METER
ENVIRONMENT

MEASURING WATER POTENTIAL IN CONCRETE

Research and development engineer, Trevor Dragon, was pouring concrete at his Beeville, Texas, farm one day and wondered if he could measure moisture in concrete with a METER matric potential sensor instead of the more traditionally used volumetric water content sensor (VWC) to get more accurate readings. Dragon says, "We had about five concrete trucks come in that day, and we poured five different slabs. Every truck had a different amount of water added. One particular batch of concrete was really wet and soupy, and I became curious to measure it and compare it to the other slabs."

WHY MEASURE MOISTURE IN CONCRETE?

As concrete hardens, portland cement reacts with water to form new bonds between the components of the concrete. This chemical process, known as hydration, gives concrete its characteristic rock-like structure. Too much or too little water can reduce the strength of the concrete. Adding excess water can lead to excessive voids in concrete, while providing too little water can inhibit the cement hydration reaction. Thus, when you pour a slab in south Texas, where it's exposed to high wind and intense heat, sufficient water must be added, and precautions must be taken to minimize evaporation of water from the slab surface as the concrete hardens.

BETTER READINGS

Dragon chose the water potential sensor because he wondered if it would be more accurate than a VWC measurement. He says, "I knew that VWC sensors were calibrated for soil, and because of that they would lack accuracy. But the MPS is calibrated for the ceramic it contains. I figured it would be closer to the real thing without having to do a custom calibration."

Moisture in concrete has been difficult to measure because the high electrical conductivity early in the hydration process throws off water content sensor

calibration. So, Dragon was surprised when his data turned out to be really good. He comments, “The dry down curve of the matric potential sensor was a perfect curve. There was a nice knee (drop from saturation) after about 200 minutes, and it just went down from there. We’re kind of stumped because we are trying to understand why the data came out so well and why the curve looks so good.”

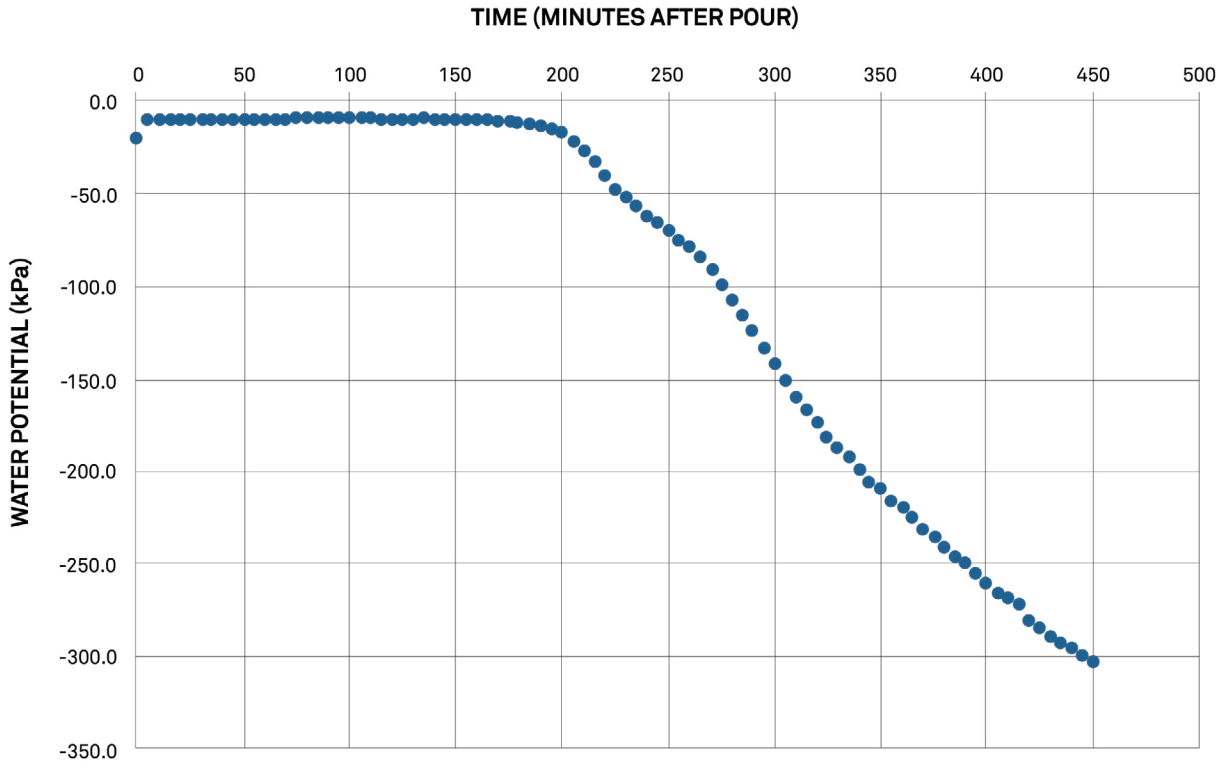

Figure 1. TEROS 21 water potential data in concrete

The scientists at METER sent the drydown curve to Dr. Spencer Guthrie, a civil engineering professor, to see what he thought. He explains, “I suspect that the concrete is experiencing initial set at around 200 minutes. This is a very normal time frame by which finishing operations need to be complete. At this stage in cement hydration, the concrete becomes no longer moldable. A rigid capillary structure is forming, and individual pores are taking shape. As hydration continues, the pores become smaller and smaller, which may explain the decrease in matric potential.”

TEROS 21 water potential sensor

NEW METHODS

One theory Dragon and his colleague Dr. Colin Campbell came up with was that perhaps Dragon's unique method of inserting the sensors made a difference in the measurements. He explains, "The first thing I did was look for the rebar in the concrete, and I placed the sensors in the exact center of one of the squares to avoid the influence of metal on the sensor electromagnetic field. Also, I didn't insert the sensors the same way you would insert them into soil. In soil, you put the sensors in vertically; I placed the water potential sensor horizontally because in this case, I was not interested in how water was moving in the slab but how it was being used over time.

WHAT DOES IT MEAN FOR THE FUTURE?

The behavior of the water potential sensor embedded in the concrete clearly indicated a drying process where water becomes less available over time. However, the implications are still unknown. Can the quality of the concrete be determined from the speed or extent of water becoming less available? Hopefully, this opportunistic experiment by Dragon will lead to more tests to show whether this approach is useful to others.

Dr. Guthrie agrees the idea should be explored further and comments, "The matric potential measurements were not redundant with the water content measurements. Instead, they offered additional, interesting information about the early hydration characteristics of the concrete. In the context of construction operations, the water potential data indicated what is normally determined by observing the impression left in the concrete surface from the touch of a finger. In the context of research,

however, the use of a water potential sensor may yield helpful information about how certain admixtures, for example, influence the development of hydration products in concrete over time."

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