

PRACTICAL HEALTHY HOMES

Flooring Guide



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Don't want mold under your flooring?

Mold under flooring is more common than you'd think — and once it sets in, it's a nightmare to find and fix. It can also be a major source of VOCs in a home.

The simplest fix? Skip the flooring altogether. If you build on a slab, you can simply polish the concrete. That lets your floor breathe and release moisture without any damage. But polished concrete isn't for everyone. And if you're not building on a slab, polished concrete isn't an option.

So if you want actual flooring, how do you prep your subfloor the right way to keep mold from becoming your problem? And what flooring is the healthiest choice for your home?

This guide will tell you what to consider when choosing and installing flooring for your home.

Why mold grows

To understand why mold grows under flooring, we need to go back to the basics of build science and the control layers of a home. My [“Building a Healthy and Resilient Home”](#) class explains these in detail, but here are the basics.

- Like humans, most mold needs food, water, and oxygen to grow.
- There are generally three sources for moisture underneath flooring:
 - Water soaks up from underneath via capillary action.
 - Leaks from above or from the side seep under the floor.
 - Moisture-laden air hits the dew point temperature and condenses under the floor.
- Most flooring, and most underlayments, are vapor barriers, meaning that once water gets underneath the floor, it has no way to dry out.
- Warm air rises. In heating season, the stack effect pulls cold exterior air in through any gaps at the floor level — meaning a leaky floor assembly actively draws moisture-laden unconditioned air into the floor cavity, where it can hit dew point and condense.
- Permeability - how easily water vapor moves through a material - is of utmost importance when deciding on a flooring assembly.

Preventing mold under flooring

All of these conditions can lead to mold growth in and under flooring. That's why it's especially important to apply proper building science principles to our entire flooring assembly, rather than just choosing the flooring we think is prettiest.

Just like the rest of our house, we have two basic strategies for preventing mold under flooring:

- Keep the space between the subfloor and the flooring dry.
- Allow moisture a path to get out if it does get in.

Now let's get into the details.

Installing flooring over a concrete slab

- Make sure your home site has proper grading so water isn't getting trapped underneath your foundation.
- Lay a capillary break of 3/4" of clean crushed rock underneath your foundation.
- Install insulation under your foundation as appropriate for your climate.
- Install a taped and sealed 10+ mil vapor barrier, such as Stego. Overlap seams by at least 6" and tape or mastic all joints. For complete installation instructions, consult [this video](#).
- Do not put anything (notably sand) between the Stego and the concrete.
- Make sure the concrete is thoroughly dry before installing flooring by doing multiple [calcium chloride tests](#) or tape tests (as defined by ASTM D4263-05.) These tests are easy to perform - you can do them yourself.

Installing flooring over a concrete slab - cont'd

- Make sure the subfloor is level so moisture doesn't accumulate in spots under the flooring (and so the flooring doesn't break).
- Install a breathable underlayment to allow any residual moisture to dry out. Check the flooring installation instructions to make sure the underlayment you choose is compatible with your flooring. Some floors have their own built-in underlayment. Some allow an additional one, but it can't be more than a few mm thick. Never install plastic sheeting as underlayment - it will trap moisture. QuietWalk or DMX 1-Step are underlayments you might consider, if they are compatible with your flooring.

Installing flooring over a conditioned area - top

Assuming that:

- the rooms underneath your flooring are conditioned to be the same temperature as the rooms on top of it
- are dehumidified to no more than 50% RH, and
- dew point stays consistent across the assembly

then installing flooring is fairly straightforward. This is the case when installing flooring above a conditioned crawl space, basement, or lower floor. In these situations, you can safely install flooring as follows:

- Glue the subfloor to the floor trusses for stability and air sealing. Then fasten from the top using screws, not nails.
- Airseal the subfloor seams with tape. Tescon Vana tape works well for this purpose.
- Make sure the subfloor is level, so moisture doesn't accumulate in spots under the flooring (and so the flooring doesn't break). Generally you're looking for less than 3/16" over a 10-foot span, but check the installation instructions for your flooring.
- Install a breathable underlayment such as QuietWalk or DMX 1-Step to allow any residual moisture to dry out. Make sure the underlayment you choose is compatible with your chosen flooring. In most cases you should avoid installing plastic sheeting as underlayment - it will trap moisture. A possible exception is when you're installing tile in a wet room and the priority is making sure it's waterproofed from above.

Installing flooring over a conditioned area - underneath

You'll also need to make sure that the floor trusses underneath are installed properly. To this end, you'll also need to:

- Insulate and airseal the rim boards and everywhere the floor framing meets the exterior wall. You can use impermeable rigid insulation or canned spray foam for this purpose.
- Insulate between the bays on the bottom of the subfloor. It's important that the insulation be tight up against the subfloor so there are no air gaps. You can use a light batt insulation for this, like formaldehyde-free unfaced fiberglass, and thin metal bars called Insulation Supports that push up against the insulation to hold it in tight.



Installing cold floors

With a cold floor, the rooms underneath your flooring are not conditioned or dehumidified. This is the case when installing flooring over an unconditioned garage, crawl space, basement, or patio area, or on top of a slab that doesn't have a proper capillary break and vapor barrier. Most of the floors that are built in the US are cold floors, and unless you have carefully specified otherwise and made sure it happened, yours will be too.

Cold floors are inherently risky. Moisture comes up from below and then hits dew point and condenses. Add a vapor barrier on top, such as many of the available underlayments or vinyl flooring, and voila, mold factory.

In addition to all of the steps for installing flooring over a conditioned area, for a cold floor, you'll also need to run continuous vapor impermeable rigid insulation, such as XPS or foil-faced polyiso, on the underside of the floor trusses, connecting the seams with an impermeable flashing tape such as Zip Flashing Tape. This will slow vapor drive from the room below.

See the next page for more dos and don'ts.



Installing cold floors, cont'd

Additionally, to mitigate your risk when installing cold floors:

- Never install impermeable flooring (like vinyl) over cold floors. Opt for a more permeable flooring such as tile with vapor permeable thinset and grout, or solid hardwood with a vapor permeable underlayment. Note that solid hardwood requires careful acclimation and moisture testing before installation
- You may void your flooring warranty by not installing a vapor barrier directly underneath it, even if you have waterproofed and insulated from below. Read the warranty carefully and then decide what works best for your installation.
- If you must use spray foam to insulate the trusses, cover the insulation bays and joists with at least 2 ½" closed cell spray foam. Open cell spray foam is vapor permeable and will not stop the vapor drive upward, so vapor can still accumulate under your floors.

Bottom line: Installing flooring over a cold floor or in an existing home is risky. If you decide to proceed, prepare the subfloor carefully, choose the most vapor permeable flooring you can find, and monitor the installation carefully for hidden mold growth.



Installing flooring in an existing home

Slab foundations

In most existing slab foundations, assume no proper vapor barrier was installed and moisture is constantly seeping through.

- Bare concrete is always going to be your safest choice for flooring with an unknown assembly. Remember moisture can still accumulate under furniture.
- Always test the moisture content of your slab in multiple locations before installing flooring.
- Address grading and install downspout extenders and foundation drains as needed to keep water from flowing into your slab.
- You may be able to seal an existing slab with a fluid-applied low VOC vapor barrier, such as Sika MB Epoxy, before laying flooring.
- Never use plastic sheet underlayment on top of slabs. Condensation can occur in air gaps, leading to mold.



Installing flooring in an existing home, cont'd

Garages under living space

When installing flooring in a room over a garage, pay particular attention to airsealing the floor so that vehicle and chemical fumes aren't getting into your living space.

Unconditioned crawl spaces and basements

When installing flooring in a room over an unconditioned crawl space or basement, think about whether it makes sense to seal and condition the crawl space or basement, making a safer assembly all around. If you cannot condition

Bottom line: Installing flooring in an existing home is risky. If you decide to proceed, prepare the subfloor carefully, choose the most vapor permeable flooring you can find, and monitor the installation carefully for hidden mold growth.

Evaluating flooring

Ready for a trip to the flooring showroom? Not quite. Before you go shopping, you need to understand two aspects of flooring that the salesperson will probably never mention. In all likelihood, even if you bring these up, they will have no idea what you're talking about - so you'll have to advocate for yourself and do some digging.

When choosing flooring, it's important that you consider the vapor **permeability** of the entire flooring assembly (not just the flooring itself), as well as the **VOC**, or chemical content, of the flooring.

More on the next few pages.

Understanding permeability

Permeability is how easily water in vapor form can pass through a material. Sometimes, permeability is referred to as “breathability.” It’s important to understand that the words can be used interchangeably; sometimes sales people will understand “breathability” more than they’ll understand “permeability.”

A highly vapor permeable material, like a t-shirt, allows moisture to pass through easily. A vapor impermeable material, like a plastic bag, doesn’t allow moisture to pass through at all.

The permeability of a building material is measured using its “perm rating.” A vapor permeable material has a perm rating of 10 or more. A vapor impermeable material has a perm rating of .1 or less. Anything in between is considered vapor semi-permeable. The higher the number, the more permeable the material. A good place to start is by searching the web for the “*product name* perm rating.”

If your entire flooring assembly is perfect and you live in a dry environment, you may be able to get away with impermeable flooring. If you worry that moisture may need to dry upward through your flooring, or are in a humid environment, your flooring needs to be as permeable as possible, and polished concrete may be your only safe option.

Flooring assembly permeability

It is not enough to look at just the permeability of the flooring itself. You have to consider the entire assembly - all of the products that need to be installed together in order to meet the manufacturer warranty.

Many flooring options require an “underlayment” beneath the flooring that blocks moisture from damaging the flooring. Well, guess what - if moisture is being trapped by the underlayment, the flooring might be in great shape, preserving your flooring warranty, but you’re likely to get mold under the underlayment. Make sure you aren’t keeping flooring manufacturers happy at the expense of your own family’s health.

Plank flooring may require an impermeable glue.

With tile, you have to consider the entire assembly, including the anti-cracking membrane, thinset, grout, and possibly grout sealer. Even if the tile itself is permeable (which it’s likely not - most flooring tile is porcelain, which is impermeable) the rest of the components most likely makes the assembly as a whole vapor impermeable.

Carpet is usually permeable, but it’s often installed over plastic carpet padding, which is impermeable.

Flooring assembly permeability, cont'd

Regardless of which type of flooring you're using, think through the entire assembly and make sure that any moisture that makes its way under the flooring has a way to dry out.

If you use an underlayment, choose one that allows moisture a path out.

Consider installing a click-lock floor, rather than a glue-down floor, and install it over a breathable underlayment.

If your tile isn't going in a wet room, perhaps choose a membrane, thinset, grout, and sealer that are more vapor permeable.

If you're installing carpeting, consider wool or other breathable padding.



Understanding VOCs

VOCs - Volatile Organic Compounds - are the chemicals and poisons that off-gas from the products you install in your home. The “volatile” part means that they easily break off from solid materials, like flooring, and get into the air that you breathe and live in. Many people who are sensitive to mold are also sensitive to VOCs.

If you’re not careful, flooring can be a major contributor to VOCs and unhealthy air quality in a home. Don’t believe me? Go to a flooring showroom and take a sniff.

Some of the VOCs you need to watch out for with flooring include:

Formaldehyde - found in the adhesives and binders used in engineered wood, laminate, and some hardwood products, as well as plywood and OSB flooring cores.

4-PC (4-Phenylcyclohexene) - the chemical responsible for that distinctive "new carpet smell." **Styrene** and **Ethylbenzene** are also found in carpet backing and some adhesives.

Phthalates - plasticizers used to keep vinyl (LVP/LVT) flexible.

Acetaldehyde - found in many wood flooring finishes and adhesives.

Toluene, xylene, and benzene - found in flooring adhesives, especially solvent-based ones.

Researching VOCs



Unfortunately, researching VOC content in flooring can be tricky. Manufacturers are only legally obligated to release information about chemicals that might harm the workers installing them, and they're allowed to retain certain "trade secrets" and not divulge everything. So you may need to do some digging.

A good place to start is to see if the flooring you want to use offers a Safety Data Sheet (SDS). Remember to request the SDS for all of the products in your flooring assembly, including the underlayment, any glue, any finishing chemicals, and any required cleaners.

Since it's a finished product, flooring isn't required to have an SDS. Sometimes they'll offer an SDS anyway, and sometimes they'll offer VOC testing results.

If you're sensitive to VOCs, consider calling flooring manufacturers and asking hard questions about the chemical content of their flooring.



Researching VOCs, cont'd

If there's no SDS and they won't divulge any product content, that's a red flag.

Even if you are able to find some information about chemical content, it may not be the complete list of chemicals in a product. Still, it's a start.

Designations like "Green Guard Gold" may or may not mean anything. Ideally you want to do your own research.

Once you know what chemicals are used in a product, you can research the health effects of each chemical in the [Pharos](#) database.

On top of your research, **make sure you also order samples of products you're considering and see how they make you feel.** If a 3" x 5" sample smells bad to you, imagine what an entire house full of that flooring might smell like. It's important not to skip this step.

[Habitable](#) provides general guidance on the safety of various flooring and flooring installation materials (and many other products as well).

Choosing your flooring

Choosing your flooring is the fun part! There are so many choices that the options themselves are beyond the scope of this document. My [Building a Healthy and Resilient Home](#) course goes into detail about the different types of flooring available, and recommends a few that I've had success with. I also assist consulting clients one on one in making this important decision given their particular climate, assembly, and particulars.

Looking for more?

Want to learn how to build the rest of your home? My [Building a Healthy and Resilient Home](#) course covers this level of detail for every component of your home. It's a step-by-step guide that will teach you everything you need to know to design and advocate for your own healthy home build.

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