Effective Allocation of Excavation Risk in Hydropower Projects

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ABSTRACT:

Unforeseen ground conditions can have significant effects on construction project outcomes. For hydropower projects this is particularly true. Hydropower projects commonly include excavations for hydraulic structures, water conveyance, equipment housing and foundations, all of which are subject to risk. A construction contract that effectively allocates excavation risk can make the difference between success and failure. Preparing a construction contract that provides the Employer with sufficient cost and schedule certainty to satisfy funding and insurance requirements while simultaneously limiting the Contractor's risk to a commercially acceptable level is a major challenge.

Drawing on experience from major international hydropower projects and involvement in the International Tunnelling Association (ITA) Working Group 3 on Contractual Practices, the authors will cover the major contractual areas that must be considered for projects where significant excavation is required. The paper will describe mechanisms commonly used in tunnelling projects for allocating risk and determining cost and schedule variances based on the actual ground conditions. It will discuss the feasibility of using similar mechanisms for other aspects of hydropower projects, such as foundations and surface excavations.
This paper will also address thee current trend of using turnkey forms of contract, such as the FIDIC Silver Book [2], with particular emphasis on the risks and limitations of this form of contract.

1. INTRODUCTION:

From a purely commercial perspective hydropower, which is a well-established technology for generating energy from a renewable resource, should be the preferred generation option where conditions allow. However, this is not always the case. The capital cost, project duration and risks associated with the construction of hydropower schemes often results in other technologies being preferred.

The excavations work constitutes a major part of the construction cost and time required for a hydropower project, and is definitely the project component with the most uncertainty and thus the highest risk. Defining, allocating and managing the risks associated with excavation is critical to an accurate assessment of the project’s commercial viability and to achieving its objectives.

The objective of the Project Developer (Employer) should always be to minimize the total project risk. While transferring risk to other parties is an option, it will not necessarily achieve this objective. Consequential risks must also be considered. Finance costs are a significant proportion of the total cost and lost revenue due to late completion of a project can have a serious impact on profitability. If a Contractor is unable to manage their risks effectively or fulfill their obligations, the Employer will suffer and seldom if ever recoup the consequential costs. Poor risk allocation can turn a seemingly low risk project into a nightmare.

This paper describes the types of risk that should be considered where excavation works form a large proportion of the total construction work. It will argue that a strategy of the Employer

fairly allocating and managing these risks is preferable to the current trend of attempting to transfer risk to other parties.

Much of the material presented here is based on the *ITA Contractual Framework Checklist for Subsurface Construction Contracts* (ITA WG3 2011, see also Hodgkinson 2014). This document was written by Working Group 3 of the International Tunnelling Association (ITA) on Contractual Practices, of which both authors are members. Intended for projects involving significant subsurface works, the ITA Framework Checklist explains the major contractual areas that should be considered in order to help assure successful project delivery. The Checklist's goal is not to specify how each area should be detailed, but rather to highlight the importance and tradeoffs involved in the approach taken. The Checklist is compatible with, and provides guidance for reviewing, standard contracts such as FIDIC and NEC.

2. TYPICAL RISKS IN EXCAVATION WORKS:

Some of the risks inherent to excavation works (dam foundations, tunnels and caverns) are similar to those associated with other types of construction, but many are particular to this type of work. All stakeholders should be familiar with these particular risks, which include:

Physical Risks: Excavation costs and time are strongly influenced by the ground conditions. Even with extensive site investigations, it is impossible to completely eliminate all physical risks. In spite of the Employer's wishes and the Contactor's performance, the actual ground conditions will set the real limits on the project's cost and end-date. Unlike other types of projects, the Designer must also provide continuous input throughout the construction phase, adapting the design as the actual ground conditions are revealed.

Specialised and often bespoke construction equipment with long procurement lead times, high up-front costs and requiring specialist operating personnel, is often used. The incorrect assessment of ground conditions can lead to the wrong choice of equipment or delays by the manufacturer, which will impact the construction cost and schedule.

Contract Risks: The inherent uncertainty of underground works needs to be considered in developing the contractual framework for the project and experienced professionals should draft and review the contractual documents.

Compliance Risks: Adherence to local laws and standards is mandatory on all projects, and Employers and Designers should be aware that in many jurisdictions underground construction is governed by local mining or other specific regulations that may stipulate unusual or unfamiliar requirements, including severe penalties for non-compliance.

HSE Risks: The health, safety and environmental risks associated with excavation works are often quite different to those common to other types of construction work. If not understood they may have a major impact on project cost and schedule. For health and safety compliance costly PPE typically used in mining projects may be required. On the environmental side the disposal of excavated material may require permits.

Schedule Risks: Projects which have underground works components usually have limited access to the working areas, which restricts the options available should unforeseen conditions or events arise. The working areas are also typically so small that crashing or fast tracking a schedule is impossible. Many hydropower projects are planned around seasonal river flows and small delays can quickly escalate causing significant effects on revenues; a situation that some Contractors may exploit.

Interplay of Risks: On all constructions projects when a risk materializes other knock-on effects may occur, and this issue should be accounted for when preparing risk responses. On projects with significant excavation work this factor becomes even more important. The nature of the work and the specialist equipment required for it mean that risk consequences are often severe and alternatives are limited. Therefore it is important for all parties to engage personnel experienced in this type of work who are familiar with the risks and their interconnection.

3. IDENTFYING PHYSICAL RISKS:

A thorough geotechnical investigation is the best way to identify and quantify the potential physical risks associated with excavation works. These investigations will include different elements, such as geophysical surveys, geological mapping, core drilling, Lugeon and laboratory testing. The results of the investigations are not only a fundamental input into the design but also a critical input into all contracts for excavation works.

Many Employers baulk at the cost of these investigations, particularly as they are required in the early stages of project development. However, when seen as part of a risk management process and not just as design input, the cost is much easier to justify. It is not the objective of this paper to describe what constitutes an effective site investigation (see SISG 2010), but to emphasize the importance of such investigations in providing both the design parameters and a basis for allocating excavation risk.

The output of the geotechnical investigation is a site data report, typically called a Geotechnical Data Report (GDR). The GDR contains a summary of all of the data collected during the investigations. A GDR does not provide an interpretation of the data or a definition of the anticipated ground conditions. In the past it was considered sufficient and prudent to only include the GDR in contract documents, putting the onus on the Contractor to make his own interpretation. This can increase the overall project risk because: a) the data could reasonably be interpreted in more than one way and be misleading; b) the data may not be representative of the expected conditions; c) insufficient data may result in the Contractor choosing unsuitable or inefficient construction methods. Further, some GBR data may not even be relevant, but be used in disputes to demonstrate unexpected conditions, in support of spurious claims where the condition actually had no impact.

It is better for skilled and experienced engineers with local knowledge to decide which governing parameters need to be defined and to provide a clear baseline for these parameters based on their interpretation of the data. This is typically documented in a Geotechnical Baseline Report (GBR) (see Parnass 2010 and UTRC 2007). A GBR defines the conditions the Contractor is to price for and allows him to assess any residual risk and price for it. With more accurate pricing and planning based on a GBR the Employer can expect more competitive pricing, better risk identification and lower overall project risk.

The GBR does not provide a mechanism to deal with the consequences of actual ground conditions differing from those given as the baseline. A Differing Site Conditions (DSC) clause is usually included in the contract to facilitate price and schedule adjustment as a process within the construction management.

4. RISK ALLOCATION MECHANISMS:

Project risks must be clearly allocated. The challenge in hydropower projects is to balance the Employer’s desire for price and schedule certainty against uncertain ground conditions. An Employer must accept that ground conditions are likely to be different than expected, and

define scheduling and payment mechanisms that take into account the variations in conditions that will inevitably occur. The ITA Checklist warns against Employers compelling Contractors to take on disproportionate ground risk:

> *Appropriately compensating Contractors for work necessarily and reasonably done as a result of circumstances beyond their control is generally regarded by the ITA as highly desirable. In many countries, despite technically falling out side the contract conditions, courts will award compensation for works necessarily completed for the benefit of the contract.* (ITA WG3 2011)

The passage above states that in spite of contractual risk allocation, Employers may ultimately be held liable for ground risk. Thus, Employers are better off if they explicitly accept the ground risk and define payment mechanisms that account for variations in ground conditions. The payment mechanisms should be well defined and based on clearly stated criteria. Ideally, they should be based on a methodology that separates the ground conditions from the Contractor's performance and provide rewards for superior performance.

A recommended method is to define payment mechanisms based on unit costs. The unit costs should be based on objective criteria (e.g. rock classification and inspection regimes) for assessment of actual ground conditions. Suitable systems include having the Contractor bid on price and performance for specific ground conditions and then making payments via 'automatic' variations based on the actual conditions encountered. Such mechanisms typically are based on expected unit costs and quantities for specific combinations of pre-defined excavation and support classes. During the work, the Employer and Contractor agree, via joint inspections, which classes were present, the result of which is used to calculate payments. [This is common practice in Switzerland and Austria. Details are explained in (ASG 2011), (SIA 2007) and (SIA 2004)]. Use of such mechanisms assures the Employer that the Contractor has incentives to perform, and the Contractor is assured that they will be paid fairly.

The use of such flexible payment mechanisms means that end dates for excavation and underground works cannot accurately be predicted. This is simply recognition of reality. Perfect scheduling requires perfect knowledge of ground conditions, which only become apparent during excavation. This dilemma underlines the importance of the geological studies and GBRs described in the previous section, and exposes the futility of imposing a fixed end date on the contractor. The better solution is to define contracts and risk allocation schemes that provide incentives to *all* parties to do the best job possible.

5. TURNKKEY CONTRACTS AND UNDUE ALLOCATION OF RISK:

A strategy that may appear to be most beneficial to Employers is simply to transfer risk to the construction Contractor by using Turnkey forms of contract such as the FIDIC Silver Book (FIDIX 199). This purports to provide a certainty of price and construction duration, with the cost and schedule risks borne by the Contractor. In theory, the requirements of financiers are thereby fulfilled. In reality, Employers with projects having significant excavation work are unlikely to benefit from the strategy of allocating all risk to the Contractor.

The FIDIC Silver Book contains a warning to this effect. It lists conditions for which these contract conditions are *not* suitable. The key condition associated with many hydropower projects is:

> "*...if construction will involve substantial work underground or work in other areas which tenderers cannot inspect*"

There are two main disadvantages:

1. Inflated cost. Without accurate knowledge of ground conditions, tenderers will increase their price to cover risks that may not materialize

2. Imbalanced risk. A fair allocation of risk is when risks are allocated to the party best able to manage them and bear the consequences. This results in better responses when risks do materialise and promotes better behaviour by all parties. Imbalanced risk allocation does the opposite.

The ITA Checklist states:

> " *..unfair allocation of risk in contracts will inevitably complicate the delivery of a subsurface construction project because an unfair bargain inevitably leads to conflict and disputes, as one or more of the parties struggle to survive unfair contractual burdens. In most subsurface construction projects disputes usually involve some aspect of unknown ground conditions or logistics. This is why focusing upon contractual aspects of ground conditions and logistics warrants such attention".*

If an Employer obliges a Contractor to take on excessive risk (which the Contractor may accept due to lack of work or other factors), then the Employer must accept an additional risk - that the Contractor may nevertheless be unable to respond if risks actually materialise. In this case, unwelcome outcomes are likely, which can range from excessive disputes and schedule delays, up to the contractor going bankrupt or walking away from the job.

Contractors are usually aware of the cost of finance, the impact of lost revenue due to late commencement of operations and the potential for reputational damage to the Employer should there be significant delays. No Contractor will accept, and few will have the financial resources to bear, the consequential costs associated with delayed completion and commencement of operations. These consequential risks can far exceed those carried by the Contractor. In spite of contractually transferring all cost and schedule risks to the Contractor, the Employer still faces the consequential risks. This puts the Contractor in a strong position to negotiate new terms with the Employer having little option but to agree.

Unfair allocation of risk may also result in poor quality construction, particularly in turnkey contracts where supervision by the Employer is usually limited. Quality can suffer when the Contractor is exposed to significant risk and required to deliver to a performance specification, because there will be no incentive to design or build for operating efficiency, robustness or longevity. The Employer must accept that in a competitive bidding environment where the Contractor carries significant risk, the Contractor's incentive is to provide only the bare minimum necessary to satisfy the performance specification.

For hydropower projects the desired asset life is typically over fifty years with provision made for reasonable maintenance and refurbishment requirements. Poor quality construction will result in far higher maintenance and refurbishment costs as well as a higher probability of unplanned downtime, which adversely affects profitability.

Fair allocation of risk is important because the parties that can best mitigate the risks may not be able to bear them. In other works, the money and resources required to address some risks may be beyond the party's capabilities. The fair and clear contractual allocation of risk, commensurate with each party's commercial participation in the project is therefore critical.

6. BENEFITS OF FAIRLY ALLOCATING RISK:

The allocation of risk takes place through the contract. Fair allocation of risk requires formulating contract provisions that clearly state what is expected of all parties, including the starting conditions (e.g. GBRs), work acceptance and payment mechanisms, and dispute resolution procedures. The following benefits can be expected when risks are fairly allocated:

Alignment of Interests: Fair allocation of risk helps align the Employer's and Contractor's interests. In the best case, the risk allocation should lead to a situation where all parties are incentivised to act in the best interests of the project. This is partially achieved by separating flexible performance and payment mechanisms that reward good performance over which the Contractor has control, from ground risk, which should be borne by the Employer.

Dispute Reduction: Disputes can cause serious delays in hydropower projects. Limited access to tunnel faces, and the fact that many activities are on the project's critical path, can rapidly cause the cost of delays caused by a dispute to exceed the amount at stake. It is therefore critical that disputes are recognized and dealt with in a timely manner, making use of clearly defined and efficient procedures. Ideally, the contract should define mechanisms that allow a technical solution to be implemented independently of the commercial resolution, allowing work to proceed as soon as possible. The contract should also define a series of escalating mechanisms for resolving disputes, with litigation as the last resort.

Minor disputes must not delay work and procedures that accept work and authorize partial payments, in spite of minor defects, are strongly encouraged. These procedures should also include mechanisms for ensuring that the defects are ultimately resolved.

As stated above, many disputes can be avoided or amicably settled by clearly defining what is expected of all parties in the contract and fairly allocating the risk so that all parties can bear the consequences of risks that they are responsible for in the event that they actually materialise.

Quality: Employers can expect better quality work when the Contractor doesn't carry the ground risk. By defining payment mechanisms and inspection regimes that ensure the Contractor is fairly paid, but still accountable for the quality of their work, and with the Employer taking into account the ground conditions, the Contractor will not be encouraged to cut corners to make up for the additional costs should risks materialise.

Risk Premium: When a Contractor accepts a turnkey or fixed price contract, they are charging a premium for accepting risk. An Employer can usually get a better price by accepting risks themselves or sharing them with the Contractor.

Employer's Schedule: Contractual incentives that encourage timely completion by the Contractor, together with provisions for payment and completion date adjustment according to the actual conditions encountered, help protect the Employer from delays that could result in additional finance costs and lost revenue. If the Contractor's behavior is aligned with the Employer's objectives there is a far better prospect of a successful outcome for all parties.

7. CONCLUSION:

The risks associated with excavation works make up a significant proportion of the total project risk on many hydropower projects. Correctly identifying these risks and their interrelationship is very important to managing the overall project risk. It is critical that the allocation of the risks is done in such a way that all parties' interests are aligned with the project objectives. The best strategy for doing so is for the Employer to carry the ground risk.

There are standard contract forms that include effective mechanisms for adjusting payments and the contract completion date in support of this objective.

The ITA and its Working Groups have produced publications on a broad range of topics related to underground excavation, which can be accessed through the ITA website (http://www.ita-aites.org). While not produced specifically for hydropower projects, many of these publications are useful reference documents for hydropower projects that require extensive surface and sub-surface excavation. The Contractual Framework Checklist is a useful reference when formulating contract documents for projects with substantial earthworks.

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