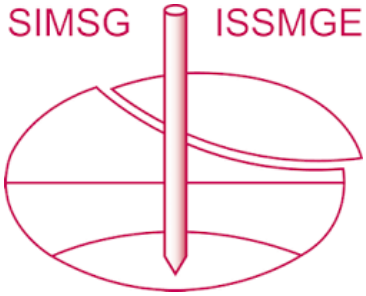
INTERNATIONAL SOCIETY FOR
SOIL MECHANICS AND
GEOTECHNICAL ENGINEERING



This paper was downloaded from the Online Library of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). The library is available here:

https://www.issmge.org/publications/online-library

This is an open-access database that archives thousands of papers published under the Auspices of the ISSMGE and maintained by the Innovation and Development Committee of ISSMGE.

Embedding Geo Risk Management. The Geo-Impuls Approach

L'implantation du management des risques géotechniques. L'approche Geo-Impuls

Staveren van M.Th.
VSRM

Litjens P.P.T., Cools P.M.C.B.M.
Rijkswaterstaat Dienst Infrastructuur

ABSTRACT: Geo-Impuls is a Dutch and industry wide geotechnical development programme. It aims to strengthen the geotechnical community by substantially reducing geotechnical failures in all types of construction projects. Over 40 Dutch organizations, including client organizations, contractors, engineering firms and knowledge institutes, work closely together in this programme that runs from 2009 up to 2015. All Geo-Impuls participants embraced geotechnical risk management (GeoRM) as leading working method to realize projects within budget and planning, as well as according to actual safety and quality standards. However, routinely applying GeoRM in projects requires embedding GeoRM in its organizations. This paper aims to present how the Dutch geotechnical community is currently embedding geotechnical risk management in its organizations. First, the Geo-Impuls program is introduced. The remaining part of this paper summarizes the four pillars of the Geo-Impuls program: (1) the process of geo risk management, (2) geo risk management principles, (3) geo risk management tools, and (4) geo risk management implementation. Finally, the main conclusions are drawn.

RÉSUMÉ : Geo-Impuls est un programme hollandais de développement géotechnique au niveau de l'ensemble de la profession. Son objectif est de renforcer la communauté géotechnique en réduisant les accidents géotechniques dans tous types les projets. Ce programme mis en œuvre de 2009 à 2015 regroupe plus de 40 organisations hollandaises (clients, entreprises, bureaux d'ingénieurs conseils et instituts d'enseignement et de recherche). Tous les participants au projet Geo-Impuls ont adopté le management des risques géotechniques (GeoRM) comme méthode principale pour réaliser des projets conformes aux budget et planning, et respectant les normes de sécurité et de qualité en vigueur. cependant, l'application routinière du GeoRM dans les projets exige son implantation dans les organisations. L'article vise à présenter de quel façon la communauté géotechnique hollandaise est en train d'implanter ce management des risques géotechniques. Tout d'abord, on présente le programme Geo-Impuls. Ensuite l'article fait une synthèse des quatre piliers du programme Geo-Impuls: (1) la processus de management des risques géotechniques, (2) les principes du management des risques géotechniques, (3) les outils du management des risques géotechniques, (4) l'implantation du management des risques géotechniques. Enfin, les conclusions les plus importantes sont tirées.

KEYWORDS: geotechnical risk, geotechnical risk management, project risk management, risk management implementation, tool box

1 INTRODUCTION

Building in, on, or with ground is risky. According to several assessments, on average geotechnical problems during engineering, construction, and operation of civil engineering projects result in cost increases of 5% of the original budgets. In the Netherlands only, this adds up to hundreds of millions of Euros, annually. So action within the geotechnical community is needed, which resulted in a major geotechnical development program in The Netherlands: Geo-Impuls.

First, the GeoImpuls program will be described, including three top geotechnical risks that drive the program, six dilemma's related to these top risks and three resulting research and development themes for providing effective and cost efficient risk remediation.

Next, the concept of geotechnical risk management or GeoRM will be presented, including an explanation what GeoRM is about and why GeoRM should be embraced by all geotechnical professionals.

An important element of GeoRM is provided by eight so-called Geo-Principles. These principles are derived from the generic risk management principles of the ISO 31000 risk management guideline (ISO 2009). By adopting these principles, Geo-Impuls decided to apply a modern principle-based risk management approach, rather than a more traditional rule-based one. The main advantage of a principle-based approach is that any type of organization, in any type of construction project, is able to design its own tailor-made risk management activities and processes. This avoids a well known "one size fits nobody" situation. The Geo-Principles are introduced in the paper by a checklist, which is ready to be used in practice by any reader.

In addition to the principles, risk management tools are welcome and useful. Therefore, a Geo-Impuls risk management toolbox is in development. Together with already available techniques, this toolbox will be filled with the results of 12 working groups. It contains sub boxes for contractual matters, for geotechnical design and construction, as well as for dealing with the many project stakeholders and its environment. The latter is particular important for the growing number of complex underground projects in densely populated and sensitive build environments.

While having the risk management processes, principles, and tools, a fourth element proves to be of paramount importance: the organizations that have to deal with geotechnics. These are either client organizations, contractors, or engineers. Adapting geotechnical risk management activities to existing working procedures and process in these organizations is a key success factor for continuous GeoRM application. Rijkswaterstaat, executive agency of the Ministry of Infrastructure and the Environment and the largest Dutch

public client organization for construction projects, provides a pioneering role in embedding GeoRM in its entire organization. Their recent experiences with the GeoRM implementation will be shared.

Finally, the paper will draw some conclusions about the main experiences within the Geo-Impuls development programme with embedding geotechnical risk management in organizations. Any reader is invited to reflect on these experiences, and to use them for the benefits of his or her own geotechnical challenges.

2 GEO-IMPULS PROGRAM

Geo-Impuls is a Dutch and industry wide geotechnical development programme (Cools 2011). It aims to strengthen the geotechnical community, by substantially reducing geotechnical failures in all types of construction projects. Over 40 Dutch organizations, including client organizations, contractors, engineering firms and knowledge institutes, work closely together in this programme that runs from 2009 up to 2015. The two key objectives of the Geo-Impuls program are (1) a completed GeoRM toolbox, including guidelines and best-practices, and (2) a number of 100 projects that demonstrate GeoRM adoption by 2015. This requires embedding GeoRM principles and practices in organizations. Therefore, the implementation of GeoRM in (project) organizations is a key issue in the Geo-Impuls program.

During several sessions with program participants a number of infrastructural projects were analyzed regarding their geotechnical risks. The overall conclusion is that three top risks can be identified, which are related to Contracts, Geo-Engineering and Project Communication:

1. Top risk of Contracts: unforeseen soil conditions
2. Top risk of Geo-engineering: failure due to settlements or collapse
3. Top risk of Project communication: loss of public support

Managing these top risks involves dealing with several dilemmas, which are related to each specific top risk:

Ad 1 Contracts:

- A small or extensive scope of ground investigations during tendering?
- Do or don't apply contractual geotechnical risk allocation?

Ad 2 Geo-engineering:

- A robust design or flexibility during construction?
- Do or don't apply on site quality measurements?

Ad 3 Project communication:

- Do or don't inform the public on risks?
- Do or don't inform the public on nuisance?

So, there are three central development themes: Contracts for dealing with legal issues, Geo-engineering for dealing with technical issues, and Project communication for paying attention to the human factor. For each theme, the by the Dutch geotechnical community perceived most important topics are worked out in Working Groups.

Theme 1: Contracts

- Geotechnical risk allocation in projects by the geotechnical baseline approach
- Risk-based soil investigation planning, including tendering issues
- Process specifications for geo-engineering in contracts and contract management
- Geotechnical risk checklists for non-geotechnical decision makers

Theme 2: Geo-engineering

- Quality control for timely tracing imperfections of cast-in-place concrete elements
- Observational Method by using risk-based scenarios in combination with monitoring
- Reliable geotechnical modelling by revealing and presenting geological and geotechnical uncertainties and using sensitivity analysis
- Long-term geotechnical monitoring for better understanding of time-dependent geotechnical behaviour, by comparing monitoring results with predictive models

Theme 3: Project communication

- Communication of geotechnical risk to communities in project environments
- Closing the gap of misunderstanding between design and construction professionals
- International knowledge exchange on reduction of geotechnical failures and geotechnical risk management
- Geotechnical risk management education and training for students and professionals

Since 2009, an industry-wide Steering Committee takes responsibility for the Geo-Impuls programme. The day-to-day execution of the programme has been assigned to the Core Team comprising the leaders of the Working Groups. The Geo-Impuls Programme Office coordinates all administrative aspects and a program advisor focuses specifically on GeoRM and its implementation in (project) organizations.

3 GEO RISK MANAGEMENT

All Geo-Impuls participants embraced Geotechnical Risk Management (GeoRM) as the leading working method to realize projects within budget and planning, as well as according to pre-set safety and quality standards. Before explaining GeoRM, it helps to define the term geotechnical risk. According to ISO31000 (2009), a risk is the effect of uncertainty on realizing objectives.

Similarly, a geotechnical risk can be defined as the effect of geotechnical uncertainty on realizing objectives, such as settlements or horizontal deformations within pre-set limits. Geotechnical uncertainty may result from randomness, fuzziness, incompleteness or simply incorrect geotechnical information (Van Staveren 2006). A geotechnical risk has a probability of occurrence, one or more causes, and usually a number of effects when happening, such as damage, cost overruns and delay.

Geotechnical risk management or GeoRM is an explicit, structured, communicated, and continuous way of dealing with geotechnical risk, in order to achieve project objectives effectively and cost-efficiently. The process of geotechnical risk management is similar to the process of project risk management and involves the same sequence of steps.

Therefore, GeoRM fits well in any sort of project risk management. The difference is that GeoRM is a more detailed and in-depth approach of project risk management, for giving geotechnical risk the attention it requires in all phases of engineering and construction projects. Figure 1 presents the six GeoRM steps.

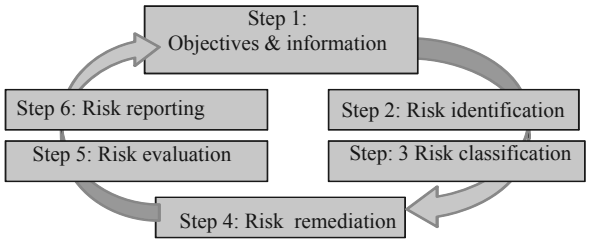


Figure 1. The GeoRM process in six steps.

While these six GeoRM steps are quite straightforward, it helps to take them according to so-called GeoRM principles. These are presented in the next section.

4 GEO RISK MANAGEMENT PRINCIPLES

Basically, there are two main routes of doing risk management: rule-based and principle-based. The rule-based approach is using rules and results into one best way for managing risk. This is not appropriate for GeoRM, because of the large diversity of engineering and construction projects in complexity, size, location, and ground conditions.

For these reasons the Geo-Impuls takes the principle-based route for allowing fit-for-purpose geotechnical risk management. Based on the eleven generic risk management principles from ISO31000 (2009), eight specific geotechnical or GeoRM principles have been defined by a number of Geo-Impuls participants.

By definition, principles are abstract and need a translation into activities. Such a translation can be done for specific projects and even for specific project phases, again in a fit-for-purpose way. By this approach GeoRM is a mean for realizing project objectives and not an end in itself. Table 1 presents the eight GeoRM interrelated principles and a number of examples of related actions in the format of a simple checklist.

Table 1. GeoRM principles in a checklist format.

GeoRM Principles	*GeoRM Actions*	*Done*	
		Yes	*No*
1. Generate and protect value	Make all geotechnical risks in each project explicit, including all risk effects and the selected risk remediation measures.		
2. Participate in decision making in all project phases	Make a geotechnical risk file from the start if the project and use it for decision making.		
3. Make geotechnical uncertainty explicit	Include geotechnical sensitivity analyses with margins in project reports		
	Use the geotechnical risk file for managing the consequences of any geotechnical changes during the project		
4. Work systematically, structured and in time	Include GeoRM explicitly in the project planning and reserve resources for it.		
5. Use all available information	Use all available historical and other relevant project information, right from the start of the project		
	Work from a general level to a detailed level, from using geological maps to geotechnical monitoring		
6. Work transparently together with all stakeholders	Asses the influence of the ground conditions on the critical success factors of the project stakeholders		
	Communicate clear about geotechnical risk with all parties involved		
	Indicate and communicate any dependencies of geotechnics with other disciplines in the project		
7. Include the role of the human factor	Make any differences in organizational culture of all involved project parties visible and feasible		
8. Use experiences and lessons for continuous improvement	Use all available and relevant project evaluations		
	Organize that geotechnical professionals participate in GeoRM courses and communities of practice		

Table 1 can be used as a checklist, by simply tick boxing whether the principle-driven GeoRM actions have been executed in a project or not.

In summary, the main advantage of a principle-based approach is that any type of organization, in any type of construction project, is able to design its own tailor-made risk management activities and processes. This avoids a well known "one size fits nobody" situation.

5 GEO RISK MANAGEMENT TOOLS

In addition to the GeoRM process and the GeoRM principles, a set of GeoRM tools is of great help for facilitating geotechnical risk management. Therefore, the Geo-Impuls program aims to provide a toolbox with tools for the three themes of contracts, geo-engineering and project communication. As a result of the Geo-Impuls program, the following tools examples become ready:

Theme 1: Contracts:

- Geotechnical Risk Allocation Reports, comparable to the concept of Geotechnical Baseline Report (GBR) from the United States. Recent project evaluations demonstrated that this concept is also beneficial to Dutch projects.
- Guideline for defining Risk-based Site Investigation programmes that provides explicit information and data for quantification of geotechnical risk
- Ground Risk Identification Checklists

Theme 2: Geo-Engineering

- Guideline with best practices for monitoring based design & construction by the Observational Method
- Long Term Subsoil Monitoring results for validation of existing numerical ground deformation models
- Techniques for checking the integrity of diaphragm-walls and in-situ made piled foundations. By using these techniques, weak spots can be detected and repaired before excavation

Theme 3: Project communication

- Communication strategies for managing expectations of the project stakeholders
- Intervention models for risk-based subsoil communication with in particular the public living and

working around projects in cities, by using tailormade workshops
- Intervention models for effective communication from geotechnical designers to construction crews.

Together with already available techniques, these tools are part of the GeoRM toolbox. A study of 40 recent geotechnical failures shows that 90 % of these failures was caused by the fact that right knowledge and tools are available in the Dutch geotechnical community, but not used by the right engineer in the right way and at the right time (van Tol 2007).

6 GEO RISK MANAGEMENT IMPLEMENTATION

Routinely applying GeoRM in projects requires embedding GeoRM in its organizations. This implementation of risk management in general, and of GeoRM in particular, is not a spontaneous process (Van Staveren 2009). Organizational conditions, like the organizational structure and the organizational culture should facilitate, rather than frustrate, the routine application of GeoRM.

For this reason specific working sessions have been organized with the Geo-Impuls, for clients, contractors, and engineers. During these working sessions it has been made explicit to which degree four key conditions for GeoRM were available in the participating organizations. These key conditions are (1) shared GeoRM understanding, (2) GeoRM is formally embedded in existing procedures, (3) interdisciplinary application of GeoRM within the organizations, and (4) GeoRM cooperation with external parties and stakeholders. During the sessions it became clear that for most organizations considerable steps for optimizing these GeoRM conditions can be made. Therefore, each participant defined at least one specific GeoRM embedment action to be executed in his or her organization. This exercise provided in total 44 concrete actions for embedding GeoRM in client, contractor, and engineering organizations of the Dutch construction industry.

Regarding the development of a shared GeoRM understanding, examples of actions are including GeoRM in internal project management courses and explicitly discussing the main geotechnical risk in regular project meetings.

Examples of formally embedding GeoRM is providing a clear internal procedure GeoRM procedure and applying GeoRM products in projects.

Concerning the interdisciplinary application of GeoRM, it was for instance decided to involve a geotechnical engineer in tender-kick off and subsequent meetings and to integrate risk-based geotechnical engineering during tenders with design, quality, contracts and safety. With regard to the GeoRM cooperation with external parties, demonstrating to project stakeholders how to deal explicitly with geotechnical risk and embedding geotechnical risk in contracts were some of the actions. All of these actions are straightforward, concrete and relatively easy to execute in the going concern of projects. These activities demonstrate that implementing GeoRM in organizations is merely a matter of a lot of relatively small steps towards an explicit way of risk-based geotechnical engineering, than one major change management jump.

Rijkswaterstaat, the executive agency of the Ministry of Infrastructure and the Environment and the largest Dutch public client organization for construction projects, provides a pioneering role in embedding GeoRM in its entire organization. They work parallel on developing all of the four key conditions for implementing GeoRM in their organization. Developing a shared GeoRM understanding is ongoing by regular meetings of the geotechnical experts, where they exchange experiences and lessons how to apply their geotechnical activities in a risk-based way by taking the GeoRM process steps. Furthermore, a formal GeoRM procedure that fits in their project process is in development. This GeoRM procedure is communicated to the project managers, contract managers and environment managers, in order to become accepted and used in an interdisciplinary way. Finally, Rijkswaterstaat is going to subscribe the application of GeoRM to the engineering consultancies and contractors, which involves the application of GeoRM together with external parties.

7 CONCLUSIONS

Due to the inherently uncertain nature of the subsoil, building in, on, or with ground remains risky. Nevertheless, modern risk management approaches are readily available for more explicitly and well-structured dealing with inherent ground uncertainty. Therefore, the Dutch industry wide geotechnical development programme Geo-Impuls has been started. It aims to substantially reduce geotechnical failures in all types of construction projects. Geotechnical risk management or GeoRM has been adopted as the main approach to achieve this objective by the forty organizations participating in Geo-Impuls.

The Geo-Impuls program is founded on four pillars: (1) the geo risk management process, (2) georisk management principles, (3) geo risk management tools, and (4) geo risk management implementation.

The process of geotechnical risk management is similar to the process of project risk management. Because it involves the same sequence of the similar risk management steps, GeoRM fits excellently in any sort of project risk management. By being geotechnically driven, GeoRM is simply a more detailed and in-depth approach of project risk management.

Geo-Impuls takes the principle-based route for allowing fit-for-purpose geotechnical risk management, which is worked out in eight specific GeoRM principles. These are based on generic ISO31000 risk management principles and translated into straightforward actions for geotechnical risk remediation. In addition to developing GeoRM tools, GeoImpuls dedicates considerable attention to routinely applying these tools by implementing the GeoRM processes and principles in organizations. These organizations are clients, contractors and engineering firms. This requires embedding GeoRM in the existing processes of organizations. Implementing GeoRM in (project) organizations is therefore considered the key success factor for effectively and cost-efficiently managing geotechnical risk. In final conclusion, applying GeoRM gives geotechnical risk the attention it requires, in all phases of engineering and construction projects, in order to realize project success.

8 ACKNOWLEDGEMENTS

The authors would like to thank all participants of the Geo-Impuls development program for sharing their knowledge and experience in the program, on which this paper is founded.

9 REFERENCES

Cools, P.M.C.B.M. 2011. *The Geo-Impuls Programme reducing geotechnical failure in the Netherlands*. In: *Proc. of 3rd International Symposium on Geotechnical Safety and Risk,* München, pp 191-198.

ISO 2009. *International Organization for Standardization 31000:2009 Risk management – Principles and guidelines*. ISO, Geneva.

Van Staveren, M.Th. 2009. *Risk, Innovation & Change: Design Propositions for Implementing Risk Management in Organizations*. Thesis, University of Twente, Enschede.

Van Staveren, M.Th. 2006. *Uncertainty and Ground Conditions: A Risk Management Approach*. Elsevier Publishers, Oxford.

Van Tol, A.F., 2007, *Schadegevallen bij bouwputten,* Cement 2007 (in Dutch).