WIND CODES AND STANDARDS: FUNDAMENTALS BEHIND THEIR PROVISIONS

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1. Introduction

These lecture notes address some fundamentals in wind engineering useful to understand the development and evolution of wind standards and codes of practice with respect to the wind design of buildings. There has been a lot of progress during the last century in the development of wind engineering and the results originating from intensive research have been incorporated into upgraded editions of various national and international wind standards and codes of practice. Special emphasis is given to the low buildings, since tall buildings, particularly those of complex shapes and inhomogeneous surroundings are still tested in boundary layer wind tunnels, although computational attempts are always on the rise. Table 1 shows the pressures in pounds per square foot on a flat surface normal to the direction of the wind for different velocities in mph, as calculated by the formula – $P = 0.004\ V^2$.

Table 1. Wind pressures specified by ARMCO steel buildings in 1944

Velocity (mph)	Pressure lbs/ft^2	
10	0.4	Fresh Breeze
20	1.6	Mild Wind
30	3.6	Strong Wind
40	6.4	High Wind
50	10.0	Storm
60	14.4	Violent Storm
80	25.6	Hurricane
100	40.0	Violent hurricane

For a rectangular building, the pressure may be taken as 80% of that given in Table 1.

A one-page description of wind code specifications has now evolved to books with hundreds of pages requiring detailed guides and commentaries to elaborate on these provisions and assist designers with proper interpretation and correct application. In fact, most national and international wind load standards have a common format in so far as they include their provisions in terms of descriptive instructions to the designer followed by a commentary or supplement or appendix with background information and explanations relaying to the origin of the provisions or rationale for their modifications from previous editions of the code / standard.

Relevant references are provided for the interested reader for further reading and understanding, although some countries' standards are mute in this regard, presumably because code committees have utilized their collective wisdom significantly and altered or not considered parts of the content of the material of the original research.

Another common characteristic in the provisions of various wind loading standards is the basic equation for the evaluation of wind pressure loads acting on building surfaces, which takes a form such as:

$$P = q\ Ce\ Cp\ Cg \quad (1)$$

This equation includes the dynamic velocity pressure (q) depending on wind climatology and terrain topography, an exposure factor (Ce) depending on height and upstream exposure characteristics, the pressure coefficient or shape factor (Cp) depending on the shape and geometric details of the building interacting with the wind and a gust effect factor (Cg), which expresses the dynamic character of the wind pressures acting on building surfaces, as well as the local fluctuations including the so-called "hot spots" influencing the design of cladding elements. Each of these basic factors will be discussed in these lecture notes.

Wind loading provisions included in the Commentaries of the National Building Code of Canada (NBCC 1995 and 2005) are indeed pioneering whereas the American National Standard ASCE 7-05 (2005) is now considered one of the best in the world since it incorporates the major research findings in the area of wind-building interaction. Upgrading the code provisions is of course an ongoing process and there are always issues to be settled and innovations to be implemented. Currently, critical issues include, among others, the evaluation of wind loads on buildings of different shapes, the stipulations for the evaluation of internal pressures, as well as the clear definition of exposure including cases of roughness transition. These are significant questions to dominate the research agenda in the years to come. In addition, the understanding and evaluation of load paths for various building configurations are real challenges, while work is expected to continue on various means to mitigate the effects of vortices generating very high suctions near roof corners, ridges and edges.

The lecture notes review the evolution of knowledge and its current state regarding the evaluation of wind loads on low buildings. These notes provide a brief historical perspective, followed by some detailed description of the University of Western Ontario's research on wind loads on low buildings carried out in the 70's. The influence of the research results on the formulation of design load provisions in contemporary wind standards and codes of practice. The notes will also discuss the status of computational wind engineering as well as the so-called computer-aided wind engineering in the evaluation of wind pressures on low buildings.

2. Wind Velocity

The dynamic velocity pressure $q = ½\ \rho\ V^2$ of Equation 1 depends heavily on the wind speed V.