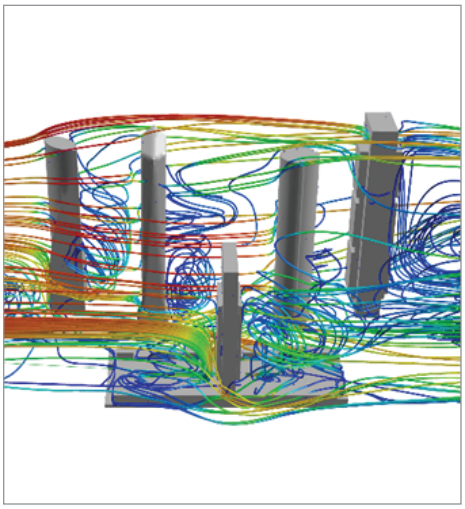
No more Gone with the Wind – Pedestrian Comfort Improvements on Quinta Torre with AcuSolve Computational Fluid Dynamics



Key Highlights

Industry
Civil Engineering, Architecture

Challenge
Predict wind conditions on the ground floor, identify problem areas with potentially stronger wind, and implement counteractive measures in the tower design

Altair solution
Altair's HyperWorks Suite, solidThinking Compose, and AcuSolve were used to conduct the analyses, including CFD analysis.

Benefits
- Results are available five months earlier than with common wind tunnel tests.
- Simulation helped the architects to make required adjustments before the final design and construction start of the building. Leading to time and cost savings.

Customer Profile

When building skyscrapers such as the Torre Caleido in Madrid, architects and builder-owners must consider many different aspects in their design. In addition to the actual architectural design and structural analysis of the building, the environment in which the building will be placed must be studied. In Madrid, naturally occurring wind loads are an important factor to consider, since they impact the construction itself and can cause discomfort for people who walk by or stay near the building.

Detailed flow studies have to be done to identify areas of possible discomfort or danger for pedestrians and find optimal design solutions.

Officially known as the Caleido project, the Fifth Tower in Madrid is owned by Inmobiliaria Espacio, a company that, among other services, deals with infrastructure and construction for all types of buildings.

Among its other properties, the company owns Torre Espacio in Madrid, which together with the fifth tower are two of the few landmark skyscrapers built in Spain to date.

The company in charge of the building design is Fenwick Iribarren Architects, founded in 1990 by the architects Mark Fenwick and Javier Iribarren. In addition to these Spanish projects, Fenwick Iribarren is well known abroad for its involvement on international projects in countries such as China, Dubai, Malaysia, and Morocco.

The Fifth Tower – An Emblematic Project for Madrid

With a height of 160 m (524 feet), Caleido is an emblematic project for the new skyline of Madrid. Its location, in the middle of the

Keywords: Espacio, The Fifth Tower, Architecture, Design, CFD AcuSolve, HyperMesh, solidThinking Compose

Fifth Tower Success Story

“The collaboration with Altair went very well. Since we knew that a lot of wind could occur in the commercial areas of the building, we wanted to make sure that we knew in which locations wind might occur and how much wind we would have to face, in order to make eventual design changes to guarantee pedestrian comfort in these areas. Since time is always short in these kind of projects, we wanted first results even before having finished the wind tunnel tests, so Altair proposed us the company´s simulation/CFD tool AcuSolve. After only a month we saw the first reliable results we could work with.”

Juan Diaz Marin,
Fifth Tower Technical Director at Inmobiliaria Espacio.

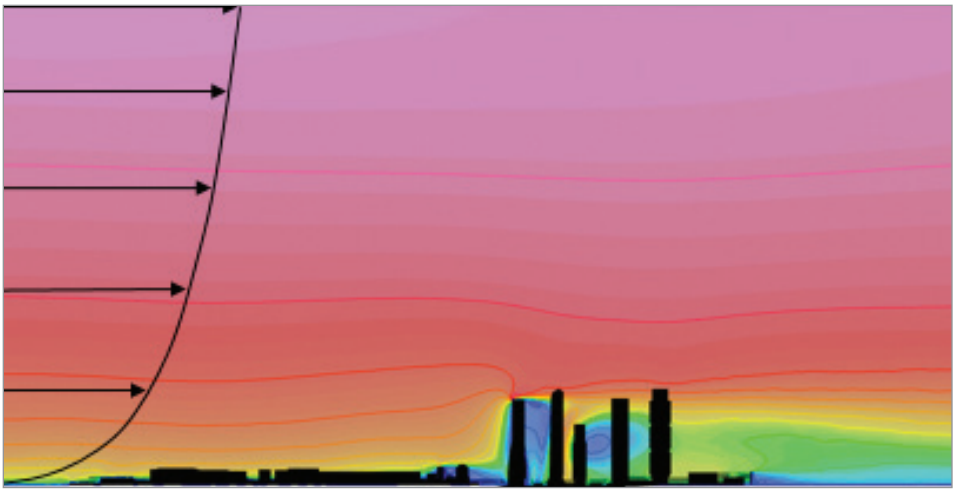
Four Towers business complex, has given the project its popular name: Quinta Torre, or Fifth Tower. Placed on a horizontal urban infrastructure base, the tower is located on the axis of the four existing towers. It stands out from the others for its slender and screened form and with its ratio of 1:4:9, the tower is designed as a minimalist element with references to the world of art, in particular to sculpture. It has a truly unique façade that emphasizes contrasts.

Work on the site began in April 2017. When completed in 2019, Quinta Torre will be the fifth tallest building in Madrid and the seventh tallest in Spain. The tower will offer office space, a health clinic, commercial space for shops and restaurants, and garden areas. The main tenant will be Instituto de Empresa. The design creates an authentic vertical campus containing plazas, double lounge areas and views toward the city of Madrid.

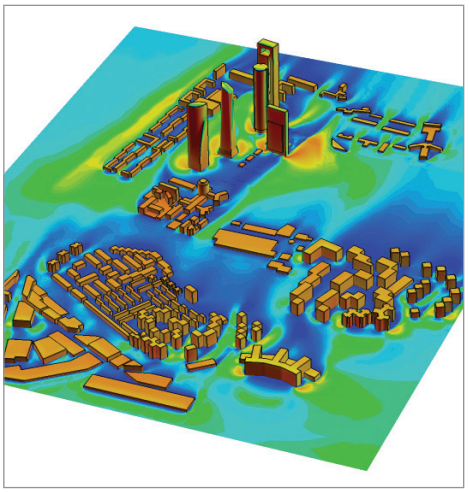
As a modern architectural project, priority is given to function and space. The ground floor is an open space which encourages the flow and comfort of pedestrians and those who use the facilities the building offers.

How to Improve Design Quickly with “Virtual Wind”

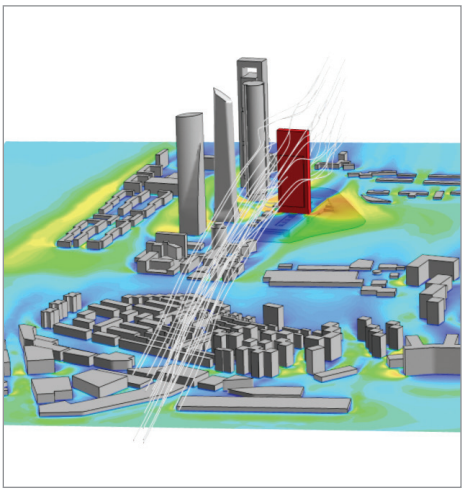
Madrid is well known as a windy city, and the area where the 4 towers are located experiences severe wind conditions on

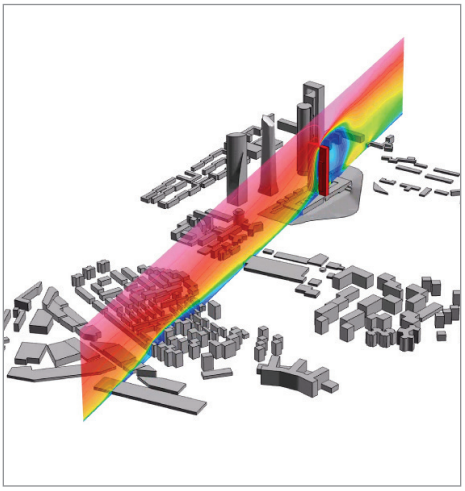


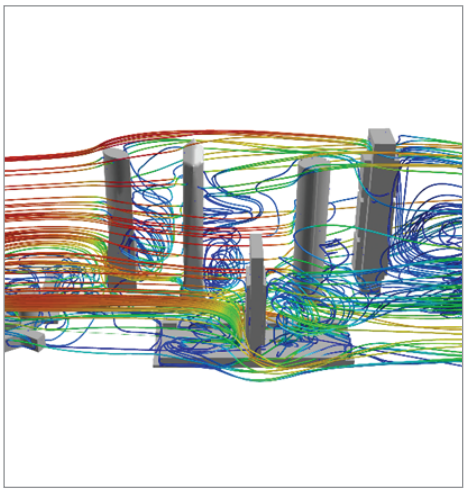
Wind profile applied to perform CFD simulation.



CFD results clearly indicate potential critical areas due to strong winds.







CFD analyses results can generate powerful visualization to study how wind interact with the buildings.
CFD analyses help architects and engineers to inform their decision and make necessary changes to improve the final design.

several days during the year. This could cause discomfort or even danger for people walking by or working near the building. A detailed study of the winds in the area was necessary to identify potential problem areas and implement counteractive measures in the tower design.

Altair offers to Inmobiliaria Espacio and Fenwick Iribarren Architects the possibility to analyse potential locations of strong winds based on data measurements from Madrid Barajas Airport by a CFD simulation of the area.

Studies like this are usually handled through wind tunnel tests, which could take up to six months. Because the project leads wanted this relevant information prior to concluding the wind tunnel tests, simulation provided a good solution to receive answers for these questions sooner. It is vital to have this kind of information as early as possible within the design process, since the new information might result in design changes, which would be unnecessarily cumbersome and expensive if carried out at a later point in time.

The Altair engineers, all from Altair's Spanish office in Madrid, used Altair's HyperWorks Suite and solidThinking Compose to conduct the analyses. AcuSolve, a proven asset for companies looking to explore their designs, was used for the Computational Fluid Dynamics (CFD) analysis. AcuSolve provides powerful fluid flow analysis capabilities without the difficulties associated with traditional CFD applications. HyperMesh, the suite's meshing tool, was used for pre-processing, and AcuFieldView, post-processor that has the ability to manage large and complex CFD data visualization requirements, was the chosen post-processing tool. solidThinking Compose, a high-level, matrix-based numerical computing language as well as an interactive and unified programming environment for all types of math operations, was used for data pre- and post-processing.

The simulation used a detailed collection of several years of wind data measurements from the Madrid Barajas airport to estimate the inlet wind speed and turbulence profile. The dimensions of the computational domain were chosen large enough to avoid creating artificial effects in the results; the horizontal homogeneity of the boundary layer was also taken into account and resolved. The roughness of the terrain was addressed by an explicit modeling of city buildings and with appropriate wall functions to implicitly model smaller objects such as trees, cars and streets. As described in the best practices guidelines, three different meshes were tested to check an independent mesh solution (the medium mesh contained almost 5 millions of nodes).

Based on the results from the CFD simulation, the Altair engineers estimated the percentage of annual time in which the wind speed exceeded a certain critical value, in the entire pedestrian area. These results identify the critical areas in the original design configuration. This allows to propose adjustments in order to attenuate the wind effect in some of these areas.

Results and Benefits

With a critical and stringent deadline, simulation made the results available earlier than common wind tunnel test.

The results helped the architects make required adjustments before the final design and construction start on the building. In the end, the simulation results were validated against the wind tunnel test results and showed a very good correlation.

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