Chapter C31
WIND TUNNEL PROCEDURE

Wind tunnel testing is specified when a structure contains any of the characteristics defined in Sections 27.1.3, 28.1.3, 29.1.3, or 30.1.3 or when the designer wishes to more accurately determine the wind loads. For some building shapes wind tunnel testing can reduce the conservatism due to enveloping of wind loads inherent in the Directional Procedure, Envelope Procedure, or Analytical Procedure for Components and Cladding. Also, wind tunnel testing accounts for shielding or channeling and can more accurately determine wind loads for a complex building shape than the Directional Procedure, Envelope Procedure, or Analytical Procedure for Components and Cladding. It is the intent of the standard that any building or other structure be allowed to use the wind tunnel testing method to determine wind loads. Requirements for proper testing are given in Section 31.2.

It is common practice to resort to wind tunnel tests when design data are required for the following wind-induced loads:

1. Curtain wall pressures resulting from irregular geometry.
2. Across-wind and/or torsional loads.
3. Periodic loads caused by vortex shedding.
4. Loads resulting from instabilities, such as flutter or galloping.

Boundary-layer wind tunnels capable of developing flows that meet the conditions stipulated in Section 31.2 typically have test-section dimensions in the following ranges: width of 6 to 12 ft (2 to 4 m), height of 6 to 10 ft (2 to 3 m), and length of 50 to100 ft (15 to 30 m). Maximum wind speeds are ordinarily in the range of 25 to 100 mi/h (10 to 45 m/s). The wind tunnel may be either an open-circuit or closed-circuit type.

Three basic types of wind-tunnel test models are commonly used. These are designated as follows: (1) rigid Pressure Model (PM), (2) rigid high-frequency base balance model (H-FBBM), and (3) Aeroelastic Model (AM). One or more of the models may be employed to obtain design loads for a particular building or structure. The PM provides local peak pressures for design of elements, such as cladding and mean pressures, for the determination of overall mean loads. The H-FBBM measures overall fluctuating loads (aerodynamic admittance) for the determination of dynamic responses. When motion of a building or structure influences the wind loading, the AM is employed for direct measurement of overall loads, deflections, and accelerations. Each of these models, together with a model of the surroundings (proximity model), can provide information other than wind loads, such as snow loads on complex roofs, wind data to evaluate environmental impact on pedestrians, and concentrations of air-pollutant emissions for environmental impact determinations. Several references provide detailed information and guidance for the determination of wind loads and other types of design data by wind tunnel tests (Cermak 1977, Reinhold 1982, ASCE 1999, and Boggs and Peterka 1989).

Wind tunnel tests frequently measure wind loads that are significantly lower than required by Chapters 26, 27, 28, 29, and 30 due to the shape of the building, the likelihood that the highest wind speeds occur at directions where the building's shape or pressure coefficients are less than their maximum values, specific buildings included in a detailed proximity model that may provide shielding in excess of that implied by exposure categories, and necessary conservatism in enveloping load coefficients in Chapters 28 and 30. In some cases, adjacent structures may shield the structure sufficiently that removal of one or two structures could significantly increase wind loads. Additional wind tunnel testing without specific nearby buildings (or with additional buildings if they might cause increased loads through channeling or buffeting) is an effective method for determining the influence of adjacent buildings.

For this reason, the standard limits the reduction that can be accepted from wind tunnel tests to 80 percent of the result obtained from Part 1 of Chapter 27 or Part 1 of Chapter 28, or Chapter 30, if the wind tunnel proximity model included any specific influential buildings or other objects that, in the judgment of an experienced wind engineer, are likely to have substantially influenced the results beyond those characteristic of the general surroundings. If there are any such buildings or objects, supplemental testing can be performed to quantify their effect on the original results and possibly justify a limit lower than 80 percent, by removing them from the detailed proximity model and replacing them with characteristic ground roughness consistent with the adjacent roughness. A specific influential building or object is