AIRFLOW AND WIND PRESSURE AROUND A FULL-SIZE CUBICAL BUILDING MODEL IN A WIND TUNNEL:
BASIC DATA FOR DEVELOPING A QUANTITATIVE TOOL FOR CROSS VENTILATION DESIGN

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ABSTRACT A new research project in the Building Research Institute aims at developing a quantitative tool for cross ventilation design for buildings. One of the approaches adopted in the project is the experiment in the wind tunnel, where a full-size cubical building model can be used at this stage. In this paper, mainly the first observation result for the building model without openings is shown and discussed.

1 Introduction

Cross ventilation is a method to remove heat from indoor space and to activate indoor air movement, which makes occupants feel more comfortable without air conditioning. There is no quantitative design and evaluation method for the cross ventilation performance of buildings. However, many designers respect the value of cross ventilation and are eager to make their products better cross ventilated, especially when they are built in a hot and humid climate. Nowadays, some aspects of building performance, such as insulation, air tightness and solar shading performance, can be evaluated quantitatively, and convenient indices for them are being introduced into a performance labeling system, which is used when people judge the quality of building. Such a quantitative performance evaluation method for cross ventilation is needed, which can also be used in the design process, in order not to make the passive method neglected nor slighted.

The study of the cross ventilation has a history as long as other aspects of building performance such as insulation. When airflow rate is as small as ventilation requirement from the viewpoint of indoor air quality, network model can be applied to simulate the phenomenon numerically. Ishihara (1969) tried to apply the network model to cross ventilation with large airflow rate, by introducing an original correction factor. Recently, a more sophisticated numerical simulation method has been applied to the cross ventilation phenomenon (Kurabuchi et al.1998, Ka et al.1998).

On the other hand, experimental approaches have been taken mainly by using wind tunnel, sometimes by field measurement under unstable wind condition. In wind tunnel experiments, wind condition (speed, turbulence and direction) can be controlled, but the size of building models has been limited according to the size of wind tunnel. In such wind tunnel experiments, overall airflow pattern and wind pressure on the building model can be observed, but it has been difficult to obtain detailed and accurate indoor airflow information such as three-dimensional airflow and ventilation rate. In field measurements, real phenomena can be observed but it is difficult to grasp outdoor wind condition and wind pressure condition depending upon the configuration of the building and its surroundings.

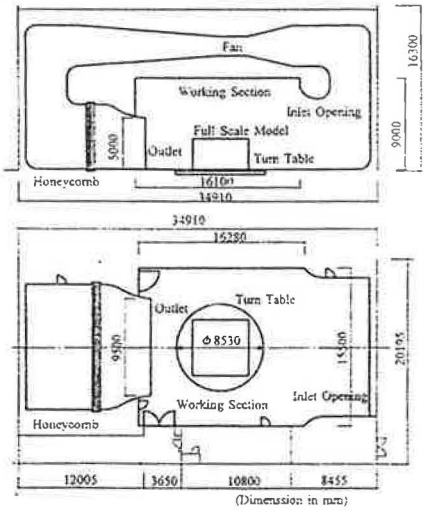

Fig.1 Section and plan of the wind tunnel in BRI

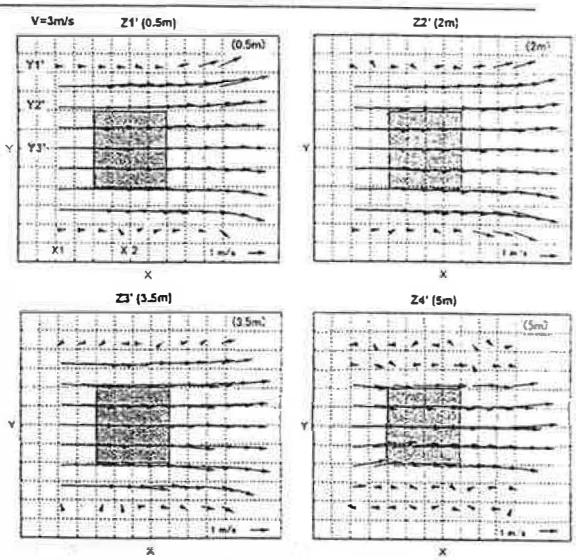

Fig.2 Horizontal view of wind vectors on four different height without the building model

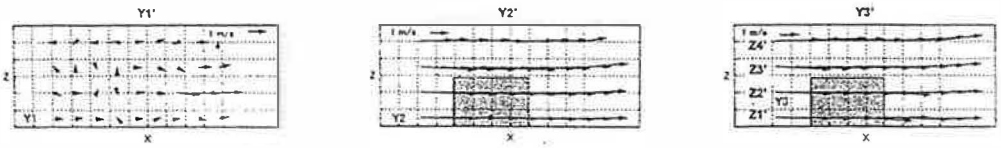

Fig.3 Vertical view of wind vectors on three different planes (Y1', Y2', Y3' as shown in Fig.1) without the building model

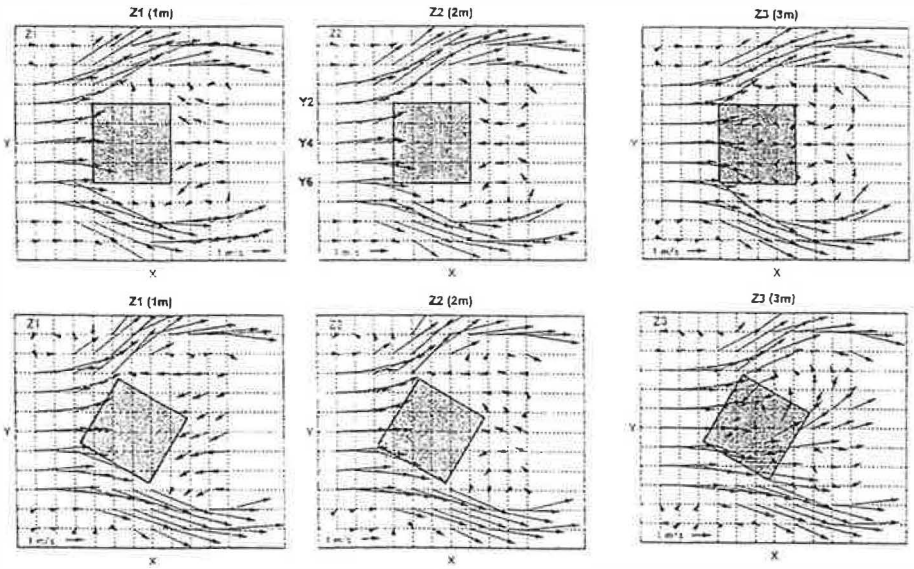

Fig.4 Horizontal view of wind vectors for the angles 0°(top) and 30°(bottom) on three different height (Z1, Z2, Z3)

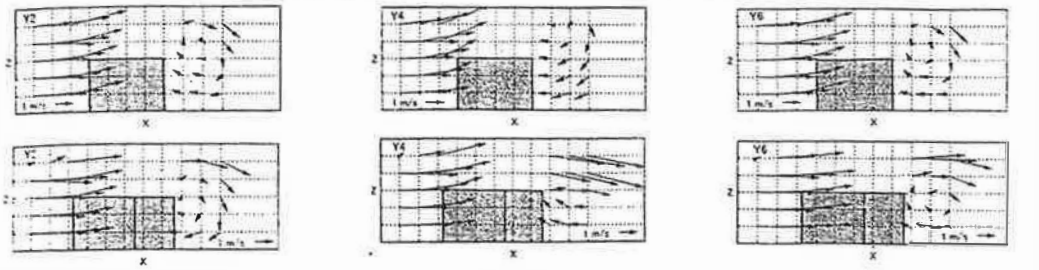

Fig.5 Vertical view of wind vectors for the angles 0°(top) and 30°(bottom) on three different planes (Y2, Y4, Y6 as shown in Fig.4)

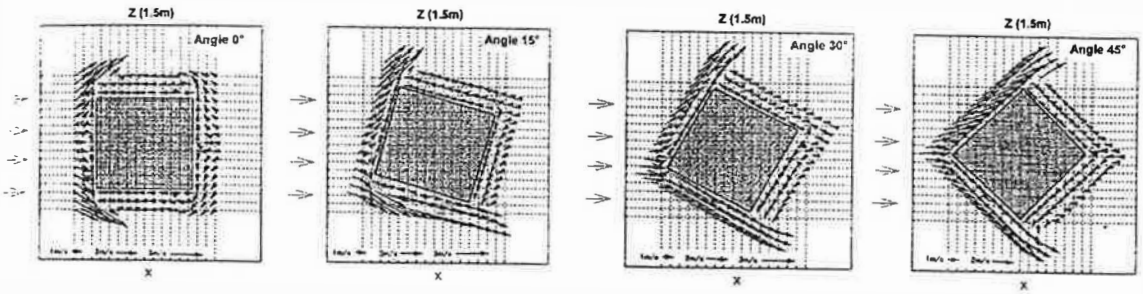

Fig.6 Horizontal view of wind vectors on 1.5m above the ground, near the walls

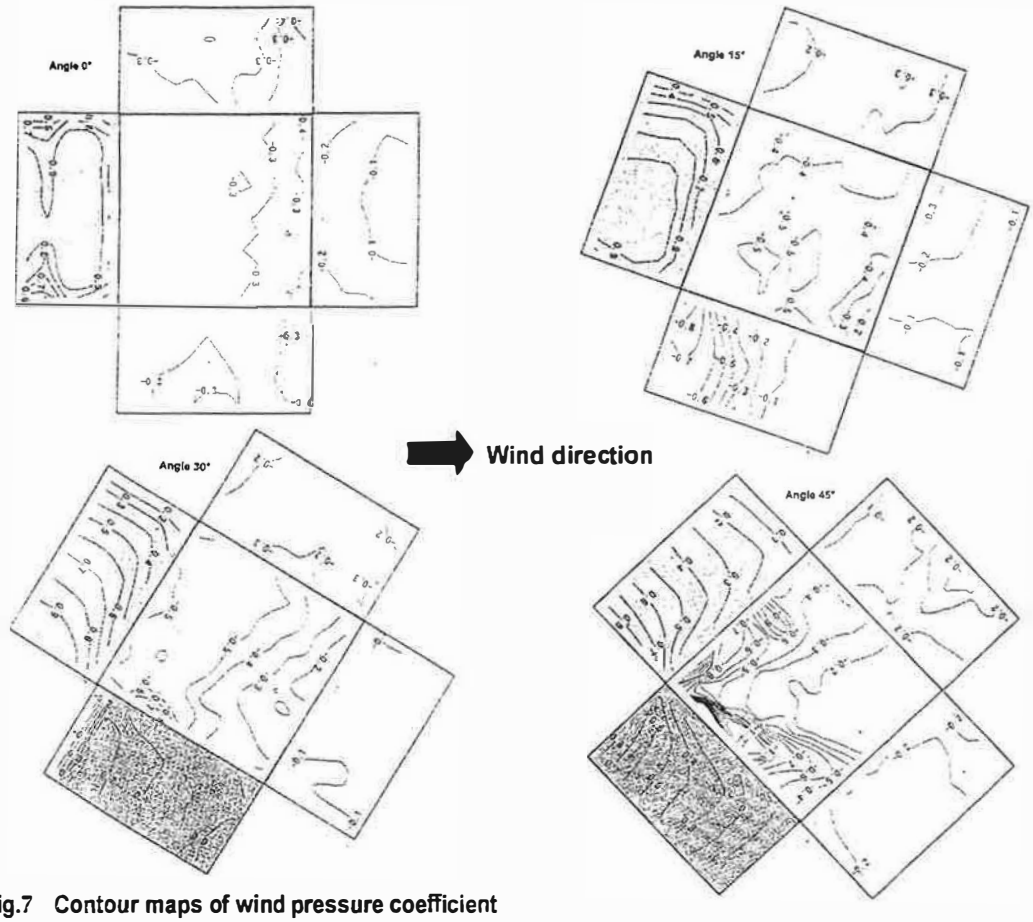

Fig.7 Contour maps of wind pressure coefficient

5 References

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