



Towards a Model for Simulating Driving Rain on an Inclined Roof during Wind Gusts and Heavy Rain

Introduction

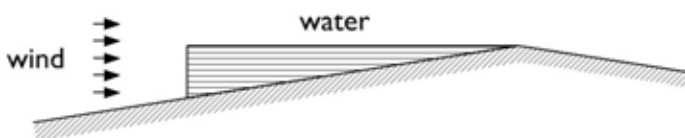
Figure 1 shows the roof of a shopping place in Amsterdam collapsed during a storm with heavy rain showers in 2002.



The main problem was that driving rain apparently washed over edges that were designed to hold the water. This is the motivation for the key research question: Can we simulate the height of the water near the edges of an inclined roof during heavy rainfall and wind gusts?

Modeling problem

Figure 2 visualizes the height of the water on an inclined roof during rainfall and wind [1].

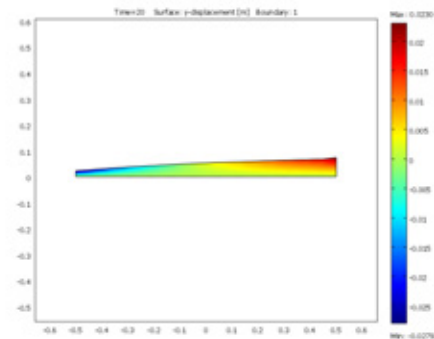


The main parameters of the default model are summarized:

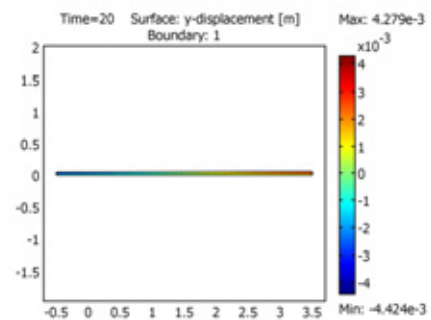
- (1) Water is used as material;
- (2) Transient simulation from initial height to steady state;
- (3) The roof inclination is modeled by 'inclined gravity' (angle is zero, i.e. horizontal);
- (4) The upper boundary is moving wall boundary with a wind induced stress of 30 N/m^2 .
- (5) Other boundaries are modeled as slipping walls.

Results using Comsol

The results of the default model with a small length of a horizontal roof (1m) are presented below. Figure 3 presents the height of the water.



A first improvement was to increase the length of the horizontal roof to the size of the compartments (10 m). However stable results were only obtained for a roof length up to 4 m. Figure 4 shows the results



Conclusions

It is concluded that combined application modes of Incompressible Navier-Stokes (ns) and Moving Mesh (ale) seems promising in simulating the height of the water near the edges of an inclined roof during heavy rainfall and wind gusts. However there are still a lot of features to be implemented before more realistic simulation results can be obtained. Furthermore if it would be possible to obtain realistic results, there would also be a great opportunity to combine this model with a structural mechanics model of the roof construction. The latter would provide a new and unique tool to reduce the risk of roof failures.

[1] Borst, J. de, 2009, 'een oriëntatie op het gedrag van waterlagen op platte daken' (A study on the behavior of water layers on flat roofs), Concept master thesis, Eindhoven University of Technology,