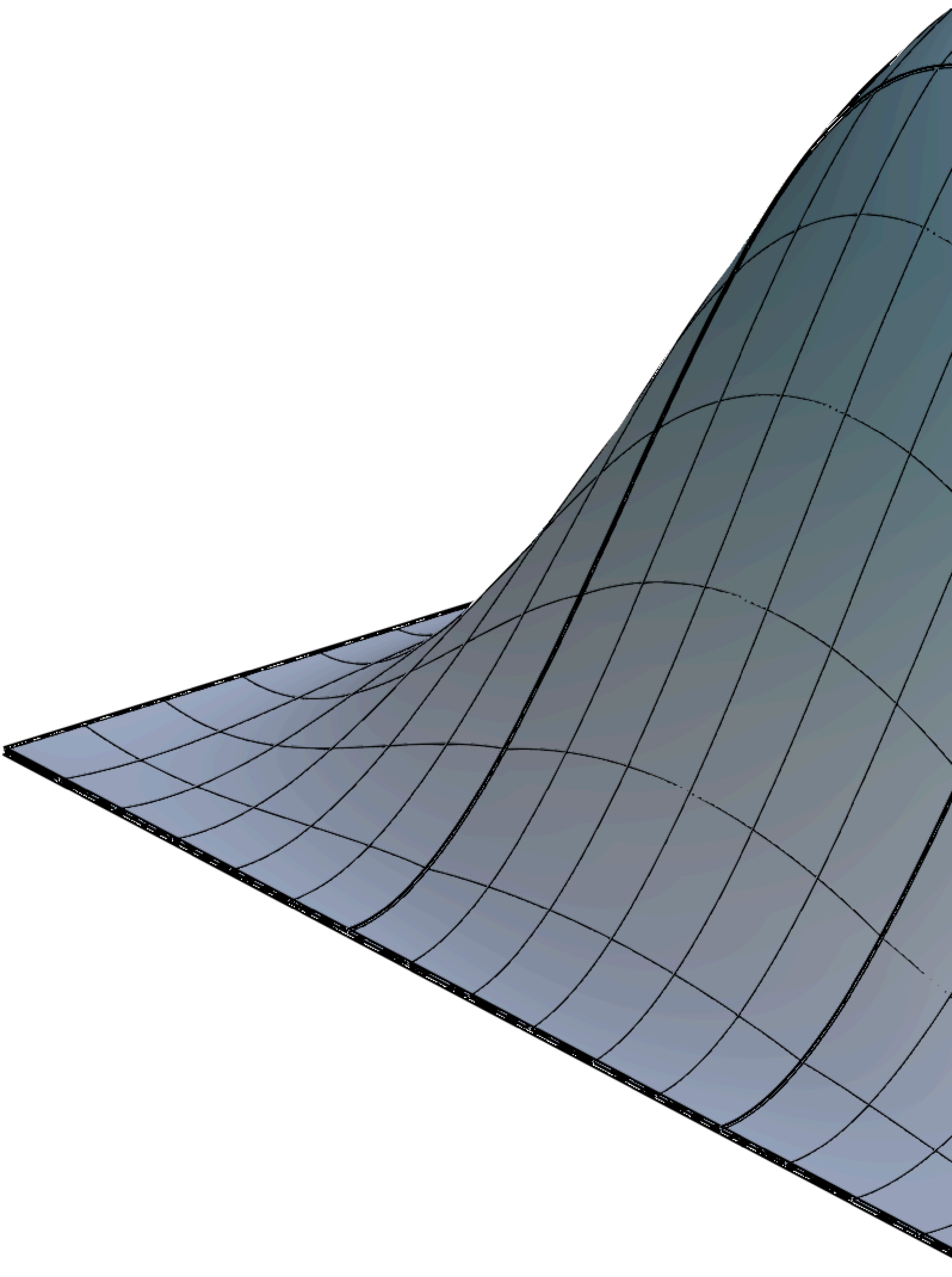
```
    push!(ww, maximum(abs.(wn[1:3:end])))
end
w_fe = ww[end];
```

```
fig = Figure(size = (230, 200),fontsize = 6, linewidth = 0.5)
Axis(fig[1, 1], title = "Konvergenzplot",xlabel="Anzahl Freiheitsgrade", ylabel="Maximale Verschiebung in mm",spinewidth= 0.5)
scatterlines!(nn, ww*1000,markersize = 5)
fig
```



1.3 Ergebnisse der Verformung

```
plotsol(p,3)
```



1.4 Schnittgrößen

```
m,wHat = plate(p,5)

# postprocessor(p, wHat)
```

```
(===============================================================================================================
Mesh{2, 2}
===============================================================================================================
Topology{2}
Entities
         0: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21,
22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36]
         2: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21,
22, 23, 24, 25]
Links
    (2, 0): [[1, 2, 8, 7], [2, 3, 9, 8], [3, 4, 10, 9], [4, 5, 11, 10], [5, 6, 12, 11],
[7, 8, 14, 13], [8, 9, 15, 14], [9, 10, 16, 15], [10, 11, 17, 16], [11, 12, 18, 17], [13,
14, 20, 19], [14, 15, 21, 20], [15, 16, 22, 21], [16, 17, 23, 22], [17, 18, 24, 23], [19,
20, 26, 25], [20, 21, 27, 26], [21, 22, 28, 27], [22, 23, 29, 28], [23, 24, 30, 29], [25,
26, 32, 31], [26, 27, 33, 32], [27, 28, 34, 33], [28, 29, 35, 34], [29, 30, 36, 35]]
---------------------------------------------------------------------------------------------------------------
Geometry{2} with 36 Points
x1: [0.0, 1.6, 3.2, 4.8, 6.4, 8.0, 0.0, 1.6, 3.2, 4.8, 6.4, 8.0, 0.0, 1.6, 3.2, 4.8, 6.4,
8.0, 0.0, 1.6, 3.2, 4.8, 6.4, 8.0, 0.0, 1.6, 3.2, 4.8, 6.4, 8.0, 0.0, 1.6, 3.2, 4.8, 6.4,
8.0]
x2: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.6, 1.6, 1.6, 1.6, 1.6, 1.6, 3.2, 3.2, 3.2, 3.2, 3.2,
3.2, 4.8, 4.8, 4.8, 4.8, 4.8, 4.8, 6.4, 6.4, 6.4, 6.4, 6.4, 6.4, 8.0, 8.0, 8.0, 8.0, 8.0,
8.0]
---------------------------------------------------------------------------------------------------------------
GroupCollection
  boundaryedges: EdgeGroup[1, 4, 5:3:14, 15, 19, 26, 30, 37, 41, 48, 51, 52:2:58, 59, 60]
  boundaryfaces: FaceGroup[]
  boundarynodes: NodeGroup[1:7, 12, 13, 18, 19, 24, 25, 30:36]
  edges: nothing
  faces: nothing
  nodes: nothing
  solids: nothing
===============================================================================================================
,      [-2.0249880217090452e-16,      3.738543898759306e-17,      8.64655092710053e-17,
1.7269909242774179e-16,        -1.6735353443862075e-16,        -2.074188759825175e-16,
1.7041781004673273e-17,        -8.488200228995857e-18,        -2.7913315143841113e-16,
-6.632305862834048e-17  …  0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0])
```