Identifying and mitigating ground risk on large Water Industry Asset Management Programmes in the UK

Identification et réduction des risques liés au sol dans les ouvrages d'art du secteur de l'eau en Grande Bretagne

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ABSTRACT

Water industry clients in the United Kingdom (UK) require assistance from consulting and contracting partners in delivering large programmes of work. Many of the projects involved in these programmes require deep excavations and major structures which impose load on the ground in some way. The ground engineering elements of these projects is an area where the risks are high and where projects characteristically have unknown elements. This paper will explain how ground risk management is used on large programmes to identify high risk projects. Once identified, systems are put in place to effectively protect schedules and reduce risk through optimising design solutions. This is done by incorporating risk reviews from technical specialists at the appropriate level.

RÉSUMÉ

En Grande Bretagne, lors de la réalisation de chantiers de grande ampleur, les opérateurs du secteur de l'eau font généralement appel à des bureaux d'ingénieurs-conseils spécialisés dans le domaine des sciences du sol et de la terre. En effet, un grand nombre de ces chantiers nécessitent de profondes excavations. Ces chantiers sont caractérisés par de nombreux risques de nature souvent inconsidérée que l'on tente de limiter par une meilleure connaissance des caractéristiques de la terre et des sous-sols concernés. Cet article apporte une explication éclairante sur la manière dont les risques liés aux différents sous-sols rencontrés doivent être abordés dans les grands chantiers de construction. Une fois ces risques clairement définis, des moyens spécifiques sont à mettre en oeuvre pour d'une part limiter les éléments de risques identifiés et d'autre part concevoir les solutions optimales. Cett démarche qui nécessite une expertise hautement spécialisée doit se faire en intégrant une revue des risques à certaines profondeurs données en fonction des sous-sols rencontrés.

Keywords : ground engineering, risk management.

1 INTRODUCTION

Investment in the UK's Water Industry is planned to be undertaken every five years following price reviews. The resulting investment programme is known as an Asset Management Plan or AMP. The current AMP is the fourth, (AMP4) and covers the period 2005-2010. It involves the investment of £17 billion on various water infrastructure projects. Water industry projects include building new reservoirs, upgrading old impounding reservoirs, updating water and wastewater treatment works and associated networks. The water companies have submitted their draft business plans to the UK Water Services Regulation Authority OFWAT with proposals to spend another £19 billion over the period 2010-2015. This represents a major proportion of infrastructure investment in the UK.

The Institution of Civil Engineers (1991) identified that in civil engineering projects the largest element of technical and financial risk normally lies in ground related problems. UK government statistics (National Economic Development Office, 1983, 1988) have shown that 'unforeseen' ground conditions result in half of projects over-running by more than a month; overspend on a significant proportion of projects; and post-construction remediation, claims and litigation.

Inadequate ground investigation was found to be a major contributing factor to these problems which lead the ICE and the UK Department of Transport and the Regions to provide best practice guidance on the management of geotechnical risk (Clayton, 2001). The advent of the new Construction (Design & Management) (CDM) Regulations have also lead to a clearer realisation of the need to consider all risks associated with the geotechnical elements of civil engineering works. This covers a broad spectrum which also includes commercial risk as indicated in Figure 1 (Clayton, 2001).

Figure 1. Summary of Ground Risks (Clayton, 2001)

2 THE NEED TO CHANGE

A recent survey (Egan, 2008) however has highlighted that in spite of the new ground risk initiatives and associated guidelines for site investigation (AGS, 2006) many clients are not benefiting from appropriate ground risk management and a less conservative foundation design.

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The scale of investment in the water industry and the high proportion of structures built below ground offer the opportunity to implement such improvements. The amount spent on ground investigation is typical of that spent in other industries ranging from less than one percent of the capital cost of routine works to over three percent on high risk projects such as tunnels and embankment dams (Littlejohn et al, 1994 and Rowe, 1972).

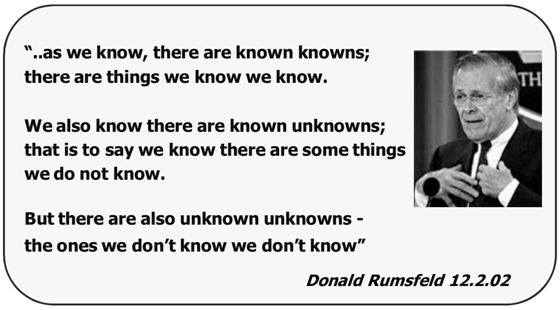
A typical spend of half a percent on the UK Water Company investment programme evenly over five years indicates that the industry utilised a significant proportion of the capacity of the UK Ground Investigation Industry. Indications from the Egan (2008) survey are that this could be better focussed in the client's interest. However in Rethinking Construction (Egan 1998, 2002) identified five key drivers of change which need to set the agenda for the construction industry at large:

- committed leadership,
- a focus on the customer,
- integrated processes and teams,
- a quality driven agenda
- commitment to people

This sets out a wider agenda to facilitate change in the industry which the authors have adopted over the last decade.

3 IMPLEMENTING CHANGE - KEEPING IT SIMPLE

In order to communicate this message and engage staff the simple connundrum posed by Donald Rumsfeld at a Department of Defense news briefing on February 12, 2002 can be used.



This translates into the ground risk context as:

- **known knowns** - areas where targeted investigations can be undertaken to allow risk to be identified and quantified.

- **known unknowns** - areas where sufficient information is available to make judgments on how to deal with unknowns using established design procedures and practices for both temporary and permanent works.

- **unknown unknowns** - areas of uncertainty where risk ownership and mitigation strategies require a broader involvement of geotechnical engineers in areas outside their traditional technical specialism.

The ICE/DETR Guidelines (Clayton, 2001) give a framework for implementing process improvements at various stages of the construction process. Egan (1998) encouraged the adoption of the 'right relationships' throughout the engineering team from project inception to commissioning as originally outlined by Latham in 1994.

4 ENCOURAGING THE RIGHT RELATIONSHIPS

A key element in implementing these improvements in large geotechnical programmes has been the advent of alliances and partnerships within the UK water industry. One of the important elements of partnering is sharing the benefits and the risks in a previously agreed and quantifiable manner. This leads to improvements in behaviors including (Ross, 2003):

- Alignment of objectives amongst partners;
- Collective responsibility for all project deliverables;
- Performance based risk/reward
- Key Performance Indicators (KPI's) to determine the gain-share/pain-share of the Alliance participants;
- A no blame culture;
- No adversarial relationships;
- "Best for Project" decisions:
- Open and honest communications.

Figure 2 illustrates the need to ensure the right balance is achieved between the behavioural and commercial elements in the alliance/partnering arrangement.

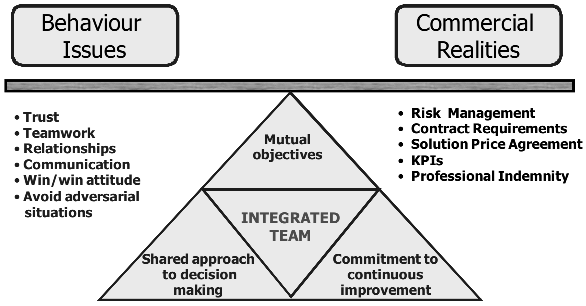


Figure 2. Typical Alliancing/Partnering balances.

It is interesting to consider how the alliance/partnering approach offers the opportunity to optimise the geotechnical input and assess the ground risks on projects. Figure 3 (based on Muir Wood, 2004) illustrates a conventional arrangement for geotechnical input to projects.

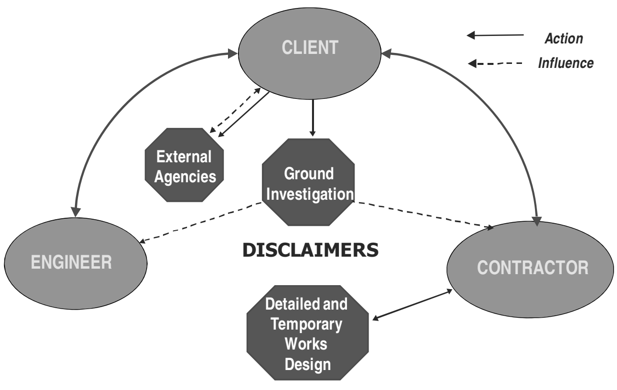


Figure 3. Traditional arrangement for geotechnical input to projects.

In this arrangement the client defines a need for the project and appoints a consultant to undertake the design work. This includes the geotechnical ground investigation which is normally procured by competitive tender. The consultant produces a Geotechnical Interpretive Report to cover design elements and considerations relating to construction. Whilst there may be some contractor input to this process it is often limited by the commercial/contractual arrangements that are in place. Whilst CDM Regulations (2007) place duties on the designer to consider both design and construction risks their application can be limited by contractual arrangements. It is becoming increasingly common that the above arrangements are being superseeded by an alliance/partnership with a variety of potentintial contractual/commercial bodies.

Figure 4 (based on Muir Wood, 2004) indicates one possible arrangement where the Client appoints Framework Contractors who are in place at the time of the design. These contractors liaise with the clients consulting engineers in identifying design and construction risks.

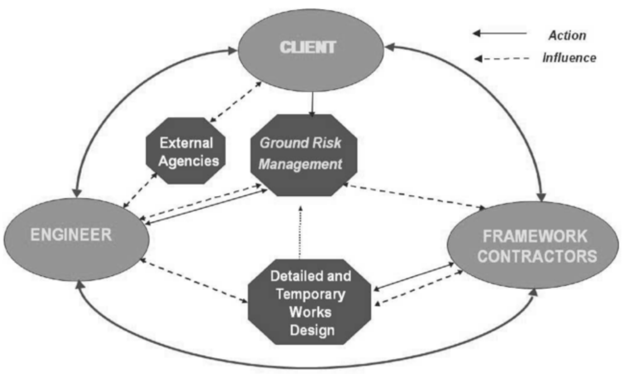


Figure 4 . Arrangement for geotechnical input to Projects in a Partnering/Alliance arrangement.

Such an approach encourages collaborative working throughout the delivery of a defined programme of work within the construction frameworks. This allows the opportunity to develop seamless and fully integrated design and construction teams. It facilitates early release of construction packages and offers the opportunity to realise significant value engineering savings through the implementation of collaborative and innovative solutions.

Incentivisation mechanisms have encouraged a collaborative working ethos which promotes knowledge management through the sharing of information, challenging asset standards and using common geotechnical software to eliminate time spent handling data. Temporary works is an area sometimes overlooked in the conventional design approach. This can also be handled in the same way with pan framework independent checking of all temporary works designs.

Alliance and partnering arrangements have also lead to the use of less adversarial forms of contract. Eddleston et al (1995) have illustrated this using the concept of "tolerance of foreseeability" of ground conditions as illustrated in Figure 5. The figure shows how the cost of a tender procured in a competitive situation may vary if the ground conditions are different than those perceived at the time of tender. There is not an absolute tender price but the price will be based on the assessment of the possible variations that could occur based on the information contained in the tender documents.

Eddleston et al (1995) call this the "tolerance of foreseeabilty". If during construction the conditions actually encountered are more favourable than those anticipated at the time of tender the contractor will make additional profit.

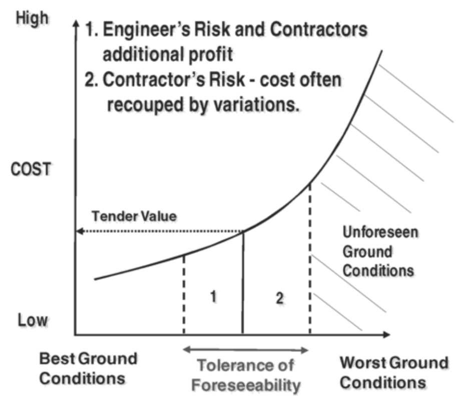


Figure 5. Tolerance of Foresseabilty in tradional contracting arrangements

If there are minor variations in the ground encountered that do not materially affect the contractors method of working the contractor may claim for a variation. It is only when the variation in the ground conditions are so different to those indicated at the time of tender that truly unforeseen conditions have been encountered.

In partnering/alliance arrangements contracts are normally based on target cost type arrangements where it is possible to undertake a "what if" exercise to establish how variations in ground conditions affect the risk and cost profile of the project. Figure 6 illustrates the possible differences that could occur between a proposal that is not particularly susceptible to changes in ground conditions to one that may have major variations in cost if the ground conditions vary.

These scenarios can be highlighted to the client prior to entering into contract such that a decision can be made on the level and consequences of accepting a higher risk tender. Any Health and Safety considerations in accepting a higher risk tender will also need to be addressed.

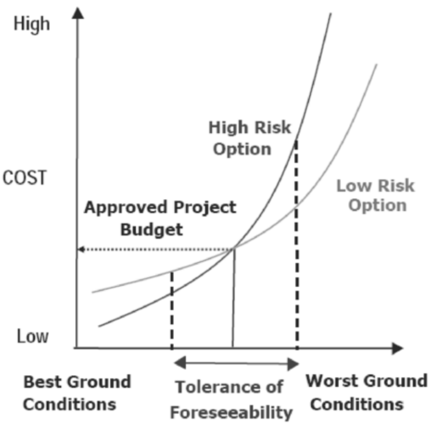


Figure 6. Tolerance of Foresseabilty as an aid to establishing the project ground risk profile.

5 CORPORATE GOVERNANCE

In undertaking high risk work MWH implements a global high risk strategy where geotechnical, dam and tunnelling projects are submitted for review by a committee consisting of senior executives who systematically review potential risks before sanctioning the go ahead to proceed with projects.

Potential risk areas considered include:

- Design Data Quality, Records & Assumptions
- Technical Complexity / Risk
- Construction Complexity
- Risk of Major Claims
- Consequence of Failure to Delivery
- Quality/Fit for Purpose
- Safety
- Buildablility
- Commercial
- Design
- Environmental
- Major cost escalation
- Programming issues
- Damage to major services
- 3rd Party Damage
- Potential Loss of Life
- Reputation
- Mitigation Measures Available

Depending on the level of risk identified a four level review procedure is implemented based on the hierarchy below:

- Internal check and review by the project team
- Internal check, review and an independent review by internal Geotechnical Specialist from another office
- Internal check, review and an independent review or specialist input by external Geotechnical Specialist (Consultant or Specialist Sub-Contractor)
- Internal check, review and an independent review by external panel of experts

6 CONCLUSIONS

In his recent review of a survey on the quality of geotechnical design in the UK, undertaken by the Federation of Piling Specialists, Egan (2008) summed up the findings by saying that, in spite of a wealth of guidance many clients are not reaping the benefits of adequate ground investigation. The aim of which, are to reduce the risk of unforeseen conditions and inappropriate over design of foundations. He concluded by citing the much quoted statement of Littlejohn et al (1994) which is worth repeating again here:

"Now and in the future, it is vital that financial decision makers appreciate that you pay for a ground investigation whether you have one or not, and you are likely to pay more if you do not, or if it is inadequately designed executed and interpreted."

This paper indicates that the improved working arrangements in the Construction Industry proposed by Latham (1994) and later by Egan (1998) encourages more collaboration throughout the whole project cycle and less adversarial forms of contract. The alliance and partnerships often seen in the UK Water Industry today are helping to improve standards of ground investigation. As a result there is more efficient investment in water companies Asset Management Plans (AMPs). This in part is due to less over-design and a reduction in projects overrunning programmes and exceeding budgets. which has lead to more certainty in their outcomes. These efficiencies can be carried forward into the next AMP period, AMP5 from 2010-2015.

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