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Wind Load Design Considerations and Stowing Strategies for a Heliostat Field

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The heliostat field represents the largest contribution of almost half of the total capital cost of a concentrating solar thermal power tower plant (Kolb et al. 2011; Pfahl et al. 2017). Depending on heliostat size, approximately 80% of the total cost of a conventional heliostat is accounted for by the wind-bearing components including the elevation and azimuth drives (30%), pedestal, foundation and mirror support structure (Kolb et al. 2011). The heliostat drive units are a critical component that need to maintain structural stiffness during high wind periods while achieving good optical performance during operation of the field. The cost of the drive units can be effectively reduced with an accurate estimation of the wind loading on a heliostat over the expected range of elevation and azimuth angles during operation of a field. For instance, the elevation angle varies between 13° and 77° during operation of heliostats located at the edge of a 150 MW field, containing 35,000 heliostats distributed over a radius of 500 m in a surround field arrangement, (Vásquez-Arango 2016). Hence, this study aims to estimate the daily and seasonal variation of the hinge, azimuth and overturning moment loads on individual heliostats in the outer row at the boundary of a heliostat field. This will be achieved through the correlation of historical wind speed data measurements (Figure 1, left) by the DLR Institute of Solar Research at the Plataforma Solar de Almeria (PSA) in Spain and non-dimensional wind load coefficients on a scale-model heliostat (Figure 1, right) calculated at a range of elevation (α) and azimuth (β) angles in the University of Adelaide wind tunnel. The outcomes of the present study will provide an understanding of the variation of the design wind loads on individual heliostats in the outer exposed row of the field. This represents an area of important future work to stow the outer exposed region of a field during high-wind events and potentially increase the operating hours of protected regions of the heliostat field to maximize the yield of the power tower plant.

Figure 1. Meteorological mast at the PSA heliostat field site (left); model-scale heliostat load measurements in the University of Adelaide wind tunnel (right).

References

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