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Air Leakage Control

Air leakage is a major source of heating load, but controlling air leakage is important for other reasons as well. Certain types of uncontrolled leakage result in moisture deposits in the building envelope. For example, when warm, moisture-laden air works its way out through the wall system, the moisture condenses on the cold outer wall panels, providing an opportunity for mold and mildew to grow, degrading insulation performance, and even causing structural damage. Air leakage can also contribute to occupant discomfort in perimeter spaces.

UNDERSTANDING THE BASICS

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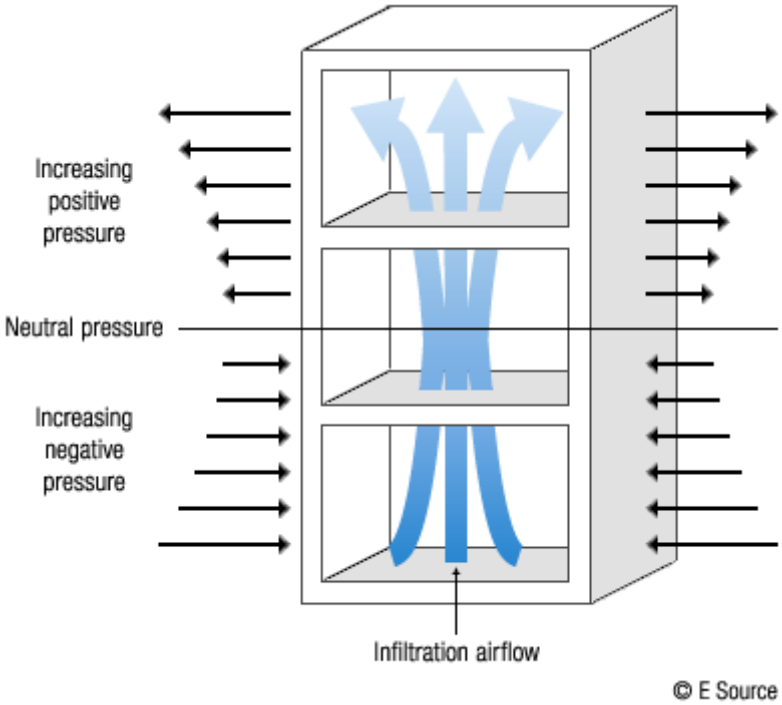
Even if the building envelope is full of holes, air can't move through the holes without a pressure difference between the inside and the outside of the building, which provides the driving force for airflow. The strength of this driving force depends on indoor and outdoor temperature differences, on wind speed and direction, and on mechanical air movement.

Indoor/outdoor temperature differentials cause the stack effect, which is the force that enables hot-air balloons to rise (**Figure 1**). If a building were light enough, the warm air inside would cause it to float away on a cold day. Instead, all that warm air collects at the top of the building and pushes against the envelope until it finds a way out. Any warm air that leaks out is replaced by cold air that tends to enter at the bottom of the building—where negative pressure results from all the warm air leaving through the top. Taller buildings leak more due to the stack effect than shorter buildings.

Figure 1: Stack effect

The buoyancy of warmer air creates high pressure at the top of a building and low pressure at the bottom.



Somewhere between the top and bottom of the building is the neutral pressure plane, where air is under neither positive nor negative pressure. Shell holes near this plane cause much less leakage than holes at the top or bottom of the building. The exact location of this plane varies depending on temperature differentials, wind, fans, and the operation of combustion equipment. Generally, leaks at the top and bottom of the building—where stack-effect forces are greatest—are most important and offer the largest potential for energy savings. Top-of-building air leaks are slightly more important to seal than bottom-of-building air leaks, because sealing the former tends to pressurize the building whereas sealing the latter tends to depressurize it. Elevator shafts and stairwells in particular can contribute to the stack effect, because they provide a ready path for air to travel across multiple floors.

Wind is another driving force for air leakage. The pressure created from wind can either pull air out of a building or push air into it. Buildings in windier climates or exposed locations have more air leakage than do buildings in calmer climates or sheltered locations.

In addition, HVAC systems can create positive and negative pressures within buildings through duct air leakage or through unbalanced airflow between supply and return air. Mitigating building pressure is just as important as sealing air leaks, especially when the pressure is negative. Negative pressure can cause backdrafting in natural-draft chimneys, or it can suck moisture and pollutants into a building.

MITIGATING AIR LEAKAGE

this section

Have an air-leakage contractor perform a fan pressurization test. This test depressurizes a space with either a large external fan or the building's own air-handling equipment. From measurements of both the inside and outside air pressures and the airflow rate, the contractor can determine the total building air leakage. In addition, while the test is being performed, the contractor can locate where the leaks are occurring within the building either by feel or by using artificial smoke to trace the airflow.

Once air leaks are found, they can be sealed using caulking, foam, or other sealants. To verify the work and quantify the air-leakage reduction, a fan pressurization test should be repeated after all sealing has been completed.

In addition, have a testing, adjusting, and balancing or other HVAC contractor verify the performance of the ventilation system. This should be done initially to mitigate air leakage and then periodically as part of recommissioning efforts, after major renovations, or in response to occupant comfort complaints. The supply and return airflow rates should be checked to ensure balanced operation. Also, outdoor airflow rates should be verified to ensure that adequate fresh air is being delivered.

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