

How to Calculate Wind Loads From Wind Speeds

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Updated May 17, 2018 By Eric Bank, MBA, MS Finance

A wind load refers to the intensity of the force that wind applies to a structure. Although you can use a simple formula to calculate wind loads from wind speed, building designers, engineers and constructors must incorporate many additional calculations to ensure their structures won't blow over in a high wind.

Wind Pressure

You can get a general idea of the pressure on a 1-foot-by-1-foot section of a structure by using the following formula: wind pressure per square foot = $0.00256 \times \text{the square of the wind speed}$. For example, a 40-mile-per-hour (mph) wind speed creates a pressure of $(0.00256 \times (40)^2) = 4.096$ pounds per square

foot (psf). According to this formula, a structure meant to withstand 100-mph winds must be built to resist a wind pressure of 25.6 psf. Several websites offer multifactor online calculators to determine wind pressures on standard structures.

Drag Coefficient

Translating wind pressure to wind load must take into account the shape of the structure, which determines its drag coefficient (C_d), a measure of wind resistance. Engineers have worked out standard C_d values for different shapes. For example, a flat surface has a C_d of 2.0, whereas the C_d of a long cylinder is 1.2. C_d is a pure number with no units. Complex shapes require careful analysis and testing to determine their C_d values. For example, car manufacturers use wind tunnels to find the C_d of a vehicle.

Load Is a Force

Armed with pressure and drag data, you can find the wind load using the following formula: $\text{force} = \text{area} \times \text{pressure} \times C_d$. Using the example of a flat section of a structure, the area – or length \times width – can be set to 1 square foot, resulting in a wind load of $1 \times 25.6 \times 2 = 51.2$ psf for a 100-mph wind. A 10-foot –by– 12-foot wall claims an area of 120 square feet, meaning that it would have to withstand a 100-mph wind load of $120 \times 51.2 = 6,144$ psf. In the real world, engineers use formulas that are more sophisticated and contain additional variables.

Other Variables

Engineers must account for the fact that wind speed can vary with height above the ground, atmospheric pressure, terrain, temperature, ice formation, the effect of gusts and other variables. Different authorities publish conflicting C_d

values, which can yield different results depending on the authority chosen. Engineers normally “overbuild” structures so they can withstand wind loads in excess of the maximum wind speed anticipated at the structure's location. Different loads apply to winds blowing on a structure from the side, behind, above or below.

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How to Calculate Wind Load on a Structure

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Updated August 07, 2017 By Allen Douglas

Wind load on a structure depends on several factors including wind velocity, surrounding terrain, and the size, shape, and dynamic response of the structure. Traditional theory assumes that horizontal wind load pressures act normally on the face of the structure. Computations for wind in all directions are calculated to find the most critical loading condition. Consideration of suction from pressure differential forces caused by wind is also typically estimated in the case of sidewalls and leeward walls. Typically, building codes allow for either calculated wind loads or wind loads determined by testing of models in a terrain setting equivalent to that of the building site.

Determine the basic wind speed for the location of the structure. If no data is available for the site, use the following approximate values for basic wind speed in the United States:

Coastal and mountainous areas 110 mph Northern and central U.S. 90 mph
Other areas of the U.S. 80 mph

Select the category of terrain for the structure. Choose category "A" for city centers with other structures nearby over 70 feet. Choose "B" for wooded or urban areas with structures under 70 feet. Choose "C" for flat areas with obstructions under 30 feet in height. Choose "D" for flat, unobstructed areas.

Use the following to find the coefficient of exposure (K) using the terrain category. For exposure "A" use .000307. For exposure "B" use .000940. For exposure "C" use .002046. For exposure group "D" use .003052.

Use the following calculation to estimate wind pressure on a structure: $q = K \times V^2$ = coefficient of exposure x basic wind velocity c basic wind velocity.

Multiply the wind pressure by 1.15 for important structures such as schools, hospitals, high-occupancy buildings, vital communication buildings, or tall or slender structures.

Multiply the wind pressure by 1.05 for buildings subject to hurricanes along the Gulf of Mexico or the Atlantic coast.

Multiply the calculated wind pressure times the surface area, in square feet, of the structure exposed to wind in each specific direction. Use the largest surface area exposed to wind for the highest wind loading.

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