PRELIMINARY STUDY OF WIND LOADS ON SUNSHADE CANOPIES OF A TALL BUILDING

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1. SUMMARY

Wind loads on sunshade canopies of a tall rectangular building have been studied in the Boundary Layer Wind Tunnel at Monash University. Mean, standard deviation and peak wind loads were measured using both strain gauge balance and differential pressure measurement techniques. The preliminary results show that the highest upward acting loads occur near the edge of the building and the highest downward acting loads on the sunshade canopies occur on the lower half of the building. The experimental data are presented in pressure coefficient form and are plotted in contour format.

2. INTRODUCTION

Many buildings have external features with appurtenances such as sunshades or balconies. The effects of these appurtenances on wind loads on the building have been studied [1]. But when it comes to the design of these appurtenances, design data are generally not available. As lighter materials are developed for long span appurtenances such as sunshades, the design for wind loading becomes critical. In the absence of quantitative data, these structures are invariably designed on the basis as for free standing walls [2] or for attached canopies [3] despite the interference effects from the building and from the other neighbouring sunshades.

As a result of this lack of design data, this paper presents an initial measurement of the wind loads on this class of structure. Further investigation on the effects of the span and spacing of the sunshade canopies will be made.

3. EXPERIMENTAL TECHNIQUE

The basic model of a tall building was 500mm by 500mm by 1200mm high, with sunshade canopies of 10mm length span around the building perimeter at 29 levels 40mm apart, starting from 50 mm above ground. Three segments of the sunshade, 30mm wide each, were installed with strain gauges to measure bending moments and were located 0, 90 and 240mm from the edge of the building at levels 1, 8, 16, 23 and 29.

The model was tested in a 1/100 scale turbulent boundary layer simulation representative of wind blowing over suburban terrain in a wind tunnel with a test cross-sectional area of $5.5m^2$. The reference wind speed at the top of the building was about 13 m/s. The model frequency of the sunshade canopy was about 150 Hz and the damping was about 1 to 2%. However, the data presented in this paper, as an initial exploration, are not corrected for damping and wind tunnel blockage. Mean, standard deviation and peak moments were measured and are expressed in pressure coefficient form C_q with respect to a calibrated equivalent static uniform load distribution.

$$C_q = \frac{q}{\frac{1}{2}\rho \overline{V}_h^2}$$

where q is the calibrated pressure of a uniform load distribution on the sunshade canopy

ρ is air density

$\overline{V}_h$ is mean wind speed at the top of the building

Differential pressure masurements across the sunshade canopy were also made at five tapping locations, top and underneath, 2mm apart, 1mm from the leading edge, along the length span at the centre of the sunshade. Pneumatically-averaged differential pressures from these five pressure tappings were also measured.

Pressure coefficients

$$C_{PA} = \frac{P_A}{\frac{1}{2}\rho\overline{V}_h^2}$$

$$C_{PV} = \frac{P_V}{\frac{1}{2}\rho\overline{V}_h^2}$$

where P_A = differential pressure at location A, 1mm from the leading edge

P_V = pneumatically-averaged differential pressure from all the five tappings

Measurements were made at $22\frac{1}{2}°$ intervals of Azimuth with finer 5° directional increments about critical wind directions. Measured coefficients are shown to be independent of wind speed for critical wind directions. The data recording period was 80 seconds.

4. RESULTS

Pressure distribution across the overhanging width of the sunshade canopy (away from the building) at the building corner at level 29, (location A1), as shown in Figure 1, is seen to be more uniformly than triangularly distributed as in cantilevered roofs [4]. Experimental data from the strain gauge measurements are hence reduced in terms of an equivalent uniformly distributed load. Mean and standard deviation coefficients from the strain gauge, differential pressure and pneumatic-average measurements are plotted as a function of wind direction as shown in Figure 2. The highest positive and negative peak coefficients from the strain gauge measurements are plotted in contour format as in Figure 3. It can be seen that the highest negative peak upward acting wind loads occur on the sunshade canopies near the edge of the building at the top and lower levels. The highest downward acting wind load are seen to occur generally on the sunshade canopies on the lower half of the building.

5. CONCLUSION

Wind loads on sunshade canopies of a tall building were measured using both strain gauge and pressure measurement techniques in a boundary layer wind tunnel. Initial experimental data have indicated that these wind loads on the canopy at some locations of the building can be higher than those design values that would have been evaluated for an isolated free standing wall or attached canopy. These results lead to further investigation of the effects of the relative building geometry, the sunshade canopy size, shape and spacing.

REFERENCES

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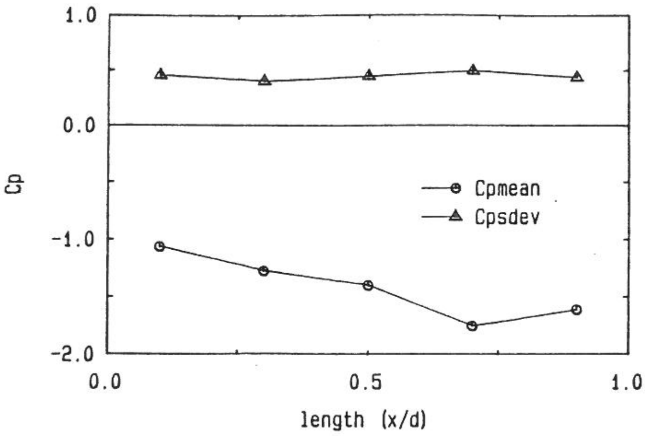
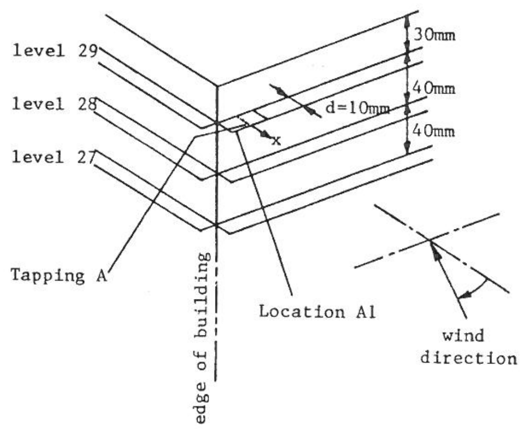


FIG. 1 PRESSURE DISTRIBUTION
Location A1 (wd45.0)



TOP CORNER OF THE MODEL BUILDING

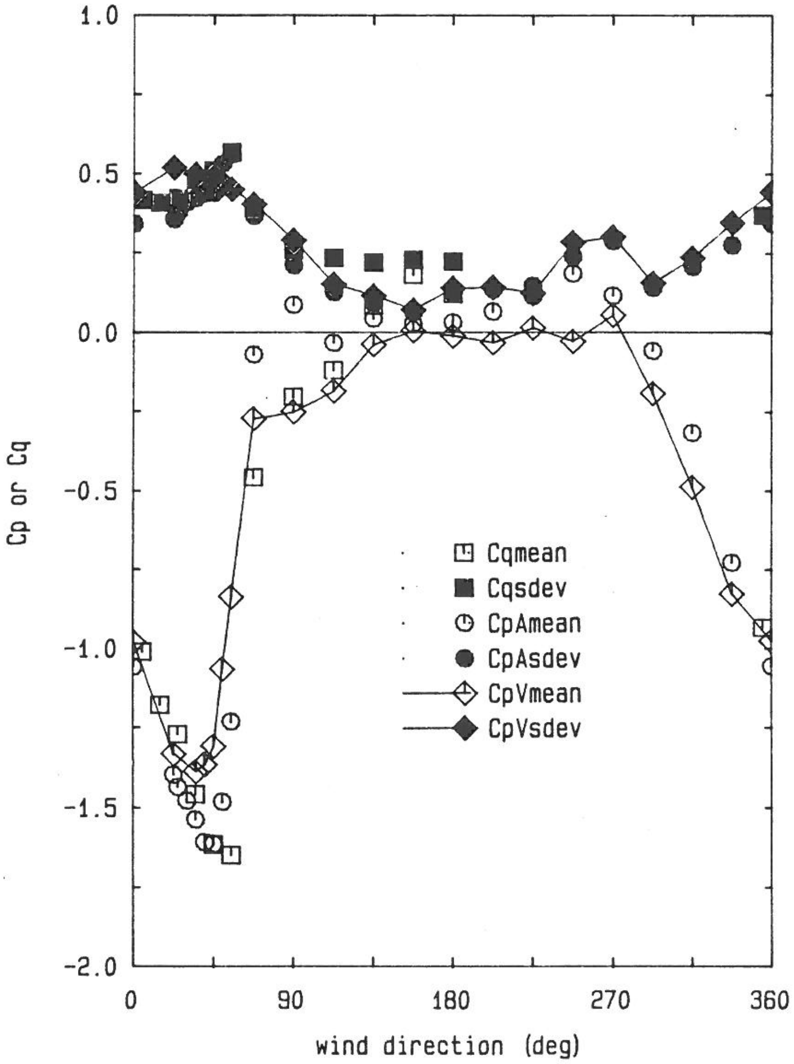


FIG. 2 WIND LOAD ON SUNSHADES
Location A1

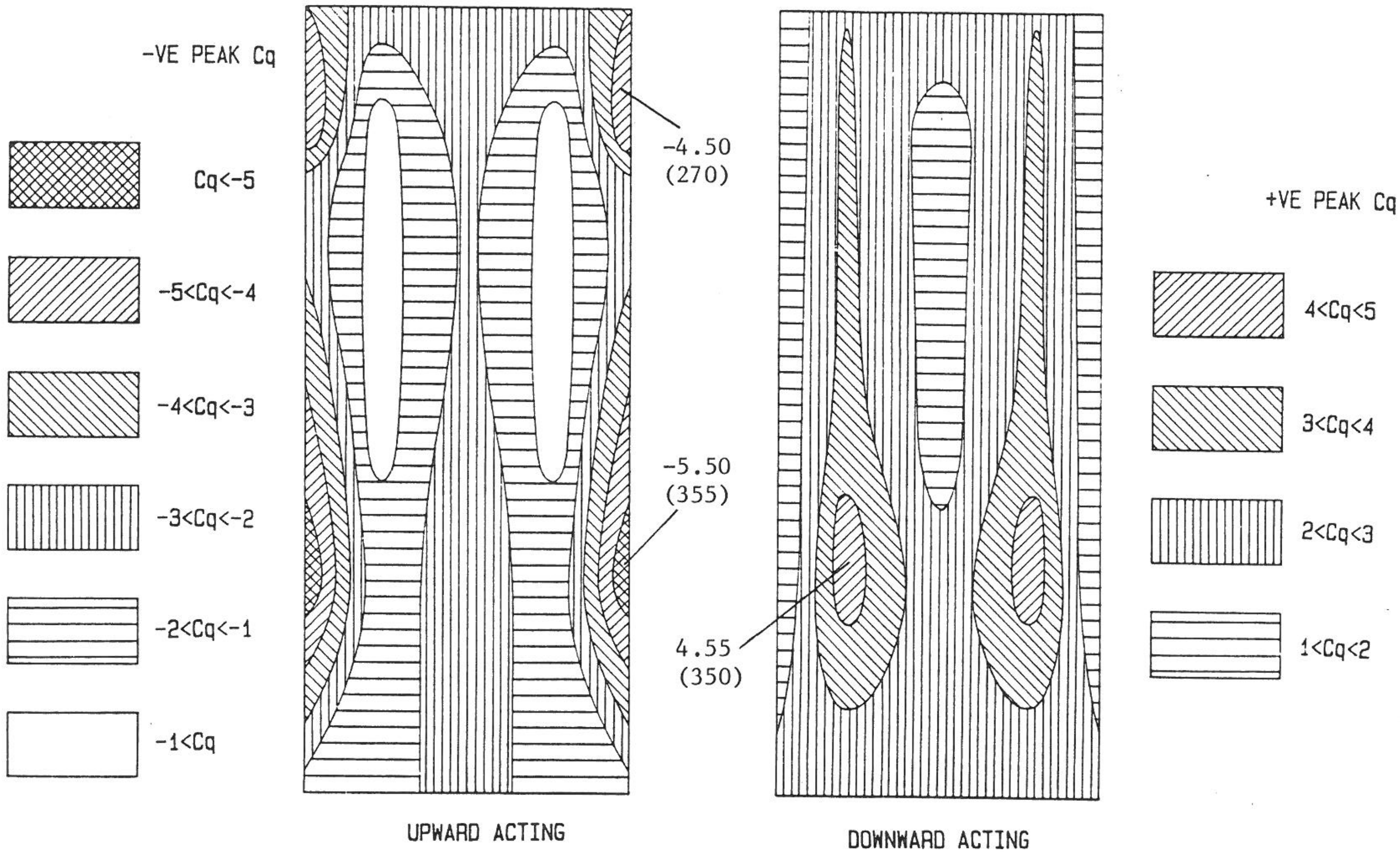


FIG. 3 HIGHEST +VE and -VE PEAK Cq (wind direction in bracket)
WIND LOAD ON SUNSHADES