Building a concrete foundation for a healthy house

Concrete foundations are a mainstay in healthy house construction. This article discusses foundations with additive-free concrete, which are used by people with severe environmental sensitivities.

Keywords: *Healthy house, foundation, concrete, concrete additives, concrete admixtures, fly ash, recycle, wet curing, environmental illness, MCS, chemical sensitivity, radiant floor heat, mold, termites, frost protection*

Introduction

The foundation is what supports the house. There are many types of foundations, some of which can be a problem for sensitive people. Even the healthier types of foundations have pitfalls to avoid.

Some foundations are prone to causing mold problems in a house, regardless of the climate. Some foundation types are also not suitable for use with tile floors, which are the healthiest kind. Some people do fine with hardwood floors, which are less demanding on the foundation.

Some problematic types of foundations are:

- basements
- crawlspaces
- anything that puts wood in contact with soil

Two of the healthiest types of foundations are:

- monopour (slab-on-grade)
- stem wall with slab

Concrete foundations have the following benefits:

- mold resistance
- rot resistance
- well-tolerated by sensitive people
- termite resistance
- thermal mass (evens out day/night temperatures)

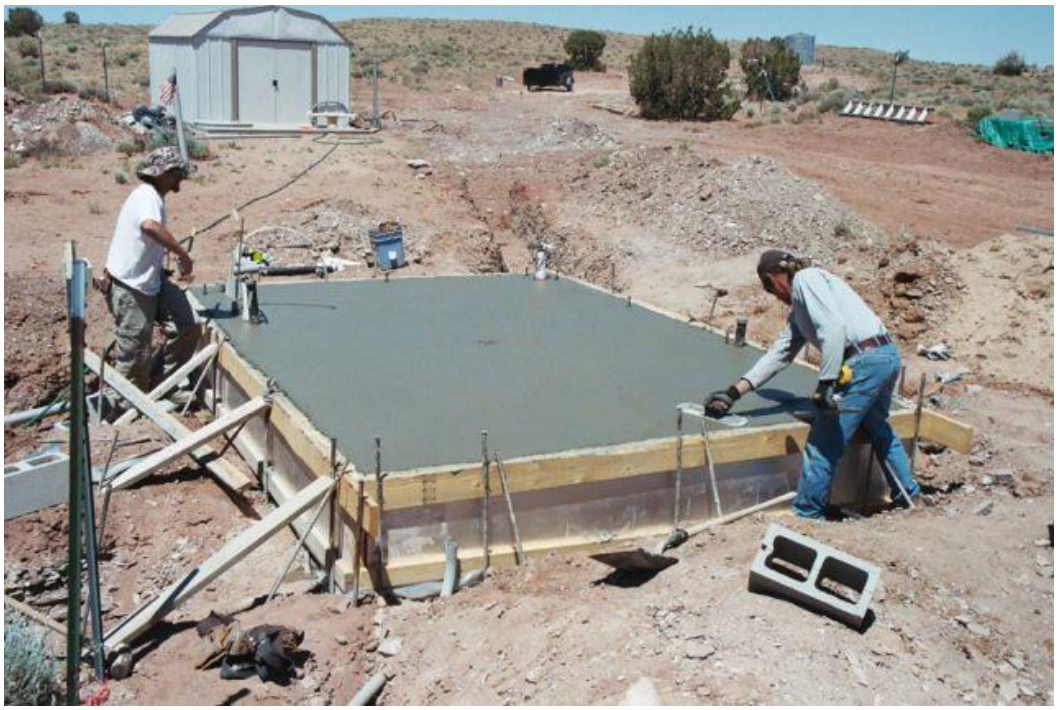
The monopour foundation

The monopoured foundation is also called “slab on grade.” It is fast, simple and cost effective.

The contractor digs down to solid soil, and possibly digs a little deeper around the edges. In most cases, the foundation goes below the frost line, which depends on the climate. Some gravel is probably trucked in and compacted, with a plastic moisture barrier placed over it. Steel rebar is then placed on top.

A form is built around the edges of the foundation. If the slab is to be insulated, insulating boards are typically mounted on the inside of the form.

One or more concrete trucks will then deliver the concrete and pour it directly into the form. After the concrete is fully cured, the slab is ready to be built upon.



Insulated monopour foundation for a small outbuilding.

The stem wall foundation

This type of foundation costs more than the monopour, but it provides much better insulation, and is the best choice when using radiant floor heating.

The contractor digs a trench around the perimeter of the house and pours a concrete footing for the wall. A wall of hollow-core concrete blocks is then built on top of the footing. Concrete is then poured into the hollow blocks, creating a solid concrete wall. This is the stem wall. The stem wall can also be poured as a concrete wall, using forms.

The cavity enclosed by the stem wall is then filled with compacted gravel, with a moisture barrier on top. This may then be covered with rigid-foam insulation boards, if an insulated slab is desired. The rebar is then placed on top. The concrete is then poured for the floor of the house.

The outer walls of the house are then built on top of the stem walls, while the interior walls are built on the concrete floor slab.

Pouring the footings for the stem wall.

Building the stem wall.

Foundation with radiant floor heating system

In-floor radiant heating is the best type of heating for healthy homes. It is very comfortable, avoids the problems of ducted heating systems, and the heat source can be placed outside the house. It is also possible to make the system virtually noiseless and zero-EMF. The downside is the cost, primarily since a stem wall foundation is needed.

With a radiant floor heating system, the whole floor is the radiator. It will be warmer than a regular floor, so it is essential that the slab is insulated, both to the sides and down towards the soil. Otherwise the system will be costly to operate. There have been cases where owners of MCS houses had to install electric baseboard heaters because they didn't insulate the slab, even in a climate with mild winters.

The slab is insulated using rigid-foam insulation boards. These are placed on the inside of the stem wall, and under the slab (over the moisture barrier). Then PEX tubing for the heating system is put on top of the rebar, and tied to the rebar so the tubes do not float up on the wet concrete.

Foundation with radiant floor heating system, ready to pour the concrete slab.

What concrete is made of

There are many types of concrete, based on these basic ingredients:

- cement
- aggregate
- water
- reinforcement
- admixtures (additives)

Cement is a mixture of calcium, silicon and aluminum oxides, and sometimes also iron oxides. Aggregate is usually gravel, sand and/or stone, but can also be recycled materials, which are best avoided. Reinforcement is typically steel rebar.

The admixtures are various chemical additives, which are all best avoided.

Possible issues with cement

Cement is made from calcium, silicium and aluminum oxides, and sometimes also iron oxides. The raw ingredients are milled to a fine powder and fed into a very large oven which mixes the materials under high temperatures.

The milling process can contaminate the materials with a lubricant, which is typically propylene glycol. Some older milling machines can spill lubricants into the materials.

Because of the high volumes and high temperatures used in the ovens, some cement factories earn extra money by feeding toxic chemical waste into their cement ovens. This has potential for contaminating the cement.

It will be difficult to safeguard against these possible problems. However, we are not aware of any cases where it actually has been a problem.

Aggregates to avoid

The aggregate is usually sand, gravel or crushed stone, which all should be fine. The problem is that some concrete is mixed with recycled materials, which otherwise would go to a landfill. Common recycled aggregates are:

- recycled concrete
- fly ash
- furnace slag

These are all problematic and should not be used for a healthy house.

Recycled concrete comes from demolition of roads, parking lots and buildings. It can be contaminated with asphalt, spilled motor oil, spilled diesel fuel and much else.

Fly ash is a waste product from coal-fired power plants, while furnace slag is a waste product from blast furnaces. They are not inert and can make the concrete smell, especially when the air is humid. They should be avoided.

The concrete admixtures

It is standard to add various chemicals to a concrete mix. These are called admixtures and can make the concrete easier to pour, cure faster and stronger, protect it against frost, etc. The admixtures include:

- accelerants
- curing compounds
- plasticizers
- silica fume (microsilica)
- frost protectants
- water reducers
- corrosion inhibitors
- pumping aids
- bonding agents
- biocides

These should generally be avoided.

Silica fume is often added to concrete to improve its strength. It is a type of ultra-fine silica that is a waste product from ore furnaces and thus may contain contaminants from coal, wood chips, etc.

Some contractors may say the admixtures are just a small fraction of the concrete, so it cannot be a problem. This author tested a type of concrete used for ceramic tiles (called a thinset), which had so few admixtures they were not even listed on the Materials Safety Data Sheet (MSDS does not have to list ingredients that are less than 1% of the product, unless carcinogenic). There was still a very noticeable difference, compared to an admixture-free thinset.

Some might say that if you intend to cover the floor with tile, that it will seal any fumes in. Tiling helps, but the grout is porous and some fumes will still get through that way, and may still be smelled by extremely sensitive people.

Some sensitive people will do fine with admixtures, others will not.

Using additive-free concrete

Concrete was used on a large scale by the Romans, with many of their large concrete projects still standing (aqueducts, bridges, the Pantheon, the Coliseum,

etc.). The Romans did not have modern admixtures, though they sometimes added volcanic ash, horse hair or blood to their concrete.

Concrete without admixtures is strong enough for the floor of a house, where 2500-3000 psi (18-20 MPa) compressible strength is sufficient.

More care is needed when using this concrete. It cannot be poured when a hard freeze is possible for the next several days and nights, and it must be wet-cured.

Wet-curing means that the concrete must be kept wet for at least three days. If the surface dries too fast, the concrete will likely crack. There are various wet-curing methods. A tarp can be placed over the concrete shortly after it has set, while the surface is still wet. Sometimes water is added. Another method is to keep the surface fully submerged for the three days. This is called "ponding."

After three or more days the tarp or ponding water is removed. At this point the concrete should be strong enough to walk on, though additional days or weeks are needed for heavier loads.

Many contractors are now unfamiliar with wet-curing and may decline such a job, or ask a premium price to do it.

Non-toxic freeze protection

If the concrete has to be poured during moderately freezing temperatures, there are two things that can keep the wet concrete from freezing:

- insulation batts
- calcium chloride

Insulation batts can be rented at a moderate cost. They are placed on top of the slab, and over the tarp that keeps the moisture in.

The concrete vendor can add calcium chloride to the mix, when they load up the truck. This is an inert chemical (check a sample to be sure) that generates a little heat when it gets wet. It will not generate heat for more than a day or so, so the insulation is still needed.

Using a concrete slab as floor in the house

It is possible to save money by using the concrete slab as the floor in a house, instead of putting down tile or a hardwood floor. The concrete can be tinted with cement coloring when it is mixed, and it can also be scored to look like it is tiled.

Concrete is porous, so spills and ground-in dirt will discolor it. Sealing the concrete with an annual coat of sodium silicate ("water glass") can prevent some of this discoloration.

A raw concrete floor may generate some dust as people walk on it; this dust can be a problem. Some sensitive people simply do not tolerate a concrete surface, even when it is a decade old. Sealing the surface with sodium silicate may help with these problems, otherwise tiling it probably will (if done with additive-free thinset and grout).

Make sure the contractor knows if you intend to use the slab as floor, so he can spend extra effort making the surface smooth. A special machine may need to be rented for this purpose.

Things to watch out for

Besides avoiding the concrete additives, there are various other pitfalls.

Some contractors pour diesel fuel over a finished concrete slab to create a nice finish. This happened for an MCS house. They were unable to correct the problem in any other way than cover the slab with a heavy membrane and then pour a new slab on top. This worked well, but cost a lot of money.

If the contractor uses reusable forms, they will use diesel fuel or some other oil to make the concrete slip the form. A better method is to use disposable wood forms. Another option is to give the contractor a gallon of cheap corn oil or olive oil.

Make sure there is a moisture barrier under the concrete slab. The moisture barrier will prevent moisture from wicking up through the concrete, which can become a mold problem. Such a barrier will also block any radon gas that may come from the soil, especially in areas with bedrock. It is best to use multiple overlapping layers.

Make sure the slab inside the house is not exposed to the outside, or there will be great heat loss. Such errors have been seen where the slab under the house extends

out on a small patio or walkway. Such thermal bridging is especially important to avoid when the slab is heated with an in-floor heating system.

Insulation used in the foundation must be designed for this use. Inappropriate insulation may compress or disintegrate over time. In America, proper insulation boards are rated for "direct burial," and are generally referred to as "blue boards."

Make sure any gravel trucked in is clean. It is not unusual for such a load to be contaminated with oil spills or other contaminants. Make sure it comes directly from a gravel quarry, and inspect each load.

Decide in advance what to do with any leftover concrete. The driver cannot take it back, it has to be dumped or used somewhere on your property. One option is to spread it on the driveway, where it turns into gravel.

Termites

Termites are an issue in many warm countries, such as much of the United States and Australia. Termites eat wood, so they can destroy a house built or framed with lumber.

In America, it is common to deter termites by soaking the building site with pesticides before the house is built. This method is usually unacceptable for a healthy house. There are alternative methods, such as using termite-resistant wood and termite shields, though they may be less effective. A source of information is the International Building Code section R320 (2006).

Termites live in mounds in or on the soil. In order to destroy a house, they need access from their mound to the lumber in the house. A concrete foundation can make a house less inviting to termites, since they will need to build shelter tubes up the side of the concrete foundation as they do not walk out in the open.

The termites' need to build these tubes makes it much easier to notice an infestation before much damage has been done, so the problem can be taken care of in time.

Make sure there is proper drainage

If rainwater reaches the top of the foundation, it may seep under the wall. It is important that the wall studs and insulation never get wet, as it will take time to dry and people can be sensitive to even small amounts of mold.

One building code (IBC 2006 R401.3) requires that the top of the foundation is at least six inches (152 mm) above grade. If the grade slopes away, then it is sufficient if the six inches is reached within 10 ft (3 m) of the wall.

Porches, patios and walkways are sometimes built level with the floor of the house, which can be a problem in case of a heavy downpour.

Put it in the contract

It is best to put all the stipulations in writing. Then it is the contractor's responsibility to correct any mistakes. Here is the short list:

- no admixtures
- no recycled aggregate (fly ash, concrete, etc.)
- no sealer on slab (diesel fuel, etc.)
- no biocides or pesticides
- forms greased with olive oil or corn oil, or use single-use forms
- all-new materials without contaminants
- moisture barrier under slab
- foundation min. 6 inches (152 mm) above grade
- foundation not level with porch/walkway
- slab cannot extend to outside patio or walkway

If the slab is to be insulated:

- no thermal bridging
- insulation under slab
- insulate sides of slab
- insulation must be approved for direct burial

More healthy-house construction information

Other articles about healthy house construction methods can be found at www.eiwellspring.org/saferhousing.html.

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