

STEP Warmfloor® Flooring Options

STEP Warmfloor® Electric Radiant
Floor Heating System

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THE FUTURE



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Contents

- TILE 4
 - GUIDELINES FOR INSTALLATION4
 - APPLICATION EXAMPLES 5
 - On slab-on-grade construction where no bending stresses occur.....5
 - Over structural floors subject to bending and deflection5
 - Over an insulated subfloor where lightweight construction is a factor and water resistance is desired.....5
 - Exterior decks or patios where positive drainage is provided5

- WET AREAS 6
 - GUIDELINES FOR INSTALLATION6
 - APPLICATION EXAMPLES7
 - Rigid waterproof membrane7
 - Flexible waterproof membrane7
 - Cement mortar shower receptor.....7

- CARPET AND CARPET CUSHION 8
 - GUIDELINES FOR INSTALLATION8
 - APPLICATION EXAMPLES 9
 - Carpet glue down.....9
 - Carpet stretch-in9
 - Carpet modules9

- WOOD 10
 - GUIDELINES FOR INSTALLATION10
 - APPLICATION EXAMPLES 11
 - Over a screeds system 11
 - Over a plywood-on-slab system 11
 - Over wood joist construction 11

- R E S I L I E N T..... 12
 - GUIDELINES FOR INSTALLATION12
 - APPLICATION EXAMPLES 13
 - Under plywood underlayment..... 13
 - Under proper floor leveler 13
 - Over a concrete substrate 13

- INSTALLATION BETWEEN JOISTS 14
 - INSTALLATION GUIDELINES 14

CONCRETE SLAB	15
CHARACTERISTICS	15
MOISTURE MIGRATION	15
SLAB INSULATION	16
GUIDELINES FOR INSTALLATION	16
APPLICATION EXAMPLES	16
Application using rigid foam insulation	16
Installation in slab and along perimeter:	17
Installation using furring strips:	17
 COMMERCIAL	 18
INSTALLATION GUIDELINES	18
 OFF PEAK HEATING	 19
CHARACTERISTICS	19
THERMAL CONCEPT	19

TILE

The use of tile dates from about 4,000 B.C. Today there are literally thousands of types and designs of hard tiles available for installation on floors, walls, and other surfaces.

GUIDELINES FOR INSTALLATION

One of the biggest mistakes made in tile selection is choosing a stone or tile that is not suited for the traffic it is to receive. Color, pattern, surface texture and glaze hardness must be considered in determining tile acceptability on a particular floor. Consideration must also be given to tile size, porosity and wear properties of surface of tile.

The TCA (Tile Council of America) provides a Handbook for Ceramic Tile Installation as a guide to assist in clarifying and standardizing installation and material specifications for ceramic tile and dimensional stone. Refer to ANSI (American National Standards Institute), ASTM (American Society for Testing and Materials), NFPA (National Fire Protection Association), and conform to local building codes, ordinances and trade practices.

Ceramic tile is an excellent heat absorbent; but can also be very cold when there is no insulation or contact with sunrays. STEP Warmfloor® will take away the chill from cold floors and give your tiles pleasant warmth. For optimal results, insulation is required under the heating elements.

The physical properties of concrete or wood subfloors are different from stone or tile finish floors. Materials react differently with changes in temperature and moisture. It is therefore important to determine the linear thermal expansion of a given material and choose the proper control/expansion joints and anti-fracture/crack suppression membrane systems to reduce failure from substrate shrinkage, thermal cycling, load bearing, expansion and contraction.

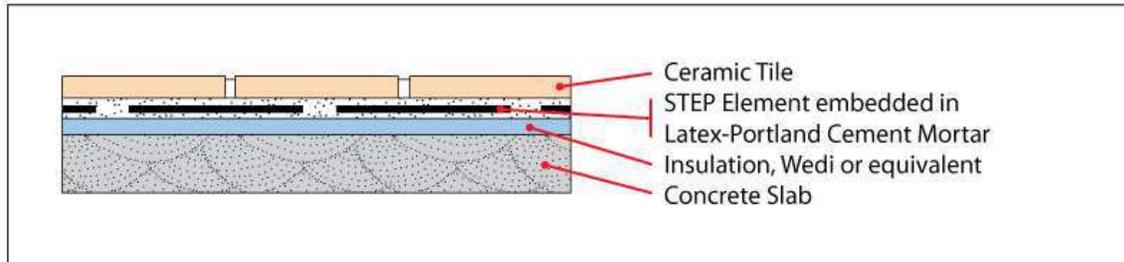
STEP Warmfloor® is strong & flexible, and can be installed on any structural sound substrate. The heating elements shall be covered using mortar bed, thin-set or cementitious backer board. When skim coating with a notched trowel over the elements, be very careful not to scrap the electric insulation on the plastic.

Setting and grouting materials are available in many forms to meet the requirements of the different kinds of tile and types of exposure. Thermal movement, coverage and tolerances should be taken in consideration; the larger the tile, the greater the total change in dimensions. A mosaic installation will produce little stress on the setting material from thermal movement but will have a larger exposed grout surface. Specify latex modified materials.

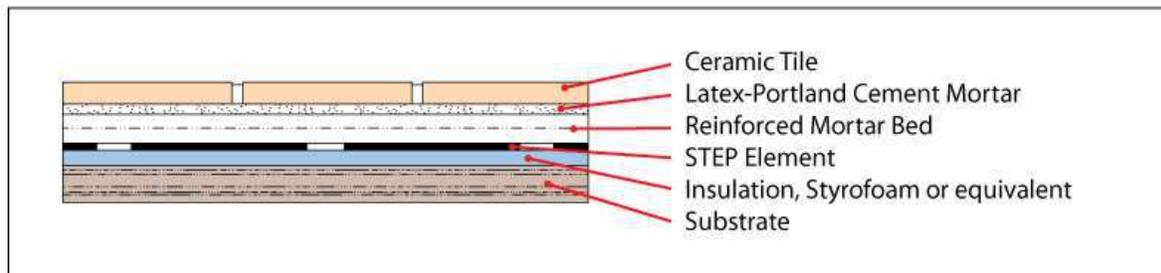
STEP Warmfloor® heating elements can also be installed under marble, granite, limestone, slate, quarry, terrazzo, etc. Sealing is recommended for most stones. The type of sealers used is based on the porosity, texture, hardness and type of tile and where it is installed.

APPLICATION EXAMPLES

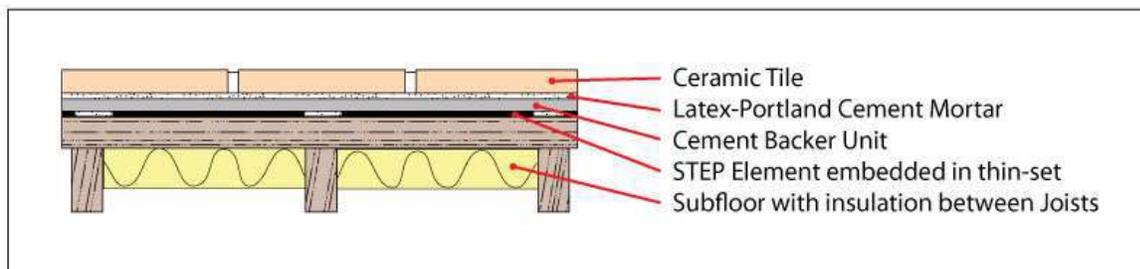
On slab-on-grade construction where no bending stresses occur



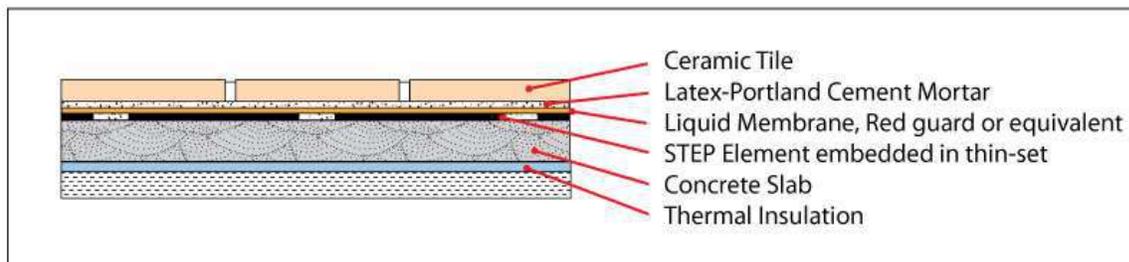
Over structural floors subject to bending and deflection



Over an insulated subfloor where lightweight construction is a factor and water resistance is desired



Exterior decks or patios where positive drainage is provided.



WET AREAS

The demand for comfortable and functional bathrooms has increased in the last few years. The sensation of a warm floor under bare feet is very desirable, especially when using ceramic tile and natural stone. STEP Warmfloor® is a low-voltage heating system and can be installed in showers, tub enclosures, laundries, steam rooms, etc.

GUIDELINES FOR INSTALLATION

Choose the proper floor covering, setting materials and grout for each application. Most ceramic tile and cement based grout are not waterproof.

Certain substrate materials used in wet areas may be subjected to deterioration from moisture penetration and freeze/thaw cycles. Thermal and electrical insulation can be, and often are, destroyed by water entering the building sections. To avoid damage to the structure, resulting from inadvertent admission of free moisture, waterproof all horizontal surfaces and wrap into perimeter walls. Test pan, membrane and drainage fittings for leaks before starting the tile work.

In wet areas, it is important that the supply water piping and the drain have the same potential; i.e., piping and drain must be grounded. Do not place the heating elements in direct contact with any conductive material, such as shower pan, wire mesh, drains, etc.

Heating elements have to be properly installed under a waterproof membrane to avoid risks of sneak current and/or short circuit. Although STEP Warmfloor® is a low-voltage (24-Volt) system and cannot harm you, it is unpleasant to feel a tingling sensation on the floor.

Secure the elements to the subfloor and cover with a protection layer, e.g. floor leveler, mortar, etc. Alternatively, the elements can be placed under cement backer unit (CBU). The material may be water resistant; but where a waterproof floor is required, a waterproof membrane shall be provided. Installation and material specifications are contained in ANSI A108.9, .10 and .11; or ASTM C1325, C1178 and C1288.

Waterproof membranes are available in built-up membranes, single-ply membranes, non-metallic and lead or copper waterproofing. In addition, liquid/paste form or flexible sheet form waterproof membranes can be applied in thin-bed or thick-bed installations.

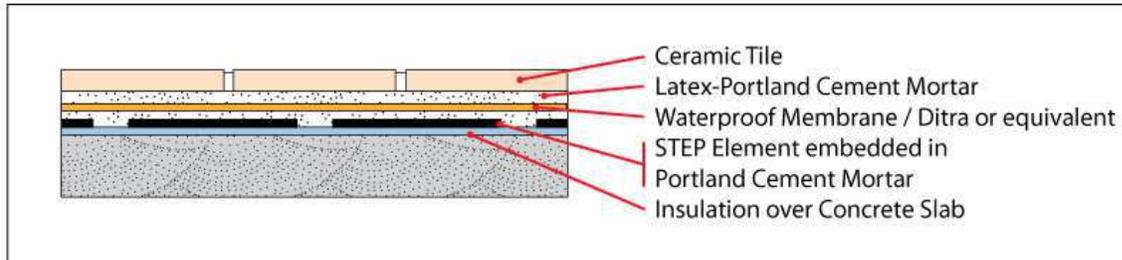
Where a mortar bed or mud float is used to cover the elements, allow the mortar to dry completely before applying the membrane and the floor covering. Water trapped under the floor could damage the substrate and/or cause sneak current. Do not use asphaltic liquid membrane directly on the element.

The Uniform Building Codes requires that horizontal weather-exposed surfaces that are sealed underneath be sloped for drainage - at least 1/4 inch per foot toward the drain. The sloping is necessary to eliminate all standing water conditions, which may promote algae/mold growth, slippery walking surfaces and deterioration of the building materials.

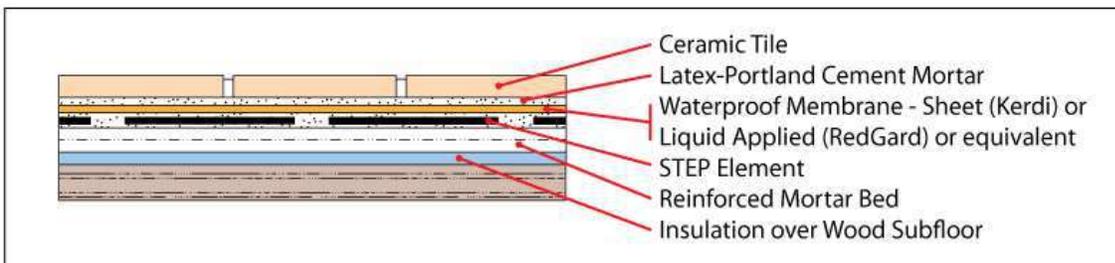
For approved assemblies and correct applications consult with the pertinent institute or association, i.e., Tile Council of America, Ceramic Tile Institute, Marble Institute of America, Masonry Institute of America, National Tile Contractors Association, etc.

APPLICATION EXAMPLES

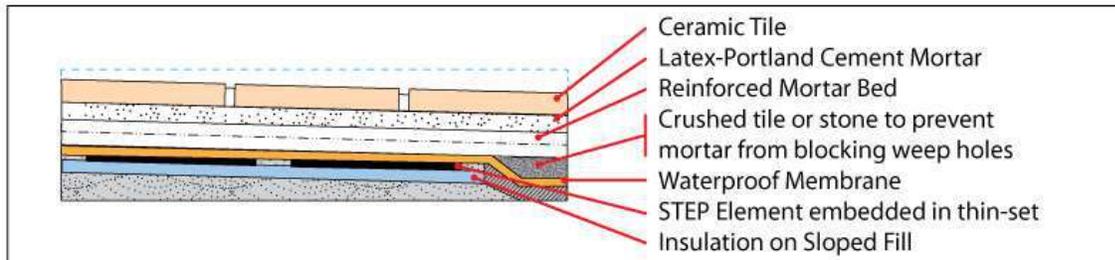
Rigid waterproof membrane



Flexible waterproof membrane



Cement mortar shower receptor



STEP Warmfloor® can also be installed:

- behind mirrors to avoid fogging and misting
- in cabinets to warm towels and keep the humidity out
- under tiles to keep the shower bench warm
- under tubs and spas to help maintain the warm temperature of the water
- on walls to impede the cold from infiltrating

Thermal insulation is required under the heating elements to push the heat where it is needed.

CARPET AND CARPET CUSHION

GUIDELINES FOR INSTALLATION

Site Conditions

The carpet, carpet cushion and adhesive shall be conditioned on-site at a minimum temperature of 65°F (18°C) and a relative humidity between 10% and 65% for at least 48 hours before installation. The carpet should be unrolled to allow it to relax and be ventilated.

The subfloor surface shall be prepared to make it suitable for carpet. Make the necessary moisture and alkalinity testing. The moisture emission from a concrete slab shall not exceed 3.5 pounds per 1000 square feet in 24 hours and the alkalinity test should not exceed pH 9.

With radiant heat thermal insulation is recommended in the floor; a higher R-value is required under the heating element as opposed to over with a ratio of 4:1.

Installation of the Heating Elements

Properly secure the STEP Warmfloor® heating elements onto the prepared substrate or onto thermal insulation. The heating elements must not overlap or touch each other. Leave sufficient spacing on the perimeter when using tackles strips. **Adhesives should not be used in direct contact with the elements.**

Make the electrical connections and have a certified electrician measure and check the elements before installing the floor leveler, carpet and/or carpet cushion. Refer to handbook, Installation Procedure and Electrical Installation (8.1). Fail Safe wiring method must be used when the elements are not embedded in a floor leveler (8.3).

It is required to cover the heating elements with a leveling compound or an underlayment to even the surface, especially in traffic areas, to avoid telegraphing of the elements and connectors.

Do not use bonded urethane (Rebond) or Leggett Platt carpet pads over the heating elements as this will impede heat transfer. Use a pad recommended for over radiant heat, e.g., Healthier Choice (Commercial).

Most carpet and adhesives manufacturers recommend that radiant heated floors should not exceed 85°F (29°C). To allow proper adhesion of the patching compounds and adhesives, the heating system should not be turned on until 72 hours after installation is completed. STEP Warmfloor® is a passive (low radiant), self-regulating heating element that keeps an average temperature of 75°F (24°C) at 24 volts.

Installation of the Carpet and Carpet Cushion

Refer to the Carpet and Rug Institute Installation Standards - CRI 104 and CRI 105. Also, consult with the manufacturers of carpet, carpet cushion, and adhesive for recommendations regarding each installation method.

Glue-down Installation

In direct glue-down installations, the carpet is adhered directly to the subfloor.

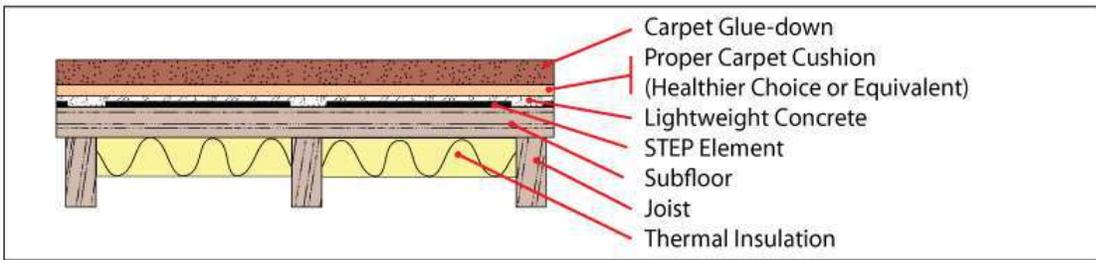
In double glue-down, a separate cushion is adhered to the floor, and the carpet is glued to the cushion.

Stretch-in Installation

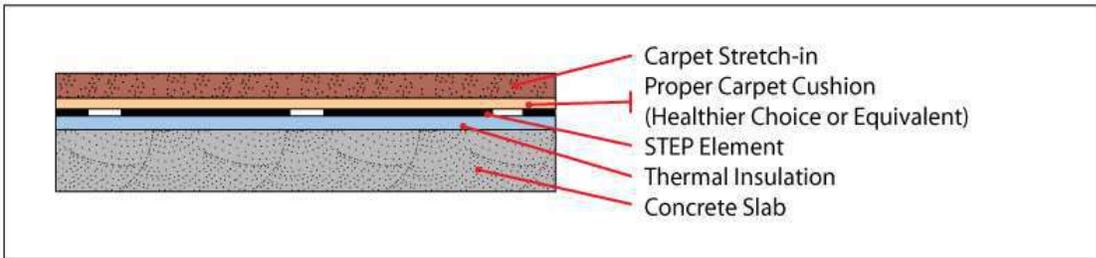
This method requires fastening the carpet under tension onto tackles strip around the perimeter of the area to be carpeted. When affixing the tackles strip, take care not to nail through lead wires and the bus braids running along each side of the heating elements. Cut the tackles strips and leave a gully on the floor where the wires are routed to the electrical box on the wall. A separate cushion shall be used.

APPLICATION EXAMPLES

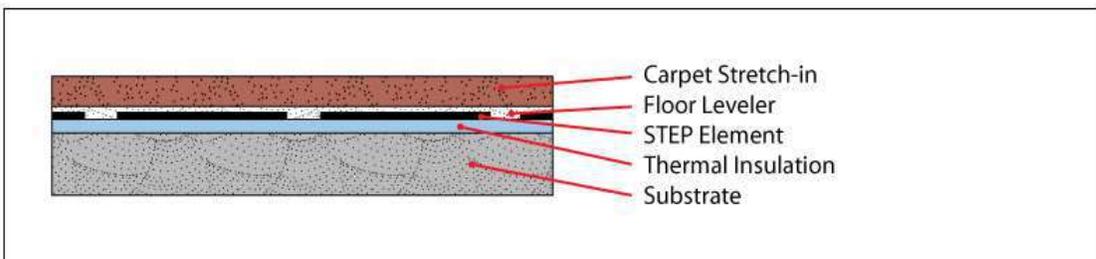
Carpet glue down



Carpet stretch-in



Carpet modules



WOOD

Under 'Wood', are included hardwood, laminate (engineered), bamboo and composite (plastic) floors. There are three installation methods for wood floors: nailed, glued, and floating. Follow manufacturer's recommendation for installation and suitable flooring type for each application. Refer to guidelines from the NWFA (National Wood Flooring Association).

GUIDELINES FOR INSTALLATION

For a wood floor, it is very important to have a low and stable temperature on the whole floor surface. Heating elements should be installed in such a way that they produce even warmth over the entire floor, all the way to the walls, regardless of the temperature setting. Because STEP Warmfloor® is self-regulating, the material acts like a sensor over the whole floor area and therefore cannot overheat.

The maximum surface temperature on the wood flooring shall be 79°F to 81°F (26°C to 27°C). For proper heat distribution and energy efficiency, thermal insulation shall be installed under the heating elements.

Radiant heat should not be turned abruptly on and off, as this will subject the wood fibers to be repeatedly traumatized causing stress fractures, gaps and twisting. With STEP Warmfloor® the heating level can be lowered to attain the ideal constant temperature by using the STEP Touch® thermostat and sensor.

Be sure that the flooring will not be exposed to high humidity or moisture, an inherent enemy of wood. The subfloor must be completely dry before installing the wood floor. Turn the radiant heating on to a low heat, then raise the supply temperature progressively until it reaches the maximum temperature and maintain it until the ambient relative humidity is stabilized.

Before installation, wood has to be acclimatized to the moisture content on the site, knowing the temperature and humidity conditions that will prevail once the structure is occupied. For the dimensional stability of the wood flooring the equilibrium moisture contents recommended is a relative humidity range of 30% to 50% and a temperature range of 60°F to 80°F (16°C to 27°C).

Hardwood flooring can be installed over a slab that is on-grade or above grade; below-grade installations are not recommended. Engineered flooring may be installed, following manufacturer's recommendations, in areas that have some humidity variations because it displays less expansion and contraction with moisture changes; moisture should still be taken in consideration. To prevent moisture from reaching the finished floor, a proper vapor barrier must be used on top of a concrete slab and over exposed earth.

Unfortunately, not all wood floors are created equal, react similarly and are made of the same quality. Inferior flooring may contribute to failures.

The heating elements should not be in direct contact with any conductive material, e.g. wire mesh, aluminum foil, etc., or aggressive solvents and acids. Always check with the manufacturer and only use approved products.

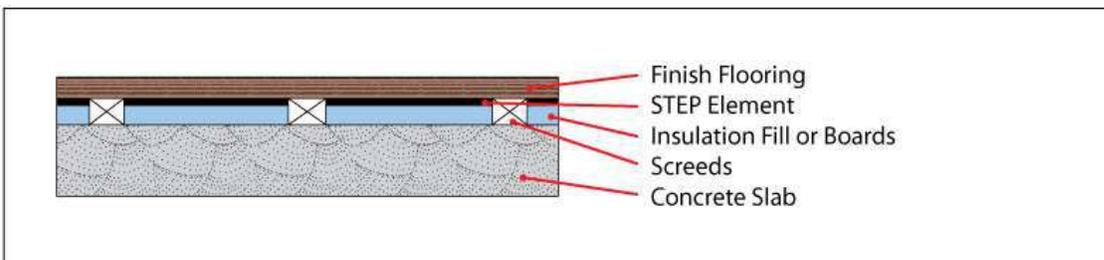
If the heating system is not self-regulating, hardwood floors should not be covered by rugs, mattresses, or heavy objects, as this will increase the temperature and may damage the floor. STEP Warmfloor® is self-regulating and cannot overheat.

Installation of the Heating Elements

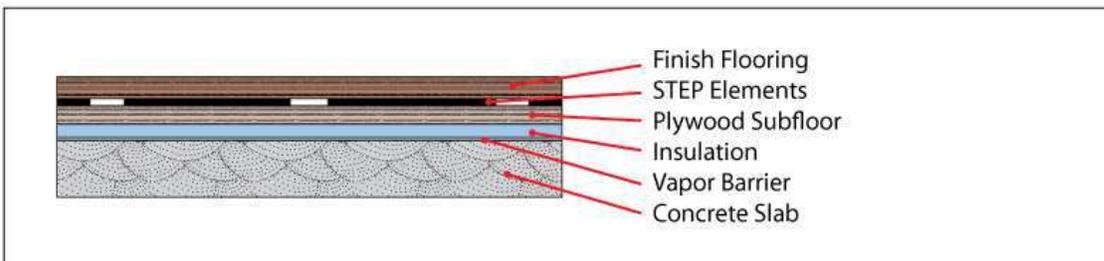
Lay the strips or planks crosswise over the heating elements and cover with a plastic film. When nailing the wood floor to the subfloor, drive the nails between the elements; if it should be necessary to nail in the elements, choose the middle where the voltage and current are zero. **Definitely, avoid penetrating the bus braids running along each side of the elements.** When using a screed system, pour masonry insulation fill or lay foam insulation boards between the screeds to **avoid air gaps** under the elements. For glue-down installations, cover the elements with floor leveler or underlayment boards. **The heating elements should not be in direct contact with aggressive solvents.** Follow flooring and mastic manufacturer's specifications for installation methods.

APPLICATION EXAMPLES

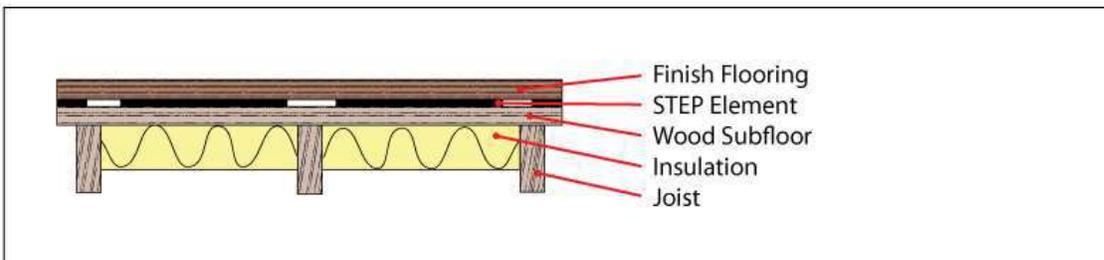
Over a screeds system



Over a plywood-on-slab system



Over wood joist construction



RESILIENT

Resilient floor coverings come in tile, plank and sheet form. The most popular are made of vinyl, linoleum, rubber, and PVC.

The top selling products in the flooring industry today are luxury vinyl and wood plastic composite. They closely mimic the look of natural material through realistic images and textures. They are waterproof and can go into myriad rooms and applications.

- LVT/LVP (luxury vinyl tile/plank) have a lower profile, which makes it easier to work with around cabinets, existing door openings and transitions. They are used a lot in multi-family and commercial applications.
- WPS (wood plastic composite) is thicker and thus has a higher perceived value. Also WPC can hide subfloor imperfections better than LVT.

There are different options for installing luxury vinyl flooring. You have dry back/glue down methods; click/locking systems or loose lay/floating products.

Due to the ease of installation and that it does not require adhesive, loose lay products are very popular.

The selection, functionally, must be based on the area where the flooring is to be used.

GUIDELINES FOR INSTALLATION

Refer to RFCI (Resilient Floor Covering Institute) general guidelines for material storage and handling, subfloor preparation, approved underlayments, floor covering layout and fitting, adhesive application, seams, etc. Also, follow ASTM (American Society for Testing and Materials) specifications. All resilient floor covering manufacturers make available a manual for installation recommendations and instructions.

If it becomes necessary to remove any resilient floor covering, which may contain asbestos, refer to the government regulation that may apply. Do not sand, dry scrape, bead blast or mechanically pulverize existing asbestos-containing materials.

The finished appearance of any resilient flooring installation will be determined, largely, by the subfloor over which it is installed. Wood subfloor / underlayment must be leveled, smooth, dry, and solid, free of movement and properly fastened.

Underlayment panels should be designed for resilient flooring purposes. Refer to proper selection and installation of APA Plywood Underlayment or equivalent. Overall concrete underlayments should be heavy weight, conventional aggregate concrete, or a manufacturer's guaranteed cement mix, installed according to manufacturer's specifications. Preferred patching materials are latex modified Portland cement. Do not use liquid premix materials, choose only products approved for over radiant heat.

On the job site, all flooring material and adhesive should be conditioned at a minimum temperature of 68°F (20°C) for 48 hours prior to, during, and 48 hours after installation. Thereafter, maintain room temperature at a minimum of 55°F (13°C). The maximum temperature recommended on resilient goods is 85°F (29°C). STEP Warmfloor®, being a low temperature, self-regulating heating element, can be installed under most resilient floor coverings.

For proper and efficient heat distribution, thermal insulation is required under the radiant heating elements.

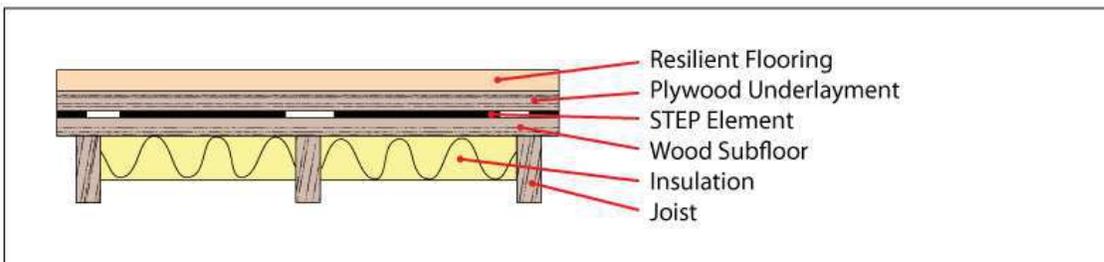
Installation of the Heating Elements

The elements can be secured with staples or approved double-sided tape onto a prepared, stable and clean subfloor. **Avoid penetrating the bus braids running along each side of the elements.** Cover the elements with underlayment panels or floor leveler to create an even flat surface to avoid that the elements telegraph onto the floorcovering. **The elements must not be in direct contact with adhesives.**

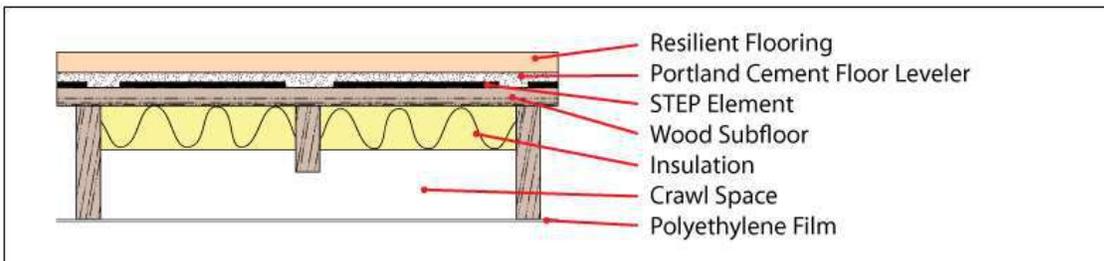
Each flooring manufacturer may require different installation and maintenance instructions. Always read and follow manufacturer's recommendations for the installation of the specific product.

APPLICATION EXAMPLES

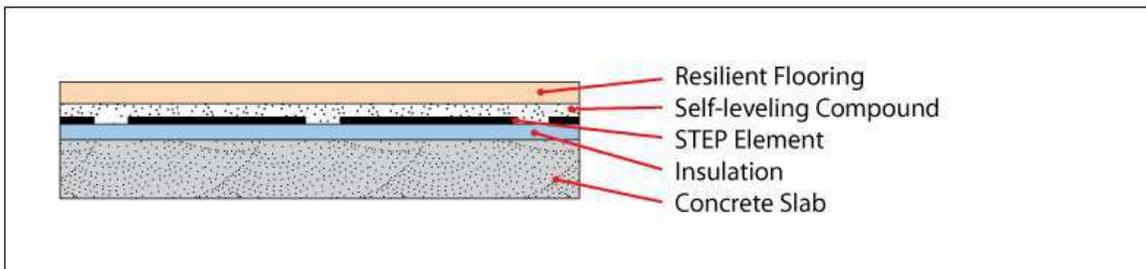
Under plywood underlayment



Under proper floor leveler



Over a concrete substrate



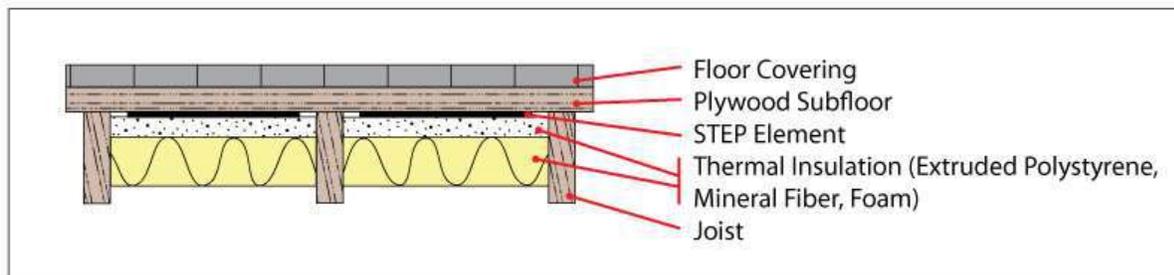
INSTALLATION BETWEEN JOISTS

This application is used when the existing finished floor needs to be maintained and there is sufficient crawl space under the subfloor.

INSTALLATION GUIDLINES

STEP Warmfloor® is a low-radiant heating system; heat is transmitted by conduction rather than by radiation. Therefore, it is very important to place insulation snug under the heating elements with no air gaps to force the heat up.

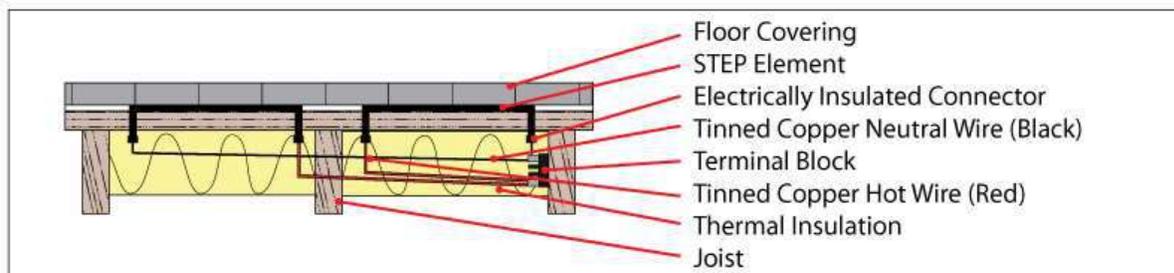
Staple the heating elements under the floorboards; the elements are one foot wide and fit between the joists. If necessary due to joist spacing, one or two 9 inch wide elements can be used. Do not puncture the bus braids on each side of the element. In this application, it is recommended that the elements be connected on both ends to make the system fail safe (see Handbook 8.3). Use insulation boards to hold the elements firmly against the subfloor. The thermal insulation values placed under the heating elements should be sufficient to compensate for the insulation values placed over the heating elements. See Insulation Under Radiant Floor Heating.



Where STEP Warmfloor® heating elements are installed on a wood subfloor, the connectors and wires can be routed under the subfloor between joists.

Cut down the plastic of the elements, on each side of the bus braid, to the second slot, removing two strips of plastic. Connect the bus braids to the wires with the STEP connectors and insulate the connections. Drop the wires and the connectors through holes drilled in the subfloor wood.

This is an easy and fast way to connect the heating system. The power supply(s) and terminal block(s) can also be placed under the subfloor. See Electrical Installation.



CONCRETE SLAB

CHARACTERISTICS

Concrete is a mixture of Portland cement, water and aggregates. The ratio of water-to-cement is a critical factor in the overall porosity of the slab. While the water/cement ratio of the concrete mix has a direct impact on the final permeability of a finished slab, the curing of the concrete has an important degree of influence upon the ability of a slab to transmit moisture vapor.

There is a significant difference between moisture content and moisture movement in concrete. Moisture (water) is a necessary and constructive constituent of hardened concrete. Movement of moisture in the form of vapor or liquid may transport beneficial chemicals out of the concrete and transport harmful chemicals in, substantially weakening the structure of the concrete substrate.

Porosity and permeability are key characteristics of moisture movement. The concentration of moisture in building materials often determines the extent of migration and the degree of damage. The common sources of excessive building moisture are rain, ground water, and condensation. Other causes of excessive moisture accumulation are building design defects and poor maintenance.

As a liquid (water) and a gas (water vapor), moisture is constantly in motion:

- From warm to cold spaces in a pore -- these movements occur when there is a great difference in temperature and in relative humidity between the interior and exterior.
- From fresh to salty conditions -- healthy concrete is extremely alkaline and moisture movement is assisted by the availability of soluble hydroxides in hardened concrete.
- From smaller pores to larger ones -- the higher the porosity of a material, the more likely it will absorb moisture -- the lower the water-cement ratio, the smaller the pores and the stronger the cement.

MOISTURE MIGRATION

Moisture problems can be largely avoided by having adequate drainage, by sealing cracks, and by grading soils so that they slope away from the foundation. Placing a vapor retarder under the floor slab hinders both vapor diffusion and capillary transport of soil moisture through the foundation. Many of the vapor retarders placed under buildings do not perform to their intended specifications due to improper placement or unintentional puncturing.

All building materials will have a certain degree of humidity since vapor emission will go from the concrete slab all the way to the ceiling. Placing STEP Warmfloor® heating elements on the concrete floor creates a natural barrier of even and low temperature stabilizing the difference between cold and warm.

Slabs that emit in excess of the water tolerance will ultimately result in the failure of any flooring material. Require a complete moisture and alkaline test report prior to any installation to insure that the substrate condition is in compliance with the floor covering.

SLAB INSULATION

The insulation must be strong (high compressive strength) and stiff (high foundation modulus) to avoid pavements bending or cracking under heavy load and traffic. Consult with insulation manufacturer for deflection/load characteristics and for maximum allowable live and dead load limits.

STEP Warmfloor® is a strong, flexible, polymer element and can reduce expansion and contraction by maintaining an even temperature on the slab.

In those regions where underlying soils are prone to frost action, unheated building structures must be insulated beneath the entire area of the floor, footings and beyond as required to adequately protect against frost heave. In heated structures, insulation is placed around and beyond the perimeter of the building to reduce frost penetration, perimeter heat loss and moisture migration.

IMPORTANT: Heat goes to cold in all directions; 360 degrees.

GUIDELINES FOR INSTALLATION

Consult manufacturer for installation recommendations and instructions. Extruded polystyrene foam insulation should be installed according to code and used in approved constructions.

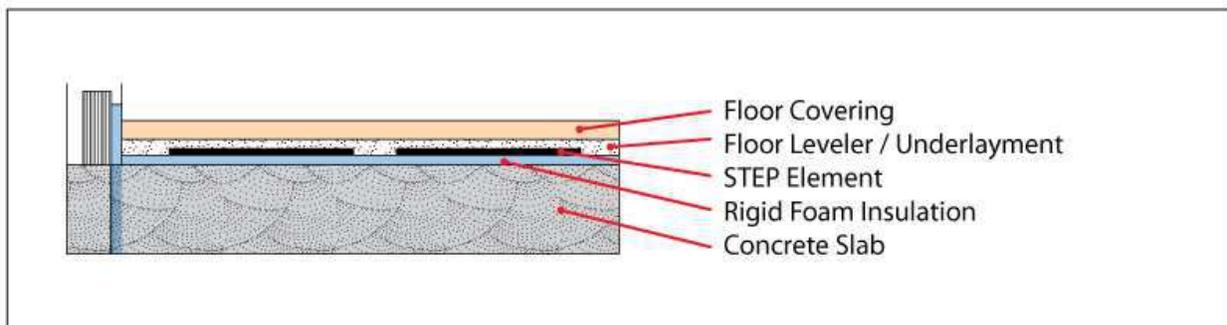
APPLICATION EXAMPLES

Application using rigid foam insulation

Installation on slab and perimeter:

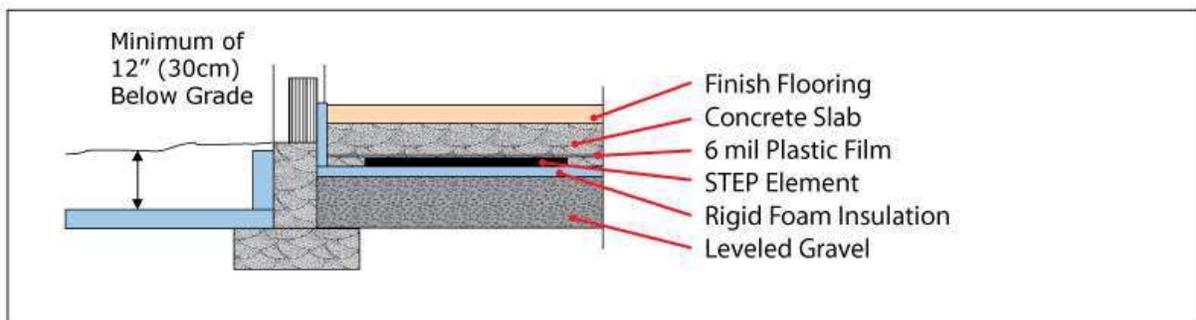
- Lay down rigid foam insulation on the slab.
- Secure the STEP elements onto the insulation.
- Cover the elements with a suitable floor covering.

For installation guidelines, see Exterior Application, Wet Areas, Tile, Resilient, Wood, Carpet and Carpet Cushion.



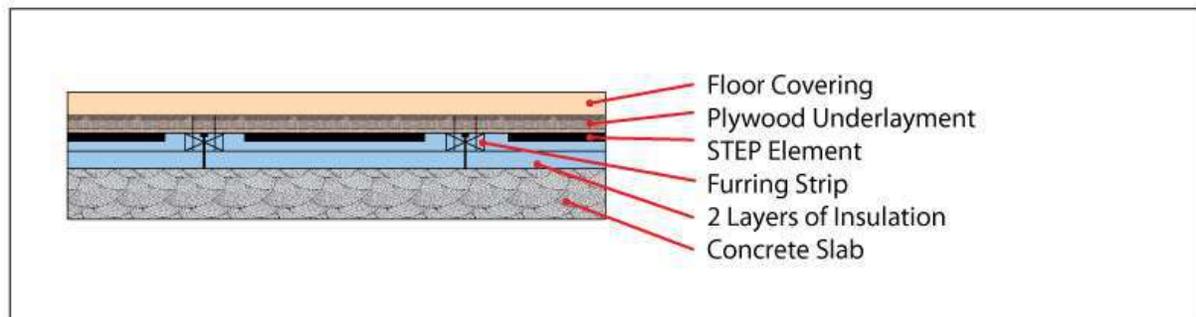
Installation in slab and along perimeter:

- As shown in the diagram below, Styrofoam insulation or equivalent is laid in a configuration that allows for corresponding reduction in foundation depth. The depth of the footing is governed by the required load bearing capacity of the soil, not the frost penetration.
- Install rigid foam insulation over the leveled gravel and along the perimeter.
- Secure the STEP elements onto the insulation.
- Lay a 6 mil plastic sheet to cover the whole surface.
- Carefully pour the concrete over the plastic sheet.
- Allow the concrete to cure properly and for the humidity to stabilize.
- The finish flooring can be a decorative concrete or any other suitable floor covering.



Installation using furring strips:

- Apply 2 layers of Styrofoam brand insulation or equivalent flush on the slab.
- Use 1" x 3" furring strips as a nailing base for 3/4" plywood underlayment.
- Secure the STEP elements over the rigid insulation.
- Install a suitable floor covering.



COMMERCIAL

The surface where the elements are going to be placed must be non-conductive, clean and dry. Insulation is very important for building's comfort level and energy efficiency. It is necessary to make heat loss calculations and prepare the layout and worksheets.

INSTALLATION GUIDLINES

Lay down thermal insulation over the whole floor, e.g. extruded polystyrene (Styrofoam or equivalent) or expanded polystyrene (The Barrier or equivalent). Position the elements on the insulation and cut them to the required length - maximum 50 feet (15 meters) per strip. Stretch and attach the elements onto the insulation with an approved tape; when using plastic pegs avoid penetrating the bus braids located along each side of the element.

Plan to locate the power supplies as close as possible to the heating elements. Make the connections according to manufacturer's specifications. Leave sufficient sag on the wires to avoid tension on the connectors. Route the wires in a tube or raceway and up the wall high enough so that they will not be covered when the concrete is poured.

Properly cover the elements and the substrate with a 6 mil polyethylene film. Concrete has high compressive strength, but limited tensile strength and has to be reinforced. There are different reinforcing techniques available; when using steel rebar, choose plastic supports and definitely avoid that the rebar touches the elements. Pour with care the concrete according to trade practices. Make sure that the elements stay in position and that there is no tension on the connections

The STEP heating elements used for this application are normally EP-30-29W-24V. Connect the elements in parallel directly to the circuit breaker(s) in the STEP power supply (maximum 450 W per circuit).



OFF PEAK HEATING

CHARACTERISTICS

Some electrical companies offer preferential rates at different hours of the day or night. For this application a heated thermal mass can be created, which would permit the heat to be released during the off time of the system.

DO NOT embed or cover the heating elements in sand as this will trap the heat and impede heat flow.

Calculations will vary depending on the location, climate, type of construction, and length of the off time. For example:

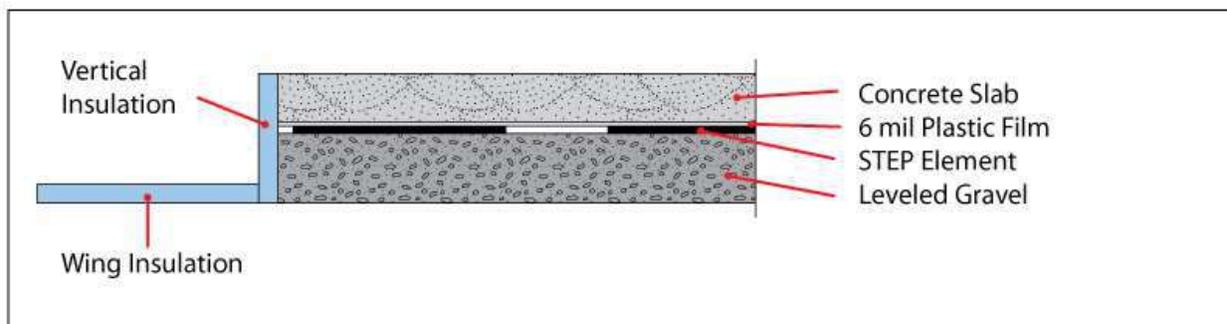
<u>Heat Storage:</u>	Slab density of concrete 1680 kg/m ³ Specific heat of slab 840 J/kg°C Thickness of slab 0.1 meter $\Delta t = (t_{\text{slab}} - t_{\text{air}}) = 25\text{ }^{\circ}\text{C} - 21\text{ }^{\circ}\text{C} = 4\text{ }^{\circ}\text{C}$ $1680\text{ kg/m}^3 \times \frac{840\text{ J/kg}^{\circ}\text{C}}{3600} \times 4\text{ }^{\circ}\text{C} \times 0.1\text{ m} = 154.6\text{ W/m}^2$	(77 °F - 70 °F) (=14.4 W/ft ²)
<u>Release Rate:</u>	Thermal conductivity of slab 0.81 W/m °C $0.81\text{ W/m }^{\circ}\text{C} \times \frac{4\text{ }^{\circ}\text{C}}{0.1\text{ m}} = 32.4\text{ W/m}^2$	(= 3 W/ft ²)

The floor will release 32.4 W/m² or 3 W/ft² of heat per hour which is sufficient to keep a house warm in the Mid-West for at least 5 hours.

For consumption, make a heat loss calculation of the building or estimate using the guideline in the Handbook, Chapter 7.

THERMAL CONCEPT

The thermal concept in an on-grade concrete slab relies on maintaining geothermal heat under the protected surface to allow the earth's stored energy to provide the bulk heat required. A perimeter vertical and wing configuration allows placement of insulation that will reduce frost penetration.



Above-grade installations will mainly depend on the type of construction and heating needs per floor level.

The choice of floor covering installed, may require insulation under the thermal mass, when the insulation values are high, e.g., carpet and carpet cushion. Consider placing a higher R-value under the heating elements as opposed to over with a ration of 4:1.

