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MEASUREMENTS ON THE SURFACE WIND PRESSURE CHARACTERISTICS OF TWO SQUARE BUILDINGS UNDER DIFFERENT WIND ATTACK ANGLES AND BUILDING GAPS

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1 INTRODUCTION

It has been frequently suffered typhoon's serious attacks during summer and autumn seasons in Taiwan. Strong winds caused severe damage on high-rise building cladding. Also, surface wind pressure distributions affect the building natural ventilation. For this purpose, it is necessary to study the building surface wind pressure characteristics which can provide more accurate and detail information for the building wall curtain cladding and natural ventilation designs.

Previous studies, like [1, 2] only studied on one building. In urban city, two buildings of side by side arrangement are commonly encountered [3]. The wind attack angle on the buildings also often changed in time. Therefore the objective of present study is to measure in wind tunnel the surface wind pressure characteristics and pressure spectrum of two square buildings in side by side arrangement with various gaps and under different wind attack angles.

2 EXPERIMENTAL SET-UP

The experiments were conducted in the Environmental Wind Tunnel of National Taiwan Ocean University. The test section of the wind tunnel had a cross section of 2 m by 1.4 m with 12.5 m long. The wind tunnel was an open suction type and it contracted to the test section with an area ratio of 4: 1. The turbulence intensity of the empty wind tunnel is less than 05 % at the free stream velocity of 5 m/s.

The X-type hot-wire incorporating with the TSI IFA-300 constant temperature anemometer was used to measure the turbulent flow signals.

The surface wind pressure was measured by using the HyScan-2000 scanning system of the Scanivalve corporation. The system includes a pressure calibration module SPC-3000, and a control pressure module CPM-3000. Pressure was measured by using the ZOC-23B pressure transducer that has 32 channels. The CSM-2000 unit receives many address information from the IFM2000 module and distributes it to the cable-serviced ZOC-23B modules, then routes the addressed analog signals back to the IFM2000 module. The IFM2000 module is the interface unit for ZOC-23B. The DAQ2000 is the self-contained high speed data acquisition and processing system. The HyScan-2000 system incorporating with the DAQ2000 can sample 16~32 channels of the pressure transducer analog data. In the present study, we sampled 24 channels almost simultaneously at the sampling rate of 2000 Hz and took the sampling time 32.468 seconds for each run.

3 MEASUREMENT RESULTS

Measurement results were analyzed to obtain the mean surface wind pressure coefficient, $\overline{C_p}$, and root mean square of fluctuating pressure coefficient, C_{prms} . The fluctuating pressure spectrum and fluctuating pressure probability density function were also investugated.

3.1 Building gap effect

Fig.1 shows the variation of the mean surface wind pressure on inner faces of two buildings at height Z/H=0.888 for different building gaps, D/W, with wind attack angle 0^o. Results indicate that the mean surface wind pressure decreases in general as the building gap decreases.

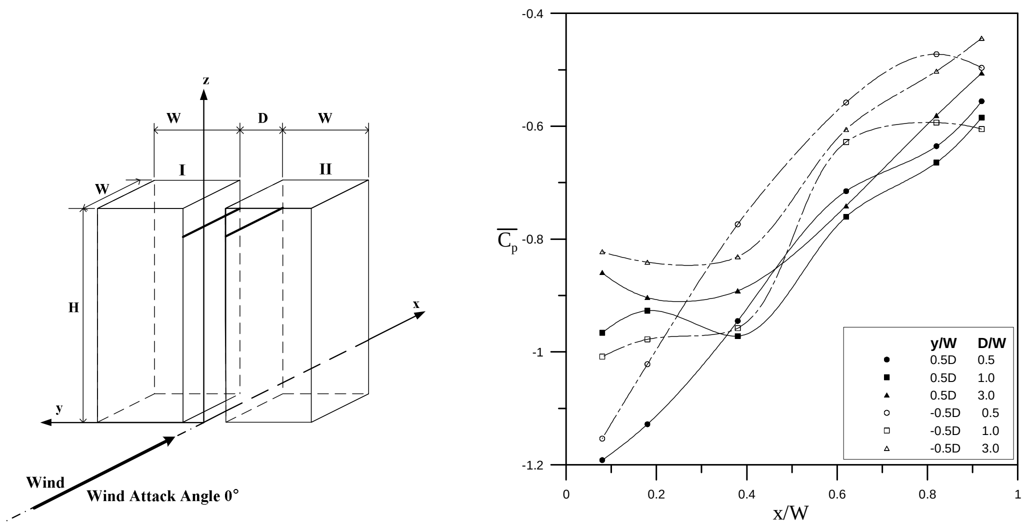

Fig.1 Variation of the mean surface wind pressure on inner faces of two buildings at height Z/H=0.888 for different building gaps, D/W, with wind attack angle 0^o

3.2 Effect of wind attack angle

For the inner faces of buildings at height Z/H=0.888, and building gap D/W=0.5, the mean and root mean square of surface wind pressure variations for different wind attack angles are shown in Fig.2. Results reveal that the mean surface wind pressure increases as the wind attack angle increases. The root mean square of pressure fluctuation becomes smaller at a farer downstream distance. At the nearer downstream distance, the root mean square of pressure fluctuation becomes larger, especially for the wind attack angles within 15^o and 30^o. The variation of root mean square of pressure fluctuation exhibits the tendency of decrease when the wind attack angle is increasing.

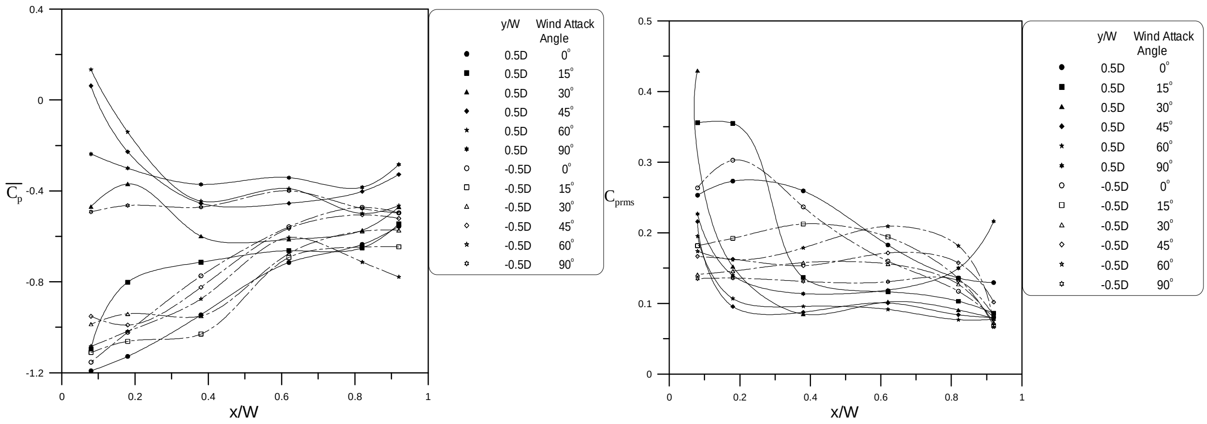

Fig.2 The mean and root mean square of surface wind pressure variations for different wind attack angles at building height of Z/H=0.888, and building gap D/W=0.5

3.3 Power spectrum of surface wind pressure fluctuation

The power spectra of surface wind pressure fluctuation for various building gaps at z/H=0.888, y/W=0.38 of building I and wind attack angle 0^o shown in Fig.3. The spectra distributions all exhibit with the curve slope of -5/3 at the inertia subrange, similar to the Kolomogrov turbulent velocity spectrum law [4]. Similar results are found for other wind attack angle cases.

3.4 Probability density function distribution of pressure fluctuation

The measured probability density functions (pdf) of the surface wind pressure fluctuation for different heights in front face of building I at y/W=0.35, wind attack angle 0^o, and building gap D/W=3 are shown in Fig.4. The measured pdf curves exhibit a little skew. The peak values of the pdf are all close to 0.4. At the lowest height location, the skewness coefficient of the pressure fluctuation becomes the largest.

4 CONCLUSIONS

Measurements of the surface wind pressure characteristics and pressure spectrum of two square buildings in side by side arrangement with various gaps and under different wind attack angles are performed in wind tunnel. Results are summarized as follows:

- The mean surface wind pressure for the inner faces of buildings at height Z/H=0.888, wind attack angle 0^o, and different building gaps decreases when the building gap decreases.
- For the inner faces of buildings at height Z/H=0.888, and building gap D/W=0.5, the mean surface wind pressure increases when the wind attack angle increases. The root mean square of pressure fluctuation becomes smaller at a farer downstream distance. At the nearer downstream distance, the root mean square of pressure fluctuation becomes larger, especially for the wind attack angles within 15^o and 30^o. The variations of root mean square of pressure fluctuation exhibit the tendency of decrease as increasing the wind attack angle.
- The power spectra of surface wind pressure fluctuation for various building gaps at z/H=0.888, y/W=0.38 of building I and wind attack angle 0^o are shown to have the slope

of -5/3 at the inertia subrange of the spectra distribution. Similar results are found for other wind attack angle cases.

- The peak values of the probability density functions of the surface wind pressure fluctuation for different heights in front face of buildings are all close to 0.4. At the lowest height location, the skewness coefficient of the pdf for pressure fluctuation becomes the largest.

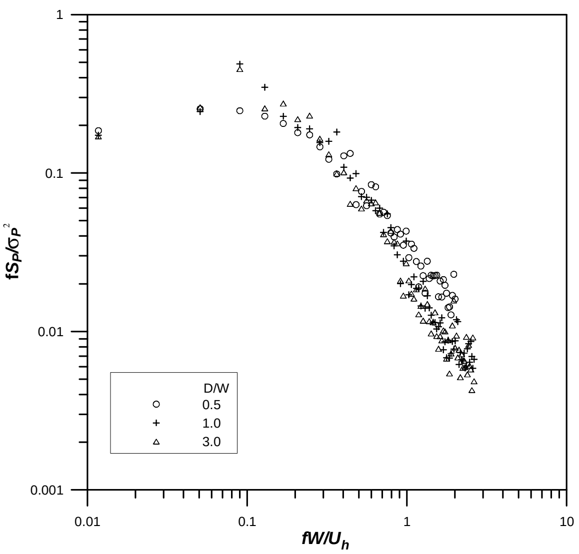

Fig.3 Power spectra of surface wind pressure fluctuation for various building gaps

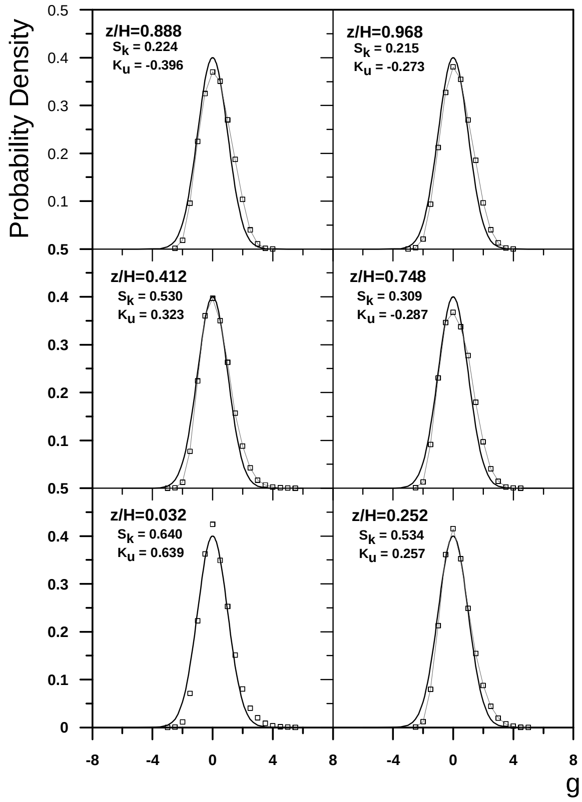

Fig. 4 The probability density function of pressure fluctuation at different heights

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