transient temperature change "watch out"

IGS Technical Note

AN ELEPHANT IN THE ROOM
CPT temperature instability

www.insitu.com.au

Mark Chapman
mark@insitu.com.au
0437-824-776

Michael (Mick) O'Rourke
mick@insitu.com.au
0407-467-025

Sergey Skrobotov
sergey@insitu.com.au
0407-467-065

Wyn Binmore
wyn@insitu.com.au
0417-423-769

Allan McConnell (founder)
allan@insitu.com.au
0417-748-669

high quality in situ testing

high quality sampling

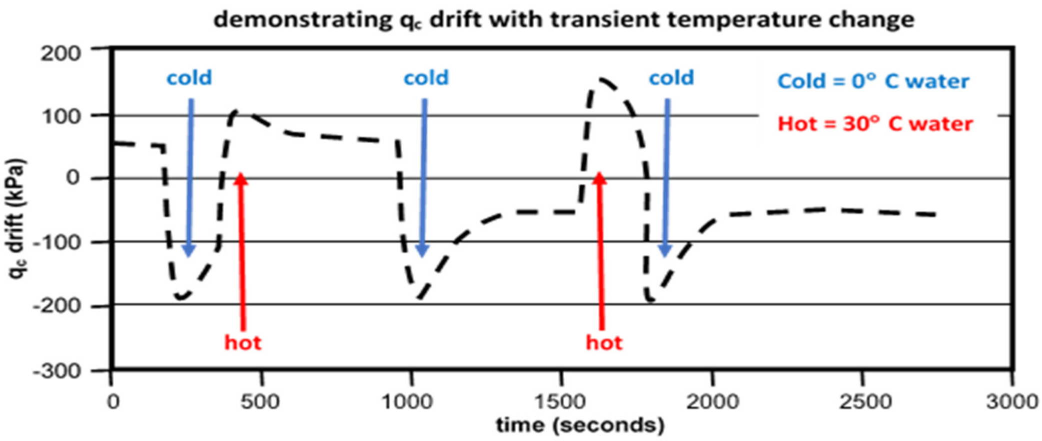
If a tester says "*trust me – my CPT cones are stable under temperature change*" - find another tester; they are either (a) unknowing or (b) being dishonest.

Modern high quality commercially available cones can be, and typically are, by design, stable at any given temperature – eg calibration at 20°, 40°, 60°, etc will all be pretty much the same. So it's possible for a manufacturer to claim their cones are "temperature compensated".

But no sensors in any cones are stable during any period of temperature change, eg while they are cooling from 30° to 20° or warming from 20° to 30° (or similar).

This sensor instability is typically very significant with (eg) q_c drift over a range 100-200kPa or more. So, if you're testing material with (eg) q_c around 300kPa then you might expect to obtain readings of as low as (say) 100kPa or as high as (say) 400kPa – huge % errors – unless dealt with. The problem is not only in q_c, but in all of the cone sensors.

The figure below demonstrates (from a calibration under the ISO 22476-1:2022 methodology, involving placing the cone into cold water then warm water under a predestined cycle). This shows q_c drift of up to 300kPa under temperature change of 30°C. All cone sensors act the same.

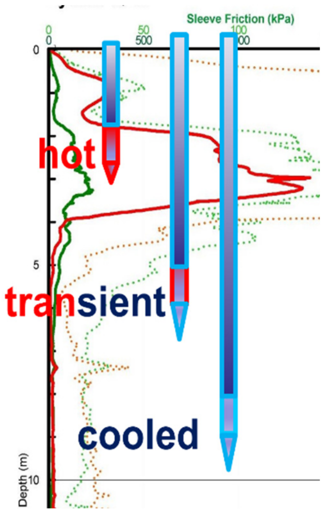


Why does this matter? On a "business-as-usual" basis, significant CPT cone temperature changes occur routinely:

a) always at the start of a test if ground temperature is different to the pre-push cone temperature, warmer or colder;

b) typically as the CPT is pushed through hard ground, especially dense sand, which heats it up markedly;

c) following (b) the CPT then enters softer stuff and starts to cool down.



This is a "big deal": push a CPT through preload sand or a TSF capping layer into soft stuff and this will happen. Unless dealt with during the test, transient temperature change can severely mess up CPT data in soft or very soft materials.

IGS (by default) manages this matter by controlling the CPT push process in real-time, consistent with measures outlined in ISO 22476-1:2022, to allow transient temperatures to stabilise.

reducing geotechnical uncertainty

Edition 23-08