

Fire Engineering[®]

Construction Concerns: Radiant Floor Heating Panels

Article and photos by Gregory Havel

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Radiant floor heating panels have been installed for more than 50 years. The most common type uses thin tubing embedded in concrete or lightweight concrete to circulate warm water to warm the floor and to warm the air above it, warming the entire room with relatively low temperature water. The tubing used decades ago was usually flexible copper. Today, polyethylene (PE or PEX) tubing is used. These floors are often finished with a hard surface material like tile, stone, or wood since they conduct and radiate heat more readily than carpeting.

Today, radiant floor heating panels are often installed on the floors of wood frame buildings and are supported by lightweight construction methods: oriented strand board (OSB) or plywood supported by parallel-chord wood trusses or I-joists.

Photo 1 shows polystyrene insulating board that is formed to hold the PEX tubing in place. This method is often used when the radiant floor panel is part of a concrete slab-on-grade. It is also used when the radiant panel is part of a floor above an unheated crawl space or a garage.

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(1) Photos by author.

Photo 2 shows the PE tubing connected to its headers. The supply and return piping will be connected to the brass fittings on the left of each header. The upper header has a row of adjustable flow-meters, one for each tube on the header, which is used to hydraulically balance the flow through the multiple tubes making up the radiant floor panel.

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(2)

Photo 3 shows a second-floor radiant panel under construction. The specification called for a latex vapor barrier to be applied with a paint roller to the top of the plywood subfloor. Two x 4 stringers were then glued to the subfloor since this floor will be finished with tongue-and-groove hardwood boards. Plastic channels were then screwed to the plywood between and around the stringers to hold the PEX tubing in place.

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(3)

Photo 4 shows the same radiant floor panel after the lightweight concrete was poured, embedding the tubing and making a level floor surface.



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(4)

Photo 5 shows the underside of the same radiant floor panel.



(5)

Note that this plywood subfloor is supported by I-joists, and these I-joists are doubled in this building to support the additional dead load imposed by the radiant floor heating panel. Following are specs:

- PEX tubing embedded in lightweight concrete with wood stringers: seven to 10 pounds per square foot (34.17-48.82 kg/m³).
- Hardwood floor boards: 4 pounds per square foot (19.53 kg/m³).

The weights of other possible floor finishes:

- Carpet and padding: one pound per square foot (4.88 kg/m³).
- Ceramic tile or thin terrazzo: two to 10 pounds per square foot (9.76-48.82 kg/m³), depending on the thickness of the tile or terrazzo and its mud base.

These radiant floor heating panels are treacherous to firefighters, especially with a fire in the space below and especially if the space below is a basement or cellar without a plaster or gypsum drywall board ceiling to protect the joists. The lightweight concrete has enough integrity and mass to appear to be a normal floor when sounded by firefighters who are entering the room as well as enough mass to appear relatively cool to a thermal

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imaging camera (TIC) when in fact the joists and subfloor may have already burned away, and the lightweight concrete is ready to collapse under the weight of a firefighter.

This phenomenon is not new. For decades, the collapse of wood-supported concrete, tile, and terrazzo floors in century old buildings has been the subject of discussions by authors of magazine articles and books, including the following:

- Vincent Dunn's *Collapse of Burning Buildings*, pgs. 86-88 (1988) and 2nd edition (ISBN-10: 1-59370-233-7).
- Francis Brannigan's 3rd edition of *Building Construction for the Fire Service*, pages 152 and 336 (1992).
- IFSTA's *Building Construction Related to the Fire Service*, 2nd edition, pages 99 and 101 (1999).
- Francis Brannigan's 4th edition of *Building Construction for the Fire Service*, pages 171 and 231 (2008).
- John Norman's *Fire Officer's Handbook of Tactics*, 4th edition, pages 425-428 (2012) ISBN: 978-1-5937-0279-3.
- Francis Brannigan's 5th edition of *Building Construction for the Fire Service*, pages 342-343 (2015) ISBN: 978-1-4496-8894-3.

Although today's radiant floor heating panel is thinner and lighter than the floors discussed by these authors, the joists that support them are of lightweight construction materials and methods that also have less mass and burn through faster than the sawn lumber joists and subfloors of the past. The end result of a fire below one of these floors is the same.

Based on the more recent history of firefighter fatality and injury because of the collapse of these radiant floor heating panels, the National Institute for Occupational Safety and Health (NIOSH) recommends that we do the following:

- Preplan large homes that same as we do commercial buildings since they are the same size or larger, use the same materials and construction methods, and expose firefighters to the same hazards.
- Use TICs during size-up and search.
- Train to recognize buildings of lightweight materials and construction methods.
- Train in the risks and hazards of working above a fire.
- Make notes on our preplans. Do NOT operate above a fire if trusses or I-joists support a radiant floor heating panel because of the rapid failure of trusses and I-joists in fire, the weight of the radiant floor heating panels, and the false readings from sounding these floors.

If our resources do not permit the preplanning of large homes, we need to develop a standard operating procedure or guideline that incorporates the NIOSH recommendations.

If we do not know what supports the floors in a fire building, we must operate today as if it is built using lightweight construction materials and methods until this assumption is proved wrong. Many older buildings have been renovated using lightweight construction materials and methods, including floor joists. Our lives may depend on this assumption.

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One of the reports by NIOSH discusses an incident in Green Bay, Wisconsin, in 2006 in which a company officer died in the line of duty and a paramedic firefighter was seriously injured and disabled when a radiant floor heating panel supported by lightweight construction collapsed under them while they performed a primary search, dropping them into a fully-involved basement. Read this report at <http://www.cdc.gov/niosh/fire/reports/face200626.html> or <http://www.cdc.gov/niosh/fire/pdfs/face200626.pdf>



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