FAST DRYING CONCRETE

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Abstract

Several research projects have been carried out in Finland to investigate the moisture control process at the jobsite and the effect of moisture on concrete construction. The main goals of these projects have been how to avoid moisture problems during the building process on a jobsite, how to evaluate beforehand the drying time of concrete and how to measure the moisture of structures. In the Nordic countries, the moisture control of concrete structures is done by using the relative humidity(RH) method. The relative humidity in the pore structure of concrete is measured with this method. The durability of floor covering materials and adhesives in certain RH values can be easily studied. Fast drying concrete has been used for the floors of buildings in Finland for the last nine years. By using high quality concrete the risk of mould growth can be decreased not only during the building process but also during the occupancy of the building. The fast strength development of rapid drying concrete can also be utilised especially during the winter in cast on site frames.

Keywords

Moisture, drying of concrete, moisture measuring, moulds, floor coverings, building process

Biographical notes

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1. INTRODUCTION

In Finland ready-mixed concrete with rapid drying qualities has been used for nearly ten years. The reason for this has been the demand to decrease the risks of bad indoor air quality. The need to shorten the timetable on the jobsite has raised up the questions how to get the constructions dry enough before the next step in the process. There has been lot of open questions in this area and too many misinformed opinions. In the fast building process we have to know the critical values of moisture levels and behaviour of different materials in high moisture conditions. When we are evaluating the moisture risks we must know the proper methods to measure moisture in materials and have good equipment for that. Fast drying concrete is one good solution to minimize drying times and also the moisture risks on the jobsite. This quality can also be utilized during wintertime because the strength development of this quality is faster than with ordinary concrete.

2. What do we measure in concrete

The relative humidity method is used to measure the drying of concrete slabs. In this method the relative humidity in the airspace of the pore structure of the concrete is measured by using RH- probes. The probe is installed inside a drilled hole and after a certain amount of time there is a balance between the RH in the pore structure and the hole (Figure 1.). In this method the moisture distribution is estimated in the slab before and after floor covering work. It is essential to know how severe the conditions just below the floor covering (how high is the RH) are. The critical value of RH for each covering material and adhesives can be studied in a laboratory. This method has been used in Nordic countries for fifteen - twenty years.

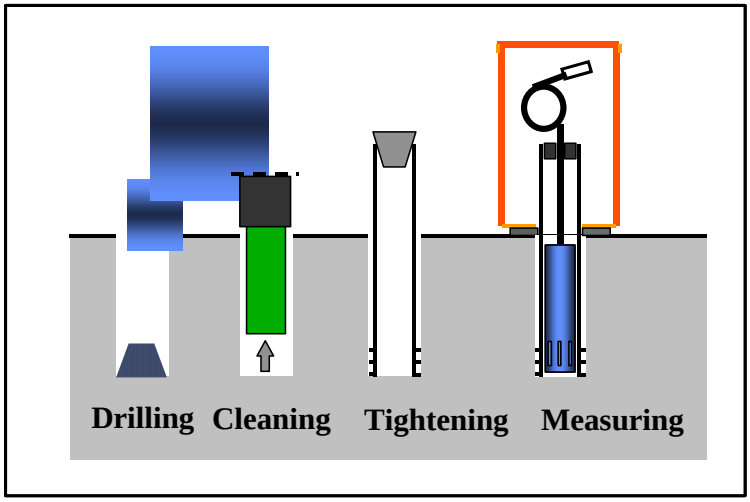


Figure 1. Measuring the relative humidity in a concrete slab.

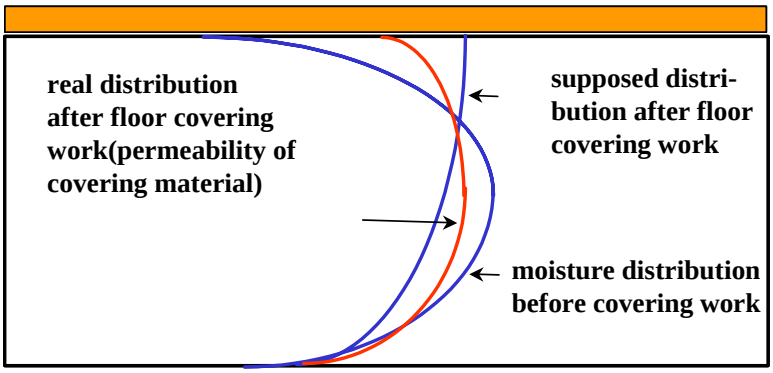


Figure 2. The moisture distribution in the concrete slab before and after floor covering work.

The critical values of RH are based on the potential deterioration, mechanical damage, chemical decomposition in the adhesives and floor covering materials.

The moisture content method is no longer used in the Nordic countries because the RH method is a more reliable way to test the conditions between the concrete slab and the flooring materials. In Finland and Sweden there currently is an education and certification system for individuals who are allowed to make moisture measurements on a jobsite. After an examination these individuals are awarded a licence to undertake measurements work on site.

3. Fast drying concrete quality

How can we decrease the drying time of concrete? The most important factor is to use a water cement ratio that is as low as possible and suitable admixtures to have workability at an optimum level for casting. The strength of this kind of concrete quality is more than is usually needed in construction. The type of structure has a great effect on the drying time of the structure. One way drying construction(drying upwards only; steel-concrete composite structure) has three-four times longer drying times compared to two way drying structures. If the slab is covered with very tight or moisture sensitive material we must pay more attention to exact time of floor covering work.

In Finland we are currently using 300 mm thick slabs in residential houses. This is because of good sound insulation and free space for HEPAC(heat, water, ventilation) -systems inside the slab. The span length of the slab can also be longer. If ordinary concrete is used the drying time of this kind of slab could be even longer than six months (figure 3.).

The effect of rapid drying concrete on the time schedule of the residential building was studied on a jobsite in Helsinki. The slab was 300 mm thick and the casting work was done in November - December. The heating system of the building was ready to use at the beginning of the following year. The drying of the slabs was followed by RH measurements of the slabs for a period of two months. An RH of 85% was required for the floor covering work to proceed. This moisture value was achieved 20 weeks after the slab was cast and between 10 -12 weeks after heating was started in the building. So the drying time of the concrete frame was 3 - 4 time faster than that with ordinary concrete qualities. The drying conditions inside the building also have a considerable effect on drying time of rapid drying concrete. In very good conditions the drying times can be even shorter.

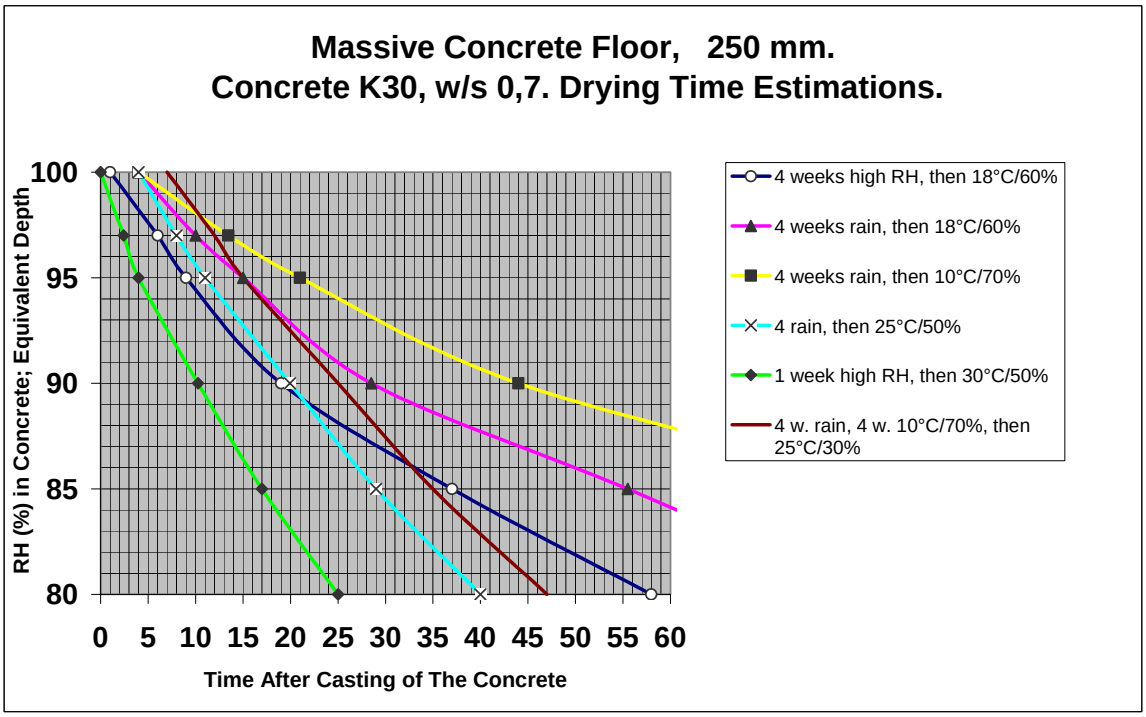


Figure 3. An example of the evaluation of drying times in the concrete floor in different kinds of drying conditions. Ordinary concrete 30 MPa.

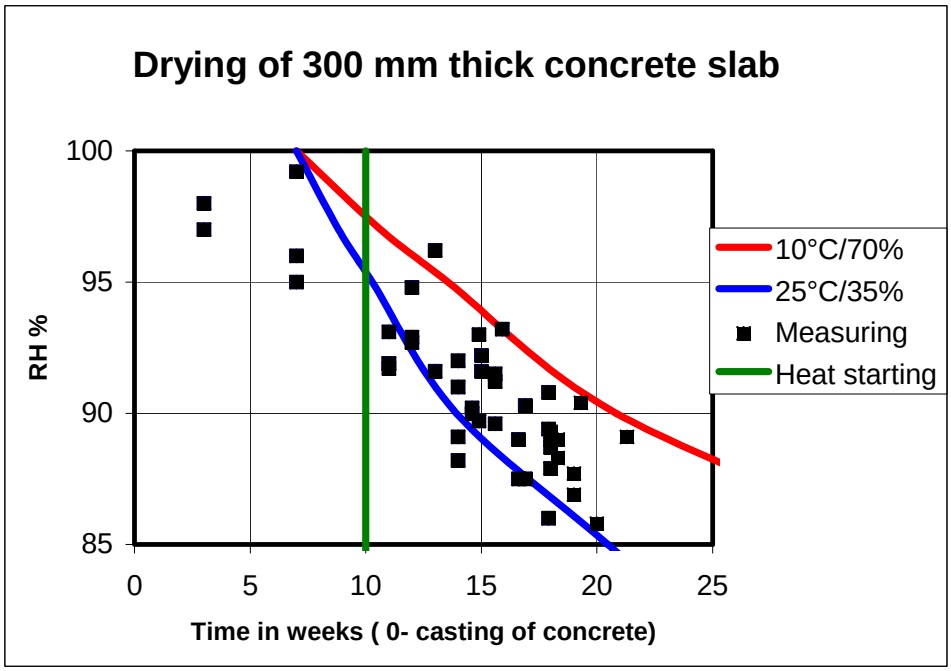


Figure 4. The drying of a 300 mm thick concrete slab on a jobsite. The concrete is NP30(at least 30 Mpa, more cement and air) - fast drying concrete quality. The continuous curves in the picture are the estimations of the drying times in different conditions.

4. The mould growth in concrete structures

It is often asked if there is a risk of mould growth between the a tight PVC covering and a concrete slab. These phenomenons have been studied in laboratories and in many renovation jobsites. The result is that with a reasonable moisture content in concrete (maximum 92 - 93 % RH) there is no risk of microbes in the floor construction. If there is a water leakage near the floor structure and the water dissolves the adhesive, the covering material will separate get from the concrete surface. An air pocket will then develop below the carpet and remarkable mould growth can occur in the structure with toxic emissions from the microbes. The same kind of reaction can be seen in a slab on the ground. If there is a concrete slab with a tight covering material and there is a connection between the slab and capillary water in the soil this reaction is very obvious. In the long term the diffusion from the soil to the slab on ground can cause the damage to the floor construction. Also, rapid drying concrete can be utilised here because the diffusion in higher quality concrete remarkable lower than in ordinary concrete.

The growth of microbes on the surface of different kinds of building materials was studied at the Finnish State Research Center (VTT). The mould growth on the surface of a clean inorganic materials starts very slowly and needs a very long time and a very high moisture surrounding the material. The concrete itself is a very bad environment for microbes. If there is organic dust or material in contact with the moist concrete the growth of the microbes is much more serious. Higher quality concrete with a higher alkali content is better is this respect.

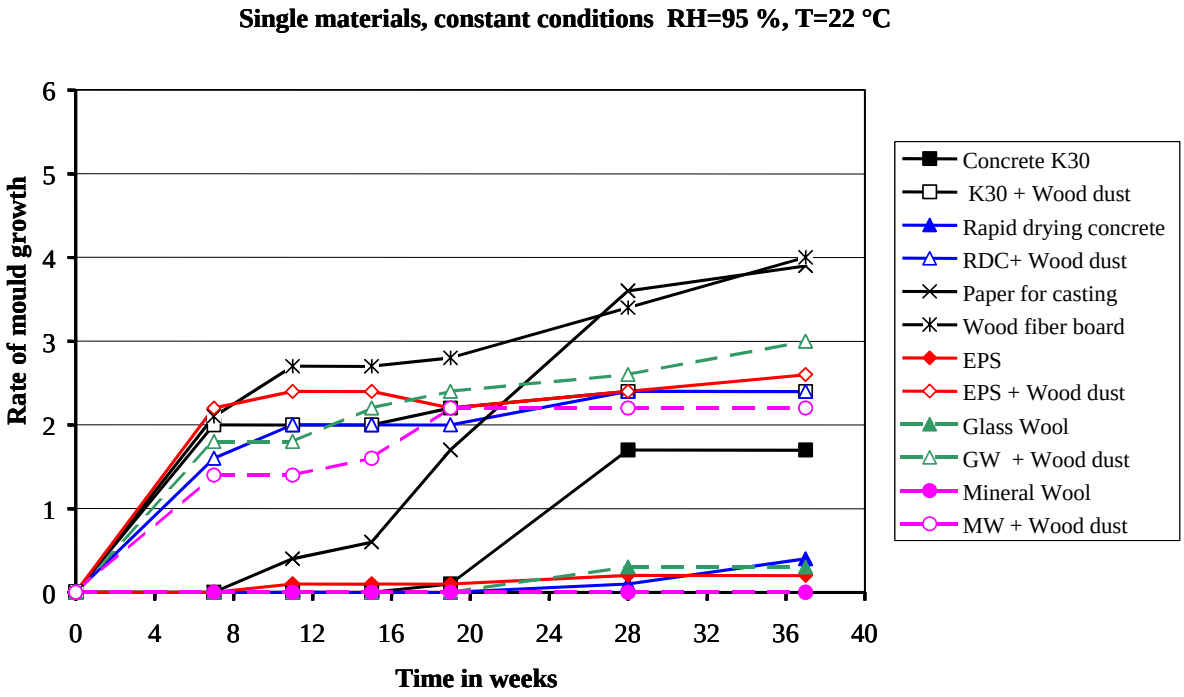
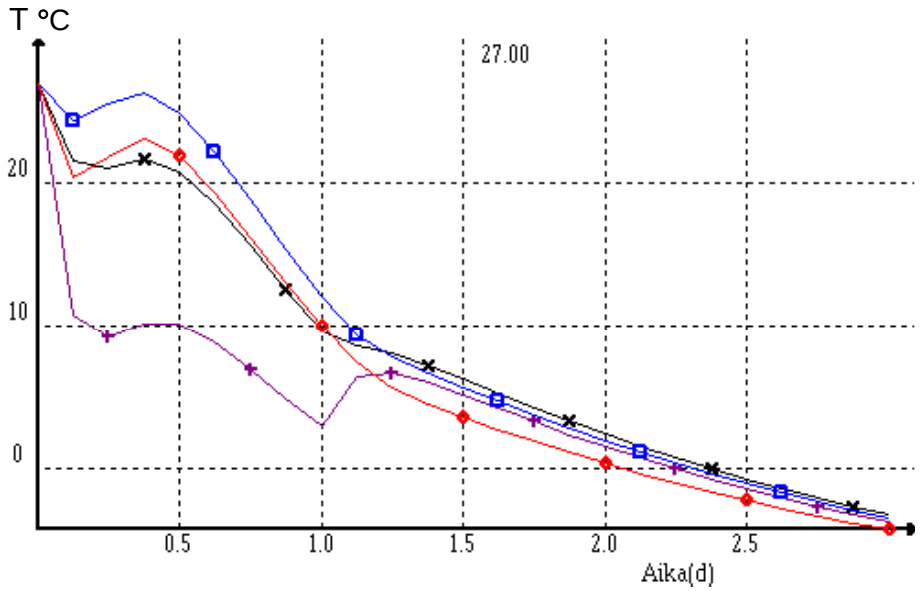


Figure 5. The mould growth on the surface of the building materials. /1/

Concreting conditions:

- Outside temperature: -10 °C
- Wind speed 2 m/s
- Extra heating no
- Insulation cover 10 mm Lohjacell - insulation after casting
- Concrete NP K35 #32 2-3Vb temperature of concrete +30°C



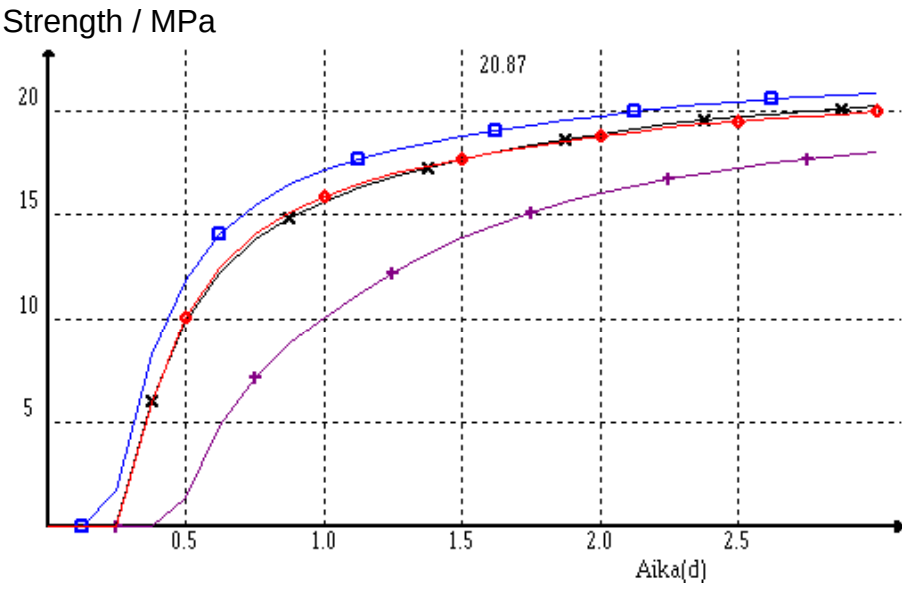


Figure 6. The temperature and strength development of a 300 mm thick slab. Rapid drying concrete w/c 0,47.

5. The utilization of fast drying concrete in winter time casting

In Finland the casting conditions on jobsite can be arctic. Concrete casting on site is done down to -15 °C (limit for pumping) and sometimes even to -20 °C. Very often the slab can not be covered with thermal insulation just after casting because the surface of the slab is spoiled by contact with the insulation material. It is important that we are able to estimate beforehand what kind of concrete quality we can use in very severe condition and how long can we keep it uncovered and when at least do we have to install thermal insulation on the slab. In Finland Beto-Plus data program is used to calculate the strength development of each concrete quality in different kind of conditions.
Outside temperature, wind speed, coverings, different kind of heating systems are other parameters.

In figure 6 one can see one example of fast drying concrete (cement 380 kg, w/c = 0.47, air 6%) in winter casting. If it is -15 degrees outside, casting is done in the morning and the covering takes place as late as 12 hours after casting the concrete surface will not freeze. The temperature of the concrete structure inside the concrete is measured on the jobsite and the program calculates the real strength of the slab according to these values.

REFERENCES

This presentation is based on the several research projects which have been carried out by national technology program "Healthy Building" financed by Finish State Technology Agency and several private companies. These projects have been carried out during the five last years. The writer has been a member of the steering group of the technology program.

/1/ Viitanen, Hannu. Mould Growth on the building materials. VTT 2004. Published in Finnish. English summary.