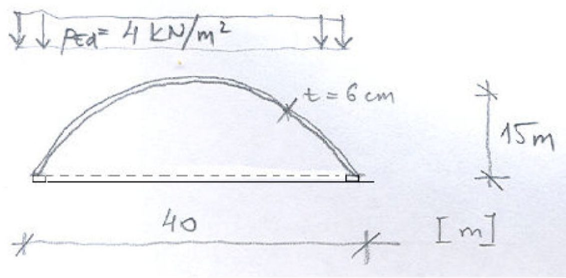
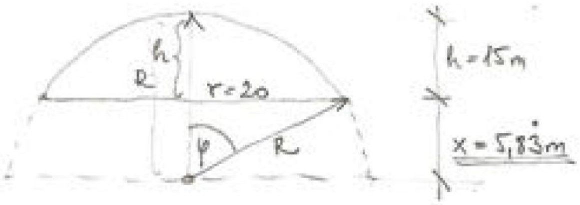
Spherical dome



Calculate the ring-directional and meridian-directional forces in the given structure with the given constant load!
Draw internal force diagrams!
Determine the appearing force in the edge-ring!

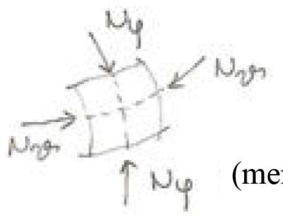
Data: L=40,0m, f=15,0m, t=6cm, p_{Ed}=4,0kN/m² (horizontal projection of the constant load)

Geometry



$$R^2 = 20^2 + (R-15)^2$$
$$R^2 = 400 + R^2 - 30R + 225$$
$$30R = 625$$
$$\underline{R = 20{,}8\dot{3}\ \text{m}}$$
$$\sin\varphi = \frac{20}{20{,}83} \rightarrow \underline{\varphi = 73{,}77^\circ}$$

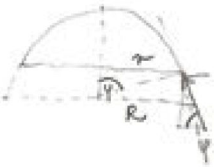
Internal forces



(ring direction)

(meridian direction)

Equation of the vertical forces → Nφ

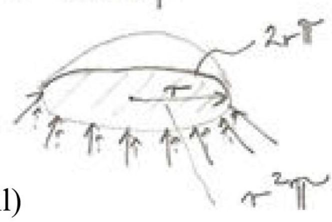


$$N_\varphi^V = \frac{r^2\pi \cdot p_{Ed}}{2r\pi}$$

$$N_\varphi \cdot \sin\varphi = \frac{R^{\cancel{2}} \cdot \sin^{\cancel{2}}\varphi \cdot \cancel{\pi} \cdot p_{Ed}}{2 \cdot \cancel{R} \cdot \cancel{\sin\varphi} \cdot \cancel{\pi}}$$

$$N_\varphi^V = N_\varphi \cdot \sin\varphi$$
$$r = R \cdot \sin\varphi$$

$$\boxed{N_\varphi = \frac{R \cdot p_{Ed}}{2}} = \frac{20{,}83 \cdot 4}{2} = \boxed{\underline{41{,}67\ \text{kN/m}}\ N_\varphi}$$



(constant along the shell)

Boiler-formula → Nυ

$$p_{Ed} \cdot \cos^2\varphi = \frac{N_\varphi}{R} + \frac{N_\vartheta}{R}$$

At the lower edge: $\varphi = 73{,}77°$

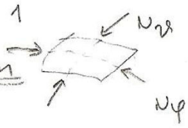
$$\boxed{N_\vartheta = p_{Ed} \cdot \frac{R}{2}\left(2\cos^2\varphi - 1\right)} = 4 \cdot \frac{20{,}8\dot{3}}{2}\left(2 \cdot \cos^2 73{,}77° - 1\right) =$$

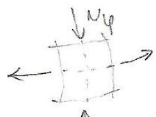
$$= \underline{-35{,}16\ \mathrm{kN/m}}$$

At the top of the dome:

$$N_\vartheta = 4 \cdot \frac{20{,}8\dot{3}}{2}\left(2 \cdot \underbrace{\cos^2 0}_{1} - 1\right) =$$

$$= \underline{41{,}67\ \mathrm{kN/m}}$$

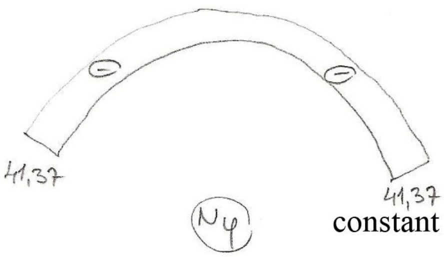




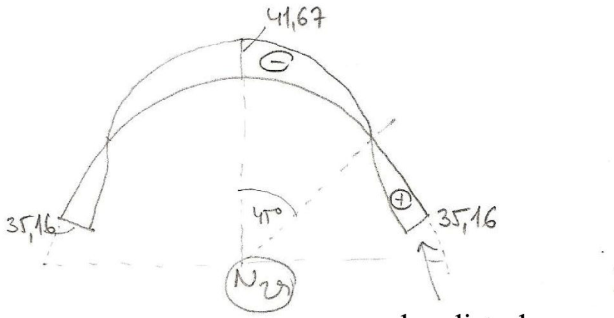
$N_\vartheta = 35{,}16\ \mathrm{kN/m}$
(tensed)

$N_\varphi = 41{,}67\ \mathrm{kN/m}$
(compressed)

Internal force diagrams:

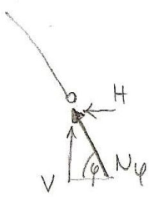


constant



edge disturbance

Equilibrium of the edge: Nυ all along



$$V = N_\varphi \cdot \sin\varphi = 41{,}67 \cdot \sin 73{,}77° = \underline{40{,}0\ \mathrm{kN/m}}$$

$$H = N_\varphi \cdot \cos\varphi = 41{,}67 \cdot \cos 73{,}77° = \underline{11{,}65\ \mathrm{kN/m}}$$

N_{ring}=H*r= $11{,}65 \cdot 20 = \boxed{233\ \mathrm{kN}}$
(Boiler formula)