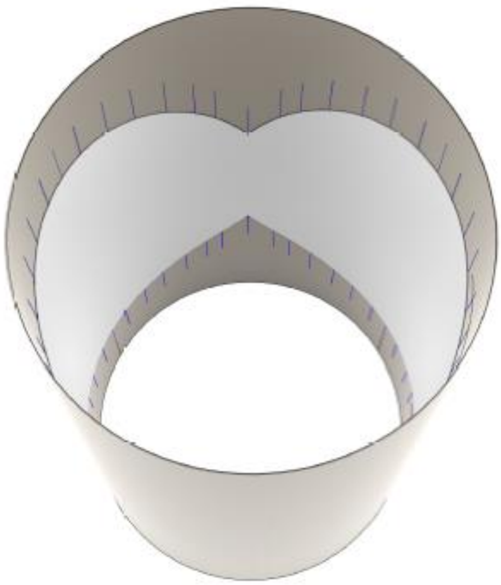
BUITINK TECHNOLOGY
Advanced Lightweight Structures

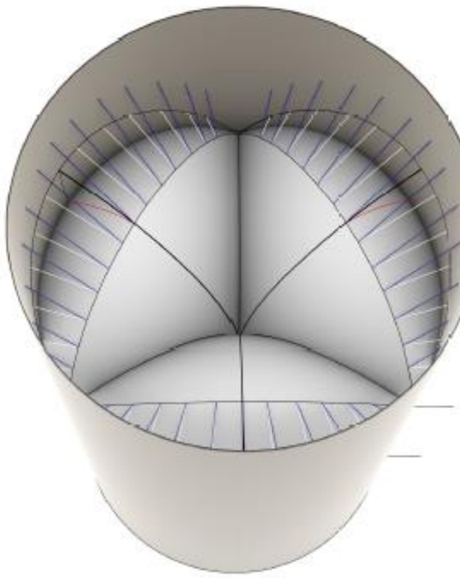
Content: 21.08.3800_ME01_BT_Chimney Valve

Inflatable chimney valve

Buitink Technology has developed an inflatable chimney valve to close a chimney if needed. When the valve is not inflated, it is positioned towards the wall of the chimney by means of springs.



Perspective



Perspective

In the chimney, a draft occurs. In this document is shown a possible behaviour of the valve due to this draft.

Draft specification

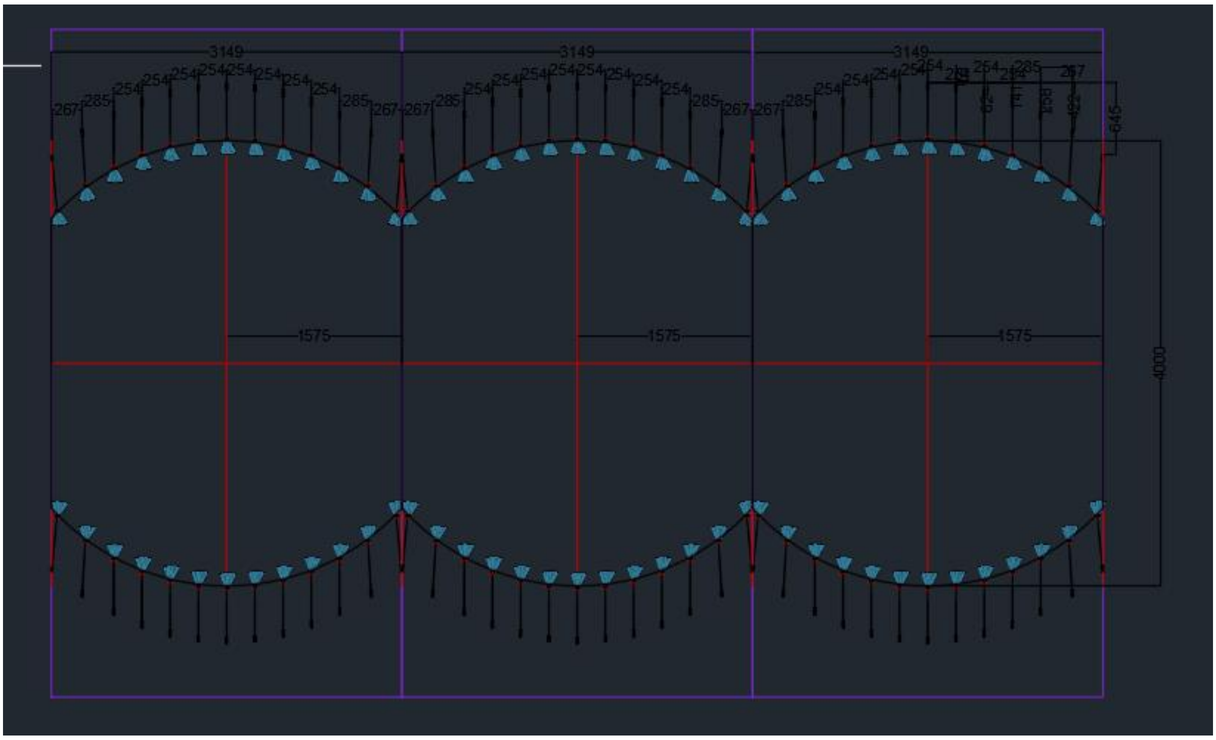
A draft is specified at a speed of 40 km/h or 11.1 m/s. This can be translated into a pressure by means of

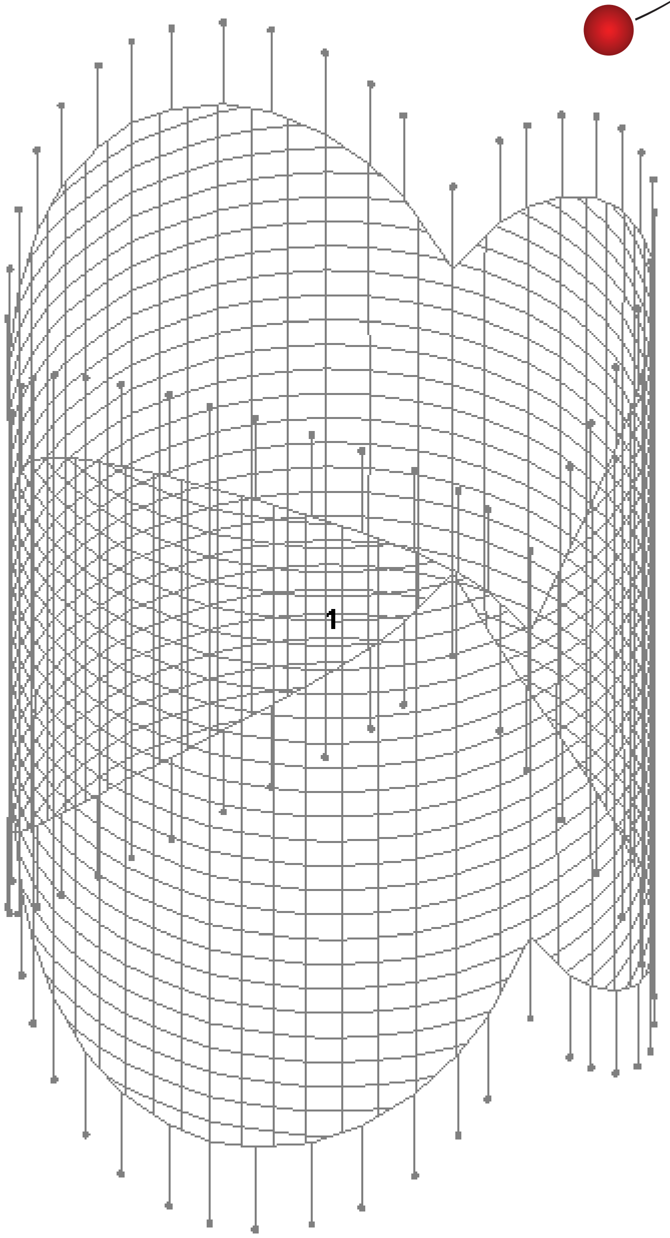
$½ \times q \times v^2 = ½ \times 1.25 \times 11.1^2 = 0.08$ kN/m^2.

Modelling

To analyse the effect of the draft, the valves are modelled into the finite element package EASYVOL that is specially developed for inflatable structures.

To do so, the cutting patterns made by Buitink are used as a starting point for the geometry.



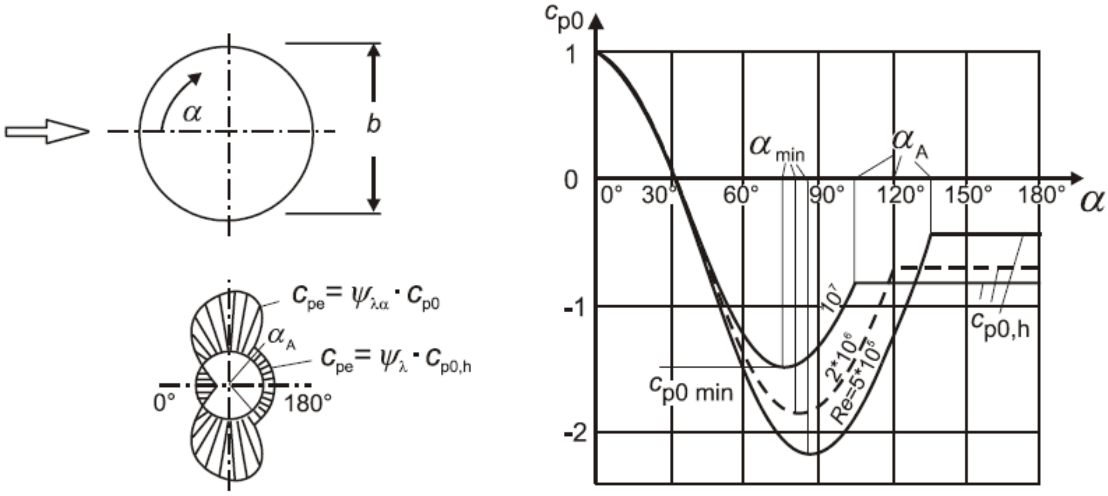


Although not visible, there are 2 layers of fabric modelled so simulate the cushions. Since the air is pulled out of the cushions when empty, an inner pressure in the cushions of 0 Pascals is assumed.

The daft will cause a suction to cushions that are positioned at the wall. The cushions will move inward. This inward movement creates a narrowing of the chimney. A narrowing forces the air to move faster and a venturi effect is created. This will be balanced by the air that can pass at the back of the valves, as at the moment that the valves move inward, the rims of the cushions will get distant from the chimney wall.

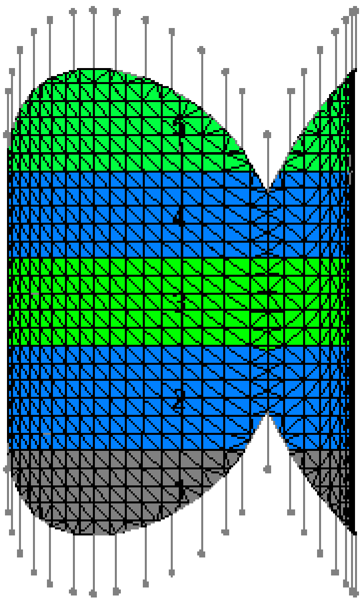
Shape factors

To get an indication of the deformation caused by the draft, an analogy is used for wind flow around circular objects as the valves will get a circular or droplet shape due to the draft.



[from EN-1991-1-4 figure 7.27]

A max Cp value of -2 can be assumed. Over the height of the valves following distribution is made:



Cp = 0.7

Cp = 2

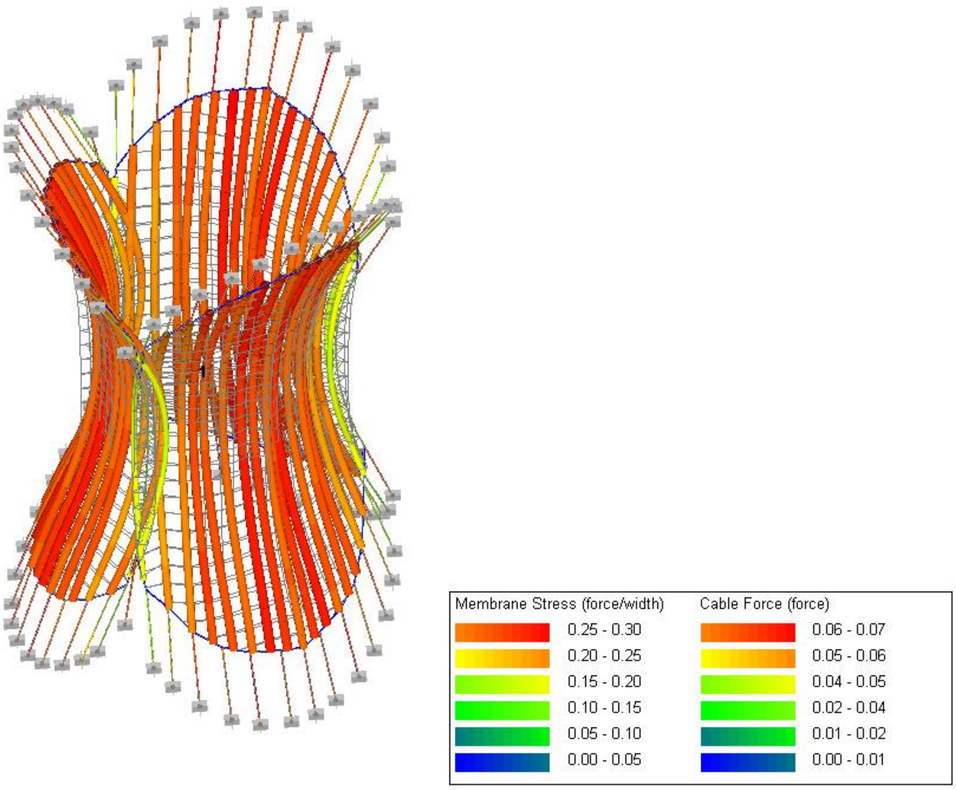
Cp = 1.5

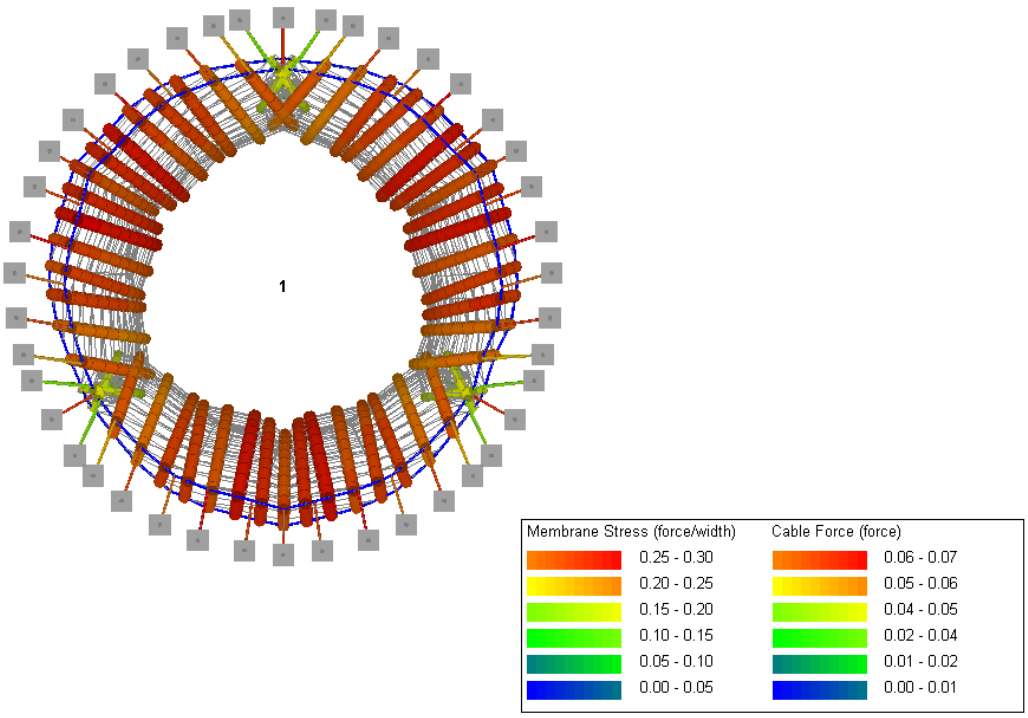
Cp = 0.9

Cp = -0.5

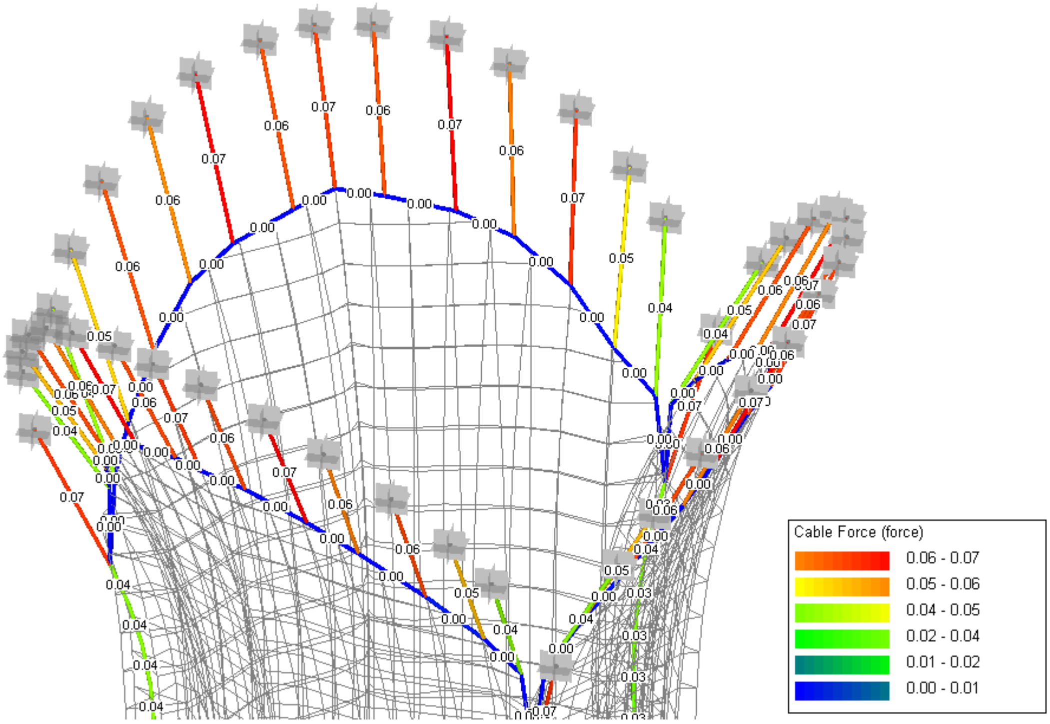
The resulting suction on the valves is obtained by mulitplying the suctions force and the Cp values.

Result of the analysis





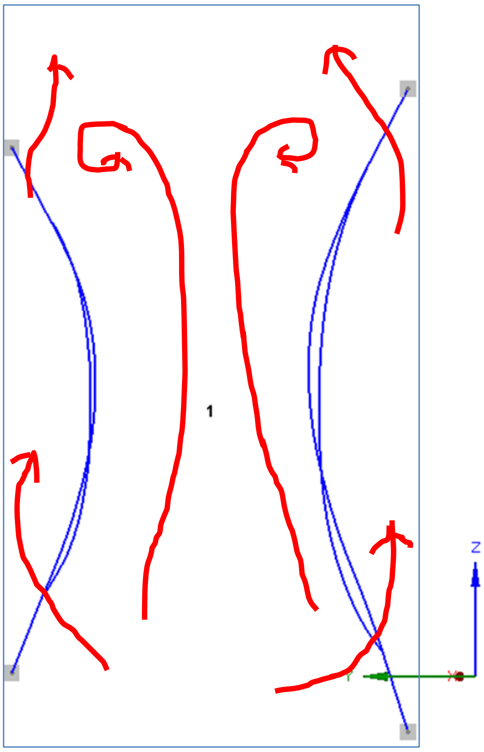
As can be seen, the valve moves inward under the draft. The stresses in the fabric stay low, appr. 0.30 kN/m’ whereas the fabric has a capacitiy of more than 8 kN/m’.



Forces in the springs are maximum 70N, where the capacity of the springs is appr. 200N. there is no overloading of the springs.

Conclusion

The draft in the chimney will cause the valves to move inward. The magnitude of the draft does not create an overloading situation of the fabric.
The fact that the fabric will move inward due to the suction caused by the draft, will cause a distance between the fabic and chimney wall. The air in the chimney then can also pass at the backside of the valves, creating underpressure and therewith reducing the magnitude of the the inward movement.



Possible air flow along Valve shown in cross section over chimney and valves.