Mechartés
SIMULATION EXPERTS

Thermal Comfort CFD Analysis

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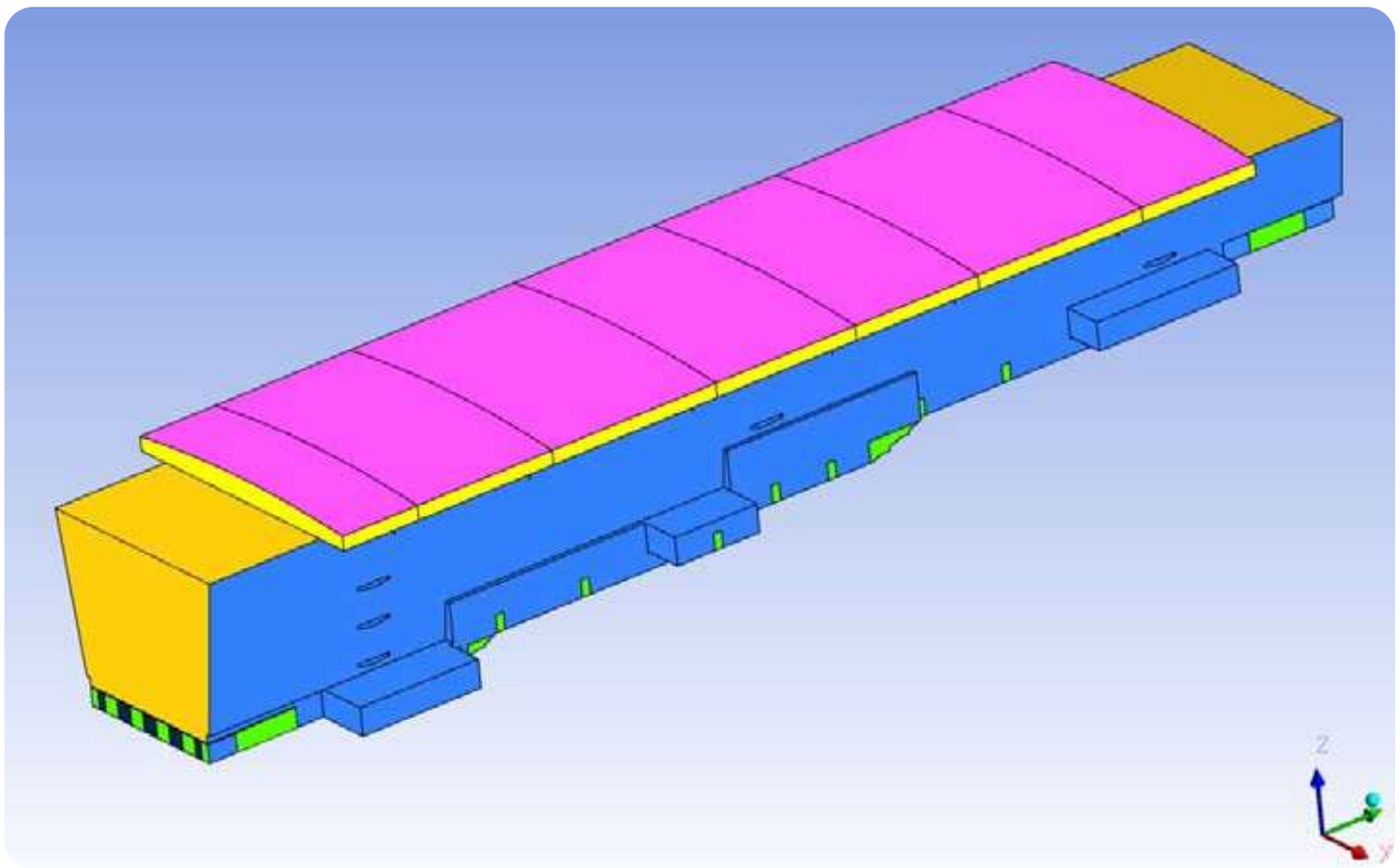
For the past 18 years, Mechartes have been working on various complex and unique building and infrastructure projects in the Middle East and across the globe in supporting the client to validate and optimize the HVAC design for Malls, Atria, Airports, mosques, temples, and churches.

Introduction

Indoor air quality in a space is influenced by the behavior of airflow, temperature distributions, and relative humidity, which vary with the number of people occupying the building. CFD Analysis helps designers and clients optimize the HVAC design to maintain proper airflow and temperature, often reducing the cooling and wastage of energy. To achieve thermal comfort inside a building, several conditions like air flow, temperature and relative humidity profiles and influence of special factors like heat source and design ventilation system are analyzed that expresses satisfaction with the thermal environment and is assessed by subjective evaluation for a given weather condition. Maintaining this standard of thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC/CFD Consultants.

In this case study we will see the application of CFD analysis for a large mall in the Middle east.



Objective

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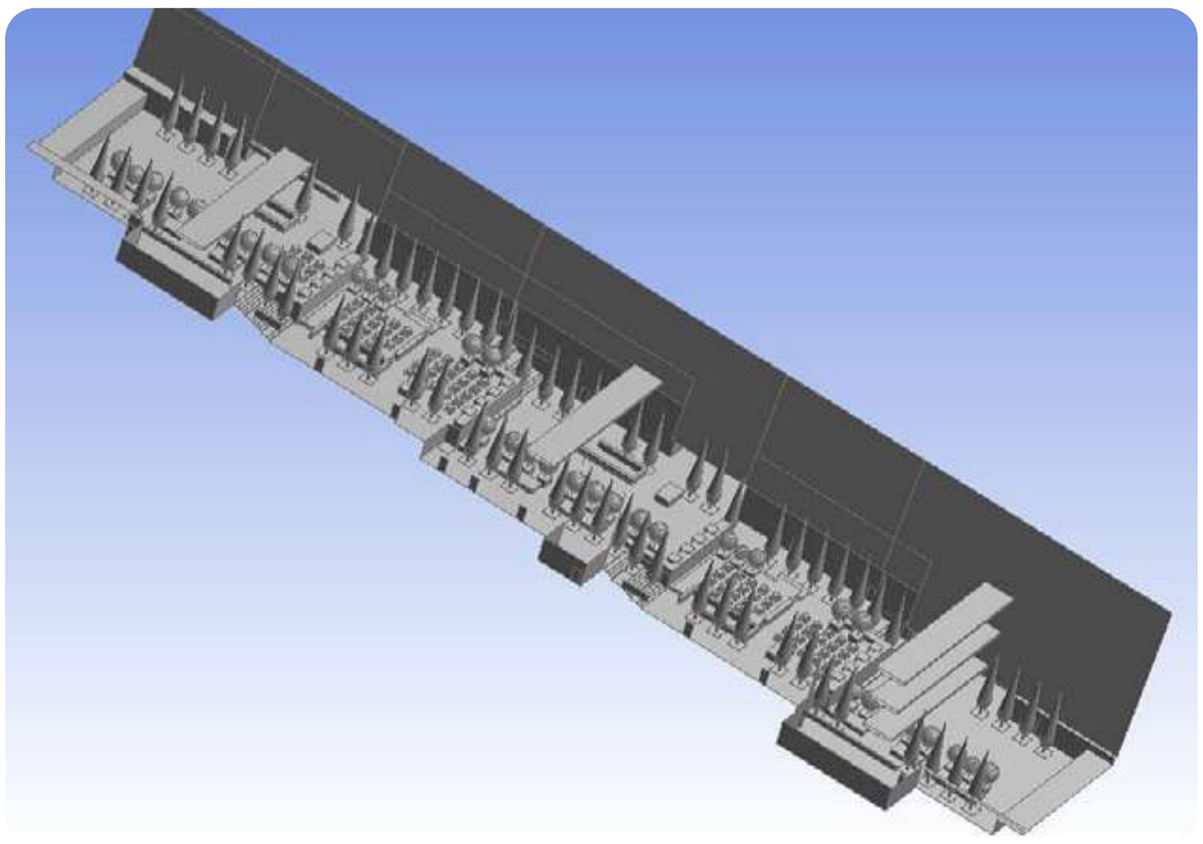
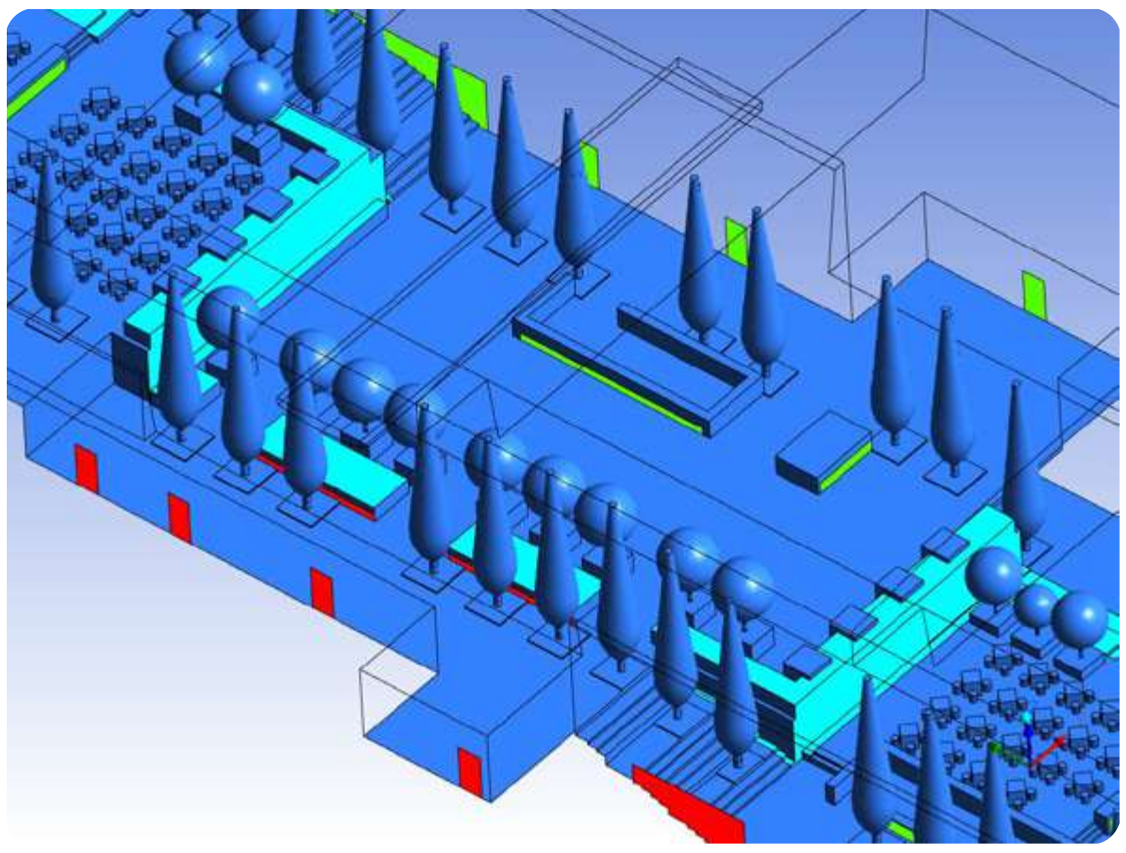
The work aims to check the parameters below for the designed air conditioning system and the given heat load conditions for the central garden area of the mall. As there were multiple artificial fountains in each level of the mall client also wanted to study the impact of the water bodies and wanted to check if there will be increase in the Relative Humidity.





i. To check whether the proper air circulation is maintained.

ii. To check whether the temperature of 24°C is maintained in summer condition and 20 to 24°C during the winter condition.

iii. To check whether the relative humidity of 40 to 70 % is maintained.

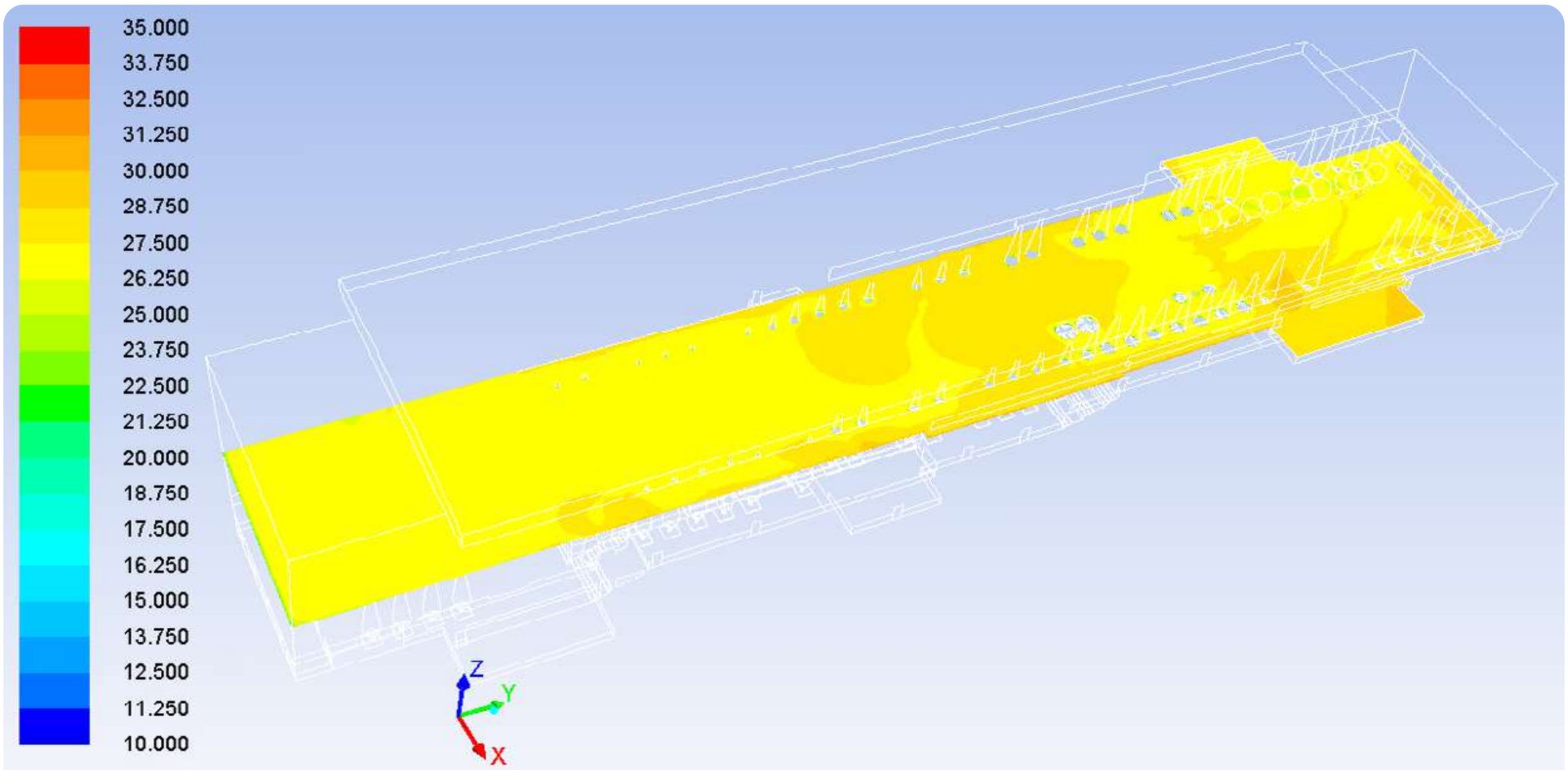
Modelling and Analysis

Modelling and Analysis

Per the inputs and design drawings received, a detailed 3D CFD model of the central garden areas was created in the CFD Software.

Detailed modelling was carried out by modelling all the obstructions including the artificial plants, decorative interiors, Tables, water bodies.. etc were modelled to replicate the exact model.

The total area of the space was 7,800 Sq.meters with 37 meters height.

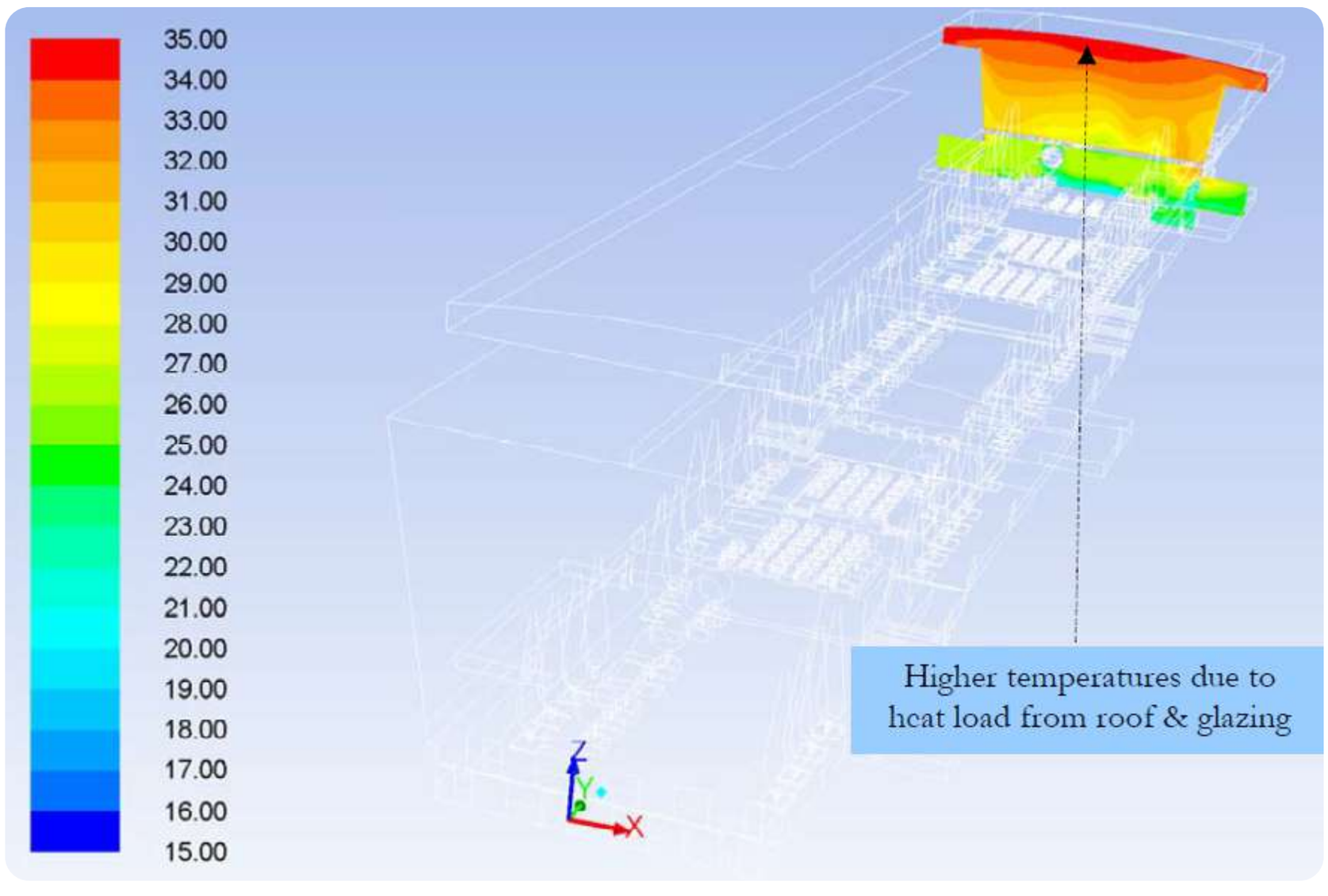


Temperature

The air conditioning system was designed by client for the Central Garden Area with supply air providing from supply air grills at each level along with underfloor cooling system and return air is extracting with the help of return air grills.

Modelling and Analysis

The detailed modelling of the HVAC design was carried out with the given location, size and the flow rates with its air properties. Appropriate boundary conditions, including the supply, return, and the heat load details, such as the people load, roof transmission at the roof, window, and skylight solar sensible loads distributed at the outer glazing, were all applied in the CFD software. Evaporate rate from the water bodies were also considered.



Temperature

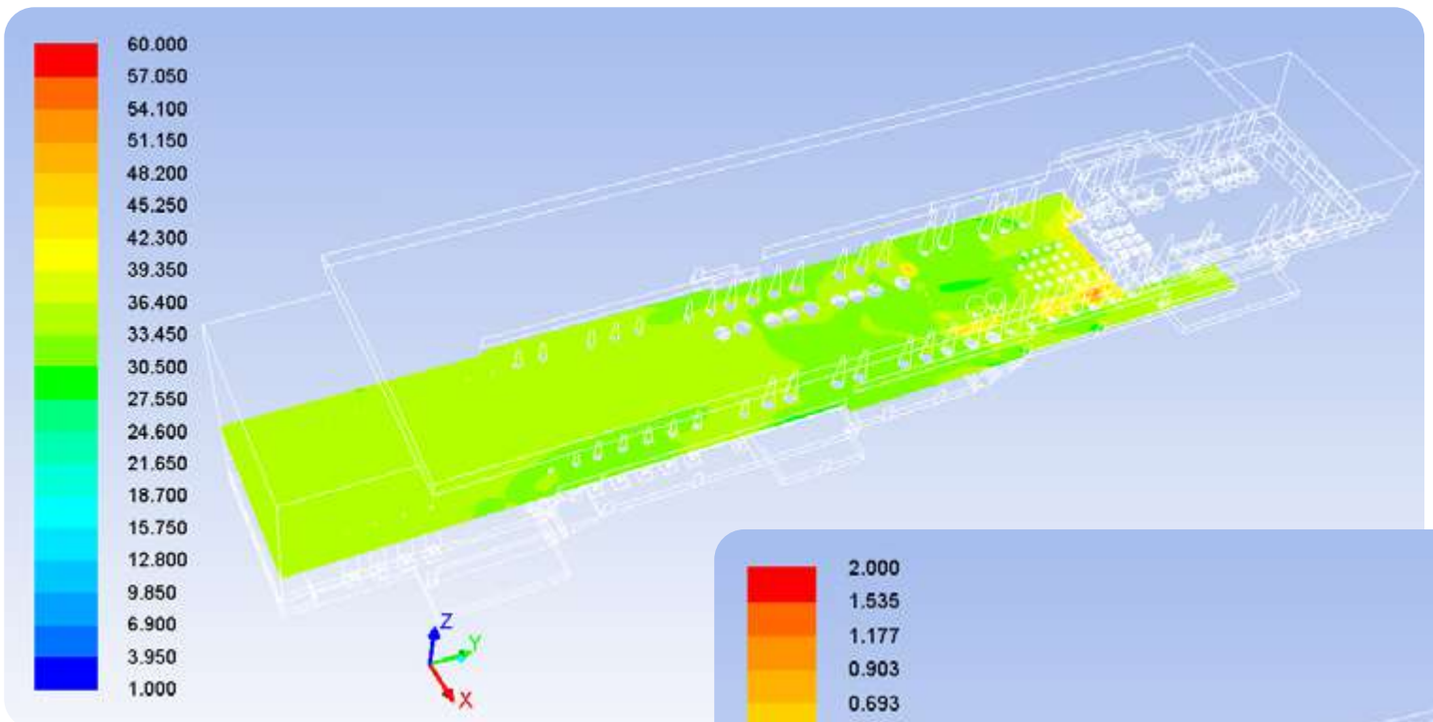
The simulation was carried out for both the Summer and Winter condition and different set of ambient and inputs were applied as boundary conditions in the CFD software.

Based on the above inputs, the CFD Simulation was executed to study the velocity, temperature, and Relative Humidity profile.

Conclusion

Conclusion

Upon completion and approval of the 3D model, a steady-state CFD Simulation was performed to study the velocity, temperature, and Relative Humidity Profile for both Summer and Winter conditions.



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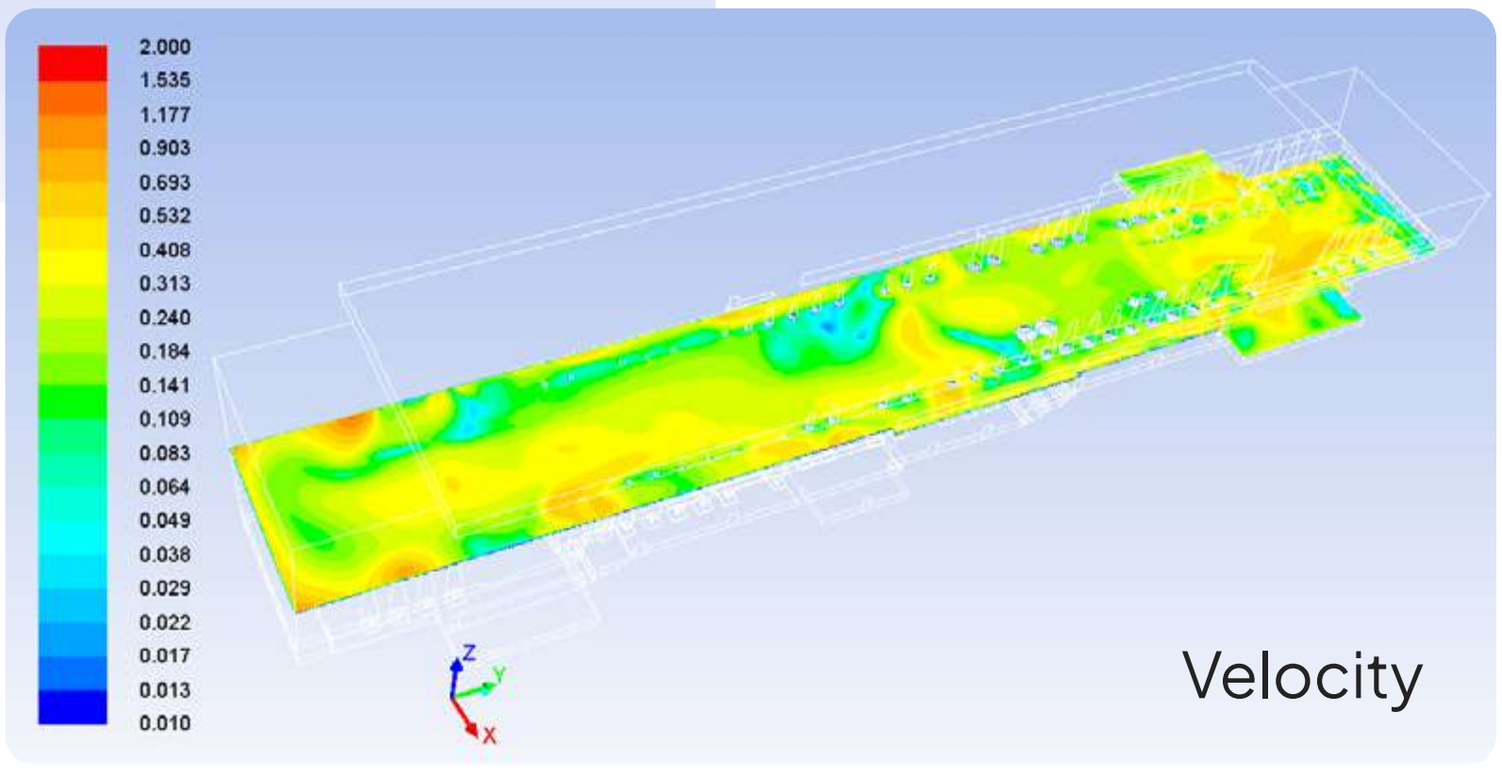

Velocity

From the CFD results it was observed that the temperature & Relative Humidity was not maintained at all levels in the summer conditions and uneven temperatures at different levels during the Winter conditions.

Appropriate recommendations were provided including the re-location of the grilles along with the increase / decrease in supply air temperature for both conditions were provided. Additional CFD analysis were carried out with the final approved design to meet the client design condition requirements.

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