Introduction by John Dunnicliff, Editor

This is the seventy-third episode of GIN. Just one article this time. As you'll see below, I'm struggling to find contributors.

Field monitoring challenges

I've agreed with colleagues at Monir Precision Monitoring Inc., Mississauga, Ontario, a specialized monitoring contractor, to include in GIN a series of articles titled *Field Monitoring Challenges*. Here's the first one. Our purpose is to tell about challenges that occurred in the field, their resolutions and the lessons learned. Straightforward practical stuff!

Lessons learned. I need you

A significant number of articles in recent GINs have described new and emerging technologies. It's been exciting for me to learn about these, but I'd now like to take a step towards nuts-and-boltsy things, and lessons learned, primarily lessons learned from unexpected events in the field. All of us in this business have such stories to tell, and if we share them we can learn from each other. So – please – ask yourself whether you could contribute some of these stories for GIN. They don't need to be complex things, and you can refer to "Project X". I well understand that you may have difficulty with employer or client approval, in which case I'm happy to refer to you as "Anonymous", and promise not to disclose your name to anyone.

In the past, I've had very little response to pleas for contributions, and have usually had to rely on arm-twisting. **Please let me hear from you.**

Smile for the day

When I was checking out of a hotel recently, the receptionist had just put her phone down and was laughing. I asked her to share the joke. She said that the call was from a man in one of the rooms, asking how he could get out of his room. "I told him that there were two doors, one to the bathroom and one to go in and out of the room". He said, "But that one has a sign on the handle saying, *"Please Do Not Disturb"*.

The next continuing education course in Florida

This will be on April 7-9, 2013 at Cocoa Beach. If it's cold where you are, come and join us, and keep warm! Details are on www.conferences.dce.ufl.edu/geotech. Also see the announcement on page 27.

Closure

Please send contributions to this column, or an abstract of an article for GIN, to me as an e-mail attachment in MSWord, to *john@dunnicliff.eclipse.co.uk, or by mail: Little Leat, Whisselwell, Bovey Tracey, Devon TQ13 9LA, England. Tel. +44-1626-832919.*

Kippis (Finland)

Field monitoring challenges. Episode 1
Unforeseen piling details and damage to inclinometer casing

Marcelo Chuaqui and Wing Lam

Introduction

We have agreed with the editor of GIN to contribute a series of articles, titled *Field Monitoring Challenges*. In these articles we will describe situations where the recommended monitoring practices could not be performed, followed by the solutions to and consequences of these challenges. We present these from the perspective of a specialized monitoring contractor, believing that there is value in sharing our experiences and the lessons learned.

In an ideal world we all could execute perfect monitoring programs. We would be able to utilize a systematic approach to the planning and execution of each project. The process of systematically planning and executing a monitoring program is well understood and defined in texts such as Geotechnical Instrumentation for Monitoring Field Performance by John Dunnicliff.

However, real-world constraints force implementation of less than ideal monitoring programs. Practical constraints include short schedules, limited budgets, no easy access to areas, damage to equipment or instrumentation, lack of understanding of roles and responsibilities, unexpected changes, and conflicting priorities/goals/experience amongst project stakeholders.

In such cases we need to evaluate the situation and adapt the monitoring program in order to achieve its objective of providing vital information. We have to remember that the monitoring data is of importance for monitoring the performance of a design or structure, to verify assumptions and mitigate risk, as well as the safety of all those involved in the construction.

Challenge 1 – Unforeseen piling details

At a high-rise condominium project in downtown Toronto, the monitoring plan included inclinometer casings attached to piles, and targets on the piles for monitoring movement of the shoring wall. These reflective targets are typically placed at the top of each pile for monitoring of horizontal and vertical movement of the shoring and are surveyed with an accuracy of ± 2mm. A typical site can have 100 to 300 piles. While there is expected

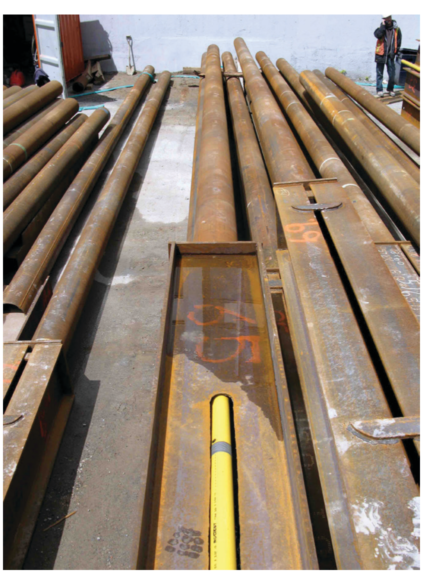

Figure 1. Lower section of pile with inclinometer casing transition to pipe pile.

movement of the wall, neighbouring buildings and structures are not expected to experience movement. The plan also included precision targets using prisms or reflective targets that are placed on the structures, usually along the perimeter of the walls and in far fewer numbers than the targets on the piles, and are surveyed with an accuracy of ± 1mm. In addition, five extensometers were installed in sensitive areas to measure horizontal wall movements and an array of electrolevels was placed along joints in the adjacent underground subway transit to monitor horizontal and vertical differential movements between tunnel segments.

Our typical installation detail for monitoring of shoring excavations involves attaching the inclinometer casings to the piles. The inclinometers were to be installed in eight locations and ranged from approximately 76 to 110 feet in length. However, due to their extreme depths, the piles for the shoring wall were not the typical wide flange I-beams used in local construction. Instead, two of the wide flange beams were welded together along their length and a pipe pile was welded to the bottom to extend the overall lengths. Due to space, budget and schedule constraints switching to drilled inclinometers was not practicable, and we needed to work with the shoring contractor to achieve an atypical method of attaching the inclinometer casings.

An installation method was devised to run the casing along the outside of the double pile at the upper end. A long notch was cut out of the middle of the pile nearing the transition to the pipe pile at the bottom. The inclinometer would be slightly curved to run down into the notch and into the centre of the pipe pile below, shown in Figure 1.

To avoid excessive movement in the pipe pile section that would affect readings, centralizers were positioned along the length of the casing as seen in Figure 2. Figure 3 shows a custom-made base, consisting of a metal tube (which would contain the bottom of the inclinometer casing) welded to a flat plate, which was in turn welded to the edge of the bottom of the pipe pile to prevent any downward movement of the inclinometer casing.

With the successful installation of the inclinometer casing, readings proceeded as the shoring wall was installed and excavation progressed.

Challenge 2 – Damage to inclinometer casing

A problem arose when during the installation of a tieback, the drill rig hit an installed inclinometer casing. Fortunately, the site personnel contacted our staff to notify us of the situation. If the tieback installation had continued, the inclinometer casing would have been filled with grout.

To salvage the inclinometer and the vital information it provided, staff developed a plan to thread a smaller diameter casing into the damaged casing. The annulus between the larger and smaller casing was grouted to prevent movement and anomalous readings. This remedy was successful and inclinometer readings were continued.

Lessons Learned

In this brief case history, the installation of the inclinometer casing was atypical and the execution was a challenge. There was also unforeseen damage to one of the inclinometer cas-

Figure 2. Centralizers in pipe pile section.

Figure 3. Custom welded inclinometer base.

ings in the midst of construction and the monitoring program.

Lesson learned 1: Work with clients, owners and contractors that value the benefits obtained from the monitoring.

With respect to the unforeseen pile details, a good relationship with the shoring contractor (Anchor Shoring & Caissons Ltd) was vital in permitting a practicable solution to be achieved. Flexibility was essential to adapt to the challenge presented as we worked together with good communication towards a solution.

It is our experience that this type of challenge can be addressed when the parties all understand the value of the monitoring. It is therefore important that those who do understand the value do all that they can to convince others.

Lesson learned 2: Have redundancy in the monitoring program.

When planning a monitoring program it is important to have back-up or build redundancy into the system. Inclinometers and targets on the piles utilize different methods to provide horizontal displacement data that can be correlated.

In this case, if the damaged inclinometer casing could not have been recovered, the targets on the piles were available as an alternative means of measuring movement of the shoring wall. In other instances, a string of targets on the piles have been added vertically to the face of the piles as a substitute for an inclinometer casing, although these alternatives would not provide data for sub- surface movements.

Marcelo Chuaqui, General Manager
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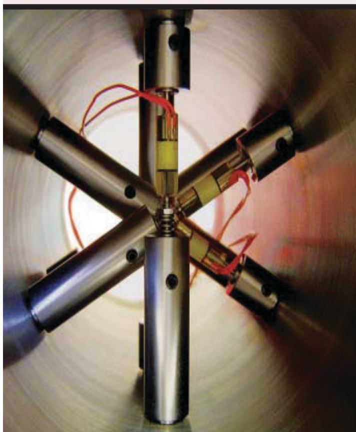

The University of Florida

Geotechnical Instrumentation (GI) for Field Measurements

April 7-9, 2013

Doubletree Hotel • Cocoa Beach, Florida

Course Director: John Dunnicliff, Consulting Engineer

COURSE EMPHASIS: is on why and how to use GI to monitor field performance. The course will include planning monitoring programs, hardware and software, recent developments such as web-based and wireless monitoring, remote methods for monitoring deformation, case histories, and lessons learned. Online sources will be included, together with an open forum for questions and discussion.

AUDIENCE: engineers, geologists and technicians who are involved with performance monitoring of geotechnical features of civil engineering projects and project managers and other decision-makers who are concerned with management of RISK during construction.

OBJECTIVE: to learn the who, why, and how of successful geotechnical monitoring while networking and sharing best practices with others in the GI community.

INSTRUCTION: provided by leaders of the GI community, respresenting both users and manufacturers:

Marcelo Chuaqui, Monir Precision Monitoring
Loic Galisson, SolData Group
Pierre Gouvin, GEO-Instruments
Aaron Grosser, Barr Engineering
Daniele Inaudi, Roctest/Smartec
Allen Marr, Geocomp
Paolo Mazzanti, NHAZCA
Justin Nettle, Federal Energy Regulatory Commission
Tony Simmonds, Geokon
Rodolfo Saavedra, DG-Slope Indicator
Robert Taylor, RST Instruments

For full details visit:

www.conferences.dce.ufl.edu/geotech