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INFILTRATION AND VENTILATION

Wind Forces, Temperature Difference Forces, Combined Forces, Calculation of Infiltration, Air Leakage Through Windows, Doors, and Walls, Natural Ventilation, Flow Due to Wind, Flow Due to Temperature Difference, Flow Due to Combined Wind and Stack Effect, Types of Openings, General Ventilation Rules

INFILTRATION is the air leakage through cracks and interstices, around windows and doors, and through floors and walls of a building of any type from a low one-story house or commercial building to a multistory skyscraper. The magnitude of infiltration depends on the type of construction, workmanship, and condition of the building. The rate of infiltration cannot be controlled by the inhabitants of the building to any considerable extent. Natural ventilation is the intentional displacement of air through specified openings, such as windows, doors, and by ventilators.

The rate of air flow into and out of a building due to either infiltration, exfiltration, or natural ventilation, depends on the magnitude of the pressure difference between the inside and outside of the structure and on the resistances to flow of air offered by openings and interstices in the building. The pressure difference exerted on the building enclosure by the air may be caused either by wind or by a difference in density of the air inside and outside. The effect of the difference in density is often called chimney or stack effect and is often the major factor. The pattern of air flow through any part of the structure depends on both the pressure difference and the area of openings. When the pressure difference is the result of wind pressure, air will enter the building through openings in the windward walls and leave through openings in the leeward walls or through ventilating ducts in the roof as may be the case of one-story commercial buildings. When the pressure difference is caused by the indoor-outdoor temperature difference, the flow will be along the path of least resistance from inlets at lower levels to outlets at higher levels in a heated building or in the opposite direction for an air-conditioned building, as may be the case of multistory skyscrapers.

In most instances the pressure difference between inside and outside will result from temperature difference forces. Mechanical ventilation and exhaust systems can affect pressure differences across the building enclosure, depending on the design.

WIND FORCES

Air flow due to wind around and over a building creates regions in which the static pressure is either above or below the static pressure in the undisturbed air stream. In general, pressures are positive on the windward side resulting in inflow of air and negative on the leeward side resulting in outflow of air. Pressures on the remaining sides may be negative or positive depending on the angle of the wind. The static pressure pattern over a roof will depend on the roof type. Pressures are generally negative over flat or low-pitched roofs, but may be positive on the windward side and negative on the leeward side of high-pitched roofs. Static pressures over the surfaces of buildings are approximately proportional to the velocity

head of the undisturbed air stream. The velocity head equivalent to a given wind speed can be expressed as:

$$p_v = 0.000482 V_w^2 \quad (1)$$

where

p_v = velocity head, inches water gage.

V_w = wind velocity, miles per hour.

Equation 1 is based on an air density of 0.075 lb per cu ft. Values of the velocity head and velocity in fpm are given in Fig. 1.

The choice of values of static pressure around buildings for use in calculations must be somewhat arbitrary due to the number of variables and the limitations in available information. Pressures may vary from +0.5 to +0.9p, on the windward side, and from -0.3 to -0.6p, on the leeward side for simple square or rectangular shaped buildings, depending on the angle of the wind. Pressures on the other sides, parallel to, or at slight angles to the wind direction, may range from -0.1 to -0.9p. These surfaces when curved may act as airfoils, resulting in negative pressures two or more times the velocity head of the free air stream. Pressures over roof sur-

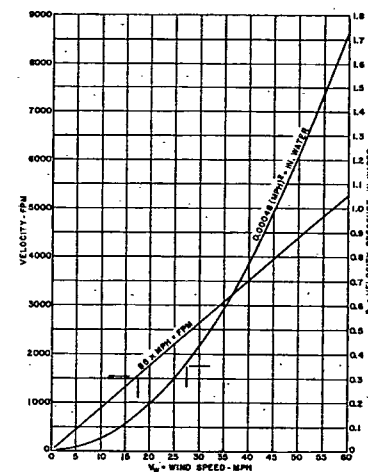


Fig. 1 Wind vs Velocity Pressure and Velocity in FPM

The general responsibility for this chapter is assigned to TC 2.5, Ventilation Requirements and Infiltration.