# New Zealand gust to mean speed ratios and implications for design

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Summary

The evaluation of structures that have a significant dynamic response to the wind is based on equations in which the gust to mean speed ratio is an important parameter. The theoretical expectation for this ratio at 10 m above ground in terrain category 2 is 1.67. Observed values on the occasions with highest gust speed at several New Zealand stations are well below the theoretical expectation. Substitution of these lower values in the design equations has the effect of increasing the expected dynamic response.

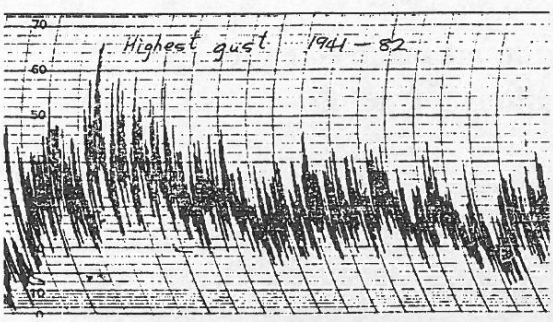
## Gust to mean speed ratios

The Australian code AS 1170.2 – 1989 was based on observed gust speed data. Turbulence and mean speed data were obtained by modifying the gust data using the so-called Deaves and Harris theory of the boundary layer in strong wind conditions. The proposed joint Australia/New Zealand loading code AS/NZS 1170.2 continues the use of the turbulence data but does not use mean speed data.

There has been some discussion of mean to gust speed ratios in Australia and New Zealand (Reid/Skinner, pers. comm., 1990). It appeared that in Australia mean speeds tended to be well below the gust speeds because the latter were mainly due to thunderstorm outflows superimposed on comparatively low mean speeds. In New Zealand extreme winds, however, observed mean speeds tended to be above the gust speed multiplied by the mean to gust speed ratio obtained from the Deaves and Harris theory.

Although mean speeds are no longer explicitly an issue in AS/NZS 1170.2, the gust to mean speed ratio is a factor in a number of equations in the section relating to dynamic design. In the equations, the term $(1 + g_v I_z)$ appears a number of times, where $I_z$ is the turbulence intensity and $g_v$ is the peak factor. Because the turbulence intensity is the standard deviation of the speed over the mean, and the peak factor is the ratio between the maximum gust in an hour minus the mean speed and the standard deviation, the term equals the gust to mean speed ratio over an hour and will be denoted by G.

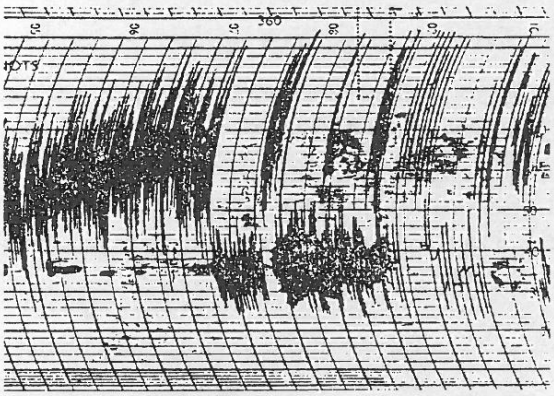
For both the along wind and the crosswind responses (Equations 6.1 and 6.8 of the draft AS/NZS 1170.2), G is in the denominator and is squared. Lower than expected values will tend to increase the expected dynamic response. This paper gives examples of magnitudes of G for New Zealand extreme winds. They are shown in the next section using copies of the important portions of wind recorder charts.




Blenheim Airport 24 September 1970
Highest gust speed.

Observed G = 66/39 = 1.7

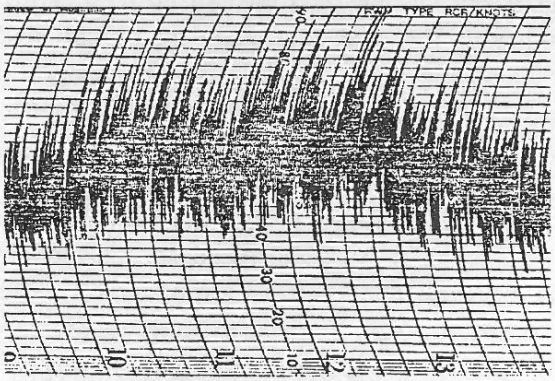
Expected G (code) = 1.67



Wellington Airport 10 April 1968
Highest gust speed.

Observed G = 101/75 = 1.35

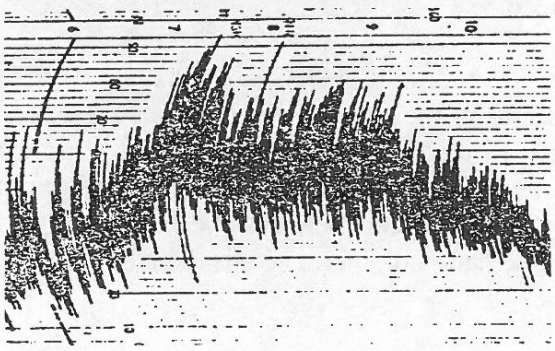
Expected G (code) = 1.67



Chatham Islands 27 July 1985
Highest gust speed.

Observed G = 91/59 = 1.54

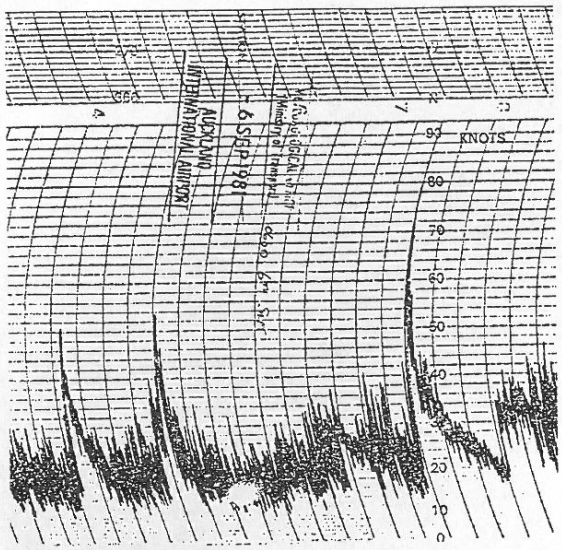
Expected G (code) = 1.67



Christchurch Airport 1 August 1975
Highest gust speed.

Observed G = 93/60 = 1.55

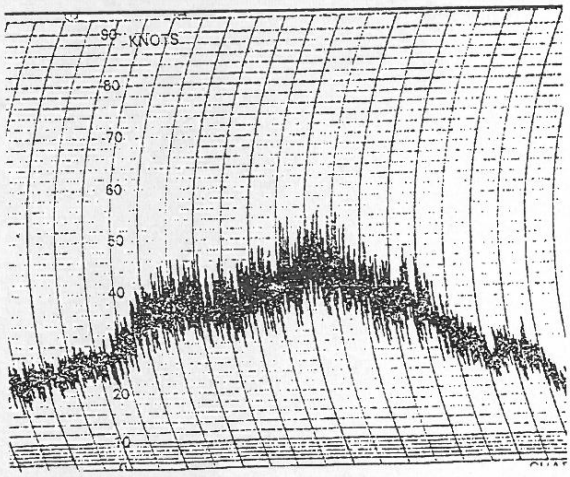
Expected G (code) = 1.67




Auckland Airport 6 September 1981
Highest gust speed.

Observed G = 79/? = ?

Expected G (code) = 1.67




Auckland Airport 15 March 1980
Near highest mean speed.

Observed G = 55/43 = 1.28

Expected G (code) = 1.67

The anemograms on page 2 and at the top of this page are for the highest gust speed at the station. The observed G values vary between 1.35 and 1.7. On these occasions, the mean speed is not necessarily at its highest.

The anemogram for the 15 March 1980 shows the winds for an occasion, at Auckland Airport, on which the mean speeds reached one of their highest values. In this case, the gust speed is comparatively low.

For dynamic design, the wind situations producing the most stringent conditions may have gust speeds below the maximum but with high mean speeds. Planning could be based on independent extreme value analyses on gusts and mean speeds. For Auckland, an extreme value analysis of the mean speeds and of the gust speeds gives a ratio between them of 1.45, well below the theoretical value used in the code. It is conservative for all the other high wind cases shown above except for that at Wellington. At that place, low gust to mean speed ratios are common, especially in southerly winds, and a lower ratio is appropriate.