

Solar Panels Wind Load - CFD Simulation Results

Input Parameters

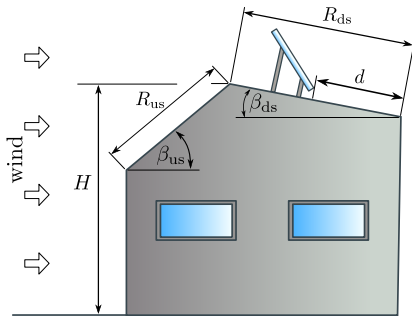


Fig 1.: Building height and solar panel position on roof.

Parameter	Note	Unit	Value
H	building ridge height	m	5.0
R_{us}	roof width upstream	m	5.0
R_{ds}	roof width downstream	m	3.0
β_{us}	roof angle upstream	°	45.0
β_{ds}	roof angle downstream	°	10.0
d	edge distance to panel	m	1.0

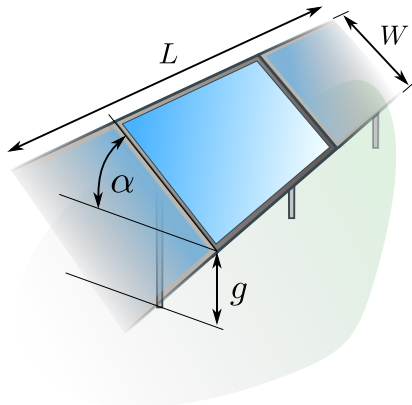
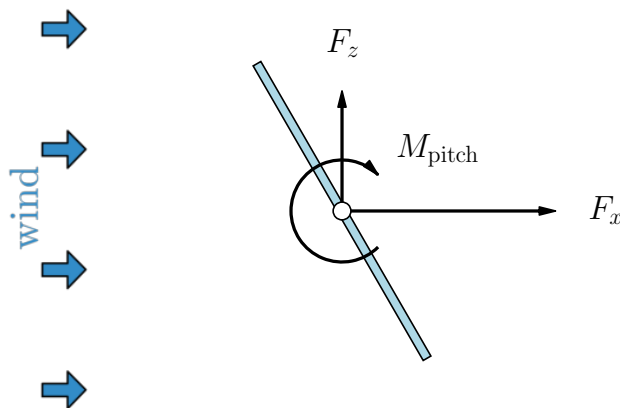


Fig 2.: Solar panel dimensions and position.

Parameter	Note	Unit	Value
L	panel or row length	m	5.2
W	panel or row width	m	1.15
g	gap between panel and roof surface	m	0.2
α	panel tilt angle	°	60.0
U_{ref}	Wind speed	m/s km/h mph	27.8 100.0 62.1
	panel orientation		back
	terrain type		type_II
Z_{ref}	Reference height above ground for U_{ref}	m	10.0

Simulation result summary



Output	Note	Unit	Result
F_x	horizontal force	N kg* lb*	1158.3 118.1 260.4
F_z	vertical force	N kg* lb*	659.1 67.2 148.2
M_{pitch}	pitching moment	Nm	135.6

Fig 3.: Forces and pitching moment acting on solar panel(s). Wind direction is from the left.

Explanation of F_x and F_z :

F_x and F_z are the wind loads exerted on the solar panel or row of panels. If F_z is pointing upward, the wind load is lifting the panels. On the other hand, when F_z is pointing downward, the wind load is pushing the panels downward. (*) For easier understanding wind loads are also given in the mass units kilograms *kg* and pounds *lb*. (In some cases, the forces might point counterintuitively against the global wind direction due to a large vortex on the building's roof. Refer to the videos to get an impression of what is going on.)

Explanation of M_{pitch} :

Whereas F_x and F_z are forces that try to move the panels, M_{pitch} is the pitching moment that tries to turn the panels.

Reference point:

The reference point of F_x , F_z and M_{pitch} is centered in the panel or row of panels.

IMPORTANT:

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Wind speed and air pressure



Fig. 4: Figure of the model domain containing a distribution of wind speed U in m/s around the solar panel. The wind flow direction is from left to right. Note that the panel might appear very small due to the large domain size.

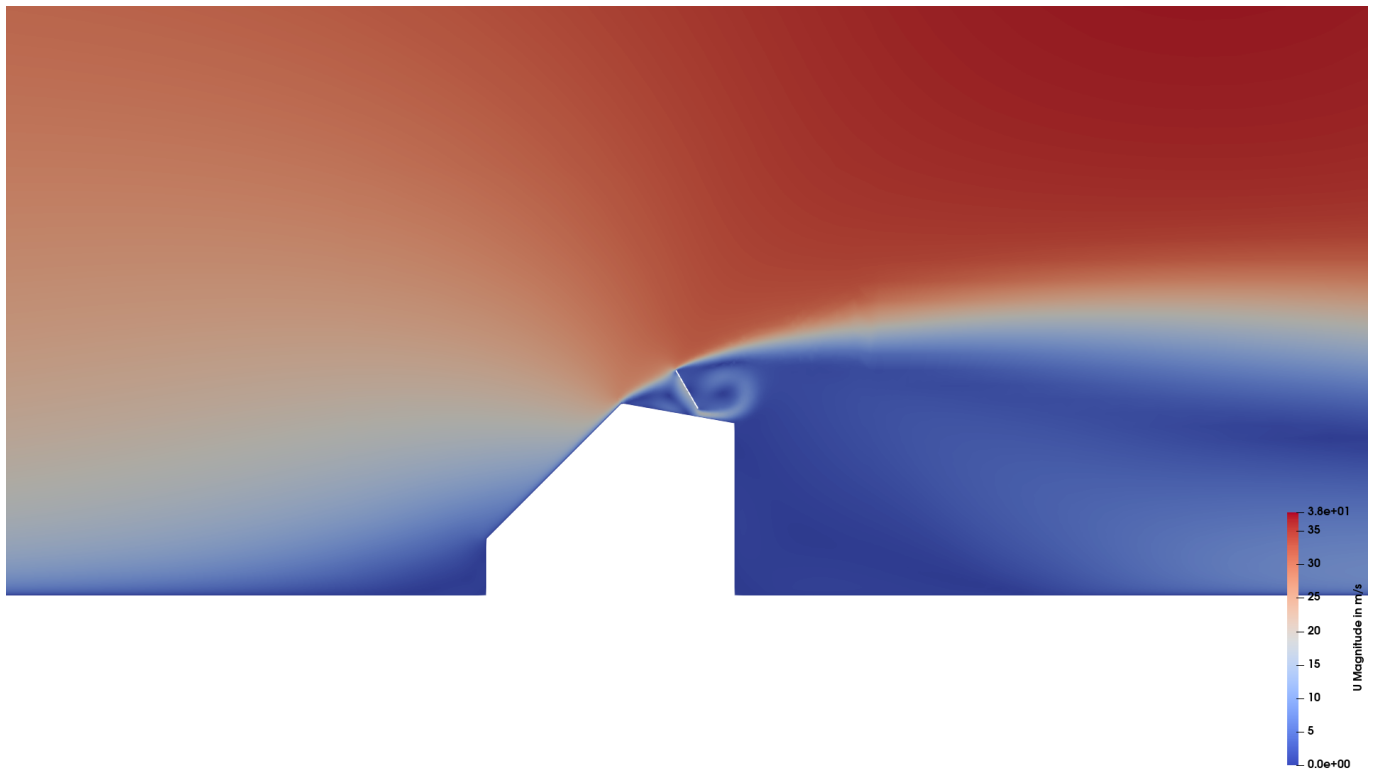


Fig. 5: Closeup-figure showing the wind speed U in m/s around the solar panel.



Fig. 6: Closeup-figure of the relative air pressure p in Pa around the solar panel.

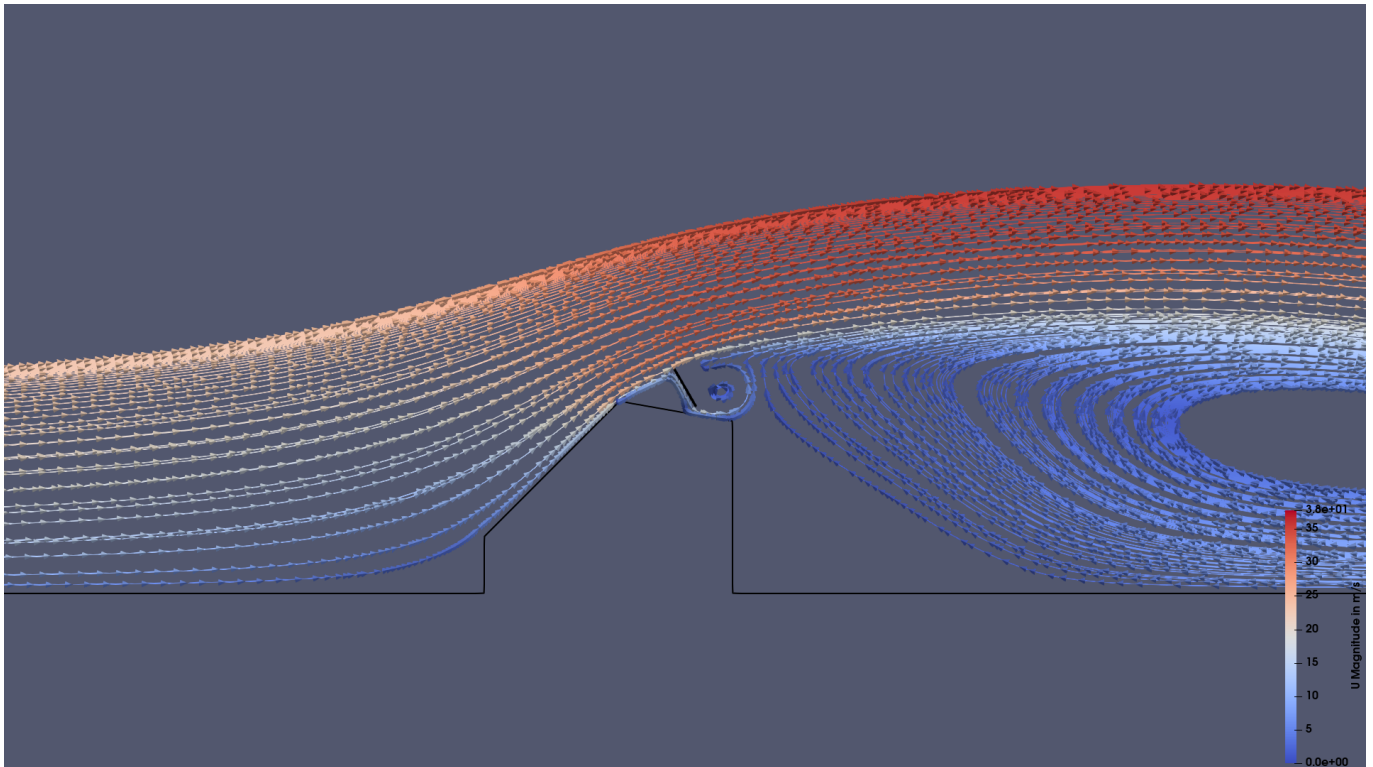


Fig. 7: Streamlines (travel paths of air molecules). Color indicate flow speed U in m/s. Arrows indicate flow direction.

Model Info

CFD Solver	OpenFOAM
solution type	incompressible, transient
turbulence	Reynolds Averaged Simulation (RAS)
inflow properties	atmospheric boundary layer (ABL)
extraction of F_x , F_z and M_{pitch}	based on time averaging the stable phase at the end of the solution time.

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