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Subsurface Views

Sensors & Software Inc.

Advanced analysis

Conquest Data in EKKO_Project

GPR systems by themselves do not solve our customers' problems. Analysis and interpretation of the GPR data provides the knowledge that ultimately drives decision making.

Recently introduced, EKKO_Project enables organizing, managing, editing, and viewing GPR data. Optional modules include data processing and interpretation. This analysis software provides tools to help users easily extract information from their GPR data. *(continued on page 2)*

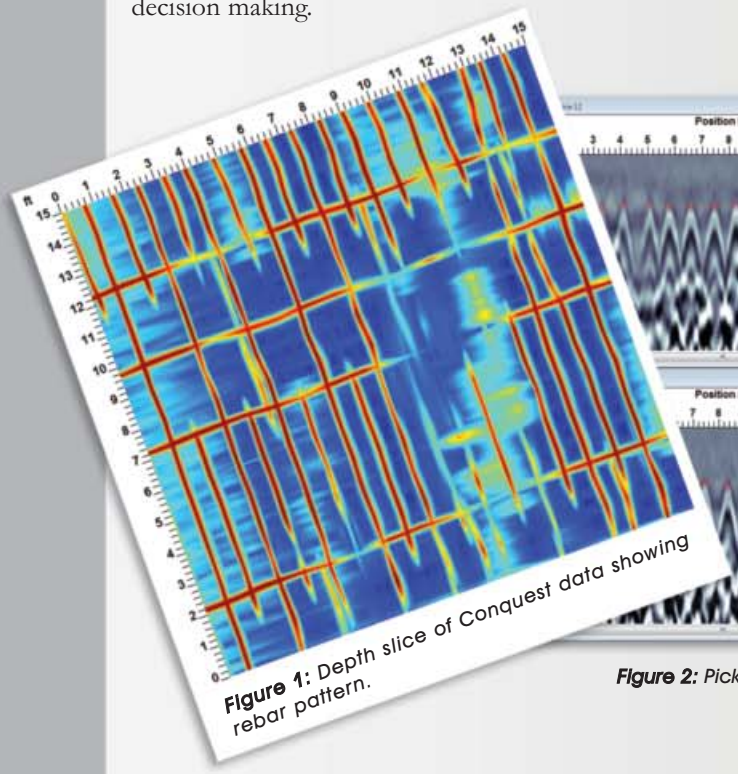


Figure 1: Depth slice of Conquest data showing rebar pattern.

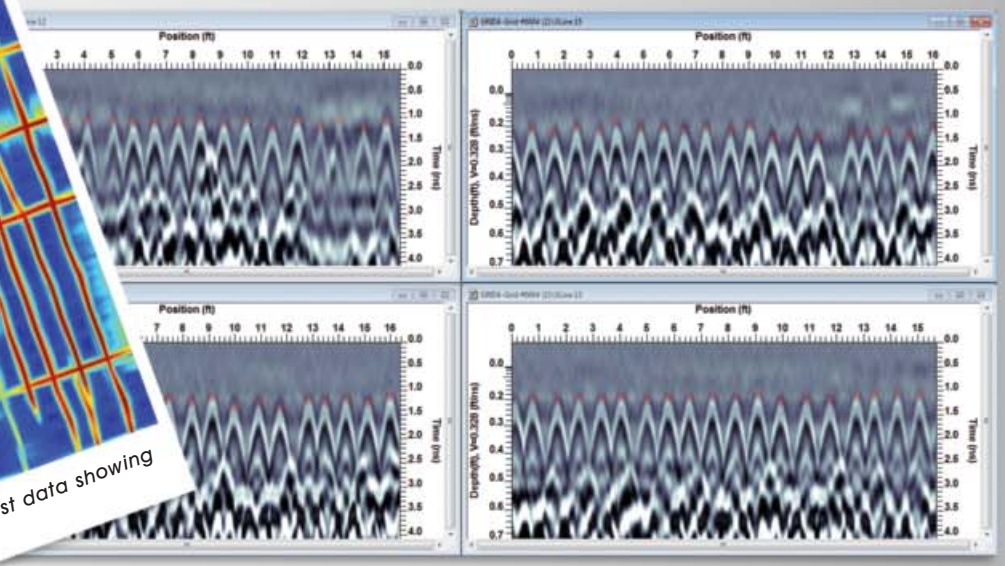


Figure 2: *Picking the tops of the rebar (+ signs) to extract information about depth and spacing.*

New Resources on www.sensoft.ca

Sensors & Software's website now includes a registration and login feature for customers or anyone interested in learning more about GPR. Basic training tutorials and our complete archive of newsletters, with more than 20 years of GPR history and technical tips, are available. Customers can access additional resources such as software downloads, system manuals, and advanced training videos.

Registered users will soon be able to access new hardware and software tutorials, the latest GPR articles, case studies, and much more.

Click Register on Sensors & Software's home page and enter the email address we normally contact you with. Once registered, go to the Resources menu to view the additional resources.

Let us know what you think. Are there other features that would improve your on-line GPR experience?

In this issue

Conquest Data in EKKO_Project

(continued from page 1)

The Processing module provides time and spatial filtering, migration, and enveloping to GPR data lines. The Interpretation module allows users to add points, polylines, boxes, and annotations to the data. Details of the interpretations added to one, two, or all the GPR survey lines in a project are easily output as reports.

EKKO_Project was recently used for a detailed analysis of a Conquest grid on a 15 x 15 foot section of concrete floor (Figure 1).

A time gain was first applied to the raw data. Using the point interpretation tool, the top of each rebar was picked (Figure 2).

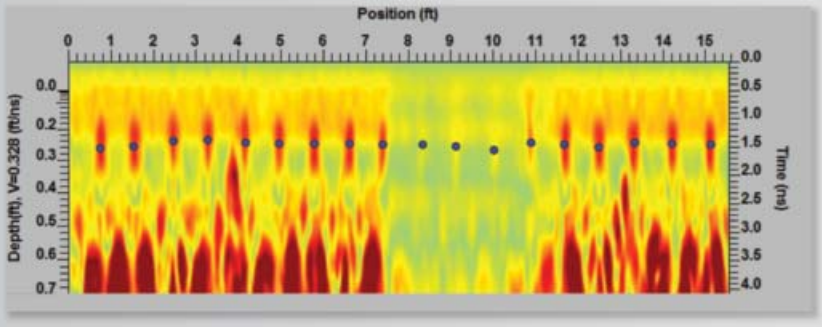


Figure 3: *Processed GPR lines displaying hyperbolic rebar responses. Peak amplitudes for each rebar were picked using the Point Interpretation tool (blue dots). Weaker amplitude rebar are visible from 7.5 to 10.5 feet.*

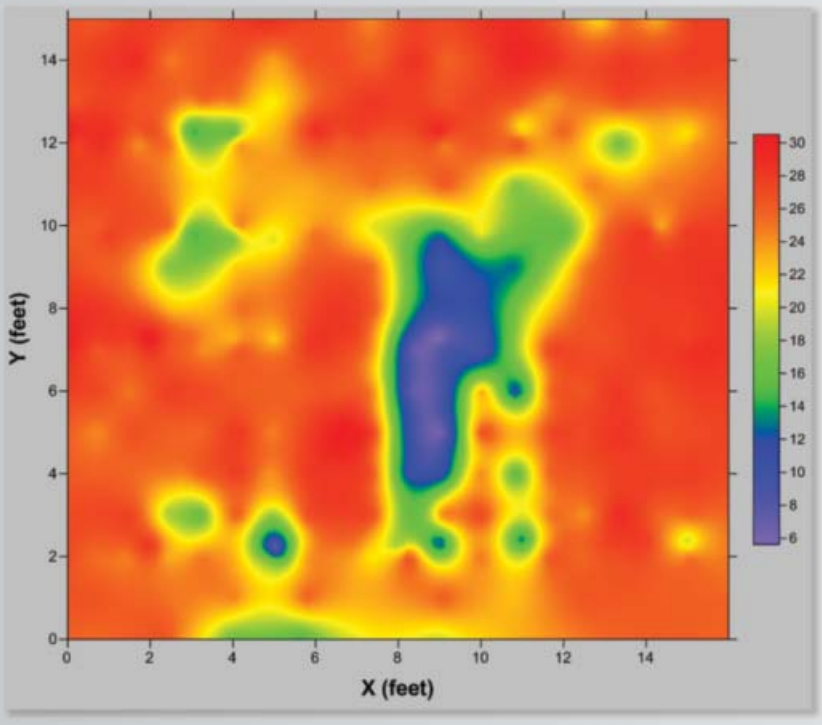


Figure 4: *GPR rebar image map displaying high amplitudes. High amplitudes are highlighted red and orange; low amplitudes are highlighted purple, blue, and green. Low amplitudes may indicate areas of rebar deterioration.*

Next, a report was generated listing, among other attributes, the rebar X and Y position in the grid and the depth of the picked rebar. Using the report, the following rebar information was quickly calculated:

Minimum depth	2.076 inches
Maximum depth	2.916 inches
Median depth	2.364 inches
Average depth	2.386 inches
Minimum Spacing	7.2 inches
Maximum Spacing	15.4 inches
Median Spacing	10.0 inches
Average Spacing	10.1 inches

GPR amplitudes provide information about the material properties in the survey area. They can also provide information about the attenuation of the material above a reflector; in this case the concrete above the rebar.

GPR amplitude is extracted from a hyperbola using the following operations from the Processing module:

- Dewow: a highpass time filter that removes low frequencies inherent in GPR data
- Migration: focuses the hyperbolic shape back to a point target
- Envelope: removes the oscillatory nature of the GPR signal (converts negative troughs and positive peaks to only positive peaks)

These processes focus the GPR energy back to a point at the location of the rebar and calculate the absolute amplitude.

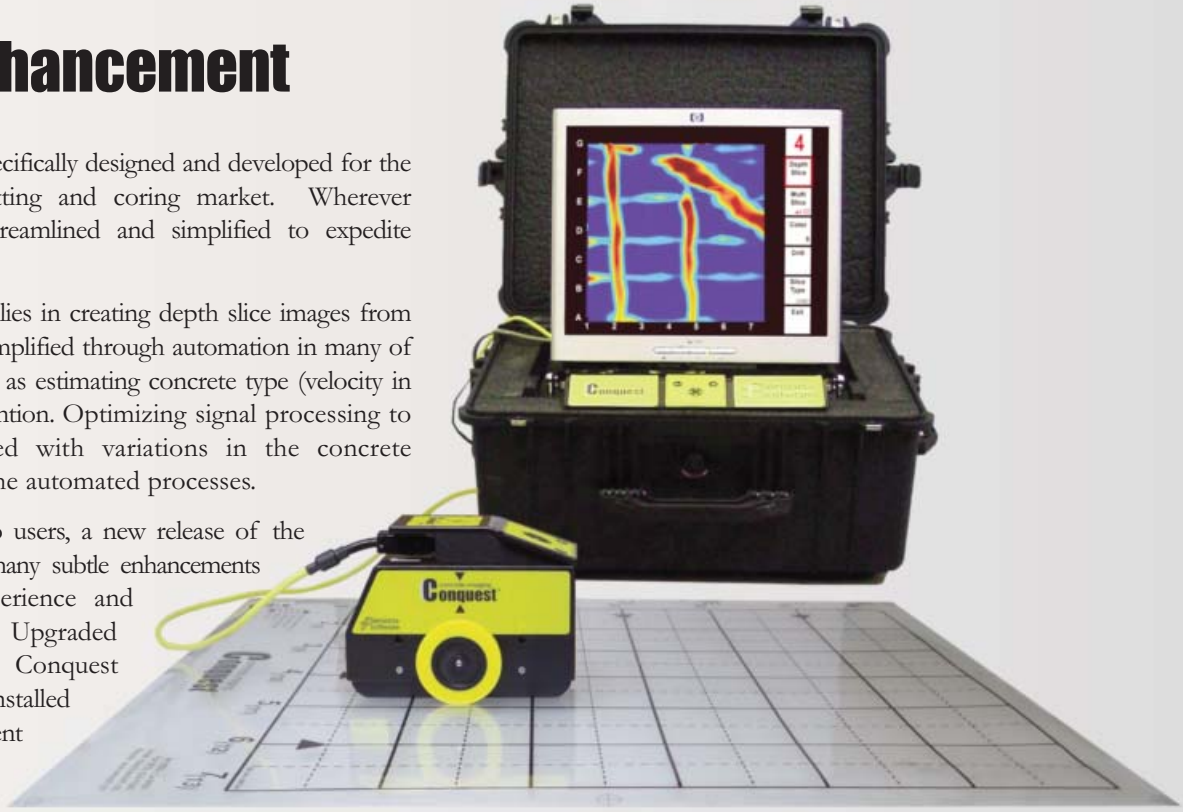
Using the Point Interpretation tool, the peak GPR amplitude for each rebar reflection in the grid was extracted from the data (Figure 3) and written to a report listing the X and Y positions and the amplitudes.

The amplitude information was then plotted as a contour map to display areas of low amplitude that may be associated with water infiltration into the concrete, and rebar deterioration (Figure 4). See Ask-the-Expert on page 3 for another use of amplitude information.

Such analysis goes well beyond locating rebar for cutting and coring. Valuable information about a structure enables civil engineers to make decisions about renovations, rehabilitation, and loading on a concrete slab.

Many of our customers are now using processing "recipes" and interpretations in EKKO_Project to add valuable knowledge to the products they supply to their clients. ■

Conquest Enhancement



Conquest is a GPR system specifically designed and developed for the concrete inspection and cutting and coring market. Wherever possible, the operation is streamlined and simplified to expedite effective use in the field.

Much of Conquest's strength lies in creating depth slice images from grids of data. Operation is simplified through automation in many of the image creation steps, such as estimating concrete type (velocity in concrete) with no user intervention. Optimizing signal processing to minimize changes associated with variations in the concrete environment has improved the automated processes.

While generally transparent to users, a new release of the embedded software provides many subtle enhancements that improve the user experience and accuracy of interpretations. Upgraded software is available for Conquest and Conquest SL and is installed by our Service Department as part of inspection and maintenance. ■

Ask-the-Expert

Can GPR determine rebar or pipe diameter?

This question arises regularly and the answer is generally no. GPR responses certainly contain information about the target diameter or width, but reliable extraction of this parameter is difficult.

In GPR jargon, diameter indications appear in two ways – the width of the hyperbolic response and the intensity (amplitude) of the response. The first characteristic is indistinguishable in normal GPR data when depth exceeds target width. The second characteristic, amplitude, is dependent on many variables other than diameter and is thus unreliable without further information.

Figure 1 shows the GPR response hyperbolas from some single 0.5" diameter rebars and a double rebar embedded in concrete. There is no visible indicator that the hyperbolic shape is any different to the adjacent rebar which are not augmented by the additional rebar, although the signal intensity is higher.

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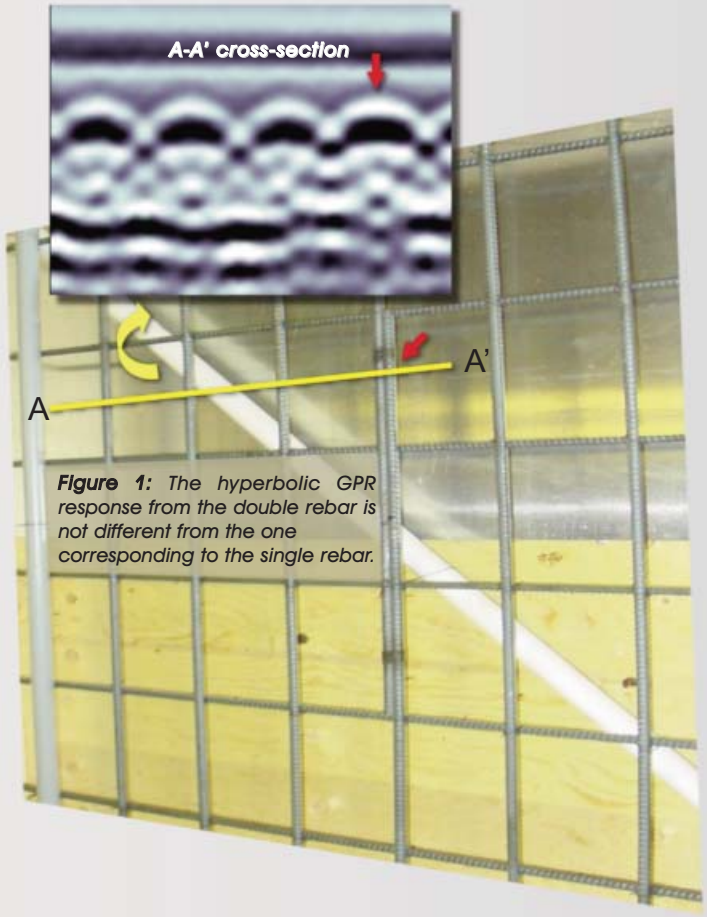

Figure 1: *The hyperbolic GPR response from the double rebar is not different from the one corresponding to the single rebar.*

Technical Papers & Notes

1. Pipe-flange detection with GPR;
   Journal of Geophysics and Engineering; IP Address: 66.252.158.210; Pg. 35-45; 2010
   By: N. Bonomo, M. de la Vega, P. Martinelli, A. Osella **ref 448**

2. Velocity of Electromagnetic Waves in Antarctic Ice;
   Antarctic Research Series; Vol. 16; Antarctic Snow and Ice Studies II; Pg. 199-208; 1971
   By: G. R. Jiracek, Charles R. Bently **ref 453**

3. Gross Errors in Height Indication from Pulsed Radar Altimeters Operating Over Thick Ice or Snow;
   Proceedings of the IRE; 1961 (Revised 1962)
   By: A. H. Waite (Senior Member, IRE), S. J. Schmidt (Member, IRE) **ref 454**

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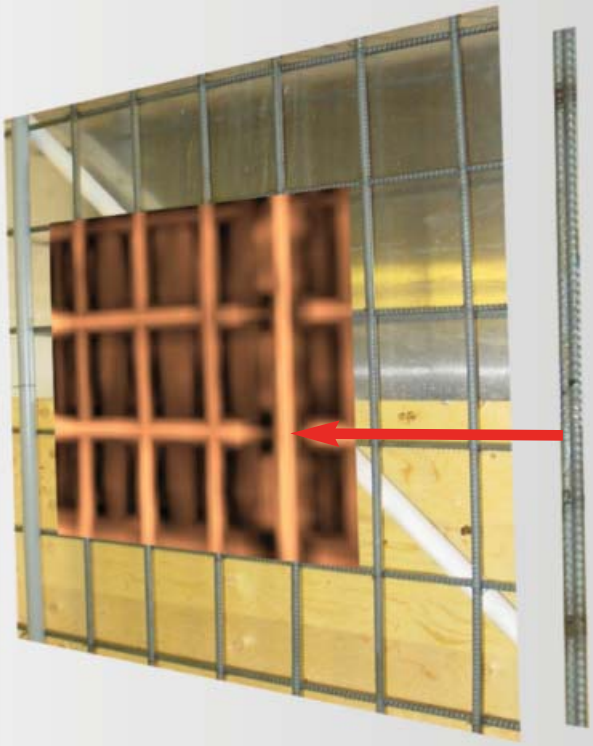
SAGEEP 2013
Denver, CO
March 17 - 20, 2013
www.eegs.org/AnnualMeetingSAGEEP/SAGEEP2013.aspx

Ask-the-Expert

(continued from page 3)

Figure 2 shows a depth slice image which displays response amplitude. The rebar augmented with the extra rebar has much higher amplitude when compared to the adjacent bars in the reinforcing mat. Given that the host material and bar depths are virtually identical, the change in amplitude is attributable to differences in the rebar character – in this case we have an effectively larger diameter bar. The target width is the combined width of the two rebars.



In summary, target diameter determination is not easily accomplished. Amplitude of signal is a strong indicator of differing target diameters, when all other variables such as depth, host material, and target composition do not change. ■

Figure 2: *The rebar augmented with the extra rebar has much higher amplitude when compared to the adjacent bars in the reinforcing mat.*