PAPWORTHS CONSTRUCTION TESTING EQUIPMENT

Perth
West Perth
0408 034 668

Melbourne
Niddrie
0428 315 502

Brisbane
Toowong
0419 477 715

Sydney
Belrose
0418 381 709

www.pcte.com.au

Intelli-Rock Maturity Measurement - Frequent Questions

Question 1: Maintenance

How do you change the batteries?

Answer:

Unscrew the back of the reader replace all 5 AA batteries.

Question 2: Calibration

Most instruments need to be calibrated before use. There is no method of doing this with the intelli-Rock

Answer:

The sensors do not need to be calibrated. intelli-Rock loggers are specified to be accurate to ± 1°C but the actual temperature sensor in the logger is accurate to ± 0.2°C range. The logger accuracy is specified to ± 1°C to give some tolerance and because the reader only displays to ±1°C. Thermocouples are typically very robust sensors, but the accuracy of thermocouples is terrible. Hence, very high precision thermistors are used in intelli-Rock.

Question 3: Extension cable type

On projects the length of cable required may vary significantly but I tend to buy a standard length of cable with my loggers. I know there are various lengths of cable available and that extension cables can be purchased but I might get stuck on a job and not have enough cable. Do I have to buy intelli-Rock extension cables?

Answer:

It is recommended that the intelli-Rock loggers with an appropriate cable length be purchased so that extension in the field is not required. From a quality assurance perspective this is the simplest means of ensuring integrity of the data. However, the cables can be extended with ANY wire. "Speaker" wire is probably the lowest cost option. Thermocouple wire is expensive and is not required as the temperature sensor is a thermistor.

If the wires are going to be extended in the field, then intelli-Rock wire extension kits are recommended. Special heat shrink tubing containing a waterproofing polymer ensures a watertight seal that bonds to the wire. If the splice will be outside of the concrete, this is not as critical. But if the splice will be inside of the concrete, then the seal must be absolutely watertight. Electrical tape is inadequate. The chemicals in concrete are quite harsh on most adhesives and the concrete paste is very conductive. This will short the wires out at the splice during the time that the concrete is 'wet'. Therefore, when a splice is made, the most dependable thing to do is:

1. Use intelli-Rock splice kit and heat shrink
2. Make the splice outside of the concrete if possible
3. Start the logger before the concrete is placed so the splice is dry
4. Once the concrete is placed, if the junction still shorts out, wait until the concrete dries. Communication usually comes back as the placement dries.

It is strongly recommended that appropriate length wires be ordered so they are not spliced. The reliability of unspliced wire is much better than spliced wire.

Question 4: Extension cable length

If I have to extend the wire what is the limit I can go to?

Answer:

The length of wire that can be used with intelliRock depends on a number of factors. This is because the conductive environment inside the concrete chokes high-speed electrical signals (even though there is not an actual electrical short). Since "coax" cable is not used, the electromagnetic field from the communication signal is not constrained inside the wires insulation (this is true with AC signals). Since the signal leaks from the wire, then the environment around the cable still affects the signal even though it is outside of the insulation. So… electrically conductive environments "choke" AC signals if they aren't in coaxial cables (that's the greatly abbreviated version of the answer).

What this means is that longer cables can be used if the bulk of the cable is outside of the concrete. In that case 60m cables have been used successfully. Even a 300m cable might work.

When the cable is in the concrete, the length is limited by the electrical properties of the concrete. There are some mix designs that will allow longer cables and some that choke the signals more than others. Exact guidelines cannot be given, but assume that 'low resistance' mixes choke the signal more.

Perth
West Perth
0408 034 668
Melbourne
Niddrie
0428 315 502
Brisbane
Toowong
0419 477 715
Sydney
Belrose
0418 381 709
www.pcte.com.au

Where long lengths of cable in the concrete are essential, e.g. pile plugs, place the loggers on the rebar cage before it is placed and start the loggers before the concrete is placed. The logger may appear to be dead after the concrete is poured, but usually the logger is fine, it just can't be communicated with until the concrete dries out.

Question 5: Battery Life

How long do the logger batteries last?

Answer:

The batteries life is unimpaired for 5years whilst the loggers are on the shelf i.e. before turning them on. Once turned on the battery will last for up to one year and the logger can be down loaded at any time during that time. However, the period of logging is limited by the storage capacity and measurement interval. Once the memory is full no further readings are possible although the battery lasts a considerably longer time.

Question 6: Relationship to Cylinder strength

Can the strength from Maturity be related to cylinder strength?

Answer:

Cylinder strengths can be derived in a number of ways; standard cured; match cured and site cured.

Standard cured cylinders do not exhibit the same temperature or moisture condition as insitu concrete and hence these are least likely to represent the insitu concrete strength. Depending on the insitu temperature and moisture contents standard cured cylinders may significantly over estimate or underestimate the insitu strength at any time in the curing history. As insitu concrete is likely to have a non-uniform temperature history and not have continuous water available and standard cured cylinders have excellent compaction and curing the standard cured cylinders are over estimate the insitu concrete strength. This is taken into account in design and should be considered when assessing the insitu strength of concrete structures.

Matched cured samples generally means that the samples are cured under the same temperature history as the insitu concrete. However, the concrete is sealed and may not have the same moisture history. It also does not have the same compaction and curing.

Site cured cylinders benefit form some of the heat of the insitu concrete but are unlikely to get the same degree of heat as concrete at the centre of a pour. These cylinders also have better compaction.

Question 7: High Strength Concrete

Is Maturity Testing Suitable for HSC?

Answer

The maturity: strength relationship is based on tests of concrete cylinders stored in water. Hence the concrete always has water available for hydration. Insitu, in high strength concrete (w/c<0.38), self-desiccation can occur at later ages (>7days). As water is consumed the hydration may be inhibited and maturity may overestimate the insitu strength. However, maturity is generally used for estimating early strengths.

Question 8: Datum Temperature

Do I have to measure the datum or can I assume a 0°C datum?

Answer

Maturity curves are shown in Figure 2 for 0°C and 5°C datums for the typical concrete and temperature data in figure 1. The 0°C curve might be the curve used in intelli-Rock if a datum is not known. The 5°C curve is what might be used in intelli-Rock if the datum temperature has been assessed from tests.

Fig 1 - Strength & Temperature Development

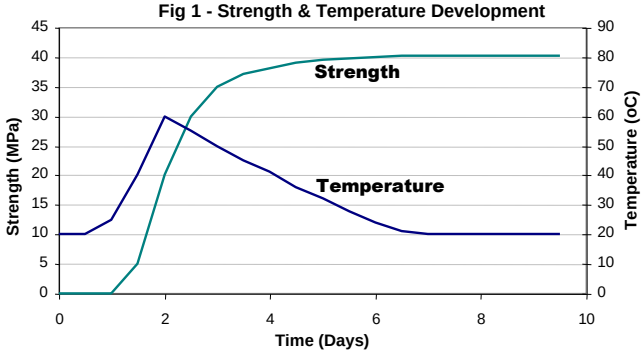
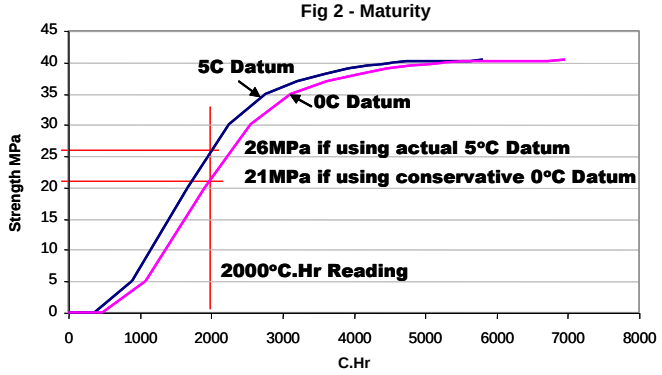


Fig 2 - Maturity



The strength predicted using the 0°C datum is 21 MPa compared to 26MPa using 5°C datum, i.e. the assumed 0°C datum gives a conservative strength assessment.

In this example if the stripping strength is 21MPa, using

Perth
West Perth
0408 034 668
Melbourne
Niddrie
0428 315 502
Brisbane
Toowong
0419 477 715
Sydney
Belrose
0418 381 709
www.pcte.com.au

the 5°C datum curve rather than the 0°C datum would have reduced the stripping time by approximately 0.5hrs.

Users need to assess if the gain in time using actual datums is worthwhile as use of 0°C datums is always conservative.

(NB concrete can not have a datum under 0°C)

Question 9: Reader Capabilities

How many loggers can be downloaded onto one reader?

Answer:
We limited the number to 1000 regardless of logger configuration. We did that just to make that question easy to answer.

Question 10: Rockware

How do you get Rockware working for non-Admin users with Windows 2000 Professional?

Answer:

1. Start with rockWare uninstalled
2. Logon as Administrator
3. Temporarily add the end user to the local Adminstrators group
4. Go to ControlPanel->Administrative Tools->Computer Management
5. Go to the folder Computer Management (Local)\System Tools\Local Users and Groups\Groups
6. Double-click on the Administrator's group and add the end user to it
7. Logon as the end user
8. Install rockWare from the CD
9. Connect a reader and turn it on in order for the USB drivers to be installed
10. Start rockWare with reader on and verify that the bottom-left hand corner indicates the reader is connected
11. Give all user full control of the C:\Program Files\rockWare\ folder. This is needed because the program saves user settings in a settings.xml file in this folder
12. Finally remove the end user from the local Administrators group

Question 11: Cost Benefit

How cost effective is it using intelli-rock instead of normal thermo couples for measuring temperature and maturity?

Answer:

To answer this, we must split up the process into calibration and construction costs.

Calibration:

Calibration costs are similar, however this assumes that the software for the system requiring the Datataker is readily available without purchase and is set up for the Maturity method. Software using the intelli-Rock system is free and updates are readily available on the Internet.

The process used for this simulation is as follows. Calibration requires 17 cylinders to be cast, probes are cast in two of them. Compressive testing is carried out on three cylinders at 5 time periods (ie 1day, 2day, etc). The compressive strengths of the cylinders are recorded with the corresponding Maturity recorded from the control cylinders.

Assuming all of the equipment is hired the process is 12% cheaper using the intelli-Rock system. The difference occurs because although the thermocouples are cheaper they cost more to set-up, and require an Engineer to wire them to a DT50. Also as the system is not specifically designed for Maturity, more Engineer hours are required to compute the results. A technician can easily carry out installation of the intelli-Rock equipment.

Construction:

This is where the real difference can be seen between the two Maturity methods. Here the cost using the Data taker system is 5.5 times more than using the intelli-Rock system. Again this assumes the software is readily available.

Firstly, the equipment using the Data taker is 3.5 times more expensive because of the protective box required as well as the data taker requiring to be on site at all times.

Next the cost of set up and commissioning is much more for the Data taker system as it would require an Engineer and a Technician 3 hours to set up the DT50 and programme it. This is compared with a Foreman tying the logger onto the reinforcing and leading the wire to the exit point. This would only take a matter of minutes.

Finally, computation of results using a Data taker and the CONAD software, would require several hours by an Engineer to upload information, then compute the

Perth
West Perth
0408 034 668
Melbourne
Niddrie
0428 315 502
Brisbane
Toowong
0419 477 715
Sydney
Belrose
0418 381 709
www.pcte.com.au

Maturity and then finally write a report outlining the process. Using the intelli-Rock system the process is much shorter. The reader takes the computed results from the probe. Uploading the probes data automatically returns a report highlighting the strength gain and the critical parts of construction (i.e. stripping).

Overall the intelli-Rock system used on an arbitrarily chosen 12 pours, would be more than 4 times more cost effective than trying to use Data takers.

All of this simulation is readily available as an Excel Spreadsheet on request.

Question 12: Reliability

What is the failure rate of intelli-Rock loggers?

Answer:

The loggers are highly reliable and that is another key advantage compared to use of thermocouples. The thermocouple failure rate can be as high as 20% depending on the quality of manufacture. With the quality assured intelli-Rock loggers the failure rate is less than 0.1%. Hence, to give the same level of reliability as one intelli-Rock logger it might be necessary to use four thermocouples at each location. In practice only one intelli-Rock logger is used at each location while two thermocouples are generally used and a low reliability is accepted. Thermocouple reliability increases if strict quality assurance procedures are followed but then the cost also increases.

Question 13: Reliability

What is the effect of temperature on intelli-Rock probes?

Answer:

As all of the processing happens inside the probe with the intelli-Rock system it is insulated from the external elements by the concrete. Additionally the robust nature of the probe and the omission of external wiring to logging equipment mean circuitry is better protected.

The same can't be said for thermocouple system when the logger box is left in sunlight. Remember, there is a cold junction compensation circuit in there along with other temperature sensitive electronics… that can lead to a lot of errors with thermocouple meters.

Question 14: Recalibration

In what circumstances would the mix require recalibration?

Answer:

The calibration of a mix of concrete must be carried out for each new mix. It is also recommended that if the mix is changed (i.e. changing accelerant concentration, more cement, new aggregate, more water etc) it should also be recalibrated. Ideally a mix calibration could also be carried out every month to ensure the mix is not changing over time and if any change has occurred it can be taken into account in the future. Additionally, prescribed validation cylinders are required to ensure the calibration is truly representative and the instructions in the handbook should be followed in this regard.

Question 15: Effect of retarder on intelli-Rock

How is the intelli-Rock system affected by retarded concrete?

Answer:

Heavily retarded concrete is of concern when using the intelli-Rock system. During calibration retarded concrete means that maturity recorded during the 'dormant stage' is redundant. The same can be said for the concrete during the construction stage. However, does the maturity recorded for the 'dormant stage' of the calibration correspond with the maturity recorded for the 'dormant stage' in-situ (i.e. construction)? Not necessarily. This is because the thermal histories will differ. A cylinder will sit at 20 degC during the dormant stage however the slab will stay at the ambient temperature and could fluctuate depending on how well it is insulated, giving differing amounts of redundant maturity.

How do we counter this? Well during calibration, we remove the redundant maturity by shifting the curve to the left. The redundant maturity can be seen as the maturity recorded before we get a temperature rise of 2 degC or more due to hydration beginning. During construction we wait until the same temperature rise of 2degC or more and then remove the maturity recorded before that. The maturity that we remove from the calibration curve and then from the construction maturity recorded will differ by a function of the differing thermal history.

Construction decisions should now be made with a revised maturity for the slab and the corrected calibration curve.