

Designing against Wind-loading: Prince Sultan Cultural Centre, Jeddah

Millwood House Consultants are involved in the development of the iconic Prince Sultan Cultural Centre in Jeddah, Saudi Arabia. They were seeking to design against wind loading of this structure to the relevant British Standard, and approached Wilde to assist them. Wilde used ANSYS software to calculate the wind flow and resultant pressure loadings, enabling Millwood to present reliable, high-quality information to their client.

Company

Millwood House Consultants Ltd are a group of 'solid, practical engineers' with a focus on innovation and cost-effective design solutions. With offices in three South-East England locations, they have undertaken major, multi-million pound projects, both within the UK and overseas.

Background

Millwood house is involved in the development of the Prince Sultan Cultural Centre in Jeddah, Saudi Arabia. This will be an iconic building. It will present as a large, upturned elliptical bowl containing an auditorium, nestling into a two storey 150m diameter circular building. The circular building will contain an underground car park at its lower storey. The entrance level, situated above the car park, will provide education spaces, exhibition spaces, hospitality areas, 'The Jeddah Experience', museum style visitor's centre, retail and multi-use spaces, all with high quality finishes. The roof above the entrance level will be a podium deck with planting, pools, seating and circulation routes for walking and meeting.

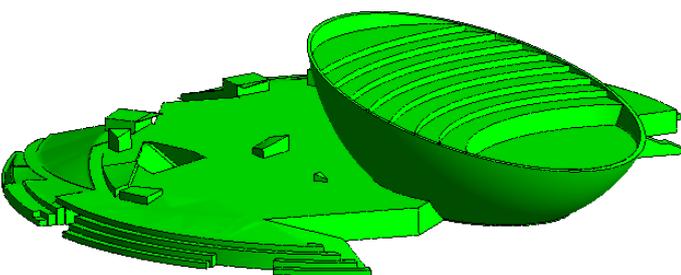


Fig. 2: Computational geometry (Courtesy: Millwood House Consultants)

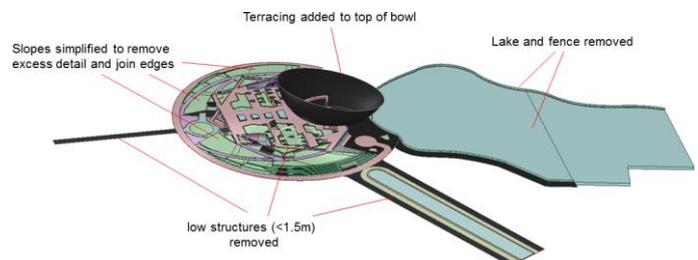


Fig. 1: Original geometry (Courtesy: Millwood House Consultants)

Challenge

In the middle of the Prince Sultan Cultural Centre's structure is a bowl measuring approximately 90 m long x 60 m wide x 30 m high at its highest point.

Millwood House were seeking to design against wind loading of this structure to the relevant British Standard.

The wind loading dictates the required strength of the cladding on the outside of the bowl. To this end, Millwood needed to calculate the forces on each element of the building based on the external pressures acting on those elements under a local "once in 50 years" maximum wind velocity.

“” The work provided enabled us to present high quality information to the client, which is excellent, given that the building is going to be an iconic one.

The British standard provides formula that enables the user to estimate wind loading on normal building shapes based on building height, prevailing wind conditions and the local environment. However, the formula cannot reliably be used for non-standard building shapes. In this case, estimation of the possible external pressures requires the wind flow around the building to be resolved.

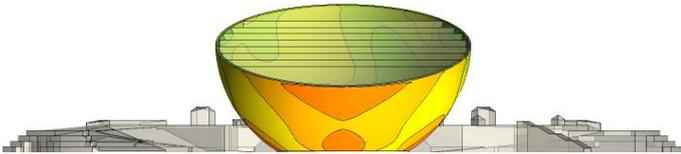


Fig. 3: Pressure contour map around sides of bowl, wind head on (Courtesy: Millwood House Consultants)

Solution

Wilde Analysis used computational fluid dynamics in the form of **ANSYS CFX** to model the wind flow and pressure field around the cultural centre and its local environment.

ANSYS SpaceClaim DirectModeler was used to convert CAD provided by Millwood House into a computational geometry covering the principal buildings of the Cultural Centre.

British Standard EN 1991-1-4 was used to guide the development of local boundary conditions based on the far field topology and wind maps for Saudi Arabia. Boundary velocity profiles were easily set up using the CFX expression language.

The wind flow and resultant pressure loadings around the bowl were calculated with the wind coming from 12 equally-spaced directions.

Business Benefits

The modelling was able to predict where and under what conditions the highest loads would occur, and to show that these loads will not be in excess of what would be expected for a conventional building under the same circumstances.