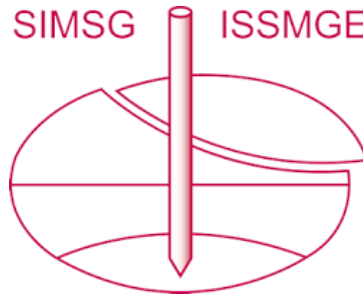


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The use of independent technical assessment in geotechnical engineering

Le rôle de l'expertise technique indépendante en géotechnique

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ABSTRACT: Independent technical assessment (ITA) for geotechnical projects is part of system engineering and quality assurance provisions. It comprises review of proposed activities, review of documentation produced, inspection of analysis and designs undertaken and checking verification of compliance. It is sometimes referred to as peer review, independent geotechnical checking, third part checking, category 3 checking or technical overview (with subtle differences), and may be undertaken for project owners, designers, contractors, regulators, insurers or financiers. This paper describes the principles and practice of ITA. This requires a clear definition of review objectives, selection of appropriately qualified and experienced team members and definition of the scope, and requirements of the assessment including implications for project gateways or regulatory compliance. The writer has found de Bono's ideas in his book "Practical Thinking" to be most helpful, regarding the levels of understanding needed to make sensible decisions, and about how to be right and how to be wrong.

RÉSUMÉ: L'expertise technique indépendante (ITA) des projets géotechniques est partie intégrante des processus d'ingénierie et d'assurance qualité. Elle comprend une revue des activités envisagées et des documents produits, une inspection des analyses et de la conception effectuées, et une vérification de la conformité. Elle est parfois appelée différemment (revue d'expert, vérification géotechnique indépendante, etc., avec de légères différences) et peut être commandée par les clients, les concepteurs, les constructeurs, les bureaux de contrôle, les assureurs ou les investisseurs. Cet article décrit les principes et la pratique de l'expertise technique indépendante. Elle nécessite de définir clairement les objectifs que l'on cherche à atteindre, de choisir une équipe qualifiée et expérimentée, de cerner le cadre d'étude et ses limites ainsi que la façon dont seront utilisés les résultats (en particulier leur articulation avec les jalons du projet et les contraintes réglementaires). Les idées de de Bono dans son livre « Practical Thinking » ont été d'une grande aide à l'auteur en ce qui concerne les niveaux de compréhension nécessaires à la prise de décisions critiques, ainsi que les façons d'avoir raison ou d'avoir tort.

KEYWORDS: ITA, system compliance, peer review

1 INTRODUCTION

Independent technical assessment (ITA) for geotechnical projects is part of system engineering and quality assurance provisions. It comprises review of proposed activities, review of documentation produced, inspection of analysis and designs undertaken and checking verification of compliance.

It is sometimes referred to as peer review, independent geotechnical checking, third part checking, category 3 checking or technical overview (with subtle differences), and may be undertaken for project owners, designers, contractors, regulators, insurers or financiers.

It can be undertaken by an individual, a review team or a review panel and may follow a gated process, albeit contingencies and provisions may be carried forward (as in the observational method).

In the initial stages of a project it may be considered a form of validation that the proposed scheme will meet the project objectives ("doing the right thing") or later as part of verification of the processes involved ("doing it right").

For major projects, there may be more than one ITA, each working for different principals and with different priorities. The project owner may engage an ITA to help ensure that the delivered project meets their functional requirements. ITA on behalf of regulators is mainly concerned with ensuring adequate public safety and may focus on compliance with codes and standards, and project insurers and financiers may be concerned about residual project risk and their potential exposure.

In all cases though, ITA should be seen as part of the solution and not an encumbrance to be overcome.

2 MITRE REPORT

The MITRE Corporation is a private not-for-profit company set up by the US government to provide engineering and technical guidance on federal government programmes.

MITRE's report by Clapp and Funch gives comprehensive guidance on setting up and implementing a technical assessment programme. While intended for large, complex and software intensive projects (US defence), its general principles and approach can be adapted to more everyday projects. It's call for a clear definition of review objectives, selection of team members and "written charter" (to define, get agreement on, and document the objectives, scope, and requirements of the assessment) are apposite at all levels.

Similarly, its definition of different types of review team can be helpful.

- Red team, - focussed on trouble shooting.
- Blue team, - focussed on problem avoidance.
- Baseline or status assessments, - looking at a set of standard criteria against which the project is measured.
- Senior review team, - for strategic assessments and to support key decisions.
- Tiger team, - sharply focused on solving a particular problem.
- Compliance assessment, - adherence to proper process across different parts of a project and a channel for feedback.

It is apparent that this terminology may be used in geotechnical aspects of civil engineering projects and may be incorporated

into overall systems management.

3 KNOWLEDGE AND AWARENESS

Boyd has cited the Joehari window of knowledge and awareness; that is positive knowledge (that which is known) and negative knowledge (that which is yet to be discovered), and positive awareness (what you know about) and negative awareness (what you don't know about, but possibly somebody else does). This was made famous by the former US Secretary of State Donald Rumsfeld in his 2002 "Known Knowns" speech (that is awareness of knowledge that exists). Rumsfeld's Unknown Unknowns (no awareness of knowledge that doesn't exist anyway), as he says, is the most difficult, and indeed impossible to address.

The inclusion of ITA introduces additional knowledge and experience to the project team, and can widen the awareness window as to what is possible (positive knowledge) and to what isn't possible (negative knowledge).

Uncertainty abounds in geotechnical engineering (Boyd 2021) and stems from spatial uncertainty in the ground, variability in materials, limits on methods of investigation and testing, and limits of understanding of how actions are applied and how structures respond, and from simplifications inherent in analysis and design. Effective ground engineering requires these uncertainties and associated risks to be recognized as early as possible in the project and addressed within a holistic design process with a full and clear reporting structure. ITA is a very successful way of ensuring that uncertainties are recognized and a proper process is employed.

4 PRACTICAL THINKING

Some years ago, the author became aware of the book "Practical Thinking" by Edward de Bono, the principles of which he has found most useful in his work in ITA.

de Bono notes 3 ways of knowing what to do.

1. Instinct
2. Learning (firsthand/second hand)
3. Understanding

Knowing that it is better to build your hut on rock rather than swamp may be in part instinct but more likely is due to experience (learning). Knowing **how** to build your hut on the swamp however, requires experience and understanding. de Bono cites 5 ways to understand.

1. Simple description (hut sinks/doesn't sink)
2. Porridge words (swampy conditions)
3. Give it a name (compressible clay)
4. The way it works (consolidation theory)
5. Full details (soil-structure interaction)

It may not be necessary to know full details to make sensible decisions but awareness of the limit of your knowledge is important. Many construction professionals have a basic understanding of ground engineering principles but often specialist geotechnical training and experience is required, coupled to knowledge of when to seek expert advice. Much depends on the consequences of being wrong. Risk is the product of likelihood of error combined with consequences.

Projects with potentially high consequences require greater reliability, and hence benefit most from ITA

de Bono also cites 4 ways to be right

1. Emotional rightness (it looks elegant/feels right)
2. Logical rightness (arguments fit together)
3. Unique rightness (only argument that fits the situation – to your knowledge)
4. Recognition rightness (this swamp looks familiar!)

Typically, a combination of these is used in building an argument for a particular course of action, but sometimes this can be the wrong interpretation or wrong option.

de Bono cites 5 ways to be wrong.

1. Monorail mistake (moving directly from one idea to the next – remember de Bono invented the term "Lateral Thinking" so looking around for connections and considering other options might give a better solution)
2. Magnitude mistake (idea is right but size of effect is wrong – easily done if you put the wrong number of zeros into a calculation! – hence need for a "sense of fitness and proportion" which comes from experience and understanding)
3. Misfit mistake (idea does not actually match the situation)
4. Must-be mistake (fixation on an idea by arrogant certainty, what de Bono calls the arrogance clamp – a very dangerous and all too frequent mistake)
5. Miss-out mistake (conclusions are derived from only part of the information and may prove wrong by not taking account of the whole)

The reader will appreciate the usefulness of these definitions when undertaking ITA.

5 MISTAKES

Report writers rely often on logical rightness combined with uniqueness in their arguments, but emotional rightness has a role (that is "gut feeling" and a sense of fitness and proportion). This is developed over years of experience and is often linked to recognition rightness, that is being able to make comparisons with other situations and precedent elsewhere. These are important traits for both designers and reviewers.

The monorail mistake is often a mistake of inexperience and often the corollary of logical and unique rightness. Monorail thinking neglects that very often one can reach a suitable conclusion by a number of different paths, or indeed reach better conclusions by looking at things differently. de Bono has written widely on creative thinking.

Magnitude mistakes often arise from inexperience as well, but sometimes may just be mistakes of input. The author regularly undertakes simplified check calculations based on something similar ("sanity checks") to assess if the order of the solution is correct and hence whether more in-depth probing is necessary.

Miss-fit and miss-out mistakes are the most common. Straight line interpolation between similar strata in boreholes for instance may not work at all in glacial terrain where the ground is often a jumble of materials, and while averaging parameters might be appropriate at a gross scale, such as for large raft foundations, lower bound properties from discrete bands or pockets might control small footings or pile tips. Similarly, discounting very high values may miss obstructions and inclusions that might interfere with construction. Interpretations consistent with geological understanding is paramount to successful geotechnical engineering.

The "must-be" mistake is possibly the most difficult to deal with as it is often associated with the "arrogance clamp" and

sometimes afflicts eminent practitioners. Direct confrontation can be counterproductive, and it is usually better for the ITA to suggest that the originators “give consideration” to an alternative and so allow them to come to another conclusion of their own accord.

6 HOLISTIC DESIGN

It is almost universally accepted today that geotechnical engineering should follow a holistic, systematic and properly documented methodology with due compliance to codes and standards and to accepted best practice, including recognising empirical methods and successful precedent.

Findings should be presented in factual reports, summarizing geotechnical reports and interpretative reports (sometimes combined), reports on analysis and design option studies, and in design substantiations which seek to explain and validate the design choices taken. Similarly, proper documentation should take place during construction and performance monitoring as part of verification.

Organizing reports into a hierarchy and achieving clarity in reporting language contributes considerably to reducing uncertainty and to increasing confidence and belief in the outcomes, and it facilitates ITA.

7 CONTINUITY OF GEOTECHNICAL THINKING

Continuity of geotechnical thinking is also essential to successful ground engineering projects, stretching from desk studies and investigation planning through to construction supervision and monitoring. The concept of a single controlling mind (a “conductor”) is very beneficial for small or medium size projects where this may be done by an individual. But, large and complex projects may require several sub-disciplines and may take place over a protracted period which can make a single individual impractical (although still beneficial if possible). It follows that proper documentation between stages is necessary and makes continuity of thinking easier to maintain, as does continuity in ITA. Indeed, the author has experience of being ITA on a major project over a ten-year period covering several project stages and different project personnel, and this has provided a degree of geotechnical continuity.

8 SQEP

Successful engineering requires use of suitably qualified and experienced personnel (SQEP) in all project roles. Additional key requirements for the ITA role are credibility and trust. Credibility is sometimes achieved by position or reputation but most importantly by experience. A wide range of experience is highly beneficial as this allows the ITA to appreciate the wider context. Trust in the ITA is built up over time by being perceptive of the full range of project objectives and constraints, offering guidance and constructive criticism as necessary and being right most of the time.

A particular problem can be loss of understanding and direction at the interface between disciplines. For instance, between geologists and geotechnical engineers, if for instance there is too much focus on measurements over geological mechanisms, and particularly between geotechnical engineers and structural engineers where the former may not appreciate the structural design context or the latter may want the complexity of the ground conditions rendered simple. Similarly, in construction, misunderstanding and miscommunication can lead to contractual difficulties of unforeseen ground or to construction dangers. Effective ITA can minimize these difficulties.

Indeed, the aim of ITA is to facilitate a successful project outcome. The ITA should not show off how clever they are (or

how stupid the other party is). This may mean accepting that something may not be how the ITA would do it but is acceptable provided it works. The ITA should not be pedantic about language provided the meaning is clear and unambiguous and the ITA may make constructive suggestions for improvements where appropriate. However, sometimes it is necessary for the ITA to maintain a contrary position until a successful solution is achieved (always recognizing the potential for the ITA being susceptible to the “must-be” mistake). Project owners do not necessarily have to follow the ITA advice (unless in a regulatory context) and indeed the writer has had some “I told you so’s” where his cautions have been overruled. But, if something is palpably unsafe the ITA must persist, even to the point of raising the issue with the authorities.

9 REVIEWING REPORTS

The author has reviewed hundreds of reports and finds the most useful technique is to use a standard review template which indicates general observations on the structure and scope of the report followed by specific section by section comments with an indication of importance, and a conclusion on report acceptability. This should allow for report author responses and follow-up acceptance of these by the reviewer or otherwise. Sometimes full acceptance may be a formal requirement before the project can proceed, but not necessarily as project owners may be able to accept uncertainty and risk without full resolution, especially if there are other project demands such as time constraints.

By way of technique, the author typically reads through the report to become aware of its structure and contents and then “thinks about it” for a day or so to assimilate the context, and he gets a hard copy print-out if the report is delivered in digital form. He then goes through the hard copy in detail marking comments as he goes. He then “has another think”, before starting to enter comments on to the template. This is then transmitted to the report authors for their response. These short thinking periods help to prevent the ITA succumbing to a monorail mistake.

Discussion with the authors is most useful both before issue of the report the report, to discuss approach and content, and during the review to solicit clarifications, and after issue of comments to aid in preparation of author responses and eventually to clear comments. This can also be a lead-in to any subsequent actions and ideally should be non-confrontational.

A danger for reviewers is to show off how smart they are compared to the writer. Sometimes, the ITA’s client expects this especially from eminent reviewers and indeed sometimes such reviewers see that as their role. However, in this writer’s view, this is not good and leads to increased confrontation (often with commercial consequences) and difficulty in resolution of issues. Beware the “arrogance clamp”.

10 GOLDEN THREAD

The “golden thread” is a line of argument presented in reports that links different aspects of a topic to explain or substantiate a course of action. It may not be a single thread but more a weaving together of different strands of an argument, and it can be quite difficult to articulate in some cases. Techniques such as “mind mapping” or decision diagrams can be helpful for illustration, especially if the arguments are complex. A key element of ITA is to see that a “golden thread” makes sense. It helps to rule out monorail, misfit or miss-out mistakes.

11 ANALYSIS AND DESIGN REVIEWS

This typically is a check to ensure that sensible design solutions are obtained and may involve review of process and checks on compliance with stated design methods and standards, and is

achieved by inspection of analysis reports, design calculations, and design substantiations reports to give a judgement that sensible conclusions have been arrived at, and importantly that verification is allowed for in construction and performance monitoring.

The same techniques of using a reporting template can be employed to raise discrepancies or alternative views.

For important and safety-critical facilities this may be extended to undertaking independent analysis or independent design calculations (sometimes referred to as Cat 3 checks). Usually an equivalent organization is commissioned for this, with similar capabilities and similar professional indemnity insurance to the originators. This may be seen as part of design development and may itself be subject to ITA.

Similarly, design option studies, sometimes involving multi-attribute analysis, and value engineering checks can lead to improved solutions, and can be amenable to ITA.

Parallel analysis and separate design checks are effective in picking up monorail mistakes, and avoiding “must-be” mistakes.

12 SANITY CHECKS

“Sanity checks” or “back-of-an-envelope” calculations are simplified analyses used to assess the order of correctness of a proposal and are an essential part of the ITA’s arsenal. Very often simplified solutions or rules of thumb can identify magnitude mistakes.

13 PANEL REVIEWS

Sometimes an ITA review panel may be convened to consider a problem. This can be particularly useful when reviewing critical situations or option studies across a range of project objectives. All the panel members should strive to be open minded and committed to achieving the best outcome for the project.

However, they can have drawbacks. They can suffer from “groupthink” that is subjugation of individual’s views in striving for consensus often involving compliance with the views of a strong individual on the panel to the exclusion of other views. The writer has experience of being on one such panel which included two eminent professors each having apparently different views. If the panel met with one professor being absent then the views tilted one way, and vice-versa if only the other professor was present. Fortunately, the panel had a strong chairman and a consensus view was achieved.

The writer also has experience of a panel involving a number of experts working independently. Again, some divergent views were obtained which required resolution by a panel editor. This involved mapping areas of consensus and indicating divergences for reconsideration by panel members and eventual resolution by the project principals. This panel suffered heavily from “must-be” mistakes and the “arrogance clamp”.

14 REVIEW OF VERIFICATIONS

All ground engineering projects should involve a degree of the observational method whether explicit or not. “Is the ground as expected and did the structures behave as expected”? If not then modifications may be required and there always needs to be the provision to stop and rethink if things are different and if provisional actions have not been identified in advance.

ITA can be applied to construction observations and monitoring such as mapping of excavations, various forms of instrumented trials, pre-loading, pile testing and the like, and performance monitoring, plus compilation of as-built records.

ITA of verification is similarly facilitated by accurate record keeping and comprehensive summarizing reports, and can again utilize the reporting template approach with appropriate liaison with report authors. Validation by ITA can be valuable for project insurance and for any future change of use or modification.

15 CONCLUSIONS

ITA can be highly beneficial to project success when undertaken well. The ITA should be SQEP in the area of geotechnics being assessed and also experienced in the wider context of the project, and should follow an open and non-confrontational approach as far as possible while protecting their client’s interests.

The MITRE report by Clapp and Funch provides an excellent set of principles and guidance on ITA that may be adapted to scale of the project.

The writer has found de Bono’s ideas about the levels of understanding needed to make sensible decisions, and about how to be right and how to be wrong, to be most helpful, especially regarding the dangers of “monorail” thinking and the “arrogance clamp” (which can also afflict the ITA if they are not careful).

Most essential for project success though is to follow a holistic design process with clear objectives and good documentation, and with continuity of geotechnical thinking between all the stages, and with the provision always to be able stop and re-think if things do not turn out as expected.

ITA helps both in validation that a project is “doing the right thing”, and in verification, that it is “being done right”.

16 REFERENCES

- Boyd R. D. 1994. Application of an engineering system for the control of risk in ground engineering. *Risk and reliability in ground engineering*, Ed, Skipp B O. Thomas Telford. ISBN 0-7277-1986-6
- Boyd R. D. 2021. A technical note on the nature of uncertainty in geotechnical engineering. *Proceedings of the 20th International Conference on Soil Mechanics and Geotechnical Engineering*, Sydney 2021.
- Clapp J. A. and Funch P. G. 2003. *A Guide to Conducting Independent Technical Assessments*. MITRE Organization. USA. Available on line at http://www2.mitre.org/work/sepo/toolkits/assessment_guide.pdf
- de Bono E. 1971. *Practical thinking: Four Ways to be Right; Five Ways to be Wrong; Five Ways to Understand*. Jonathan Cape Ltd. London. ISBN 13: 9780224005470
- Rumsfeld D. 2002. *There are Known Knowns*. US Department of Defense news briefing. See https://en.wikipedia.org/wiki/There_are_known_knowns#:~:text=Rumsfeld%20stated%3A,things%20we%20know%20we%20know.&text=But%20there%20are%20also%20unknown,known%20we%20don't%20know.