Wind Loading on Ground-Mounted East-West Solar Farms

JAMES HORSLEY\textsuperscript{12}, VICTOR REGO\textsuperscript{2}

\textsuperscript{1}SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING, UNSW, SYDNEY, AUSTRALIA
\textsuperscript{2}5B, ALEXANDRIA, AUSTRALIA
What happens when we get it wrong

https://www.youtube.com/watch?v=VjeIzcVgI0
Outline

Why is wind loading important

How to make sure we get it right

What results we have found so far
Background and declaration of interest

Mechanical engineering student at UNSW, Sydney

Work part-time at 5B, a solar company based in Sydney

Completing my thesis to investigate the effects of wind on east-west solar arrays

Wind tunnel testing data for the project has been supplied by 5B
Why do we care about wind loading?
Predominant loading case for solar farms

Four main load types to consider for structural design:

- **Snow**
  - For alpine and sub-alpine regions within Australia
- **Earthquake**
  - For structures where failure would risk loss of human life
- **Self-weight**
  - Weight of racking systems is light compared to wind loads
- **Wind**
How can we make sure we get it right?
We need to improve our knowledge of the area

Wind loading is an extremely complex field

Literature specific to east-west solar farms is limited

This means we need to draw parallels from literature on similar structures
East-west solar systems

Key Features:
Shape
Ground clearance
Farm arrangement
Comparison Structures

Shape:
- Free-standing pitched roof [1]

Ground Clearance:
- Fixed-Tilt Modules [2]

Farm Arrangement:
- Fixed-Tilt Farms [3]
What should we be looking out for?

Wind direction
- The direction the wind hits the panels affects how it flows over them

Ground clearance
- Friction between the wind and the ground greatly affects the flow characteristics

Shielding
- Upwind panels absorb most of the energy of the wind

Aspect ratio

Row and column spacing
How are we improving our knowledge? – Wind tunnel testing

- Wind direction
  - 360° at 10° intervals

- Ground clearance
  - 2 different ground clearances (250mm and 500mm)

- Shielding
  - 3 different positions of a MAV in an array

- Aspect ratio
  - 3 different MAV widths

- Row and column spacing
  - 2 different row and column spacings

Model used was a 1:20 scale of a MAV
# Measurement

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Pressure tap locations

Pressure taps to measure pressure on panel

2 taps per location – upper and lower surface

10 taps per panel
What have we found?
Results

Wind direction
  ◦ Oblique wind directions cause the highest uplift

Ground clearance
  ◦ Higher ground clearance causes larger uplift

Shielding
  ◦ Inner MAVs and panels experience reduced loads

Aspect ratio
  ◦ Uplift does not change significantly with wider MAVs

Row and column spacing
  ◦ Presence of row spaces increases uplift
  ◦ Column spacing has little effect
Results – ground clearance

Larger ground clearance increases uplift pressure

250mm ground clearance

500mm ground clearance

Peak uplift per panel
Results – MAV farm

Shielding on inner MAVs

Presence of a row space increases uplift

Presence of a column space has negligible effect

Peak uplift per panel
Results – MAV farm

Shielding on inner MAVs

Presence of a row space increases uplift

Presence of a column space has negligible effect

Peak uplift per panel
Results – aspect ratio

Peak uplift not significantly affected by aspect ratio

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Peak uplift per panel
Results – Standalone MAV

Inner panels experience significantly lower loads

Peaks occurred at oblique wind directions
Next Steps

This is a great first step but there is much more to do

Future work will focus on providing more detailed insight into the flow characteristics around the MAV. This will be done by:

- Discretising data into wind directions
- Discretising data into pressure taps
- CFD simulation validated by wind tunnel data
References

