Administrative Report: TC 40 – Forensic Geotechnical Engineering

Rapport administratif : Comité technique 40 - Technologie géotechnique légale

Dr. V. V. S. Rao
Chair

Dr. (Prof) G. L. Sivakumar Babu
Secretary

ABSTRACT

Forensic geotechnical engineering involves scientific and legalistic investigations and deductions to detect the causes as well as the process of distress in a structure, which are attributed to geotechnical origin. Cases of remedied installations where the analysis and evaluation of adopted remedial measures with regard to their effectiveness and economy may be subjected to judicial scrutiny also fall under this purview. The normally adopted standard procedures of testing, analysis, design and construction are not adequate for the forensic analysis in majority of cases. The test parameters and design assumptions will have to be representative of the actual conditions encountered at site. The forensic geotechnical engineer (who is different than the expert witness) should be able to justify the selection of these parameters in a court of law. Hence he has to be not only thorough in his field of specialization, but should also be familiar with legal procedures.

RÉSUMÉ

La technologie géotechnique légale implique des investigations et des déductions scientifiques et juridiques de détecter les causes comme le processus de la détresse dans une structure, qui sont attribuées à l'origine géotechnique. Les cas des installations remédiées à où l'analyse et l'évaluation des mesures réparatrices adoptées en ce qui concerne leur efficacité et économie peuvent être soumises à l'examen minutieux juridique également tombent sous cette portée. Les procédures standard normalement adoptées de l'essai, de l'analyse, de la conception et de la construction ne sont pas proportionnées pour l'analyse légale dans la majorité de cas. Les paramètres d'essai et les prétentions de conception devront être représentant des conditions réelles produites à l'emplacement. L'ingénieur géotechnique légal (qui est différent que le témoin expert) devrait pouvoir justifier le choix de ces paramètres dans une cour de loi. Par conséquent il doit être non seulement complet dans son domaine de spécialisation, mais devrait également être au courant des procédures légales.

1 BACKGROUND

In order to develop this subject, Prof. Pedro Seco e.Pinto, President, ISSMGE established during February 2006 a Technical Committee on Forensic Geotechnical Engineering. The committee consisted of the following members:

Chair: Dr.V.V.S.Rao
Coremembers: Prof. Yoshi Iwasaki, Japan,
Dr. Richard Hwang, Moh & Associates, Taiwan,
Mr. David Starr, Golder Associates, Australia,
Prof. K.K. Phoon, Singapore,
Mr. P.W. Day, South Africa
Prof. J. Mesci, Hungary,
Dr. Jan Hellings, U.K.,
Mr. D.S. Saxena, USA.

Subsequently, Prof. Sivakumar Babu, India was co-opted as Secretary. A number of member societies nominated their representatives on the committee as General members.

2 TERMS OF REFERENCE AND SCOPE OF ACTIVITIES

The committee agreed to prepare a book on the Forensic Geotechnical Engineering (FGE) as its main task. It was decided to have seven chapters in the book. Each core member chose to form a subcommittee to draft one chapter. Accordingly, the titles of the chapters and the conveners of the committee were formed as:

SC 1: Characterization of distress. Convener: Mr. P.W. Day
SC2: Diagnostic Tests. Convener: Mr. David Starr
SC 3: Back Analysis. Convener: Dr. Richard Hwang
SC 4: Instrumentation. Convener: Prof. Yoshi Iwasaki
SC 5: Development of failure hypothesis: Convener: Dr. J.Hellings
SC 6: Reliability Checks. Convener: Prof. K.K.Phoon
SC 7: Legal Issues: Convener: Mr. D.S.Saxena

During Feb.2009, Prof. Mihail Popescu took as the convener of SC3 as Dr. Hwang withdrew due to health problems.

3 COMMUNICATION AND INFORMATION EXCHANGE

Each convener formed a subcommittee by inducting interested members. These members are designated as Corresponding Members. The complete composition of TC40 is given in Annex.1.

A one day discussion session was organized in Singapore on 30th May 2006 by Prof. K. K. Phoon. The conveners of the subcommittees attended the session. Technical content to be considered by each subcommittee was discussed and a overall format of the proposed book on Forensic Geotechnical Engineering was finalized.

During the Asian Regional Congress of ISSMGE a separate discussion session was organized on 11th December 2007. The conveners of SCs presented papers relevant to their committees.

Though initially a discussion meeting was to be held in USA, due to unavoidable circumstances, it could not be held. However, a discussion session was arranged br Dr. Hellings in London on December5,2008. Detailed discussions were held regarding the contents of each chapter.

On the basis of above discussion meetings, summaries of each chapters have been prepared by the conveners and the same are given in Annex.2. Presently, the subcommittees are preparing the detailed chapters. It is hoped to complete the task

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and bring out a book "Introduction to Forensic Geotechnical Engineering" before the Alexandria conference of ISSMGE.

During 2004-2006, The Indian Geotechnical Society had established a task committee on FGE under the convenership of Dr.V.V.S.Rao. A one day workshop on FGE is being planned in Bangalore to discuss merging of findings of this Task Committee with TC40 work.

ANNEXURE 1

COMPOSITION OF TC 40: FORENSIC GEOTECHNICAL ENGINEERING

Chairman:Dr.V.V.S.Rao, India dr_rao@nagadi.co.in
Secretary: Prof. G.L. Sivakumar Babu, India, gls@civil.iisc.ernet.in

Core Members:

1. Prof. Yoshi Iwasaki, Japan, yoshi-iw@geor.or.jp
2. Dr. Richard Hwang, Moh & Associates, Taiwan, richard.hwang@maa.com.tw
3. Mr. David Starr, Golder Associates, Australia, david_starr@bigpond.com
4. Prof. K.K. Phoon, Singapore, cvepkk@nus.edu.sg
5. Mr. P.W. Day, South Africa, day@jaws.co.za
6. Prof. J. Mesci, Hungary, mecsi@pmmk.pte.hu
7. Dr. Jan Hellings, U.K., jan@janhellings.com
8. Mr. D.S. Saxena, USA. dsaxena@ascworld.net

General Members:

1. Prof. L.G.De Mello, Brazil lgdemello@usp.br
2. Dr. Dianging Le, China dianging@whu.edu.cn
3.Prof. Zeliko Arbanas, Croatia zeliko.arbanas@gh.hr
4.Mr. Jack Pappin, Hong Kong jackpappin@arup.com
5. Prof. Lingwei Kong, China lwkong@dell.whrsm.ac.cn
6. Mr. W.K.Pun, Hongkong wkpun@ceddigov.hk
7. Dr. R.Szepeshazi, Hungary szepesr@sze.hu
8. Prof. S. Hamsin, Kazakstan
9. Dr.W.Cichy, Poland wcic@pg.gda.pl
10. Prof. R. Gilbert, USA bob.gilbert@mail.utexas.edu
11. Dr. Chan S. F. Malaysia sfchan@pc.jaring.mv

Corresponding Members:

1. Mr. Marco Uzielli Italy, marco.uzielly@ngi.no
2. Mr. Gil Yoon, South Korea glyoon@kordi.re.kr
3. Mr. Masahiro Shirato, Japan, shirato@pwri.go.jp
4. Mr. Makoto Suzuki, Japan, makoto.suzuki@shimz.co.jp
5. Mr. Limin Zhang, Hong Kong, cezhangi@ust.hk
6. Mr. Chris Basile P.E. (USA) christopherbasile@yahoo.com
7. Mr. Grey Stephan P.E. (USA) gstephan@ascworld.net
8. Dr.Phili Pells pells@psmtoo.com.au
9. Mr. Michael Marley, mmarley@golder.com.au
10. Strath Clarke
11. Prof. Mihail Popescu , mepopescu@usa.com

THE SUBCOMMITTEES

SC 1: Characterization of distress. Convener: Mr. P.W. Day
SC2: Diagnostic Tests. Convener: Mr. David Starr
SC 3: Back Analysis. Convener: Dr. Hwang
SC 4: Instrumentation. Convener: Prof. Yoshi Iwasaki
SC 5: Development of failure hypothesis: Convener: Dr. J.Hellings
SC 6: Reliability Checks. Convener: Prof. K.K.Phoon
SC 7: Legal Issues: Convener: Mr. D.S.Saxena

SC 1: CHARACTERIZATION OF DISTRESS.

Convener: Mr. Peter W. Day day@jaws.co.za
Members:
1. Prof. Luiz de Mello lgdmello@usp.br
2. Jack Pappin jackpappin@arup.com
3. Prof. Bob Gilbert bob_gilbert@mail.utexas.edu
4. Dr. Jan Hellings jan@janhellings.com
5. Nick Shirlaw nshirlaw@golder.com.sg

SC 2: DIAGNOSTIC TESTS.

Convener: Mr.David Starr david_starr@bigpond.com
Members:
1. Dr Philip Pells, Pells Sullivan & Meynink (PSM) pells@psmtoo.com.au (general enquiries to their office terrigal@psmtoo.com.au - in case Dr Pells is away
2. Mr Michael Marley, Golder Associates mmarley@golder.com.au
3. Strath Clarke (he works for PSM)

SC-3: BACK ANALYSIS.

Convener: Dr. Mihail Popescu
mihail.e.popescu@gmail.com
Co-Convener:Dr.RichardHwang.
richard.hwang@maa.com.tw
Members:
1.Dr.StephenButtling
stephen.buttling@hyderconsulting.com
2.Mr.NiclauseShirlaw nshirlaw@golder.com.sg
3.Dr.TingWenHui tingwh@pop.jaring.my
4.Prof.FusaoOka foka@mbox.kudpc.kyoto-u.ac.jp
5.Dr. Chung Tien Chin ct.chin@maaconsultants.com

SC 4: INSTRUMENTATION

Convener: Dr. Yoshinara Iwasaki yoshi-iw@geor.or.jp
Members:
1.Mr. Craig A. Davis (USA) craig.dvis@ladwp.com
2. A. WADA (Singapore) : wada@agacorp.com.sg

SC 5: DEVELOPMENT OF FAILURE HYPOTHESIS.

Convener: Dr. Jan Hellings. jan@janhellings.com
Members:
1. Bill Grose. Ove Arup & Partners (UK). bill.grose@arup.com
2. Rab Fernie. Cementation Foundations Skanska Ltd rab.fernie@skanska.co.uk
3. Kjell Karlsrud. NGI (Norway). kjell.karlsrud@ngi.no
4. Dirk Luger. GeoDelft (The Netherlands). dirk.luger@geodelft.nl
5. Mahmoud Mahmoud. GES Geotech (Canada). mahmoud@gesgeotech.com
6. Darren Page. OTB (UK). geoscience@hotmail.com
7. Roger Thomson. EDGE Consultants UK Ltd. rpt@edgeconsultants.co.uk

SC6: RELIABILITY CHECKS.

Convener: Prof. Kok-Kwang Phoon (Singapore,) – cvepkk@nus.edu.sg
Members:
1. Prof. Sivakumar Babu (India) - gls@civil.iisc.ernet.in
2. Mr. Robert Gilbert (USA) - bob_gilbert@mail.utexas.edu
3. Mr. Dian-qing Li (China) - dianqing@whu.edu.cn

4. Mr. Marco Uzielli (Italy) - Marco.Uzielli@ngi.no
5. Mr. Gil Yoon (South Korea) - glyoon@kordi.re.kr
6. Mr. Masahiro Shirato (Japan) - shirato@pwri.go.jp
7. Mr. Makoto Suzuki (Japan) - makoto.suzuki@shimz.co.jp
8. Mr. Jack Pappin (Hong Kong)
9. Mr. Limin Zhang (Hong Kong) - cezhangl@ust.hk

SC 7- LEGAL ISSUES INVOLVING JURIPRUDENCE SYSTEM

Convener: Mr. Dhirendra S Saxena P.E. (USA)
dsaxena@ascworld.net
Members:
1. Mr. Christopher C Basile P.E. (USA)
christopherbasile@yahoo.com
2. Mr. Greg A Stephan P.E. (USA) gstephan@ascworld.net

ANNEXURE 2

Chapter 1: INTRODUCTION

The introductory chapter of the book starts out by defining what constitutes failure of a geotechnical structure. It differentiates between failures involving instability (the ultimate limit state) and those which impair of the functionality of the works (the serviceability limit state) in a manner similar to that used in the Eurocodes.

Although it is important to maintain an open mind when investigating failures, the most common causes of failure of geotechnical works are described to in an effort to alert the forensic geotechnical engineer to the possible causes of failure to be considered. These range from shortcomings in investigation, interpretation, modelling, design and execution of the works and unanticipated or abnormal actions.

The chapter concludes with a classification of the severity of distress which is applicable to most types of structures. This classification is based on the degree of impairment of the structure's functionality and the extent of the remedial work required.

CHAPTER 2: DATA COLLECTION

Chapter 2 starts out by highlighting the difference between normal geotechnical investigations and forensic investigations. The former is predictive and the latter retrospective. Furthermore, there is an urgency involved in forensic investigations arising from the likely destruction of evidence, particularly with the commencement of remedial work. Forensic investigations need to consider all aspects of the project including the works, the failure and the site. As far as the works are concerned, the key considerations are the works as designed, the works as constructed and the state of completion thereof. When looking at the failure, the investigator should take cognisance of and record the circumstances prior to failure, the sequence of events and the resulting distress. Some key sources of information are identified such as eye witnesses' accounts, geotechnical and design reports, construction records and data from external sources (weather, seismic activity, etc). The need to consider all potential failure mechanisms and combinations of events is emphasised. With regard to the site, the essential data to be recorded is listed and includes site conditions prior to construction, the extent to which these were altered by construction, geological setting, groundwater regime and available geotechnical data. In recording the data, the importance of complete and accurate reporting and systematic referencing of data is emphasised. Wherever possible, an effort should be made to obtain agreement between the parties on factual information and sequence of events at the time as this can go along way to elimination unnecessary argument in the future. As the investigation of even minor failures can drag on for years, it is essential that data is adequately recorded and stored in a format that can be retrieved and analysed by others in future as the investigation will often outlive tenure of the original investigator.

In conclusion, the need for impartiality and objectivity of the investigator is emphasised. The investigator should be mindful of the fact that the data gathered may be subject to scrutiny in subsequent legal proceedings. Obvious bias in the collection and reporting of data will discredit the findings of the investigation.

CHAPTER 3: DIAGNOSTIC TESTS

Depending upon the failure pattern and assessed probable causes of failure, both insitu and laboratory tests will have to be performed to reconstruct the soil behavior. For ex. large size plate load tests or footing tests may need to be performed in both saturated and unsaturated conditions using load increments representative of the actual construction stage. Laboratory Shear tests might become necessary under stress increment conditions. Pore pressure measurements might also have to be done. Hence, selection of tests and their procedures should have correlation with the type of project and the failure pattern.

CHAPTER 4: BACKANALYSIS

Back-analysis is commonly believed to be one of the most reliable ways to estimate soil / rock strength and deformability parameters in forensics geotechnical engineering. With an accurate assessment of failure causes and mechanisms, back-analysis can predict reliable soil / rock parameters operating at the time of failure. However, there are situations when back-analysis can lead to misinterpretation and the interpreted soil / rock behavior can be in significant error.

This chapter discusses back-analysis procedures for different types of geotechnical structures including slopes and excavations, foundations, retaining structures and landfills. Consideration is given to both two- and three-dimensional idealizations. Uses and abuses of back-analysis in geotechnical engineering are discussed. Several case histories of geotechnical failures with extensive monitoring are described and it is shown how these measurements were used along with advanced numerical modeling to analyze soil / rock behavior at failure. Finally, this chapter illustrates that back-analysis is reliable only when the model and all assumptions are reasonable and accurate representations of the real system.

CHAPTER 5: INSTRUMENTATION AND MONITORING

The instrumentation at the site will have to be done in conjunction with the diagnostic tests. This stage gains importance while assessing the immediate danger that might occur as well as the assessment of the rate of progress of failure. Typical instruments for measurements of deformation, forces, etc., including their limitations have to be illustrated with case histories.

CHAPTER 6: DEVELOPMENT OF FAILURE HYPOTHESIS

With the background of the characteristics of the failure, results of the diagnostic tests and back analysis, the most probable causes for the failure have to be developed. These causes should be correlated to different rheological models for soil as well as for soil+structure system so that the most probable process of failure can be identified. This process is illustrated with few examples.

CHAPTER7: RELIABILITY CHECKS:

This chapter discusses some possible roles for reliability and risk in forensic geotechnical engineering. A preliminary statistical framework is presented to quantify the difference between expected and observed performance in the presence of unavoidable and potentially significant geotechnical variabilities. Other potentially useful results in the recent reliability and risk literature are highlighted. The intention of

this chapter is to stimulate further discussions and research in this important but somewhat overlooked area.

CHAPTER 8: LEGAL ISSUES:

For geotechnical engineers it is only a myth to believe that practicing perfect engineering, or conforming to normal standards of care, will provide immunity from civil liability. Unfortunately, when problems or failures occur, all parties including engineers get named in the lawsuit regardless of their innocence.

In USA, attorneys sue everyone involved with a damaged project to secure compensation or claim to their liability insurance limit. A practicing geotechnical engineer cannot provide services without the fear of a lawsuit. Strategies for limiting liability range from assessing risk to securing professional liability insurance and including limitation of liability classes in consulting contracts between engineer and the client. Although experts retained by opposing parties generally disagree on issues resulting from differences in professional judgment, they are invaluable to the jurisprudence system in America. This chapter presents some legal issues involving jurisprudence system and introduces a case history that includes Sall elements of forensic geotechnical engineering.