NUMERICAL INVESTIGATION OF WIND EFFECTS ON ROOF-MOUNTED OBJECTS WITH VARIOUS SHAPES

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Wind flow over low-rise buildings is quite complicated because of the flow separation over the roof. Accordingly, wind flow over roof-mounted objects such as water tanks, solar panel arrays, solar water heaters, and chimneys mounted on a low-rise building can drastically influence the flow patterns and pressure distribution on roofs and the object. A series of Computational Fluid Dynamics (CFD) simulations were conducted to estimate the drag forces on objects and lift forces on the roof. Different shapes of objects were modelled on the leeward and windward slopes of a gable roof to estimate their susceptibility to wind damage. Wind-induced pressure on roofs was estimated to investigate how these objects affect the wind flow over the gable roof. This study gives suggestions for the selection of the best aerodynamic shape, orientation, or installation location for a certain roof-mounted object to avoid wind damage. The lift coefficients showed a variable change with different shapes of objects mounted on the windward and leeward slopes of the roof. The results showed that the objects mounted on the windward slope are more prone to wind damage as they experienced the largest wind loads, and objects with sharp edges experience the highest drag forces. The solar panel array mounted on the leeward slope closer to the ridge showed a 51% reduction in lift coefficients and the solar panel array mounted in the middle of the windward slope showed a 42% increase in lift coefficients compared to the bare roof case. Finally, this study recommends that it is safer to mount objects on the leeward slope and mounting a solar panel array on the leeward slope closer to the ridge can reduce the overall lift force acting on the roof of a low-rise gable roof building. Also, this study recommends avoiding solar panel arrays installed at the middle of the windward slope as it can compromise the safety of both the object and the roof.

Keywords: Wind loads, Roof-mounted objects, Low-rise buildings, CFD, Drag and lift coefficients

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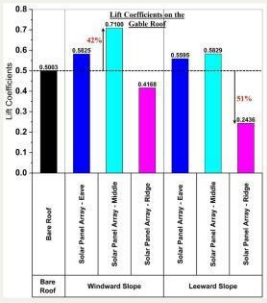
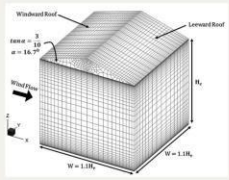
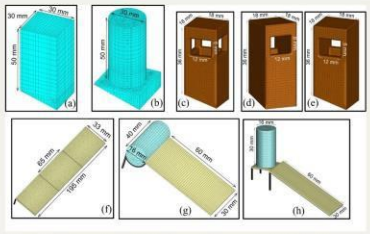
This numerical investigation recommends advantageous installation locations, shapes and orientations for different roof-mounted objects on a low-rise gable roof building against extreme wind effects.

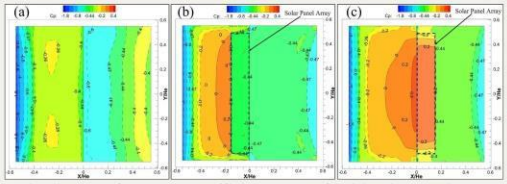


Lift coefficients on roof with varying installation locations for solar panel arrays.





Base case low-rise gable roof building and modelled roof-mounted objects.



Distribution of pressure-coefficients on roofs with solar panel arrays mounted on leeward and windward slopes close to the ridge.

Objects	Recommended Shape / Orientation	Recommended Installation Location
Water Tanks	Cylindrical Shape	Leeward Slope
Solar Panel Arrays	Tilted Solar Panels	Windward Slope - Eave Leeward Slope - Eave Leeward Slope - Middle
Solar Water Heaters	Vertically Oriented Tank	Leeward Slope
Chimneys	Windward 2 Openings	Leeward Slope

Major Recommendations

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