DESIGN FOR WEATHER TIGHTNESS

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SUMMARY

Simultaneous data of wind and rain, obtained from a computer based weather station at North Ryde, are analysed to understand the impact of various parameters to the design of low to medium-rise building. The relevance of this data to the specification and evaluation of weather resistance performance is discussed.

INTRODUCTION

Humanity has long recognised its vulnerability in what can be a hostile environment.The basic requirements of any building are: maintaining the structural integrity, excluding water and managing internal temperature and occupants comfort. Although these requirements are common to all climatic zones, the emphasis of each parameter varies. Modern architectural design is essentially global in nature. The structural aspect is controlled by structural and wind engineers. However, the watertightness is generally conceived to be universal and usually has little regard for the prevailing local climate.

It is no surprise, therefore, to find that wind driven rain poses major problems to any type of building. A recent survey conducted in the northern hemisphere has concluded that 30% of building envelopes experience water ingress problems almost immediately, and 80% experience severe weather related problems within 15 years of construction (although the design life is 50 years!). The survey highlights two main areas which contributes significantly to the watertightness problems: poorly designed buildings (due to the scarcity of appropriate data) and poor workmanship.

The design of a building facade is evaluated by testing a full-scale mock-up in a laboratory. Two fundamental premises are used world-wide when water resistance performance is specified – that acceptable performance should be evaluated at a test pressure that is a proportion of the structural design wind loading, and that water is sprayed over the test sample at a considerable rate, typically approximately 200 mm/hour. Thus the test parameters for buildings in a city such as Wellington, NZ, which is noted for its high winds and rainfall, are likely to be similar to those specified for the coastline north of Perth, WA. This region encounters similarly high winds, but experiences significantly lower rainfall. It is sensible, therefore, to base designs for weather resistance on regional data.

From the above, it is clear that to design an efficient watertight building an understanding of the local climatic conditions are required. Once designed, the performance of the building must be evaluated using appropriate local conditions and not the universal conditions.

The combined wind and rain information available from Bureaux of Meteorology or other similar sources is unlikely to provide detailed information on wind driven rain, as the data are collected over long durations (typically 10 minutes). To overcome the deficiency of appropriate wind driven rain data, a computer based weather station has been established at CSIRO, North Ryde (Sankaran and Paterson, 1995). The aim of this paper is to provide an analysis of some of the wind driven data collected from this facility. It is believed that the rain "events" discussed in this paper are typical and some valuable lessons can be learned from these events.

DATA COLLECTION

A full description of the data collection facility is given by Sankaran and Paterson (1995). The instrumentation of the facility include: a 3 cup anemometer, a wind vane, pressure, temperature and humidity measuring modules, rain gauges with tipping bucket mechanism. When there is no rain, all the data are collected at 1 hr intervals. However, when it is raining the data are collected at 1 minute intervals. A Datataker 200 is used for data acquisition. The collected data are regularly transferred to a lap-top computer and stored for analysis.

DATA ANALYSIS

In an earlier paper, a simple analysis of the data collected over July 1993-June 1994 included total and average rainfall intensity/month, number of rainy days/month etc. In the current paper, we look at a typical rain event and see what can be learned.

In Figures 1a and 1b, the average rainfall intensity and number of rain days for each month are shown. The maximum rainfall intensity occurs in the month of April (about 12.5 mm), however, the number of rainy days in the month is about 8.5. This implies that each rain event in this month is more intense than in the other months, therefore individual events during the month of April are analysed.

There were 9 events in the month of April with total vertical and horizontal rainfalls of 115 mm and 106 mm respectively. The total rainfall intensities are plotted in Figure 2. It can be seen that almost all of the wind driven rain comes from SW, S and SE direction with little or no contribution from other directions. While it is known that the "Southerly" contributes to major rainfall in Sydney, it is a bit of a surprise that most wind driven rain comes from the SW.

Figure 3 shows the wind direction during the events. As we are considering short term events (say less than 40 min.), the wind direction during rainfall 2 and 4 are plotted in Figures 3a and 3b. It can be seen that most of the wind direction lies between 200° and 250°. A long term event is also plotted in Figure 3c. Once again, it can be seen that most of the wind is from about 225°. These observations support the suggestion that most of the wind driven rain is coming from the SW direction.

The mean and 3 sec gust velocities during a rain event are plotted in Figure 4. It can be seen that the general trend of the gust wind follows that of the mean wind. From the current data, there is no indication that the gust wind record contains more fluctuations than the mean wind, as one would expect. A correlation carried out between the two essentially yielded a co-efficient of 0.77, indicating that a reasonable relationship exists between the two. It is also interesting to note that there is also significant similarity between the horizontal and south west rainfall intensity patterns (Figure 5).

CONCLUDING REMARKS

The described research program focuses on collecting and analysing weather data to enable the design of effective water resistant buildings, as well as establishing appropriate parameters to evaluate these designs.

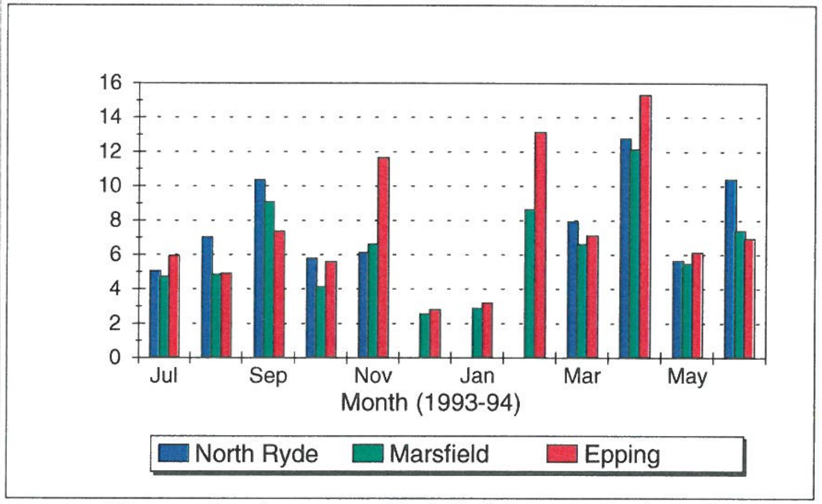

Figure 1a Average Rainfall Intensity (mm)

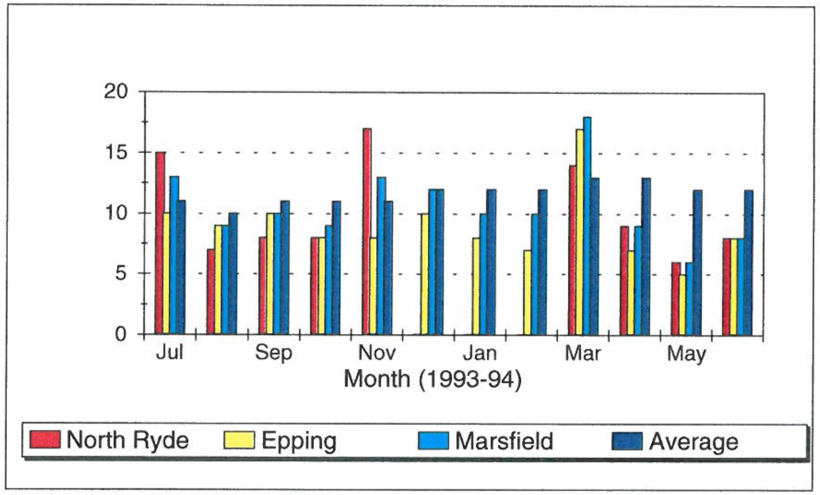

Figure 1b No. of Raindays

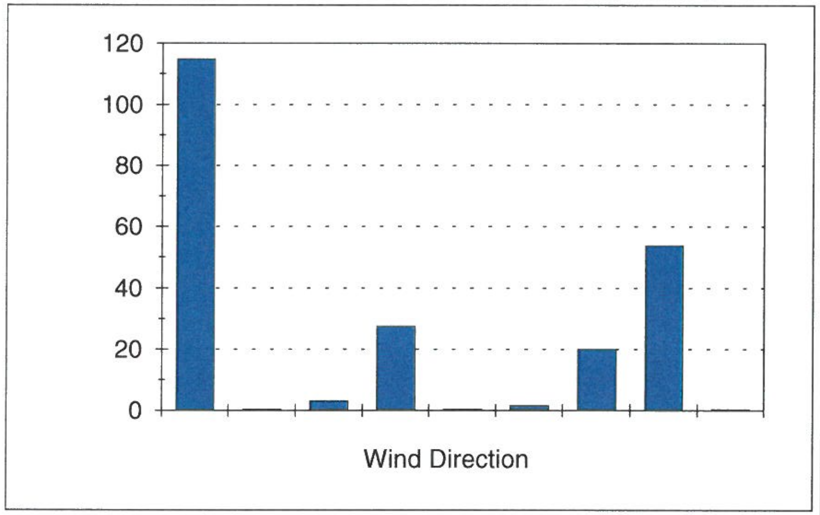

Figure 2 A Typical rainfall

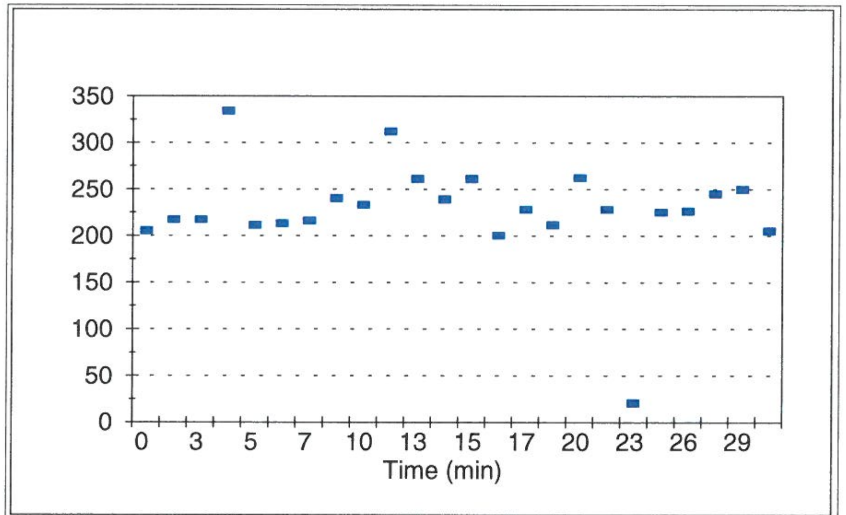

Figure 3a Rainfall No. 2

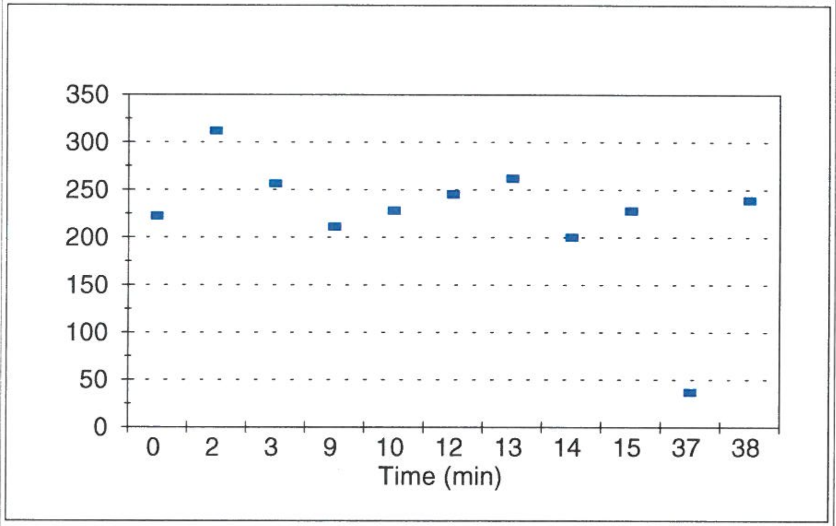

Figure 3b Rainfall No. 6

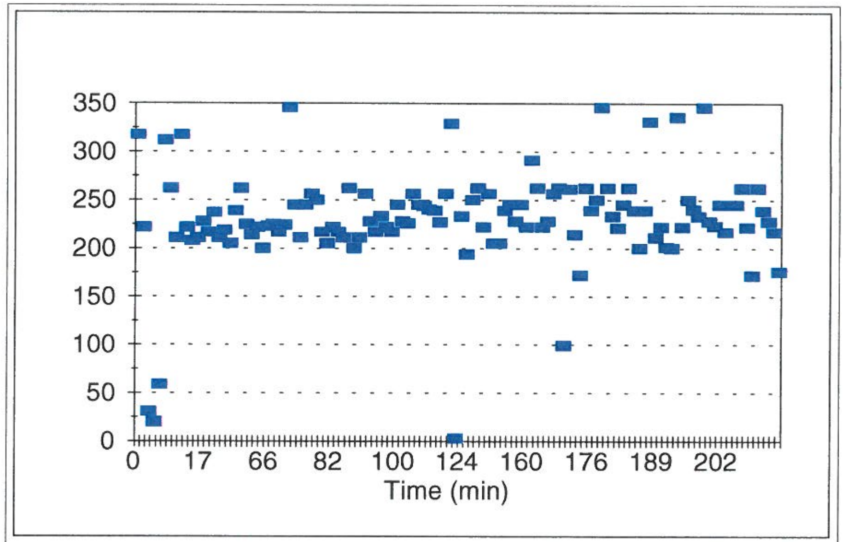

Figure 3c Rainfall No. 9

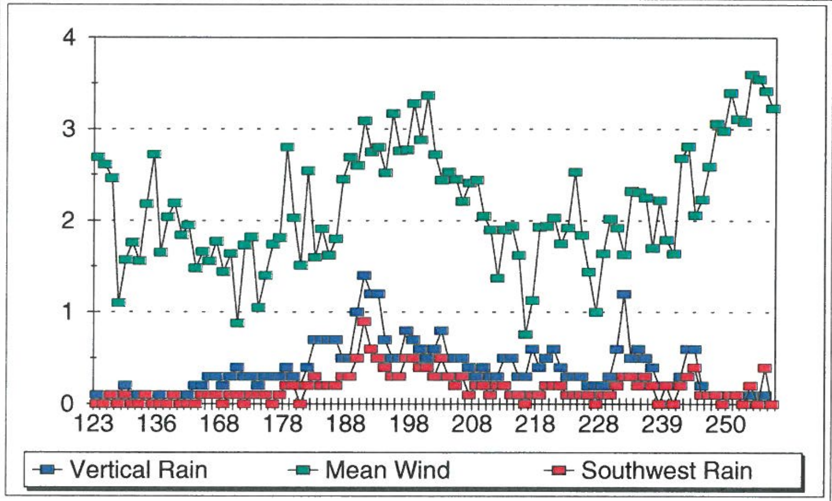

Figure 4 Patterns of wind and rain

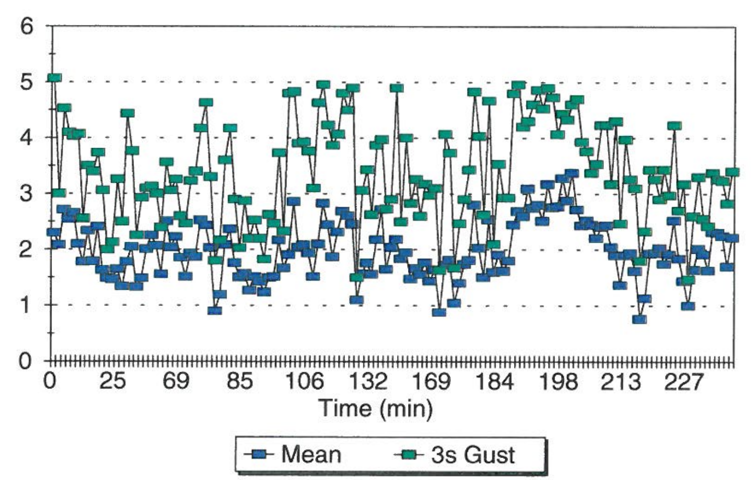

Figure 5 Patterns of mean and gust wind