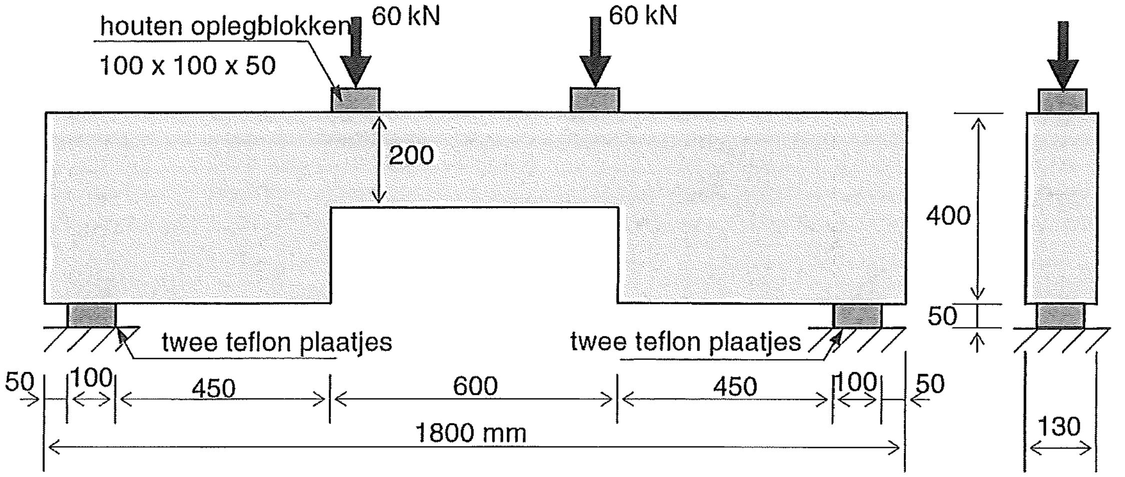
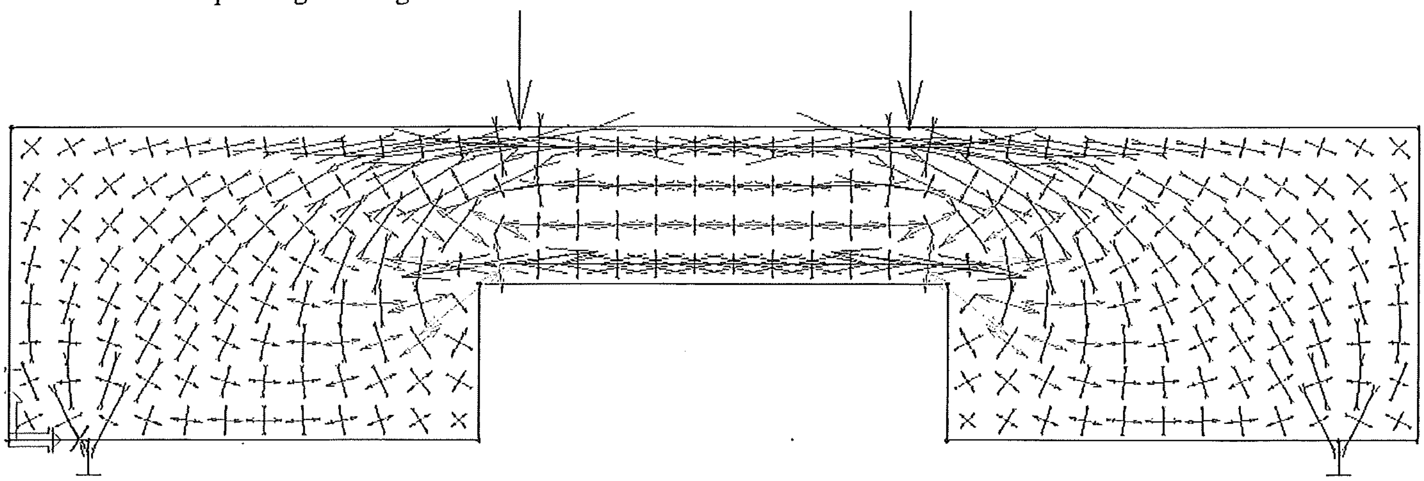
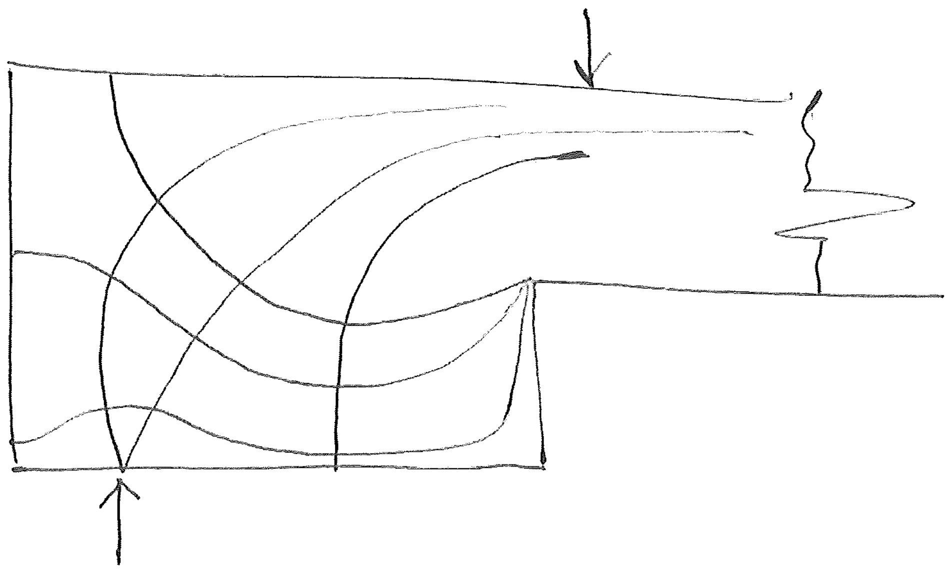
Voorbeeld



Hoofdspanningsrichtingen



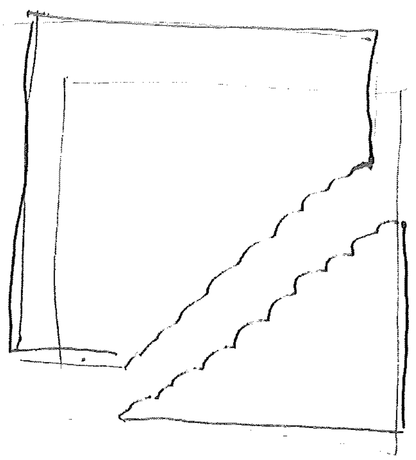
Volg met een potlood de pijlen, dan krijg je de trajectoriën.



De trajectoriën staan loodrecht op elkaar en loodrecht op de randen.

(Vierkantennet)

Het kubusje schuift

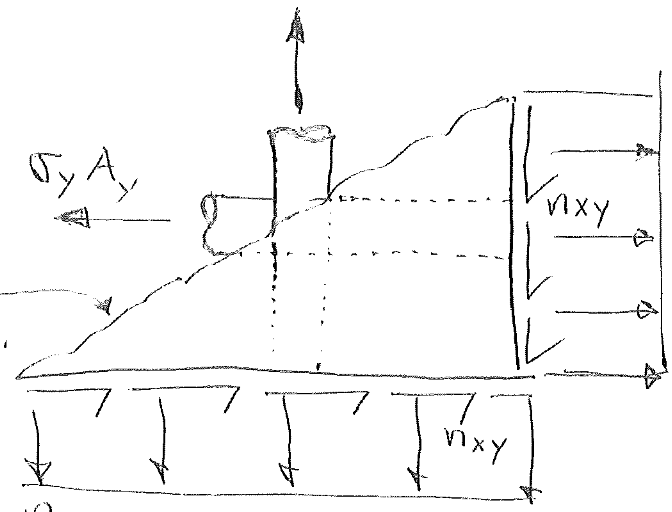


uiterste grenstoestand (UGT)
wanneer het aan het instorten is.

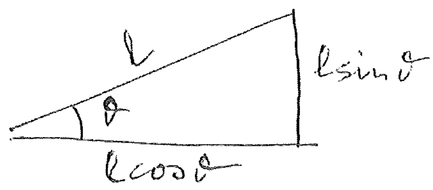
Er zit wapening in (géén bewapening)

vloeispanning

$\sigma_y A_x$ ← doorsnede oppervlak



helemaal geen spanning.
(In werkelijkheid schuifspanning.
aggregate interlock)



Evenwicht in de x-richting:

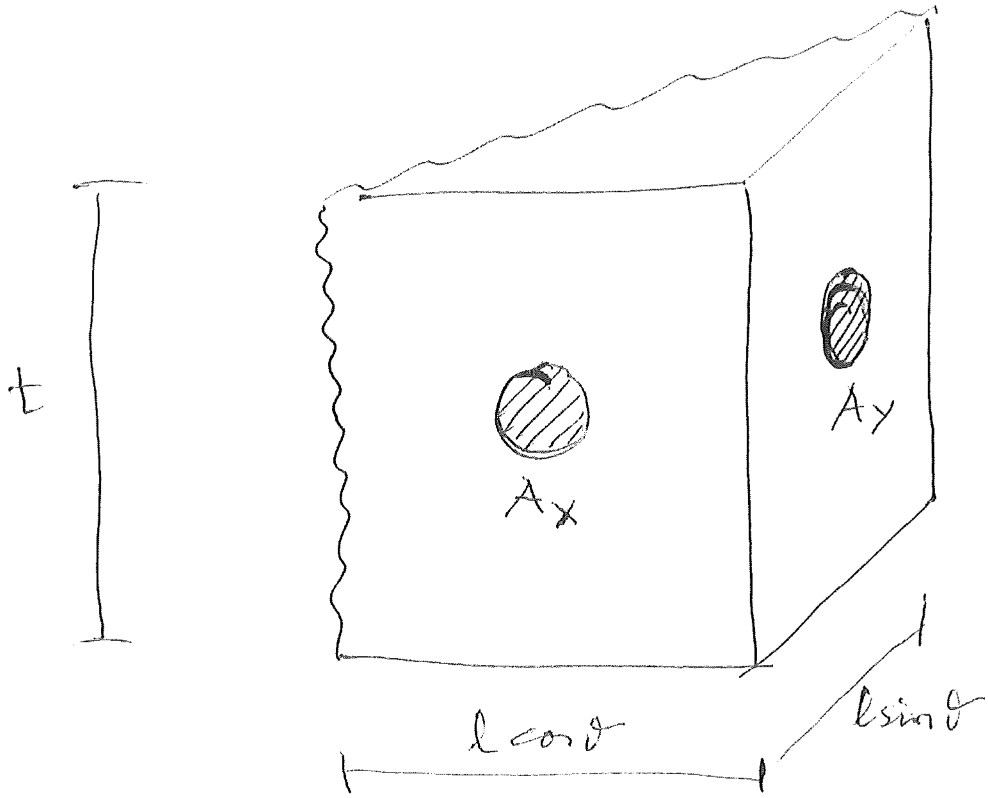
$$n_{xx}\, l\cos\theta + n_{xy}\, l\sin\theta = \sigma_y A_x \qquad (1)$$

Evenwicht in de y-richting:

$$n_{yy}\, l\sin\theta + n_{xy}\, l\cos\theta = \sigma_y A_y \qquad (2)$$

Wapeningspercentages

$$\rho_x = \frac{A_x}{t\, l\cos\theta} \qquad \rho_y = \frac{A_y}{t\, l\sin\theta} \qquad (3)\ (4)$$


t
A_x
A_y
$l\cos\vartheta$
$l\sin\vartheta$

De belasting n_{xx}, n_{yy}, n_{xy} dragen met zo min mogelijk wapening.

$$\rho = \rho_x + \rho_y = \text{minimaal} \qquad (5)$$

$$\rho_x \geq 0 \qquad \rho_y \geq 0$$

substitueer (1) in (3)

$$\rho_x = \frac{n_{xx} \cancel{l} \cos\theta + n_{xy} \cancel{l} \sin\theta}{\sigma_y t \cancel{l} \cos\theta}$$

$$= \frac{n_{xx} + n_{xy} \tan\theta}{\sigma_y t} \qquad (6)$$

subsitueer (2) in (4)

$$\rho_y = \frac{n_{yy} l \sin\theta + n_{xy} l \cos\theta}{\sigma_y t l \sin\theta}$$

$$= \frac{n_{yy} + n_{xy} \cot\theta}{\sigma_y t} \qquad (7)$$

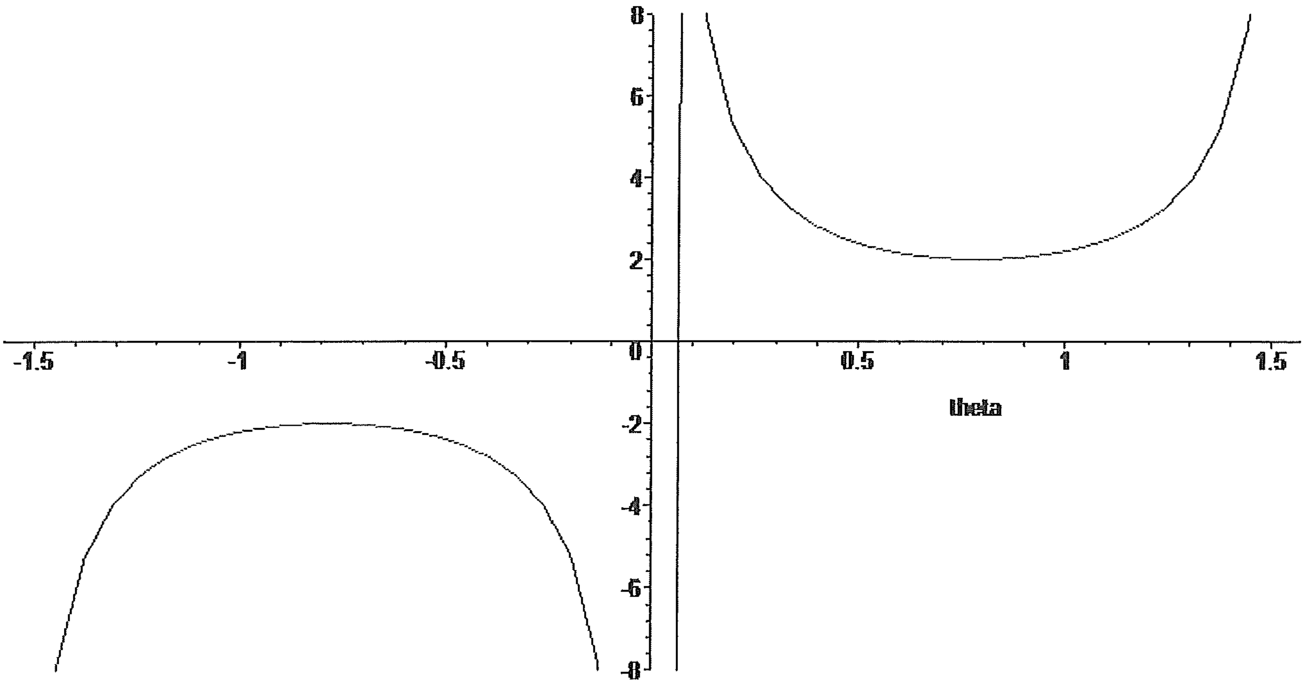
substitueer (6) en (7) in (5)

$$\rho = \frac{n_{xx} + n_{yy} + n_{xy}(\tan\theta + \cot\theta)}{\sigma_y \cdot t}$$

Maple 13 - [Untitled (1) - [Server 1]]

File Edit View Insert Format Spreadsheet Window Help

```
> restart:
> f1 := tan(theta) + cot(theta):
> plot( f1, theta= -Pi/2..Pi/2, -8..8 );
```




```
> f2 := diff( tan(theta)+cot(theta), theta );
```

$$f2 := \tan(\theta)^2 - \cot(\theta)^2$$

```
> solve( f2=0, theta );
```

$$\frac{\pi}{4}, -\frac{\pi}{4}$$

```
> theta:=Pi/4:
> tan(theta);
```

$$1$$

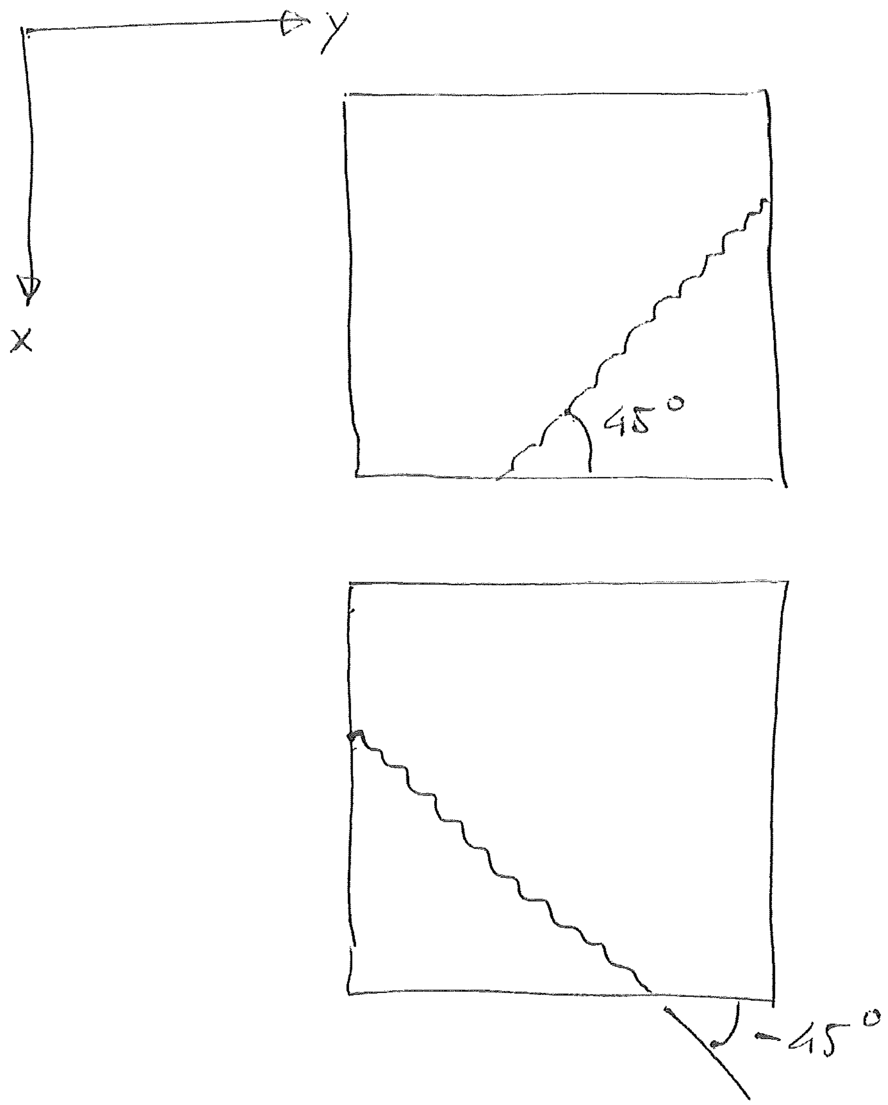
```
> theta:=-Pi/4:
> tan(theta);
```

$$-1$$

Time: 0.3s | Bytes: 1.44M | Available: 676M

Dus:

Als we de wapening minimaal kiezen is de scheurrichting 45° of −45°



De optimale wapening is

$$\rho_x = \frac{n_{xx} + |n_{xy}|}{\sigma_y t}$$

$$\rho_y = \frac{n_{yy} + |n_{xy}|}{\sigma_y t}$$

spanning in beton

$$\sigma_c = \frac{-2|n_{xy}|}{t}$$

Tenzij $\rho_x < 0$. In dit geval is de optimale wapening (zonder bewijs)

$$\rho_x = 0$$

$$\rho_y = \frac{n_{yy} - \frac{n_{xy}^2}{n_{xx}}}{\sigma_y t}$$

$$\sigma_c = \frac{n_{xx} + \frac{n_{xy}^2}{n_{xx}}}{t}$$

Tenzij $\rho_y < 0$. In dit geval is de optimale wapening (zonder bewijs)

$$\rho_x = \frac{n_{xx} - \frac{n_{xy}^2}{n_{yy}}}{\sigma_y t}$$

$$\rho_y = 0$$

$$\sigma_c = \frac{n_{yy} + \frac{n_{xy}^2}{n_{yy}}}{t}$$