THE POSITIONAL EFFECT OF THE REFERENCE DYNAMIC PRESSURE ON FULL-SCALE PRESSURE MEASUREMENTS

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1. SUMMARY

In September 4-7, 1989 a paper was presented at the 8th Colloquium on Industrial Aerodynamics in Aachen Germany by the above author, titled "Further full-scale and model pressure measurements on a grandstand". Detail analysis using decreasing sampling intervals showed an unexpected increase in pressure coefficient which seemed unlikely.

The present paper shows the importance of the positional location of the Reference Dynamic pressure to be used for the evaluation of the coefficient pressure measurements taken on the cantilever roof of a grandstand. The reason of the unexpected increases in full-scale pressure coefficients can now be clearly identified. Since the dynamic wind pressures and the roof pressures obtained for the evaluations of pressure coefficients are analysed simultaneously and the reference dynamic pressure in a different location to the roof pressure, the pressure coefficients are affected by the time delay in between measurement locations.

2. INTRODUCTION

A computing programme [1] applicable to data acquisition and reduction was modified to analyse low frequency data from full-scale measurements taken on the roof of a cantilever grandstand at the Cronulla Sutherland Leagues Club in Sydney (Caltex Oval). The full-scale pressure measurements [2] were not filtered during testing. In order to identify between large peak pressure measurements and possible electrical interference that may occur during switching of heavy current equipment, the computer programme allows the reduction of the real time display by essentially "stretching the signal" identifying the "real" data signal. However, since the data obtained on a simultaneous analogue tape recording:-

(a) The wind direction
(b) The wind velocity (a cup anemometer)
(c) The wind dynamic pressure (at the selected reference position)
(d) The pressure on the grandstand cantilever roof, using the process of "stretching" the signal to identify the "real" data and obtaining the pressure coefficient of the same designated real time display, an increase of the pressure coefficient was observed when the "stretching" operation was performed.

At the time of the analysis it was assumed (with suspicion) that it might be due to the fluctuating component of the dynamic reference pressure, since the wind-tunnel testing did not show the same phenomenon. The above assumption was presented at The 8th Colloquium on Industrial Aerodynamics in Aachen Germany, 1989. The author felt that the fluctuation component of the dynamic reference pressure should only have a small influence on the pressure coefficient and suggested more investigation was needed.

Further investigation was carried out and the reason for the unexpected increase in full-scale pressure coefficient was identified. The Journal of Wind Engineering and Industrial Aerodynamics in its special issue on the above mentioned conference, (volume 38, Nos. 2-3, July-August 1991) included an additional paragraph by the author as follows:-

"Since then, further investigation has identified the reason for the unexpected increase in the full-scale pressure coefficient, this being the position of the reference dynamic pressure measurement approximately 50 m. downstream of the roof pressure measurement region. The analysis of 4 channels (Wind direction, wind velocity, dynamic pressure, and roof pressure) are carried out simultaneously. The delay effects shown to be the main reason for the superficial increase of pressure coefficient and the smaller influence of "The fluctuating component of the reference dynamic pressure".

3. IDENTIFICATION OF THE SUPERFICIALLY HIGH PRESSURE COEFFICIENTS

In reference [2], large pressures were recorded and doubt had been raised that the data might be affected by possible electrical interference. Detailed analysis indicated that the data was actual pressure measurements. To confirm the above, the "stretching" operation was used. In the process, the statistical data output calculates average, standard deviation, root mean square, minimum and maximum values. As a normal routine the coefficient of pressures were also calculated. When plotted, it clearly showed an increase in value by reducing the sampling period, thus giving larger coefficients for full-scale data, whilst only negligible changes were observed in the wind tunnel comparisons. It was assumed that the high values in full-scale measurements were due to the "fluctuating component of the reference dynamic pressure."

In figure 1, the above phenomenon is not clearly identified. The positive signals shown are the dynamic reference pressure measurements, and the negative signals are the roof pressure measurements. By using, the "stretching" operation and reducing the sampling time, figure 2 shows the negative roof peak pressures preceding the positive dynamic reference peak pressures. The approaching wind is from the south easterly direction, the roof pressure location recorded the gust wind pressure before the reference point.

Figures 1 and 2 are from data obtained in January 1991 where 45 location positions where measured in the upper surface of the grandstand and 25 locations on the under surface. Wind tunnel model tests have been measured but are not yet fully analysed.

Figures 3 and 4 obtained in February 1989, shows the location of the reference dynamic pressure was 20 m. south of the grandstand. Figure 3 shows the approaching wind was from the south easterly direction and the roof pressure location position is in the southern end of the grandstand, whilst Figure 4 the wind is from the north easterly direction, the location roof pressure position is in the northern end of the grandstand with the reference dynamic location is as in Figure 3. As clearly shown in Figure 3, the positive peak reference pressure preceded the negative roof peak pressure, while Figure 4 has the opposite effect.

Under normal circumstances when analysing full-scale data, attention should be given to a sample range where the wind direction is fairly stable. If the sample analysed is of a long duration, and the reference dynamic pressure position is near the roof measurement region the positional effect should be negligible. If a small time sample is to be analysed then it is essential that the time delay between measuring points must be accounted for by "synchronising" the signals.

4. CONCLUSIONS

The location of the reference dynamic pressure on full-scale measurements is critical when the pressure coefficient has to be calculated for small time duration analysis, and both peak pressures (dynamic and roof) are not fully included in the analysis. The above comment is clearly shown in the paper presented at the 8th Colloquium on Industrial Aerodynamics, Aachen, Germany, 1989, (Figure 6a,6b, & 6c Page 295).

5. REFERENCES

(1). Newman, D.M. "ADAR" Analog Data Acquisition and Reduction, User Guide. Internal Report, Department of Aeronautical Engineering, University of Sydney, 1991.

(2). Pitsis, N.G. and Apperley, L.W. "Further Full-scale and Model Pressure Measurements on a Cantilever Grandstand. 8th Colloquium on Industrial Aerodynamics, Aachen, Germany, September 4-7, 1989. (Pages: 285-295).

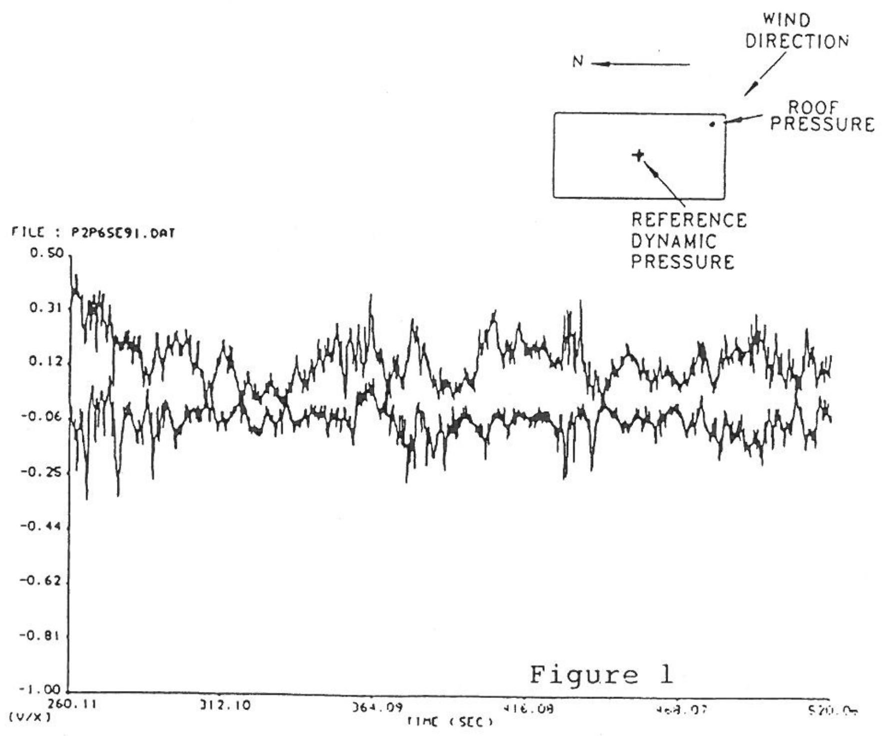

Figure 1

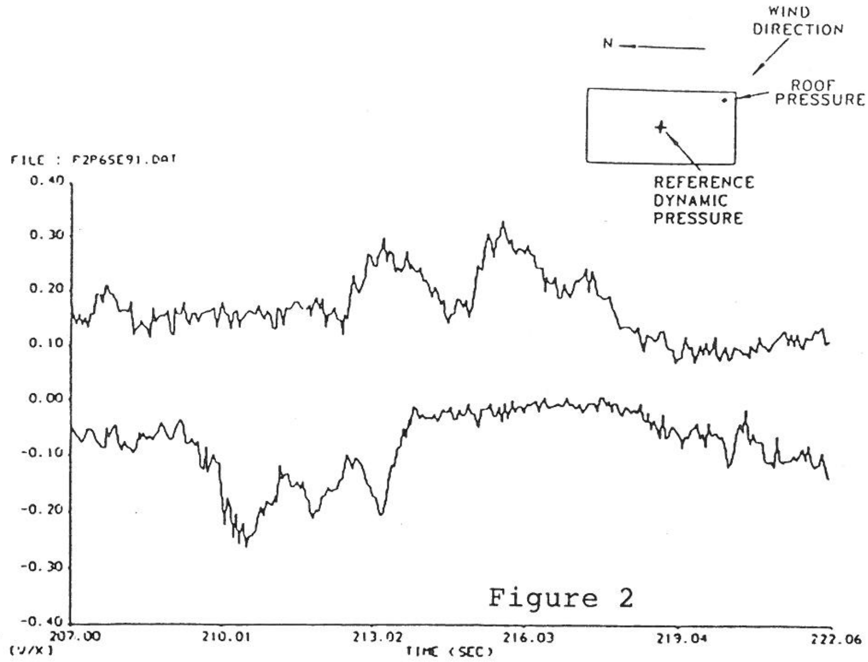

Figure 2

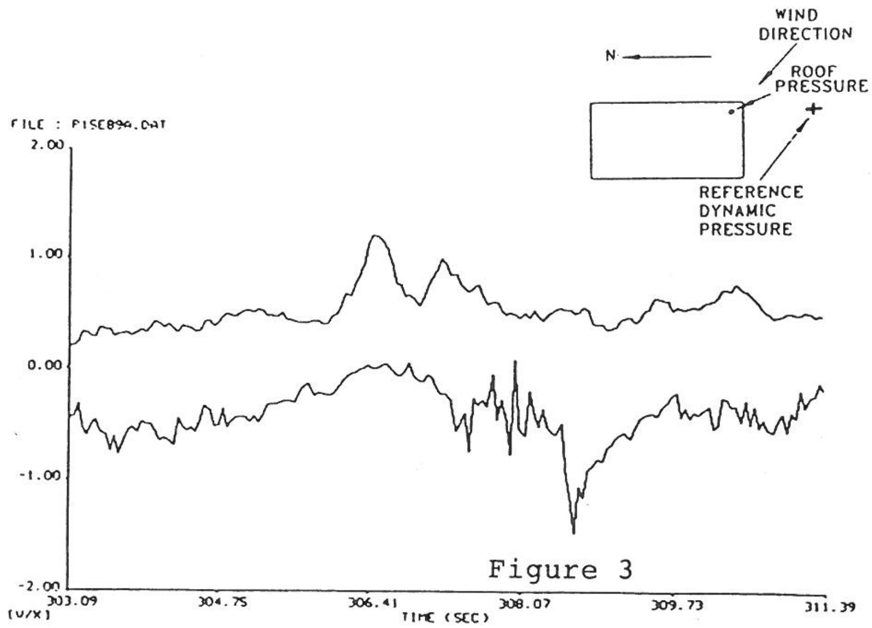

Figure 3

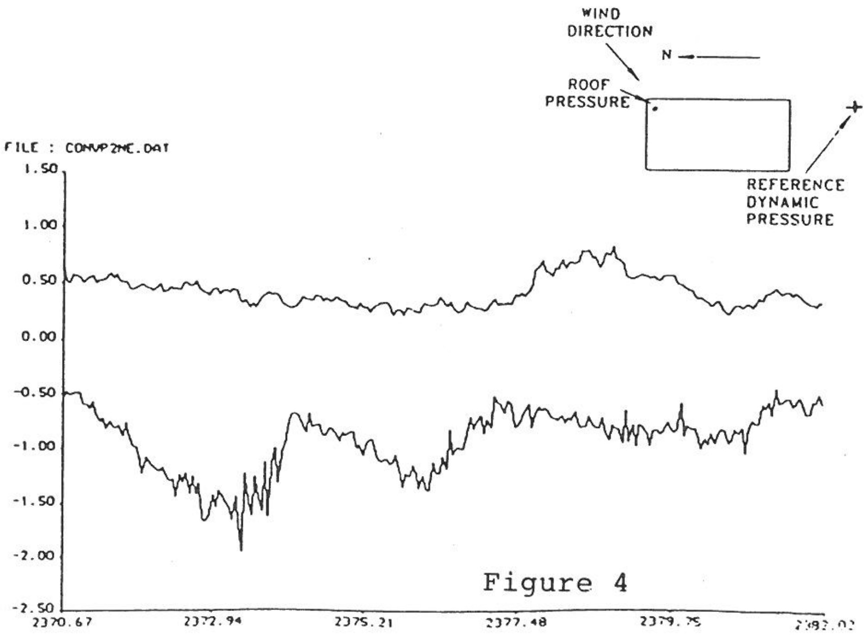

Figure 4