Vibration Isolation and Seismic Control
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Understanding the Wind Provisions of the 2015 National Building Code of Canada (CNBC) – Computing Forces

The computation of wind forces when using the National Building Code of Canada differ from those used by the IBC in that they are wind pressure based, rather than wind speed based. Also, to those of us used to working in I-P units, the input data, which is provided in S-I units, needs to be converted to the proper I-P units as part of the analysis process.

The basic Wind design equation used in the CNBC looks like this:

$$P = I_w * q * C_e * C_t * C_g * C_p$$

Where:

I_w *is the Wind based importance factor*

q *is the reference Wind pressure*

C_e *is the exposure factor*

C_t *is the topographic factor*

C_g *is the gust factor*

C_p *is the external pressure coefficient*

In an effort to make this simple, we can look at the terms one at a time.

I_w is the Wind importance factor. Unlike the IBC, where there are different wind maps that are to be used based on the building use, the CNBC code uses one set of wind pressure values and applies to it a factor based on building criticality. These range from .8 to 1.25 and are listed in Table 4.1.7.3.

q is the reference wind pressure for the location in question. The source of this data is Division B, Appendix C, Table C-2 for every significant town in Canada. The column of interest in this table is the one labeled 1/50. The number that is displayed there is the pressure in kPa. (If you are metrically challenged as am I, the number can be converted to psf by multiplying it by 20.88.)

C_e, the exposure factor is based on the roughness of the surrounding terrain as well as the elevation above grade of the vertical centroid of the exposed component being evaluated.

> For open terrain (when adjacent to a lake for example) the C_e factor is equal to $(h/10)^{0.2}$ where h is in meters. There is a minimum screen on this number that is equal to 0.9
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> For rough terrain (where the structure is surrounded by trees, buildings, etc., for a minimum of 1 km (or 20 times the height of the structure, whichever is greater)) the governing equation is $0.7 * (h/12)^{0.3}$. Again h is in meters and in this case the minimum screen value is 0.7.
>
> For exposures in between these extremes, linear interpolation can be used as long as it is performed in a justifiable fashion.

C_t is the topographic factor. If any grades of significant length and a slope of greater than 1:10 are adjacent to the structure containing the equipment being evaluated, there are multiple parameters involving the shape of the feature and the elevation of its rise that can impact this factor. This becomes relatively complex and should this be the case, section 4.1.7.4 of the code should be consulted. If this is not the case, the coefficient should be set to 1.0.

C_g, the gust factor, is assumed to be 2.5 for equipment and cladding.

The C_p factor addresses positive and negative pressures on the various sides of a component. When working with an exposed piece of equipment, if the positive and negative pressures both are generating loads in the same direction, they need to be considered simultaneously. Unfortunately, the factors for equipment are not clearly spelled out in the code, however, the section that appears most to fit is 4.1.7.5 (4) which deals with cladding and secondary structural elements that support the cladding. The factors listed here are generally greater than those used in the preceding sections 4.1.7.5 (2,3) which deal with the main structural system, so if anything, the results should be conservative.

> In section 4.1.7.5 (4a) it is indicated that external pressure factors of +/- 0.9 must be considered. As these factors are additive, the combined wind load factor for horizontal loads would be 1.8.
>
> In section 4.1.7.5 (4c) an upward external pressure factor of -1.0 for the central area of the structure is indicated. This covers all of the building roof area except for a perimeter band that is 10% of the building width wide. If located in the band, an upward pressure factor of -1.5 should be considered.

Combining these factors will result in both a maximum horizontal pressure and a maximum vertical pressure that can be applied to the components being restrained. To convert this to a force, the horizontal and vertical pressures need only be multiplied by the exposed face area (for horizontal loads) or by the exposed plan view area (for the vertical load) of the equipment.

Note that forces acting in the horizontal plane can be substantially different as the wind acts along the short or long axis of the equipment.

When evaluating the anchorage, both the horizontal and vertical loads should be considered to act simultaneously.

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