Large Ray Optics Simulations for the Prediction of Solar Radiation Concentration Due to Reflective Walls

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Abstract

Abstract: Some of recent and unconventional buildings are using reflective material for their walls. In case of curved walls, like in the Vdara Hotel tutorial, or of complex shape walls like in the present case, the risk of solar radiation concentration is difficult to predict. Such concentration may damage the impinged material. Then it has to be studied by simulation.

The presented case deals with a very complex. The reflective walls consist of some thousands pieces to fill the complex shapes of the buildings. Unfortunately, for property and confidentiality reasons, we are not able to publish images of this project in this article. Then only small parts of it will be shown.

The simulations were done using COMSOL Multiphysics® software and the Ray Optics Module. The geometry were done from CAD data and some small modifications in order to be able to do the volume mesh. The surfaces mesh specifications allow 2 triangles at least for each piece of plane surface of the walls. The mesh consist in 2,3 million of triangles and more than 14 million tetraedra. The model uses solar source on all external surfaces of the domain, specular reflection on all wall surface and windows, and accumulator on bottom surface where the concentration phenomena has to be evaluated.

The study has been organized in 3 steps. Step 1: simulations every hours of the 1 of each month. Step 2: simulation every minutes in order to check the minimal duration of a concentration, and the frequency of the 3rd step. Step 3: systematic simulation, every 1/4h during all summer months. A part of the reflexion is diffusive, but for memory usage reasons we used the surface to surface radiation model, from the Heat Transfer Module, for this part. The results show a large area with total received radiation density over 1100W/m2 during midday in June and July, and few spot of radiation over 1400W/m2.

Figures used in the abstract

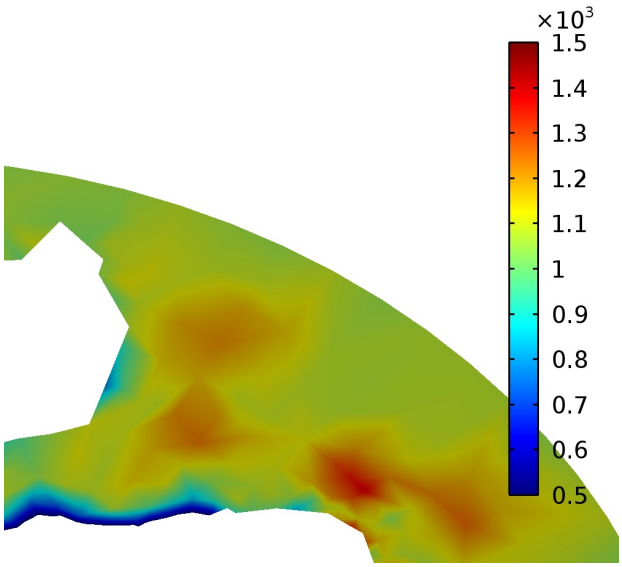

Figure 1

Figure 2

Figure 3

Figure 4