

Cantilevered Floor Evaluation

RE: Floor joist bleeder ducts

11/17/02

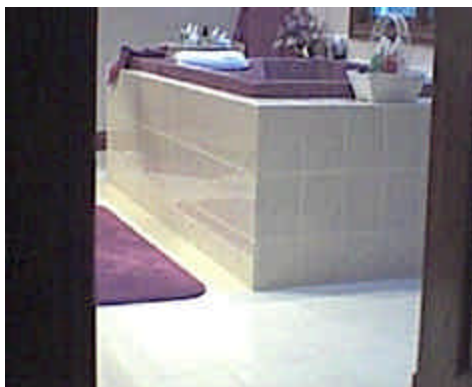


The following is a thermal evaluation of a master bath cantilevered floor system in my home in Elyria OH. The purpose is to illustrate thermal stability in a properly insulated floor joist cavity over cold space. Annual 30-year weather data for Elyria, 5818 HDD, is an anomaly. Elyria is 5-6 miles from the lake; Oberlin, 6 miles south is 6614; Cleveland on the lake is 6179 HDD.



My home is a 2 story with a finished walk out lower level and a finished attic. The EIFS stucco system has looks, added insulation value and is an exterior air barrier. This picture is from a previous winter.

The master bath has a 4' cantilever to accommodate a Jacuzzi tub. The bottom side is wrapped with the EIFS system. This is the north, sun shaded side of the house.



The tub enclosure is fully enclosed with no added heat source. The floor joist space that isn't full of insulation is open to the kitchen ceiling joists below.



The early morning temperature was 27°F. The high for the last several days was in the low 30s. Cleveland weather history includes lows of 7°F in 2001, 3° in '00, -3° in '99, 12° in '98, -4° in '97, -10° in '96, -1° in '95, -20° in '94, -8° in '93.

I have never had a frozen pipe or a slow drain in this bathroom or in any room in this home.

Floor #1: The master bath is cooler than other rooms in the house. Temperatures were recorded as follows:

Outside walls 63°F; cathedral peak 63°; cantilever floor 63-65°; other floor 65°; tub surface 62°; tub drain (approx. 2' into pipe) 67°; the kitchen ceiling below was 68°.

The area under the tub is within the thermal envelope.



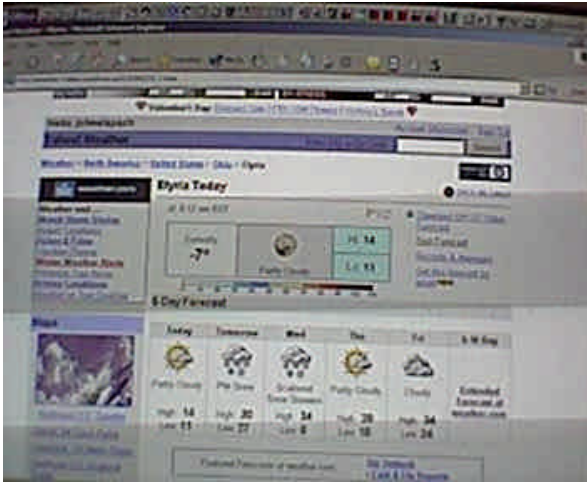
Floor #2: The master bedroom is a bonus room with floor over unheated garage. The several temperatures were as follows:

Outside walls 66°F; carpeted floor 67°; utility box sub-floor (in joist cavity) 66°; garage ceiling 56°; garage slab floor 55°; garage/ house common wall 55°.

The floor joist cavity is again within the thermal envelope.

Conclusion:

Floor joist cavities, both bonus rooms over unheated garage and cantilevers over outside air, can have stable, conditioned temperatures if properly insulated *and if the insulation is protected from air wash*. Cold bonus rooms and frozen pipes typically occur when floor joist cavities connect to kneewall attics (outside); have an air gap against the floor (outside); and have insulation against the garage ceiling below (worthless).



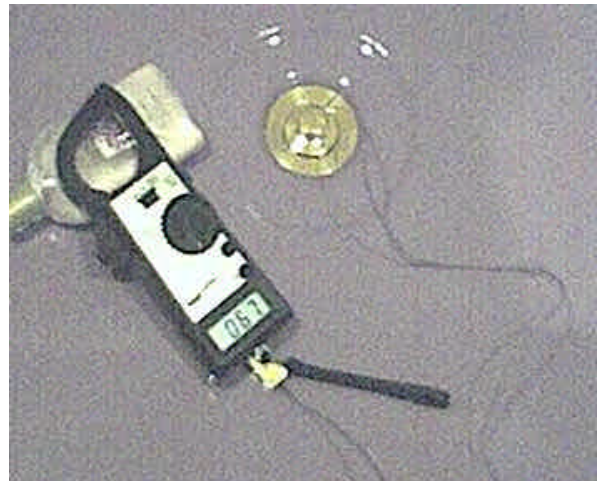
2nd Measure
 1106 Gulf Rd, Elyria OH
 January 27, 2003:

The early morning temperature was -7°F . The last several days have been highs of low to mid teens, lows in sub teens.

Floor #1:

The Master Bath under tub temperature as measured 2' into the Jacuzzi drain is 67°F . The previous reading at 27°F outdoor temperature was also 67°F .

The subfloor is within the thermal envelope.



Floor #2:

The Master Bedroom subfloor temperature was 64°F . The previous reading at 27°F outdoor temperature was 66°F .

The garage temperatures were

Slab floor	37°F
Retaining wall	40°F (to earth)
House wall	37°F
Outside wall	33°F
Ceiling	37°F
Outside	-7°F

Conclusion:

The above readings support the previous conclusion; however, with the outdoor -7°F and the greater temperature differences across the floors, the conclusion is even more definitive. Again, neither floor has a bleeder duct or additionally supplied heat.



Bonus Room Floor Cavity Temperature Calculation

Heat loss or transmissive load of building components can be calculated by:

U-value of component X Area X Temperature difference, or Load = $U \times A \times \Delta T$.

We can use this relationship to calculate the temperature of the bonus room floor cavity based on conductive heat loss through the adjacent layers.

Using a worst-case scenario:

Conditioned space (bonus room) at 50°F (standby heat, owner in Florida)
Garage temperature, at 5°F, door open (Columbus design base temperature)
The bonus room floor is an R-2 (carpet and sub-floor). $R-2 = U-0.5$; $1/R = U$.
The garage ceiling is R-20 (6" FG and .625 drywall). $R-20 = U-0.05$.
Ignore air films and dead-air space; they are equal on both surfaces
Use 1 sq ft to model on a foot-by-foot basis; drop the Area in the above equation

The room above is 50°, the garage below is 5°, what is the temperature of the floor joist cavity, which we can call "X"?

From the above equation:

$0.5 * (50 - X) = .05 * (X - 5)$ and we solve for X

$X = 49.9^\circ\text{F}$

We see that from a conductive heat loss evaluation, the cavity temperature will be *well above* freezing even at the unlikely extremes of building maintenance temperature and ambient outdoor temperature.

If we assume the room is 70° and the garage is 40°F, a more likely scenario, the cavity temperature is 67.3° [$0.5 * (70 - X) = 0.05 * (X - 40)$].

Conclusion:

The practice of frame down boxing to add insulation beneath bath plumbing in bonus rooms misses the mark. Code required R-19 can be met with 6" of FG, 3" of foam board, etc. If we can hold the plumbing up near the floor surface above, most floor joist cavities will allow for 3" of insulation between it and the cold garage below.

We don't need added insulation; we do need to stop the airflow across this otherwise heated cavity. R-38 won't work if it is misaligned, or if cold air comes between it and the warm surface. Bleeder ducts can band-aid this incorrect construction practice, but controlling the airflow will eliminate the problem.

This issue highlights the most common insulation failure, misaligned thermal boundaries.