Assessing Concrete Moisture

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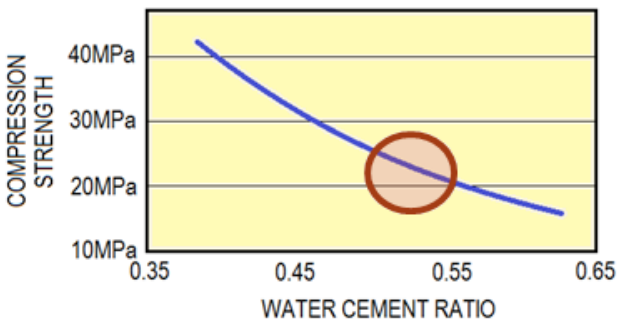
Introduction

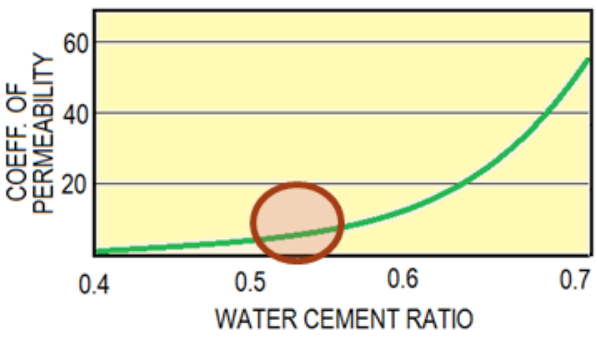
A high percentage of timber floors are laid over concrete slabs. Often a moisture vapour retarding barrier is applied to the slab or a black plastic membrane may be used. However, this does not necessarily negate the need to assess slab moisture. Many installers also rely on careful assessment of the slab and may not use a moisture vapour retarding barrier. This information sheet outlines recognised practices in assessing slab moisture prior to timber floor installation. However, before discussing the more common methods it is important that we have an understanding of moisture in concrete.

Moisture in Concrete

As we are all aware, to make concrete it requires the aggregate, cement and water, which are mixed together to form a paste. After placing the concrete a chemical reaction occurs, known as a hydration reaction, which uses up some of the water. This reaction that takes place over time is referred to as curing and the result is a solid concrete mass that also contains left over water not consumed in the reaction. It is this remaining water that moves through and evaporates from the slab surface that we have to be careful of when laying timber floors.

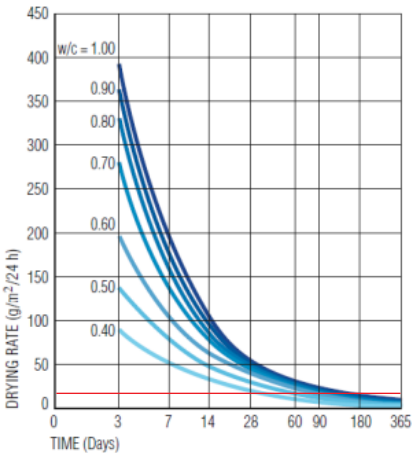
With concrete the water cement ratio is most important as it determines many of the properties of concrete including its strength, permeability and quantity or water remaining after the hydration reaction. Note that a house slab may typically have a water cement ratio of about 0.5 or a little higher. As can be seen from the graphs below, an increase in the water cement ratio results in a reduction in slab strength as well as an increase in slab permeability. Permeability relates to ease at which water can move through a slab.





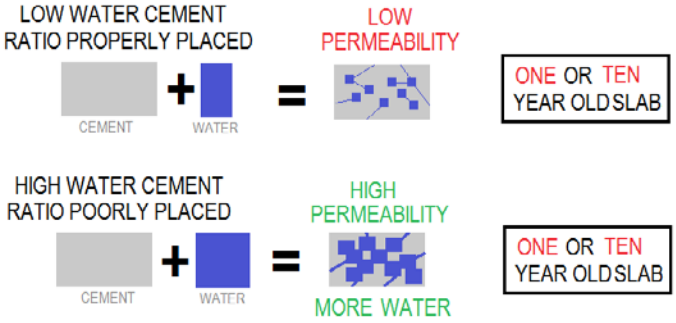
Next to consider is how long it takes for concrete to dry and again the water cement ratio has an influence on this. In the following graph the drying rate for a 100mm thick slab (typical house slab), drying from one side, is shown. The drying rate in measured as the grams of water released from a square meter of concrete over a 24 hour period.

This measure is important to us with timber flooring as a value of 15gm/m^2/24hrs or in imperial units 3lbs/1000ft2/24hrs has often been the cut level above which many moisture sensitive floor coverings should not be laid. It is therefore not uncommon to see these figures in both adhesive and timber flooring data sheets. Now with reference to the graph and the red line, it indicates that three months is about a minimum time to reach this level and the higher the water cement ratio, the longer it will take. Adding water to concrete on site to make it flow better is bad practice increasing both the water content and the permeability of the slab, as well as reducing slab strength.

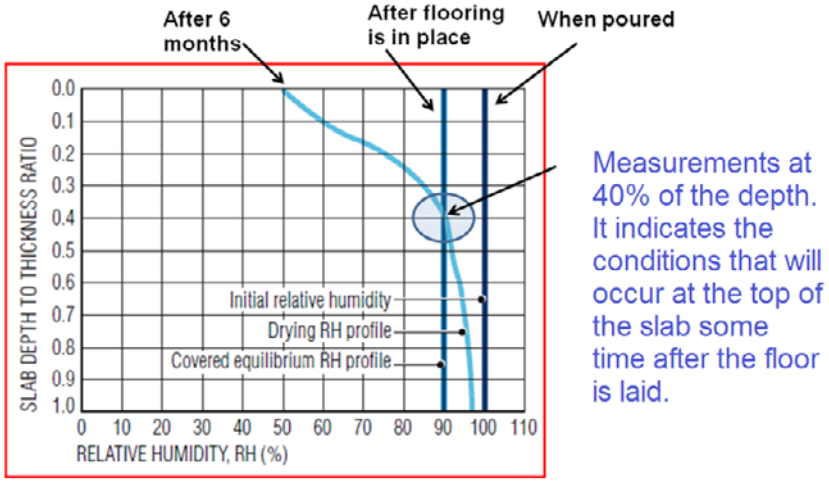


Source: CC&A Moisture in Concrete pg.4

Therefore as can be seen from the adjacent diagram the water contained in a slab that must dry through evaporation from the surface is a function of the water cement ratio and the water remaining after curing. Also the more water present, the larger the pores in the concrete. Larger pores are more likely to connect and this has a direct effect on the permeability, or ability of the water to move through the slab. Most importantly, because permeability relates to the concrete mix when poured, 'old' slabs are not necessarily 'dry' slabs. If a slab is says 10 years old you should not presume that it is dry.



It is also important to understand what happens when a timber floor or similar floor covering is then laid over a concrete slab. The slab will begin to dry from the exposed surface and the rate of drying will depend on the humidity of the air above the slab. With high humidity in the air, drying is slower and with low humidity it is faster. Therefore climatic and seasonal conditions as well as rain wetting influence the rate at which a slab will dry. When a slab is poured and has hardened there will still be a lot of moisture evenly distributed through the depth of the slab. Over time the slab dries from the exposed upper surface and deeper down the slab will still be quite moist. If at this stage flooring is laid, stopping much of the evaporation from the slab surface, then over time the moisture deeper in the slab will rise toward the drier upper surface. As a consequence of this there can be a significant increase in the moisture content of that part of the slab directly beneath the timber floor that has been laid. If sufficiently high, and no moisture retarding barrier has been used, then moisture related problems can occur with the timber flooring. This may be some weeks to months after laying the floor. The effect is shown on the adjacent graph with the relative humidity within the slab at different depths. The three lines represent when the slab was poured, after 6 months of drying and then when a floor is laid over the slab. This graph also indicates for a slab which is drying from one side, that if we could measure the moisture conditions or relative humidity at 40% of the depth of the slab at any time during its drying, then this will also predict or be equivalent to the moister conditions that will develop under the timber floor some time after it is laid.

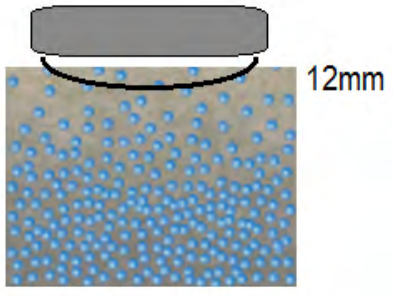


Measuring Moisture in Slabs

In the timber flooring industry in Australia many installers use concrete moisture meters to assess slab moisture prior to laying. In the past resistance meters were used but most now prefer the capacitance meter. More recently and in line with the discussion above some floor installers are using in-slab relative humidity meters. It is the capacitance moisture meter and in-slab relative humidity meter that we will consider in more detail here.

Capacitance Moisture Meters

The photo to the right shows a concrete capacitance moisture meter that is commonly used. These meters assess the concrete to a depth of about 12mm and can therefore only provide information on the moisture conditions in the upper part of the slab, which is also the region that will dry more quickly. They cannot provide information on the moisture levels deeper in the slab although those experienced in their use consider that they can determine where slab thickenings are present. Therefore as an assessment tool some installers use these meters in combination with the knowledge that they have about the slab and particularly its age. The table is provided as a guide only and indicates levels of risk from slab moisture from different aged slabs affecting a site sanded and coated solid timber. We saw in the earlier section above on 'Moisture in Concrete' that a house slab will typically take at least 3 months to come down to an acceptable level where the drying rate does not exceed 15g/m2/24hr and it is usual to wait four to six months to account for other factors. Hence, as shown in the table, slabs of 3 months where readings may be about 5%, are still a high risk but we are aware that the slab is drying. If after 6 months to 3 years the readings are under about 3% then the slab is drying to expectations and the risk is low. However the table also points out that if an older slab has a reading over 3.5% then the moisture risk increases because in a slab of that age readings should be lower.



SLAB AGE	MOISTURE CONTENT	RISK
< 3Months	-	Very High
3 Months	Up to 5%	High
3 to 6 Months	Up to 4%	Moderate
6 Months - 3 yrs	Below 2.75%	Low
6 Months - 3 yrs	2.75% to 3.5%	Moderate
6 Months - 3 yrs	Over 3.5%	High
> 3 years	Over 3.5%	High

It is very easy to take readings with these meters, and in a particular location there will be some variance in the readings. Where the readings do vary it is usual to record the highest reading. Readings should be taken in the centre and the external edge of each room and readings recorded. In addition to this some areas requiring specific attention include where water could pond against the dwelling and in corners where the house changes direction. Some consideration of slab thickenings is also necessary and in particular the location of peers under the slab which may enter into the water table below.

As well as moisture content, there are other considerations in that slab moisture can change on a seasonal basis depending on weather patterns and water table levels. Slabs that are cut into the ground can be subject to hydraulic pressure, which can also exceed the limits of moisture retarding barriers. When slabs are at a similar height to external patios, then the risk of slab edge dampness increases. Also, slabs that are of an age where no plastic membrane is likely under the slab, this again presents a higher risk. Therefore when assessing slab moisture using a moisture meter, it should be seen as only one part of the assessment. Where risks are considered sufficiently low, a flooring contractor may decide not to use a moisture retarding barrier and fix the flooring direct to the slab. But where risks are higher that same contractor may decide to use a moisture retarding barrier.

In-slab Relative Humidity

In recent years in-slab relative humidity has become more popular for assessing slab moisture and many of the companies selling timber moisture meters are now also selling equipment to measure in-slab relative humidity. When using this method on a slab drying from one side, the measurement is taken at 40% of the slab depth (20% if drying from upper and lower surfaces). In line with the discussion above, by taking a measurement at this depth, the reading is predicting what the conditions will be some time after a floor is laid over the slab. In-slab relative humidity is therefore a predictive tool and the reduction in humidity over time is also very predictable. The temperature inside a slab varies little on a day to day basis compared to the air in the room above and therefore in-slab relative humidity measurements are not significantly influenced by air temperature changes in the dwelling. It is for these reasons that this method is now considered by many as being the most useful tool for assessing slab moisture.

However, it is not as convenient to use as a capacitance moisture meter. Fairly large diameter holes need to be drilled into the slab and this is not always convenient with the likes of in-slab heating. It is also not an instant test and requires return visits to site. The test method is outlined in the standard ASTM 2170-02 and to meet the requirements of this standard:–

- The slab is to be at the in the service conditions
- Three test samples are required for the first 100m2 and then one sample for each additional 100m2
- Test holes need to equilibrate for 72 hours before readings are taken
- The measuring probe needs to be left in the hole until the reading stabilises (30 mins to 1 hr)
- Results are to be recorded
- The measuring probe also requires regular calibration checks unless disposable sensors are used (Wagner system)

Finally it must also be recognised that this too only forms one part of the slab moisture assessment and those additional items noted when using a moisture meter, such as the effects of weather and water table levels are also applicable.

Test result limits

The question is often asked, *"what does the reading need to be before I can lay the floor?"*. However you can see from the above that there is a process to work through and in addition to this it is also dependent on the product which is laid, as all products have different abilities to 'breath'. Some products such as bamboo and prefinished solid products being less able to pass moisture through them than say polyurethane site finished solid T&G flooring. However, slabs that are say a year old and drying normally with reading less than 3% would be considered dry for timber based flooring products and similarly where the in-slab relative humidity readings are less than 75%. Many are also laying without problems solid T&G flooring, when new slabs have dried down to about 4% after 6 months. It should also be noted that in-slab relative humidity remains at relatively high levels for the life of the slab, starting at about 98% but infrequently going below about 70%. Overseas, with in-slab relative humidity, it is expected that the cut-off limits will be provided by the flooring product manufacturer. Some international standards indicate 80% as being a suitable cut-off limit for solid timber flooring and we also note that some engineered flooring product information sheets indicate 75%. Therefore, in consideration of the above, the option after checking slab moisture, is still available to use a moisture vapour barrier, if there are any questions over the slabs suitability.