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EDITORIAL

CFD an exploration tool for Passive ventilation

In the age of Artificial intelligence, from AI 1.0 to AI 4.0, the built environment and human interaction have been shaped by the nature and natural laws of physics. Computational Fluid Dynamics is a potential tool to establish the dynamics of particle motion within architectural space, in the past, still today and continue to be. The more exciting exploration is the application of natural laws of particle velocity and pressure that brings and quick evacuation of air with the difference in state or conditions.

Keywords: Computational Fluid Dynamics; Natural Ventilation; indoor Environment; Particle Physics

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Introduction

Passive measures have not challenged the way humans can relate with nature and architectural environment in the age of AI 1.0 to AI 4.0. Amongst the variety of energy tools, the behavior of air as a fluid to compute the energy that particles possess and dissipate are predicted in Computational Fluid Dynamics (CFD). Fluent is one of the solvers that is being used to demonstrate the passive potential of natural ventilation systems. The spaces and its components have the inherent properties of the passive energy potential that are being utilized to demonstrate the potential of natural ventilation.

Envelope design includes the typical openings of doors and windows as the most common solution that remain utilizable under all circumstances. Other passive features such as wind catchers brought a high-level air dynamics to the indoor spaces and spaces are cooled and cleaned. The air change occurs with the help of acceleration or pressure difference of air particles that are being simulated to predict the flow field. The harnessing potential of outdoor environment with wind catcher passively changes the indoor conditions. The computational models representing the field conditions as a digital prototype are simulated and equations of energy, momentum, viscous model and its properties are solved at the nodes. The particle behavior is predicted for the air being entered through a narrow channel, changing the flow field due to the change in the external shape of various components.

> ***"Fluent solver computes particle physics to predict the natural laws and system that predicts passive nature of ventilation."***

Technology Overview

Wind catchers and wind towers are used for air circulation within a variety of buildings. Their application includes both residential and commercial, but their use in the offices is less observed due to modernization and air conditioning. With the power of computational fluid dynamics (CFD), the potential use, function, design, industrialization, marketing and healthy buildings for employees and occupants can be visualized. CFD is an excellent tool for design optimization, demonstrating particle physics, natural ventilation in the indoor

environment and exploring product properties, with its mesmerizing technological capability. Within the passive systems for architecture and design, wind catcher research and development will advance the concept of design optimization for the wind catcher and tower design combination. The CFD designs tested in fluent are the digital prototype that can reach the next level of product development with direct application in the real world. The wind tower is an inlet channel that brings high level wind to the inside of the room, circulates within the room and exhausts through the wind catcher. The colored contours develop a persuadable methodology for the user choice and technology communicates the deep science of air flow patterns developed due to the buoyancy forces of air particles and air pressure difference. The science of outdoor environment is being depicted in Figure 1 that explains the behavior of air dynamics inside the room and maintains a comfortable air temperature for the seated occupants. These wind tower and catcher combo is recommended in offices of Pakistan that can controlled the thermal comfort to an optimum level.

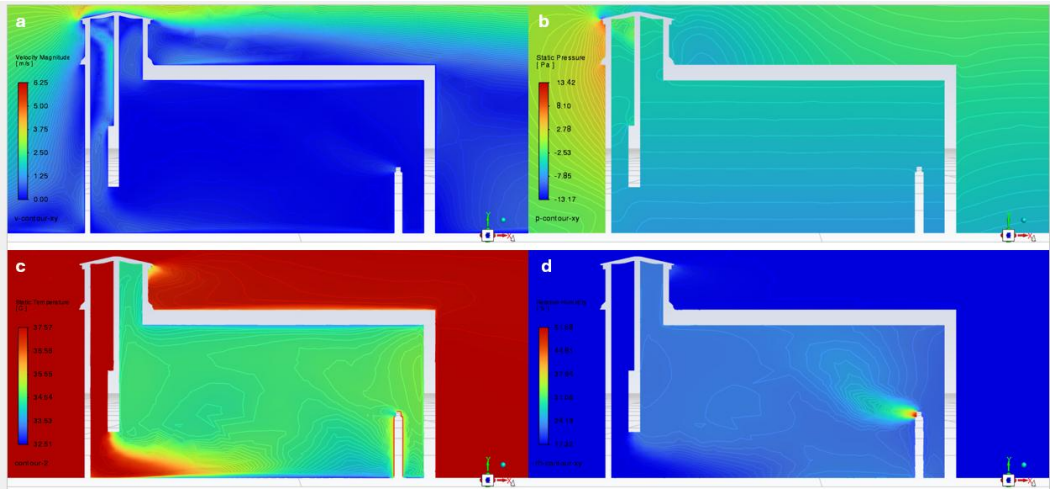
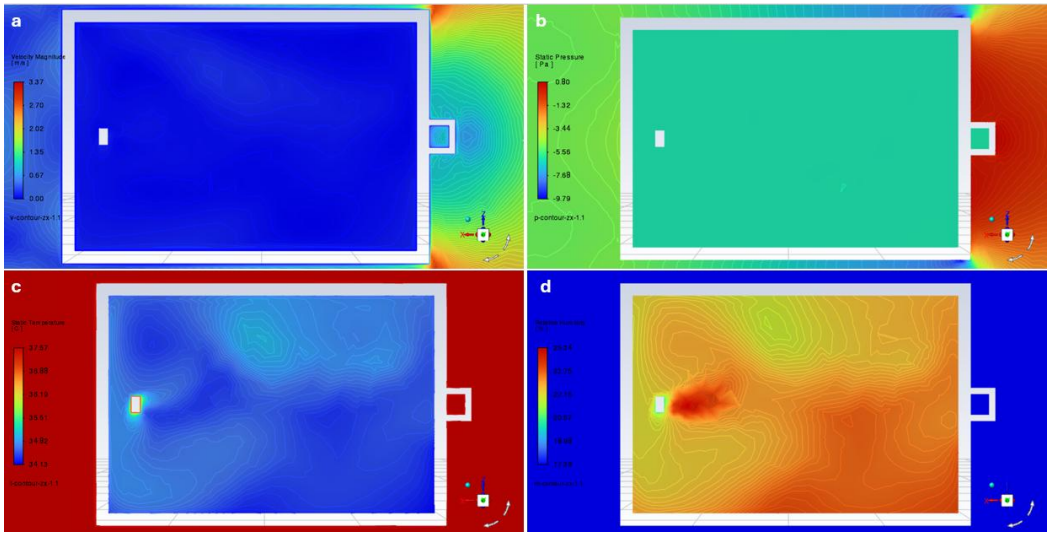


Figure 1: Horizontal Section of CFD Contours for Wind Tower and Catcher Combo a. Velocity Contours, b) Pressure Contours, c) Temperature Contours, d) Relative Humidity Contours, Credit: Authors



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Key Findings & Impact

The wind tower brings cool air, circulates and keeps a comfortable temperature (=/< 35 ^{0}C) inside the office and warm stale air exhausts the wind catcher directly from the roof. The CFD contours present a thermally stable indoor environment and negligible thermal stratification. The uniform distribution of temperature suggests a natural convection of air distribution and air eddies are mixed from bottom to the top for air exhaust through the wind catcher opening at the top. Th localized influence of low indoor wind velocity with high pressure difference between the inside and outside evacuates the air quickly.

The wind catcher and wind tower combo presents an excellent combination of optimized design with countless variations of head, divider, inlet/outlet opening size and can also be combined with other passive features. The architectural companies can take initiatives of encouraging design startups of wind catcher systems dependent on natural ventilation, both onsite fabricated and factory modules to develop energy efficient culture in Pakistan.

What's Next?

Still, its diaspora to decipher that real time data from the outdoor climate of Lahore and other metropolitan cities can help to design a physical time wind catcher system that can work through all conditions. From passive air to high and low wind conditions, snowy weather to hailstorm, intense solar heat, cloudy and rain weather conditions, a phase change design or an adaptable system can possess all in one. With the increased dependency on the air -conditioning system, raising concerns of extreme weather conditions, problem of power failure and psychological response of architectural spaces extend the dimension of CFD towards new solutions.

> ***"Predictability is the next approaching future through design, rational thinking and computational modeling. Act now for a better tomorrow in Building Science."***

CFD is a cutting-edge tool to inspire the designs of next generation, of today and past. It can parametrize the design power with little modification to a modernized, eco-friendly and graphically sound solution for building users.

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