Geotechnical Instrumentation NEWS

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John Dunnicliff

Introduction

This is the thirty-ninth episode of GIN. There's one article about instrumentation this time, and one book review.

Would US readers please read page 10 for a forewarning about direct subscriptions to BiTech Publishers for Geotechnical News after the December 2004 issue?

Do You Want GIN to Continue?

The next episode of GIN will be the tenth anniversary episode. **If you want more, I need you.** Most of the articles in GIN have been the result of arm-twisting of colleagues, and very few have been submitted spontaneously. My reservoir of possible future articles is running low, as is my list of colleagues with healthy arms. So – if you welcome GIN, please stop being passive, and send me stuff. Guidelines for articles are on www.bitech.ca. The first step is to send me a 200- to 300-word (no more) abstract in MSWord, so that we can agree on basic content.

Test Your Knowledge

The instrumentation article that follows this column is a multiple-choice quiz by Allen Marr and Barry Christopher. If you hot shots out there find it easy, try others in your office. "Have a go", as they say on this side of the pond!

Laurits Bjerrum

The March 2004 episode of GIN included a lecture given in 1965 at Loyola College in Baltimore by Laurits Bjerrum, the first Director of the Norwegian Geotechnical Institute (NGI). The lecture, titled *"On Being a Civil Engineer",* is in a recently published book *"Laurits Bjerrum – more than an engineer"*, edited by Kaare Flaate, Elmo DiBiagio and Kåre Senneset. In my March column I suggested that your spouse might read the lecture - it illustrates so very well the wisdom and communication skills of Bjerrum, and is understandable by non-engineers.

A review of the book, by Ralph Peck, follows the quiz. Enquiries about availability of the book should be addressed to Wenche Enersen at NGI, we@ngi.no.

Sir Alec Skempton

I appreciate that this topic doesn't belong under the GIN umbrella, but I wanted to share it with you. A biography of Alec Skempton, by his daughter Judith Niechcial, has just been published by Whittles Publishing, ISBN 1-870325-84-2. The title is *"A Particle of Clay. The Biography of Alec Skempton, Civil Engineer"*. The following is from the publisher's flyer (at the time of going to press, my copy of the book is on order, so I can't write my own views):

> *One of the most eminent engineers of the 20th century, both on the national and international stage, Professor Sir Alec Skempton was truly an influential figure in the discipline of soil mechanics. In the late 1940s he was instrumental in developing the subject, and formed the first university department of soil mechanics at Imperial College, London. Over the years the research, papers and books flowed, as did the accolades and recognition. But this is not a book about soil mechanics alone - it relates much more, about the man and how he really viewed life, how he approached challenges and how he would be content only with a job well done.*
>
> *Skempton combined his skills as an engineer advising on immense international projects with his university teaching and research for which he was known the world over. But in addition, he was a world-renowned engineering historian, an accomplished musician - a veritable polymath.*
>
> *Written by his daughter, the book illustrates Skem's contribution to engineering knowledge, what influences formed him, and how his ideas developed - it reveals the private man behind the public image and in so doing it also sets in context a dynamic age in engineering.*
>
> *This book will be appreciated by many people as an insight into the mind and work of a great man. It will be immensely interesting to civil and geotechnical engineers, engineering geologists and applied scientists in related disciplines; engineering historians and those with a fascination for biographies of significant figures of the 20th century.*

Next Instrumentation Courses

Two are planned. The first will be in Delft, The Netherlands on November 2 thru 5, 2004 *(www.geodelftacademy.nl/nl/page161.asp).* The second will be in Clearwater, Florida on March 14 thru 17, 2005 *(www.doce-conferences.ufl.edu/geotech/).*

Closure

Please send contributions to this column, or an article for GIN, to me as an e-mail attachment in MSWord, to *johndunnicliff@attglobal.net, or by fax or mail: Little Leat, Whisselwell, Bovey Tracey, Devon TQ13 9LA, England. Tel. and fax +44-1626-832919.*

Kanpai! (Japan). Thanks for this to my attorney client, Michael Turner, at a sushi bar in Orange County, California.

Test Your Knowledge of Geotechnical Instrumentation

W. Allen Marr
Barry Christopher

We have had the opportunity to teach the US Federal Highway Administration Geotechnical Instrumentation course to State Departments of Transportation for several years – the course and the associated 240-page manual were originally developed by John Dunnicliff. Over that time we have developed a list of questions that are intended to help people apply their knowledge of geotechnical instrumentation. John obtained a copy of our questions and encouraged us to prepare something similar for GIN. Thanks to his urging and patience, we have developed those provided below.

We think it would be interesting to evaluate the answers of the geotechnical community to these questions. To take the test, go online at www.geocomp.com/GINquestions or if you prefer, circle your answers on a copy of this article and fax to the first author at (978) 635-0266, with your comments attached. It is not necessary to disclose your name. We will compile the results and prepare a discussion of the answers in a subsequent episode of GIN. Also if you have other good questions, send them to wam@geocomp.com and if there is sufficient interest, we will prepare a second version.

Please note that some questions have multiple answers and some may have no correct answer.

1. The best approach to obtaining high quality results from an instrumentation program is to:

(A) Bid instrumentation work as part of general contract
(B) Make instrumentation the responsibility of the owner
(C) Make the party with the most vested interest in a successful outcome responsible for the instrumentation
(D) Bid instrumentation to firms specializing in instrumentation
(E) None of the above

2. What is the primary hindrance to more use of geotechnical instrumentation?

(A) Cost of hardware
(B) Cost of personnel
(C) Poor definition of the benefits of effective instrumentation
(D) Not enough time is available
(E) None of the above

3. What are valid reasons to use geotechnical instrumentation?

(A) Avoid surprises during construction
(B) Control construction
(C) Answer questions about geotechnical performance
(D) Avoid damage to adjacent structures
(E) Monitor contractor's means and methods

4. What is the recommended approach to obtain an effective geotechnical instrumentation program?

(A) Design by committee
(B) Delegate to staff engineers
(C) Hire an instrumentation expert
(D) Use a step-by-step systematic process
(E) None of the above

5. Which measurement is most useful for monitoring a cut slope in fractured rock?

(A) Temperature
(B) Rainfall
(C) Horizontal deformation
(D) Strain
(E) None of the above

6. Which one of the following is an advantage of an open standpipe piezometer?

(A) Reliability
(B) Long time lag
(C) Porous filter can plug
(D) Gives reading in digital form
(E) None of the above

7. Which one of the following is an advantage of a vibrating wire piezometer?

(A) Short time lag
(B) Sensor is stable over long times
(C) Lead wires don't affect the reading
(D) All of the above
(E) None of the above

8. Which of the following is used to measure deformation?

(A) Tiltmeter
(B) Inclinometer
(C) Extensometer
(D) Liquid level gage
(E) All of the above

9. Crack gages

(A) Show where a crack might occur
(B) Point to the local drug dealer
(C) Are not expensive
(D) Are difficult to install
(E) None of the above

10. Settlement platforms

(A) Should be placed on top of the fill after construction is complete
(B) Should be placed on a cushion layer of dry bentonite to avoid overstressing the plate
(C) Should not exceed 6 inches in size
(D) May require extensions to be added during construction
(E) None of the above

11. Earth pressure cells

(A) Should be very stiff so they can survive installation
(B) Should be used on every earthfill job to measure how much fill is placed
(C) Should be placed in a bed of bentonite to obtain uniform stresses
(D) Are affected by temperature changes
(E) None of the above

12. Load in a tieback is best measured with

(A) A load cell with a center hole
(B) A strain gage welded onto one of the strands of the tie back
(C) A hydraulic jack with a pressure gage
(D) A proving ring
(E) None of the above

13. The load at the tip of a pile can be measured most easily and reliably with

(A) Four strain gages located in the bottom one foot of the pile
(B) An Osterberg load cell
(C) A dynamic load test
(D) The number of blows required to drive the last inch of the pile
(E) None of the above

14. Strain gages are used

(A) In load cells
(B) In pressure transducers
(C) To measure bending in steel sheeting
(D) To measure changes in distance
(E) All of the above

15. Geotechnical instrumentation is used for construction of fills on soft ground to

(A) Measure rate of settlement
(B) Measure pore pressure in the soft ground
(C) Determine when it is safe to add more fill
(D) All of the above
(E) None of the above

16. Specifications for instrumentation hardware and software

(A) Should be obtained from the instrument manufacturers
(B) Aren't necessary because the equipment are all standard products
(C) Are available from various organizations, such as CSSI
(D) Should be prepared for each project
(E) None of the above

17. At most sites, groundwater

(A) Does not exist
(B) Is in a static state

(C) Is experiencing flow
(D) Can be determined from borehole measurements
(E) None of the above

18. For mechanically stabilized earth walls (MSEW)

(A) Instrumentation is never used because it is too expensive for this application
(B) May be used to measure load in the reinforcement
(C) Is installed after construction of the wall to avoid being damaged by the contractor
(D) Is not used because MSW structures are designed to not move
(E) None of the above

19. Which of the following instruments are used to measure loads in struts to support a deep excavation?

(A) Proving rings
(B) Strain gauges
(C) Pressure transducers
(D) Accelerometers
(E) None of the above

20. A reading on an instrument that differs significantly from the previous reading

(A) Is a warning that failure may soon occur
(B) Is not possible because all changes in geotechnical instrumentation are slow
(C) Should be confirmed by re-reading the instrument immediately
(D) Is definitely wrong and should be ignored
(E) None of the above

21. Which of the following steps are necessary for instruments obtained from a reliable manufacturer?

(A) Pre-installation acceptance tests
(B) Calibration check
(C) Establish purpose of the instrument
(D) Maintenance
(E) All of the above

22. Which of the following can cause significant errors in data from geotechnical instruments?

(A) Surveying error
(B) Temperature changes
(C) Atmospheric pressure changes
(D) Human error
(E) None of the above

23 Which of the following may affect modern electronic sensors?

(A) Temperature
(B) Moisture
(C) Lightning
(D) Vibrations
(E) None of the above

24 Piles may be instrumented to

(A) Determine the load capacity of the pile
(B) Determine if the pile material is overstressed by driving
(C) Determine when driving of the pile can be stopped
(D) All of the above
(E) None of the above

25. Geotechnical instrumentation can be used to

(A) Answer questions that come up during design
(B) Reduce claims
(C) Reduce risk
(D) All of the above
(E) None of the above

26. Which one of the following is a disadvantage when using a vibrating wire strain gage to measure strains in a geosynthetics?

(A) Allowable range of strain measurements
(B) Interference from gage-soil interaction
(C) Strain compatibility between gage and geosynthetic material
(D) All of the above
(E) None of the above

27. Which one of the following characteristics is the most important for selecting an instrument?

(A) Accuracy
(B) Reliability
(C) Size
(D) Manufacturer
(E) Price

28. Which statement is true?

(A) All instruments should usually be read manually to reduce the possibility of errors
(B) Instrumentation data are always reported in tabular form to provide the most precision.
(C) A warning alarm should be issued as soon as a high reading is recorded.
(D) A significantly different reading can be ignored until the next scheduled reading.
(E) None of the above

29. Which of the following are potential benefits that can be obtained from effective geotechnical instrumentation?

(A) Reduce delays
(B) Prevent surprises from unexpected ground behavior
(C) Improve labor relations
(D) Save money
(E) None of the above

30. The demand for geotechnical instrumentation

(A) Is increasing because it is required on all projects funded by the government
(B) Is decreasing because geotechnical engineers are much better than they used to be
(C) Is decreasing because quality control of construction is much better than it used to be
(D) Is increasing because modern electronics have made it very cheap to install the instruments
(E) None of the above

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BOOK REVIEWS

Book Review: Laurits Bjerrum - More Than an Engineer

by editors Kaare Flaate, Elmo DiBiagio and Kåre Senneset

Review by Ralph B. Peck

Soil Mechanics became recognized as a discipline when, after the publication of Erdbaumechanik in 1925, Terzaghi was invited to MIT in the hope that he could explain the unexpectedly large settlements of its new engineering building. By the time of the First International Conference, at Harvard in 1936, both the teaching and practice of soil mechanics had become widespread; at the Second International Conference in Rotterdam in 1948 there were major centers of activity worldwide; at the Third Conference in Zurich in 1954, it became known that a young Dane by the name of Laurits Bjerrum had been selected to become the head of the new Norwegian Geotechnical Institute, although he had not yet quite completed his doctoral studies at the Swiss Federal Institute.

This book is the story of how Bjerrum developed the fledgling Norwegian Geotechnical Institute into the leading center of geotechnical research and practice, as well as a training ground for geotechnical workers worldwide. He accomplished this feat, in an unfortunately short lifetime, by a remarkable combination of technical skill, understanding of human nature, and human qualities that led NGI to its preeminence in the geotechnical world. How he did this is the subject of this book, a collection of writings by many of his colleagues, associates, family and friends.

The three "editors" contributed portions of the book themselves, but they also requested contributions from members of his family, friends and co-workers. These contributions, artfully interwoven with writings and lectures by Bjerrum himself, present a convincing picture of the man, his impact on geotechnics, his method of working, and the organization he created.

Laurits was a family man. This reviewer remembers well that the first action Laurits would take on arriving at his hotel or his quarters at a jobsite was to unpack and set up photographs of his wife, Gudrun, and their children. It is not surprising, therefore, that the contributions to the volume by his wife, their son and their daughters are the most enlightening stage for all that follows. They convey the sense of excitement that Laurits engendered in whatever activity he participated.

Laurits and Gudrun Bjerrum in September 1965 at the fall convention of Loyola College in Baltimore, Maryland, when Laurits was awarded an honorary degree from Loyola

After finding brief descriptions of Laurits' education and early experience with a civil engineering consulting firm, and after noting his research studies in soil mechanics at the Swiss Federal Institute, the reader finds Laurits as the head of the new Norwegian Geotechnical Institute, and the book becomes a revealing series of accounts of how Laurits crafted a superb organization, working as a family that welded laboratory research and measurement of field behavior into powerful means of solving geotechnical problems. This required the development of new equipment, making studies in the field for such novel projects as offshore drilling and oil production in the North Sea, understanding and mitigating quick-clay slides and meeting a variety of similar challenges. The staff of the Institute became a group of experts converging on some elusive but vital objectives, educating each other and the geotechnical fraternity as well.

Such breadth of interest engendered broad expertise. Laurits believed in sharing this knowledge and he did so by inviting many ''NGI Fellows" to participate in projects at the Institute for several months or years and then return to their parent organizations as practitioners or educators.

Readers will find accounts by many engineers and others who became part of NGI's extended family - a group of productive and renowned educators and practitioners worldwide. They will also be introduced to unique managerial skills and approaches to solving problems. They will discover that, in Laurits Bjerrum, NGI and the entire engineering profession had the good fortune to benefit from a remarkable leader.

This book is an insightful and revealing picture of Laurits and his accomplishments. It rings true in many, if not most respects. Yet, to this reviewer, it curiously overlooks at least one important vital connection - his interaction with Alec W. Skempton and Imperial College. Certainly, on many occasions when this reviewer met with Laurits, either at Illinois or on a project, Laurits had passed through London on the way and he described with enthusiasm his discussions with Skempton and his associates. Skempton disliked travel, and to hold discussions Laurits usually had to visit London, there was undoubtedly vigorous give-and-take between the two. Strangely, only the contribution to the book by Gudrun notes the I.C. connection. In the same vein, the very interesting and thorough section on "The researcher - highlights of a career", while factually of great interest, may leave the impression that all the advances described were attributable to NGI, whereas most were the results of work at many organizations, among which NGI was an active, and sometimes major contributor.

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