Hilti Concrete Sensor

Remote concrete strength and temperature monitoring

Manufacturer	Hilti
GT Business Department	Highways
Site of testing	Grantham Relief Road
Testing period	October 22 – January 23
Cost	£148/unit

The Hilti concrete sensor is a remote sensor that is embedded In the top 150mm of a concrete pour, i.e. a slab, which then provides strength and temperature readings over the 28 day curing period. These are received through the Hilti CS App, with the sensors sending data when someone walks near them on site. The target of these sensors is to reduce reliance on concrete cube crushing, saving time through data showing earlier strength achievement than cubes.

These sensors were trialled on two pile caps on the Grantham Phase 3 Project, with 2 being embedded in each the north and south pile caps of Pier 4.

Key Findings and Recommendations

- The concrete sensors were easy to install, with this being achieved by the site team without any specialist help
- The sensor data for both pours showed higher temperatures and thus quicker curing and achievement of the necessary strength earlier when compared to the cubes, which is to be expected as the higher volume of concrete will cure quicker
- This product is recommended for projects wherein programme is constrained and early striking of the concrete based on strength (i.e. High rise buildings) would allow for benefits through time saved
- Further trials with alternative sensors are underway within Highways

Strength Reference Curve and Calibration

Before setting up a project within the Hilti App, the sensors must be calibrated in accordance with a strength-curve specific to the concrete mix that is going to be used with the sensors.

This is achieved through recording the cube crushing data for cubes from the mix at days 1, 3, 7, 14 and 28 – in a 20 degree controlled water bath. The MPA data sheet/results is then sent to Hilti, and this data is entered into their software and used to calibrate the concrete sensors.

This data is then also manually added in the Hilti app, being linked to a specific pour as set up on the dashboard, and then to the sensors. Each sensor has the specific pour strength reference added to it

Details

The first pour took place on November 14th with the second pour on 21st December, with each of these sensors running for the full 28 days and generating conclusion reports.

The sensors were zip tied in place in the top 40-50 mm of the slab to the top rebar, with guidance stating a maximum f 150mm depth when placed, with nothing between the sensor and air aside from concrete for best results. The sensors were activated by exposure to torchlight, and then gave readings from day 3, as our cube crush started as this point so this is when the strength reference began.

Reports can be generated from the app whenever the user chooses, but we generated reports at 7 and 28 days, with the live data showing the temperature and strength at any given time. Once the batteries in the sensors die, the data stops being recorded, however this occurred long after the 28 day period.

One potential advantage of the sensors that we did not get to trial would have been investigating the concrete temperature in cold weather pours, in line with Cold Weather work – *Series 1700 of the Specification for Highways works – Structural Concrete*. When pouring below 2C you must maintain the concrete temperature at 5°C or above until 5N/mm2 is achieved.

Part of the trial included a planned pour in low temperatures, meaning additional strike cubes would typically need to be taken to ensure we were in line with the guidance – and theoretically the sensor data would have reduced the need for these additional pours, giving us live data to ensure the concrete was above 5°C whilst curing. Unfortunately the concrete plant froze, so we were unable to assess this aspect and the pour happened later in warmer temperatures. Whilst the opportunity for a free trial has now passed, a paid trial of the sensors in winter may yield increased use cases in line with this.

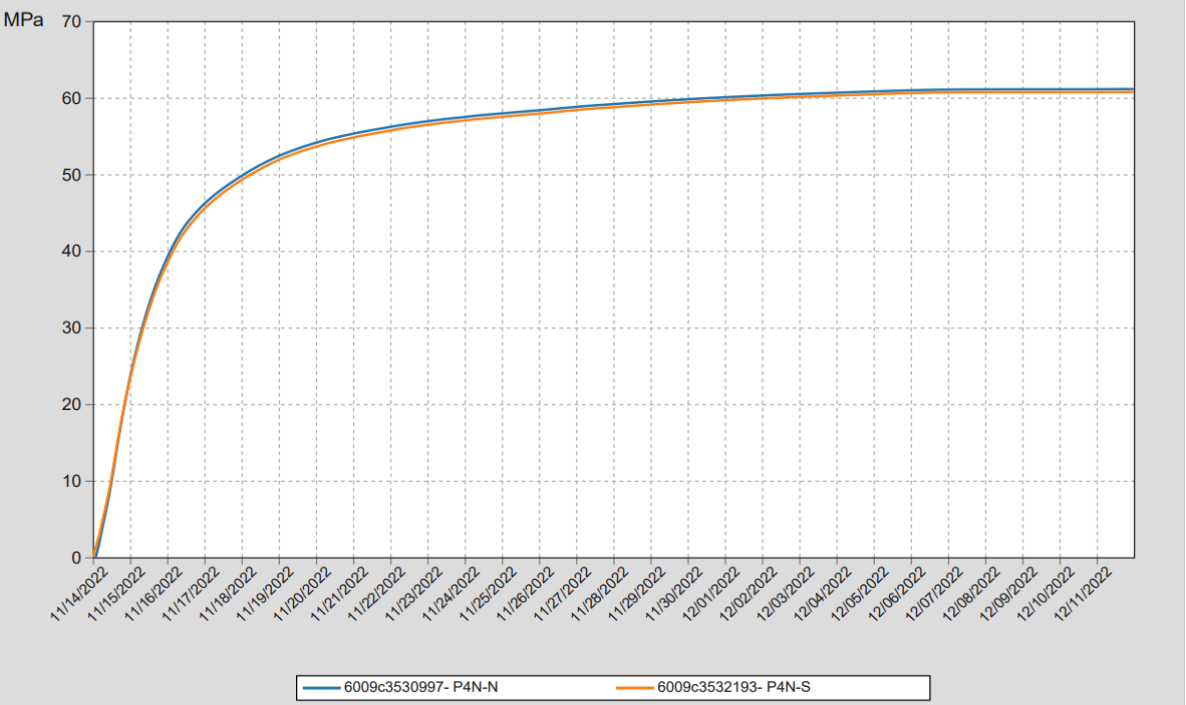
Conclusions

The data from the sensors showed the concrete had cured to the target strength quicker than the cube crushes would suggest, and the ability to view the data live also allowed the site team a more dynamic understanding of the ongoing concrete strength.

The primary benefit from this product lies in the ability to prove that concrete pours have cured at an earlier time in the programme, allowing for early striking of formwork where based on meeting a strength requirement. This could see benefits on incredibly programme constrained projects, or high-rise tower projects where starting work on the slab as early as possible is vital.

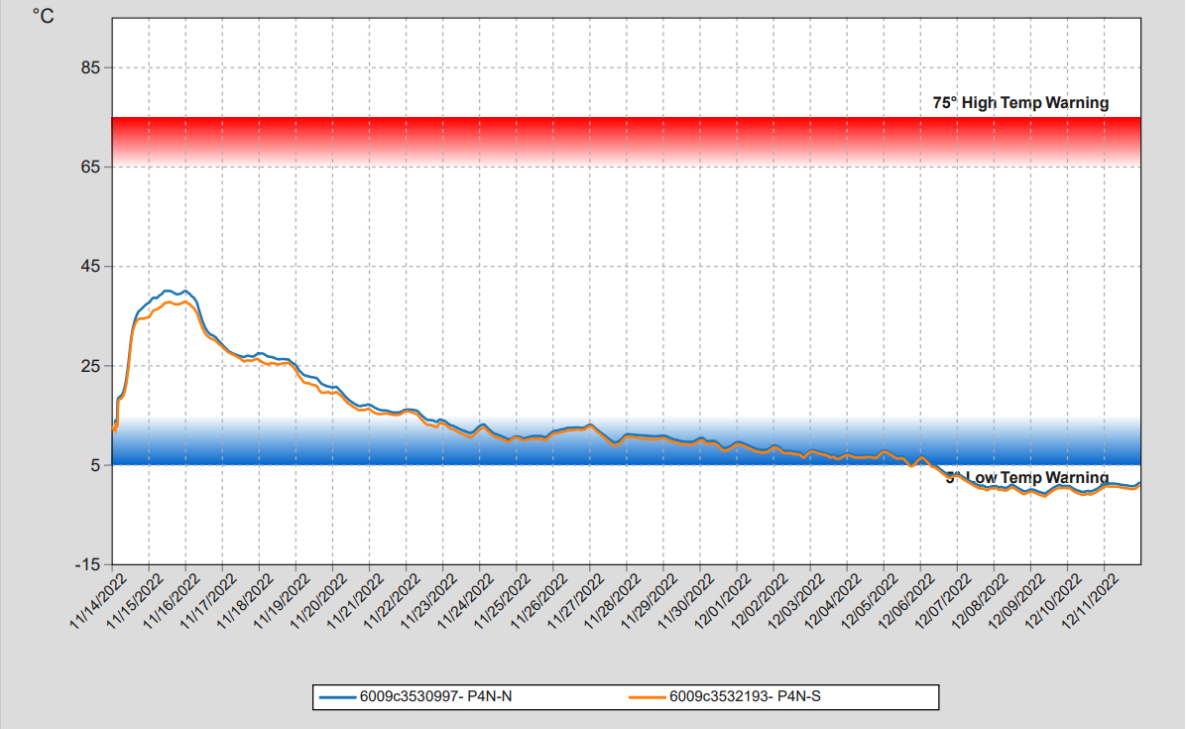
Whilst there is the added benefit of a reduced reliance on cubes, the site team felt that for standard works these were unnecessary, and if needed additional cubes could be poured for more frequent crushing at a much lower price.

Feedback on installation and usage was overall positive, and this emergent technology is becoming more frequent, with a separate trial using sensors from the manufacturer Maturix currently underway on the A303.



Strength Report: First 28 Days, Pier 4 North Pilecap

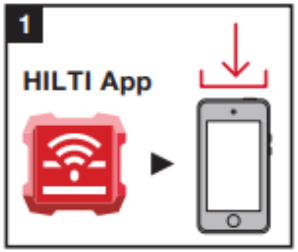
Mix Design: Breedon: C40/50 DC-3 (380 0.40) S/P (Mix B)

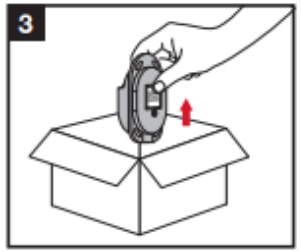


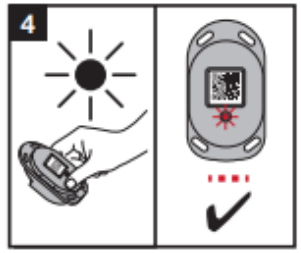
Temperature Report: First 28 Days, Pier 4 North Pilecap

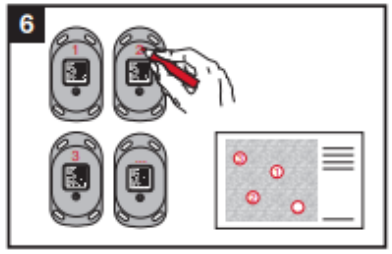
Mix Design: Breedon: C40/50 DC-3 (380 0.40) S/P (Mix B)

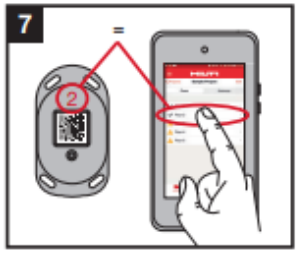
Sensor instructions

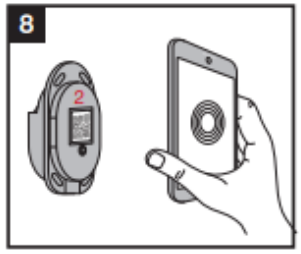


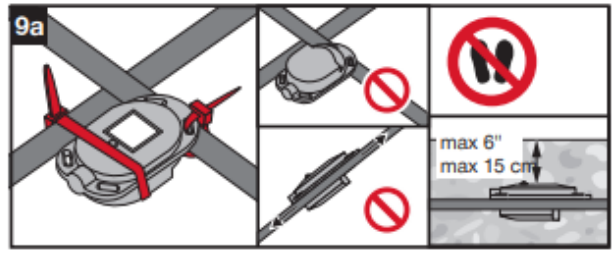


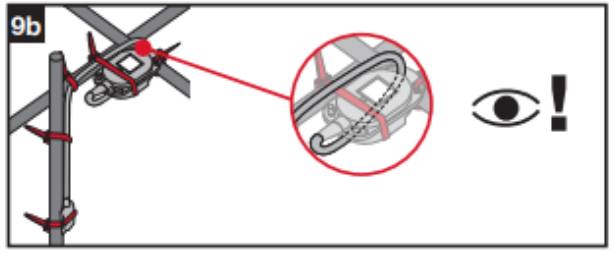


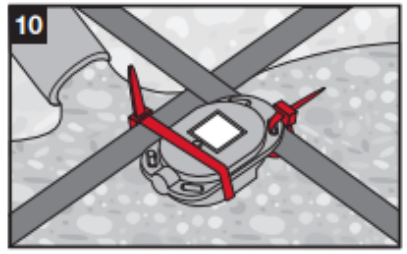












Step 1:
Download Hilti Concrete Sensors app (available from iOS and Android)

Step 2:
If using Bluetooth sensors, please skip this step.
If using Long Range data collection option with a Gateway, please follow Gateway setup instructions.

Step 3:
Remove sensors from their packaging, which you intend to install in your upcoming concrete pour.

Step 4:
Activate sensors by exposing them to a bright light. If red indicator LED isn't blinking, try using a flashlight or direct sunlight.

Step 5:
Follow in-app instructions to add a Project and respective concrete Pours. Including the Pour name and date. (Android: Use plus (+) sign to add)

Step 6:
Check pour area on floorplan and decide on intended sensor locations. Label surface of each sensor with its intended name. Clearly mark floorplan hardcopy to show each sensor name/location. (Optional: see in app instructions on how to add the floorplan and pin each sensor location).

Step 7:
Select Pour which the sensors are intended for. Select Add Sensor. (Android: Use plus (+) sign to add)

Step 8:
Scan QR code, enter sensor name and Save.

Step 9a:
Secure sensor to rebar or mesh at intersection for stability and fasten at minimum two points. IMPORTANT: Ensure QR code is facing upwards. Be careful not to step on sensors. Sensor can be no deeper than 6" from surface of concrete.

Step 9b:
For sensors with cable and temperature probe ("B-side"), ensure the large end (radio transmitter) is near the concrete surface (max depth for transmitter is 6"). Ensure cable is looped (see image 9b) around rebar in such a way to avoid pull-out during concrete pour. Fasten temperature probe ("B-side") at intended monitoring point and secure cable to rebar.

Step 10:
Pour Concrete

Step 11:
Connect to sensors as often as needed to monitor progress. Sensors store all data onboard for life of battery (~2 years) and will also be stored in the mobile app once collected.