Smart technology for measuring concrete maturity

At three major London high-rise projects – No 1 Blackfriars, Highpoint and White Collar Factory – concrete-frame construction firm Dunne Group is using a new smart technology and service to increase its on-site productivity and at the same time deliver a quality concrete structure. ***Ashley Simons*** *of* ***Doka*** *reports.*

Being able to measure in real time the development of in-situ concrete maturity can speed up the construction of a concrete frame. By knowing the earliest possible time to safely strike formwork and carry out prestressing operations at their respective concrete target strengths, means these operations can be performed with confidence and minimum risks to safety and quality.

Doka's Concremote service provides concrete mix calibration metrics, hardware, sensors and data transmitters, plus 24/7 real-time access to accurate data monitoring in measuring the progressive development of the in-situ concrete strength.

Instantaneous alerts are received from a service centre advising site engineers when target concrete strengths are reached; these alerts are received either on site computers, tablets or mobile phones. Dunne also has constant internet and telecom access to the service centre to enable it to forecast strength development and target strengths, resulting in improved planning and use of formwork, prestressing operations, on-site plant and labour.

The Concremote uses the internationally accepted method of concrete maturity to measure strength gain in in-situ concrete. The Maturity Method was first developed in the UK in the late 1940s and early 1950s and led to a simplified equation:

$$M = \sum_{0}^{t} (T - T_0)\,\Delta t$$

where:

- M = maturity index, °C (or °C-days)
- t = average concrete temperature (°C) during the time interval
- T_0 = datum temperature (usually taken to be –10°C)
- t = elapsed time (hours or days)
- Δt = time interval (hours or days)

This fundamental formula proposes that concrete strength is a function of the product of time and concrete temperature, and more recent research in the 1980s has refined the equation, which is the norm for ASTM

Concremote wall sensor.

Concremote slab sensor.

Site engineer monitoring real-time data and data transmitter.

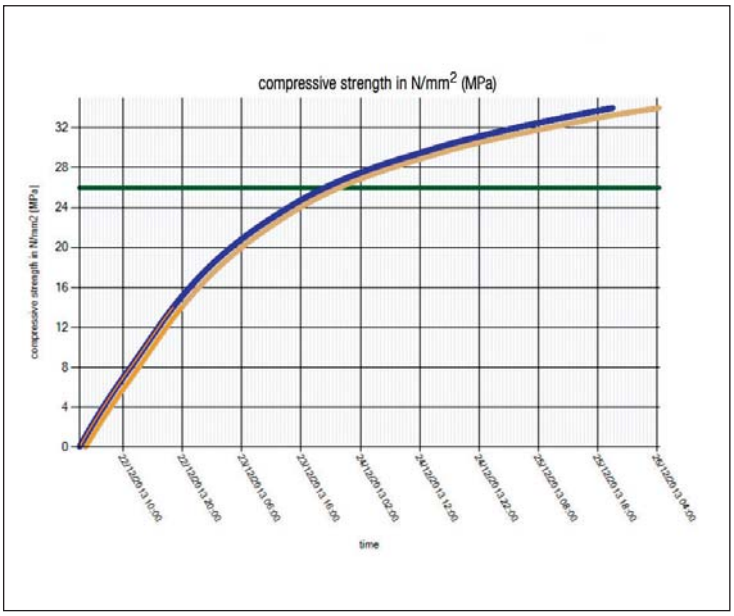
C1074[1] *Standard Practice for Estimating Concrete Strength by the Maturity Method*. The Concremote conforms to these Standards and its sensors simultaneously measure in-situ concrete temperature and time, and compare this real-time data against a known calibrated concrete, raising real-time alerts when the required in-situ target strength is reached.

The dual benefits in using the service, integrated with Doka formwork are two-fold: construction and environmental, as outlined in Table 1.

White Collar Factory

At the White Collar Factory, Dunne used Concremote not for reasons of concrete strength, but for the production of uniform colour tones for the specified high-quality architectural concrete surface finish.

The colour of as-struck concrete is dependent on a number of consistent criteria; however, maturity has a significant influence



Typical on-line concrete strength chart.

Table 1 – Concremote benefits

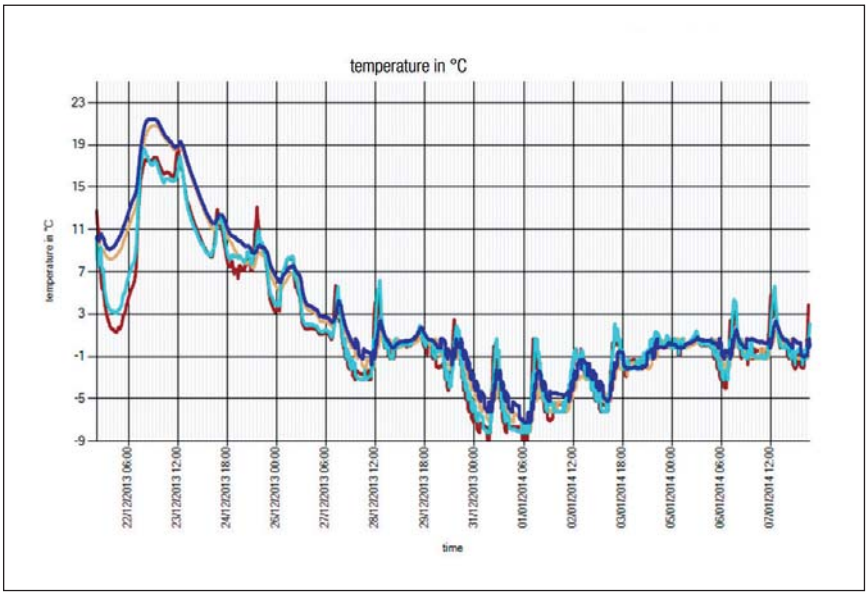
Feature	Construction benefit	Environmental benefit
Shorter construction cycle time	High site productivity with lower risks to health and safety	Good safety record
Optimised sub-discipline activities: formwork and prestressing, cranage, concrete cube test, etc	Improved discipline productivity and better use of working trades	Lower volumes of sub-discipline material on-site resulting lower logistic pollutants (noise, vibration, nitrates, CO_2, congestions, etc)
Reduced overall construction period	Savings on site overheads, plant and workforce	Lower overall environmental disruption
Real-time concrete quality	Live recording/reporting of concrete properties; maturity and early strength	Lower future risk of underperforming concrete quality
Potential for optimised concrete mix design	Lower operational cost concrete	Potential use of partial cement replacement, lower carbon footprint
Striking of formwork for uniform concrete colour	Lower variation in grey tones	Visually more attractive concrete buildings

in producing consistent surface colour tones of the as-struck concrete. If you strike formwork at consistent and known concrete maturity (product of temperature and time) the result will be lower variation in tones between pours, resulting in a visually more uniform and attractive structure.

On a typical 44-storey service core, the use of Concremote can normally cut 24 hours off a five-day construction cycle, resulting in a 20% increase in productivity and an overall shortening of the core construction by 44 days. Contractors can drive forward the tangible gains in productivity, significant potential to lower construction costs and reduced quality risks in the cast concrete. Formwork striking and post-tensioning times are carried out with confidence at the earliest possible times. ■

Reference:

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS, ASTM C1074. *Standard Practice for Estimating Concrete Strength by the Maturity Method*. ASTM, West Conshohocken, Pennsylvania, USA, 2011.



Typical on-line in-situ temperature profile.