INCREASED PEAK WIND PRESSURES ON THE TEXAS TECH BUILDING CAUSED BY AN ADJACENT SIMILAR BUILDING

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1. INTRODUCTION

A programme of wind tunnel research currently in progress at Central Laboratories, Works Consultancy Services Ltd, concerns the effect of building configuration on wind loads. The research aims to determine the influence of the relative orientations of two rectangular blocks so that the configurations which generate substantially increased pressures, compared to a single block, may be recognised. The worst combinations can then be either avoided or allowed for in the design wind load analysis. In practice, these blocks may be two adjacent buildings or they may be components of a single building of more complex planform.

2. TEST PROCEDURE

The building shape chosen as the basic block for this research was the well known Texas Tech experimental building. The atmospheric boundary layer simulation was also chosen to match that of the Texas Tech building. Therefore the turbulence intensity at eave height was 21%. Previous tests on the 1:25 scale model of the Texas Tech building have been reported by Jamieson and Carpenter (1993). By selecting this basic shape, the results are comparable with measurements at full scale and measurements obtained in other wind tunnels. The results of the earlier tests were very encouraging in comparison with full scale data.

The initial series of research focused on determining the increase in the highest peak pressures which occur when two identical blocks are placed adjacent to each other. The two blocks could be moved relative to each other, but a restriction was imposed that the long axes of the two blocks would remain parallel. For a single block, the highest peak pressures are known to occur on the roof, very close to the windward corner, for wind directions blowing obliquely onto the corner. The highest peak pressures on the walls are much smaller than those on the roof. They occur very close to the top windward corner of a wall for wind directions nearly parallel to the wall. These locations were therefore chosen to examine the pressure increases produced by an adjacent building.

Measurements were obtained using conventional pressure tap testing techniques. Wind tunnel mean speed at building roof height was 7.6 m/s. Sampling time for each tap was typically 96 seconds at 1000 Hz. The peak Cp's were calculated using an extreme value analysis of the measured data for an effective sampling time of 47 seconds, which is equivalent to 15 minutes for a nominal mean speed of 10 m/s at building roof height at full scale. A Honeywell 163PC pressure transducer was used, connected to the pressure taps via a Scanivalve pressure scanner. The equipment has been calibrated to have a reasonably flat frequency response from 0-270 Hz, which is therefore equivalent to a frequency response of 0-14 Hz at full scale.

3. RESULTS

Figure 1 shows the locations of three selected pressure taps (two on the roof and one on the long wall) at the windward corner where the largest peak pressures occur. The taps have been labelled R1, R2 and W1. R2 and W1 are both very close to the windward edge of the building. R2 is the location of tap 50101 on the full scale building, for which both full scale and wind tunnel results have been widely reported. The coordinates are all measured from the top windward corner (the southwest corner).

The sketch in Figure 2 shows the approximate relative positions of the two buildings which produce the largest minimum peak pressures on the roof of the test building. The critical oblique wind direction (about 245°) is similar to that for the isolated building. The short walls are facing, the adjacent building is separated from the test building and is also offset rearwards. Measured as a ratio of the length of the short face of the test building, the largest peak pressures on the roof occur for a separation of about 0.3 and offset of about 0.3, as shown. Therefore these largest pressures are caused by the relative positions of the two buildings causing funnelling through the gap between them, and hence increased wind speeds at the windward corner of the test building.

Figures 3 and 4 show the measured pressures for taps R1 and R2, both for the isolated test building and with the adjacent building at the position shown in Figure 2. The largest minimum pressures at the roof corner are increased by about 40% by the inclusion of the adjacent building. This is shown in Figure 3, where the largest minimum Cp increases from –13 to –18. However, this increase is not uniform over the corner of the roof: for tap R2 (Figure 4) the increase in the minimum Cp is quite small.

The results in Figures 3 and 4 were measured for a separation of 0.3 and offset of 0.3. However, the exact position of the adjacent building has relatively little effect for a wide range of separation and offset distances. Figures 5 and 6 show the effects of varying the separation and offset respectively for tap R1 for wind direction 245°. The separation was varied while the offset remained constant, and vice versa. The minimum Cp remains fairly uniform for separation distances between 0.2 and 0.6, and offset distances between 0.2 and 0.4.

On the walls, a similar 40% increase in the largest minimum Cp was measured due to an adjacent building. The largest pressures occur on the adjacent walls of the two buildings at the top windward corners. For example, on the short walls the largest pressures occur with the short walls facing (as in Figure 1), while on the long walls the largest pressures occur with the long walls facing. The results in Figure 7 were measured on the long wall at tap W1, with the long walls facing. The separation was 0.3 and the offset was –0.3 (i.e. adjacent building to windward of the test building). The minimum Cp was increased from –5 to –7 by the adjacent building. This increase was again maintained over a wide range of relative positions of the two buildings; in this case quite similar pressures were measured for zero offset, with separation remaining at 0.3.

4. CONCLUSIONS

This research has demonstrated that a substantial increase in peak wind pressures can be produced by positioning two identical blocks adjacent to each other. These increased pressures occur for a wide range of relative positions of the two blocks, and therefore such combinations occur frequently in practice when buildings or building components are sited near each other. As standard design procedures are largely based on measurements performed on isolated blocks, the research indicates that standard calculations may significantly under-estimate the actual wind loads for many common building configurations. This research is continuing.

REFERENCE

Jamieson, N.J. and Carpenter, P. (1993): "Wind Tunnel Pressure Measurements on the Texas Tech Building at a Scale of 1:25, and Comparison with Full Scale", 7th US National Conference on Wind Engineering, UCLA, Los Angeles, June 1993.

ACKNOWLEDGEMENT

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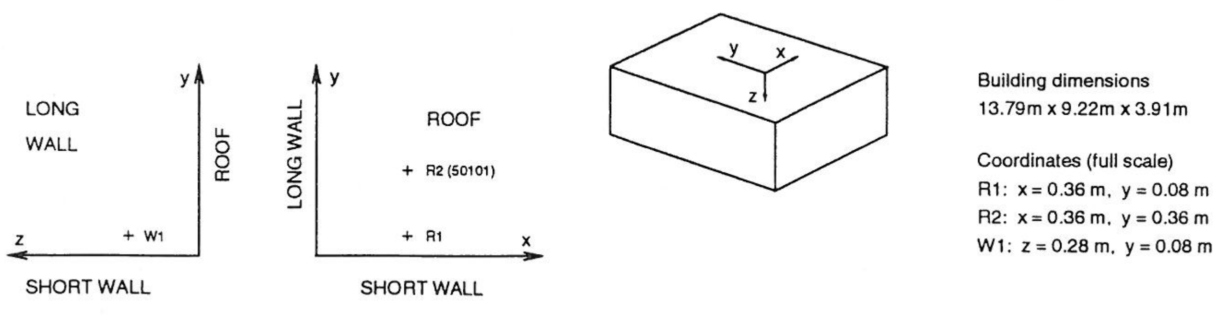

FIGURE 1: Pressure Tap Locations

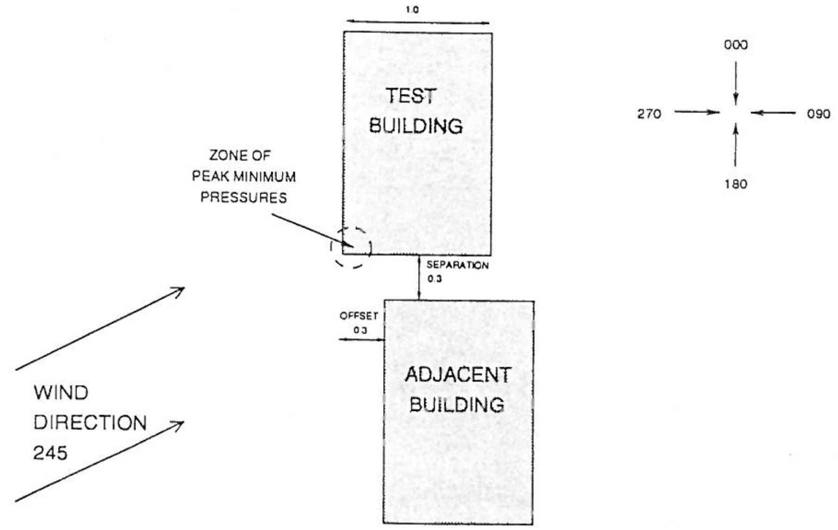

FIGURE 2: **Sketch of Building Orientation**

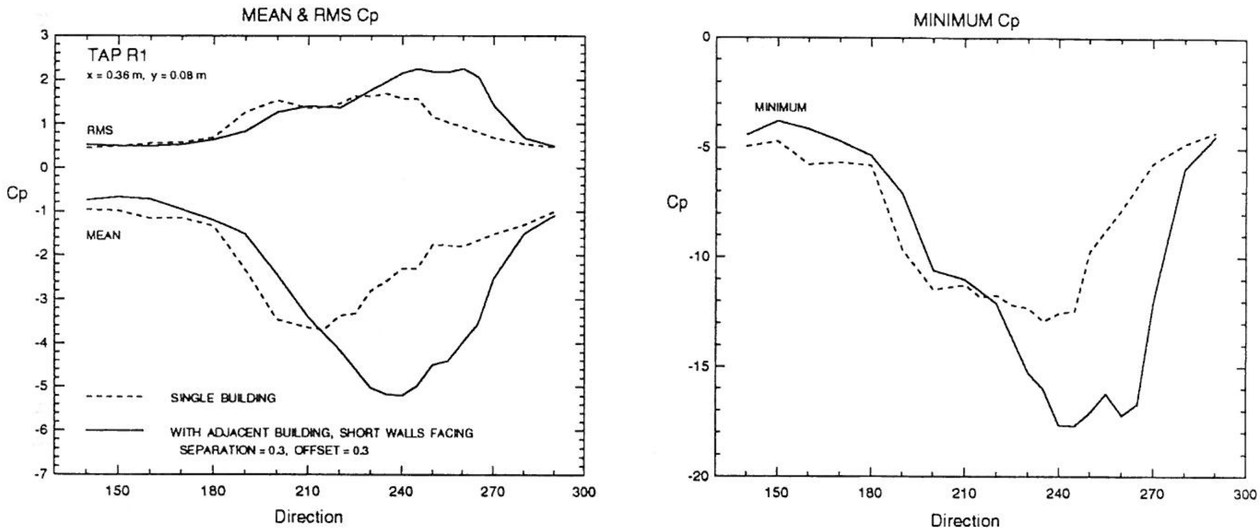

FIGURE 3: **Effect of Adjacent Building on Wind Pressures at a Location of Large Minimum Peak Pressures Near the Roof Corner (Tap R1)**

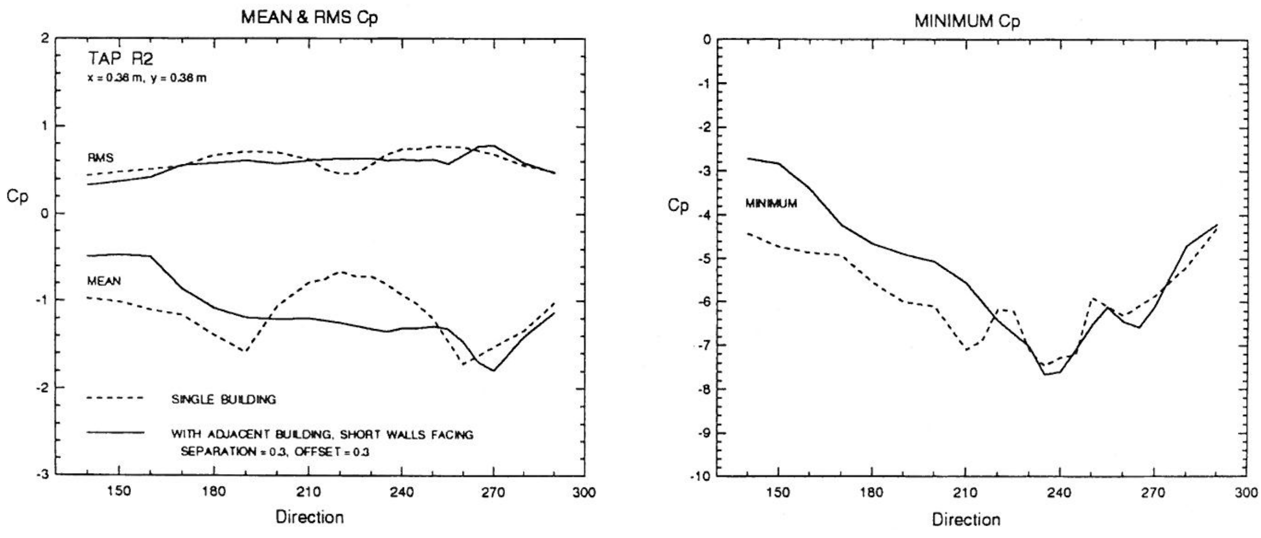

FIGURE 4: **Effect of Adjacent Building on Wind Pressures at Roof Tap R2**

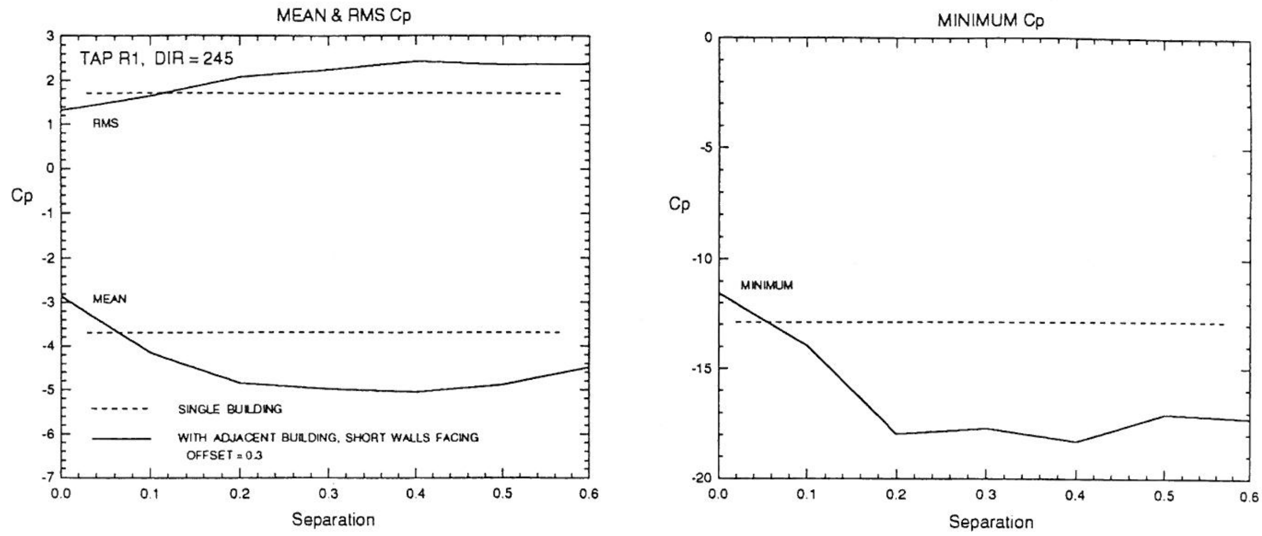

FIGURE 5: Effect of Building Separation on Wind Pressures at Roof Tap R1

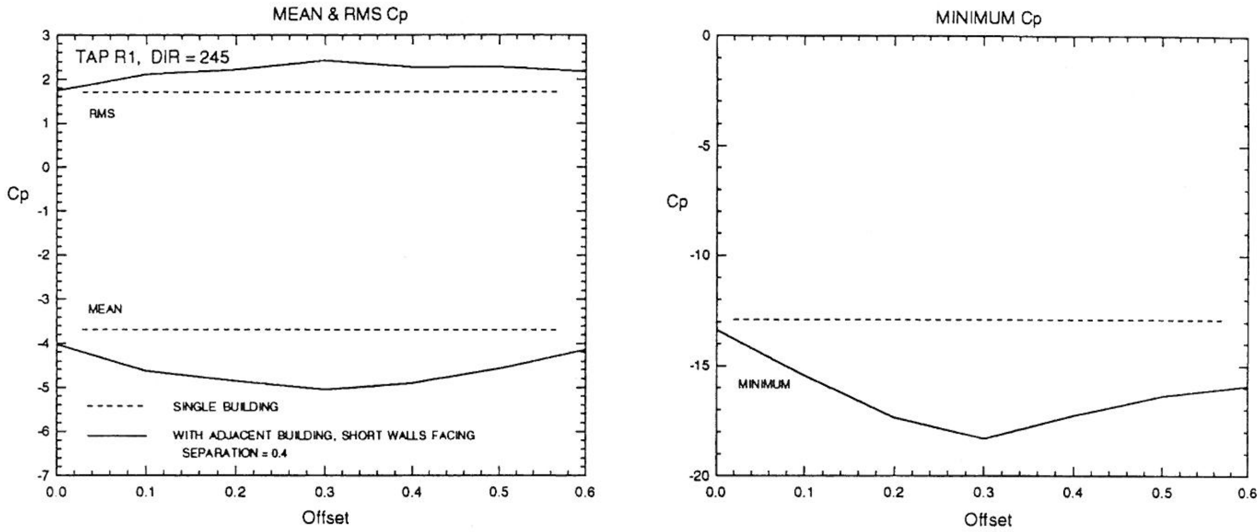

FIGURE 6: Effect of Building Offset on Wind Pressures at Roof Tap R1

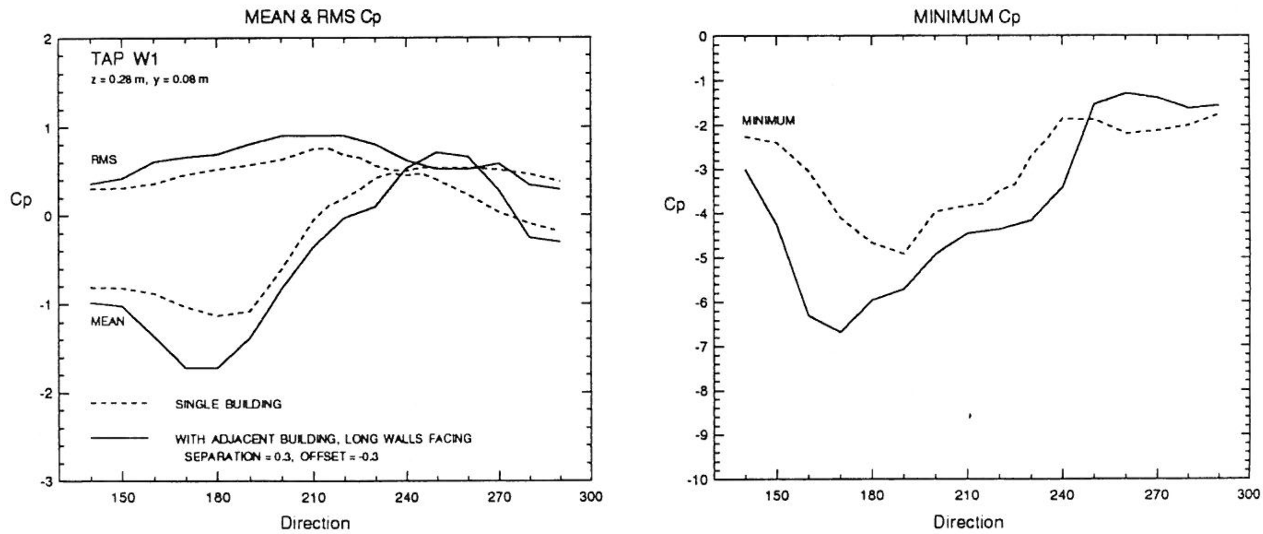

FIGURE 7: Effect of Adjacent Building on Wind Pressures at Wall Tap W1