Ultrasonic test application in geothermal heat exchangers and civil works to monitor the grout integrity (TUC)

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The working of a vertical geothermal probe, realized with a pipe U-tubes of high-density-polyethylene (HDPE) inserted in a grouted boreholes, is linked to the possibility to exchange heat with the surrounding soil. The concrete material useful for the borehole heat exchangers allows to satisfy a double purpose: sealing the polyethylene pipes from groundwater in the event of loss and increasing the thermal properties of the whole probe to provide a greater interaction with the underground. If this operation is not performed properly, the complete system may not satisfy the required heat demand, even with a well dimensioned installation, wasting the value of the entire carried out work.

This paper offers to a wide group of professional actors a possible ultrasonic method of a draft and economically sustainable investigation for the identification of defects that could be present in the cementation realized inside a geothermal probe, but also in the realization of sonic piles.

The instrument used for this type of test (TUC - Test Ultrasonic Cementation) has been designed and tested by the technicians of AG3, a Spin Off Company of Torino University, in collaboration with 3DM Electric and PASI companies, then subjected to patenting procedure (Patent Pending TO$_2$011A000036).

The main innovative feature of this approach has been the miniaturization of the equipment, able to investigate the geothermal probes with U-tubes with standard dimension (the maximum overall dimensions of the instruments detectors is 26 mm), maintaining a sampling rate appropriate to investigate the cementation and the early centimetres of the surrounding soil.

The processing of the recorded data was performed by a dedicated Matlab software.

In the first part of the article is presented the calibration process, that it was carried out through ad hoc creation of two situations likely to be investigated, while in the second part the paper reports the results obtained by the application of the TUC method to real case studies.