Wind Tunnel Testing

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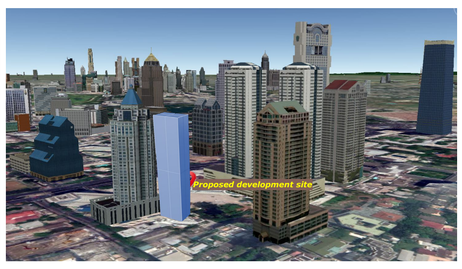
Abstract

This poster presents an overview of wind tunnel testing. Wind loads provided in most codes and standard are for regular shape buildings in an isolated case and include many assumptions. In practical, wind loadings are influenced by several factors namely building shape, terrain effect, surrounding structures, etc. The results obtained from wind tunnel study incorporates the effects of building shape, complex terrain, surrounding structures, and wind directionality, which results in the accurate results with minimum assumptions than the loading obtained from the international codes, therefore wind tunnel testing is necessary. The saving on the structure and cladding cost can be achieved from wind tunnel study. Wind tunnel study can be done for various purposes like; wind loads for structural design, serviceability check, and cladding design. Wind tunnel testing is also useful to study the effect of the structure on the wind environment of surroundings. Different techniques are developed over the years for wind tunnel testing. This poster presents a brief introduction to different wind tunnel study.

Why Do Wind Tunnel Testing?



Proposed development in two different surrounding scenarios

Aerodynamic modifications to rectangular building shape

- Accurate wind loads to minimize assumptions
- Significant savings in cost of structure and cladding
- Assurance of the results
- Facilitates wind response suppression study
- Environmental impact assessment

Wind Tunnel Testing

Overall structural wind load study

- Fluctuating wind loads can be measured either by high frequency force balance (HFFB) or high frequency pressure integration (HFPI) techniques.

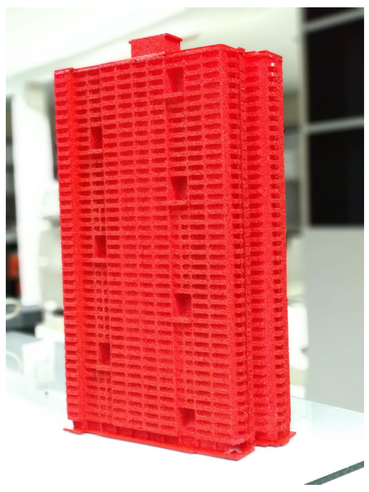
Cladding Pressure study

- Local wind-induced pressures can be directly measured from the test and it will be represented in the form of pressure contour to assist façade engineer in design.

Environmental wind study

- The pedestrian comforts at key areas such as walking, entrances, recreational areas can be evaluated by integrating local wind models with wind tunnel results.

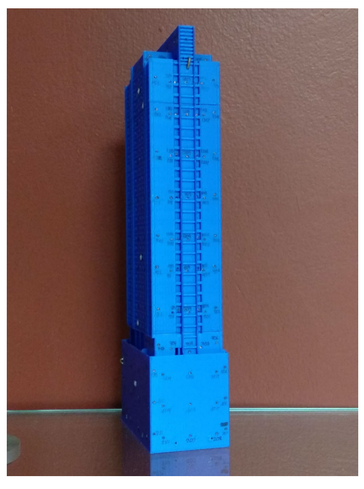
Overall Wind Load Study



Force balance model

High Frequency Force Balance

- The fluctuating wind loads are measured using force balance in terms of the base shear forces, base bending moments and base torque (Fx, Fy, Mx, My, and Mz).
- Mode of vibration of the building must be linear with the height.
- Assumed wind load distributions.



Pressure model using rapid-prototype technique

High Frequency Pressure Integration

- Pressure on the surface of the model can be measured simultaneously. These measured pressures can be integrated to obtain the loads on the building.
- Distributions of wind load can be directly obtained from the measurement.
- Capable for non-linear mode of vibrations.

Overall Wind Load Study

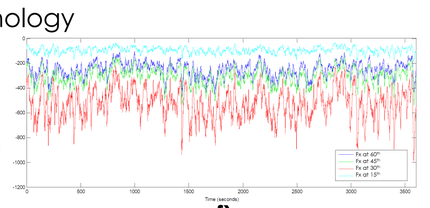
a) **b)** **c)**

d)

e)

g)

a) High density foam target model made by using CNC technology
b) Carbon fiber sting and multi axis force sensor
c) Setup for HFFB test in wind tunnel
d) Wind rose showing the wind climate at the proposed site
e) Application of wind load in commercial software like ETABS
f) Time history point loads at different elevations
g) Equivalent static floor by floor wind loads



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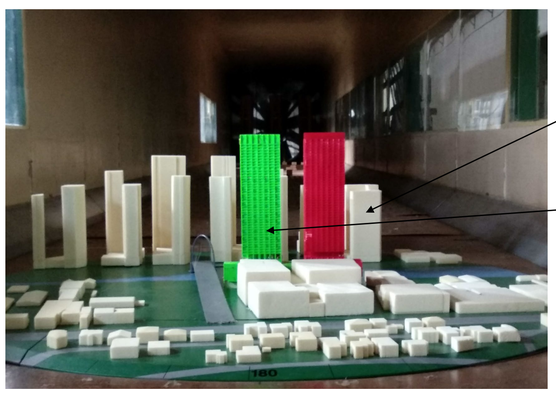
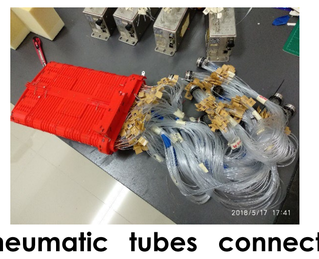
Cladding Pressure Study

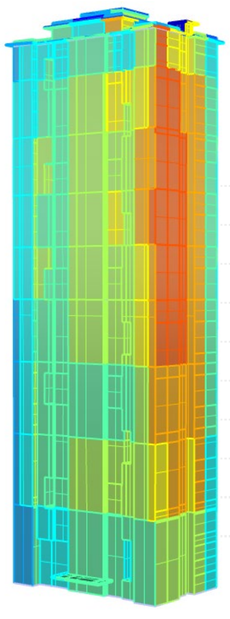


Pressure model with surrounding buildings



Pneumatic tubes connected to pressure model

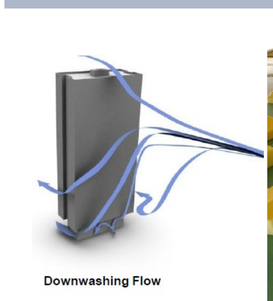
Pressure sensor

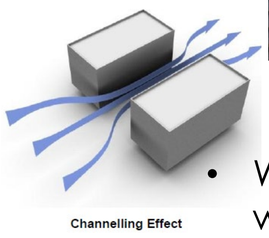


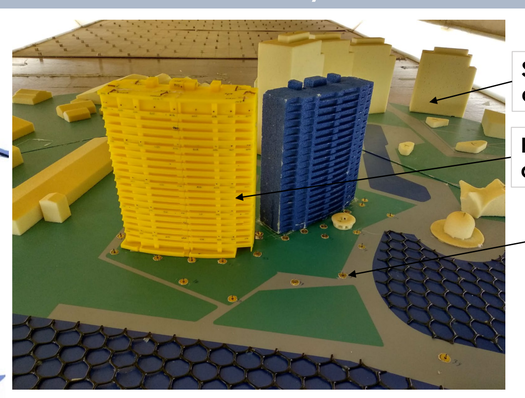
Peak positive net pressure for cladding design

The cladding pressure on façade can be measured in wind tunnel and scaled to full scale pressure after combining with the local wind climate.

Environmental Wind Study







Wind environment assessment using Irwin probes

- Wind speed at pedestrian height can be measured in wind tunnel to assess the wind environment around the proposed development in terms of pedestrian comfort and safety.

Conclusion

- Various kinds of tests and study related to wind speeds and wind loadings can be conducted in wind tunnel facility.
- Effects of different aerodynamic modifications can be studied.
- Wind tunnel testing provides the accurate wind loads with minimum assumptions.
- Wind tunnel testing provides economic results.

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