Laboratory Study of Tornado-Like Loading on a Low-Rise Building Model

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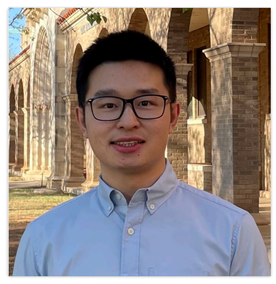

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The tornado-like loading on the model is significantly affected by the **static pressure deficit** and the variation of the loading is dictated by the **spatial variation of the velocity and pressure fields** of the flow.

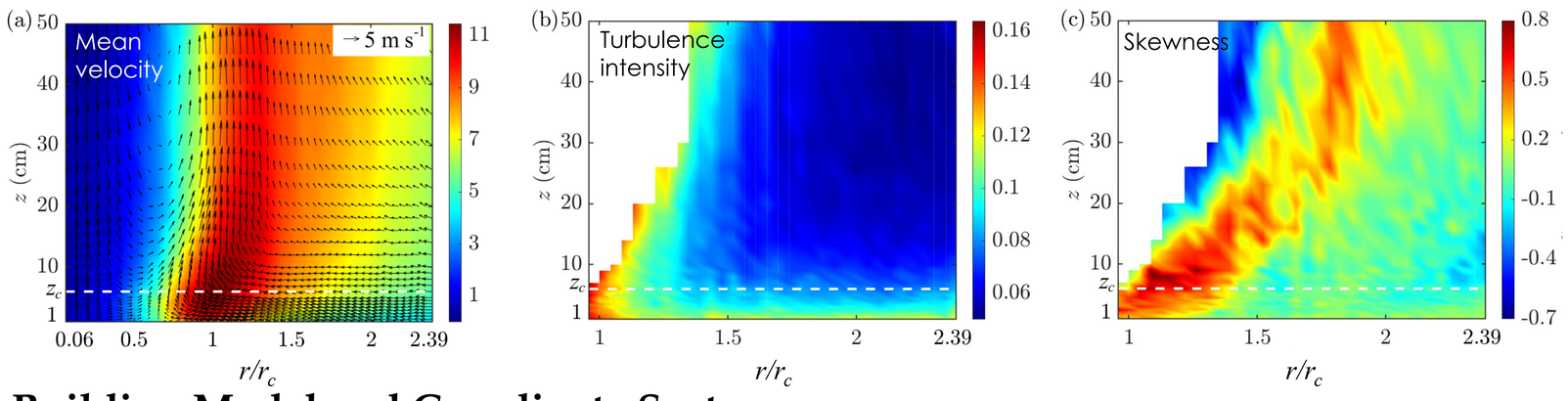
Introduction

- This paper presents a comprehensive experimental study conducted to investigate tornado-like loading on a low-rise building model.
- The statistical characteristics of the pressures acting on the model as well as those of the force resulting from the pressures are evaluated, and these characteristics are interpreted in the context of the features of the flow velocity as well as those of the static pressure deficit caused by the flow.

Methods

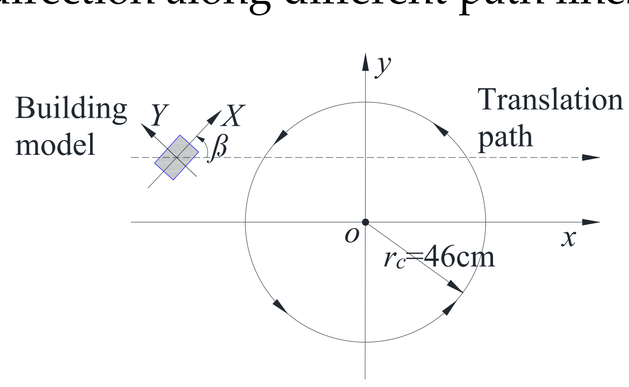
Simulated Tornado-like Flow

- The experiments were conducted in the tornado simulator at Texas Tech University. The tornado-like vortex was simulated at a swirl ratio of $S = 0.83$, an aspect ratio of $a = 0.5$ and a radial Reynolds number of $R_{er} = 5.1 \times 10^5$.
- The down draft around the axis of the vortex that reaches the simulator floor, and the tangential component of the flow becomes more turbulent, and the turbulence of this component exhibits non-Gaussian features.



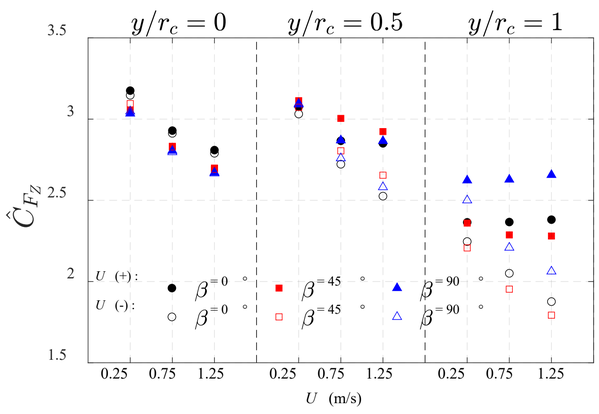
Building Model and Coordinate System

- Building model was mounted on an on the simulator floor and translated through the simulated vortex with different speeds, direction along different path lines.

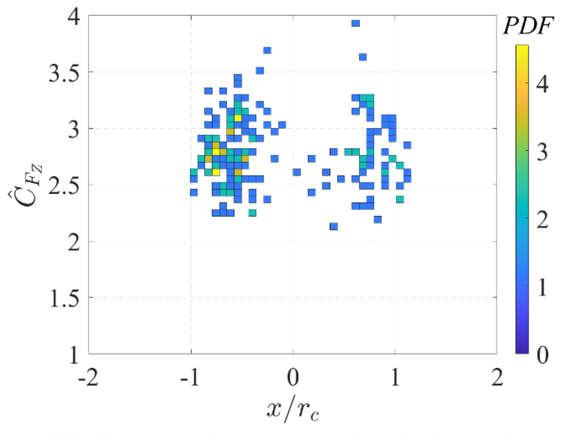


Results

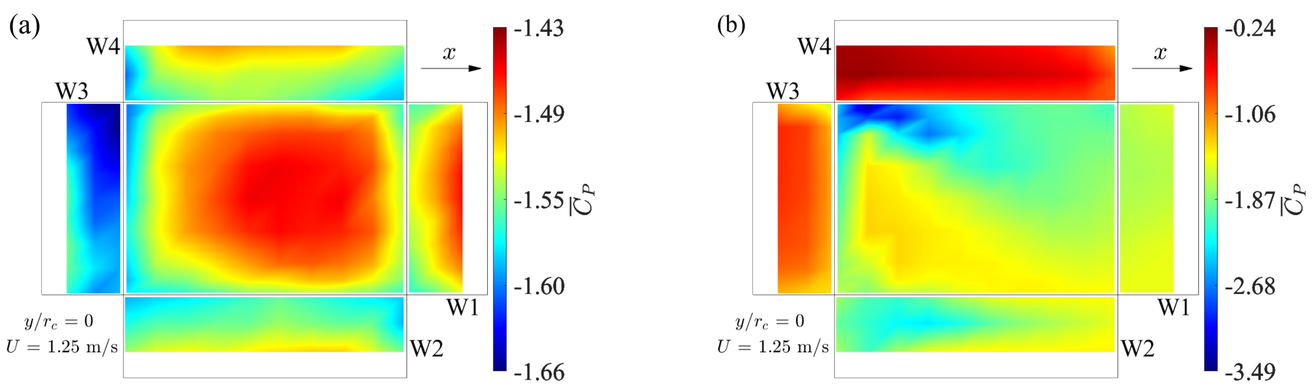
- The pressures are markedly different when the model is at the two positions because the loading on the model is primarily due to the static pressure deficit of the flow in the center.
- The mean extreme uplift force depend on the model's orientation, translation path lines, speed and direction. Most of the peak vertical forces occur when the model is inside the core of the vortex.



Mean extreme uplift force coefficients



Peak uplift forces from the individual runs when the model of orientation β=0° translates at a speed of 1.25 m/s along path line $y/r_c = 0$



Mean pressures on the model (a) $x/r_c = 0$ and (b) $x/r_c = -1$

Conclusions

- The tornado-like loading on the model is significantly affected by the static pressure deficit.
- When the model is at the core radius location, the aerodynamic induced pressure contributes significantly to the surface pressures.

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