SPECIALREPORT >>

The 8 rules of building performance

By understanding and applying these 8 rules, we can build buildings that are more tolerant of the elements and forces that impact a building's durability.

Part 1: Consider the laws of thermodynamics

Heat flows from warm to cold

In winter, heat inside the house seeks to move outside and in summer, heat wants to move in. This flow of warm to cold not only affects comfort and energy loss, it also brings moisture and uncontrolled airflow into walls. We manage this flow of energy and moisture by air sealing, properly installing insulation and window selection.

Moisture moves from warm to cold

Rain falls on a brick exterior wall and is absorbed. The sun comes out, heats it up and drives the water to the interior side of the brick where it's cooler. From there it either drains out or it moves out through the wall as a vapor.

Air conditioning also pulls moisture through the wall to the inside. Here again, moisture wants to move to where it's cooler – the interior of the wall system. Temperature differences help drive the movement, so if you don't design the wall system with the proper materials for the climate, this moisture could condense inside the wall cavity and cause mold growth and decay. To manage this process, select an exterior weather barrier and interior finishes that allow the wall to dry along with sheathing materials that help effectively manage rain and water vapor.

Moisture moves from more to less

This rule primarily applies to moisture in the form of vapor. This movement happens through diffusion and airflow. Diffusion is the movement of moisture in a vapor state caused by either a difference in vapor pressure and/or temperature. In summer, when the humidity outside is high, moisture seeks to move from the outside to the inside, where the air conditioner is working to pull moisture out of the interior air. In winter when there's less moisture in outside air, moisture wants to move from the inside out.

Since moisture moves from more to less, the type and permeability of the wall system materials you choose is important. For example, if you live in a hot, humid climate and use a vinyl wall covering on the drywall, moisture drawn from the outside in can condense on the back of the vinyl where it can create mold. Conversely, if you install a low permeable, non-insulating sheathing, in winter, moisture moving from the interior of the house outside may condense on the interior side of the sheathing. This condensation occurs when moisture reaches its dew point at the cold interface of the exterior sheathing and can cause performance problems or decay.

IN SUMMER, WHEN THE HUMIDITY OUTSIDE IS HIGH, MOISTURE SEEKS TO MOVE FROM THE OUTSIDE TO THE INSIDE, WHERE THE AIR CONDITIONER IS WORKING TO PULL MOISTURE OUT OF THE INTERIOR AIR.

The other significant way moisture moves from more to less is through airflow. Moisture can be carried by the flow of air in or out of the house through holes and cracks in the building envelope. This airflow is caused by a variety of forces, including stack effect, wind and mechanical systems.

Brick dries in, not out. Water that is absorbed during a rainstorm is actually driven inward when the sun comes out. Without a clear drainage plane, and capillary break, that moisture can work its way into wall framing.

Stack effect is created when there is a difference in temperature from the inside to the outside. Cold air leaks into the building through cracks and unsealed openings as warm air escapes out of the building through similar cracks and unsealed openings in sealing. When wind blows against the building, it creates a pressure difference across the building. On the windward side air flows in; on the leeward side, air is drawn out.

Fans – both furnace and exhaust fans – can create a difference in pressure that can either draw moisture in or allow it to flow out. So, by building a tight envelope and controlling mechanical pressures, moisture flow through a building can be reduced.

Part 2: Understand how air behaves

Air out equals air in

This is a key principal. It is not climate related and yet it's potentially life threatening. Few of us know how much air is exhausted by a clothes dryer or kitchen exhaust hood. What we do know is that in physics, for every cubic foot of air we push out of a building, another cubic foot has to come in to replace it. When we turn on a kitchen exhaust hood and push air out of the house, an equal amount of air must find its way back inside.

Sealed ducts don't leak. Almost a third of the air going through ductwork leaks out. If it leaks into an attic or crawlspace, it can add moisture to the space causing mold growth. At the very least, it wastes energy. These ducts are sealed with mastic, which is better than tape.

Siding and soil don't mix. All exterior wall claddings should be separated from the soil by at least a foot, depending on how much snow and rain an area gets. Otherwise, the siding will wick water into the wall system causing rot and decay.

Make sure your materials are compatible. This particular house wrap is a woven plastic, which does not stop bulk liquid from getting through. Worse, there is no space behind the brick to allow drainage and drying.

This air comes in through the path of least resistance. The bigger the hole, the easier the path is and the greater the quantity of flow from this area. The challenge here is that the path of least resistance can often be the flue for the water heater, fireplace or furnace and with this return air can come combustion gases that can produce deadly carbon monoxide.

Other common paths of least resistance include soffits and chases, house-to-garage connections, unsealed ductwork in attics and crawl spaces, outlets and switch boxes placed in exterior walls, recessed light fixtures, and unsealed foundation drainage systems. All can carry unhealthy air.

Intrusion of carbon monoxide, odors and unhealthy air is compounded when consumers choose large exhaust fans and kitchen exhaust hoods without considering a controlled and safe source of make-up air. To manage this problem, consumers and builders need to select closed combustion appliances, provide a properly sealed building envelope and provide controlled make-up air when large exhaust fans are installed in the house.

Air behaves like a fluid

Use the same principals of fluid movement for air that you use for water. Too often, ductwork is installed in crawl spaces, outside walls and in attics. If the ducts are not sealed as tightly as those that carry water, air will escape into the crawl spaces, attics and wall cavities. In winter, this heated air can easily cause moisture problems when it hits a cold surface and condenses. It can lead to ice dams and sheathing deterioration, which can lead to mold growth and indoor air quality problems.

We pressure test plumbing vent stacks, but we do not seal and pressure test ducts and yet we install ducts in unconditioned spaces, which can carry unhealthy air into the house. By sealing ductwork, we will improve comfort and HVAC system performance, and reduce the potential for building failures.

Part 3: Work with water, not against it

Rain follows gravity

The goal is to have rain spend as little time as possible in contact with building materials. To do this, we need to drain rain. If we don't drain rain and flash openings properly, water can enter the structure and cause decay, material failure and mold growth. Install gutters, properly extend downspouts, slope site drainage, manage landscaping, and use appropriate foundation waterproofing and drainage systems.

It's tempting to believe if you've installed gutters and downspouts, everything is okay. But, rain usually comes with wind and wind-driven rain passes through all exterior cladding – wood, vinyl, steel, aluminum, brick, stone, stucco and cement. In climates with heavy rain and high winds, cladding should be installed over a vented drainage plane or rain screen.

If it gets wet, let it dry

There is no stopping water; the key is to build houses that allow building materials to dry out once they get wet. For example, once, builders kept a 10- to 12-inch space between the ground and the exterior cladding. This concept still holds true, and a minimum of 6 to 8 inches should be maintained between the ground and all materials that can absorb water.

However, today, we are often stuck with the idea that owners don't want to see foundations, they want siding to go down to the dirt.

When siding or cladding stay in contact with the soil, they'll wick water causing paint film failure and degradation. When wood or concrete get wet, the water can move upward, against gravity. To control this, siding needs a method that either allows it to dry out or a system that keeps it from getting wet. By keeping building materials up off the ground or by sealing them, we can prevent this wicking action.

Part 4: Where the action is

It all happens at surfaces and connections

Each material dictates what is going to happen when it comes in contact with the elements in the environment and in the adjacent building materials. Is the material foam, wood or masonry? How does it react to moisture? Does it absorb water, shed it or drain it? Does it dry quickly? How does it react to the environment? Will the environment alter or degrade the material? How does it react with adjacent materials?

Most building materials are picked based on price and aesthetics, not by how the surface is going to react to its environment. We need to choose materials that are compatible with the environment and the materials they contact if we want the building to last.

CHOOSE MATERIALS THAT ARE COMPATIBLE WITH THE ENVIRONMENT AND THE MATERIALS THEY CONTACT IF YOU WANT THE BUILDING TO LAST.

All of these rules of building performance apply to the materials we select and the environment we use them in.

We're not trying to build perfect buildings; we're trying to build more tolerant buildings. By understanding and applying these 8 rules, we can build buildings that are more tolerant of the elements and forces that impact a building's durability. And at the same time, we can keep our clients safe, comfortable and out of harm's way.

This special feature is provided by Construction Instruction (CI). Among the most-respected building scientists in North America, CI (constructioninstruction.com) teaches best-practice building methods.