Moisture Measurement
– A technology that concrete cannot do without

by Jason Laffan, Managing Director of Hydronix Ltd

The use of moisture control also allows improved profitability for a concrete production operation.

In a time when most organisations are looking to maximise profits while reining in costs and maintaining quality, it is no longer economical to overlook the benefits that moisture measurement can bring to the manufacturers of concrete, both ready-mix and precast.

One of the major sources of inconsistency in concrete production is the ever varying moisture content of the sand and aggregates. Water content changes can originate from different parts of the concrete production process with differing effects:

- Natural moisture content variation in aggregates.
- Accuracy of water feeding system into the concrete mixer, not usually an issue in modern concrete plants

- Uncovered material transport or storage systems allow increments of water content by rainfall or their reduction by evaporation
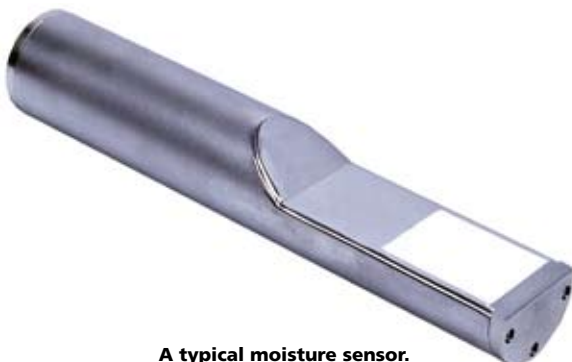
The most significant source of moisture variation is the natural aggregate moisture content. A variation of 1 percent moisture content in a dry aggregate by weight results in a change in 10 kg of aggregate loaded into the mixer for every 1000 kg of dry aggregate weighed. Therefore, the greater the variation of moisture, and the greater the weight of aggregate used, the more serious this condition becomes. Water content in aggregates can be as high as 16 percent, which has large repercussions to the economics of trading in this material.

Size	Moisture % Range
Fine Sand	0 to 16
Course Sand	0 to 12
8mm	0 to 10
10mm	0 to 4
12mm	0 to 3
20mm	0 to 2

Typical moisture ranges for concrete aggregates.

As can be seen from the table above, the range of moistures that different size aggregates can 'hold' as free water increases with the fineness of the aggregate. Therefore, concrete producers should initially concentrate on measuring moisture in the finest materials.

Options For Moisture Measurement In Concrete Production

A typical moisture sensor.

Today, there are products available in the market that allow the measurement of the moisture content of aggregates and fresh concretes with a high degree of accuracy. The microwave technique has emerged as the most suitable for measurement of moisture in concrete production, mainly due to its accuracy (usually in the range of +-0.2 percent depending on the quality of the calibration), its lack of influence by dust or colour, and the competitive cost-benefit relationship of this type of equipment.
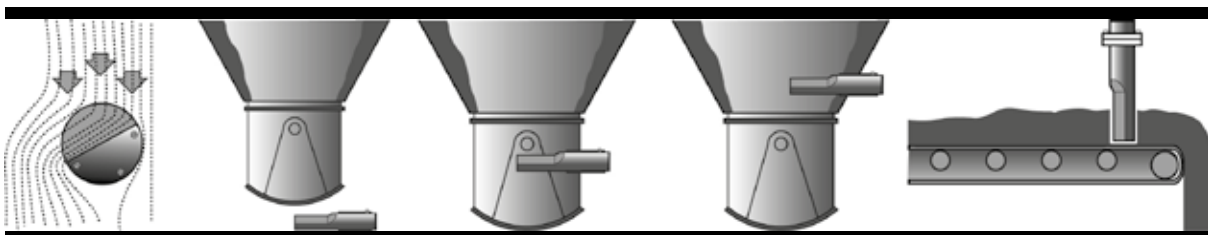
Measuring Moisture in Aggregate Bins

In ready-mix concrete, varying moisture content affects both the yield achieved for a given amount of cement and the quality and strength of the concrete. A modern ready-mix plant would typically install microwave moisture sensors at the gate of the aggregate bins. Once the sensor has been set up correctly, average moisture readings can be taken for each batch. The plants' control system can then use these values to adjust the 'wet weights' of the aggregates to ensure that the correct dry weight of each aggregate is loaded into the mixer. A plant producing 160 m^3 of concrete would see a payback period for moisture measurement equipment of three months at three percent moisture error, thereafter gaining considerable benefits in both increased yield and improved quality.

A sensor under the bin.

For precast and concrete product manufacturers, high quality materials and well-controlled moisture levels are critical to ensure consistent products. Significant savings in cement, colour and admixtures as well as reductions in the number of wasted batches are all common benefits of moisture measurement. As well as installing aggregate bin moisture sensors at their plants to ensure aggregate dry weight gradings, precast and concrete product manufacturers will generally also opt for a mixer system to ensure the correct total water in the mix, batch after batch.

Typical installation positions for a moisture sensor.

Measuring Moisture in Mixers

Measuring the moisture of fresh concrete in a mixer allows the concrete producer to have full control over the final moisture content before the mix is discharged. This ensures that variations due to aggregate wetting/drying during transport from the hopper to the mixer, or variable water pressure are eliminated.
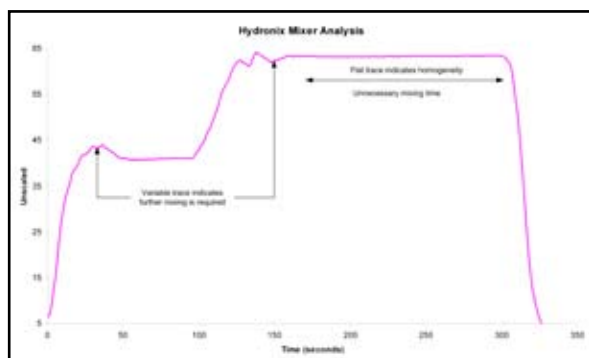
There are two options for moisture measurement in mixers – flush mounted sensors that are fitted to the floor of concrete mixers, or 'in-mix' sensors that are either rotating with mixer arms or static in rotating pan mixers. The measurements from mixer floor moisture sensors and in-mix sensors are used to calculate the correct volume of water required to achieve constant water contents inside the mixer, batch after batch.

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Homogeneity Control Using Moisture Measurement

Using moisture as an indicator of the degree of homogeneity achieved by the concrete mixer at any stage of mixing is also possible using microwave mixer sensors. Based on the use of water as an indicator of material dispersion, when materials are loaded onto the mixer, the sensors 'see' variable moisture contents over

A typical mix cycle as seen by a Hydronix mixer sensor (Hydronix data).

time as usually aggregates will be wet and cementitious materials will be dry. As these materials mix with water and admixtures, gradually a flatter trace is achieved as the water disperses evenly over the entire mix. A flat trace output from the mixer sensor indicates that homogeneity has been reached.

The use of homogeneity control allows the optimisation of mix cycles. Once the producer can evaluate whether the mix is homogenous or not, he can then adjust the mixing time to ensure that only the time required to homogenise the mix is used. This in turn has large benefits in terms of reduced power consumption, reduced wear of parts, and increased production output.

Asphalt And Other Quarry Product Applications

In asphalt production, cost savings and quality improvements can also be achieved. Initial correction for dry weight before the aggregate reaches the burners can help to prevent incorrect material gradings and the consequent effect on quality. Too high a moisture content will cause the bitumen not to bond correctly with the aggregate. Too low and moisture and fuel will be wasted heating the aggregate to higher temperatures than those required. Moisture correction optimises the efficiency of the burners and can therefore lead to a reduction in energy costs.

There is increasing pressure on users of quarry products to ensure that their yields are maximised while ensuring their products conform to the required standard. If raw materials delivered by the quarry are of varying moisture contents, in-line measurement allows the control of the exact 'dry weight' of material used. Consequently the next logical step is to associate or compare the final yield to the production costs and purchased materials. With a heightened awareness of both material and energy costs, producers that would not have previously considered moisture measurement or control can now justify this cost-effective investment.

Moisture Measurement In Concrete Production Is Cost-Efficient

As well as improvements in quality, the use of moisture control also allows improved profitability for a concrete production operation. Concrete producers will achieve reduced material costs and increase production yield. Although more difficult to quantify, the reduced number of sub-standard batches, reduced wear part and energy savings, all increase profitability.

If you are considering using moisture control equipment or wish to receive further advice, ensure that you choose a company that has an excellent reputation, that can integrate with your current system and that will be able to give you the customer service and after-sales support that you expect.