Floors with underfloor heating

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Introduction

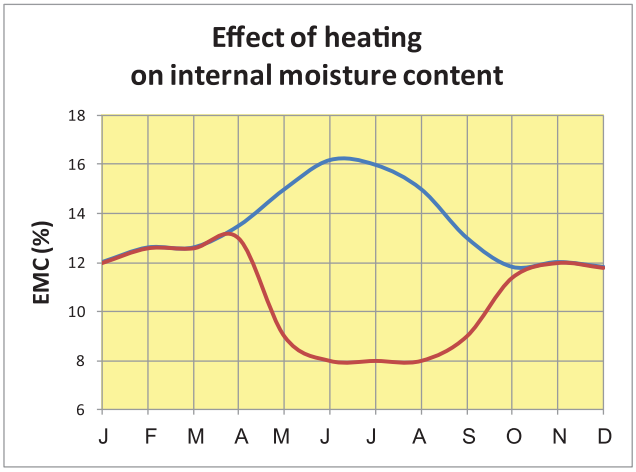
Timber and associated floors with underfloor heating systems are common in Europe and North America, however in the cooler southern states of Australia they are not as common, yet public interest is increasing. Due to the limited number of installations, experience in Australia is limited, particularly with solid timber medium and higher density hardwoods that are available. However, in addition to solid timber flooring there is also a range of other flooring products including engineered and bamboo that can be used.

This information sheet will discuss some of the heating systems used and the application of flooring systems over such systems. Firstly though, an understanding of the heated environment and movement experience in these flooring products will be explained.

The Climate Experienced With Heating Systems

Temperature and relative humidity are the two key factors that influence the internal climate or environment within a dwelling. An increase in the temperature inside the dwelling will cause a lowering of the relative humidity and with this the drying capacity of the air increases. Low relative humidity will result in timber and similar flooring releasing some of its moisture to the air, and thereby reduce in moisture content and shrink. As such the moisture content of a floor is affected by changes in the heated environment. The term equilibrium moisture content (EMC) is often used. EMC can be thought of as the moisture content that timber will attain under set conditions of relative humidity and temperature. Therefore if the conditions inside a dwelling are maintained at 20°C and 50% Relative Humidity (RH) then the flooring, depending on its current moisture content will either take up or loose moisture to try to attain a moisture content of about 9%.

The external EMC can be calculated from weather data and the adjacent graph illustrates how this varies seasonally for the southern states (blue line). The external RH during winter is high and in summer it is lower. When cooler external air is then heated, as in an internal environment, the RH and therefore the EMC drops significantly. Recent studies calculated the effect on EMC values resulting from heating to 20°C for the period from May to September and this is also shown on the graph (red line).



Source:- Adapted from FWPA Project PN07.104 – Advanced Research into Floor Performance Issues – University of Tasmania - 2008.

As can be seen from the graph the effect is dramatic and suggests that the conditions associated with a heated internal environment will result in EMC's between 8% and 9% during the heating period. Note that the graphs are based on external relative humidity values and a less extreme variation would be expected inside a dwelling. Even so the flooring needs to be able to cope with very dry conditions during the heating period over winter and moderate rises in moisture content over summer. While this can be catered for, there is an obvious concern if the underfloor heating system was not to operate for a significant period over winter as this could create expansion that was greater than would occur over the summer months.

Choice of Flooring Product

If solid timber flooring is chosen then there are two considerations. Firstly, as a flooring product, its shrinkage or swelling to changing EMC will be greater than other products such as engineered flooring. Due to this, narrower board widths are preferred. Secondly, under changing EMC, stability is gained from thicker flooring and for this reason 19mm thick boards are less susceptible to warping and movement effects compared to thinner overlay material. It must be considered that in times when heating may not be on and floor expansion occurs, then the thinner boards will be more reactive and the risk of cupping is higher. For this reason a board thickness of 19 mm is recommended even though there will be less heat transfer through it.

In the United Kingdom recommendations are to limit board width to 75 mm with underfloor heated applications however with American Oak, a cover width up to 130 mm has been found to give good results. It is not recommended that board widths in Australia exceed 130 mm and the preference is for 80 mm or 85 mm boards in these applications to minimise gapping and the potential for a cupped or crowned appearance.

Sydney Blue Gum floor with underfloor hydronic heating

With regard to the moisture content of the flooring, Australian Standard AS 2796 indicates a normal manufacturing range of 9% to 14%. However research has indicated that 8% to 9% which is near the middle of the expected internal seasonal range in Australia's southern states is more appropriate. Overseas an average of 8% is often recommended. In Australia it is unlikely that manufacturers will produce specific batches of flooring at these low moisture contents. Much of the flooring is however produced to the lower end of the 9% to 14% range of AS 2796 and flooring packs with boards averaging 10% are likely to be available. To obtain this, close liaison between manufacturer or supplier and the installer would be necessary. To determine suitability, the flooring proposed to be used would need to be sampled and oven dry testing undertaken to determine exact moisture contents. This can be expected to add some cost but is considered important. Also, great care of the lower moisture content flooring needs to be taken to ensure minimal change in moisture content prior to laying. Irrespective, some gapping at board edges after installation can be expected as a result of the underfloor heating.

In addition to solid timber flooring, some manufacturers and suppliers of engineered flooring and bamboo flooring also indicate that their products can be laid over underfloor heating systems. Others, however, do not recommend their products for this application. It is therefore emphasised that the range of suitable products is limited and that the specific requirements for the product needs to be adhered to. Suitable products in this category are often thinner providing better heat transfer than 19mm thick solid timber flooring and due to their fabricated construction, they can provide greater stability than solid timber. Manufactured moisture content is also more consistently in the 8% to 10% range which is in line with expected service conditions.

Heating System Considerations

Heating systems used range from hydronic heating where warm water is piped through a concrete slab beneath the floor to electric heating systems beneath the floor. It is necessary that the client makes available to the floor installer full installation and operating instructions of the system that is in place, and that the system or proposed system is considered compatible with the floor by the heating system manufacturer.

Even heat distribution is vitally important as hot spots can cause greater board movement (shrinkage or cupping) in some areas of the floor compared to others. Pipes within a slab set at different heights can be the cause of this and both installers and owners need to be aware of this possibility.

Blackbutt flooring (130 mm wide) with electric underfloor heating in Adelaide

The owner should also recognise that with seasonal operation of the system, some gapping and change in board shape (slight cupped or crowned appearance) is likely and particularly so if the client has chosen wider boards. This will also depend on the flooring product used. The owner also needs to be aware of the constraints to the system with regard to operating temperature and the need to avoid abrupt changes when adjusting floor temperature. Small increments of 2°C per day are appropriate and underfloor temperatures should not exceed 27°C.

Typical Installation Procedures

A typical procedure, provided for guidance involves the following steps. Regarding the specifics of floor installation and product and slab assessment, refer to product manufacturer guidelines and ATFA publication Timber Flooring.

1. *Site conditions*
   The site should be free from all wet trades, be in a state where the dwelling can be lived in and with the heating system fully commissioned. The sub-floor should also have been levelled if necessary to accept the timber floor.

2. *Pre-heat the sub-floor prior to laying to remove excess sub-floor moisture*
   The heating system needs to be operated for a period of 2 weeks prior to floor installation to lower the moisture content of the sub-floor and particularly so if it is a slab to remove further moisture. The possibility of higher levels of humidity in the room during this process should be checked for and ventilation provided as required. When conditions are sufficiently dry the flooring should be stored in the installation location in a manner that does not interfere with the drying of the sub-floor. During and particularly toward the end of this period the room conditions regarding temperature and humidity should be checked and the relative humidity should be in the range from 45% to 60% at a temperature of about 20°C. This equates to an EMC of 8.5% to 11%. The moisture content of the flooring to be laid should have already been thoroughly checked prior to supply to ensure that boards are generally 9% to 10% moisture content and this should again be checked prior to laying. Similarly the sub-floor should also be checked to ensure it is suitable for accepting a timber floor. The sub-floor temperature should not exceed 27°C with in-slab heating (With hydronic heating water temperatures may be 45°C or so to attain an underfloor temperature up to 27°C).

3. *Turn off the heating and follow this by a non-heating period*
   The period of time that the heating remains off is generally about two days.

4. *Lay and fix the floor*
   If the floor is laid direct to a slab then an elastomeric polyurethane adhesive is used and as this may differ from those used with normal floor installation, advice should be obtained from the adhesive supplier. For other types of sub-floor, normal fixing practices apply. Following installation the heating is to remain off for a further two days.

5. *Gradually increase the Under Floor Heating (UFH) to normal expected temperature*
   The heating should be increased in stages from a low level to the desired room temperature over a period of about 10 days, incrementing by no more than 2°C each day and then maintained for a further two weeks.

6. *Sanding and finishing*
   Recommendations vary with some indicating that it should be carried out about 3 days after the heating was turned back on while others indicate that the heating should be turned off and the floor sanded two days after the floor has cooled.

7. *Turn the heating system on*
   The system with installed and finished floor can then be operated but again the temperature should be raised gradually to the desired operating temperature. With an UFH system in place the optimum relative humidity range is between 45% and 60% year round with room temperatures of about 18°C to 24°C.