As concrete cures, large temperature differentials can form between the core and surface of the concrete structure. These temperature differentials can lead to thermal cracks, which in turn can cause increased permeability for easy penetration of water and air, plus reduced durability and structural integrity.

**Temperature monitoring**

Concrete temperature monitoring is critical to ensure the long-term strength and stability of concrete structures. To this end, 24/7 automated monitoring enables on-site engineers to determine any necessary temperature control strategies. These can then be implemented to ensure that temperature differentials between the core and surface of the concrete do not go beyond safe limits.

Roadbridge specialises in the international delivery of infrastructure projects from £1 million to £300m. For around four years now, the company has been using thermocouple temperature probes with Onset HOBO data loggers, (supplied by Tempcon Instrumentation) on windfarm construction projects.

Barry O’Riordan, project quality manager at Roadbridge, explains that in recent years, a lot of cracking problems have come to light with concrete bases that were poured ten to 15 years ago. Many of these problems are attributed to temperature issues when the concrete was curing.

**Data loggers**

Thermocouple probes are installed before a concrete pour, typically spread out at specified locations, with a number of them concentrated on the central core, where the most heat is likely to be generated. The thermocouples are secured in place with plastic cable ties on the steel reinforcement. The cables run back along the reinforcement to the data logger. Each logger can take up to four thermocouple cables. Once monitoring is finished, the cables leading to each thermocouple probe are snipped off and the thermocouples remain in the concrete.

“Temperature monitoring kits can be configured with 3G/4G cellular or satellite communications for remote web-based monitoring, or purely as standalone devices.”

O’Riordan explains, “For the project we’re currently working on, we will be monitoring nine separate locations within the concrete foundation, so we are using three loggers altogether. The loggers are easy to set up to record the correct titles and correct measurement frequency, whether that is half-hourly, hourly, daily, etc. Then we go ahead and pour the concrete and straightaway you’ve got the live temperatures, plus the loggers are continuously recording.

“Now we can get live temperature readings...
and make decisions on-site straightaway.”

Throughout the curing process, the entire concrete mass needs to be at thermal equilibrium. Without monitoring and taking necessary steps, the outer edge could for example get down to 20°C, while the core could be at 60°C.

“On a daily or twice-daily basis, we check the temperature recordings and immediately we can make decisions,” O’Riordan continues. “For example, we may add more insulation to a part that is cooling too quickly. The temperature will peak two-and-a-half to three days after the pour, then as the days and weeks progress, the concrete temperatures will drop and we can gradually remove insulation and formwork. We need to avoid the base experiencing thermal shock (caused by the temperature dropping too quickly). It could be three to four weeks before all the insulation is removed from a concrete pour.”

Temperature monitoring kits can be configured with 3G/4G cellular or satellite communications for remote web-based monitoring, or purely as standalone devices with their own display screen.

With standalone loggers, temperature data can be read off the data logger’s LCD screen and historical data downloaded to a laptop via a shuttle (data transporter) device. From there, it is easy to export the data to Excel for reporting purposes.

Benefits of thermocouple data loggers include: around-the-clock measurement and reporting of temperature at critical locations; can be configured and installed in minutes; display readout of current temperatures; and visual alarms, etc.

The live temperature information provided by the data loggers is also being used to assist with the design of wind turbine platforms and the specification of concrete to be used to avoid cracking.

**Measured and managed**

Being alerted to cure temperatures outside safe parameters enables engineers to take corrective action while they have the chance. The implications of knowing (or not knowing) whether concrete is curing correctly can be huge, including long-term structural integrity and having records for insurance purposes.