

Installing PEX Tubing in Concrete Slabs

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The following topics are covered:

- Types of concrete slabs with radiant floor heating
- Common pitfalls in installing slab radiant heating and how to avoid them
- Typical PEX installation process in a slab
- Basic materials for radiant floor heat installation in a slab

Remember, since you will only have 1 chance to pour the concrete slab, you will only have 1 chance to put the PEX tubing in it. So even if there are no existing plans for the radiant floor heating or a snow melting system, installing PEX tubing in it may turn out to be a good decision.

Types of concrete slabs with radiant floor heating

Thick slabs

Thick slabs are concrete slabs with an overall thickness of 4-6" or greater and can be either grade level (slab on grade) or below grade (i.e. basement foundations). All thick slabs can be categorized into:

- Reinforced slabs – where welded wire mesh or rebar is used to reinforce the slab.
- Non-reinforced slabs – where no reinforcement is added.

While reinforcement itself does not affect the radiant floor heating system, it determines placement of the PEX tubing in the slab, which in itself is an important factor. Unless special design considerations require otherwise, the tubing should always be positioned on top of the reinforcement, in order to stay closer to the surface of the slab.

If using welded wire mesh, you may want opt for sheets rather than rolls whenever possible. They are noticeably easier to install and provide a flatter surface. The main downside is that the sheets have to be tied together.

Optimal depth of PEX tubing in the thick slab is considered to be in the 1-2" range and, whenever possible, should not be deeper than 4" for the following reasons:

1. Placing tubing too deep in the slab will increase response time, which means it will take longer for the floor to reach the desired temperature, will result in increased BTU load, require more energy and possibly will require larger tubing diameter.

2. Concrete height above PEX adds additional R value, and while it's minimal in most instances, more energy would be required to heat the topmost surface.

Since in non-reinforced slabs tubing is generally positioned at the bottom (secured with foamboard staples or PEX rails), their thickness should not exceed 4-5". Otherwise, the system will not run efficiently. The only remedy for a deep slab is to install reinforcement and position PEX tubing on top, closer to the surface.

Thin slabs

Thin slabs are generally poured over a subfloor, which can be plywood or another slab. Adequate minimal thickness of a thin slab is considered to be 2", not including insulation.

Common pitfalls in installing slab radiant heating and how to avoid them

Plan in advance

1. Calculate proper BTU load to determine factors such as size and total length of PEX tubing needed, insulation type and thickness, etc.
2. Have a PEX tubing layout made – this is essential regardless of the project size.
3. Optionally, using spray paint, you may draw PEX tubing circuits on the insulation according to scale. It's best to use (2) or more colors for different tubing circuits, since it will help to visualize the actual tubing layout. Mark the runs with arrows showing the direction of the water flow.
4. Prepare manifold stations – a simple stand made from 2x4's with a piece of plywood is sufficient in most cases. Install the manifold in advance (or, if not available, use a temporary version) for the purposes of pressure testing.
5. Calculate all your materials in advance. We offer a basic list at the end of this text.
6. Plan for any plumbing supply or drainage piping which may interfere with PEX tubing layout.
7. Mark locations of walls or bearing columns – PEX must not be installed underneath these.

How to avoid random cracks and sagging in slabs

1. Provide a well compacted and properly leveled (sloped where needed) base. Specific recommendations for the thickness and type of materials used in a base will vary depending on the area and availability of materials. The two main rules of thumb are: it should provide stability and adequate water drainage.
2. Use either rebar or wire mesh reinforcement with addition of fiberglass. Depth at which reinforcement is placed also directly affects structural stability and load-bearing properties of the slab.
3. Have crack control joints made, especially for large area slabs and non-reinforced slabs.

How to prevent heat loss in a radiant heated slab

Non-insulated slabs may account for as much as 70% of energy waste. Use adequate insulation both underneath the slab and at the perimeter/wall. 2" XPS foamboard is a popular choice for thick slabs (above and below grade) and is the most commonly recommended insulation for slabs with PEX radiant heating systems.

How to prevent early deterioration of a slab

1. Use a vapor barrier. 6 mil thick is an absolute minimum, with 10-15 mil recommended depending on the type and abrasiveness of material used for the base (thinner for river rock and thicker for crushed stone). Without a vapor barrier, concrete will absorb moisture like a sponge. Unless you're using bubble/poly insulation or waterproof tarp, both of which also act as a vapor barrier, a vapor barrier is required. It should be positioned underneath the insulation, properly taped on seams and overlapped over the edges for maximum protection.
2. Use concrete sealers (outdoor – i.e. driveway with a PEX snow melt system). A good concrete sealer protects the slab surface from absorbing water, which would otherwise freeze and thaw inside the micropores, causing small cracks and early deterioration of the top of the slab.
3. Unless using a salt-resistant concrete sealer, do not salt the slab during the first winter – use sand instead.

Avoid costly slab and PEX tubing repairs

1. Confirm in advance that any chemical additives used in the concrete mix will not react with PEX tubing.
2. Do not step on PEX tubing. While PEX is a tough pipe, it can be damaged by a piece of rock or other abrasive stuck in an outsole of a shoe.
3. Pressure-test the PEX system before, during and after the pour. This would help to identify and address any possible leaks in PEX piping at early stages. More details on pressure-testing can be found [here](#).
4. Use sleeving over PEX where it runs through an expansion joint/crack. A b, crack-resistant poly piping is preferred and should cover (sleeve over) the PEX pipe at least 1-1.5ft on both sides of the joint. For 1/2" or 5/8" PEX, 3-4ft long pieces of 1" PEX can be used for sleeving. Sleeve ends should be duct-taped to prevent concrete mixture from getting inside. If using a split pipe (cut open length-wise), tape the seam also.
5. Have a couple PEX splicing/repair kits and a tool handy. Remember that when repairing a PEX pipe with any fitting, it must be isolated with electricians tape to avoid a chemical reaction. If the system is pressurized during the pour, location of a leak can be clearly seen in most cases and can usually be remedied quickly.

6. Do not leave PEX exposed to sunlight for too long (5-7 days at most). While different PEX manufacturers may have 30-60 day exposure limit and in some cases even more (UV-stabilized PEX), a safer alternative is to cover PEX with poly tarp or other non-abrasive covering until the slab is poured.

Typical PEX installation process in a slab

When slab base, vapor barrier, insulation, reinforcement (if used) and radiant heat manifold(s) are installed, PEX tubing installation can begin.

1. Start installing PEX. Determine the circuit(loop) to install first and select appropriate PEX coil length from your list of materials. You may connect PEX to or near the manifold, but always leave 5-10ft spare in case manifold location will shift (and often it will).

If you're using conduit elbows (and we highly recommend that you do), slip the elbow over the pipe prior to connecting it to the manifold. Secure the elbow to the reinforcement, or, if not available, directly below the manifold station.

Gradually uncoil and secure the pipe using zip ties, wire mesh clips, foamboard staples or other approved means. Do not use metal rebar ties to secure PEX. If using PEX rails, these must be installed prior to installation of tubing.

In a 2-person installation, one is uncoiling the pipe, while the other secures it at intervals ~3ft.

A 1-person installation can be challenging unless you're using a PEX uncoiler or PEX rails. Cost-wise, an uncoiler can range anywhere between \$280-300 for basic and \$400-500 and above for professional models. PEX rails will cost about \$75 for every 250 sqft (#PXR12-16 at 3ft spacing), or about \$300 for 1,000 sqft of heated slab space.

Also consider that smaller rolls (300ft vs 1000ft) weigh less, are easier to handle and the price difference per ft is considerably small.

Use steel PEX bend supports anywhere where tubing makes a 90-degree turn. Never use PEX fittings of any kind (brass or poly) in a concrete slab unless it is necessary for a leak repair.

Where tubing runs over a crack control/expansion joint, use sleeving in a manner described above.

Following the layout, run the PEX pipe back to the manifold, completing the circuit. Proceed with the same manner for all other PEX circuits.

2. Pressure-test the system. Unless you want to test each PEX line individually, connect the tubing to the manifold (do not cut the pipe yet – leave 5-10ft length protruding from the slab). Open all the circuits, close one of the main shut-off valves on the radiant manifold (supply or return) and connect the pressure testing kit (pressure gauge with Schrader valve or compression hose adapter). Since pressure testing in radiant heating is always below 100 psi, a 0-100 psi test gauge is adequate. We also offer a pre-assembled kit [here \(#TESTKIT\)](#).

A 30-minute minimum test is required at pressures 40-100 psi range. Duration requirements may change based on local codes.

3. Pour the cement. An overhead pump truck is the best option, since it will minimize traffic over the installed PEX tubing and will reduce chances of damage. Be sure to keep the PEX system under pressure and monitor it when pouring concrete. If PEX tubing is damaged, test gage will display a pressure drop and bubbles will burst/form where the leak is, making it easy to identify the location. The concrete can then be finished in a normal way.

Basic materials for radiant floor heat installation in a slab

1. PEX Tubing

Select between the oxygen barrier PEX and PEX-AL-PEX tubing types. Barrier PEX is much more common and is generally a preferred choice.

To calculate total length of tubing, you'll need to know the BTU load. Using the table below, the BTU load can be used to determine Size, Spacing and average Circuit Length of PEX tubing to be used. Once available, tubing spacing can be used to determine total length needed for the slab:

$$\text{Length} = (\text{Heated Slab Area, sqft}) \times 12 \times 1.05 / (\text{Tubing Spacing, in})$$

For example, a 20t x 80ft slab (1600 sqft) with PEX spaced at 10" on center:

$$1600 \times 12 \times 1.05 / 10 = 2016 \text{ ft.}$$

(x1.05 multiplier accounts for extra length needed for slack)

Determine the optimal number of PEX circuits to meet average recommended circuit length.

For instance, in case of 1/2" PEX, the optimal number of circuits is (7), since $2016/7 = 288\text{ft}$, which is very close to the 300ft standard recommended circuit length for 1/2" tubing.

The project will therefore require $7 \times 300 = 2,100$ linear ft of pipe, which translates into:

(7) 300ft rolls

(3) 600ft and (1) 300ft rolls

(2) 600ft and (1) 900ft rolls and so on.

The remaining 12ft ($300 - 288 = 12$) length is used to connect tubing to the manifold.

PEX tubing size and spacing based on BTU load

Tubing size	Circuit length (Radiant Heat / Snow Melt)	BTU Load (BTUh/sq. ft) and pipe spacing OC (On Center)					
		<50	50-75	75-100	100-125	125-150	150-200
1/2"	300-350ft / 200ft	12"	10"	8"	6"	Not recommended	
5/8"	400-500ft / 250ft		12"	10"	8"	6"	
3/4"	500-600ft / 300ft				12"	12"	9"

Tubing size	Circuit length (Radiant Heat / Snow Melt)	BTU Load (BTU/sq. ft) and pipe spacing OC (On Center)					
		<50	50-75	75-100	100-125	125-150	150-200
1"	750ft / 500ft	Not recommended					12"

1/2" oxygen barrier PEX is the most popular size used for radiant floor heating in both thick and thin slabs. This size is adequate for all small to medium size jobs both in residential and commercial projects.

5/8" barrier PEX can be used for larger projects where high BTU load is present due to lack of proper insulation, larger than normal slab thickness or special project considerations.

3/4" barrier PEX is not a typical choice for floor heating applications (unless the heat load is high) and is generally more common in snow/ice melting systems.

1" barrier PEX is intended for use in large commercial projects which are beyond the scope of this article.

2. Manifolds

Manifold is the central distribution station for all of your PEX tubing circuits. The size of the manifold must correspond to the number of circuits in your radiant heating system.

Radiant heat manifolds – designed for use with 3/8", 1/2" and 5/8" PEX and PEX-AL-PEX tubing. These are sold in pairs (supply and return) and include flow indicators, flow regulating valves and other basic components.

Copper headers – designed for use with 3/4" PEX pipe and available with 1-1/4", 1-1/2" or 2" copper pipe size trunk diameters. 3/4" copper pipe size outlets can be used for installation of circulators or zone valves. Each copper header manifold is sold separately.

3. Insulation

Insulation is a must for all slab-on-grade systems. It prevents heat loss and allows for quicker warm-up of the slab. Among several options available on the market and listed from highest R-value to lowest are:

- Extruded polystyrene (XPS) foam board (1-1/2" - 2" thick)
- EPS (expanded polystyrene) tarp in rolls
- Bubble/foil insulation in rolls

Vapor barrier, installed under the insulation, is also essential in protecting the slab from moisture. Select insulation types (bubble foil & tarp) may act as a vapor barrier, while others (XPS) may require a separate vapor barrier.

4. Installation Accessories

Foamboard Staples and Tools – for securing PEX or PEX-AL-PEX tubing to foamboard or tarp insulation with 1" - 2" or greater thickness. In cases where pipe is positioned directly over the insulation, PEX staples are the only way to secure it.

PEX Rails – a great accessory overall recommended for both thin (non-structural) and thick (reinforced) slabs. They can be installed directly over the plywood subfloor, foamboard insulation or over the rebar/mesh. PEX rails also allow for a 1-person installation and significantly reduce installation time.

Wire Mesh Clips – used to secure 1/2" PEX on top of wire mesh used to reinforce the slab. These clips are removable and can slide along the wire to adjust tubing spacing as needed.

PEX Bend Supports – used to provide smooth 90-degree bends of PEX pipe where needed. Metal bend supports are most common for concrete slabs.

Nylon Zip Ties – a quick, easy and economical way to tie/secure PEX tubing to rebar or wire mesh. Appropriate for all PEX sizes up to 1".

The above (4) categories comprise a basic list of materials required for any PEX radiant heating or snow melting installation inside a slab. Some of the components listed below may also be required, depending on the nature of the project:

- Circulator Pumps
- Switching Relays
- Mixing Valves
- Zone Valves
- Zone Valve Controls
- Thermostats
- etc.