Wind Speeds for Temporary Structures

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Abstract

When conducting a wind load analysis on a stacker, reclaimer or similar structure, the ultimate limit state wind speed is selected based on the design lifetime of the machine and its importance level. Sometimes, maintenance work is conducted on those machines that involves the use of temporary jacks, props or scaffolding which will need to be assessed under an ultimate limit state wind speed. The ultimate wind speed for the maintenance work could be calculated from the machine's design wind speed, however doing so will result in speeds that are unlikely to be experienced during temporary maintenance work. An alternative method for wind speed calculation is required that considers the short duration of the work and the improving accuracy of modern weather predictions.

1. Introduction

On regular occasions, mobile material handling machines such as stackers, reclaimers and shiploaders will undergo maintenance that requires the use of additional structures that are temporarily added to the machine to facilitate the work. These temporary structures could include, among others, hydraulic jacks and rigid stands for a slew bearing change, jacking beams for a wheel change or encapsulated scaffolding for painting. Before the work is carried out, the structural integrity of the additional components will need to be assessed. Additionally, the structural integrity of the machine with the additional temporary components will need to be assessed and, in some cases, the global stability of the entire machine, with additional components, will need to be checked. One of the key loads that is considered for the temporary works is wind induced loads.

2. Temporary Structure Wind Speed

AS1170.0—2002 (Standards Australia) gives a range of structure design lifetimes that assume the minimum lifetime is six months. However, there are many "structures" whose use is shorter, with lifetimes measured in small numbers of weeks or months. For these temporary structures, Wang, and Pham (Wang & Pham, 2011) have developed a method that can be used to calculate ultimate wind speeds for temporary structures. The method uses an equation for the probability of non-exceedance to modify the set of equations given at the bottom of Table 3.1(A) in AS1170.2—2021 (Standards Australia). A generalized version of this equation is given in Equation (1), where values for the coefficients a and b can be found in Table 3.1(A) of the Standard.

The new equation, Equation (2), is derived from Equation (1) by modifying the variable R, the average recurrence interval. The new equation can be used to calculate a windspeed, $V_{R,s}$, for a reference period s – less than one year in length. The variable R_s is the average recurrence interval that is determined for the temporary structure and the variable T represents the number of reference periods per year. For example, there are 12 month-long reference periods in one year. When calculating wind speeds for temporary works, it is advisable to assume that R_s is the same as the average recurrence interval R that was used in the design of the machine undergoing maintenance.

$$V_R = a - bR^{-0.1} \qquad \text{Equation (1)}$$

$$V_{R,s} = a - b\left[1 - \left(1 - \frac{1}{R_s}\right)^T\right]^{0.1} \qquad \text{Equation (2)}$$

Equation (2) is valid under the following conditions:

- The lifetime of the temporary structure is the combined sum of the length of time of each use of the structure, not the length of time for individual uses.
- The equation is valid for times between one week and one year and is not to be extrapolated.
- The minimum regional wind speeds defined in AS1170.2—2011 (Standards Australia) are still valid.

Using Equation (2), the regional wind speeds are calculated and shown in Figure 1 to Figure for regions A, B, C and D, respectively. The charts can be used to define an ultimate limit state wind speed for a short duration project by determining the region of interest from AS1170.2—2021 (Standards Australia); the annual probability of exceedance from AS1170.0—2002 (Standards Australia); and the expected duration of the temporary works.

In some cases, it may be desirable to use a windspeed that is below the minimum that is shown in each chart. It is possible to use lower windspeeds; however, this can only be done by conducting a statistical analysis of measured windspeeds, logged over an extended period, from the project site.

The work conducted by Wang and Pham relates to the Building Code of Australia (Australian Building Codes Board, 2010) which requires that the design-life probabilities of exceedance of the main structure are used for the temporary structure's windspeed calculation and, as such, this is what is recommended here.

3. Interpolating Wind Speeds

When calculating ultimate limit state wind speeds for a project, it is tempting to interpolate between given values to determine the wind speed for a project with an intermediate duration. As an example, Wang and Pham provide wind speeds of 50m/s and 62m/s for lifetimes of one month and six months respectively for an annual probability of exceedance of 1/500 for region C. For a two-month project, linear interpolation yields a windspeed of 52m/s. The actual calculated windspeed is 55m/s. The difference between these two wind speeds seems trivial but it results in an 11% reduction in the predicted wind force that the structure may be exposed to. The curves for the interpolation and the calculated values are shown in Figure 5 where it can be seen that linear interpolation will always yield a non-conservative result.

4. References

Australian Building Codes Board. (2010). The Building Code of Australia 2010. Canberra, Australia.

Standards Australia. (n.d.). 1170.0-2002 Structural Design Actions Part 0: General Principles.

Standards Australia. (n.d.). 1170.2-2021 Structural Design Actions Part 2: Wind Actions.

Wang, C. H., & Pham, L. (2011). Design Wind Speeds for Temporary Structures. *12(2)*, 173 - 177. Australian Journal of Structural Engineering.

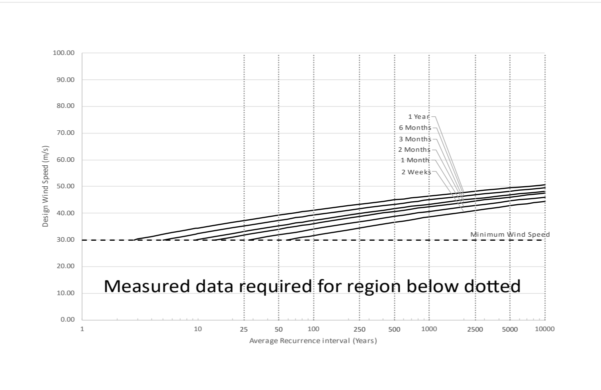

Figure 1 Region A temporary structure ultimate limit state wind speeds.

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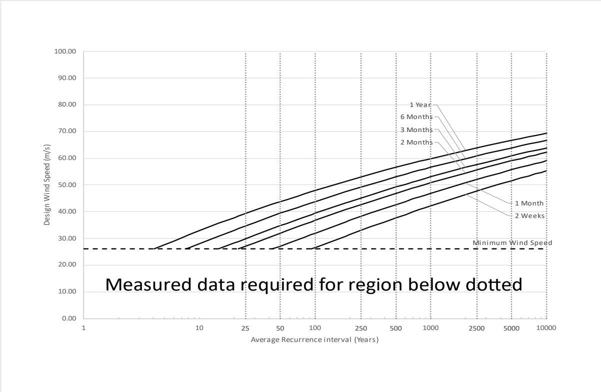

Figure 2 Region B temporary structure ultimate limit state wind speeds.

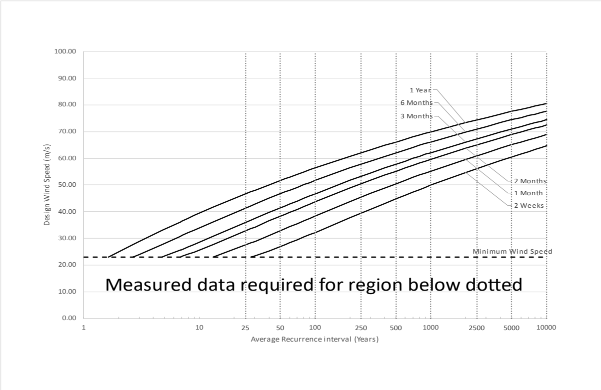

Figure 3 Region C temporary structure ultimate limit state wind speeds.

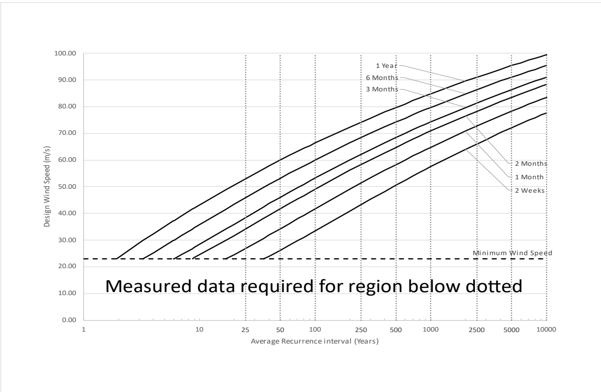

Figure 4 Region D temporary structure ultimate limit state wind speeds.

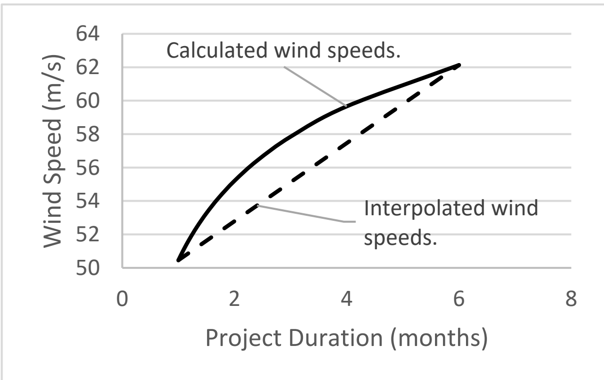

Figure 5 A comparison of interpolation and calculation of temporary structure wind speeds.