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How Contracting Method Affects Ground Conditions Risk

Roger Olds Managing Director Coffey International Ltd

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Abstract

The author has practised as a geotechnical consultant for 30 years, and has been involved in many civil construction projects over these three decades. He has been involved in disputes regarding geotechnical matters and has acted as an expert witness in many such cases. In this paper the author outlines his views on how the type of construction contract can impact on the management of geotechnical risks. He outlines several examples where alliance contracts have provided a new way to manage geotechnical risks and allow substantial innovation to occur. These projects have been epitomised by no disputes and excellent outcomes for the owners, the constructors and the designers.

1. Introduction

Construction of large civil and building projects involves significant geotechnical risk. The management of this risk has often led to significant disputes between owners, contractors and designers. Such disputes invariably add substantial cost to the project and add to insurance costs and uncertainty about such risks in future projects.

This commercial environment can lead to conservative geotechnical design and a desire from all parties to not accept undue risk.

The advance of contracting methods has altered the risk and opportunities related to geotechnical conditions. This paper describes some of the experiences of the author in managing geotechnical outcomes on major alliance contracts in Australia over the past ten years.

2. Contract Types

2.1 Introduction

For the purposes of this paper I will talk about three different forms of contract

- Construct only

- Design and Construct
- Alliance

2.2 Construct Only Contracts

Construct only contracts require the owner to undertake sufficient design for contractors to price the works, typically in a lump sum price.

The owner therefore needs the capability to design the works to procure and manage the design of the works, including the geotechnical investigation and design.

In these types of contract the geotechnical advisers will most likely have a contract with the owner, but not with the constructor directly. Hence there is little scope for the advisers to influence construction, unless they act as an agent for the owner during construction to verify design assumptions, and direct the construction works.

Due to the number of contractual relationships and the lack of intervention between the constructor and the designers, there is usually little scope for innovation in the geotechnical works. Designers are invariably conservative either because the owner specifications require it, and/or because of the risk of being sued if a loss occurs as a result of geotechnical issues.

This type of contract has led to many claims and disputes over many years in many countries. Such disputes cause increased insurance costs and also lead to a lot of time being spent documenting, specifying and closely managing constructors, in the hope of preventing such events recurring.

2.3 Design and Construct Contracts

Design and construct contracts place the design onus on the constructor, such that the owner only provides limited design information, sufficient to allow tendering and pricing. In these contracts more of the geotechnical risk is passed to the constructor, particularly in relation to the design component, and potentially the latent condition risk.

The benefits of this approach are that the designers and constructors work closely together during design and construction, and can therefore better understand the risks during the tender phase, and manage them during the construction phase. The constructor is also responsible for gathering sufficient geotechnical information to manage the construction risks, although this does not necessarily mean there will be no claims for latent conditions.

Invariably owners still require the design to meet specifications, which may be outdated and relate to old construction methods. This can often cause the project cost to be excessive by not taking advantage of modern construction techniques and more advanced understanding and design of geotechnical issues.

2.4 Alliance Contracts

Alliance contacts started to become more popular in Australia in about 2000, and over the past decade, numerous infrastructure projects have been delivered using this approach.

The concept is to form a single high performance team between the staff of the owner, the constructor and the designers. The author has been involved in several of these contracts, where the geotechnical issues warranted the geotechnical advisors being part of the alliance.

The alliance is formed on the following key principles

- We will not sue each other
- Insurance will be used to protect/loss

- We all win together or all lose together
- We choose the best person for the job
- All decision are best for project
- No variations

The project is governed by an alliance leadership team (ALT) formed by senior managers from the alliance member companies. All decisions of the ALT must be unanimous.

Another key feature of alliances is that the best team is selected to work with the owner to develop the scope and prepare a Target Cost Estimate (TCE). The TCE is independently verified due to the absence of competitive pricing during the selection phase. Once agreed, the TCE is locked in as a fixed price (the Target Out-turn Cost or TOC) to complete the work with no variations for the defined scope. Hence the price must adequately address all risks and opportunities to deliver the project.

Invariably the owner defines key issues that are crucial to the project being successful. These may involve, cost, time, community impacts, environmental issues, safety, quality, or other important matters. Such parameters will then be measured and rewarded or penalised depending on performance.

High performance on all parameters can lead to above normal margins for the designers and constructors, but only when the owner has been provided with greater value than business as usual. Poor performance will lead to a loss of margin, but this is usually capped at zero, ensuring suppliers are paid direct costs at least.

Such contracts remove the adversarial behaviour noticeable in other contract forms. Essentially trust is high due to shared objectives, so there is no value in the role of ‘watching’ over the constructor.

It is also possible to create innovation opportunities because it is easier to explain and share the benefits with the owner.

In the author's experience this has led to substantial benefits to the owner in all the projects he has been involved with, despite major geotechnical risks being indentified when the project was first formulated.

3. Project Examples

3.1 Port of Brisbane Motorway

This involved the construction of a multi-level freeway interchange with the Gateway Motorway, and 4.5 kms of dual freeway standard carriageway with grade separated interchanges.

Most of the project was built on deep soft marine sediments in flood prone areas but there were road cuttings as well, where fill could be sourced. Key geotechnical benefits delivered included;

- Fills being minimised and kept to constant height to minimise differential settlement and removing the need for pre-consolidation works originally planned.
- Piling of the viaduct section with jointed segmental precast piles instead of large single length pre tensioned piles. Smaller piles meant smaller equipment and less site preparations, plus it was safer (and new to this authority in this type of soil)
- New pavement design methods were adopted (new to this authority)
- Unsuitable materials were left in place as removal would have created major construction difficulties, and the impact of unsuitable material was insignificant compared to settlement of the deep soft soils (normal specification would have required removal of this material).
- Unexpected post construction movement in a 20 metre high bridge abutment was remediated by all parties without blame, and the cost shared in accordance with the principles in the agreement, despite it being outside the agreed maintenance period.
- An extra bridge was added to the project from savings made, but it required lightweight fill due to the limited construction time available to complete it.

No variations were claimed and all parties contributed to the cost from their gain-share.

3.2 Wivenhoe Dam Spillway Upgrade

The Wivenhoe dam spillway necessitated upgrading from a 1 in 15,000 flood capacity to the probable maximum flood PMF. Earlier feasibility studies considered 185 options, and concluded a particular solution was the best option.

Early in the project, the alliance team established a list of criteria that was of primary value to the client. The team expanded the options based on these criteria and sought solutions that would better meet the client's objectives. Despite this work taking a year and costing more than originally planned for, the subsequent construction work was quicker, cheaper and a much better solution for the owner and other stakeholders.

The close working relationships and understanding of the client's needs, allowed the alliance to work as a single team and develops the trust of the owner to invest more time and money in developing a better solution.

3.3 Port of Brisbane Expansion

The Port of Brisbane container facilities are all built on reclaimed land at the mouth of the Brisbane River. The Port of Brisbane Corporation (PBC), obtained environmental approval to expand their facility into Moreton Bay to create 250Ha of land, and a further 25 years of future expansion capacity.

This project involved the construction of a 4.5km long sea wall, within which PBC would commence placement of dredged materials to reclaim the land.

The underlying sediments are very soft and get deeper with distance from the current facilities. The concept design proposed very flat batters, and because the seawall was largely proposed as rock fill, the volume was large, particularly after accounting for settlement.

The client was extremely sensitive to any risk of embankment failure that could damage the sea grass in the adjoining marine park.

The key features that altered the design and added substantial value to the client were as follows:

- Adopting a factor of safety of 1.2 on undrained failure of the batter slopes, in knowledge that the strength gain that would occur during consolidation

- Pumping dredged sand to form the core of the embankments, upon which rock could then be placed by truck.

- Opening an old quarry near a rail line and transporting rock in purpose made shipping containers that could be offloaded at the client's rail terminal, and then taken by truck to the dumping face on the wall. This avoided transporting rock by truck through Brisbane streets and residential areas. It also avoided placing the rock by barge which was more expensive.

- Monitoring settlement and lateral movement to ensure embankment failure did not occur. The worst area was unloaded by 1m after this monitoring alerted excessive movements. It was reloaded after allowing consolidation to occur.

3.4 Inner Northern Busway

This project involved building a dedicated busway tunnel and station under the Brisbane CBD. It included partial demolition and retrofitting of the bottom two levels of an underground car park

It also included realignment of a rail line and conversion of the rail station to a bus station.

The challenges on this project were numerous. Unlike the seawall, where one good idea could be applied over the whole 4.5km length, on this project things changed very quickly over short distances, so innovations did not create large savings.

There were major issues related to working in the CBD and managing traffic and materials supply. A lot of work went into the alignment selection and construction methods to minimise risk to adjacent structures, some of which are old and heritage listed.

Due to the amount of piling works required on the project, and the criticality of these works to the project outcome, the Alliance negotiated a sub- alliance agreement with the piling sub-contractor to share risk and reward.

A major benefit was obtained by designing and subcontracting the mechanical ventilation systems rather than employing a specialist design and construct sub contractor.

Multiple scope expansions occurred during the work including adding a pedestrian bridge for another stakeholder, and including the rail station upgrade into the project, including all the issues of access to rail operations.

3.5 Seacliff Bridge

The Seacliff bridge project came to market suddenly after a rock fall from the coastal cliffs above Lawrence Hargrave Drive, hit a car and led to a Ministerial declaration to close this coastal road for safety reasons.

The Road Traffic Authority of NSW needed to act quickly to find a solution, and took the opportunity to form their first alliance.

Very quickly the team developed the key criteria that mattered to the client, including; time, cost, road safety, construction safety, community impact and others. The team then agreed weightings for each parameter and proceeded to assess 75 options using a multi-criteria analysis.

Quickly the preferred option to build a bridge across the ocean, outside the rockfall zone, emerged as the best option.

This led to bridge design and construction being the key challenges, but significant geotechnical issues related to

- Establishing the likely pathway for rockfalls and debris flows off the cliffs
- Stabilising selected sections of the cliffs
- Managing site safety related to possible rockfalls during construction
- Piling over coal seams and coal workings, and or coastal rock platforms

The end result was a spectacular structure which has now become a tourist attraction and prime piece of infrastructure for filming of car advertisements for television

3.6 Windsor Road Duplication

The second alliance we undertook in NSW was for a suburban arterial road duplication. This was delivered with an alternative form of alliance which involved pricing in addition to creating the best team.

There were many risks in this project that could not be assessed at tendering time, many of which involved underground services and subgrade conditions under the existing road

The alliance contract however included normal alliance conditions where we agreed to not pursue variations.

As we started building the project under the traffic, we discovered major errors in the locations and nature of services, and due to the tight corridor, the relocation of these was a massive task. We also discovered major areas of wet, unsuitable subgrade that had to be replaced.

In a normal design and construct contract these issues would have been readily accepted as variations, which could have resulted in cost increases in the order of 20% of the contract value.

Within the alliance we dealt with these issues without dispute or aggravations. We worked together to use all our resources to solve the problems as quickly and effectively as we could.

Once the services were dealt with we completed the project rapidly due to alternative pavement designs and construction proposals which may not have been accepted under a design and construct contract.

The net result was the client recognised scope changes to the value of about 5% of the project value, and we actually ended up slightly under the TOC. We had outstanding scores on all KPI's including early completion. The client knew they obtained excellent value for money and commercially the constructors and designers obtained good outcomes.

However I would not pursue such a contract again due to the unforseen risks that were built into the price without a proper method to assess and price them during tender. It should also be noted that the client has not used this practice again.

3.7 Other Contracts

There are several more alliances Coffey has worked on where geotechnical risks have been actively and innovatively managed in a manner that would have been constantly challenging under any other form than alliance contracts.

On Ballina By Pass we had been working for the RTA for several years on the design of embankments over very soft clay. Due to our knowledge of the issues, RTA actually put us into the owner's team, and we participated in selecting the preferred constructors and designers for the project. We then became a normal alliance partner.

4.0 CONCLUSION

Alliancing is an exceptionally innovative form of delivery, particularly well suited to complex projects which need to be delivered quickly, and where matters cannot be easily specified at tender stage. This is particularly beneficial on projects where ground conditions and their impact on the project are uncertain.

If there is an acceptance that attempts to shed the risk of uncertain ground conditions invariably lead to unacceptable outcomes for all parties, then a new mindset of sharing risk and using the knowledge of all participants to fairly evaluate and price this risk and to also consider opportunities as well, provides a paradigm shift that can create value for all concerned.

The process of bringing together the combined knowledge of all participants in a collaborative arrangement to work to an aligned objective, is surprisingly powerful for those who have been subjected only to adversarial contracts.

The critical element is to ensure the principles of alliancing are adhered to by all parties. This creates a total focus on solving problems innovatively, and providing major value to the owner.

Staff working on such projects enjoy the lack of adversarial behaviour and wastage that other contract forms can create.

Alliances not only manage geotechnical risk well, they provide clear opportunities to turn these risks into opportunities to the benefit of all participants.